International Council for the Exploration of the Sea

CM 1994/H:22
Pelagic Fish Committee

1993 ICES COORDINATED ACOUSTIC SURVEY OF ICES DIVISIONS IVa, IVb AND VIa

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SUMMARY

This paper provides a report on the combined acoustic survey of herring stocks in the North Sea and ICES division IVaN in June-July 1993. The surveys were carried out by Norway, Scotland, Denmark and Netherlands and covered the period 29 June to 30 July. The results and distributions of herring by age are given for area by 30 Nmile statistical rectangles. 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 abundance is included in the report.

METHODS

Five surveys were carried out during late June and July covering most of the continental shelf north of 54°N in the North Sea and 55°N to the west of Scotland to a northern limit of 62°N. The eastern edge of the survey area is 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 five surveys.

INDIVIDUAL SURVEY REPORTS

Survey by RV *Johan Hjort* 1-16 July 1993

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, Foote *et al.*, 1991). The echo sounder system was last calibrated on 14 February 1993, and then showed no change from the previous calibration of 5 December 1992.

Pelagic trawling was carried out mainly with a large "Åkra" pelagic trawl with approximately 28 x 28 m opening, usually with floats on the warps to fish close to the surface. A "Fotö" herring trawl with approximately 20 m vertical opening and 35 m horizontal opening was also used for some hauls. A "Campelen" shrimp trawl was used for bottom trawling. Figure 1 shows the survey track and trawl stations. The distance between transects was 15-18 nautical miles.

Integrator values were allocated to "herring", to some other categories of fish, and to "plankton/0-group" based on the density and shape of the fish schools, the trawl catches, and the target strength distributions.

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 60´ 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 expression for herring was used:

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

Herring estimates were split between North Sea autumn spawners and Division IIIa/ Baltic spring spawners on the basis of vertebral count distributions using the formula (56.5-v)/0.7 as described by Anon. (1993).

Survey results

Figure 2 shows the herring estimate by ICES statistical rectangles. Table 1 gives numbers and biomass by age groups for North Sea herring and for Division IIIa/Baltic spring spawners, respectively, in each of the areas shown by thick lines in Figure 2.

Total estimates for herring in the surveyed area are:

	North Sea autumn spawners, mature	North Sea autumn spawners, immature	IIIa/Baltic spring spawners
Number N x 10^{-6}	1629.11	6690.40	1190.69
Biomass (tonnes x 10^{-3})	322.01	569.93	148.78

In the northwestern part of the investigated area some larger and older herring were found, which may have been Norwegian spring spawners. The quantity of those was negligible, however, and no attempt was made to separate them from North Sea autumn spawners by calculation.

The herring was seen on the echo sounder as small dense schools in the upper 40 m both during day and night. The results of the trawling indicated that there was also some herring in the plankton/0-group scattering layer in-between the schools. However, only in a few instances could this be seen from the echograms, and there may have been some underestimation of the herring for this reason. Only on one occasion was a herring school seen on the sea-bed.

The occurrence of herring infected with the fungus Ichthyophonus is shown in Figure 3. Although the occurrence was high in some samples, those were samples with few fish and in areas with low concentrations of herring. In areas with high densities of herring the infection rate was very low.

Survey Report RV *Tridens* 29 June - 16 July 1993

The survey area covered the western North Sea between 54° and 59°N and west of 2°E. Cruise track and position of trawl stations are shown in Figure 4. Shortage of time prevented sampling of the rectangles south of 55°N. However, judging from the herring density in the adjacent squares and also from historical data, it is assumed that the abundance of adult herring in these rectangles was low.

Survey methods

Fish densities were measured by a Simrad EK-500 system, using a 38 kHz hull mounted transducer. This year, no permission was obtained to calibrate the equipment in a nearby area along the Norwegian coast. However, during a period of very calm weather, the equipment was calibrated in the open sea just prior to the start of the survey. The results of the calibration are presented in Table 2.

Identification of fish traces was based on: a) the shape of fish schools on the echogram; 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. Results of the trawl sets are given in Table 3, and length composition of the herring is shown in Table 4.

The area north of 57°N was covered by a grid of north/south transects spaced at 15 mile intervals. This survey design was aimed at synchronisation with the Norwegian and Scottish vessels working in adjacent areas. South of 57°N, the usual pattern of east/west transects was adopted. Ship's speed during periods of calm weather was 12 knots; at wind speeds above 6 BF the speed was reduced to approximately 10 knots. The survey was stopped during the hours of darkness, that was from 2100-0300 UTC, as it was observed that a major part of the herring population would rise to the surface and disappear from the echo sounder (see below).

Observations

In the northern part of the survey area, most herring were found between 58° and 59°N. These were mainly older herring, with a length of about 30 cm. The herring occurred in schools of varying dimensions, and identification of traces by means of trawling was relatively easy. Overall abundance of herring in this area was less than in 1992.

In the vicinity of trawl station 9, a concentration of large herring was observed from 1600-2300 UTC in order to study the vertical migration at the onset of darkness. It was seen that the schools remained near the bottom until 2100 UTC, and then disintegrated. About two thirds of the herring subsequently rose to the surface, and disappeared from the echogram.

In the southern half of the survey area, a major concentration of herring was found at 56°40'N. Several purse seiners were exploiting the schools in this area. The herring, mostly three year-olds, had probably moved into the area fairly recently. Earlier, the Dutch fleet had reported a scarcity of herring in the central North Sea in June.

As in last year's survey, some very dense concentrations of 0-group herring were observed in the open North Sea. The first patch was found at 56°25′N, 1°40′E. The herring, of about 10 cm length, occurred in very dense bottom schools that were similar in appearance to schools of adult herring. A trawl set for identification purposes yielded 1,200 kg of these small herring. A similar patch of juvenile herring was found 15 miles south. These herring were observed from late evening, throughout the night, until the following morning. At 2100 UTC the dense bottom schools dissolved, and all herring rose to a depth of 30 m (just above the thermocline) to form a very dense scattering layer that extended over several square miles.

Data analysis

The procedure for data analysis was slightly changed from last year. Eight sub-areas were identified in which length composition and length/weight were assumed to be fairly uniform (Fig. 5). Within each sub-area, the length distributions of all trawl samples were combined (in some cases after giving certain samples extra weight). The same was done with samples for age/length, weight and maturity.

For each sampling area, the overall mean length of the herring was calculated, and the corresponding TS and sigma values were obtained from the usual formulas:

$$TS = 20\mathrm{Log}10(L)-71.2 \text{ and } \sigma = 4\mathrm{pi}^{*}\ 10 \exp (TS/10)$$

SA-values attributed to herring were averaged by statistical rectangles (1° longitude by 0.5° latitude). For each rectangle, the total number of herring was found by dividing the mean SA value by the mean sigma for the corresponding sampling area, and then multiplying with the surface area of the rectangle (Fig. 6). The length distribution (in absolute numbers) for each sampling area was found by applying the average % length distribution for that area to the total number of herring. These length distributions were converted into age distributions by applying the ALKs for the corresponding areas. The summarised results for the entire survey area are presented in Table 5.

Ichthyophonus

The level of Ichthyophonus infection appeared to be low. Out of a total 1,475 fish investigated, only six specimens appeared to be infected.

Survey Report for FRV *Scotia* 10-30 July 1993

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 Lab Analysis systems. The survey track (Fig. 7) was selected to cover the area at 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 in most parts of the area. On the administrative boundaries of 2°E and 4°W 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. Transects at the coast and shelf break were continued to the limits of the stock and the transect ends omitted from the analysis. The origin of the survey grid was selected randomly with a 15 Nm interval the track was then laid out with systematic spacing from the random origin.

Trawl hauls (Fig. 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 24 cm, and 10 per 0.5 cm class for 24 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 knots). Echo integrator data were collected from 9 m below the surface (transducer at 5 m depth) to 1 m above the seabed. The data were divided into five categories, by visual inspection of the echo-sounder paper record and the integrator cumulative output; "herring traces", "probably herring traces" and "probably not herring traces" all below 50 m, shallow herring schools and shallow schools probably not herring both from above 50 m. For the 1993 survey 68% of the stock by weight was attributable to the "herring traces" and 17% to the "probably herring traces" and 16% to the shallow herring schools. The third category which gave 21% of total fish was attributable to whiting, norway pout, mackerel, haddock and horse mackerel in that order of importance. Most of these species were either easily recognizable from the echo-sounder record or did not appear to occupy the same area as the herring. The final category of surface schools not allocated to herring constituted 4% of the total fish biomass. Generally herring were found in waters where the seabed was deeper than 100 m. Similar small schools were found close to the seabed over "hard ground" in shallower water of 70 to 90 m depth. Fishing on these traces consistently gave considerable numbers of Norway pout through the meshes of the trawl. One exception to this was a trawl of stage 5 and 6 herring in 90 m of water north of Orkney.

Two calibrations were carried out during the survey. Agreement between these was better than 0.10 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:

$$W = 1.08\ 10^{-3}\ L^{3.62} \text{ g L measured in cm}$$

Survey results

A total of 45 trawl hauls were carried out, the results of these are shown in Table 6. Thirty-two hauls with significant numbers of herring were used to define three survey sub areas (Fig. 7). The mean length keys, mean lengths, weights and target strengths for each haul and for each sub area are shown in Table 7. 3,206 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 4,015 million herring or 865,000 tonnes was calculated for the survey area. 766,000 tonnes of these were mature. Herring were found mostly in water with the seabed 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 4°W. Herring were generally found in similar water depths to 1992 however, the distributions were characterised by larger numbers of small schools and an absence of large schools in the north of the area. Table 8 shows the numbers, mean lengths, weights and biomass of herring by sub area by age class.

The stock found in the Orkney-Shetland area has a spread of age classes with substantial numbers of six and seven ring fish, a shortage of four ring fish and a similar two ring age class to the one observed in 1992. This confirms the prevalence of older fish seen in previous years with lower recruitment for the current four ring fish. There was no problem with the fishing this year and trace identification was much easier than in 1992, however, the main problems were with small schools found near the bottom with the seabed between 100 and 120 m deep. A depth related division in the catch indicated that with minor exceptions the deeper schools contained only large herring.

In addition to the 866,000 tonnes of herring, approximately 289,000 tonnes of other fish were observed in mid water. Examination of the catch by species (Table 6) 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 two ring and three ring herring were estimated at 73% and 74% respectively. This is a smaller proportion for mature fish than those found in 1992.

Survey Report for MFV *Azalea* 14-29 July 1993

Methods

The acoustic survey on the charter vessel MFV *Azalea* (14-29 July 1993) 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. 9) was selected to cover the area in two levels of sampling intensity based on herring densities found in 1991/92. 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. Where appropriate the between-track data could then be included in the data analysis. Between track data were abandoned at the westward end of all transects, and on the eastward ends between 56°45′ and 58°00′N, along the coast of the Outer Hebrides.

Thirty-six trawl hauls (Table 9) 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. 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 m below the surface (transducer at 5 m depth) to 1 m above the seabed. The data were divided into five categories, by visual inspection of the echo-sounder paper record and the integrator cumulative output; "herring traces", "probably herring traces", "surface schools", "other pelagic fish" and "gadoids and others". For the 1993 survey 75% of the stock by number was attributable to the "herring traces" and 25% to the "probably herring traces". The third category which was scored was for identifiable surface, or near surface schools, trawl hauls identified these as sprat. The fourth category was for other identifiable pelagic schools, usually mackerel or horse mackerel. Other traces attributable to norway pout, whiting, and haddock were allocated to a fifth category. Most of these categories were either recognizable 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 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 and east of 5°W). Trawl samples showed these to be made up substantially of norway pout (<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. In addition, pout marks were generally considered as being closely in contact with the seabed, while herring schools were more pelagic. Unlike 1992, pout were found throughout the area and sometimes in deeper waters (eg hauls 11, 14 and 29). One trawl sample (haul 5) was dominated by sprat in readily identifiable near surface schools. Four other hauls (9, 18, 22 and 27) contained significant quantities of mackerel, Where these occurred with herring, readily identifiable marks could be seen on the echogram. These hauls allowed separation of schools of both species from herring schools.

Two calibrations were carried out during the survey. 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) for clupeoids:

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

The weight of herring 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:

$$W = 0.7257\ 10^{-2}\ L^{3.06} \text{ g L measured in cm}$$

Survey results

A total of 36 trawl hauls were carried out, the results of these are shown in Table 9. Twenty-one hauls contained more than 70 herring and these hauls were used to define three survey sub areas (Fig. 10). The mean length keys, mean lengths, weights and target strengths for each haul and for each sub area are shown in Table 10. 2,203 otoliths were taken to establish the three age length keys. The numbers and weights of fish by quarter statistical rectangle are shown in Figure 11. A total estimate of 4,187 million herring or 893,600 tonnes was calculated for the survey area. 866,510 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 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 11 shows the numbers and weights of herring by sub area by age class.

The stock found in the overall area is dominated by 2/3 and six ring fish. This compares well with 1992 where the stock was dominated by two and five ring fish. The three sub-areas identified were geographically similar to 1992 allowing comparison of the age structures by sub-area. The different sub-areas showed varying age structures. Sub-area III (Shelf break), representing 44% of the total stock, was dominated by six ring fish (31.5%). In 1992 the dominant age classes were four and five ring fish. Sub-area II (south-west Hebrides), (46% of the total stock) contained similar numbers in all age classes between three and six, with the largest year classes being three and four ring fish (44.9%). In 1992 a similar structure was identified with similar numbers in all age classes between two and five. Sub-area I (north-east Hebrides), representing 10% of the total stock, was dominated by two and three ring fish (71.7% and 13.6% respectively), in 1992 this sub-area was dominated by one and two ring fish. Fishing appeared to be successful and trace identification was straight forward with the exception of some areas west of Orkney containing small schools of herring and gadoids.

The stock estimate shows a substantial increase between 1992 and 1993 (428,600 to 893,600 tonnes). There is no evidence from the age structure of the population that there has been significant recruitment to the stock, the same cohorts appear to be present in similar proportions in 1992 and 1993. Therefore, some discussion of the wide discrepancy in stock estimates is required. The survey area was expanded in 1993 to include the area between 56° and 56°30′N. Alone this extra area only accounts for 7.3% of the total stock. The data used in working up this survey were examined exhaustively for potential sources of error. The two calibrations carried out during the survey gave constants within 1% of each other, both were in close agreement with other calibrations on similar equipment. The fishing during the survey was generally very successful and allowed a good degree of certainty in identifying schools. As has been noted above, in some parts of the area, schools of Norway pout were seen which could be confused with herring. Whenever any potential doubt existed on the identification the fish were assigned to category 5 (gadoids and others). One potential source of error would be misidentification of horse mackerel schools as herring. A substantial part of the stock was found close to the shelf break were horse mackerel are also common. No marks were positively identified as horse mackerel during this survey, however again, where any potential doubt existed the traces were categorised as other pelagic fish (category 4).

The most likely explanation for the high estimate, given no change in the age structure of the population and no evidence of errors in the data gathering process, is simply that more fish were seen in the area this year. There are two factors which may, in part, account for this. Firstly, the 1992 survey found a large concentration of herring close to the southern limit at 56°30′N the limit was extended south by 30′ in 1993 possibly including more fish. In both 1992 and 1993 there appeared to be high densities of fish just north of this latitude, particularly near Stanton Bank at approximately 8°W, which is a known spawning ground (95,670 tonnes - 22.3% of the total - in 1992 and 233,000 tonnes - 26.1% of the total - in 1993). It is possible that in 1993 fish which were south of this latitude and were missed during the 1992 survey, have moved further north in 1993. Secondly, acoustic surveying, like all survey techniques on patchy phenomena, are subject to sampling precision. Frequency histogram analysis comparing 15 minute echo integrals from *Azalea* surveys in 1992 and 1993 (Fig. 12) suggests that both years surveys have similar underlying distributions. In 1993 there was a greater number of large observations, but very similar distributions at the lower values. The largest single 15 minute sample is responsible for approximately 12% of the total estimate. While this may be considered excessive, it should be noted that this is similar to the contribution of a single large value observed on other acoustic surveys for herring and reported in Anon. (1993b). It should also be noted that in the 1992 VIa(N) herring larval survey, a single station contributed 45% of the total larval abundance index.

In conclusion, the most likely explanation of the results of this survey is that, firstly, there may have been a greater migration into the area from VIa(S) than in 1992 and, secondly, that due to sampling variance, a greater than usual number of large single sample observations were recorded. It is suggested that in 1994 a higher sampling intensity be used in the southern part of the area to reduce the effects of this variance. It is also hoped that the survey area to the south will be covered by an additional vessel provided by Eire.

Survey Report RV *Dana*, 10-23 July 1993

Methods

The echo integration survey covered the North Sea east of 5°E between 57° and 59°N, and Kattegat. Acoustic data were collected by a 38 kHz Simrad ES400 echosounder using a towed body mounted transducer. The integration data were stored by the echo analysis system ECHOANN (Degnbol *et al.*, 1990). Figure 13 shows the survey track and areas. Table 12 gives the total area, number of Nm, number of trawl stations mean Sa and TS by area. Distance between transects was about 5-10 nautical miles. Ship's speed during the survey was about 10 knots.

Pelagic trawling was carried out mainly with a Fotö trawl (16 mm in cod-end), but also Expo trawl (16 mm in cod-end) was used. Trawl hauls (Table 13) were carried out mainly during night (1600-0600). Each haul was sampled for species, length, age and weight. Fish were measured to the nearest 0.5 cm and weighed to the nearest 0.1 g. Otoliths were sampled from herring with 10 per 0.5 cm class above 15 cm. Total 1,453 otoliths were sampled from herring.

Target strength for each length group of herring was estimated by:

$$TS = 20 \log L - 71.2 \text{ dB}$$

and for sprat by: $TS = 20 \log L - 71.2 \text{ dB}$

gadoids by: $TS = 20 \log L - 67.5 \text{ dB}$

mackerel by: $TS = 21.7 \log L - 81.5 \text{ dB}$

horse mackerel by: $TS = 20 \log L - 71.2 \text{ dB}$

Results

A total of 37 trawl hauls were carried out, the results of these are given in Table 13. The main biomass was found in Kattegat and between 4°E and 8°E north of 57°N. A total estimate of 23,299 million herring (Table 14) or 1,340,527 tonnes was estimated for the survey area (Table 16). Table 15 shows the spawning biomass by age and area. The mean weight of herring by age and area are given in Table 17.

COMBINED SURVEY REPORT

Figure 14 shows survey areas for each vessel. The results for the four surveys have been combined. Procedures and TS values are the same as 1992 surveys (CM 1992/H:11). The stock estimates have been worked out by age and maturity stage for 30 min by 1° 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. The region east of 6°E is presented separately and data on a split between North Sea and Baltic stocks is not available. Where the survey areas for individual vessels overlap the mean estimates for each overlapping rectangle have been used. Stock estimates are shown in Table 18 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. Table 19 gives the mean weights used to convert numbers to biomass. Figure 15 shows the distribution of abundance (numbers and biomass) of all herring for all areas surveyed. Figure 16 shows the distribution split by age of one ring, two ring and three ring and older herring. Figures 17 and 18 show the density distribution of numbers and biomass of all herring as contour plots.

Ichthyophonus Infection

Figure 19 shows the prevalence found in samples which were taken during all the surveys and inspected for infection. The samples have been combined using linear interpolation for un-sampled squares. These were assumed to be the mean proportions of surrounding squares with samples (equal weight to each square). The distribution of infection rates for the weighted method is shown in Figure 20. The total numbers infected are shown in Figure 21. 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. A total of 148 million fish were estimated as infected, all in ICES area IVa. This is 3.6% of the total population in this area. The age breakdown of this was estimated using the infected fish found on the *Scotia* survey for 1992 and 1993 for comparison. Samples were assumed to have equal weight and a single age infection length key was determined by combining all the samples. A single length key was obtained for same area by combining the individual sub area length keys in and weighting them by the abundance for these areas. The infection rate by age for the Orkney Shetland area is given in Table 20. Also included in this table is the number of otoliths sampled and found infected to give an indication of the quality of the estimates at age. It should be borne in mind that column 4 in this table is not derived directly from columns 2 and 3. Also the assumption that the age at length within the area is homogenous is questionable. However, the biggest changes are for one and two ring fish which show effectively zero prevalence of infection so this problem is not important. The numbers infected are sensibly zero for three years and younger with a rapid rise through four year olds and a peak at five years. The infection rate shows some reduction for older fish but the rise shown for eight and 9+ is unlikely to be real.

Precision of Abundance Estimates

It is difficult to get a good estimate of the precision of a single survey. Examination of survey methods (Simmonds and Fryer 1993) indicated that the precision of the spatial sampling element of a single estimate from a survey of the Orkney Shetland and Buchan area using 40 transects at the 90% probability level would be about 15% of the abundance. These simulations are based on data from four annual surveys and were directed at examining survey methods. The precision of the estimates of abundance relied on estimates of variance from these four surveys. The same simulation indicated that the precision of the survey variance, estimated at the 90% level, is about 140% of the mean variance. So the precision of the abundance was 15% but the precision of the variance from the same survey was 140%. Following changes in recent years sampling intensity has been reduced by about 50%. In addition three surveys are carried out covering approximately three times the area. The effects of this are uncertain but the best guess would be to assume that the three surveys of the North Sea stock are independent. The spatial sampling precision of the North Sea estimates for IVa and IVb combined would thus be estimated at the 90% probability level as being between 7% and 17% of the abundance. It should be borne in mind that estimating variance for any survey is likely to suffer from the same precision as above (140%) and therefore only substantial differences in variance (factors of 2) should be regarded as real. In addition other sources of error need to be considered such as; errors due to year on year changes in calibration, errors in estimating fish target strength via length keys, errors due to parts of the population being in unsurveyed areas, errors due to equipment performance and errors due to weather or changing hydrography. It is my view that obtaining good estimates of the variance of surveys for fish populations is very difficult. It is important that comparisons of variance take into account the assumptions that have been made to calculate the variance and the precision of that variance estimate. These must be included in any study before conclusions can be drawn.

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TABLE 1: Numbers and biomass by sub area for North Sea autumn and Baltic spring spawning herring from survey by *Johan Hjort*

	Autumn + spring spawners		North Sea autumn spawners		IIIa/Baltic spring spawners	
Area 1						
1 ring	1308.00	87.90	1210.12	81.14	97.88	6.76
2 immature	325.72	26.71	106.60	8.61	219.12	18.11
2 mature	37.03	2.96	37.03	2.96	0.00	0.00
3 immature	154.99	13.38	19.05	1.59	135.94	11.78
3 mature	16.43	1.39	16.43	1.39	0.00	0.00
4 rings	104.00	11.70	18.91	1.51	85.09	10.19
5 rings	47.00	5.80	4.25	0.95	42.75	4.85
6 rings	22.00	3.20	3.06	0.36	18.94	2.84
7 rings	1.00	0.10	1.00	0.10	0.00	0.00
8 rings	4.00	1.00	4.00	1.00	0.00	0.00
9+ rings	2.00	0.50	2.00	0.50	0.00	0.00
Total	2022.17	154.65	1422.45	100.12	599.72	54.53
Area 2						
1 ring	103.00	6.80	93.49	6.22	9.51	0.58
2 immature	127.57	12.21	68.66	6.53	58.92	5.68
2 mature	25.69	2.75	25.69	2.75	0.00	0.00
3 immature	88.84	10.50	12.36	1.72	76.49	8.78
3 mature	8.79	1.31	8.79	1.31	0.00	0.00
4 rings	85.00	12.90	45.21	6.41	39.79	6.49
5 rings	57.00	9.10	24.47	2.36	32.53	6.74
6 rings	20.00	4.30	14.29	2.82	5.71	1.48
7 rings	15.00	3.60	11.73	1.85	3.27	1.75
8 rings	4.00	1.10	4.00	1.10	0.00	0.00
9+ rings	2.00	0.50	2.00	0.50	0.00	0.00
Total	536.89	65.06	310.68	33.56	226.21	31.50
Area 3						
1 ring	3795.00	289.10	3795.00	289.10	0.00	0.00
2 immature	727.65	91.01	694.06	86.87	33.59	4.14
2 mature	295.88	38.42	295.88	38.42	0.00	0.00
3 immature	555.82	79.93	473.65	67.92	82.17	12.01
3 mature	219.75	32.00	219.75	32.00	0.00	0.00
4 rings	361.00	62.30	298.67	50.85	62.33	11.45
5 rings	287.00	51.00	230.88	41.80	56.12	9.20
6 rings	112.00	22.50	98.30	19.42	13.70	3.08
7 rings	79.00	17.10	58.20	12.86	20.80	4.24
8 rings	27.00	6.80	17.20	5.22	9.80	1.58
9+ rings	2.00	0.40	2.00	0.40	0.00	0.00
Total	6462.10	690.56	6183.58	644.87	278.52	45.69

	Autumn + spring spawners		North Sea autumn spawners		IIIa/Baltic spring spawners	
Area 4						
1 ring	170.00	14.40	170.00	14.40	0.00	0.00
2 immature	32.20	4.16	23.66	3.39	8.54	0.77
2 mature	17.32	2.46	17.32	2.46	0.00	0.00
3 immature	43.36	5.43	22.77	2.55	20.58	2.87
3 mature	6.16	1.00	6.16	1.00	0.00	0.00
4 rings	48.00	10.90	43.66	9.84	4.34	1.06
5 rings	56.00	11.70	37.31	8.33	18.69	3.37
6 rings	44.00	10.20	32.33	7.71	11.67	2.49
7 rings	39.00	10.70	18.28	4.70	20.72	6.00
8 rings	19.00	5.40	16.31	4.82	2.69	0.58
9+ rings	14.00	4.30	14.00	4.30	0.00	0.00
Total	489.04	80.64	401.82	63.49	87.22	17.15
All areas						
1 ring	5376.00	398.20	5268.61	390.85	107.39	7.35
2 immature	1213.14	134.09	892.98	105.39	320.16	28.70
2 mature	375.92	46.59	375.92	46.59	0.00	0.00
3 immature	843.01	109.23	527.82	73.79	315.19	35.44
3 mature	251.13	35.70	251.13	35.70	0.00	0.00
4 rings	598.00	97.80	406.45	68.61	191.55	29.19
5 rings	447.00	77.60	296.91	53.45	150.09	24.15
6 rings	198.00	40.20	147.98	30.30	50.02	9.90
7 rings	134.00	31.50	89.21	19.51	44.79	11.99
8 rings	54.00	14.30	41.51	12.15	12.49	2.15
9+ rings	20.00	5.70	20.00	5.70	0.00	0.00
Total	9510.20	990.91	8318.52	842.04	1191.68	148.87

TABLE 2

Calibration report EK5000. *Tridens* 29 June-16 July 1993. 38 kHz transducer

Date and time:	30 June 1993 0700-1000 UTC	Position:	Open sea (floating) 56.19°N 02°12´E
Bottom depth:	100 m	Wind:	0 BF
Water temperature:		Wave height:	0.2 m

Transceiver menu before calibration

Pulse length:	Medium	Bandwidth:	Wide
Maximum power:	4,000 W	Angle sensitivity:	22.1
2-way beam angle:	-20.6 dB	Sv transducer gain:	26.9 dB
TS transducer gain:	26.9 dB	3 dB beam width:	7.1
Alongship offset:	0	Athw ship offset:	0
Ping interval:	0.6	Transmitter power:	normal

Standard target:	Copper sphere, -33.6 dB
Target depth:	21.50 m
TS values measured:	-39.6
New TS transducer gain:	24.4
New TS values measured:	-33.6/-33.7 (very stable)
SA values measured:	1,414
SA value calculated:	4,673
New Sv transducer gain:	24.2
New SA values measured:	4,478-4,869

TABLE 3: Trawl station list. *Tridens* 29 June-16 July 1993. Trawl catches in kg

Haul	Date	Time UTC	Latitude	Longitude	Depth (m)	Duration min	Herring	N pout	Other gadoids	Mackerel	Sprat	Others	Remarks
1	01 07	1010	58.55	01.22E	120	100	0	0	5	5	0	0	Traces missed
2	01 07	1520	58.39	01.14E	107	25	3,000	0	4	1	0	0	
3	01 07	1855	58.37	01.15E	125	35	260	20	24	0	0	2	
4	02 07	0700	57.54	01.15E	101	20	30	220	76	0	0	0	
5	02 07	1453	57.12	00.44E	85	30	80	0	17	2	0	0	
6	02 07	1940	57.50	00.45E	131	35	210	10	15	0	0	1	
7	03 07	0655	58.22	00.45E	144	15	440	0	20	0	0	50	Maurolicus
8	03 07	1200	58.54	00.29E	150	35	2,475	25	180	0	0	0	
9	03 07	1545	58.41	00.14E	144	30	2,400	5	95	0	0	5	
10	05 07	1000	58.41	00.45E	119	45	3,100	110	85	5	0	1	
11	05 07	1500	58.16	00.45W	102	30	840	20	6	1	0	0	
12	06 07	0627	57.17	01.15W	74	30	0	0	0	2	0	0	
13	06 07	1650	58.31	01.14W	100	25	1,900	4	0	0	0	1	
14	07 07	0620	58.23	01.45W	99	15	760	1	48	5	20	0	
15	07 07	1355	57.06	01.43W	90	85	240	0	6	0	10	0	0-group herring
16	09 07	0722	58.37	02.39W	70	70	2	0	1,220	600	0	0	
17	09 07	1753	57.49	02.43W	89	50	5	0	7	5	250	0	
18	10 07	0900	56.54	00.01W	82	135	40	0	8	0	0	5	
19	10 07	1710	56.55	01.32E	100	30	720	720	0	0	0	0	
20	12 07	0702	56.24	00.37E	84	62	6,340	22	0	1	0	5	
21	12 07	1420	56.10	01.30E	76	15	1,455	0	35	0	0	0	0-group herring
22	12 07	1936	56.10	00.01W	84	16	2,775	65	1	20	0	15	
23	14 07	0625	55.54	01.28E	70	30	370	0	0	0	0	0	0-group herring
24	14 07	0905	55.48	01.44E	87	130	1	200	0	2	0	2	
25	15 07	0620	55.25	00.46W	87	40	40	0	5	0	320	8	

TABLE 4: Length distributions herring

Length	Haul 2	Haul 3	Haul 4	Haul 5	Haul 6	Haul 7	Haul 8	Haul 9	Haul 10	Haul 11	Haul 13	Haul 14	Haul 15	Haul 16	Haul 17	Haul 18	Haul 19	Haul 20	Haul 21	Haul 22	Haul 25
15.0															23.88						
15.5													0.86		25.37						
16.0													1.72		19.40				2.33		
16.5													1.72		19.40				2.33		
17.0													7.73		4.48				4.65		0.88
17.5				0.94									9.01						6.98		2.63
18.0													17.17		1.49				4.65	0.22	3.51
18.5													17.60	8.33	1.49				6.98	1.30	6.14
19.0			1.56										13.73			0.68			16.28	2.38	6.14
19.5													9.44			4.08			11.63	9.52	3.51
20.0			2.34	0.94								0.29	11.16			10.20			11.63	17.75	7.89
20.5			0.78	2.83								0.87	3.86			13.61		0.64	4.65	19.26	5.26
21.0			3.13	1.89	1.08						0.36	5.20	3.00			24.49		2.24	4.65	20.56	7.02
21.5			1.56	7.55							0.36	8.09	1.29			21.77	0.42	3.21	9.30	10.82	6.14
22.0			1.56	17.92	1.08						0.72	13.01	0.86			12.24		6.73		6.49	5.26
22.5			0.78	19.81	2.15						1.09	10.12		8.33		5.44		7.05	6.98	3.68	0.88
23.0			1.56	13.21						1.90	5.07	10.69	0.43	8.33	1.49	2.72	0.42	8.65	2.33	2.16	0.88
23.5			3.13	13.21	4.30				0.52	3.80	5.80	8.09	0.43	16.67	1.49	1.36	0.42	7.69	2.33	1.08	4.39
24.0			14.84	9.43	6.45		0.53	1.03	2.60	6.84	7.97	12.14		16.67	1.49	0.68	0.42	7.69		1.08	1.75
24.5	0.57		17.97	5.66	2.15	1.32	1.06	1.03	6.77	7.60	10.87	9.54					0.85	10.90		1.73	5.26
25.0		1.75	18.75	1.89	7.53	1.32	3.72	3.08	3.65	11.03	12.68	5.49		16.67		0.68	4.66	13.46		0.22	9.65
25.5	1.15	3.51	11.72	2.83	4.30	1.32	6.38	4.10	6.25	12.17	15.58	4.91		16.67			6.78	10.58	2.33	0.65	5.26
26.0		2.92	9.38	1.89	5.38		5.85	6.15	5.21	18.25	12.32	5.20		8.33		0.68	10.17	5.77			5.26
26.5	2.30	3.51	2.34		9.68	2.63	4.79	6.67	5.73	10.65	7.97	4.05				0.68	13.56	5.13		0.22	4.39
27.0	2.87	5.26	2.34		7.53	3.95	9.57	6.15	7.81	6.08	7.61	1.45					8.47	4.49			5.26
27.5	2.87	8.19	1.56		5.38	7.89	6.38	4.10	6.25	5.32	4.71	0.58					6.78	1.60		0.43	0.88
28.0	3.45	8.19	2.34		9.68	6.58	4.79	6.67	6.77	3.80	2.17	0.29					8.90	1.28			0.88
28.5	6.32	10.53	1.56		7.53	13.16	4.26	10.26	9.90	4.18	1.81						9.32	1.92			
29.0	12.07	17.54	0.78		5.38	14.47	9.57	15.90	11.46	2.28	1.45						12.29	0.64		0.22	
29.5	18.97	14.04			8.60	15.79	8.51	8.72	7.29	2.66	0.72						8.05			0.22	
30.0	18.39	12.28			5.38	15.79	15.43	7.69	6.77	1.90	0.72					0.68	5.93				
30.5	17.24	9.36			6.45	9.21	10.11	10.26	6.77	1.14							2.54	0.32			0.88
31.0	10.92	2.92				5.26	4.79	5.13	3.65												
31.5	2.30					1.32	1.60	3.08	1.56	0.38											
32.0	0.57						2.66		0.52												
32.5																					
33.0																					
Mean length	29.54	28.66	24.62	22.83	27.02	28.96	28.47	28.44	27.86	26.11	25.45	23.50	18.70	23.83	16.18	21.34	27.52	24.44	19.76	20.95	22.44
TS mean length	-41.72	-41.98	-43.29	-43.94	-42.49	-41.89	-42.04	-42.05	-42.22	-42.78	-43.00	-43.69	-45.65	-43.57	-46.89	-44.52	-42.33	-43.35	-45.18	-44.67	-44.08
Mean weight	215	197	112	89	162	203	192	197	184	143	133	103.00	49			79	169	123	66	72	91.20

TABLE 5: Summarised results all sampling areas. *Tridens* 29 June-16 July 1993

Summary all sampling areas
Numbers in millions

Area	Autumn spawners												Spr sp all ages	Totals
	1991	1990J	1990A	1989J	1989A	1988	1987	1986	1985	1984	1983	1982		
A	2.7	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9
B	15.8	59.8	158.1	18.3	47.6	27.8	10.7	9.4	13.8	0.0	0.0	3.3	2.0	366.6
C	0.0	2.7	47.0	10.3	138.8	146.5	90.8	76.8	102.0	21.8	2.7	2.8	0.0	642.3
D	235.3	51.2	10.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	297.5
E	6.4	32.8	48.8	28.3	49.6	48.7	33.8	0.0	4.1	16.8	0.0	0.0	0.0	269.3
F	815.5	151.6	40.0	22.1	23.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,052.5
G	39.5	545.1	407.2	118.9	262.4	91.9	102.9	26.7	32.9	16.1	0.0	0.0	0.0	1,643.6
H	25.0	2.4	6.4	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	19.6	53.8
Totals	1,140.2	845.7	717.5	197.9	521.6	315.4	239.2	112.9	152.9	54.8	2.7	6.1	21.6	4,328.5

Summary all sampling areas
Weights in '000 tonnes

Area	Autumn spawners												Spr sp all ages	Totals
	1991	1990J	1990A	1989J	1989A	1988	1987	1986	1985	1984	1983	1982		
A	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
B	1.2	5.5	21.1	2.1	7.4	5.3	2.2	2.2	3.4	0.0	0.0	0.9	0.4	51.8
C	0.0	0.4	7.7	1.2	22.1	31.1	18.7	17.1	23.7	5.3	0.7	0.6	0.0	128.6
D	13.0	4.2	0.9	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	18.3
E	0.4	2.7	6.0	3.1	7.2	8.4	6.6	0.0	0.8	3.6	0.0	0.0	0.0	38.7
F	55.1	12.2	3.7	2.3	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	76.0
G	2.6	56.0	52.7	14.4	40.1	17.1	18.0	5.0	6.4	3.1	0.0	0.0	0.0	215.4
H	1.4	0.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	4.7
Totals	73.8	81.3	92.7	23.1	79.6	61.9	45.8	24.3	34.3	11.9	0.7	1.5	2.7	533.7

Spr sp = spring spawning herring; 1990J = juveniles 1990 year class; 1990A = adults 1990 year class

TABLE 6: Catch composition by trawl haul. *Scotia* 10-30 July 1993

Haul number	Position		Depth (m)	Numbers caught								Comments
	Latitude (°N)	Longitude (°W)		Herring	Whiting	Haddock	Pout	Mackerel	Horse mackerel	Blue whiting	Gurnards	
290	58 35.0N	002 35.0W	68									Foul haul
291	58 34.8N	001 40.9W	118	2542	1	1	188					4 gadoids
292	58 47.2N	001 45.7E	146	495		50	524					4 gadoids
293	58 50.1N	000 51.8E	150	3712	100	100	2660					
294	58 52.0N	000 33.5W	140	3540	52	8	248					
295	58 50.4N	002 34.9W	76	736	795	172	6	1	1		2	
296	59 05.0N	002 03.0W	80		4935	345						
297	59 05.1N	001 21.6W	109	277	151	27	5	5			2	
298	59 03.2N	000 22.3W	110	1410								
299	59 05.0N	000 36.0E	122	5875		25	1025					
300	59 20.3N	000 36.4W	135	2010		45	1110	8				
301	59 20.1N	001 31.8W	92	2628		12	78	12				1,836 sprats
302	59 20.3N	001 51.2W	86									"0" group pout
303	59 37.1N	001 35.1E	120									
304	59 50.1N	001 00.0W	125	2262								Sandeels
305	60 01.3N	000 08.5W	65									
306	60 05.1N	000 38.2W	120	4515		35		927				
307	60 21.3N	000 01.5E	134	288	6	3		17				
308	60 24.2N	000 41.5E	90	51	22			3				
309	60 36.3N	000 25.4W	140	1338	66	102	210					
310	61 05.5N	000 32.8E	156	437			2	32		15	2	29 saithe
311	61 04.8N	000 04.2W	153	54		2	17	13	1	1	4	1 saithe
313	61 05.1N	000 28.8W	133	1480		10	510	165	360			64 saithe
313	61 14.1N	000 44.3W	154	975	5	4	125	40	45			2 saithe
314	61 20.1N	000 07.4E	162	9					6			Maurolicus
315	61 20.2N	000 13.0E	170	1608				32				
316	61 28.9N	001 45.0E	150	29	1	2		94				Euphausiids
317	61 44.9N	000 14.9E	213									Maurilicus
318	61 09.7N	000 45.0W	150	105		1		2	10			
319	61 05.8N	001 15.0W	130	636			8	264	16			
320	60 49.5N	001 54.8W	121	110				1				
321	60 50.3N	000 58.0W	95	18	426	9	38					"0" group pout
322	60 40.4N	002 07.9W	135	375	5		1	215			1	
323	60 40.4N	002 16.9W	140									Missed mark
324	60 32.1N	002 15.5W	146	84				274				
325	60 25.2N	002 12.4W	120	10080	70	105			158		18	3 sprats
326	60 25.2N	002 36.7W	152	836								
327	60 17.0N	002 18.6W	112		59			3	19			
328	60 05.0N	001 48.0W	85	1564	492			4	8			
329	60 05.1N	002 19.8W	95	176	454	12	6	11				
330	60 05.3N	002 50.0W	90	103	1							
331	59 44.7N	001 34.7W	120	700	12671	140	210	210				
332	59 35.4N	002 27.0W	90	6570								
333	59 28.1N	003 16.5W	80									"0" group pout
334	59 10.4N	003 16.1W	72	1				66				

TABLE 7a: Length frequency numbers, mean length mean weight and target strengths by haul and subarea (subareas I and II) from FRV *Scotia*

Length	295	Mean	297	301	328	329	331	Mean
17.0	0.4	0.4						
17.5	1.0	1.0						
18.0	7.1	7.1						
18.5	15.1	15.1						
19.0	23.4	23.4						
19.5	22.4	22.4						
20.0	11.8	11.8						
20.5	5.3	5.3	0.4	0.9				0.3
21.0	5.3	5.3	1.5	8.7	0.3			2.1
21.5	2.9	2.9	5.1	13.5	0.5		0.6	3.9
22.0	1.0	1.0	9.9	16.9	4.3		1.7	6.6
22.5	0.4	0.4	7.4	11.9	11.5	5.1	3.1	7.8
23.0	1.0	1.0	8.5	12.6	23.0	7.4	8.8	12.0
23.5	0.2	0.2	10.3	8.4	21.7	12.5	8.2	12.2
24.0	1.0	1.0	8.5	8.4	16.1	21.6	11.3	13.2
24.5	0.8	0.8	12.9	6.6	10.2	17.6	12.7	12.0
25.0	0.4	0.4	15.8	5.3	6.6	11.9	13.0	10.5
25.5			11.8	1.1	2.3	8.5	15.3	7.8
26.0	0.2	0.2	3.7	1.4	1.5	7.4	9.9	4.8
26.5	0.2	0.2	1.8	1.6	0.8	4.5	6.8	3.1
27.0			1.1	0.7	0.8	2.8	4.2	1.9
27.5			0.4	0.2	0.3	0.6	1.7	0.6
28.0			0.4				0.6	0.2
28.5			0.4	0.2				0.1
29.0				0.2			0.3	0.1
29.5			0.4	0.2				0.1
30.0							0.8	0.2
30.5				0.7				0.1
31.0				0.5				0.1
31.5								
32.0							0.3	0.1
32.5							0.6	0.1
33.0								
33.5								
34.0								
34.5								
35.0								
35.5								
36.0								
36.5								
37.0								
37.5								
Number	491		272	438	391	176	353	
Length	20.1	20.1	24.5	23.5	24.1	25.0	25.4	24.5
Weight	58	58	118	103	111	126	135	119
TS/individual	-45.1	-45.1	-43.4	-43.8	-43.5	-43.5	-43.1	-43.4
TS/kgm	-32.7	-32.7	-34.1	-33.9	-34.0	-34.2	-34.4	-34.1

TABLE 7b: Length frequency numbers, mean length mean weight and target strengths by haul and subarea (subarea III) from FRV *Scotia*

Length	291	292	293	294	298	299	300	304	306	307	309	310	311	312	313	315	316	318	319	320	322	324	325	326	332	330	mean
17.0																											
17.5																											
18.0																											
18.5																											
19.0																											
19.5																											
20.0		0.2																									0.0
20.5		0.2																									0.0
21.0		0.2																									0.0
21.5		0.6																									0.0
22.0		1.6						0.3																	0.5		0.1
22.5		1.2						0.3																			0.1
23.0	0.3	1.4					0.4																			1.9	0.2
23.5	0.9	1.0					1.1	1.6													0.4						0.2
24.0	0.6	3.2					1.9	5.0		0.3													0.7				0.5
24.5	2.9	4.4	0.7		0.9		2.2	7.2	1.6		0.4								0.6		2.2	1.2	4.2	1.0	1.4	1.0	1.2
25.0	7.1	7.3	2.7	2.1		0.9	8.2	10.3	5.0	0.7	3.6									0.9	3.1	6.0	6.9	0.5	3.2	2.9	2.7
25.5	9.1	10.9	2.7	1.3		1.3	7.5	9.8	10.5	0.7	2.2			2.8							4.4	14.3	7.3	3.3	2.3	1.9	3.6
26.0	9.1	6.9	7.7	2.5		1.7	14.9	14.9	12.4	2.1	3.6			5.2	0.5					0.9	6.2	7.1	9.7	2.9	3.2		4.3
26.5	5.9	7.9	6.1	0.8	0.4	1.7	6.7	10.6	10.1	2.4	1.3			8.4	1.0						6.2	7.1	9.7	3.3	3.7	1.0	3.6
27.0	7.6	6.9	3.7	3.0	0.4	0.9	2.6	9.5	14.7	5.9	3.6			12.2	0.5					1.8	3.1	10.7	7.3	1.9	1.8	1.0	3.8
27.5	5.9	6.7	4.0	2.5	0.4	2.6	4.5	7.7	8.1	2.8	5.4	0.4		6.3	1.0						1.8	2.4	5.9	2.4	1.8	1.9	2.9
28.0	3.5	7.3	5.1	2.5	1.7	2.6	4.1	3.7	6.6	1.0	3.1	1.1	3.7	5.2		1.0		1.0		2.7	2.2	4.8	5.6	1.4	2.3		2.8
28.5	4.7	6.9	7.1	6.8	1.7	0.9	2.6	2.9	5.8	3.5	2.7	2.3	1.9	4.9	1.0	0.5			0.6		1.8	6.0	4.5	1.0	1.4		2.7
29.0	10.3	9.3	9.1	8.9	6.8	4.7	6.7	2.1	5.0	2.4	5.4	1.9	1.9	3.5	1.5			1.0	0.6	4.5	2.7	6.0	5.9	7.2	1.4	1.9	4.3
29.5	13.2	5.5	11.1	11.9	9.8	6.8	6.3	4.0	5.4	5.9	9.9	3.1	1.9	3.8	4.6	1.5		1.0	4.5	2.7	4.9	2.4	6.9	4.8	1.8	2.9	5.3
30.0	10.0	5.3	16.2	15.7	18.7	14.0	10.1	3.4	5.4	10.1	13.5	7.6	7.4	7.0	6.2	5.5		8.6	9.6	7.3	7.1	1.2	8.0	9.6	8.7	5.8	8.5
30.5	2.6	2.4	13.5	16.1	21.7	12.3	9.7	2.9	2.3	11.5	16.1	9.2	14.8	8.7	16.4	6.5		3.8	6.4	9.1	7.6	9.5	5.6	10.5	11.4	9.7	9.2
31.0	2.9	1.2	5.7	13.1	16.2	20.0	3.0	1.9	5.0	13.2	14.3	12.2	16.7	8.7	14.9	10.9	13.8	21.0	17.3	10.0	11.6	2.4	5.2	12.0	16.4	10.7	10.8
31.5	1.8	0.6	3.0	5.1	11.5	14.9	3.4	0.8	1.6	13.5	7.2	18.3	16.7	7.3	13.8	15.9	17.2	13.3	17.3	11.8	11.1	8.3	1.4	8.6	15.1	9.7	9.6
32.0	0.9	0.4	0.7	5.9	6.4	7.7	2.2	1.1	0.4	12.2	4.0	12.2	13.0	7.3	13.3	22.4	31.0	13.3	16.0	11.8	8.0	4.8	2.4	14.4	13.2	12.6	9.1
32.5	0.3	0.6	0.7	1.3	2.1	3.0	1.5			5.6	2.2	11.5	5.6	5.2	14.4	11.9	20.7	9.5	12.8	11.8	8.0	2.4	2.4	7.7	6.4	14.6	6.2
33.0	0.3		0.3		1.3	3.4	0.4			4.5	0.9	8.0	9.3	1.7	5.1	11.9	3.4	11.4	10.3	18.2	3.6	1.2	0.3	3.8	2.3	10.7	4.3
33.5						0.9				1.7		6.1	3.7	0.7	3.1	7.5	3.4	7.6	1.3	3.6	2.2			2.9	1.8	5.8	2.0
34.0				0.4								1.9		0.3	2.6	2.0	3.4	5.7	2.6	0.9	0.4			0.5		2.9	0.9
34.5											0.4	2.3				1.5		2.9		1.8	0.9	2.4				1.0	0.5
35.0												1.1	1.9	0.3		0.5								0.5			0.2
35.5													1.9	0.3			3.4										0.2
36.0												0.4															0.0
36.5																					0.4						0.0
37.0																0.5	3.4										0.2
37.5												0.4															0.0
No	340	495	297	236	235	235	268	377	258	288	223	262	54	287	195	201	29	105	156	110	225	84	288	209	219	103	
Length (cm)	28.3	27.5	29.3	30.2	30.9	30.9	28.4	27.2	28.0	30.8	30.1	32.1	31.9	29.8	31.8	32.4	32.8	32.4	32.0	31.9	30.2	28.8	28.4	30.8	30.7	31.5	30.3
Weight (g)	201	182	227	252	272	273	205	173	192	273	249	313	304	242	301	323	339	322	308	307	258	218	205	273	270	298	261
TS/ind	-42.1	-42.4	-41.8	-41.6	-41.4	-41.4	-42.1	-42.5	-42.2	-41.4	-41.6	-41.1	-41.1	-41.7	-41.1	-41.0	-40.9	-41.0	-41.1	-41.1	-41.6	-42.0	-42.1	-41.4	-41.4	-41.2	-41.5
TS/kg	-35.2	-35.0	-35.4	-35.6	-35.7	-35.8	-35.2	-34.9	-35.1	-35.8	-35.6	-36.0	-36.0	-35.5	-35.9	-36.1	-36.2	-36.1	-36.0	-36.0	-35.7	-35.3	-35.2	-35.8	-35.7	-35.9	-35.7

TABLE 8: Numbers mean length mean weight and biomass by age and maturity class by sub area from FRV *Scotia*

Age/maturity	Numbers ($*10^6$)	Mean length (cm)	Mean weight (g)	Biomass (tonnes 10^{-3})
Area I				
1A	445.27	19.33	54.67	24.34
2I	14.47	22.03	86.68	1.25
2M	10.85	24.09	118.30	1.28
3I	1.21	22.00	85.45	0.10
3M	0.96	26.50	165.45	0.16
4A	0.00			0.00
5A	0.96	26.00	154.61	0.15
6A	0.00			0.00
7A	0.00			0.00
8A	0.00			0.00
9+	0.00			0.00
Total	473.73	19.56	57.61	27.29
Area II				
1A	40.92	21.68	81.29	3.33
2I	162.70	23.11	102.57	16.69
2M	242.48	24.46	125.93	30.54
3I	65.54	24.22	121.18	7.94
3M	42.69	25.33	141.93	6.06
4A	24.08	25.43	144.98	3.49
5A	0.97	27.21	182.92	0.18
6A	1.19	31.83	318.67	0.38
7A	0.82	30.80	283.98	0.23
8A	0.00			0.00
9+	0.00			0.00
Total	581.39	23.96	118.23	68.74
Area III				
1A	4.47	22.02	86.12	0.38
2I	34.94	25.35	143.80	5.02
2M	320.98	26.27	162.03	52.01
3I	89.29	25.62	147.80	13.20
3M	429.98	27.65	196.16	84.35
4A	336.69	30.02	260.99	87.87
5A	400.38	30.76	283.67	113.58
6A	672.20	31.15	296.05	199.01
7A	423.27	31.58	311.10	131.68
8A	135.49	32.18	332.76	45.09
9+	105.58	32.84	358.05	37.80
Total	2953.28	29.84	260.67	769.82

Age/maturity	Numbers ($*10^6$)	Mean length (cm)	Mean weight (g)	Biomass (tonnes 10^{-3})
Total survey area				
1A	490.66	19.55	57.17	28.05
2I	212.11	23.40	108.28	22.97
2M	574.32	25.47	145.96	83.83
3I	156.04	25.00	136.14	21.24
3M	473.63	27.44	191.21	90.56
4A	360.77	29.71	253.25	91.36
5A	402.32	30.74	283.12	113.90
6A	673.39	31.15	296.09	199.39
7A	424.09	31.58	311.05	131.91
8A	135.49	32.18	332.76	45.09
9+	105.58	32.84	358.05	37.80
Total	4008.40	27.77	216.01	865.85

TABLE 9: Catch composition by trawl haul. *Azalea* 14-29 July 1993

Haul number	Position		Depth (m)	Numbers caught								
	Latitude (°N)	Longitude (°W)		Herring	Whiting	Haddock	Pout	Mackerel	Horse mackerel	Blue whiting	Gurnards	Others
1	58 19.82	6 05.31	50	-	26			4				
2	57 38.72	6 28.86	100	16	66	1	493					
3	57 37.87	6 34.01	90	11	2		396	1				
4	57 21.57	6 48.66	70	6	23		165	62				
5	57 07.72	6 25.07	100									191 sprat
6	56 37.64	6 56.05	70	2	16			4				
7	56 37.37	6 54.95	66	4	141		21112	51	8			
8	56 37.40	7 42.19	110	33740								
9	56 20.35	7 45.21	180	7992				324				
10	56 07.72	7 01.32	88				360		1			
11	56 38.36	8 14.86	170	12091	45	15	285		105			
12	56 37.45	8 32.84	160	12874								
13	56 52.35	8 00.90	150	4059			8	8		4		4 spurdog
14	57 22.33	8 21.84	170	2695	2	4	879	15			2	4 spurdog
15	57 37.70	8 19.47	170	1491	4	2	75	7		2	1	3 hake
16	57 37.84	9 25.34	200	141	1		3	3	16			
17	58 04.21	8 33.95	150	935	4	1			1			1 hake
18	58 13.14	7 09.68	150	1839	6			85	2			
19	58 18.95	7 09.74	125	1912				10				
20	58 18.97	8 38.02	190	73				1		1		
21	58 26.04	8 23.00	190	8	1			64		7		3 pearlside 1 hake
22	58 25.80	5 20.74	85	9	6		6	151				
23	58 34.11	6 29.46	80				4436	3				
24	58 40.87	7 39.94	150	767				13	2			
25	58 40.92	7 08.47	100	436		1		27				
26	58 40.80	5 24.58	80	1379		1	1672	4				2 black-mouthed dogfish
27	58 49.12	6 25.71	110	3202			34	316				
28	58 55.81	7 16.02	196	15				1				
29	58 55.97	6 49.42	196	538	9	2	257	6		11	1	2 argentine
30	59 03.88	7 09.76	180	83		5				13		1 saithe
31	59 09.95	6 18.20	110	913	4		1	1				1 plaice
32	59 09.91	4 12.74	85			1	8832					
33	59 19.99	3 49.59	135	4554	12	11	248	7				
34	59 20.08	6 04.33	130	3784	61		13	56				
35	59 33.97	6 05.64	180									1 saithe
36	59 50.03	4 55.97	140						3			1 ling

TABLE 10: Herring length frequency by trawl haul by sub area. *Azalea* 14-29 July (mean length - cm, mean weight - g, target strength - dB)

Haul No	Area I			Area II										Area III										
	26	27	mean	8	9	11	12	13	14	15	18	19	mean	16	17	20	24	25	29	30	31	33	34	mean
18.0																								
19.5																						0.5		0.0
19.0																						0.2		0.0
19.5																								
20.0																						0.2		0.0
20.5																						0.2		0.0
21.0		0.2	0.1										0.0									0.2		0.0
21.5								0.4					0.0											
22.0																						0.2		0.0
22.5		0.2	0.1										0.0									0.2		0.0
23.0	0.6	0.2	0.4									0.4	0.0											
23.5	1.3	1.0	1.2		0.5				0.4		0.2		0.1									0.2		0.0
24.0	8.3	5.7	7.0			0.4		1.5	0.4		0.2	0.4	0.3									0.5	0.3	0.1
24.5	12.6	10.2	11.4		0.5			3.1	0.4	0.9	1.7	1.7	0.9			1.2						0.5		0.2
25.0	16.2	14.5	15.3	0.8	4.1	2.7		6.9	1.3	0.4	4.1	5.9	2.9					0.2			0.5	1.2		0.2
25.5	17.0	17.4	17.2	0.4	4.1	1.9	0.5	9.1	1.3	1.3	5.1	5.6	3.3						0.2			2.7	0.3	0.3
26.0	14.4	13.1	13.8	4.6	10.8	7.2	1.9	10.0	2.2	1.7	5.3	5.2	5.4	0.7				0.2			0.2	4.4	0.9	0.6
26.5	10.1	9.8	9.9	3.7	7.2	8.7	4.8	10.8	6.5	4.8	4.1	7.3	6.4				1.0	0.2	0.2		0.2	4.4	2.0	0.8
27.0	7.6	6.5	7.1	10.8	10.4	17.8	17.8	13.1	13.8	9.9	6.5	6.7	11.9	2.8	1.3	2.5	1.3	1.4	0.6		1.3	5.4	2.6	1.9
27.5	2.8	5.3	4.0	20.7	19.8	20.5	19.2	16.5	24.7	21.1	11.6	9.2	18.2	5.7	10.2	3.7	2.3	6.7		1.2	3.5	5.4	4.9	4.4
28.0	1.8	6.1	4.0	28.2	19.8	20.1	26.0	14.6	25.1	31.1	17.5	16.3	22.1	16.3	23.9	16.0	12.0	17.7	0.7		6.0	7.7	10.5	11.1
28.5	2.2	3.9	3.0	14.9	13.1	11.4	18.3	9.2	16.0	20.3	15.7	12.6	14.6	16.3	22.1	18.5	12.0	20.2	1.5		11.0	10.4	13.4	12.5
29.0	2.5	2.7	2.6	10.8	6.3	5.7	10.1	3.4	6.0	6.4	9.2	10.7	7.6	14.9	22.1	9.9	11.0	13.8	2.0	2.4	12.6	10.9	13.1	11.3
29.5	1.3	0.4	0.9	2.9	2.3	2.7	1.0	0.8	1.7	1.7	7.3	5.6	2.9	12.8	11.0	12.3	16.0	12.2	7.2	7.2	10.7	13.4	12.5	11.5
30.0	0.9	1.0	1.0	2.1	1.4	0.8		0.4		0.4	3.6	4.8	1.5	12.8	6.8	12.3	13.2	6.2	11.7	9.6	9.6	11.4	8.7	10.2
30.5	0.1	0.6	0.4			0.4					3.9	1.9	0.7	10.6	0.9	12.3	11.7	8.7	14.1	21.7	11.8	5.9	6.7	10.5
31.0		0.2	0.1				0.5				2.0	2.1	0.5	2.1	0.4	3.7	11.7	6.4	18.4	15.7	7.9	5.2	6.1	7.8
31.5	0.1	0.4	0.3								0.7	1.7	0.3	3.5	0.9	6.2	5.1	4.1	18.8	20.5	7.7	3.5	5.2	7.5
32.0	0.1	0.2	0.2								1.2	1.5	0.3	1.4	0.4	1.2	2.1	1.4	15.4	10.8	8.2	2.5	5.8	4.9
32.5		0.2	0.1									0.2	0.0				0.5	0.2	7.2	7.2	4.4	1.5	4.4	2.5
33.0												0.2	0.0					0.2	1.1	1.2	2.4	0.7	1.2	0.7
33.5																		0.2	0.6	2.4	0.9		1.2	0.5
34.0																			0.2		0.5	0.2	0.3	0.1
34.5																								
35.0																					0.2			0.0
35.5																								
36.0																					0.2			0.0
mean l	26.3	26.6	26.4	28.4	27.9	28.0	28.3	27.4	28.1	28.3	28.5	28.4	28.1	29.6	29.2	29.7	30.1	29.6	31.5	31.5	30.5	29.2	30.0	30.1
mean w	163	169	166	205	195	196	203	184	200	203	208	206	200	234	222	237	245	234	281	282	258	226	245	246
TS/ind	-42.8	-42.7	-42.7	-42.1	-42.3	-42.3	-42.2	-42.4	-42.2	-42.2	-42.1	-42.1	-42.2	-41.8	-41.9	-41.7	-41.6	-41.8	-41.2	-41.2	-41.5	-41.9	-41.6	-41.6
TS/kg	-34.9	-35.0	-34.9	-35.2	-35.2	-35.2	-35.2	-35.1	-35.2	-35.2	-35.3	-35.3	-35.2	-35.4	-35.4	-35.5	-35.5	-35.5	-35.7	-35.7	-35.6	-35.4	-35.5	-35.5

TABLE 11: Herring numbers and biomass by age, maturity and sub area. *Azalea* 14-29 July 1993

Category	Number x 10^{-6}	Mean length (cm)	Mean weight (g)	Biomass (tonnes x10^{-3})
Area I				
1 ring	0.64	21.00	87.23	0.06
2 ring immature	27.23	24.42	137.57	3.75
2 ring mature	420.19	25.52	157.14	66.03
3 ring immature	10.27	25.73	161.71	1.66
3 ring mature	63.66	26.74	181.44	11.55
4	20.49	27.61	200.10	4.10
5	22.02	28.90	228.10	5.02
6	19.23	28.93	229.03	4.40
7	1.74	31.70	301.07	0.52
8	0.00			
9+	0.80	29.00	229.80	0.18
Total	586.28	25.94	165.93	97.28
Area II				
1 ring	0.00			0.00
2 ring immature	20.88	25.09	149.72	3.13
2 ring mature	266.10	25.98	165.66	44.08
3 ring immature	66.11	25.99	166.34	11.00
3 ring mature	373.34	27.42	194.65	72.86
4	502.10	27.71	200.93	100.89
5	298.48	28.16	210.86	62.94
6	379.93	28.35	215.11	81.73
7	84.87	28.84	226.81	19.25
8	37.55	29.33	238.51	8.95
9+	26.27	29.76	249.16	6.54
Total	2056.62	27.64	200.02	411.37
Area III				
1 ring	2.04	19.58	71.33	0.15
2 ring immature	6.98	25.65	160.82	1.12
2 ring mature	54.36	27.28	193.02	10.49
3 ring immature	28.54	27.84	204.45	5.84
3 ring mature	137.54	28.39	216.58	29.79
4	130.88	28.95	229.67	30.06
5	231.75	29.63	246.67	57.17
6	486.68	29.82	251.27	122.29
7	210.92	30.35	264.70	55.83
8	123.76	30.42	266.50	32.98
9+	137.74	30.92	279.70	38.53
Total	1551.20	29.65	247.70	384.24
Total area				
1 ring	2.68	19.92	75.13	0.20
2 ring immature	55.09	24.83	145.12	7.99
2 ring mature	740.65	25.82	162.84	120.61
3 ring immature	104.91	26.47	176.26	18.49
3 ring mature	575.54	27.58	198.43	114.20
4	653.47	27.96	206.66	135.04
5	552.25	28.80	226.58	125.13
6	885.84	29.17	235.28	208.42
7	297.52	29.93	254.10	75.60
8	161.31	30.17	259.99	41.94
9+	164.81	30.72	274.59	45.25
Total	4194.09	28.14	212.89	892.88

TABLE 12: Survey area, number Nm, number trawl stations, mean Sa and TS by area *RV Dana*

Area	Areal Nm**2	Number Nm	Number trawl st	Mean Sa $*10^{-6}$	Mean TS $*10^{-5}$
560E06	4,350	18	0	2.398	0
570E04	3,871	161	4	6.833	4.784
570E06	3,600	452	6	9.469	3.345
570E08	3,406	324	9	7.861	4.392
580E04	3,072	160	3	7.641	2.539
580E08	1,822	153	4	6.127	3.208
C	988	14	2	4.87	2.224
D	1,837	204	4	9.378	5.306
E	5,228	22	4	11.44	2.834
Total	28,174	1,508	36		

TABLE 13: Trawl stations from survey by R/V *Dana*, 10-23 July 1993

Date	Trawl no	Time	Int sq	Trawl	Fishing depth (m)	Mean-depth (m)	Catch (kg)
10 07	0928	0200	44F9	Fotö	Overfladen	125	1,539
10 07	0947	0600	44F8	Fotö	300	520	20
10 07	1076	2240	46F5	Fotö	Overfladen	250	341
11 07	1095	0230	46F5	Fotö	Overfladen	250	540
11 07	1116	0908	46F5	Fotö	230	265	61
11 07	1214	1940	45F5	Fotö	121	295	76
11 07	1238	2300	45F5	Fotö	Overfladen	312	622
12 07	1253	0225	44F5	Fotö	Overfladen	193	685
12 07	1271	0530	44F5	Expo		105	712
12 07	1368	1830	44F5	Expo		125	3,800
13 07	1535	2130	43F8	Expo		21	129
13 07	1553	0030	44F8	Fotö	Overfladen	42	1,850
14 07	1569	0320	44F8	Fotö	Overfladen	130	2,025
14 07	1698	1730	44F9	Expo		180	645
14 07	1735	2300	44F8	Fotö	Overfladen	245	300
15 07	1761	0210	45F9	Fotö	Overfladen	405	699
16 07	1932	2330	45F6	Fotö	Overfladen	332	1,056
16 07	2055	1630	43F6	Expo		60	1,460
16 07	2102	2230	44F6	Fotö	Overfladen	150	570
17 07	2129	0230	44F6	Fotö	Overfladen	336	1,800
17 07	2249	1530	44F6	Expo		200	426
17 07	2315	2330	43F7	Fotö	Overfladen	177	3,312
18 07	2330	0230	43F7	Fotö	Overfladen	65	1,300
18 07	2460	1830	44F8	Expo		170	528
18 07	2488	2330	43F8	Fotö	Overfladen	65	3,082
19 07	2504	0230	44F8	Fotö	Overfladen	75	*507
19 07	2604	1446	45F9	Expo		160	987
19 07	2673	2330	45F9	Fotö	Overfladen	550	944
20 07	2688	0230	46F9	Fotö	Overfladen	600	724
20 07	2838	1920	45G0	Expo		190	924
20 07	2864	2320	44G0	Fotö	Overfladen	56	3,000
21 07	2880	0230	44G1	Fotö	Overfladen	86	*415
21 07	3004	1610	43G1	Expo		25	687
21 07	3062	2315	42G2	Expo	Overfladen	30	1,116
22 07	3084	0225	42G1	Expo	Overfladen	35	trawl itu
22 07	3176	1440	41G2	GOV		30	90
22 07	3209	1930	41G1	GOV		25	270
Total	37 hauls	23 Fotö	12 Expo	2 GOV			37,242

NB *½ hours stations

TABLE 14: Number (millions) of herring by age, R/V *Dana*, 10-23 July 1993

Area	0	1	2	3	4	5	6	7	8	9	>=10	Total
570E04	0	258	148	156	71	56	18	1	0	0	0	712
570E06	0	1,870	466	278	110	57	25	6	0	0	0	2,815
570E08	0	624	184	87	83	69	34	26	0	0	0	1,110
580E04	0	1,378	345	181	54	24	4	0	0	0	0	1,989
580E06	0	229	218	175	137	90	35	1	2	0	0	890
C	288	78	70	83	59	33	13	0	0	0	0	629
D	266	201	64	55	41	58	10	0	2	0	0	701
E	0	3,404	1,367	226	63	0	0	0	0	0	0	5,061
Total	554	8,042	2,862	1,241	618	387	139	34	4	0	0	13,907

TABLE 15: Spawning biomass (tonnes) of herring by age, R/V *Dana*, 10-23 July 1993

Area	0	1	2	3	4	5	6	7	8	9	>=10	Total
570E04	0	0	6,021	12,932	7,187	6,244	2,942	175	0	111	0	35,616
570E06	0	0	16,240	18,703	9,886	6,207	3,807	1,362	0	105	0	56,313
570E08	0	0	5,960	7,694	10,818	12,399	5,940	7,186	8	0	0	50,007
580E04	0	0	11,535	11,377	4,290	2,333	470	0	0	0	0	30,007
580E06	0	0	8,131	16,256	16,559	13,106	5,521	221	402	0	0	60,200
C	0	0	2,919	8,345	7,037	4,633	2,093	44	122	0	0	25,195
D	0	0	2,527	5,353	5,161	9,225	1,516	17	345	0	0	24,146
E	0	0	30,973	9,033	3,125	0	67	0	0	0	0	43,199
Total	0	0	84,306	89,693	64,063	54,147	22,355	9,005	877	216	0	324,683

TABLE 16: Biomass (tonnes) of herring by age, R/V *Dana*, 10-23 July 1993

Area	0	1	2	3	4	5	6	7	8	9	>=10	Total
570E04	0	16,006	12,042	15,215	7,187	6,244	2,942	175	0	111	0	59,927
570E06	0	108,426	32,481	22,004	9,886	6,207	3,807	1,362	0	105	0	184,281
570E08	0	28,362	11,920	9,052	10,818	12,399	59,40	7,186	8	0	0	85,687
580E04	0	81,324	23,071	13,384	4,290	2,333	470	0	0	0	0	124,875
580E06	0	11,349	16,262	19,125	16,559	13,106	5,521	221	402	0	0	82,549
C	1,072	2,575	5,838	9,818	7,037	4,633	2,093	44	122	0	0	33,236
D	1,084	6,935	5,054	6,297	5,161	9,225	1,516	17	345	0	0	35,638
E	0	121,908	61,947	10,627	3,125	0	67	0	0	0	0	197,675
Total	2,156	376,885	168,615	105,522	64,063	54,147	22,355	9,005	877	216	0	803,868

TABLE 17: Mean weight of herring by age, R/V *Dana*, 10-23 July 1993

Area	V0	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11
570E04	0	0.062	0.081	0.097	0.1	0.111	0.157	0.171	0	0.16	0	0
570E06	0	0.058	0.07	0.079	0.089	0.108	0.151	0.225	0	0.16	0	0
570E08	0	0.045	0.065	0.104	0.129	0.179	0.172	0.272	0.145	0	0	0
580E04	0	0.059	0.067	0.074	0.079	0.094	0.102	0	0	0	0	0
580E06	0	0.049	0.075	0.109	0.12	0.145	0.156	0.175	0.145	0	0	0
C	0.004	0.033	0.083	0.117	0.118	0.138	0.157	0.175	0.145	0	0	0
D	0.004	0.034	0.078	0.113	0.124	0.159	0.151	0.175	0.145	0	0	0
E	0	0.036	0.045	0.047	0.049	0	0.118	0	0	0	0	0

TABLE 18: Numbers (millions) and biomass (thousands of tonnes) by age and maturity by ICES area and east of 6°E

Age and maturity	Numbers (millions)						Biomass (thousands of tonnes)					
	VIa North	Autumn Sp. IVa	Autumn Sp. IVb	Autumn Sp. IVa&b	All fish east of 6°E	Baltic SSp west of 6°E	VIa North	Autumn Sp. IVa	Autumn Sp. IVb	Autumn Sp. IVa&b	All fish east of 6°E	Baltic SSP west of 6°E
0 ring					554.00						2.16	
1 ring	2.76	4347.05	1144.78	5491.82	6410.29	107.13	0.21	308.23	74.94	383.17	279.63	7.19
2 juvenile	52.57	942.54	756.73	1699.27	1185.71	319.78	7.66	102.96	73.18	176.14	66.76	28.88
2 mature	697.70	997.97	485.51	1483.48	1185.71	0.00	113.96	133.65	60.08	193.73	66.76	0.00
3 juvenile	105.81	534.64	152.39	687.03	135.97	315.01	18.72	72.46	17.91	90.38	11.54	35.16
3 mature	575.36	794.31	320.63	1114.94	770.40	0.00	114.33	132.99	46.81	179.81	65.39	0.00
4 ring	653.05	761.12	116.62	877.74	494.96	191.52	134.82	160.62	20.34	180.96	52.58	27.35
5 ring	544.00	653.86	120.23	774.09	308.20	149.88	122.89	156.37	20.58	176.95	45.57	24.30
6 ring	865.15	749.82	31.65	781.47	117.31	49.78	202.78	212.04	5.50	217.55	18.94	9.39
7 ring	284.11	508.89	36.74	545.63	33.94	44.43	72.07	149.13	7.11	156.24	8.83	10.87
8 ring	151.73	162.07	16.35	178.42	6.06	12.44	39.41	51.31	3.13	54.44	0.88	3.22
9 and older	156.18	115.54	0.25	115.79	0.65	0.00	43.12	39.37	0.05	39.43	0.10	0.00
Spring spawners	0.00	1192.69	110.33	1303.02	0.00		0.00	86.53	2.90	89.44	0.00	
Juvenile	4088.40	10567.80	3181.87	13749.67	11203.21	1189.96	869.98	1519.15	329.65	1848.79	619.14	146.36
Mature	161.13	5824.23	2053.90	7878.13	8285.97	741.92	26.59	483.65	166.04	649.69	360.08	71.23
Category Total	3927.27	4743.57	1127.98	5871.55	2917.24	448.04	843.39	1035.49	163.61	1199.10	259.05	75.13
Area Total	4088.40	11760.49	3292.20	15052.69	11203.21	1189.96	869.98	1605.68	332.55	1938.23	619.14	146.36

TABLE 19: Mean weight at age by ICES area

Age/Maturity	Mean weights (g)					
	VIa North	IVa autumn spawners	IVb autumn spawners	IVa&b autumn spawners	All fish east of 6°E	Baltic SSp west of 6°E
0 ring					3.89	
1 ring	74.61	70.05	65.36	69.11	43.43	67.10
2 juvenile	145.70	107.28	96.50	102.58	55.94	90.31
2 mature	163.34	130.92	122.86	128.33	55.94	
3 juvenile	176.95	134.62	117.14	130.73	84.17	111.62
3 mature	198.72	162.13	143.41	156.78	84.17	
4 ring	206.45	207.63	168.69	202.21	105.83	142.83
5 ring	225.90	236.51	167.64	225.43	148.37	162.14
6 ring	234.39	282.15	172.74	277.40	161.67	188.63
7 ring	253.68	293.02	193.46	286.29	260.78	244.71
8 ring	259.74	316.62	191.22	305.13	144.66	258.72
9 + older	276.11	340.64	193.02	340.20	160.07	
Spring spawners		60.85	19.20	56.84		
Total juvenile	165.00	81.62	80.55	81.35	43.30	96.01
Total mature	214.75	214.40	143.20	200.58	88.15	167.69
Catagory total	212.79	139.99	103.03	131.57	54.84	123.00
Area total	212.79	131.01	99.33	124.20	54.84	123.00

TABLE 20: Numbers of fish otolithed and examined for icthyophonus infection and percentage infection rate by age class for *Scotia* Surveys in 1992 and 1993. (Column 4 is derived a using global length stratified age length infection key, and a global length key derived from the complete *Scotia* survey)

Age class	*Scotia* 1992 Survey			*Scotia* 1993 Survey		
	Total number of otoliths taken by age	Numbers of infected fish by age	Percentage infection rate	Total number of otoliths taken by age	Numbers of infected fish by age	Percentage infection rate
1	82	0	0.0	78	0	0.0
2	260	0	0.0	689	1	0.1
3	115	1	0.7	668	5	0.6
4	125	3	5.0	348	13	3.4
5	187	11	12.3	360	27	8.3
6	162	11	14.2	558	26	5.0
7	54	0	0.0	345	10	3.0
8	25	2	11.3	113	6	4.8
9	19	0	0.0	90	7	6.9
Total	1,029	28	5.6	3,249	95	2.8

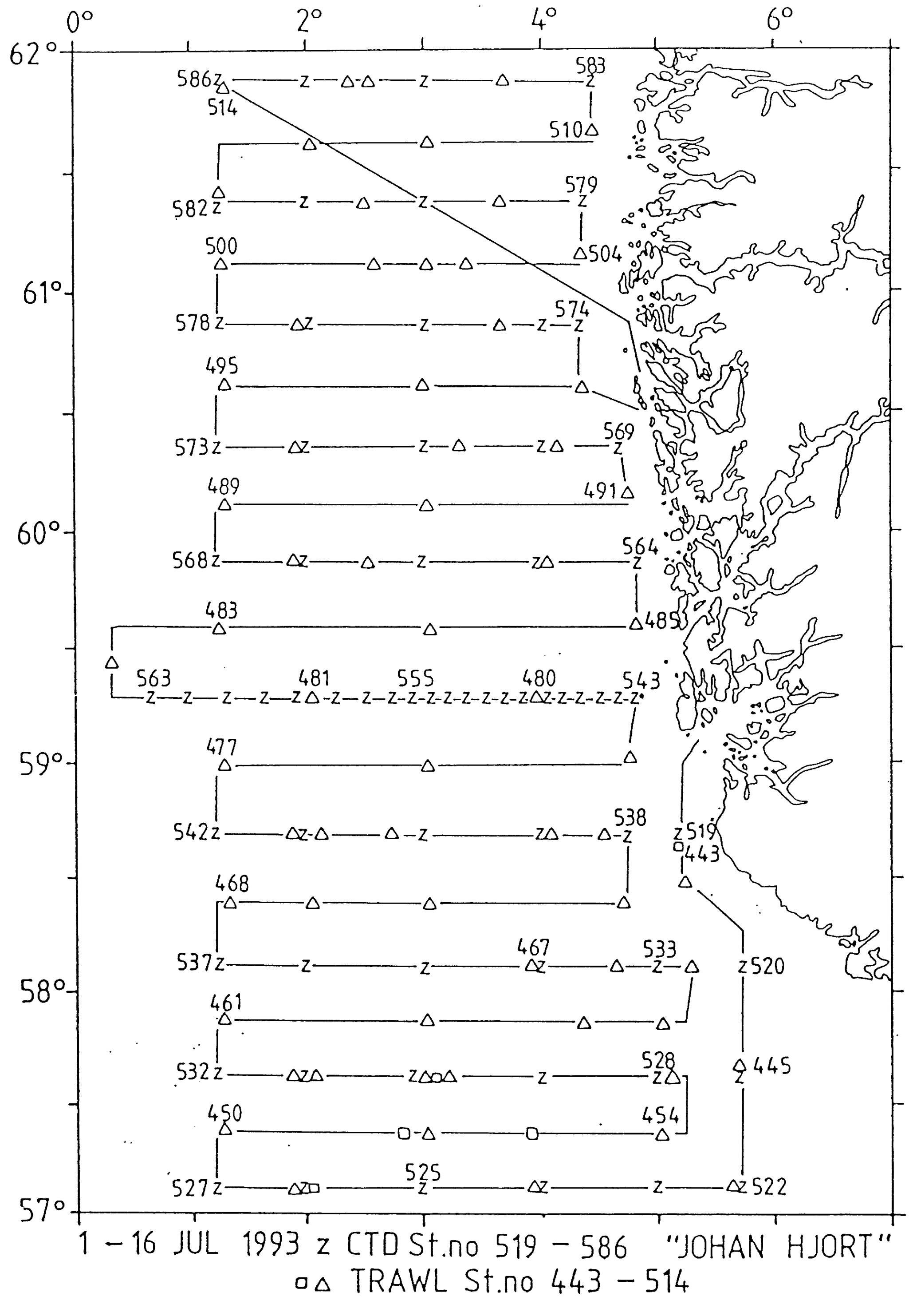


Figure 1 Cruise track CTD and trawl stations for survey by *Johan Hjort* 1-16 July 1993.

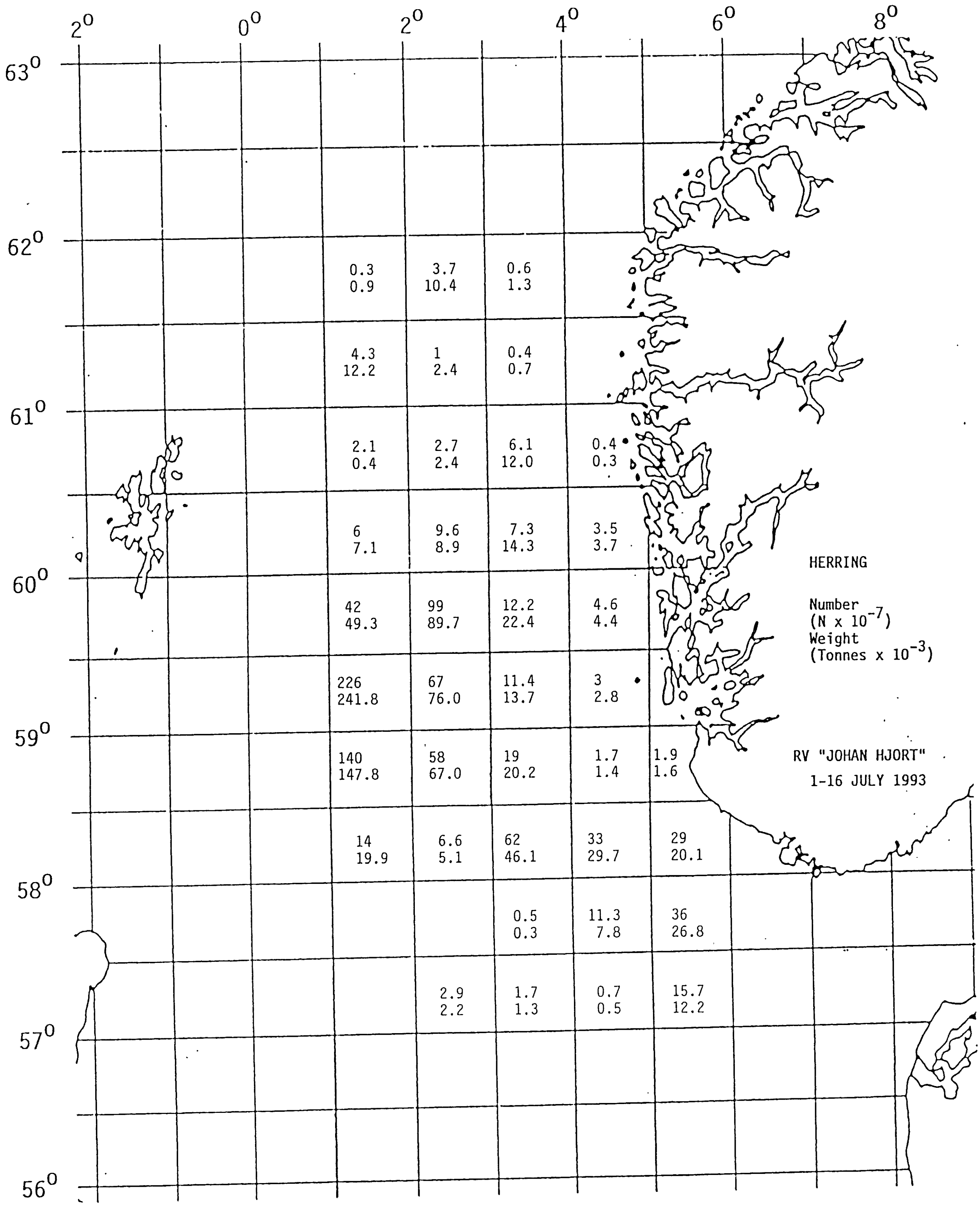


Figure 2 Numbers (millions) and biomass (thousands of tonnes) of herring from survey by *Johan Hjort* 1-16 July 1993.

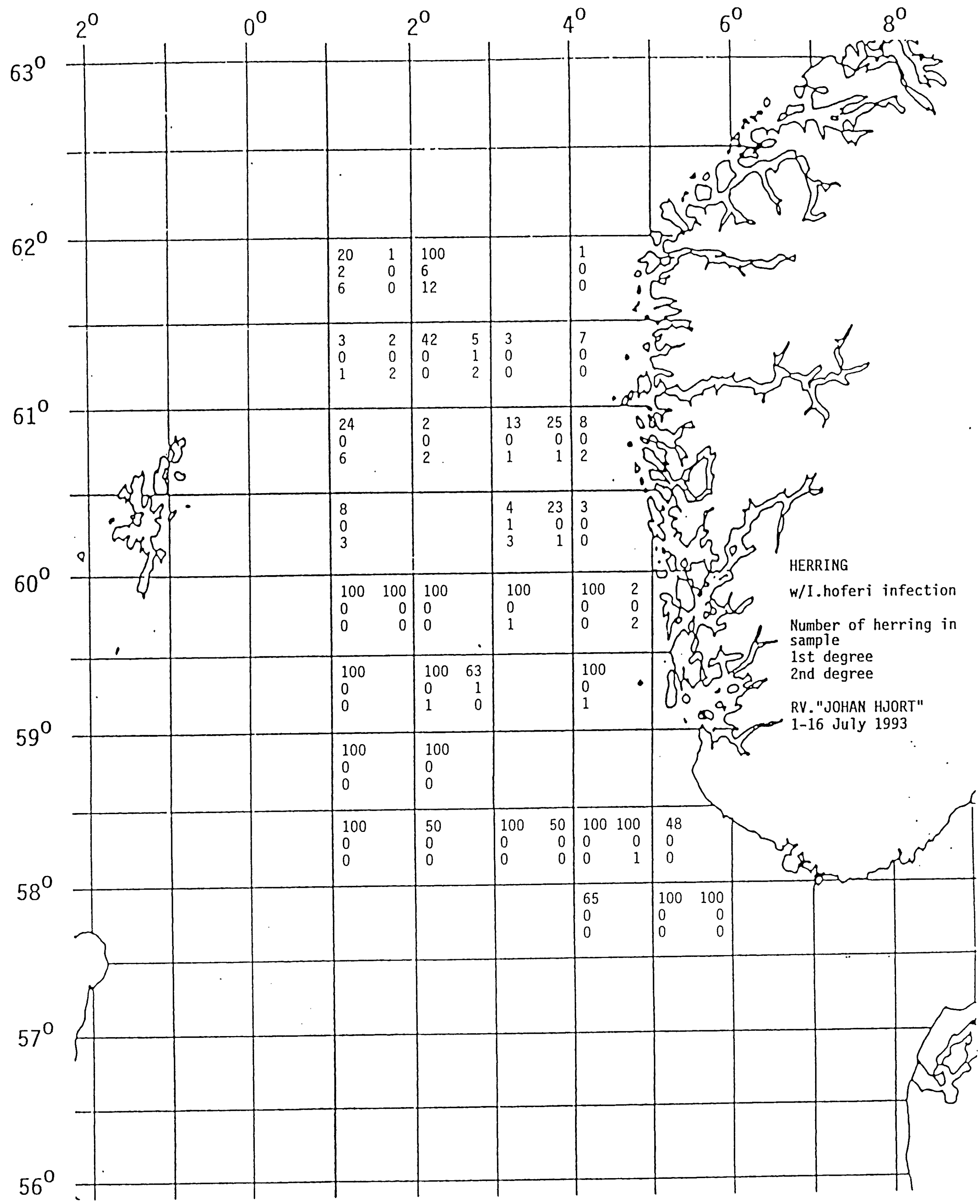


Figure 3 Ichthyophonus infection. Numbers of herring sampled and found infected from survey by *Johan Hjort* 1-16 July 1993.

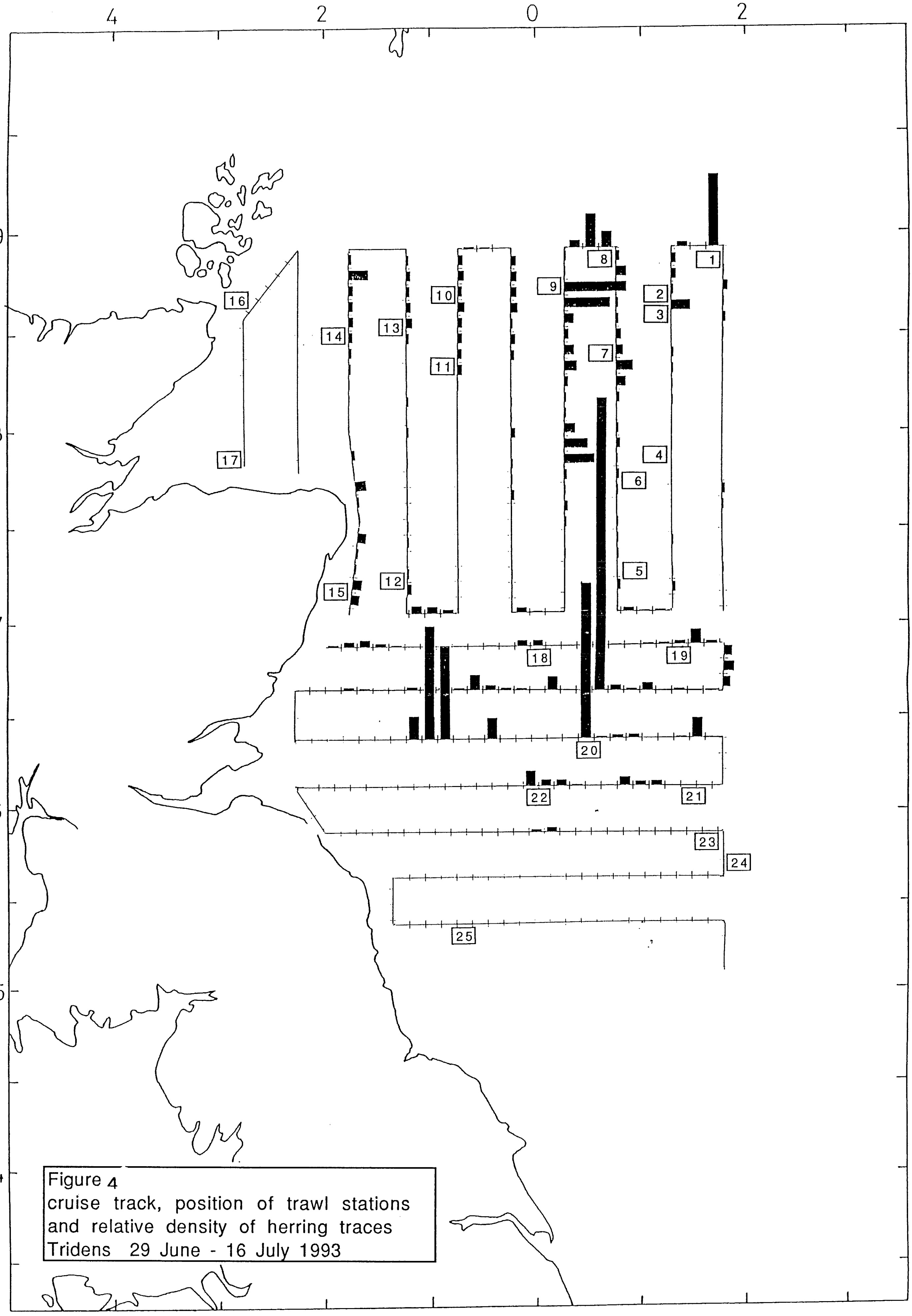


Figure 4
cruise track, position of trawl stations
and relative density of herring traces
Tridens 29 June - 16 July 1993

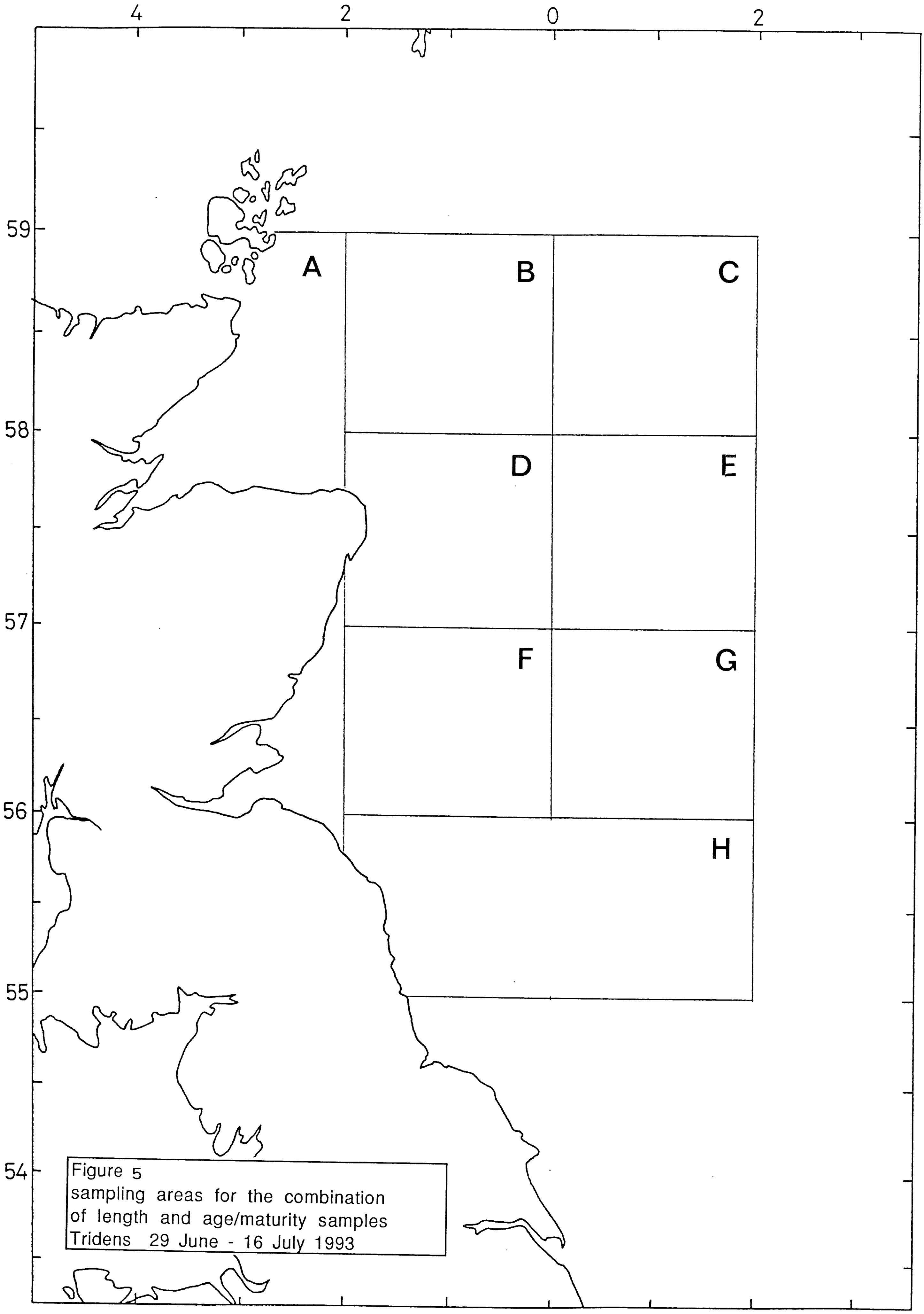


Figure 5
sampling areas for the combination
of length and age/maturity samples
Tridens 29 June - 16 July 1993

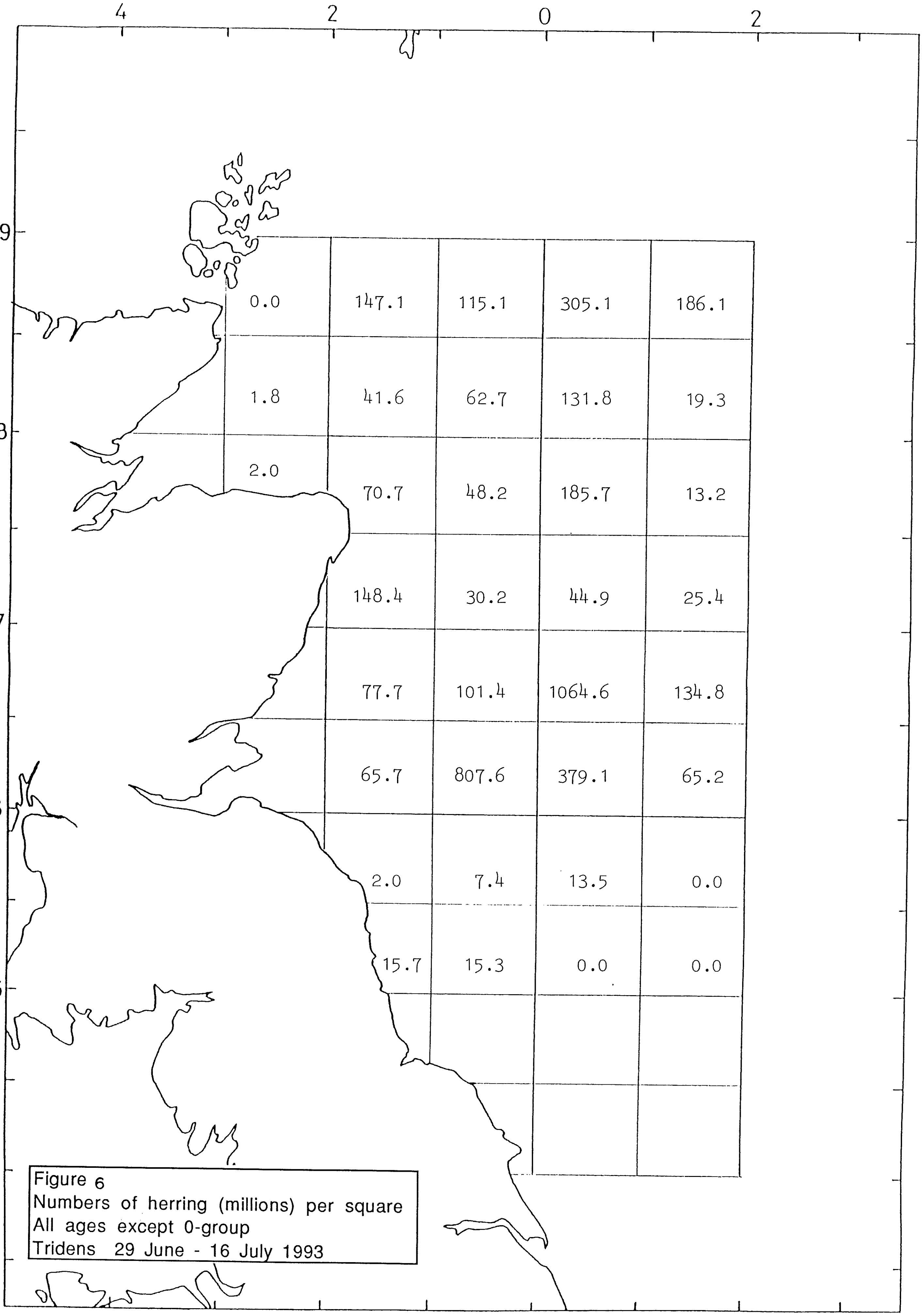


Figure 6
Numbers of herring (millions) per square
All ages except 0-group
Tridens 29 June - 16 July 1993

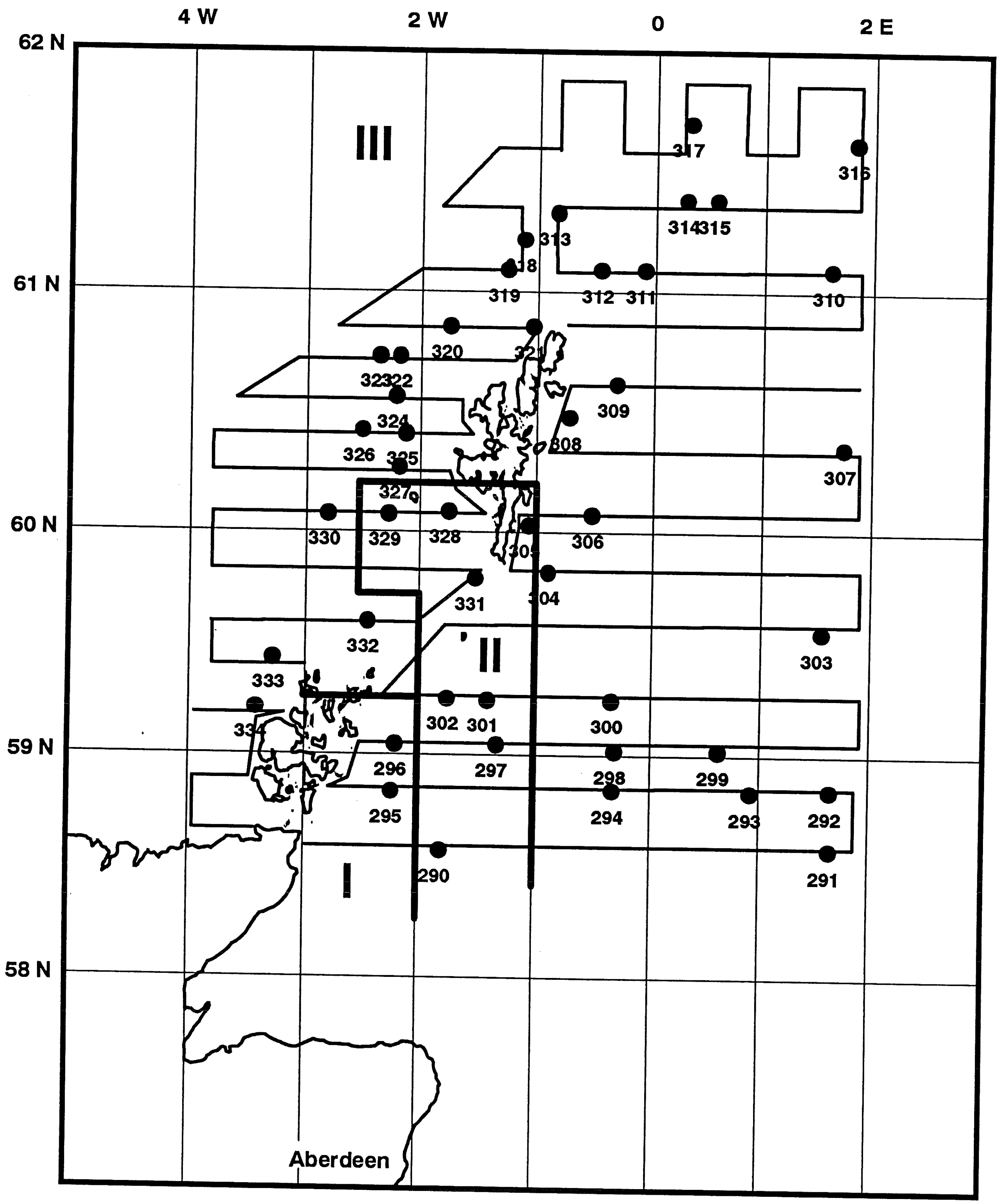


Figure 7. Scotia Survey 10-30 July 1993 Cruise track, trawl stations and sub areas used for data analysis.

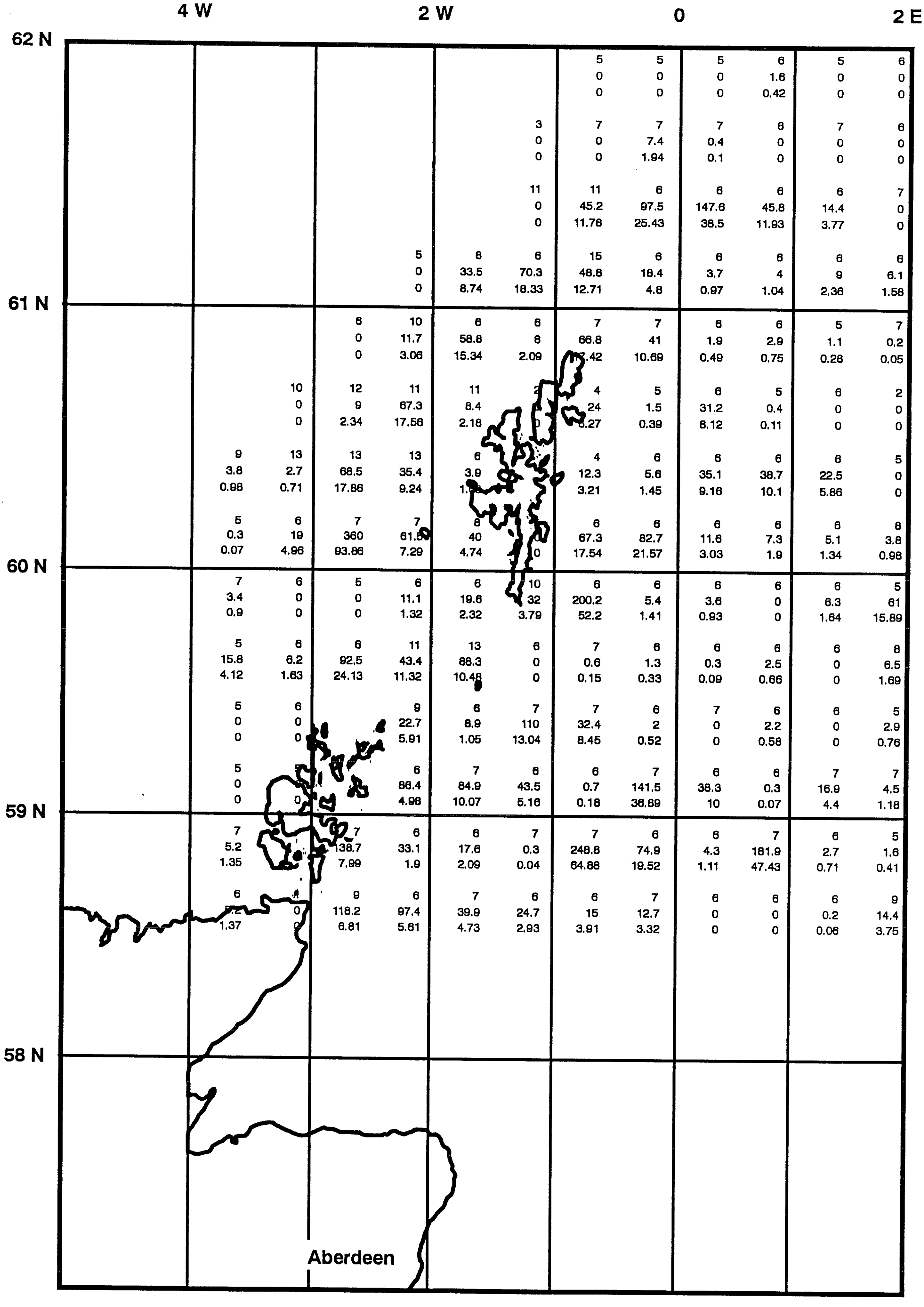


Figure 8. Scotia Survey 10-30 July 1993 15 min runs, Numbers (millions) Biomass (thousands of tonnes).

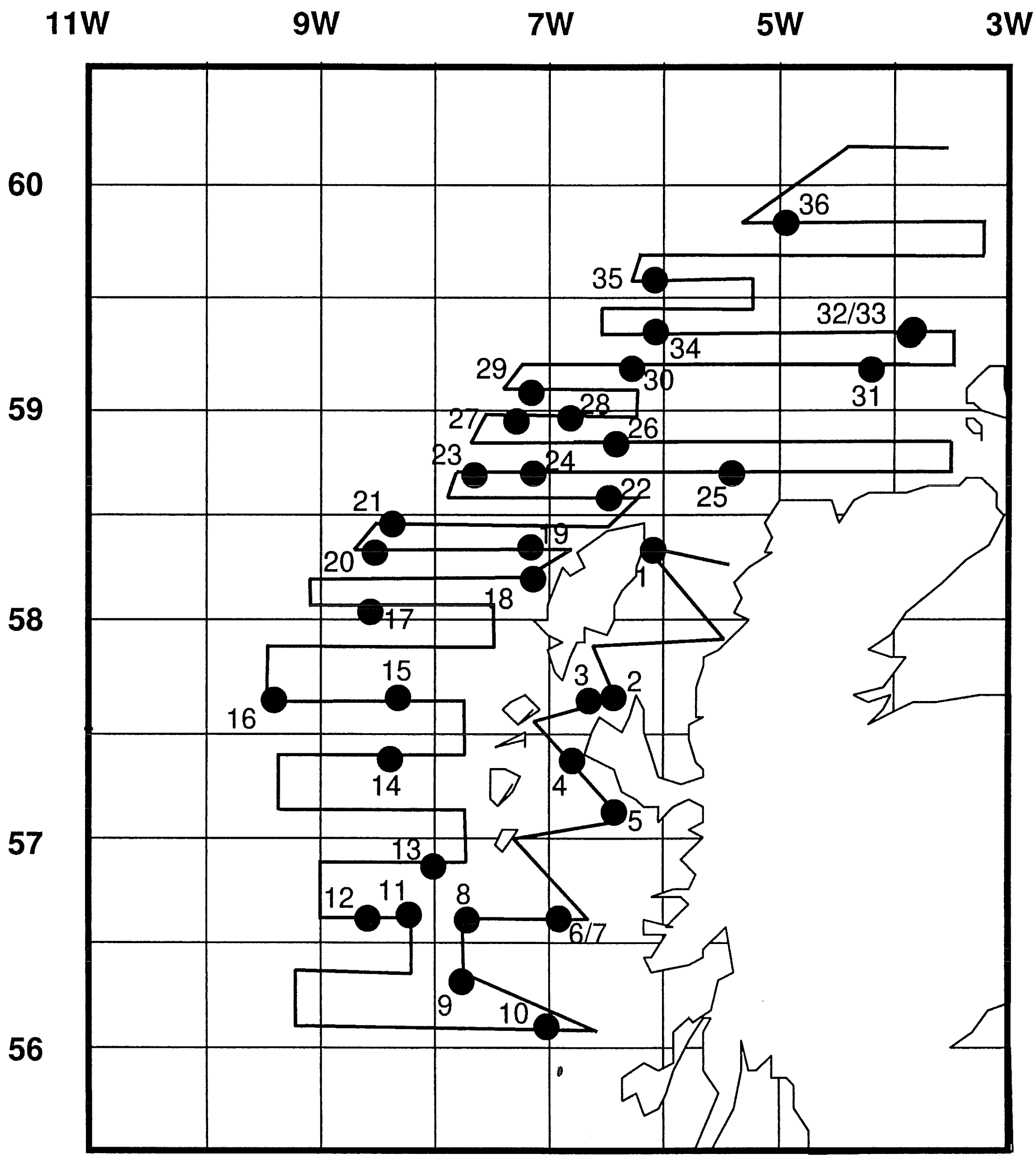


Figure 9. Survey track and trawl stations. Azalea 14 - 29 July

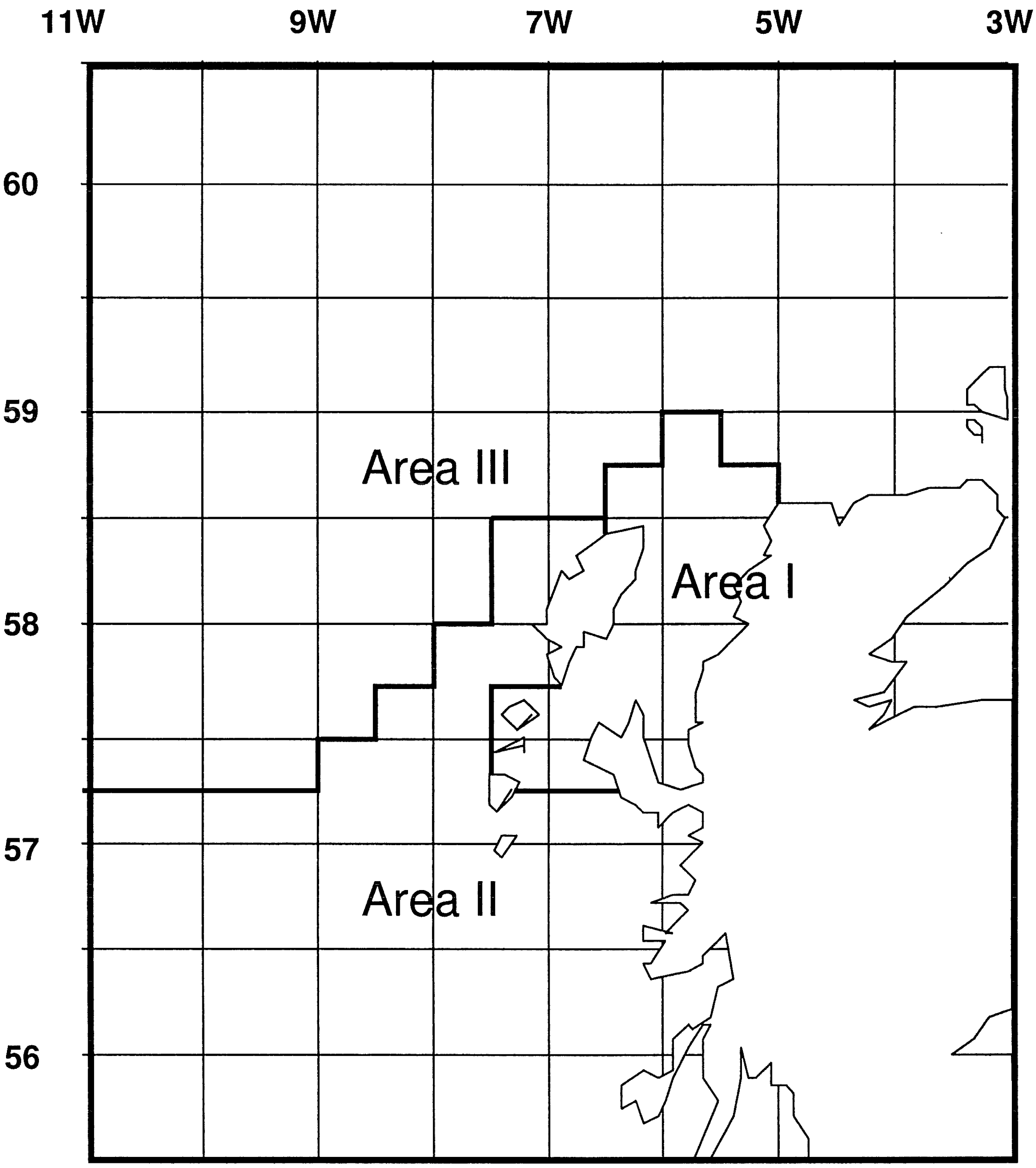


Figure 10. Herring area sub-divisions. Azalea 14 - 29 July

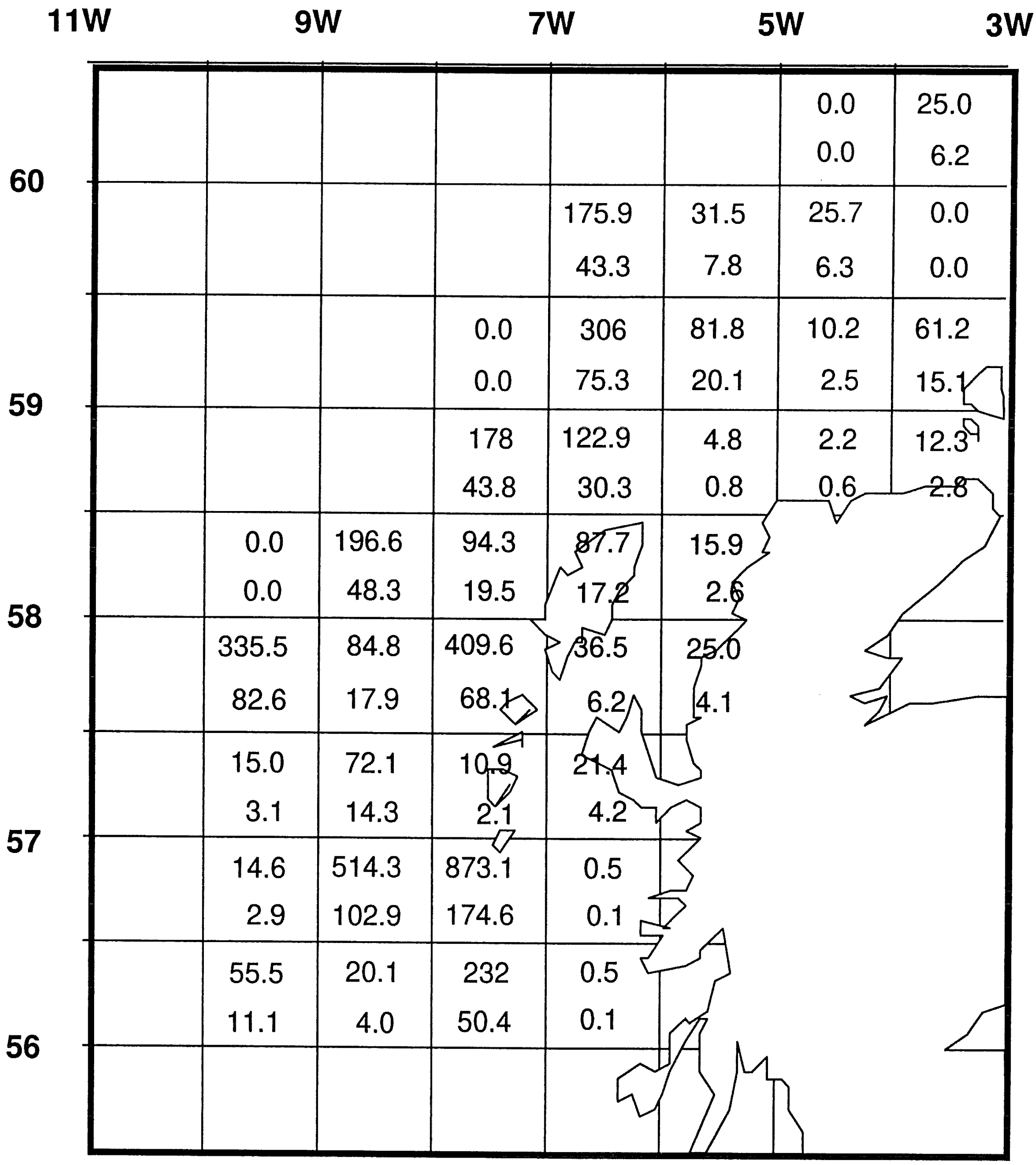
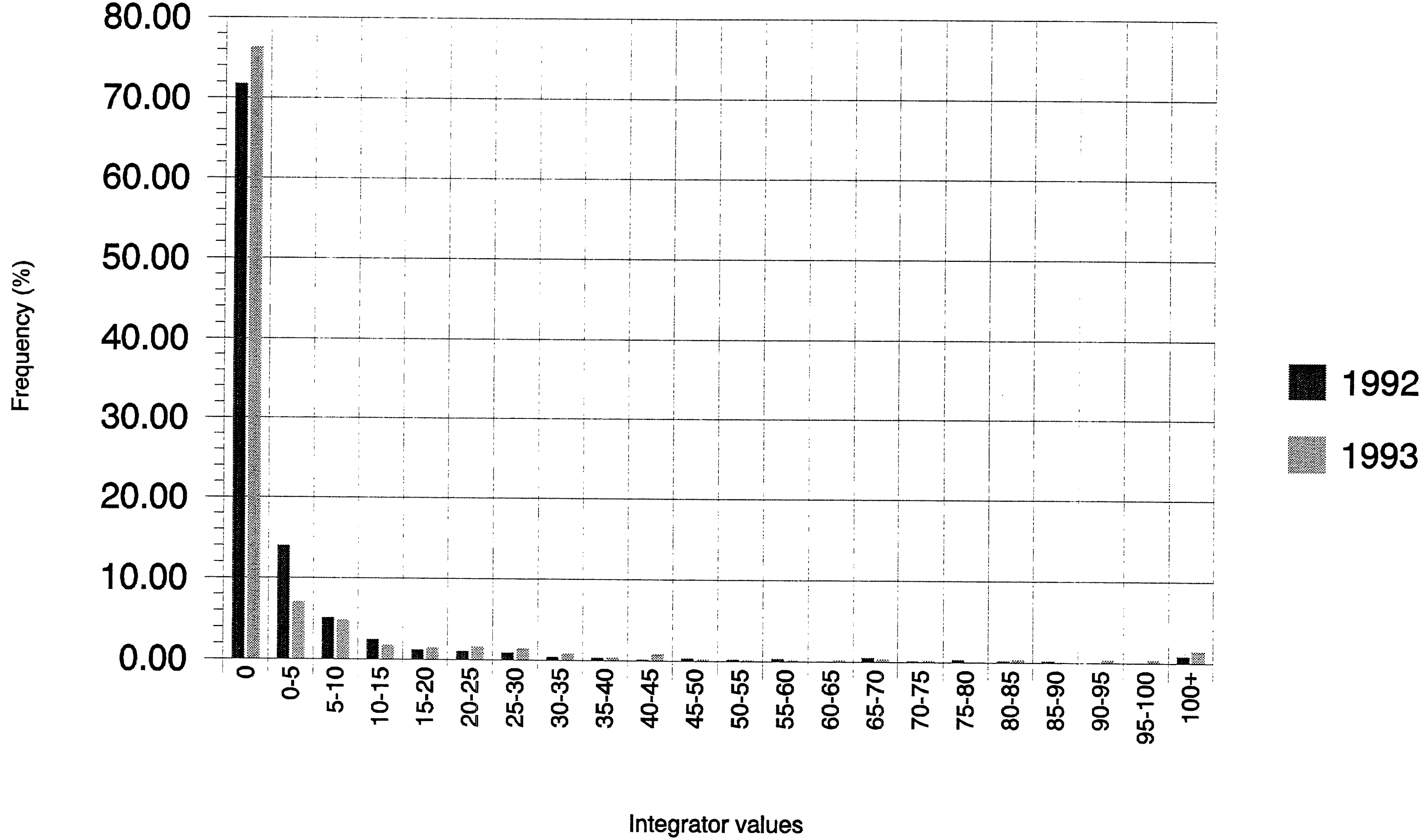


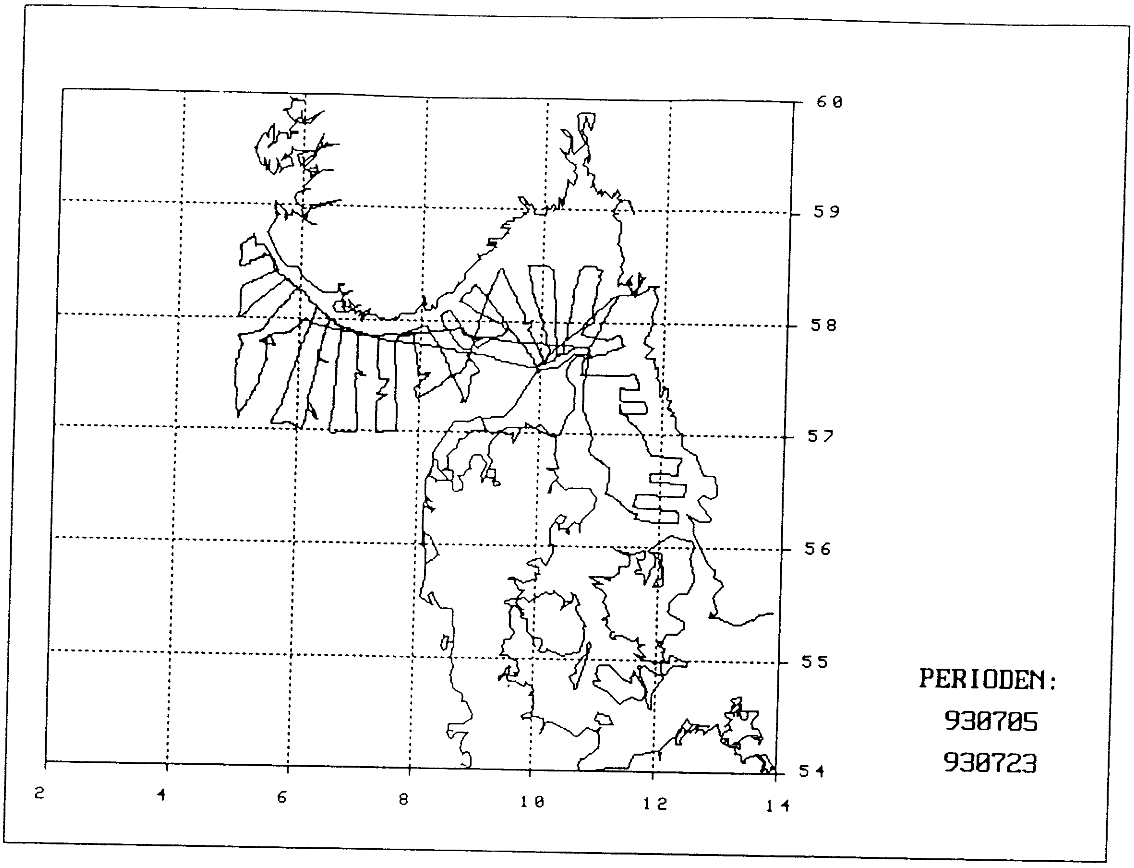
Figure 11. Herring abundance (millions) top

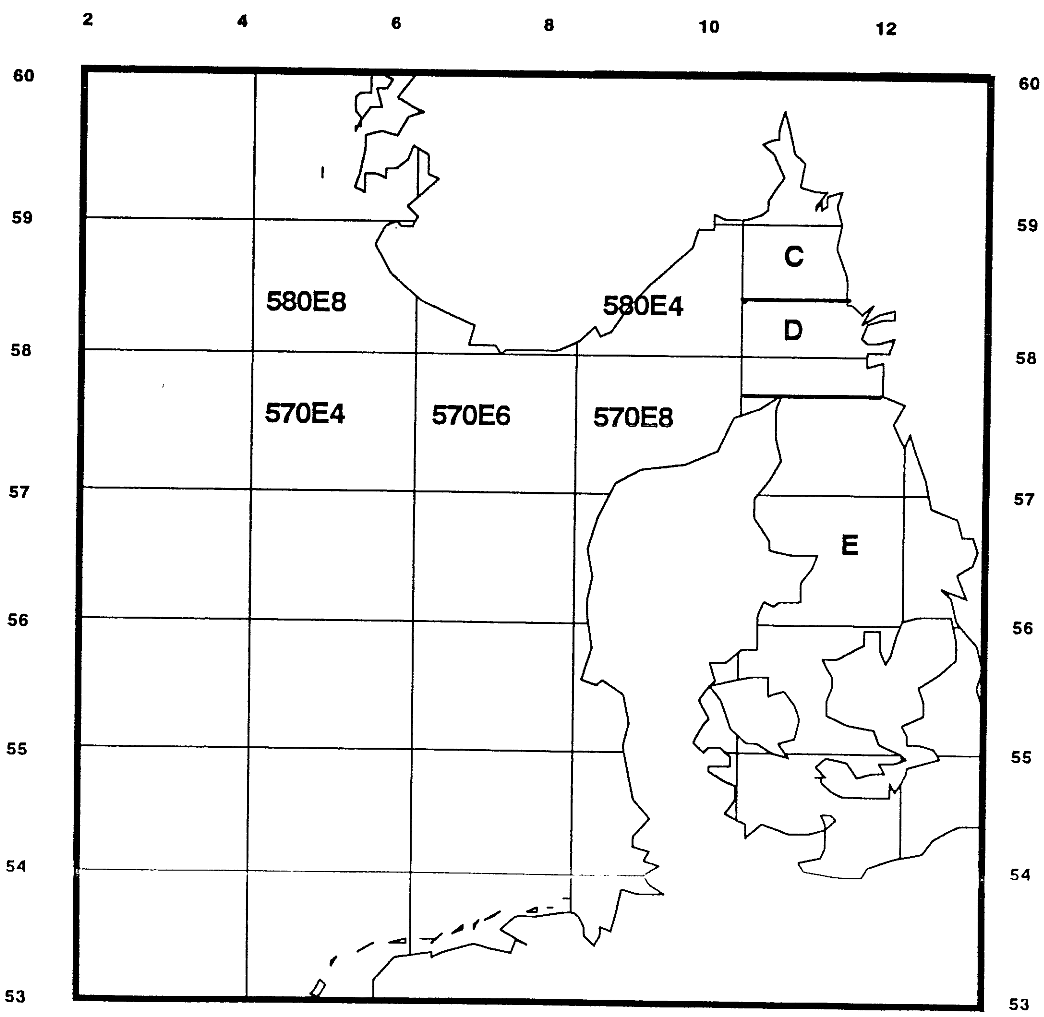
and biomass (thousands of tonnes) bottom

Azalea 14 - 29 July

Figure 12. Frequency histogram of herring integrator values for surveys of area Via(N) in 1992 and 1993







Fugure 13. Cruise track and analysis areas fro DANA survey 5-23/7/93

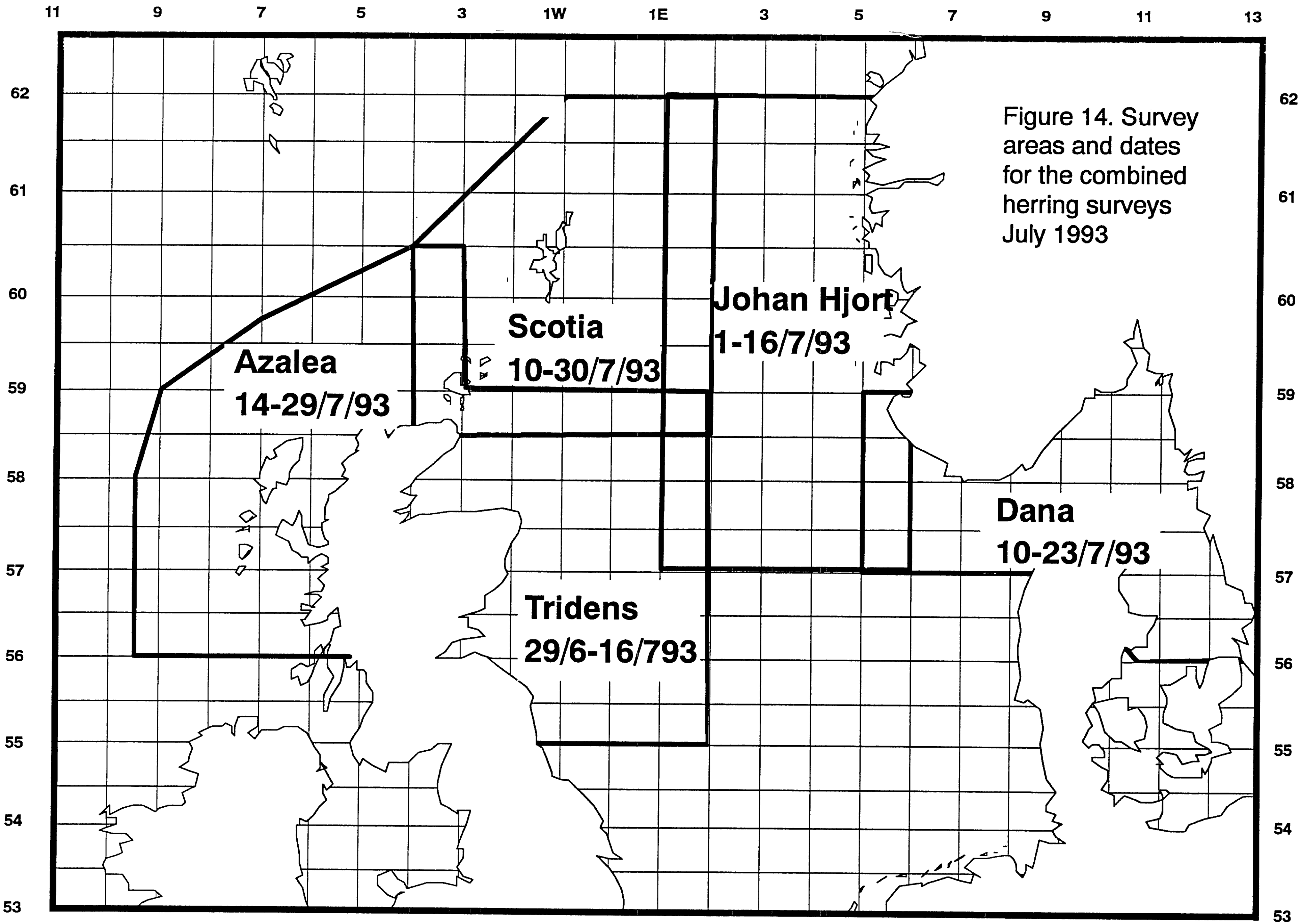


Figure 14. Survey areas and dates for the combined herring surveys July 1993

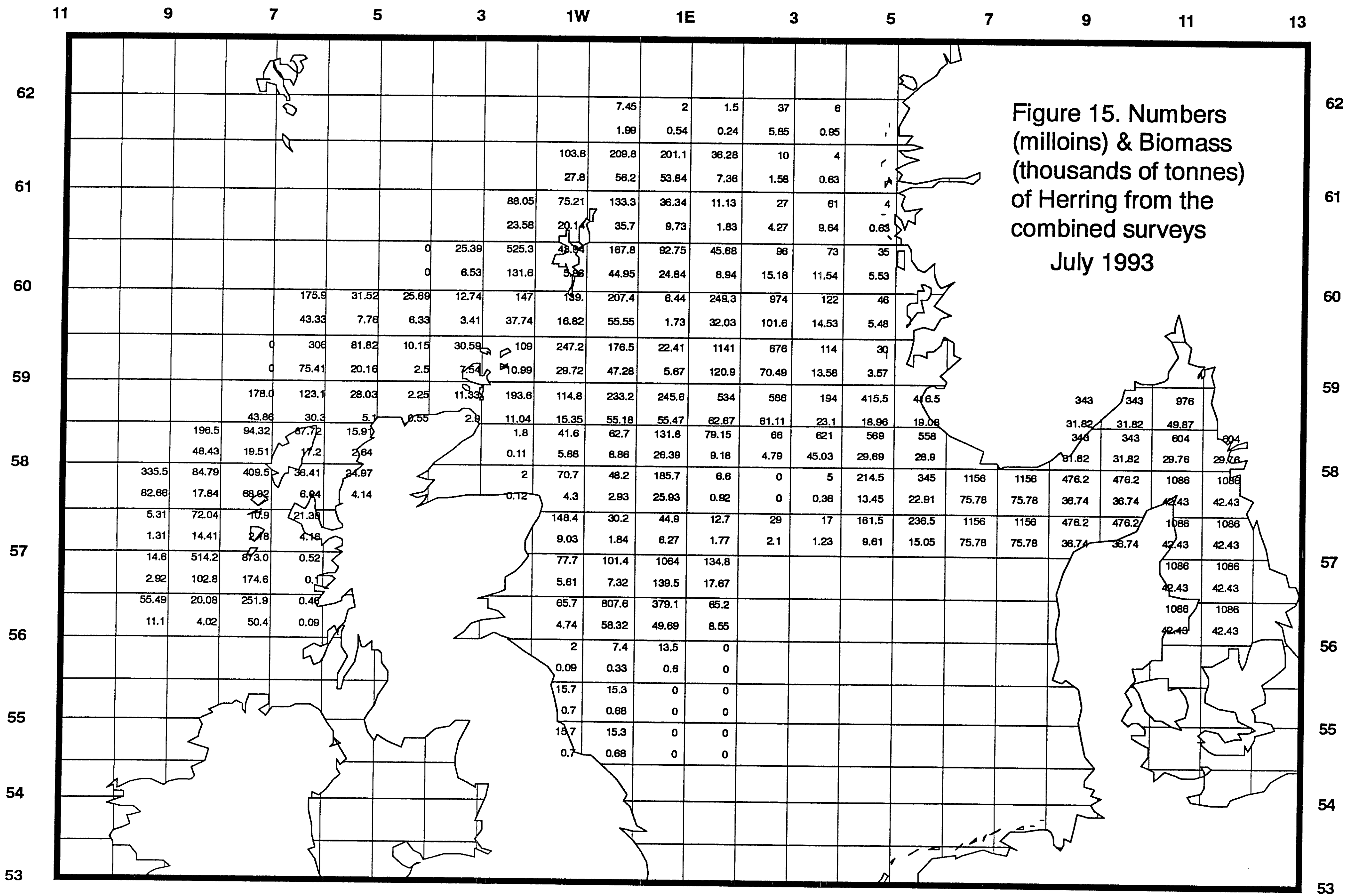


Figure 15. Numbers (milloins) & Biomass (thousands of tonnes) of Herring from the combined surveys July 1993

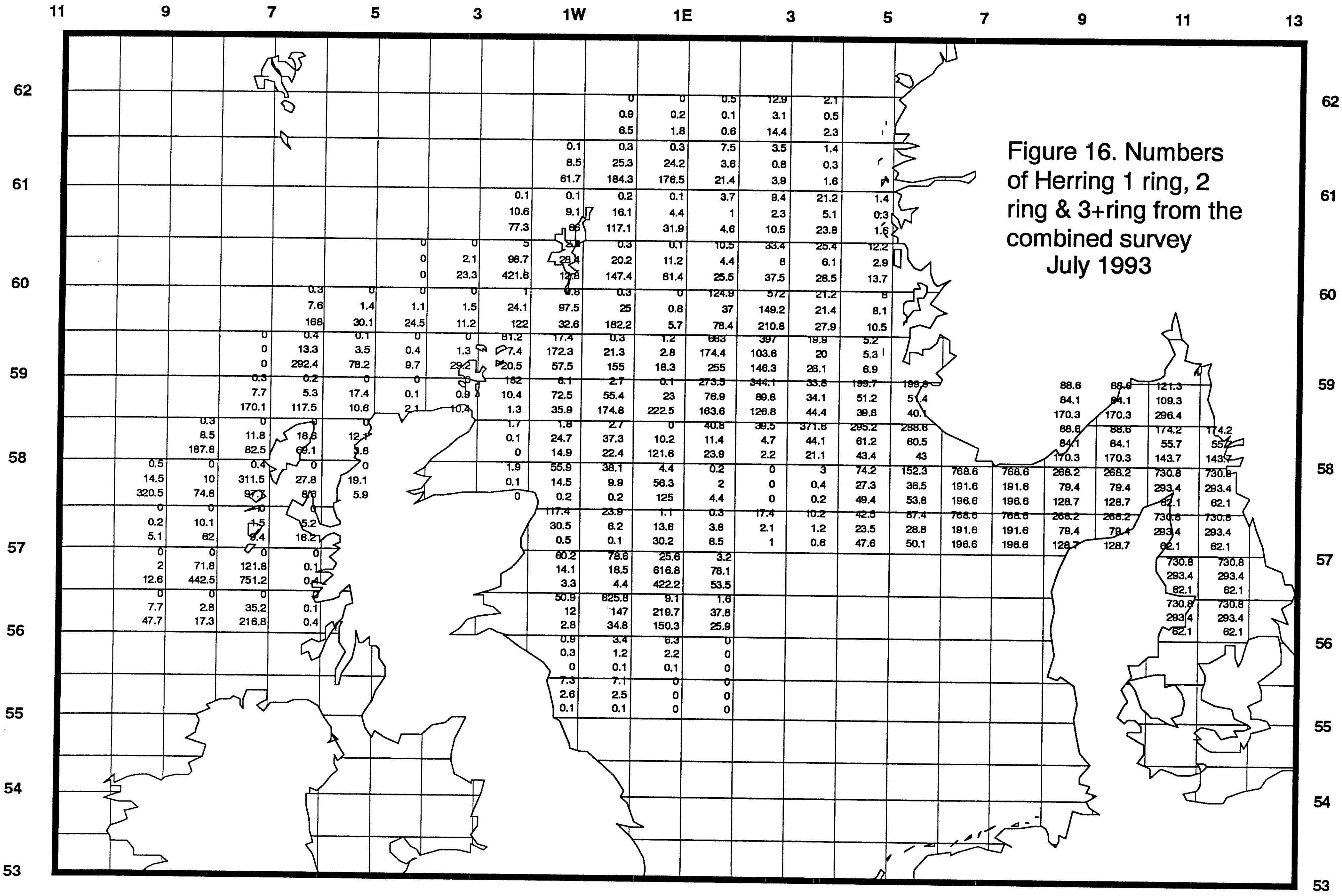


Figure 16. Numbers of Herring 1 ring, 2 ring & 3+ring from the combined survey July 1993

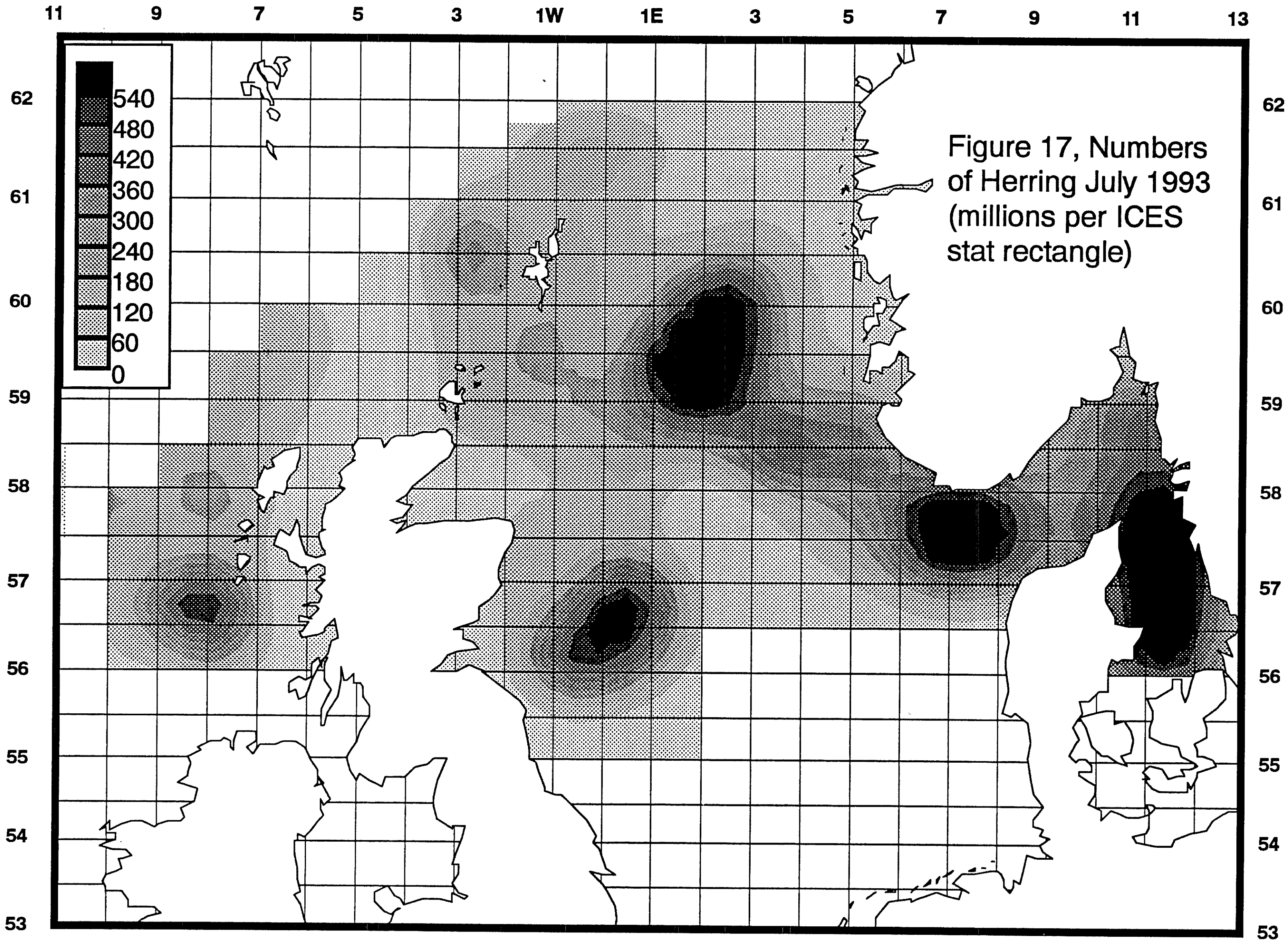


Figure 17, Numbers of Herring July 1993 (millions per ICES stat rectangle)

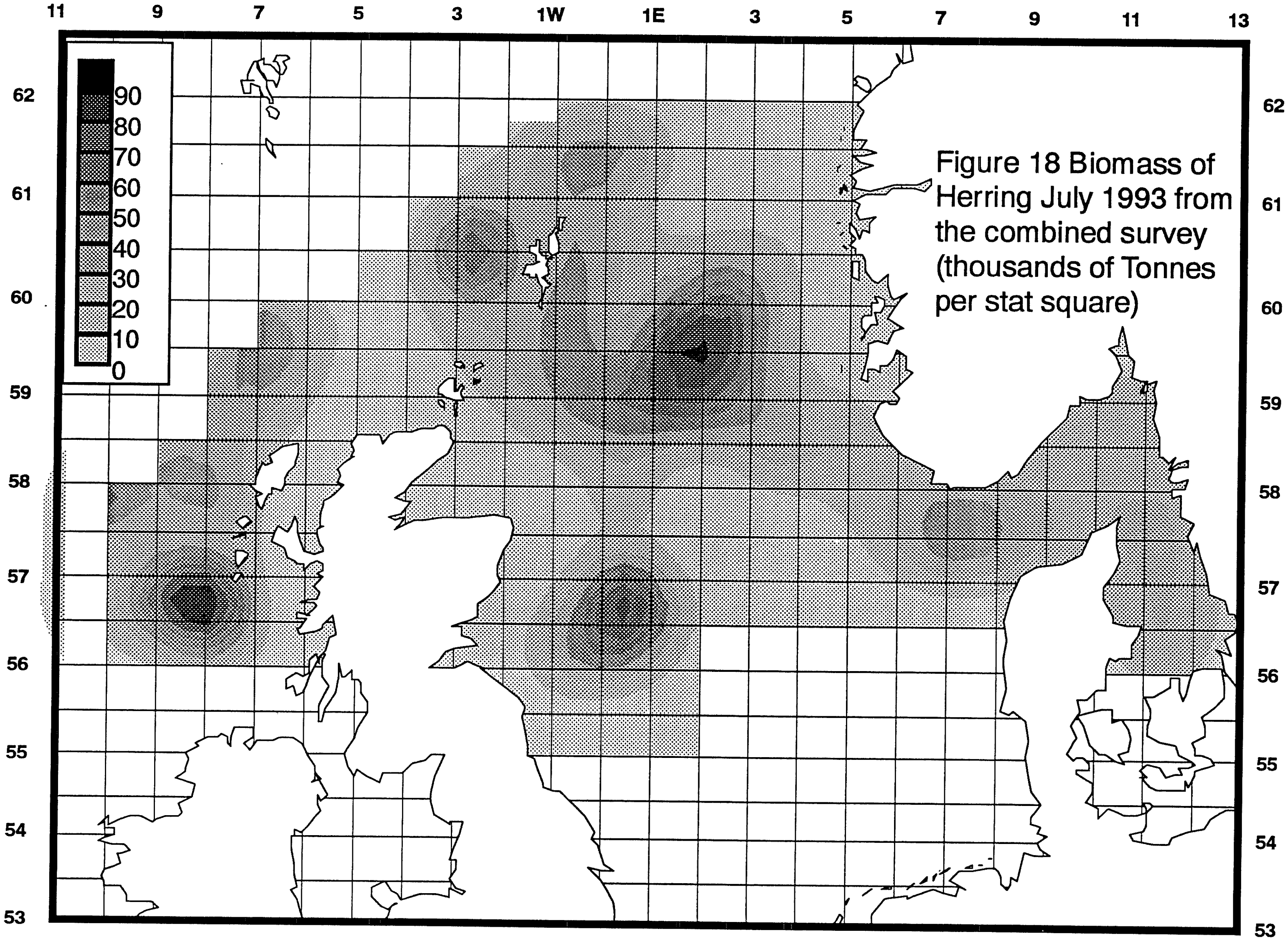


Figure 18 Biomass of Herring July 1993 from the combined survey (thousands of Tonnes per stat square)

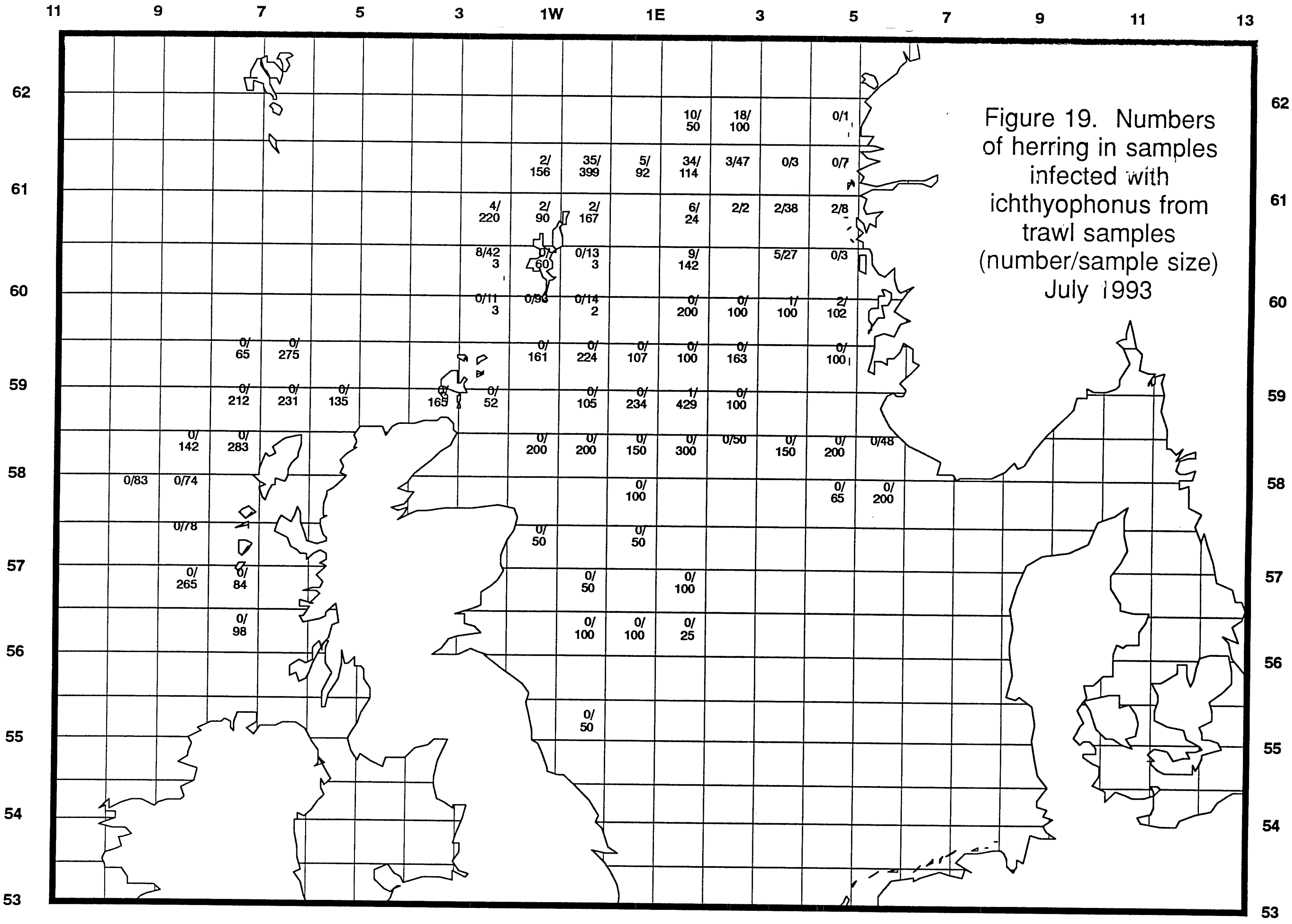


Figure 19. Numbers of herring in samples infected with ichthyophonus from trawl samples (number/sample size) July 1993

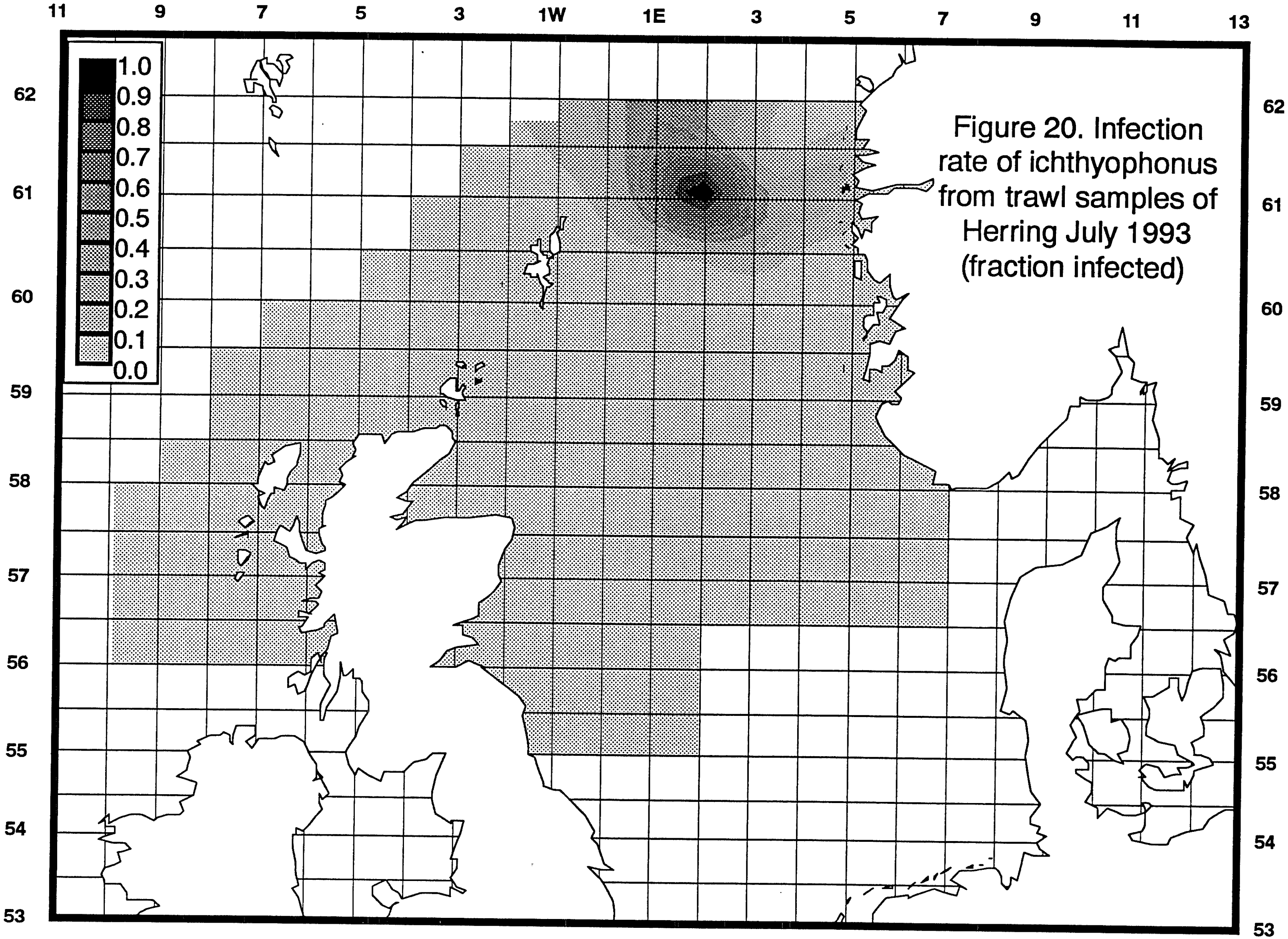


Figure 20. Infection rate of ichthyophonus from trawl samples of Herring July 1993 (fraction infected)

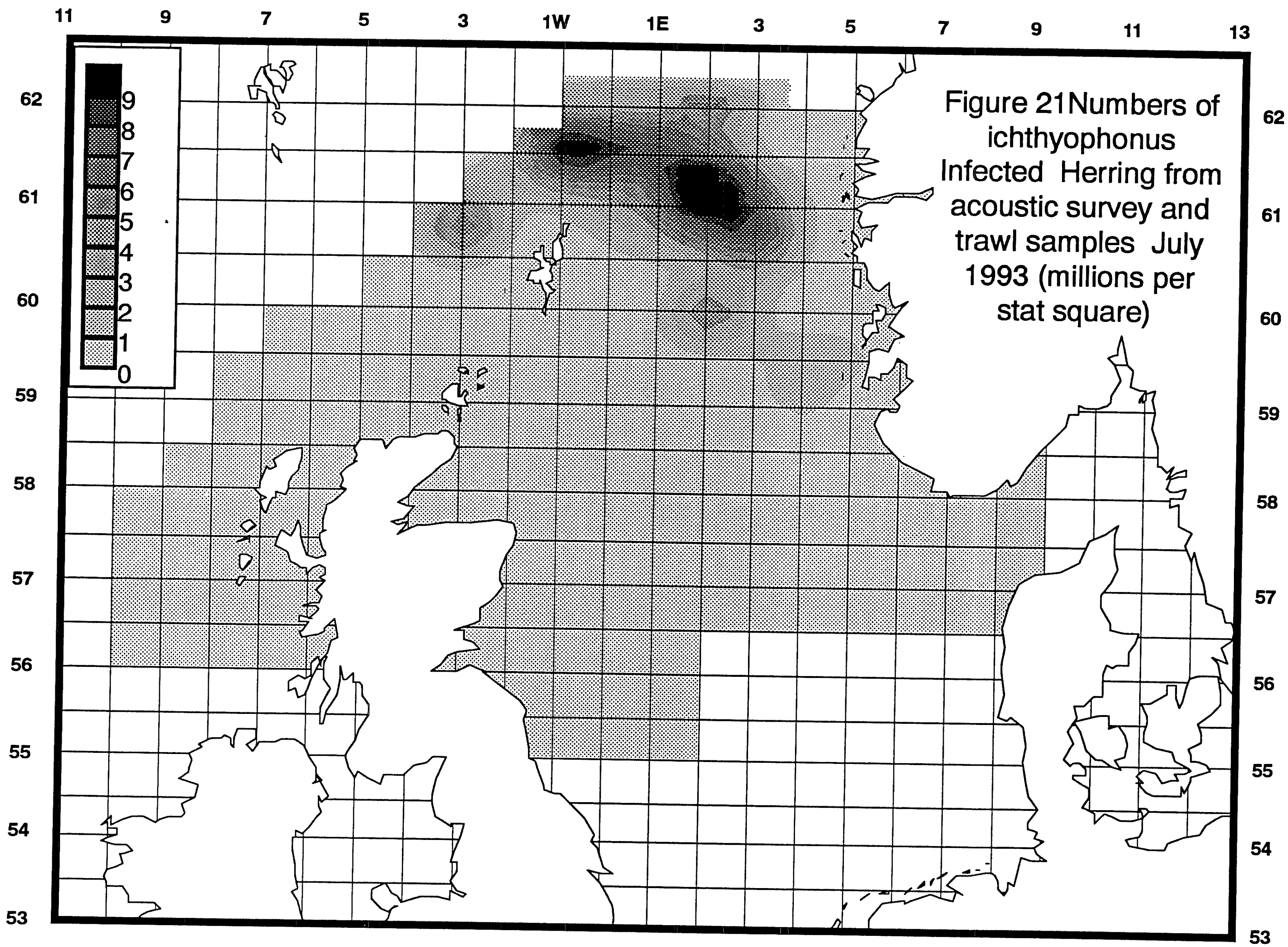


Figure 21Numbers of ichthyophonus Infected Herring from acoustic survey and trawl samples July 1993 (millions per stat square)
9
8
7
6
5
4
3
2
1
0
11
9
7
5
3
1W
1E
3
5
7
9
11
13
62
61
60
59
58
57
56
55
54
53