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# 1996 ICES COORDINATED ACOUSTIC SURVEY OF ICES DIVISIONS IIIa, IVa, IVb and VIa

DRAFT FOR HERRING ASSESSMENT WORKING GROUP
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## SUMMARY

Seven surveys were carried out during late June and July covering most of the continental shelf north of 54°N in the North Sea and Ireland 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 from the data from all seven surveys. The combined survey results provide spatial distributions of herring abundance by number and biomass at age by stat rectangle.

## METHODS

Seven surveys were carried out during late June and July covering most of the continental shelf north of 54°N in the North Sea and Ireland 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 from the data from all seven surveys.

## SURVEY REPORT FOR FRV *SCOTIA* IN THE NORTHERN NORTH SEA
13-31 JULY 1996
E J Simmonds, FRS Marine Laboratory, Aberdeen, Scotland

### 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. 1) was selected to cover the area in one levels 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 with the exception of a section east and west of Shetland where short additional transects were carried out at 7.5 nm spacing. On the administrative boundaries of 1°E and 4°W the ends of the tracks were positioned at ½ 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. Where 7.5 nm spacing was used the same random origin was used.

Trawl hauls (positions shown in Fig. 1) 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 five per 0.5 cm class below 24 cm, and 10 per 0.5 cm class for 25 cm and above. The same fish were sampled for sex maturity and macroscopic evidence of Ichthyophonus infection. Fish weights were collected at sea from both a random sample of 50 fish and for length stratified sampling on all hauls.

Data from the echo integrator were summed over quarter hour periods (2.5 nm at 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" 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 1996 survey 82% of the stock by number was attributable to the "herring traces" and 8% to the "probably herring traces" and 10% to the shallow herring schools. The third category which gave 10% of total fish was attributable to particularly to Norway pout in the south of the area and mixtures of herring and whiting north of Orkney. Apart from these two locations the rest of the fish species in the area were either easily recognisable 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 2% of the total fish biomass. Generally herring were found in waters where the seabed was deeper than 100 m, except close to Orkney. The area to the east of Orkney between 1°W and 1°E also contained large numbers of young Norway pout.

During the survey the towed body was lost and had to be replaced, two calibrations were carried out on each of the two transducer and cable systems used during the survey. Agreement between calibrations on the same systems was better than 0.09 dB. The performance difference between the two systems was 0.25 dB and compensation factor of 1.06 was used to correct for this. 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:

$$W = 0.153\ 10^{-3}\ L^{3.541} \text{ g L measured in cm}$$

**Survey Results**

A total of 42 trawl hauls were carried out (Fig. 1), the results of these are shown in Table 1. 27 hauls with significant numbers of herring were used to define three survey sub areas (Fig. 1). The mean length keys, mean lengths, weights and target strengths for each haul and for each sub area are shown in Table 2, 3,973 otoliths were taken to establish the three age length keys. The numbers and biomass of fish by ICES statistical rectangle are shown in Figure 2. A total estimate of 6,782 million herring or 1,376 thousand tonnes was calculated for the survey area. 1,285 thousand 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 300 m depth for most of the western and northern edge between 0° and 4°W. Herring were generally found in similar water depths to 1995 however, the distributions were more dense to the east and north of Shetland and the west of Orkney and an absence of schools in the south of the area. Table 3 shows the numbers mean lengths weights and biomass of herring by sub area by age class.

In addition to the 6,782 of herring, approximately 780 million 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 Norway pout. The proportions of mature 2 ring and 3 ring herring were estimated at 71% and 99% respectively. This is a lower proportion for 2 ring mature than those found in 1995. Only two of the 3,973 herring examined for Icthyophonus were found with macroscopic signs of infection.

## SURVEY REPORT RV *GO SARS*
## 25 JUNE - 14 JULY 1996

### Objectives

Abundance estimation of herring and sprat in the area between latitudes, 57°00'N and 62°00'N and between longitudes 01°00'E and 07°00'E. Map the general hydrographical regime and monitor the standard profiles, Utsira - Start Point, Feie - Shetland.

### Participation

A L Johnsen, K Strømsnes, B V Svendsen, H Søiland, R Toresen (crl), E Torstensen, H Hammer, E Øvretveit

### Schedule

The survey started in Bergen, 25 June 1996. A calibration of the echo sounder was done in a nearby fjord the same day. A call was made in Lerwick, Shetland on 27 June and in Aberdeen on 12 July. The survey was finished in Bergen on 14 July. It was good weather conditions during the whole survey period.

The survey started in north by doing systematic parallel transects, 15 nm apart, north-south. In the central and southern part of the survey area the investigations were carried out systematic parallel transects in the east-west direction. South of 58°30'N the distance between the transects was 20 nm.

### Survey Effort

Figure 3 shows the cruise track with fishing stations and the hydrographic profiles. Altogether 3,000 nm were surveyed and the total number of trawl hauls were 99, 93 pelagic and six on bottom. The number of CTD stations for temperature, salinity and density measures were 114.

### Methods

The catches were sampled for species composition, by weight and numbers. Biological samples, ie length and weight compositions were taken of all species. Otoliths were taken of herring, sprat and mackerel for age determination. Herring were also examined for fat content and maturity stage in the whole area, and vertebral counts for the separation of autumn spawning herring and Baltic spring spawners in the area to the east of 03°00'E.

The acoustic instruments applied for abundance estimation were a SIMRAD EK500 echo sounder and the Bergen Echo Integrator system (BEI). The setting of the instruments were as follows:

| | |
|---|---|
| Absorption coeff | 10 dB/km |
| Pulse length | medium |
| Bandwidth | wide |
| Max power | 4,000 W |
| Angle sensitivity | 21.9 |
| 2-way beam angle | -21.0 dB |
| Sv transd gain | 25.3 dB |
| TS transd gain | 25.3 dB |
| 3 dB beamwidth | 7° |
| Alongship offset | -0.09° |
| Athw ship offset | 0.10° |

Sounder: ES 38 B

The $S_A$-values were divided between the following categories on the basis of trawl catches and characteristics on the echo recording paper:

| | |
|---|---|
| Herring | Sprat |
| Mackerel | Other pelagic fish |
| Other demersal fish | Plankton |

The following target strength (TS) function was applied to convert $S_A$-values of herring and sprat to number of fish:

$$TS = 20 \log L - 71.2 \text{ dB} \qquad (1)$$

or on the form:

$$C_F = 1.05 - 10^6 - L^{-2} \qquad (2)$$

where L is total length. The following formula was programmed into Excel (5.0) sheets to calculate the number of fish (herring and sprat) in length groups (1/2 cm) in ICES statistical squares (Annex 2):

$$N_i = A \cdot S_A \cdot \frac{p_i}{\sum_{i=1}^{n} \frac{p_i}{C_{Fi}}} \qquad (3)$$

where $N_i$ = number of fish in length group i
$A$ = area in $nm^2$
$S_A$ = mean integrator value in the area
$p_i$ = proportion of fish in length group i in samples from the area
$C_{Fi}$ = fish conversion factor (Eqn 2) applying the length of fish in length group i

The number per length group were then divided in age groups according to the observed age distribution per length group observed in the samples representing the square. The number in each length category and age group were then summed and the total number of fish obtained. The proportion of Baltic spring spawners and North Sea autumn spawners within each square were calculated by applying the corresponding stage of maturity, ie herring which appeared to have spawned this year were allocated to Baltic spring spawners and all the rest to North Sea autumn spawners. To calculate the maturing part of the two stocks in each length group, the observed maturity stage for North Sea autumn spawners was applied for this stock while the maturity ogive as presented by last year's HAWG was applied for the Baltic spring spawners.

The biomass of fish was calculated applying observed mean weights per age group multiplied by number of fish in the same group.

## Results

### Hydrography

The horizontal distributions of temperature at 5 m, 50 m and at bottom in the surveyed area are shown in Figures 4a-c. The surface water is characterised by summer heating with temperatures ranging from 10-13°C. The surface heating is most pronounced in the south where the temperature in 50 m is significantly lower. In the north the temperature difference between 5 and 50 m is smaller, but for most of the area the thermocline is found in the upper layers of the water column. The overall temperature regime in the surface (where most of the herring were found) is significantly colder (2-3°) this year than in 1995, especially in the northern part of the survey area.

**Distribution and Abundance of Herring and Sprat**

**Herring**

The horizontal distribution of herring is shown in Figure 5. A main concentration of herring was found in the area off the east coast of Shetland. Here maturing herring, 2-4 ring olds dominated. Further east, in central parts, and at the same latitude, older and larger herring predominated. In the south-eastern part of the survey area, off the south-western Norwegian coast, young North Sea autumn spawners (2-ringers) were mixed with Baltic spring spawners.

The registrations were very scattered in all regions and the herring were mainly found close to the surface.

The central northern distribution of herring was strongly correlated to the inflow of Atlantic salmon characterised by higher temperature and higher salinity.

For estimation, the survey area was divided in four sub areas based on biological characteristics of the herring (length and age composition and maturity stage), as shown in Figure 6. The abundance by ICES statistical squares, divided in Baltic spring spawners and North Sea autumn spawners is shown in Table 4. The numbers are given age disaggregated and the numbers in age groups 2 and 3 are split in mature/immature parts. The surveyed squares where no herring were recorded are also presented in the table. The mean weights at age applied for biomass estimation are shown in Table 5. The total estimated number of herring by age and length is shown in Table 6. The total estimated biomass per age group and stock is also shown in this table. The total estimated biomass in the area covered by the Norwegian vessel has decreased severely from last year (220 v 130,000 t). The estimated spawning stock biomass is reduced from last years estimate of 160,000 t to 115,000 t. The Norwegian vessel has covered the same area in 1996 as in 1995. The estimated number of young individuals in the region surveyed by the Norwegian vessel has decreased drastically compared with last years estimate, while the older age groups are better represented.

**Ichthyophonus**

All herring sampled during the survey were examined for the Ichthyophonus decrease. No infected fish were found this year.

**Sprat**

Only a few individuals of sprat were caught in a few of the pelagic trawl hauls, but no sprat could be seen as echo recordings and allocated $S_A$-values.

SURVEY REPORT RV *TRIDENS*
24 JUNE - 19 JULY 1996

**Calibration - 25 June**

The calibration was conducted in a small Norwegian fjord off Mandal harbour. The correction factor for the TS-gain was found without a problem. The calibration for the SV-gain however gave problems. After entering the calculated SV-gain the $S_A$-values in the intergrator tables gave values of approximately 4% lower than the theoretical value. During the following survey, the default settings of 26.5 dB were used for TS-gain and SV-gain. Based on the results of the TS calibration, al $S_A$-measurements collected during the survey were corrected by a factor 0.8710. This correction factor was calculated from the formula:

$$10^{(TS_{st}-TS_m)/10}$$

where $TS_{st}$ is the target strength of the standard target in dB and $TS_m$ is the measured target strength. The calibration report is presented in Table 1.

**Survey - 2-19 July**

The methods used were similar to those in previous years. A SIMRAD EK-500 system was used with a 38 kHz hull mounted transducer. Integration of echo recordings was done by the BI post processing system. Calibration details are given in Table 7.

Ship's speed was 12-13 knots, and the survey was conducted from 0400 UTC to 2100 UTC. During the hours of darkness, the survey was interrupted because results from previous surveys had shown that herring at this time may rise close to the surface, and may not be seen by the transducer. However, due to lack of time, in low density areas the survey was continued during dark until some kind of traces showed up.

Trial fishing was done with a 2,000 mesh pelagic trawl with a 20 mm cod-end lining.

During the first one-and-a-half days it was not possible to trawl because the permit for fishing in UK waters was not year issued. Fortunately this caused not too much trouble since only a few traces were detected. Traces in ICES square 44E8 were scrutinised, based on a trawl which was conducted one day later (haul 5).

**Results**

**Herring**

Figure 7 shows the survey track and the trawl stations.

The main concentration of herring was found in large schools at the bottom between 58° and 59°N at a bottom depth of 120 m in ICES square 46E8. In the north-eastern part of the area, adult herring was caught mixed with Norway pout (hauls 2, 3 and 12), close at the bottom. Immature herring was found in the western part of the area in small schools (red-green traces) some metres above the bottom at depths of 80-100 m, together with large quantities of sprat. In the south (stratum H) immature herring and sprat were found at depths between 60 and 75 m in thin, dense pillars at the bottom and in the midwater. In this part of the area it appeared to be impossible to make a distinction between herring and sprat schools with help of the trawl information. Although the catch (haul 23-26) suggested slightly more sprat in this pillars, 50% of the SA values has been assigned to herring, because observations on the netsounder screen showed that part of the fish avoided the net. It was assumed that this must have been the relatively large fish, in this case herring.

Unlike observations during the 1995 survey, no herring was found close to the surface. Also no commercial fishing vessels were seen fishing for herring. This is probably due to the decision of the European Commission in June to reduce the herring quota by 50%. None of the trawls contained spring spawners or 0-group herring.

Results form the *Tridens* survey are presented in Tables 8-10 and Figures 8 and 9. These figures and tables provide best estimates after scrutinising. They include SA-values which have been assigned to "certainly herring" and "probably herring". Most detailed results are presented in the Appendix. In the appendix also numbers and weights of only "certainly herring" are given. These should be considered as minimum values.

**Sprat**

Sprat was found mainly in the western and the southern part of the area, as mentioned above. Sprat from the northern part of the area was smaller (6.5-12.5 cm) than sprat from the southern part (10.0-15.0 cm). Unfortunately, weights of the sprat samples were not properly taken during the survey. Therefore the mean weight per size-class was derived from sprat samples taken on *Tridens* during the IBTS survey in January and February this year. Samples for ageing were not taken during the *Tridens* survey.

Results on sprat are presented in Tables 11 and 12.

SURVEY REPORT FOR *RV DANA*
19 JULY - 30 JULY 1996

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## Introduction

In several years Denmark has participated in the international acoustic survey of herring in the North Sea, Skagerrak and Kattegat. In the past five years Denmark has covered the North Sea east of 5°E and between 57°N and 59°N, Skagerrak and Kattegat. The effort of the Danish survey has decreased from 22 days in 1991 to 12 days in 1996.

## Survey Area

The survey was carried out in the North Sea east of 5°E and between 57°N and 59°N, Skagerrak and Kattegat (Fig. 11). The area was split up into eight subareas (Fig. 12). The survey started in the west by doing parallel transects, 10-20 nm apart in an north-south direction. In the eastern part of the survey area the transects were carried out westwards to the Swedish coast. The origin of the survey transect was selected "randomly". The track was then laid out with semi-systematic spacing.

## Methods

Acoustic data were sampled using a Simrad EK400 38 kHz echo sounder with a hull mounted split-beam transducer (type Es 38-29). The echo sounder operated in conjunction with a Simrad ES400 split-beam echo sounder and the ECHOANN analyser system, with the EK400 sounder serving as the transmitter (Degnbol *et al.,* 1990). The pulse duration was 1 ms and the receiver bandwidth 1 kHz between -3 dB point during the survey. The integration data was stored by the ECHOANN analyser system for each nautical mile for each 1.0 m depth interval. Speed of the ship during acoustic sampling was 9-12 knots.

The hydroacoustic equipment was calibrated using a standard copper sphere of 60 mm in diameter at Bornö, Gullmarn fjord, Sweden in May 1996 (Table 13).

The subsampling method was length stratified for age and length-weight relationship. Pelagic trawling was carried out using a Fotö trawl (16 mm in cod-end), while benthic trawling was carried out using an Expo trawl (16 mm in cod-end). Trawling was carried out in the time interval 1200-1800 hours and 2300-0500 hours (Table 14). Immediately after or before each trawl haul CTD profiles were collected, where temperature, salinity, density and fluorescence were recorded.

Each trawl haul was analysed for species, length, age and weight. Fish were measured to the nearest 0.5 cm total length and weighed to the nearest 0.1 g wet weight. In each catch 10 herring and otoliths were sampled per 0.5 cm length class of herring for separation of North Sea autumn spawners and Baltic spring spawners, and for determination of age and maturity. Micro structure formed during the herring's larval period is retained as the central part of the adult otoliths and used to discriminate between North Sea autumn spawners and Baltic spring spawners. A total of 3,200 otoliths of herring were sampled and examined. Sprat were sampled and analysed for age and maturity. A total of 400 otoliths were examined for determination of age.

The acoustic data were judged for each nautical mile. Herring and sprat was not observed on depths below 150 metres. Layers below 150 metres was therefore skipped during the acoustic judging. The contribution from plankton, air, bubbles, bottom echoes and noise were removed. When fish echoes were mixed with plankton echoes the contribution from plankton was estimated by comparing the integration values with values obtained at other close sampling positions with similar plankton recordings not containing fish. Significant contribution from air bubbles, bottom echoes and noise were removed by skipping those layers.

For each subarea the mean back-scattering cross-section was estimated for herring, sprat, gadoids and mackerel by the TS-length relationship recommended by The Planning Group for Herring Surveys (Anon, 1994):

herring TS = 20 log L - 71.2 dB
sprat TS = 20 log L - 71.2 dB
gadoids TS = 20 log L - 67.5 dB
mackerel TS = 21.7 log L - 84.9 dB

where L is the total fish length in cm. The number of each fish species was assumed to be in proportion to their contribution in trawl hauls. The density of a particular fish species was therefore estimated by subarea using the contribution of the species in trawl hauls. The nearest trawl hauls was allocated to subareas with uniform depth strata. Allocation to length-age for each species was assumed to be in accordance with the length-age distribution in the allocated trawl hauls.

The spawning biomass of herring was estimated using the maturity key:

age 0 and 1: no mature individuals
age 2: 50% mature individuals
age 3: 85% mature individuals
age 4+: 100% mature individuals

as the current maturity of North Sea autumn and Baltic spring spawning herring was found to be below 10%.

**Results**

The temperature of the water in the surface was characterised by summer heating with temperatures ranging from 13-16°C. The surface temperature recorded this year however was 2-3°C below the temperature measured in 1995. Below the thermocline which was found in 20-25 metres depth the temperatures were ranging from 7-8°C.

Approximately 2,000 nautical mile were surveyed and 36 trawl hauls were carried out (Table 14). The total catch was 22,828 kg and the mean catch then 634 kg. Approximately 33% of the catch was made up by herring as the total catch of herring was 7,419 kg and the mean catch of herring 206 kg. The catch of sprat was insignificant (total 519 kg or mean 14 kg). The length frequency of herring and sprat by trawl haul is given in Tables 15 and 16, respectively.

A total estimate of 5.8 x $10^9$ herring or 394,147 tonnes was estimated (Table 17). The spawning biomass of North Sea autumn and Baltic spring spawning herring was estimated to 31,015 and 135,186 tonnes respectively (Table 18). The main densities of herring was found in subarea IX, which contributed with 36.5% of the total biomass (Table 17). The mean weight of herring by age was significant higher in subarea I-V than in subarea VI-IX (Table 19). Significant difference in length of herring by subarea was not found. However, herring caught within the 100 m line of depth show a tendency to be smaller than herring caught within the area of the 100-200 m lines of depth and above the 200 m line of depth (Fig. 3a-c). The length-weight relationship between North Sea autumn and Baltic spring spawning herring was found not to be significant different (Table 20). Furthermore, the growth of North Sea autumn spawners and Baltic spring spawners was found not to be significant different (Table 21).

The total number sprat estimated was 7.9 x $10^8$ or 14,267 tonnes (Table 22). The main densities of sprat was found in subarea VIII-IX. The sprat caught was 1-7 year old and in the size interval 10-16 cm. However, 93% of the sprat was 1-3 year old and 12-14 cm.

**Discussion**

In 1995 the total herring stock was estimated to 542,059 tonnes in Skagerrak and Kattegat (Simmonds *et al.*, 1996). In 1996 the total herring stock was 394,147 tonnes (Table 17), which was 27.3% lower than in 1995. The spawning biomass decrease from 401,309 tonnes in 1995 (Simmonds *et al.*, 1996) to

166,202 tonnes in 1996 (Table 18). The decrease was higher for the Baltic spring spawners than for the North Sea autumn spawners (approximately 62% and 26%, respectively).

During the hours of darkness herring rise close to the surface in Skagerrak and Kattegat, and may not be seen by the hull mounted transducer. Therefore, a towed-body mounted transducer which can be towed closer to the surface normally is used for echo integration during the Danish surveys. However, in 1996 the hull mounted transducer was used as the towed-body was out of function. The change in transducer depth from 1995 to 1996 could possible explain the decrease in biomass observed between 1995 and 1996. But decrease in total catch from 39,264 kg in 1995 (Simmonds *et al.*, 1996) to 22,828 kg in 1996 (Table 14) indicate a decrease in stock size as the effort was alike both years. The catch of herring decrease with approximately 50% from 1995 to 1996 (15,672 kg in 1995 to 7,419 kg in 1996).

**Acknowledgements**

I am grateful to Torben F Jensen and Annegrete D Hansen (The Danish Institute for Fisheries Research) for invaluable help with computer calculations and registration of fishing data.

## SURVEY REPORT FOR MFV *CHRISTINA S* IN ICES AREA VIA(N)
## 13-30 JULY 1996

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### Methods

The acoustic survey on the charter vessel MFV *Christina S* (13 to 30 July 1996) 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. 13) was selected to cover the area in three levels of sampling intensity based on herring densities found in 1991-95. Areas with highest intensity sampling had a transect spacing of 4.0 nautical miles, areas with medium intensity sampling had a transect spacing of 7.5 nautical miles and lower intensity areas a transect spacing of 15 nautical miles. The track layout was systematic, with a random start point. The ends of the tracks were positioned at ½ 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-nine trawl hauls (Fig. 14 and Table 23) 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. Length, weight and target strengths are summarised in Table 24.

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 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", "probably not herring traces", and two species mixture categories.

For the 1997 survey the total estimated stock was 397,580 tonnes. The spawning stock biomass (mature herring only) was estimated at 370,300 tonnes. 81.9% of the stock by number was attributable to the "herring traces", 10.7% to the "probably herring traces" and 7.4% were attributable to herring in a mixture with other species. Fish schools scored in category 3 (probably not herring) were identified from the echogram and trawling exercises, and were probably mostly pout, and other small gadoids. If all these traces were scored as herring they would total 347,520 tonnes, giving a maximum stock size of 745,100 tonnes.

As in previous years, in general, herring were found in waters where the seabed was deeper than 100 m, however, herring were also caught in reasonable quantities in shallower waters on three hauls (haul 13, 23 and 36). Norway pout and blue whiting were found irregularly throughout the north of the survey area, and often in deeper waters. Dense marks were seen on hard seabeds in the north part of the area which were difficult to fish and sometimes contained herring. It is possible that a significant part of the fish scored in category 3 were in fact herring and this would indicate an underestimate of the true stock. It was not usually possible to make a definite assignment of these marks to species, and where doubt existed it was assumed that they were NOT herring. Similar difficulties were encountered in 1994.

Three calibrations were carried out during the survey. One towed body was lost early in survey and had to be replaced. The first transducer was calibrated at the start of the trip. The replacement was calibrated immediately and also later on the survey. The integrator data were corrected for the deviations between the calibrations of the two transducers. 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:

$$W = 0.027124\ L^{2.660} \text{ g } L \text{ measured in cm}$$

**Survey Results**

A total of 39 trawl hauls were carried out, the results of these are shown in Table 23. Twenty hauls contained more than 100 herring and these hauls were used to define 4 survey sub areas (Fig. 14). The sub-areas were defined as:

I. Minch
II. Hebrides
III. Shelf break (NW of Lewis)
IV. North VIa(N)

The stock estimate shows a considerable decrease from 1993 (597,900 to 397,580 tonnes). There were some changes in stock distribution, although the general pattern was largely as in previous surveys (Fig. 15). Large numbers of fish were found south- west of the Hebrides, although these were not found as previously along the edge of the Barra Head Bank. A high biomass was seen again in the north-east of the survey area as in 1995 confirming the change in this area since 1994. This area had been largely barren in previous surveys.

There are also some indications of changes in the age and maturity structure of the stock (see Table 25 and Fig. 16). In 1995 21.5% of the two ringers were mature, while in 1996 78.5% were mature. The proportion of older fish (4+) in the stock was also reduced from 55% in 1995 to 43% in 1996. Combined with the reduced numbers, and the apparent reduction in numbers in the previously densely populated Barra Head area, this may indicate an increase in fishing pressure on this stock. Reports from fishermen indicate an increased tendency to genuinely fish in VIa(N), rather than simply misreport catches from IVa.

Large numbers of blue whiting were again found in the area of the shelf break NW of Lewis.

**Methods**

The survey was carried out in the north east Atlantic Ocean off the north and west coasts of Ireland, extending from the Isle of Islay off Scotland, to Dingle Bay, Ireland. The survey design (Fig. 17) was stratified according to the expected herring distribution based on the results from previous years surveys. Areas in waters between 100 m and 200 m depth were surveyed at twice the intensity of areas in waters less than 100 m depth. The transect spacing was set at 15 nm and 7.5 nm, giving two and four transects per ICES statistical rectangle respectively. The start point of the survey was randomised within 10 minutes of latitude, with a 1 nm buffer on each side (ie 1-8 nm start point). The transects extended from close inshore at the 20 m contour, to the limit of the continental shelf (200 m contour) up to 80 nmiles (148 km) offshore. In Galway Bay, the cruise track was modified to sample the area more intensely. Zig-zag transects dividing the bay into equal segments were undertaken. The total cruise track length was 2,178 nm (4,034 km).

Acoustic data were collected with a Simrad "EK500" scientific echo-sounder interfaced to a personal computer running version 5.0 of Simrad's "EP500" software. A Simrad ES-38D (38 kHz) transducer was used, mounted in a towed body. Data from the echo-integrator were summed over 15 minute periods using a constant ping rate of 0.8 seconds and a "ping based" log option set to 1,125 pings. In accordance with the other coordinated surveys, most of the data obtained between 1200 hours and 0400 hours was not used for integration. However, due to time constraints some transects were surveyed throughout the night. These were usually undertaken in areas where no herring had been observed.

Two calibrations using a tungsten carbide standard target were attempted. The first calibration was unsatisfactory due to positioning problems. The positioning equipment was modified during the mid-cruise break and a second calibration was performed at the end of the survey. In this case the sphere was easily centred at the required depth, however, serious errors were encountered with the integrated sphere values. $S_A$ values were 1/10th of those expected and target strength values were greater off centre. These observations were consistent with the errant performance of the whole system throughout the latter part of the cruise.

The transducer cable was inspected at the end of the cruise and was found to be seriously contaminated with salt water. This provides part of the explanation for the poor performance of the system. The cables were serviced and re-terminated and a calibration of the transducer was carried out on 3 October 1996 in Ringaskiddy Harbour, Cork. This is the calibration that has been used for this survey (see Table 26 for details). Comparisons of the transmit pulse during this calibration and at the start of the survey has indicated that the calibrated system performed in a similar manner to that of the system as it was at the start of the survey (to within 0.3%). This vindicates the use of the Ringaskiddy calibration exercise.

However, other problems were encountered after the first few days of the survey. At 0830 hours on 20 July 1996 (day 3) a red-line event took place. These events have been experienced before and as yet have no explanation. A red line was marked on the paper trace and was followed by an immediate drop in the integrator reading. This drop was sustained for tens of minutes before gradually restoring to normal. Subsequently, the system would experience a drop in the signal, either directly after a red-line event, or for no apparent reason. On other occasions the system would flip between a normal state and a low signal state. In total nine red-line events occurred, signal losses occurred on five occasions, and the flip state was present on at least six occasions. The most significant red-line event resulted in a blown fuse in the transceiver card (at 0530 hours, 23 July). These problems are unlikely to be associated with the aforementioned cable problems.

The immediate concern was to assess the impact of the signal loss. Fortunately none of the major herring marks (definitely and probably herring categories) were seen during flip states or after red-line events in low signal states. However, this year a large proportion of $S_A$ values were attributed to mixtures and these were on some occasions in flip or low signal states. Analysis of the transmit pulse has identified the low signal and flip states. Correction factors based on changes in running averages of the appropriate plankton integrator values were applied to allocated $S_A$ values. Despite the intensive analysis the ad-hoc corrections applied are likely to be insufficient to compensate for true signal loss. The results must therefore be treated with caution as they are likely to be underestimates of the true values.

Fishing was carried out using a 25-30 m rectangular pelagic trawl. Fish samples were broken into species composition by weights. Measurements of lengths were taken to the nearest 0.5 cm, and in the case of herring, samples were taken for maturity, age (otolith extraction), and weight.

The $S_A$ values from each log interval were partitioned by inspection of the echogram into the following categories: 1) Definitely herring; 2) Probably herring; 3) Herring in a mixture; 4) Northern school herring. Allocated integrator counts ($S_A$ values) from these categories were used to calculate herring numbers using the "Marine Laboratory echo integrator survey logging and analysis programme" (MILAP). The TS/length relationship used was that recommended by the acoustic survey planning group (Anon, 1994):

$$\text{Herring TS} = 20 \log L - 71.2 \text{ dB per individual } (L = \text{length in cm})$$

Herring biomass was calculated from numbers using the length-weight relationship determined from the trawl samples taken during the cruise:

$$\text{Herring weight (grams)} = 0.003469 \times L^{3.286} \; (L = \text{length in cm})$$

**Results**

A total of 774 data samples were taken, of which 71 had at least one of the three categories assigned to them (and consequently a total of 703 zero values). A total of 31 trawl hauls were taken. The positions of these hauls are indicated in Figure 17. Herring was present in 14 of the 31 trawl hauls, of which nine captured sufficient numbers to provide adequate samples to qualify the acoustic data. The sampled area was sub-divided into three areas according to similar length distributions: Offshore North (represented by trawls 2 and 3) and containing the northern schools group; Offshore South (trawls 12, 13, 14 and 16); and Galway Bay (trawls 18, 19 and 21). The borders of these sub-divisions and the length frequency histograms are illustrated in Figure 18.

The total biomass estimate for the survey area was 34,290 tonnes. A breakdown of the biomass estimate by area, is given in Figure 19. The biomass estimates by age and maturity are given in Table 27.

The biomass estimate for the current survey is significantly lower than that of last year (which itself was lower than the year before). Part of this years reduction is likely to be due to the performance loss of the echo-sounder system. Despite great efforts to account for this loss in post-processing, its magnitude remains uncertain and this uncertainty must be conveyed to the final estimate.

The number of samples greater than zero were similar to last years (71 compared to 74). However, this year, a large number of these were allocated to mixture categories; the number of definitely herring and probably herring samples was significantly reduced (60 in 1995 compared to 10 this year). This probably accounts for the major difference between the two surveys - in the current survey, schools of herring were very rarely observed. These observations would have been largely unaffected by the loss in performance of the system and, therefore, it would be realistic to assume a reduction in stock size.

## SURVEY REPORT FOR FRV *SOLEA* IN THE EASTERN NORTH SEA, 1996

The acoustic survey for FRV *Solea* was carried out in the eastern North Sea from 57°00'N 04°00'E to 54°30'N 08°00'E in July 1996. The age structure was determined from examination of otoliths and found that herring in the survey area consisted of 0, 1 and 2 ring fish. Numbers (millions), average lengths (mm), and total biomass (tonnes) of herring by statistical rectangle and age class are given in Tables 28, 29 and 30 respectively. Total calculated biomass of herring for the area surveyed was 70,744.51 tonnes (Table 30) while the total number of herring estimated from the survey was 8939.2 million (Table 28).

COMBINED SURVEY REPORT

Figure 20 shows survey areas for each vessel. The results for the seven surveys have been combined. Procedures and TS values are the same as for the 1994 surveys (CM 1995/H:15). The stock estimates have been calculated by age and maturity stage for 30'N-S by 1°E-W statistical rectangles for the survey area north of 52°N to the west of Scotland. The combined data give estimates of immature and mature (spawning) herring for ICES areas VIa north, VIa south, IVa and IVb separately. The data from all areas have been split between North Sea and Baltic Stocks. Where the survey areas for individual vessels overlap the effort weighted mean estimates by age and maturity stage for each overlapping rectangle have been used. Stock estimates by number and biomass are shown in Tables 31 and 32 respectively for areas VIa north, VIa south, IVa and IVb separately. The mean weights at age are shown in Table 33. Stock estimates for Baltic herring by number and biomass are shown in Tables 34 and 35 respectively. Figure 21 shows the distribution of abundance (numbers and biomass) of all mature autumn spawning herring for all areas surveyed. Figures 22 and 23 show the distribution of numbers and biomass split by age of 1 ring, 2 ring and 3 ring and older herring respectively. Estimates of 'O' group have been omitted in all plots. Figures 23 shows the density distribution of numbers of spawning stock biomass autumn spawning herring as contour plots. Table 36 shows the mean weight (g) of Baltic herring by age class and area.

## Ichthyophonus Infection

The numbers of fish with ichthyophonus was limited to two fish from *Scotia* and zero from *Tridens* and *GO Sars*.

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**Table 1**: Numbers of fish caught by species *Scotia* 13-31 July 1996

| Haul No | Date | Time | Position | | Depth | Species | | | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Lat | Long | | Herring | Sprat | Haddock | Norway pout | Blue whiting | Mackerel | Whiting | |
| 236 | 15 07 | 05:20:00 | 58°39.60'N | 000°00.17'W | 148 | | | | | | | | Foul haul |
| 237 | 15 07 | 12:50:00 | 58°40.36'N | 001°20.54'W | 116 | 1,174 | 53 | | 3 | | | 29 | |
| 238 | 15 07 | 17:45:00 | 58°40.80'N | 002°25.25'W | 75 | | | 5 | 195 | | | 2 | |
| 239 | 16 07 | 08:05:00 | 58°55.24'N | 000°30.80'W | 135 | 4,004 | | 24 | 105 | | 6 | | |
| 240 | 16 07 | 11:44:00 | 58°54.99'N | 000°11.69'E | 142 | | | | | | | | "0" group pout |
| 241 | 16 07 | 17:22:00 | 59°10.38'N | 000°33.70'E | 128 | | | | | | | | "0" group pout and sandeels |
| 242 | 16 07 | 22:25:00 | 59°10.13'N | 000°32.28'W | 145 | 7,780 | | | | | | | |
| 243 | 17 07 | 11:30:00 | 59°24.69'N | 001°56.43'W | 119 | 1,414 | 1540 | 1 | | | | 1 | |
| 244 | 17 07 | 15:15:00 | 59°24.70'N | 001°11.01'W | 121 | 4,720 | | | | | | | |
| 245 | 17 07 | 20:04:00 | 59°25.15'N | 000°09.72'W | 143 | | | | | | | | "0" group pout |
| 246 | 18 07 | 09:35:00 | 59°40.55'N | 000°38.11'W | 135 | 5,834 | | 18 | 141 | | | 9 | |
| 247 | 18 07 | 17:41:00 | 59°50.40'N | 000°37.75'W | 130 | 22,008 | | | | | | | |
| 248 | 19 07 | 07:09:00 | 60°10.35'N | 000°07.42'W | 120 | | | | | | | | "0" group pout |
| 249 | 19 07 | 10:13:00 | 60°08.81'N | 000°38.69'W | 125 | 324 | | 3 | | 22 | | 3 | 9 Argentina |
| 250 | 19 07 | 18:50:00 | 60°32.80'N | 000°39.68'W | 115 | 3,045 | | | | | 10 | | |
| 251 | 21 07 | 11:55:00 | 60°40.00'N | 000°32.58'W | 118 | 2,490 | | | | | 35 | 5 | 5 Argentina |
| 252 | 21 07 | 15:26:00 | 60°47.54'N | 000°36.04'W | 111 | 4 | | | 143 | | 3 | | |
| 253 | 21 07 | 17:36:00 | 60°47.69'N | 000°29.05'W | 112 | 126 | | | 176 | | 1 | 3 | 2 *T. minutus* |
| 254 | 21 07 | 20:55:00 | 60°48.08'N | 000°03.04'E | 149 | 4,800 | | | | | | | |
| 255 | 22 07 | 07:30:00 | 61°03.04'N | 000°50.42'W | 142 | 5,530 | | | | | | | |
| 256 | 22 07 | 10:50:00 | 60°55.05'N | 000°41.69'W | 104 | | | | | | | | |
| 257 | 22 07 | 14:10:00 | 60°54.79'N | 000°08.32'W | 154 | 27,950 | | | | | | | |
| 258 | 23 07 | 05:55:00 | 61°07.17'N | 000°15.10'W | 144 | 333 | | | | | 1 | | 3 Saithe |
| 259 | 23 07 | 18:46:00 | 60°54.91'N | 001°48.70'W | 137 | 1,161 | | | | | | | 7 Horse mackerel |
| 260 | 24 07 | 04:02:00 | 61°03.15'N | 001°19.07'W | 135 | 6,337 | | | | | 349 | | 60 Horse mackerel |
| 261 | 24 07 | 10:37:00 | 60°47.89'N | 001°13.73'W | 98 | 124 | | 1 | | | 48 | | 8 Horse mackerel |
| 262 | 24 07 | 16:35:00 | 60°40.28'N | 002°11.15'W | 138 | 1,427 | | | | 366 | 14 | | 7 Horse mackerel |
| 263 | 24 07 | 20:25:00 | 60°40.06'N | 002°54.02'W | 242 | | | | | 643 | 216 | | |
| 264 | 25 07 | 06:10:00 | 60°24.90'N | 002°53.80'W | 160 | 29 | | | | 1,151 | | | 28 *M. muelleri*, 1 saithe |
| 265 | 26 07 | 12:29:00 | 59°22.91'N | 003°38.92'W | 179 | 12,750 | | | | | 960 | | |
| 266 | 26 07 | 16:41:00 | 59°41.00'N | 003°45.18'W | 140 | 186 | 20 | | 212 | | | 3 | 1 Argentina |
| 267 | 26 07 | 19:47:00 | 60°00.00'N | 003°46.00'W | 120 | 1,875 | | | | 155 | 250 | | |
| 268 | 27 07 | 09:15:00 | 60°32.63'N | 002°40.60'W | 138 | 3,520 | | | | | 50 | | "0" group pout |
| 269 | 27 07 | 17:02:00 | 60°25.56'N | 002°15.96'W | 151 | 24,825 | | | | | | | |
| 270 | 28 07 | 09:34:00 | 60°09.81'N | 002°33.02'W | 92 | 1,464 | | | | | 4 | | |
| 271 | 28 07 | 12:23:00 | 60°10.17'N | 002°56.45'W | 159 | 12,700 | | | | | | | |
| 272 | 28 07 | 15:15:00 | 60°02.92'N | 002°45.42'W | 79 | | | | | | | | "0" group pout |
| 273 | 28 07 | 19:07:00 | 60°03.04'N | 001°58.87'W | 94 | 10 | | 1 | 3 | | | 126 | |
| 274 | 29 07 | 09:22:00 | 59°52.68'N | 003°29.66'W | 148 | 6,630 | | | | | 60 | | |
| 275 | 29 07 | 13:30:00 | 59°47.82'N | 002°42.66'W | 76 | | | | | | 1 | | "0" group pout |
| 276 | 29 07 | 18:07:00 | 59°47.95'N | 001°40.11'W | 115 | 65 | | 16 | 8 | | 3 | 52 | "0" group pout |
| 277 | 30 07 | 07:34:00 | 59°36.18'N | 003°30.04'W | 160 | 63 | 1 | 1 | | | | 7 | |

**Table 2**: Proportions of herring by length class by trawl haul in areas (Fig. 1) totals caught, mean length (cm), mean weight (g), target strength (TS) and area means used on the survey

| Length | Haul | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 239 | 242 | 244 | 246 | 247 | 249 | 250 | 251 | 253 | 254 | 255 | 257 | 258 | 259 | 260 | 262 | 264 | 266 | 267 | 268 | 269 | 271 | 274 | 276 | 277 | mn | 237 | 243 | mn | 261 | 265 | 270 | mn |
| 15.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | 0.2 | | 0.1 | | | | |
| 15.5 | | | | | | | | | | | | | | | | | | | | | | | | | | | 0.3 | 0.1 | 0.2 | | | | |
| 16.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0.1 | 0.1 | | | | |
| 16.5 | | | | | | | | | | | | | | | | | | | | | | | | | | | 0.5 | 0.4 | 0.4 | | | | |
| 17.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | 1.2 | 3.7 | 2.4 | | | | |
| 17.5 | | | | | | | | | | | | | | | | | | | | | | | | | | | 2.5 | 3.9 | 3.2 | | | | |
| 18.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | 5.6 | 8.8 | 7.2 | | | | |
| 18.5 | | | | | | | | | | | | | | | | | | | | | | | | | | | 5.8 | 9.1 | 7.4 | | | | |
| 19.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | 6.0 | 11.0 | 8.5 | | | | |
| 19.5 | | | | | | | | | | | | | | | | | | | | | | | | | | | 5.6 | 9.5 | 7.6 | | | | |
| 20.0 | | | | | | | | | | | | | | | | | | 1.6 | | | | | | | | 0.1 | 10.4 | 10.8 | 10.6 | | | | |
| 20.5 | | | 1.1 | | | | | | | | | | | | | | | 1.1 | | | | | | | | 0.1 | 10.1 | 8.1 | 9.1 | | | 11.2 | 3.7 |
| 21.0 | | | 2.3 | | | | | | | | | | | | | | | 1.6 | | | | | 0.2 | | | 0.2 | 11.2 | 5.3 | 8.3 | 0.8 | | 18.0 | 6.3 |
| 21.5 | | 0.1 | 1.7 | 0.2 | | | | | | | | | | | | | | 1.1 | | | | | | 1.5 | | 0.2 | 6.4 | 3.7 | 5.0 | 4.0 | | 18.9 | 7.6 |
| 22.0 | | 0.1 | 3.0 | 0.4 | | | | | | | | | | | | | | | | | | | | 1.5 | | 0.2 | 7.3 | 2.3 | 4.8 | 7.3 | 0.2 | 20.8 | 9.4 |
| 22.5 | 0.2 | 0.4 | 4.7 | 0.4 | 0.2 | 0.6 | 0.2 | | 0.8 | | | 0.2 | | | | | | 1.6 | | | | 0.2 | 0.2 | | | 0.4 | 5.8 | 1.8 | 3.8 | 7.3 | | 9.6 | 5.6 |
| 23.0 | 0.2 | 1.0 | 9.1 | 0.8 | 2.5 | 0.9 | 1.0 | | 2.4 | | | 0.2 | | | 0.2 | | | 1.1 | | | 0.3 | 0.5 | 0.9 | 4.6 | | 1.0 | 6.9 | 2.1 | 4.5 | 17.7 | 0.5 | 7.1 | 8.4 |
| 23.5 | 0.8 | 3.9 | 10.2 | 2.8 | 4.3 | 2.8 | 1.3 | | 9.5 | | 0.4 | 0.4 | | 0.4 | 0.2 | 0.2 | | 2.2 | | | | 1.4 | 0.9 | 10.8 | | 2.1 | 4.1 | 2.5 | 3.3 | 16.9 | 5.4 | 5.5 | 9.3 |
| 24.0 | 1.1 | 6.6 | 14.2 | 5.7 | 8.6 | 4.3 | 2.3 | 1.4 | 16.7 | 0.2 | 0.2 | 0.9 | | | 0.4 | | 3.4 | 0.5 | 0.3 | 0.9 | 0.3 | 2.5 | 1.6 | 4.6 | | 3.1 | 3.2 | 3.3 | 3.2 | 18.5 | 14.4 | 5.2 | 12.7 |
| 24.5 | 3.0 | 7.7 | 11.2 | 6.4 | 10.4 | 4.3 | 3.8 | 2.4 | 16.7 | 0.6 | 1.3 | 2.3 | 0.3 | 0.2 | 2.6 | 0.9 | | 2.2 | | 0.6 | 2.7 | 5.0 | 2.7 | 4.6 | 1.6 | 3.7 | 2.0 | 2.8 | 2.4 | 13.7 | 16.2 | 1.1 | 10.3 |
| 25.0 | 5.5 | 13.5 | 12.5 | 10.0 | 12.3 | 8.6 | 7.1 | 5.4 | 11.1 | 1.3 | 2.2 | 2.0 | 0.6 | 0.2 | 5.5 | 1.6 | 3.4 | 2.2 | | 0.9 | 1.5 | 6.9 | 3.4 | 7.7 | | 5.0 | 2.0 | 3.3 | 2.6 | 5.6 | 19.5 | 1.9 | 9.0 |
| 25.5 | 5.8 | 12.0 | 7.4 | 7.0 | 8.8 | 5.9 | 5.6 | 6.8 | 8.7 | 1.7 | 4.2 | 2.7 | 1.8 | 0.7 | 5.7 | 4.9 | 3.4 | 4.8 | 0.3 | 1.7 | 4.2 | 6.8 | 3.8 | 24.6 | 6.3 | 5.8 | 1.0 | 2.5 | 1.8 | 3.2 | 15.5 | 0.3 | 6.3 |
| 26.0 | 7.5 | 12.5 | 6.6 | 8.8 | 11.0 | 4.9 | 7.6 | 9.0 | 5.6 | 2.9 | 4.0 | 2.5 | 3.9 | 1.6 | 10.1 | 8.6 | | 2.2 | 0.5 | 2.0 | 8.5 | 6.5 | 4.8 | 10.8 | 6.3 | 5.9 | 0.5 | 1.6 | 1.0 | 1.6 | 9.2 | 0.3 | 3.7 |
| 26.5 | 5.0 | 7.5 | 5.3 | 7.5 | 5.9 | 3.4 | 5.3 | 10.6 | 3.2 | 1.5 | 3.8 | 2.7 | 4.5 | 1.0 | 9.3 | 10.7 | | 3.8 | 1.6 | 3.4 | 10.6 | 6.1 | 5.9 | 15.4 | 4.8 | 5.5 | 0.2 | 1.1 | 0.7 | 0.8 | 4.5 | 0.3 | 1.9 |
| 27.0 | 10.3 | 6.4 | 3.6 | 9.0 | 6.5 | 6.2 | 6.9 | 12.0 | 4.0 | 2.7 | 6.0 | 2.7 | 6.9 | 3.3 | 11.6 | 12.8 | | 3.8 | 7.7 | 3.4 | 13.9 | 7.1 | 8.1 | 3.1 | 12.7 | 6.8 | 0.4 | 0.9 | 0.7 | 0.8 | 5.6 | | 2.2 |
| 27.5 | 8.9 | 4.9 | 1.5 | 7.6 | 6.0 | 7.7 | 6.7 | 11.8 | 4.0 | 4.2 | 8.0 | 3.8 | 7.5 | 1.6 | 10.9 | 15.6 | 3.4 | 6.5 | 9.1 | 5.1 | 14.5 | 7.6 | 8.1 | 6.2 | 12.7 | 7.3 | 0.2 | 0.5 | 0.3 | | 3.5 | | 1.2 |
| 28.0 | 14.0 | 7.5 | 1.3 | 8.0 | 5.8 | 11.1 | 12.6 | 12.0 | 0.8 | 6.7 | 11.8 | 7.0 | 9.6 | 7.1 | 10.4 | 14.7 | 3.4 | 10.8 | 14.9 | 7.4 | 11.5 | 8.8 | 10.6 | 1.5 | 12.7 | 8.9 | 0.2 | 0.4 | 0.3 | | 2.1 | | 0.7 |
| 28.5 | 9.8 | 4.6 | 1.9 | 6.4 | 4.0 | 8.0 | 10.3 | 10.0 | 0.8 | 9.0 | 13.0 | 10.7 | 12.9 | 11.2 | 10.7 | 10.0 | | 7.5 | 17.6 | 9.4 | 7.3 | 6.9 | 11.8 | | 11.1 | 8.2 | 0.3 | 0.2 | 0.2 | | 2.1 | | 0.7 |
| 29.0 | 9.0 | 4.2 | 0.8 | 6.4 | 5.0 | 9.9 | 9.4 | 10.6 | 7.1 | 10.0 | 14.6 | 14.3 | 13.8 | 16.4 | 6.1 | 6.3 | 17.2 | 11.3 | 14.1 | 10.5 | 6.3 | 6.8 | 10.0 | 1.5 | 4.8 | 9.1 | 0.2 | 0.1 | 0.2 | | 0.5 | | 0.2 |
| 29.5 | 5.0 | 1.9 | 0.4 | 3.3 | 2.6 | 6.5 | 4.9 | 3.8 | 3.2 | 12.9 | 8.1 | 11.8 | 9.6 | 11.4 | 3.9 | 3.3 | 6.9 | 7.5 | 8.0 | 10.5 | 4.2 | 6.1 | 5.2 | | 7.9 | 6.0 | | 0.1 | 0.0 | 0.8 | 0.2 | | 0.3 |
| 30.0 | 5.6 | 1.4 | 0.2 | 3.2 | 2.4 | 6.5 | 5.4 | 2.2 | 2.4 | 10.8 | 7.8 | 12.5 | 9.6 | 12.1 | 3.8 | 3.0 | | 5.4 | 6.7 | 9.7 | 4.2 | 6.3 | 6.8 | | 4.8 | 5.3 | | | | | 0.2 | | 0.1 |
| 30.5 | 3.1 | 1.0 | 0.2 | 2.1 | 1.4 | 3.7 | 3.4 | 1.0 | 1.6 | 9.2 | 5.2 | 6.8 | 5.1 | 8.4 | 3.0 | 2.6 | 10.3 | 5.4 | 6.1 | 6.8 | 2.4 | 4.3 | 4.5 | 1.5 | 1.6 | 4.0 | | | | | 0.2 | | 0.1 |
| 31.0 | 2.3 | 0.8 | 0.6 | 1.0 | 0.9 | 0.9 | 2.5 | 0.6 | 1.6 | 7.3 | 3.4 | 5.5 | 6.3 | 7.6 | 1.6 | 1.2 | 13.8 | 4.8 | 2.4 | 8.2 | 2.1 | 2.0 | 2.7 | | 4.8 | 3.4 | | | | | | | |
| 31.5 | 1.5 | 0.6 | 0.2 | 1.2 | 0.7 | 1.2 | 1.6 | | | 6.3 | 2.0 | 4.8 | 4.2 | 5.0 | 1.4 | 1.6 | 13.8 | 2.2 | 3.5 | 5.1 | 2.4 | 1.7 | 1.8 | | 4.8 | 2.7 | | | | | | | |
| 32.0 | 0.9 | 0.8 | | 0.6 | 0.2 | 0.9 | 0.8 | | | 5.4 | 1.4 | 2.9 | 0.3 | 3.0 | 1.2 | 0.9 | 10.3 | 2.2 | 2.1 | 4.5 | 1.5 | 2.2 | 2.7 | | 1.6 | 1.9 | | | | 0.8 | | | 0.3 |
| 32.5 | 0.2 | 0.1 | | 0.4 | 0.2 | 0.3 | 1.0 | | | 3.5 | 0.7 | 1.1 | 1.2 | 3.4 | 1.0 | 0.7 | 3.4 | 1.6 | 1.6 | 3.7 | 0.6 | 1.6 | 1.8 | | | 1.1 | | | | | | | |
| 33.0 | 0.3 | 0.3 | | 0.3 | 0.1 | 0.6 | 0.3 | | | 1.9 | 1.1 | 1.4 | 1.2 | 3.3 | 0.2 | 0.2 | 3.4 | 2.7 | 1.3 | 2.6 | 0.3 | 1.6 | 1.1 | | 1.6 | 1.0 | | | | | | | |
| 33.5 | | 0.3 | | 0.2 | | 0.6 | | | | 0.8 | 0.5 | 0.7 | | 1.3 | 0.2 | | | 1.6 | 1.3 | 2.0 | 0.6 | 0.3 | 0.2 | | | 0.4 | | | | | | | |
| 34.0 | | | | | 0.1 | | | | | 1.0 | 0.2 | | | 0.9 | 0.2 | | 3.4 | | 0.5 | 1.1 | | 0.5 | | | | 0.3 | | | | | | | |
| 34.5 | | | | | | | | | | 0.2 | | | 0.6 | | | | | 0.5 | 0.3 | 0.6 | | 0.2 | | | | 0.1 | | | | | | | |
| 35.0 | | | | | | | | | | | 0.2 | 0.2 | | 0.2 | | | | 0.5 | | | | | | | | 0.0 | | | | | | | |
| 35.5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 36.0 | | | | | | | | | | | | | | | | | | | | | | 0.2 | | | | 0.0 | | | | | | | |
| No | 4004 | 7780 | 4720 | 5834 | 22008 | 324 | 3045 | 2490 | 126 | 4800 | 5530 | 27950 | 333 | 1161 | 6337 | 1427 | 29 | 186 | 1875 | 3520 | 24825 | 12700 | 6630 | 65 | 63 | | 1174 | 1414 | | 124 | 12750 | 1464 | |
| mn lgt | 28.2 | 26.8 | 25.1 | 27.3 | 26.7 | 28.0 | 28.1 | 27.8 | 26.1 | 30.1 | 29.0 | 29.5 | 29.3 | 30.2 | 28.1 | 28.2 | 30.5 | 28.6 | 29.5 | 30.0 | 28.3 | 28.3 | 28.6 | 25.9 | 28.7 | 28.3 | 21.5 | 21.1 | 21.3 | 24.2 | 25.8 | 22.5 | 24.2 |
| mn wt | 213 | 179 | 141 | 192 | 178 | 208 | 212 | 201 | 165 | 267 | 235 | 250 | 244 | 270 | 210 | 212 | 284 | 230 | 248 | 266 | 215 | 218 | 225 | 158 | 227 | 218 | 83 | 80 | 82 | 124 | 154 | 95 | 124 |
| TS/ind | -42.2 | -42.6 | -43.2 | -42.4 | -42.6 | -42.2 | -42.2 | -42.3 | -42.8 | -41.6 | -41.9 | -41.8 | -41.8 | -41.6 | -42.2 | -42.2 | -41.5 | -42.0 | -41.8 | -41.6 | -42.2 | -42.1 | -42.0 | -42.9 | -42.0 | -42.1 | -44.5 | -44.7 | -44.6 | -43.5 | -43.0 | -44.2 | -43.5 |
| TS/kg | -35.5 | -35.1 | -34.7 | -35.3 | -35.1 | -35.4 | -35.5 | -35.3 | -35.0 | -35.9 | -35.6 | -35.8 | -35.7 | -35.9 | -35.4 | -35.4 | -36.0 | -35.6 | -35.7 | -35.9 | -35.5 | -35.5 | -35.6 | -34.9 | -35.6 | -35.5 | -33.7 | -33.7 | -33.7 | -34.4 | -34.8 | -33.9 | -34.5 |

**Table 3**: Numbers (millions) mean lengths (cm) mean weights (g) and biomass (tonnes x $10^{-3}$) for *Scotia* survey 13-31 July 1996

| Category | Number (millions) | Mean length (cm) | Mean weight (g) | Biomass (tonnes x $10^{-3}$) |
|---|---|---|---|---|
| | | **Area I** | | |
| 1A | 24.13 | 21.03 | 80.76 | 1.95 |
| 2I | 301.08 | 24.11 | 130.54 | 39.30 |
| 2M | 1,578.12 | 25.62 | 160.89 | 253.91 |
| 3I | 29.08 | 25.22 | 152.79 | 4.44 |
| 3M | 2,154.22 | 27.97 | 217.77 | 469.13 |
| 4A | 1,045.07 | 29.63 | 265.80 | 277.78 |
| 5A | 259.36 | 30.18 | 283.71 | 73.58 |
| 6A | 87.31 | 31.32 | 322.60 | 28.17 |
| 7A | 81.95 | 31.26 | 319.94 | 26.22 |
| 8A | 125.69 | 31.69 | 336.34 | 42.27 |
| 9+ | 176.07 | 31.91 | 346.01 | 60.92 |
| Total | 5,862.07 | | 217.96 | 1,277.68 |
| | | **Area II** | | |
| 1A | 215.11 | 19.30 | 60.83 | 13.09 |
| 2I | 77.93 | 21.56 | 88.75 | 6.92 |
| 2M | 58.55 | 24.18 | 131.62 | 7.71 |
| 3I | 0.48 | 25.00 | 146.30 | 0.07 |
| 3M | 10.30 | 26.06 | 173.18 | 1.78 |
| 4A | 0.75 | 27.50 | 204.68 | 0.15 |
| 5A | 0.00 | | | 0.00 |
| 6A | 0.00 | | | 0.00 |
| 7A | 0.00 | | | 0.00 |
| 8A | 0.00 | | | 0.00 |
| 9+ | 0.00 | | | 0.00 |
| Total | 363.13 | | 81.84 | 29.72 |
| | | **Area III** | | |
| 1A | 75.16 | 21.23 | 83.33 | 6.26 |
| 2I | 177.47 | 22.93 | 110.03 | 19.53 |
| 2M | 263.04 | 24.30 | 133.80 | 35.19 |
| 3I | 0.00 | | | 0.00 |
| 3M | 36.05 | 26.80 | 187.68 | 6.77 |
| 4A | 4.03 | 28.74 | 239.06 | 0.96 |
| 5A | 0.00 | | | 0.00 |
| 6A | 1.50 | 32.00 | 345.36 | 0.52 |
| 7A | 0.00 | | | 0.00 |

| Category | Number (millions) | Mean length (cm) | Mean weight (g) | Biomass (tonnes x $10^{-3}$) |
|---|---|---|---|---|
| 8A | 0.00 | | | 0.00 |
| 9+ | 0.44 | 28.50 | 230.70 | 0.10 |
| Total | 557.69 | | 124.32 | 69.33 |
| **Area Total** | | | | |
| 1A | 314.40 | 19.89 | 67.74 | 21.30 |
| 2I | 556.49 | 23.38 | 118.14 | 65.75 |
| 2M | 1,899.72 | 25.39 | 156.24 | 296.81 |
| 3I | 29.56 | 25.21 | 152.69 | 4.51 |
| 3M | 2,200.57 | 27.94 | 217.07 | 477.68 |
| 4A | 1,049.85 | 29.62 | 265.66 | 278.90 |
| 5A | 259.36 | 30.18 | 283.71 | 73.58 |
| 6A | 88.81 | 31.33 | 322.98 | 28.68 |
| 7A | 81.95 | 31.26 | 319.94 | 26.22 |
| 8A | 125.69 | 31.69 | 336.34 | 42.27 |
| 9+ | 176.50 | 31.90 | 345.73 | 61.02 |
| Total | 6,782.89 | | 202.97 | 1,376.73 |

**Table 4**: Estimated number of herring in ICES stat squares divided in stocks and age groups. RV *GO Sars*, 25 June - 14 July 1996

| 1 | 2I | 2M | 3I | 3M | 4I | 4M | 5I | 5M | 6.00 | 7.00 | 8.00 | 9+ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **44F1 North Sea Autumn Spawners** | | | | | | | | | | | | | |
| 1.39 | 50.10 | 36.28 | 4.35 | 31.88 | 0.00 | 2.79 | 0.00 | 1.39 | 0.00 | 1.39 | 0.00 | 0.00 | 129.57 |
| **44F5 North Sea Autumn Spawners** | | | | | | | | | | | | | |
| 0 | 2.84 | 2.06 | 0.38 | 2.77 | 0.00 | 0.93 | 0.00 | 0.94 | 0.00 | 0.00 | 0.00 | 0.00 | 9.91 |
| **44F5 Baltic Spring Spawner** | | | | | | | | | | | | | |
| 0 | 0.85 | 0.23 | 3.52 | 0.83 | 1.85 | 1.09 | 1.58 | 1.58 | 0.70 | 0.23 | 0.00 | 0.23 | 12.68 |
| **44F6 North Sea Autumn Spawners** | | | | | | | | | | | | | |
| 0 | 4.96 | 3.59 | 0.66 | 4.84 | 0.00 | 1.62 | 0.00 | 1.65 | 0.00 | 0.00 | 0.00 | 0.00 | 17.31 |
| **44F6 Baltic Spring Spawner** | | | | | | | | | | | | | |
| 0 | 1.50 | 0.38 | 1.90 | 5.69 | 0.00 | 5.13 | 0.00 | 5.51 | 1.23 | 0.41 | 0.00 | 0.41 | 22.15 |
| **45F5 North Sea Autumn Spawners** | | | | | | | | | | | | | |
| 0 | 5.14 | 3.72 | 0.68 | 5.01 | 0.00 | 1.68 | 0.00 | 1.70 | 0.00 | 0.00 | 0.00 | 0.00 | 17.93 |
| **45F5 Baltic Spring Spawner** | | | | | | | | | | | | | |
| 0 | 1.56 | 0.39 | 1.97 | 5.90 | 0.00 | 5.31 | 0.00 | 5.71 | 1.27 | 0.42 | 0.00 | 0.42 | 22.94 |
| **45F6 North Sea Autumn Spawners** | | | | | | | | | | | | | |
| 0 | 2.60 | 1.89 | 0.35 | 2.54 | 0.00 | 0.85 | 0.00 | 0.86 | 0.00 | 0.00 | 0.00 | 0.00 | 9.09 |
| **45F6 Baltic Spring Spawner** | | | | | | | | | | | | | |
| 0 | 0.79 | 0.20 | 1.00 | 2.99 | 0.00 | 2.69 | 0.00 | 2.89 | 0.64 | 0.21 | 0.00 | 0.21 | 11.63 |
| **48F2 North Sea Autumn spawners** | | | | | | | | | | | | | |
| 0 | 0.64 | 0.97 | 0.00 | 0.72 | 0.04 | 1.30 | 0.00 | 0.86 | 0.14 | 0.31 | 0.75 | 2.02 | 7.75 |
| **48F3 North Sea Autumn Spawners** | | | | | | | | | | | | | |
| 0 | 1.68 | 2.52 | 0.00 | 1.88 | 0.10 | 3.38 | 0.00 | 2.23 | 0.36 | 0.80 | 1.97 | 5.27 | 20.20 |
| **49E9 North Sea Autumn Spawners** | | | | | | | | | | | | | |
| 0 | 7.46 | 24.99 | 0.40 | 39.43 | 0.00 | 10.91 | 0.00 | 2.36 | 0.89 | 0.30 | 0.59 | 0.00 | 87.32 |
| **49F0 North Sea Autumn Spawners** | | | | | | | | | | | | | |
| 0 | 2.50 | 8.38 | 0.13 | 13.22 | 0.00 | 3.66 | 0.00 | 0.79 | 0.30 | 0.10 | 0.20 | 0.00 | 29.28 |
| **49F2 North Sea Autumn Spawners** | | | | | | | | | | | | | |
| 0 | 3.65 | 5.47 | 0.00 | 4.07 | 0.23 | 7.34 | 0.00 | 4.85 | 0.78 | 1.75 | 4.27 | 11.45 | 43.84 |
| **49F3 North Sea Autumn Spawners** | | | | | | | | | | | | | |
| 0 | 0.46 | 0.69 | 0.00 | 0.52 | 0.03 | 0.93 | 0.00 | 0.61 | 0.10 | 0.22 | 0.54 | 1.45 | 5.55 |
| **50E9 North Sea Autumn Spawners** | | | | | | | | | | | | | |
| 0 | 3.95 | 13.22 | 0.21 | 20.86 | 0.00 | 5.78 | 0.00 | 1.25 | 0.47 | 0.16 | 0.31 | 0.00 | 46.21 |
| **50F0 North Sea Autumn Spawners** | | | | | | | | | | | | | |
| 0 | 10.04 | 33.62 | 0.54 | 53.05 | 0.00 | 14.69 | 0.00 | 3.18 | 1.19 | 0.40 | 0.79 | 0.00 | 117.49 |

| 1 | 2I | 2M | 3I | 3M | 4I | 4M | 5I | 5M | 6.00 | 7.00 | 8.00 | 9+ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **50F1 North Sea Autumn Spawners** | | | | | | | | | | | | | |
| 0 | 2.16 | 7.22 | 0.12 | 11.40 | 0.00 | 3.16 | 0.00 | 0.68 | 0.26 | 0.09 | 0.17 | 0.00 | 25.24 |
| **50F2 North Sea Autumn Spawners** | | | | | | | | | | | | | |
| 0 | 6.41 | 9.62 | 0.00 | 7.17 | 0.40 | 12.91 | 0.00 | 8.53 | 1.36 | 3.07 | 7.51 | 20.13 | 77.12 |
| **50F3 North Sea Autumn Spawners** | | | | | | | | | | | | | |
| 0 | 0.30 | 0.44 | 0.00 | 0.33 | 0.02 | 0.59 | 0.00 | 0.39 | 0.06 | 0.14 | 0.35 | 0.93 | 3.55 |
| **51F1 North Sea Autumn Spawners** | | | | | | | | | | | | | |
| 0 | 2.01 | 3.01 | 0.00 | 2.24 | 0.13 | 4.04 | 0.00 | 2.67 | 0.43 | 0.96 | 2.35 | 6.30 | 24.14 |
| **51F2 North Sea Autumn Spawners** | | | | | | | | | | | | | |
| 0 | 1.85 | 2.78 | 0.00 | 2.07 | 0.12 | 3.73 | 0.00 | 2.47 | 0.39 | 0.89 | 2.17 | 5.82 | 22.30 |

In the following squares, no herring were recorded: 43F1, 43F2, 43F3, 43F4, 43F5, 43F6, 44F2, 44F3, 45F1, 45F2, 45F3,45F4, 46F1, 46F2, 46F3, 46F4, 46F5, 47F1, 47F2, 47F3, 47F4, 48F1, 48F4, 49F4

**Table 5**: Herring. Weight at age (g) for age groups and mature/immature fish in subareas. RV *GO Sars*, 25 June - 14 July 1996

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Area 1** | | | | | | | | | | | | |
| 1 | 2I | 2M | 3I | 3M | 4I | 4M | 5I | 5M | 6 | 7 | 8 | 9+ |
| 0.00 | 115.70 | 144.90 | 121.00 | 186.50 | 0.00 | 218.40 | 0.00 | 228.50 | 266.00 | 263.00 | 241.00 | 0.00 |
| **Area 2** | | | | | | | | | | | | |
| 1 | 2I | 2M | 3I | 3M | 4I | 4M | 5I | 5M | 6 | 7 | 8 | 9+ |
| 0.00 | 142.60 | 172.80 | 0.00 | 227.50 | 186.00 | 259.40 | 0.00 | 257.00 | 264.00 | 278.80 | 286.40 | 313.40 |
| **Area 3** | | | | | | | | | | | | |
| 1 | 2I | 2M | 3I | 3M | 4I | 4M | 5I | 5M | 6 | 7 | 8 | 9+ |
| 86.00 | 109.00 | 128.60 | 113.30 | 151.20 | 0.00 | 150.50 | 0.00 | 157.00 | 0.00 | 176.00 | 0.00 | 0.00 |
| **Area 4** | | | | | | | | | | | | |
| 1 | 2I | 2M | 3I | 3M | 4I | 4M | 5I | 5M | 6 | 7 | 8 | 9+ |
| 0.00 | 117.30 | 147.10 | 125.50 | 145.70 | 123.20 | 162.40 | 129.30 | 169.10 | 179.80 | 180.50 | 0.00 | 194.00 |

**Table 6**: Estimated number and biomass of herring divided in age and length groups. Totals also divided in stocks. RV *GO Sars*, 25 June - 14 July 1996

| Length (cm) | Age groups | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9+ | N (mill) | W (ton E-3) |
| 15 | | | | | | | | | | | |
| 15.5 | | | | | | | | | | | |
| 16 | | | | | | | | | | | |
| 16.5 | | | | | | | | | | | |
| 17 | | | | | | | | | | | |
| 17.5 | | | | | | | | | | | |
| 18 | | | | | | | | | | | |
| 18.5 | | | | | | | | | | | |
| 19 | | | | | | | | | | | |
| 19.5 | | | | | | | | | | | |
| 20 | | | | | | | | | | | |
| 20.5 | 1.39 | | | | | | | | | 1.39 | 0.12 |
| 21 | | 1.28 | | | | | | | | 1.28 | 0.11 |
| 21.5 | | 0.64 | | | | | | | | 0.64 | 0.06 |
| 22 | | 3.43 | | | | | | | | 3.43 | 0.29 |
| 22.5 | | 5.74 | 0.64 | | | | | | | 6.38 | 0.61 |
| 23 | | 8.78 | 2.03 | | | | | | | 10.81 | 1.09 |
| 23.5 | | 19.88 | 0.64 | 0.64 | 0.64 | | | | | 21.80 | 2.36 |
| 24 | | 32.65 | 4.48 | 1.28 | | | | | | 38.42 | 4.39 |
| 24.5 | | 29.75 | 13.01 | 0.64 | 0.64 | | | | | 44.04 | 5.41 |
| 25 | | 56.04 | 16.58 | | 1.28 | | | | | 73.90 | 9.53 |
| 25.5 | | 33.29 | 14.47 | 2.56 | 1.28 | 0.64 | | | | 52.24 | 7.34 |
| 26 | | 28.30 | 19.28 | 5.99 | 3.20 | 0.64 | | | | 57.41 | 8.62 |
| 26.5 | | 18.79 | 22.87 | 3.20 | 1.92 | | | | | 46.78 | 7.61 |
| 27 | | 17.43 | 36.80 | 2.71 | 2.67 | | 0.64 | | | 60.25 | 10.44 |
| 27.5 | | 12.52 | 35.92 | 11.06 | 4.24 | 0.64 | 1.39 | | | 65.78 | 12.14 |
| 28 | | 5.68 | 33.37 | 4.77 | 6.03 | 0.64 | | 1.03 | | 51.52 | 10.00 |
| 28.5 | | 0.90 | 16.37 | 8.38 | 2.19 | | 0.64 | | 0.64 | 29.12 | 6.11 |
| 29 | | | 11.88 | 13.29 | 5.15 | 1.03 | | | 0.90 | 32.25 | 7.38 |
| 29.5 | | | 1.81 | 15.23 | 6.45 | 0.64 | 1.03 | 0.90 | 0.64 | 26.71 | 6.09 |
| 30 | | | 1.81 | 8.52 | 2.58 | 0.64 | 1.81 | 1.03 | 4.52 | 20.92 | 5.25 |
| 30.5 | | | | 4.65 | 3.62 | 1.03 | 0.90 | 2.71 | 0.90 | 13.82 | 3.54 |
| 31 | | | | 6.33 | 2.84 | 1.94 | | 5.43 | 5.43 | 21.97 | 5.91 |
| 31.5 | | | | 1.81 | 2.71 | | 0.90 | 2.71 | 3.62 | 11.76 | 3.37 |
| 32 | | | | 2.71 | 0.90 | | 3.62 | 1.81 | 7.24 | 16.28 | 4.76 |
| 32.5 | | | 1.81 | 0.90 | 1.81 | 1.81 | | 2.71 | 7.24 | 16.28 | 4.96 |
| 33 | | | | | 2.71 | | 0.90 | 1.81 | 10.86 | 16.28 | 5.18 |
| 33.5 | | | | | 0.90 | 0.90 | | 1.81 | 4.52 | 8.14 | 2.84 |
| 34 | | | 0.90 | 2.71 | | | | | 3.62 | 7.24 | 2.35 |
| 34.5 | | | | | | | | | 3.62 | 3.62 | 1.38 |
| 35 | | | | | 0.90 | | | | | 0.90 | 0.28 |
| 35.5 | | | | | | | | | | | 0.00 |
| 36 | | | 0.90 | | | | | | | 0.90 | 0.13 |
| Tot number | 1.39 | 275.11 | 235.57 | 97.40 | 54.69 | 10.56 | 11.85 | 21.97 | 53.75 | | 143.15 |
| NS herring | 1.39 | 269.23 | 211.79 | 81.33 | 37.42 | 6.72 | 10.57 | 21.97 | 53.37 | | |
| Baltic spring | 0.00 | 5.88 | 23.78 | 16.07 | 17.26 | 3.84 | 1.28 | 0.00 | 0.38 | | |
| | | | | | | | | | NS-herring (1000' t) | | 129.19 |
| | | | | | | | | | Baltic spring | | 13.97 |
| | | | | | | | | | SSB, NS herring | | 115.22 |

**Table 7**: Calibration report EK500. 37 kHz transducer. *Tridens*, 2-19 July 1996

| | | | |
|---|---|---|---|
| Date and time: | 25 June 1996<br>1400-1900 UTC | Position: | Off Mandal Harbour 58°00.60'N 007°27.60'E |
| Bottom depth: | 41 m | Wind: | 4BF |
| Salinity: | 35% | Wave height: | 0.1 m |
| Water temperature: | 16.0°C | | |

Transceiver menu before calibration

| | | | |
|---|---|---|---|
| Pulse length: | Medium | Bandwidth: | Wide |
| Max power: | 2000 W | Angle sensitivity: | 21.9 |
| 2-way beam angle: | -20.6 | Sv transducer gain: | 26.5 |
| TS transducer gain: | -26.5 | 3 dB beam width: | 7.1 |
| Alongship offset: | ? | Athw ship offset: | ? |
| Ping interval: | 1.0 | Transmitter power: | 2,000 |

| | |
|---|---|
| Standard target: | Copper sphere, -33.6 dB |
| Distance transducer- target: | 18.75 |
| TS values measured: | -33.0 |
| New transducer gain: | 26.8 |
| New TS vaues measured: | -33.5 |
| SA values measured: | ±8,000 |
| SA value calculated: | 6,346 |
| New Sv transducer gain: | 27.0 |
| New SA values measured: | 5,986-6,316 (n=7) |

**Table 8**: Trawl station list. *Tridens*, 2-19 July 1996. Trawl catches in kg

| Haul | Date | Time | Lat (N) | Long | Depth (m) | Duration (min) | Herring | N pout | Other gadoids | Mackerel | Sprat | Others | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 Jul | 1350 | 58.07 | 1.50E | 80 | 5 | 0 | 150 | 2 | 0 | 0 | 0 | |
| 2 | 3 Jul | 1550 | 57.55 | 1.41E | 90 | 40 | 35 | 25 | 0 | 0 | 0 | 0 | |
| 3 | 3 Jul | 1917 | 58.10 | 1.44E | 85 | 11 | 66 | 83 | 0 | 0 | 0 | 4 | |
| 4 | 4 Jul | 1230 | 58.10 | 1.29W | 90 | 40 | 69 | 0 | 6 | 0 | 0 | 5 | sandeel in the meshes |
| 5 | 4 Jul | 1600 | 57.55 | 1.50W | 90 | 30 | 7 | 0 | 0 | 0 | 86 | 1 | |
| 6 | 5 Jul | 0845 | 58.25 | 0.55W | 120 | 20 | 12 | 2 | 7 | 0 | 0 | 1 | |
| 7 | 5 Jul | 1240 | 58.24 | 0.09E | 140 | 10 | 26 | 0 | 0 | 0 | 0 | 0 | |
| 8 | 6 Jul | 0620 | 58.40 | 0.19E | 145 | 6 | 500 | 0 | 1 | 0 | 0 | 4 | |
| 9 | 6 Jul | 0738 | 58.40 | 0.10E | 145 | 44 | 0 | 37 | 0 | 0 | 0 | 8 | |
| 10 | 6 Jul | 1340 | 58.40 | 1.03W | 120 | 15 | 2,190 | 1 | 1 | 2 | 0 | 1 | |
| 11 | 6 Jul | 1750 | 58.40 | 2.04W | 80 | 40 | 19 | 0 | 1 | 0 | 214 | 0 | |
| 12 | 8 Jul | 1650 | 57.40 | 1.05E | 90 | 20 | 54 | 185 | 2 | 0 | 0 | 0 | |
| 13 | 9 Jul | 0738 | 57.25 | 0.13E | 85 | 35 | 1,995 | 0 | 5 | 20 | 0 | 0 | |
| 14 | 9 Jul | 1305 | 57.25 | 1.18W | 100 | 30 | 2 | 0 | 1 | 0 | 7 | 1 | |
| 15 | 10 Jul | 1155 | 56.55 | 0.23W | 75 | 25 | 610 | 0 | 210 | 1 | 0 | 0 | |
| 16 | 10 Jul | 1956 | 56.55 | 1.36W | 100 | 24 | 71 | 0 | 8 | 0 | 2 | 0 | |
| 17 | 11 Jul | 1515 | 56.25 | 0.56E | 85 | 30 | 2 | 0 | 65 | 0 | 0 | 0 | traces missed |
| 18 | 11 Jul | 1945 | 56.25 | 0.15W | 80 | 30 | 0 | 0 | 64 | 0 | 0 | 2 | traces missed |
| 19 | 12 Jul | 0617 | 56.10 | 1.27W | 55 | 11 | 0 | 0 | 0 | 0 | 0 | 1 | |
| 20 | 12 Jul | 1245 | 56.10 | 0.37E | 85 | 35 | 61 | 0 | 0 | 0 | 0 | 0 | |
| 21 | 16 Jul | 550 | 55.37 | 1.50E | 72 | 22 | 0 | 0 | 9 | 0 | 0 | 0 | 0-group cod |
| 22 | 16 Jul | 1135 | 55.25 | 0.31E | 73 | 30 | 0 | 0 | 9 | 22 | 0 | 10 | also many jellyfishes |
| 23 | 16 Jul | 1740 | 55.25 | 1.20W | 60 | 35 | 260 | 0 | 2 | 0 | 300 | 8 | |
| 24 | 17 Jul | 0550 | 55.10 | 0.14W | 75 | 70 | 49 | 0 | 1 | 21 | 730 | 0 | |
| 25 | 18 Jul | 0634 | 54.40 | 0.17W | 60 | 21 | 210 | 0 | 4 | 0 | 185 | 4 | |
| 26 | 18 Jul | 0941 | 54.40 | 0.26E | 60 | 14 | 450 | 0 | 2 | 0 | 1,245 | 4 | |

**Table 9**: Length distributions herring

| Length | haul 2 | haul 3 | haul 4 | haul 6 | haul 7 | haul 8 | haul 10 | haul 11 | haul 12 | haul 13 | haul 14 | haul 15 | haul 16 | haul 17 | haul 20 | haul 23 | haul 24 | haul 25 | haul 26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13.5 | 0.00 | 0.00 | 4.46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 14.0 | 0.00 | 0.00 | 3.18 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.85 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 14.5 | 0.00 | 0.00 | 7.64 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.39 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 15.0 | 0.00 | 0.00 | 16.56 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.09 | 0.00 | 5.93 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 15.5 | 0.00 | 0.00 | 13.38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.82 | 0.00 | 11.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 16.0 | 0.00 | 0.00 | 15.29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 13.64 | 0.00 | 11.86 | 0.00 | 0.00 | 0.00 | 3.33 | 0.68 | 0.65 |
| 16.5 | 0.00 | 0.00 | 10.19 | 0.00 | 0.00 | 0.00 | 0.00 | 2.04 | 0.00 | 0.00 | 18.18 | 0.00 | 6.78 | 0.00 | 0.00 | 0.00 | 0.00 | 3.42 | 1.31 |
| 17.0 | 0.00 | 0.00 | 9.55 | 0.00 | 0.00 | 0.00 | 0.00 | 10.20 | 0.00 | 0.00 | 20.45 | 0.00 | 5.08 | 0.00 | 0.00 | 0.00 | 0.00 | 8.90 | 5.88 |
| 17.5 | 0.00 | 0.00 | 2.55 | 0.00 | 0.00 | 0.00 | 0.00 | 22.45 | 0.00 | 0.00 | 6.82 | 0.00 | 4.24 | 0.00 | 0.00 | 0.83 | 6.67 | 10.27 | 13.73 |
| 18.0 | 0.00 | 0.00 | 3.82 | 0.00 | 0.00 | 0.00 | 0.00 | 24.49 | 0.00 | 0.00 | 4.55 | 0.00 | 5.93 | 0.00 | 0.66 | 0.83 | 3.33 | 19.86 | 15.03 |
| 18.5 | 0.00 | 0.00 | 2.55 | 0.00 | 0.00 | 0.00 | 0.00 | 14.29 | 0.00 | 0.00 | 6.82 | 0.66 | 5.08 | 0.00 | 1.99 | 5.00 | 10.00 | 16.44 | 18.95 |
| 19.0 | 0.00 | 0.00 | 3.82 | 0.00 | 0.00 | 0.00 | 0.00 | 10.20 | 0.00 | 0.00 | 6.82 | 1.32 | 11.86 | 0.00 | 3.31 | 5.83 | 10.00 | 20.55 | 16.99 |
| 19.5 | 0.00 | 0.00 | 0.64 | 0.00 | 0.00 | 0.00 | 0.00 | 8.16 | 0.00 | 0.00 | 0.00 | 1.32 | 6.78 | 0.00 | 5.30 | 24.17 | 16.67 | 11.64 | 16.99 |
| 20.0 | 0.00 | 0.00 | 0.64 | 0.00 | 0.00 | 0.00 | 0.00 | 4.08 | 0.00 | 0.00 | 0.00 | 0.66 | 9.32 | 0.00 | 8.61 | 25.83 | 20.00 | 6.16 | 4.58 |
| 20.5 | 0.00 | 0.00 | 1.27 | 0.00 | 0.00 | 0.00 | 0.00 | 4.08 | 0.00 | 0.00 | 0.00 | 0.66 | 5.93 | 0.00 | 11.92 | 22.50 | 6.67 | 0.68 | 3.92 |
| 21.0 | 0.00 | 0.00 | 1.91 | 1.03 | 0.00 | 0.00 | 0.00 | 0.00 | 1.54 | 0.00 | 0.00 | 3.95 | 2.54 | 14.29 | 12.58 | 5.83 | 10.00 | 0.68 | 1.96 |
| 21.5 | 0.00 | 0.00 | 1.27 | 1.03 | 0.00 | 0.00 | 1.39 | 0.00 | 3.08 | 0.83 | 2.27 | 5.26 | 3.39 | 0.00 | 10.60 | 2.50 | 3.33 | 0.00 | 0.00 |
| 22.0 | 0.00 | 0.00 | 0.64 | 0.00 | 0.00 | 0.00 | 2.08 | 0.00 | 4.62 | 0.00 | 2.27 | 5.92 | 0.00 | 7.14 | 9.93 | 3.33 | 6.67 | 0.00 | 0.00 |
| 22.5 | 0.00 | 0.83 | 0.00 | 1.03 | 0.00 | 0.00 | 0.69 | 0.00 | 6.92 | 0.83 | 0.00 | 12.50 | 0.00 | 7.14 | 7.28 | 0.83 | 0.00 | 0.68 | 0.00 |
| 23.0 | 2.26 | 3.31 | 0.64 | 6.19 | 0.00 | 0.00 | 2.78 | 0.00 | 6.92 | 0.00 | 0.00 | 8.55 | 0.00 | 21.43 | 7.28 | 0.83 | 3.33 | 0.00 | 0.00 |
| 23.5 | 8.27 | 9.09 | 0.00 | 10.31 | 0.65 | 0.63 | 4.17 | 0.00 | 7.69 | 4.13 | 0.00 | 9.21 | 0.00 | 0.00 | 3.97 | 0.00 | 0.00 | 0.00 | 0.00 |
| 24.0 | 19.55 | 18.18 | 0.00 | 13.40 | 0.65 | 1.25 | 9.72 | 0.00 | 4.62 | 6.61 | 2.27 | 7.24 | 0.00 | 14.29 | 1.99 | 0.00 | 0.00 | 0.00 | 0.00 |
| 24.5 | 12.78 | 22.31 | 0.00 | 16.49 | 7.74 | 4.38 | 13.89 | 0.00 | 7.69 | 7.44 | 0.00 | 7.89 | 0.00 | 21.43 | 1.99 | 0.00 | 0.00 | 0.00 | 0.00 |
| 25.0 | 15.79 | 18.18 | 0.00 | 16.49 | 9.68 | 3.75 | 13.19 | 0.00 | 7.69 | 8.26 | 0.00 | 10.53 | 0.00 | 0.00 | 3.31 | 0.00 | 0.00 | 0.00 | 0.00 |
| 25.5 | 14.29 | 8.26 | 0.00 | 14.43 | 11.61 | 2.50 | 9.72 | 0.00 | 10.00 | 18.18 | 0.00 | 3.95 | 0.00 | 7.14 | 1.32 | 0.00 | 0.00 | 0.00 | 0.00 |
| 26.0 | 14.29 | 5.79 | 0.00 | 7.22 | 10.32 | 6.88 | 11.81 | 0.00 | 4.62 | 13.22 | 0.00 | 7.24 | 0.00 | 7.14 | 1.99 | 0.00 | 0.00 | 0.00 | 0.00 |
| 26.5 | 8.27 | 3.31 | 0.00 | 3.09 | 12.90 | 8.75 | 6.94 | 0.00 | 4.62 | 15.70 | 0.00 | 1.97 | 0.00 | 0.00 | 1.99 | 0.83 | 0.00 | 0.00 | 0.00 |
| 27.0 | 1.50 | 6.61 | 0.00 | 8.25 | 14.19 | 7.50 | 7.64 | 0.00 | 8.46 | 9.09 | 0.00 | 3.95 | 0.00 | 0.00 | 0.66 | 0.00 | 0.00 | 0.00 | 0.00 |
| 27.5 | 3.01 | 1.65 | 0.00 | 1.03 | 9.03 | 13.13 | 5.56 | 0.00 | 9.23 | 4.96 | 0.00 | 1.32 | 0.00 | 0.00 | 1.32 | 0.00 | 0.00 | 0.00 | 0.00 |

| Length | haul 2 | haul 3 | haul 4 | haul 6 | haul 7 | haul 8 | haul 10 | haul 11 | haul 12 | haul 13 | haul 14 | haul 15 | haul 16 | haul 17 | haul 20 | haul 23 | haul 24 | haul 25 | haul 26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28.0 | 0.00 | 1.65 | 0.00 | 0.00 | 8.39 | 16.25 | 2.78 | 0.00 | 8.46 | 4.96 | 0.00 | 2.63 | 0.00 | 0.00 | 0.66 | 0.83 | 0.00 | 0.00 | 0.00 |
| 28.5 | 0.00 | 0.83 | 0.00 | 0.00 | 7.10 | 8.13 | 3.47 | 0.00 | 1.54 | 1.65 | 0.00 | 1.97 | 0.00 | 0.00 | 0.66 | 0.00 | 0.00 | 0.00 | 0.00 |
| 29.0 | 0.00 | 0.00 | 0.00 | 0.00 | 1.29 | 8.75 | 3.47 | 0.00 | 0.77 | 1.65 | 0.00 | 0.66 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 29.5 | 0.00 | 0.00 | 0.00 | 0.00 | 1.94 | 8.75 | 0.69 | 0.00 | 1.54 | 0.83 | 0.00 | 0.00 | 0.00 | 0.00 | 0.66 | 0.00 | 0.00 | 0.00 | 0.00 |
| 30.0 | 0.00 | 0.00 | 0.00 | 0.00 | 1.94 | 5.00 | 0.00 | 0.00 | 0.00 | 1.65 | 0.00 | 0.66 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 30.5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.65 | 0.63 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 31.0 | 0.00 | 0.00 | 0.00 | 0.00 | 1.94 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 31.5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 32.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| mean l | 25.02 | 24.88 | 16.27 | 24.78 | 26.70 | 27.68 | 25.52 | 18.23 | 25.15 | 25.94 | 17.18 | 23.93 | 17.76 | 23.46 | 21.95 | 20.15 | 19.72 | 18.45 | 18.61 |
| TS | -43.15 | -43.19 | -46.84 | -43.23 | -42.59 | -42.28 | -42.98 | -45.86 | -43.10 | -42.84 | -46.37 | -43.53 | -46.09 | -43.70 | -44.27 | -45.01 | -45.19 | -45.76 | -45.69 |
| weight | 128.10 | 129.00 | 33.60 | 126.80 | 169.70 | 169.90 | 145.80 | 46.90 | 141.50 | 150.40 | 36.40 | 122.40 | 44.90 | 114.30 | 93.10 | 63.30 | 63.40 | 51.40 | 52.30 |

**Table 10**: Summarised results all sampling areas. *Tridens*, 2-19 July 1996

| | 1 | 2L | 2M | 3L | 3M | 4 | 5 | 6 | 7 | 8 | 9+ | | | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 94 im | 93 im | 93 ad | 92 im | 92 ad | 91 | 90 | 89 | 88 | 87 | 86 | 85 | 84 | |
| **Number in millions - autumn spawners** | | | | | | | | | | | | | | |
| A | 240.9 | 10.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 251.0 |
| B | 0.0 | 8.8 | 879.4 | 0.0 | 733.8 | 54.6 | 29.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1,706.3 |
| C | 0.0 | 0.0 | 206.6 | 0.0 | 296.2 | 118.8 | 49.1 | 37.1 | 0.0 | 13.7 | 0.0 | 0.0 | 0.0 | 721.4 |
| D | 320.4 | 33.7 | 59.5 | 0.0 | 254.1 | 5.7 | 11.4 | 2.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 687.7 |
| E | 0.0 | 0.0 | 150.4 | 0.0 | 146.9 | 8.7 | 13.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 319.5 |
| F | 1,227.9 | 347.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1,574.9 |
| G | 67.5 | 317.5 | 206.1 | 36.6 | 20.6 | 52.0 | 4.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 705.0 |
| H | 1,028.1 | 268.5 | 28.9 | 11.2 | 0.0 | 0.0 | 0.0 | 0.0 | 2.8 | 0.0 | 0.0 | 0.0 | 2.8 | 1,342.3 |
| Totals | 2,884.9 | 985.7 | 1,530.9 | 47.8 | 1,451.6 | 239.8 | 108.2 | 39.9 | 2.8 | 13.7 | 0.0 | 0.0 | 2.8 | 7,308.1 |
| **Weight in '000 tons - autumn spawners** | | | | | | | | | | | | | | |
| A | 9.4 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 10.1 |
| B | 0.0 | 0.6 | 102.1 | 0.0 | 115.9 | 11.0 | 7.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 236.8 |
| C | 0.0 | 0.0 | 26.3 | 0.0 | 48.7 | 23.0 | 9.8 | 8.3 | 0.0 | 3.5 | 0.0 | 0.0 | 0.0 | 119.6 |
| D | 10.8 | 3.0 | 7.4 | 0.0 | 37.5 | 1.2 | 2.4 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 62.8 |
| E | 0.0 | 0.0 | 16.6 | 0.0 | 22.3 | 1.6 | 2.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 42.9 |
| F | 47.0 | 22.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 69.2 |
| G | 4.7 | 29.3 | 24.0 | 4.5 | 3.2 | 8.7 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 75.4 |
| H | 54.8 | 16.6 | 3.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 0.5 | 75.3 |
| Totals | 126.8 | 72.4 | 179.4 | 4.5 | 227.7 | 45.5 | 22.7 | 8.9 | 0.4 | 3.5 | 0.0 | 0.0 | 0.5 | 692.2 |

**Table 11**: Length distribution sprat

| Length | haul 5 | haul 11 | haul 14 | haul 16 | haul 23 | haul 24 | haul 25 | haul 26 |
|---|---|---|---|---|---|---|---|---|
| 6.5 | 0 | 0 | 0 | 1.82 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 7.27 | 0 | 0 | 0 | 0 |
| 7.5 | 3.03 | 0 | 0 | 12.73 | 0 | 0 | 0 | 0 |
| 8 | 25.25 | 0 | 0 | 27.27 | 0 | 0 | 0 | 0 |
| 8.5 | 32.32 | 0 | 2.44 | 21.82 | 0 | 0 | 0 | 0 |
| 9 | 27.27 | 0 | 19.51 | 16.36 | 0 | 0 | 0 | 0 |
| 9.5 | 10.1 | 1.03 | 48.78 | 9.09 | 0 | 0 | 0 | 0 |
| 10 | 1.01 | 19.59 | 29.27 | 1.82 | 1.89 | 0 | 0 | 0 |
| 10.5 | 1.01 | 17.53 | 0 | 1.82 | 4.72 | 0 | 0 | 0 |
| 11 | 0 | 42.27 | 0 | 0 | 6.6 | 0 | 0 | 1.98 |
| 11.5 | 0 | 14.43 | 0 | 0 | 15.09 | 0 | 0 | 3.96 |
| 12 | 0 | 3.09 | 0 | 0 | 23.58 | 6.85 | 5.88 | 13.86 |
| 12.5 | 0 | 2.06 | 0 | 0 | 21.7 | 16.44 | 11.76 | 17.82 |
| 13 | 0 | 0 | 0 | 0 | 10.38 | 41.1 | 31.37 | 32.67 |
| 13.5 | 0 | 0 | 0 | 0 | 8.49 | 16.44 | 25.49 | 16.83 |
| 14 | 0 | 0 | 0 | 0 | 6.6 | 13.7 | 17.65 | 10.89 |
| 14.5 | 0 | 0 | 0 | 0 | 0 | 4.11 | 7.84 | 1.98 |
| 15 | 0 | 0 | 0 | 0 | 0.94 | 1.37 | 0 | 0 |
| mean length | 8.62 | 10.84 | 9.52 | 8.33 | 12.25 | 13.16 | 13.3 | 12.9 |
| TS mean lgt | -52.25 | -50.31 | -51.4 | -52.53 | -49.26 | -48.65 | -48.56 | -48.82 |
| mean weight | 4.4 | 8.84 | 5.95 | 4.05 | 13.37 | 16.24 | 16.68 | 15.44 |

**Table 12**: Total sprat, numbers in millions and weight. *Tridens*, 2-19 July 1996

| Length | Stratum A-G | Stratum H | Total |
|---|---|---|---|
| 6.5 | 1 | 0 | 1 |
| 7.0 | 4 | 0 | 4 |
| 7.5 | 10 | 0 | 10 |
| 8.0 | 40 | 0 | 40 |
| 8.5 | 45 | 0 | 45 |
| 9.0 | 44 | 0 | 44 |
| 9.5 | 36 | 0 | 36 |
| 10.0 | 33 | 2 | 35 |
| 10.5 | 19 | 5 | 24 |
| 11.0 | 41 | 9 | 50 |
| 11.5 | 14 | 20 | 34 |
| 12.0 | 3 | 47 | 50 |
| 12.5 | 2 | 59 | 61 |
| 13.0 | 0 | 90 | 90 |
| 13.5 | 0 | 51 | 51 |
| 14.0 | 0 | 37 | 37 |
| 14.5 | 0 | 9 | 9 |
| 15.0 | 0 | 2 | 2 |
| Total | 292 | 331 | 623 |
| Million fish | 10,298.8 | 9,354.6 | 19,653.4 |
| Mean weight | 5.8 | 15.4 | |
| 000 tons | 59.8 | 144.4 | 204.2 |

**Table 13**: Settings and calibration data of the haul mounted split-beam transducer at RV *Dana* during the calibration at Bornö, Gullmarn Fjord, Sweden in May 1996

| | |
|---|---|
| Echo sounder | EK/ES 400, 38 kHz |
| Transducer | Simrad ceramic 39-29/25 |
| SL + VR (dB) | 131.9 |
| 10 log psi | -20.2 |
| Sound velocity (m/s) | 1470 |
| Pulse length (s) | 0.001 |
| TVG | 64.6 |
| Vpp/unit (20 log r, EK) | 0.001004 |
| Vpp/unit (40 log r, ES) | 0.00131 |
| A/D zero point adjust | |
| Phase 1 | 12 |
| Phase 2 | 12 |

**Table 14**: Catch information by trawl haul during the acoustic survey of RV *Dana* in Skagerrak and Kattegat in the period 19-30 July 1996

| Date dd mm yy | Haul no | Time | ICES square | Trawl | Catch depth (m) | Mean depth (m) | Trawling speed (kn) | Trawling time (min) | Total catch (kg) | Main species |
|---|---|---|---|---|---|---|---|---|---|---|
| 19 07 96 | 30 | 2340 | 44F6 | FOTÖ | surface | 160 | 4.0 | 60 | 192 | mackerel, herring, krill |
| 20 07 96 | 46 | 0219 | 44F5 | FOTÖ | surface | 250 | 3.8 | 60 | 739 | mackerel, herring |
| 20 07 96 | 195 | 1934 | 45F5 | FOTÖ | 185-200 | 325 | 3.2 | 60 | 50 | krill, jellyfish |
| 20 07 96 | 222 | 2332 | 45F6 | FOTÖ | surface | 281 | 3.4 | 60 | 194 | mackerel, herring, krill |
| 21 07 96 | 242 | 0222 | 45F5 | FOTÖ | surface | 283 | 4.1 | 60 | 402 | herring, mackerel, krill |
| 21 07 96 | 340 | 1226 | 44F6 | FOTÖ | 235-250 | 310 | 3.5 | 60 | 20 | pearlsides, krill |
| 21 07 96 | 361 | 1605 | 44F6 | FOTÖ | 260-275 | 400 | 3.5 | 60 | 32 | blue whiting, krill, jellyfish |
| 21 07 96 | 425 | 2330 | 43F5 | FOTÖ | surface | 75 | 3.5 | 60 | 368 | mackerel, juvenile whiting and Norway pout |
| 22 07 96 | 446 | 0221 | 43F5 | FOTÖ | surface | 56 | 3.4 | 60 | 379 | mackerel, herring, sandeel |
| 22 07 96 | 533 | 1230 | 43F6 | EXPO | bottom | 57 | 3.6 | 60 | 903 | haddock, cod, Norway pout |
| 22 07 96 | 557 | 1543 | 43F6 | EXPO | bottom | 67 | 3.5 | 60 | 1,399 | haddoch, Norway pout, cod |
| 22 07 96 | 626 | 2350 | 44F7 | FOTÖ | surface | 450 | 4.0 | 60 | 583 | herring, mackerel, krill |
| 23 07 96 | 642 | 0223 | 43F7 | FOTÖ | surface | 230 | 4.2 | 60 | 1,452 | herring, mackerel |
| 23 07 96 | 742 | 1245 | 44F7 | FOTÖ | 235-250 | 485 | 3.5 | 60 | 112 | herring, blue whiting |
| 23 07 96 | 763 | 1608 | 44F8 | FOTÖ | 125-150 | 520 | 3.5 | 60 | 90 | jellyfish, pearlsides, lumpsucker, saithe |
| 23 07 96 | 834 | 2327 | 43F8 | FOTÖ | surface | 62 | 4.0 | 60 | 812 | herring, mackerel |
| 24 07 96 | 854 | 0219 | 44F8 | FOTÖ | surface | 500 | 3.6 | 60 | 798 | herring, blue whiting |
| 24 07 96 | 947 | 1224 | 44F9 | EXPO | bottom | 41 | 3.5 | 60 | 1,428 | herring, whiting |
| 24 07 96 | 970 | 1602 | 44F9 | EXPO | bottom | 180 | 3.2 | 60 | 1,178 | blue whiting |
| 24 07 96 | 1039 | 2331 | 45F9 | FOTÖ | surface | 695 | 4.0 | 60 | 1,144 | herring, mackerel |
| 25 07 96 | 1058 | 0221 | 45F9 | FOTÖ | surface | 100 | 4.0 | 60 | 409 | herring, blue whiting |
| 25 07 96 | 1159 | 1246 | 46F9 | FOTÖ | 180-200 | 350-400 | 4.0 | 60 | 74 | argentina, blue whiting, krill |
| 25 07 96 | 1259 | 2334 | 45G0 | FOTÖ | surface | 260 | 3.5 | 60 | 400 | herring, mackerel, blue whiting |
| 26 07 96 | 1276 | 0216 | 46G0 | FOTÖ | surface | 106 | 4.0 | 60 | 489 | herring, mackerel |
| 26 07 96 | 1355 | 1229 | 45G0 | EXPO | bottom | 201 | 3.5 | 60 | 1,652 | blue whiting |

| Date dd mm yy | Haul no | Time | ICES square | Trawl | Catch depth (m) | Mean depth (m) | Trawling speed (kn) | Trawling time (min) | Total catch (kg) | Main species |
|---|---|---|---|---|---|---|---|---|---|---|
| 26 07 96 | 1382 | 1626 | 45G0 | EXPO | bottom | 100 | 2.5 | 40 | 907 | Norway pout, saithe |
| 26 07 96 | 1418 | 2340 | 44G0 | FOTÖ | surface | 125 | 3.5 | 60 | 556 | herring, mackerel, krill |
| 27 07 96 | 1435 | 0219 | 44G1 | FOTÖ | surface | 87 | 4.1 | 60 | 1,047 | krill, jellyfish, mackerel, herring |
| 27 07 96 | 1512 | 1237 | 44G0 | EXPO | bottom | 26 | 3.3 | 60 | 638 | sprat, jellyfish |
| 27 07 96 | 1535 | 1354 | 44G1 | EXPO | bottom | 69 | 3.4 | 60 | 975 | herring, Norway pout |
| 27 07 96 | 1598 | 2331 | 43G1 | FOTÖ | surface | 70 | 3.5 | 60 | 667 | herring, jellyfish |
| 28 07 96 | 1615 | 0218 | 43G1 | FOTÖ | surface | 58 | 4.2 | 60 | 285 | herring, jellyfish |
| 28 07 96 | 1702 | 1329 | 42G1 | EXPO | bottom | 30-35 | 3.3 | 60 | 698 | herring, sprat, jellyfish |
| 28 07 96 | 1714 | 1546 | 42G1 | EXPO | bottom | 30 | 3.7 | 60 | 635 | herring, jellyfish |
| 28 07 96 | 1784 | 2322 | 42G2 | FOTÖ | surface | 45 | 3.5 | 60 | 525 | jellyfish, herring |
| 29 07 96 | 1797 | 0147 | 41G2 | FOTÖ | surface | 36 | 4.3 | 60 | 596 | jellyfish, herring, mackerel |
| | | | | | | | | Mean catch | 634.1 | |
| | | | | | | | | Total | 22,828 | |

**Table 15**: Length frequency of herring by trawl haul obtained during the acoustic survey of RV *Dana* in the period 19-30 July 1996

| 0.5 cm intervals | Trawl haul number | | | | | | | | | | | | | | | | | | | | | | | | Total number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 46 | 222 | 242 | 446 | 626 | 642 | 742 | 834 | 854 | 947 | 1039 | 1058 | 1259 | 1276 | 1418 | 1435 | 1512 | 1535 | 1598 | 1615 | 1702 | 1714 | 1784 | 1797 | |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 8 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 9 | | | | | | | | | | | | | | | | | | 1 | | | | | | | 1 |
| 10 | | | | | | | | | | | | | | | | | | 3 | | | | | | | 3 |
| 11 | | | | | | | | | | | | | | | | | | 15 | | | | | | | 15 |
| 12 | | | | | | | | | | | | | | | | | 8 | 74 | | 1 | | | | | 83 |
| 13 | | | | | | | | | | | | | | | | | 7 | 116 | | 1 | | | | | 124 |
| 14 | | | | | | | | | | | | | | | | 2 | 6 | 56 | | 5 | | | | | 69 |
| 15 | | | | | | | | | | | | | | | | 10 | 44 | 21 | | 3 | | | | | 78 |
| 16 | | | | | | | | | | | | | | | | 36 | 26 | 10 | | 2 | | | | | 74 |
| 17 | | | | | | | | | | | | | | | | 11 | 18 | 13 | | 1 | | | | | 43 |
| 18 | | | | | | | | | | | | | | | | 14 | 5 | 7 | | | | | | | 26 |
| 19 | | | | | | | | | | | | | | | | 3 | 2 | 2 | | 1 | | | | | 8 |
| 20 | | | | | | | | | | | | | | | | 1 | 1 | 2 | | | | | | | 4 |
| 21 | | | | | | | | | | | | | | | | | | 2 | | | | | | | 2 |
| 22 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 23 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 24 | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| 25 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 26 | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| 27 | | | | | | | | | | | | | | | | | | 1 | | | | | | | 1 |
| 28 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 29 | | | | | | | | | | 1 | | | | | | | | | | | | | 1 | | 2 |
| 30 | | | | | | | | 2 | | 12 | | | | | | | | | | | | | | | 14 |
| 31 | | | | | | | | 3 | | 36 | | | | | | | | 1 | | 1 | | | | | 41 |
| 32 | | | 1 | | | | | 21 | | 72 | | | | 1 | | | 3 | 1 | | 1 | | | 10 | 1 | 111 |
| 33 | | 1 | | 1 | | | 1 | 57 | | 94 | | | | 2 | | 1 | 3 | 1 | 2 | | | 1 | 33 | 10 | 207 |
| 34 | | 2 | | 3 | | | 1 | 103 | 5 | 131 | | 1 | | 2 | | | 3 | 5 | 8 | 5 | 10 | 16 | 86 | 58 | 439 |
| 35 | | 3 | 4 | 5 | | | 2 | 117 | 6 | 101 | | | 1 | 12 | 1 | 1 | 2 | 6 | 42 | 20 | 53 | 63 | 107 | 87 | 633 |
| 36 | 3 | 7 | 9 | 16 | | | 8 | 141 | 5 | 100 | 1 | 1 | 1 | 9 | | 5 | 1 | 6 | 90 | 48 | 125 | 79 | 97 | 94 | 846 |
| 37 | 4 | 3 | 12 | 19 | 2 | | 4 | 132 | 8 | 93 | | 2 | 5 | 18 | 6 | 18 | 2 | 10 | 94 | 67 | 91 | 64 | 54 | 61 | 769 |
| 38 | 10 | 1 | 4 | 13 | 2 | | 2 | 104 | 5 | 80 | 2 | 5 | 14 | 25 | 9 | 30 | | 16 | 74 | 40 | 48 | 24 | 37 | 37 | 582 |
| 39 | 2 | 2 | 12 | 8 | 1 | 1 | 9 | 91 | 15 | 50 | 5 | 18 | 28 | 71 | 25 | 34 | | 4 | 45 | 28 | 14 | 12 | 32 | 32 | 539 |
| 40 | 16 | 5 | 10 | 9 | 5 | | 11 | 81 | 19 | 26 | 19 | 34 | 66 | 120 | 51 | 30 | 1 | 7 | 37 | 19 | 14 | 10 | 24 | 17 | 631 |
| 41 | 19 | 6 | 19 | 12 | 8 | 2 | 22 | 70 | 22 | 13 | 30 | 36 | 96 | 95 | 65 | 24 | | | 25 | 12 | | 2 | 12 | 20 | 610 |
| 42 | 27 | 10 | 51 | 4 | 15 | 6 | 30 | 70 | 38 | 5 | 43 | 45 | 50 | 82 | 55 | 22 | | 3 | 10 | 8 | 5 | 3 | 12 | 9 | 603 |
| 43 | 34 | 12 | 49 | 2 | 24 | 6 | 27 | 51 | 31 | 1 | 51 | 55 | 65 | 66 | 48 | 12 | | 1 | 4 | 3 | 1 | 1 | 6 | 5 | 555 |
| 44 | 35 | 14 | 67 | 2 | 48 | 21 | 34 | 32 | 31 | | 77 | 46 | 64 | 28 | 37 | 5 | 1 | | 4 | 1 | 1 | 2 | 6 | 4 | 560 |
| 45 | 42 | 20 | 71 | | 66 | 25 | 27 | 35 | 34 | | 78 | 44 | 49 | 22 | 39 | 6 | | | 1 | 2 | | | 6 | 9 | 576 |

| 0.5 cm intervals | Trawl haul number | | | | | | | | | | | | | | | | | | | | | | | | Total number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 46 | 222 | 242 | 446 | 626 | 642 | 742 | 834 | 854 | 947 | 1039 | 1058 | 1259 | 1276 | 1418 | 1435 | 1512 | 1535 | 1598 | 1615 | 1702 | 1714 | 1784 | 1797 | |
| 46 | 36 | 9 | 49 | 1 | 65 | 36 | 30 | 24 | 36 | | 60 | 36 | 42 | 17 | 33 | 2 | | | 3 | 5 | | | 2 | 1 | 487 |
| 47 | 51 | 10 | 49 | | 84 | 35 | 18 | 17 | 29 | | 62 | 50 | 31 | 17 | 27 | 2 | | | | | | | | 5 | 487 |
| 48 | 40 | 9 | 40 | | 74 | 30 | 12 | 13 | 35 | | 56 | 26 | 11 | 6 | 14 | 1 | | | | | | | | | 367 |
| 49 | 48 | 9 | 64 | | 84 | 42 | 12 | 7 | 28 | | 47 | 24 | 21 | 3 | 8 | 3 | | | | 1 | | | | 1 | 402 |
| 50 | 49 | 7 | 41 | | 69 | 47 | 5 | 9 | 43 | | 35 | 15 | 7 | 2 | 11 | 1 | | | | | | | | | 341 |
| 51 | 48 | 3 | 23 | | 35 | 46 | 3 | 5 | 28 | | 13 | 10 | 5 | 2 | 2 | | | | | | | | | | 223 |
| 52 | 25 | | 9 | | 24 | 38 | 2 | 1 | 25 | | 11 | 5 | 2 | 1 | 4 | | | | | | | | 1 | 1 | 149 |
| 53 | 15 | 3 | 15 | 1 | 24 | 35 | 1 | | 14 | | 8 | 3 | 3 | | 3 | | | | | | | | | 1 | 126 |
| 54 | 15 | | 9 | | 20 | 19 | 2 | | 14 | | 6 | 7 | 3 | 2 | 5 | 1 | | | | | | | | | 103 |
| 55 | 15 | 2 | 6 | | 19 | 18 | 1 | 2 | 8 | | 15 | 3 | 2 | | 5 | | | | | | | | | | 96 |
| 56 | 3 | 2 | 5 | | 12 | 20 | 2 | 1 | 12 | | 8 | 1 | 3 | 1 | | | | | | | | | | 1 | 71 |
| 57 | 11 | | 5 | | 17 | 13 | | | 11 | | 4 | 1 | | | 1 | 1 | | | | | | | | | 64 |
| 58 | 3 | | 1 | | 11 | 12 | | | 14 | | 2 | | 1 | | | | | | | | | | | | 44 |
| 59 | 5 | 1 | 1 | | 7 | 10 | 2 | 1 | 12 | | 5 | | | | | | | | | | | | | 1 | 45 |
| 60 | 4 | | | | 6 | 5 | | | 8 | | | | | | | | | | | | | | | | 23 |
| 61 | 2 | 1 | | 1 | 5 | 5 | 1 | | 4 | | | | | 1 | | | | | | | | | | | 20 |
| 62 | | | | | 1 | 4 | | | 6 | | | | | | | | | | | | | | | | 11 |
| 63 | | | | | | 1 | | | | | | | | | | | | | | | | | | | 1 |
| 64 | | 1 | | | | 2 | | | | | | | | | | | | | | | | | | | 3 |
| 65 | | | | | | | | | 1 | | | | | | | | | | | | | | | | 1 |
| 66 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 67 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 68 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 69 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 70 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 71 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 72 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 73 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 74 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 75 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| number | 562 | 143 | 626 | 97 | 728 | 479 | 269 | 1190 | 547 | 815 | 638 | 468 | 570 | 605 | 449 | 276 | 133 | 384 | 439 | 275 | 362 | 277 | 528 | 455 | 11315 |

**Table 16**: Length frequency of sprat by trawl haul obtained during the acoustic survey of RV *Dana* in the period 19-30 July 1996

| 0.5 cm intervals | Trawl haul number | | | | | Total number |
|---|---|---|---|---|---|---|
| | 1512 | 1598 | 1615 | 1702 | 1714 | |
| 6 | | | | | | 0 |
| 7 | | | | | | 0 |
| 8 | | | | | | 0 |
| 9 | | | | | | 0 |
| 10 | | | | | | 0 |
| 11 | | | | | | 0 |
| 12 | | | | | | 0 |
| 13 | | | | | | 0 |
| 14 | | | | | | 0 |
| 15 | | | | | | 0 |
| 16 | | | | | | 0 |
| 17 | | | | | | 0 |
| 18 | | | | | | 0 |
| 19 | | | | | | 0 |
| 20 | 1 | 1 | | | | 2 |
| 21 | | 2 | | | | 2 |
| 22 | 3 | 19 | | 1 | | 23 |
| 23 | 4 | 49 | 3 | 3 | 3 | 62 |
| 24 | 17 | 91 | 1 | 12 | 19 | 140 |
| 25 | 51 | 127 | 12 | 31 | 51 | 272 |
| 26 | 68 | 43 | 31 | 64 | 63 | 269 |
| 27 | 68 | 50 | 20 | 68 | 57 | 263 |
| 28 | 32 | 20 | 20 | 65 | 29 | 166 |
| 29 | 7 | 14 | 9 | 45 | 17 | 92 |
| 30 | 4 | 7 | 7 | 33 | 13 | 64 |
| 31 | 1 | 6 | 7 | 20 | 6 | 40 |
| 32 | 1 | 1 | 1 | 6 | 6 | 15 |
| 33 | | | | | | 0 |
| 34 | | | | | | 0 |
| 35 | | | | | | 0 |
| 36 | | | | | | 0 |
| 37 | | | | | | 0 |
| 38 | | | | | | 0 |
| 39 | | | | | | 0 |
| 40 | | | | | | 0 |
| 41 | | | | | | 0 |
| 42 | | | | | | 0 |
| 43 | | | | | | 0 |
| 44 | | | | | | 0 |
| sum | 257 | 430 | 111 | 348 | 264 | 1,410 |

**Table 17**: The total biomass (tonnes) and number (*1,000,000) of herring measured by subarea during the acoustic survey of RV *Dana* in the period 19-3 July 1996

| Subarea | Biomass tonnes | Number *1000000 | % of biomass | % of number |
|---|---|---|---|---|
| I | 22698.8 | 223.6 | 5.6 | 3.9 |
| II | 30239.2 | 352.5 | 7.5 | 6.1 |
| III | 3645.2 | 37.4 | 0.9 | 0.6 |
| IV | 74263.7 | 876.9 | 18.5 | 15.1 |
| V | 26111.6 | 277.9 | 6.5 | 4.8 |
| VI | 45684.4 | 550.8 | 11.4 | 9.5 |
| VII | 6734.8 | 89.6 | 1.7 | 1.5 |
| VIII | 21306.5 | 352.0 | 5.3 | 6.1 |
| IX | 171295.7 | 3045.2 | 42.6 | 52.5 |
| Total | 401979.9 | 5805.9 | 100 | 100 |

**Table 18**: The total number (*1,000,000), biomass and spawning biomass (tonnes) or North Sea autumn and Baltic spring spawning herring by subarea and age estimated during the acoustic survey of RV *Dana* in the period 19-30 July 1996

| Subarea | Age | | | | | | | | | | | | | Total biomass tonnes | Number $*10^5$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2Im | 2MAT | 3Im | 3MAT | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| **North Sea autumn spawners** | | | | | | | | | | | | | | | |
| I | | 1038.8 | 1128.6 | 1128.6 | 65.0 | 368.5 | 106.2 | 79.0 | 14.0 | | | | | 3928.7 | 48.8 |
| II | | 5981.9 | 2758.4 | 2758.4 | 106.6 | 604.0 | 154.9 | 70.6 | 16.3 | 36.3 | 47.1 | | | 12534.5 | 178.6 |
| III | | 190.2 | 213.4 | 213.4 | 9.2 | 52.0 | 15.5 | 19.9 | 3.3 | 0.8 | 2.1 | 1.0 | | 720.7 | 8.9 |
| IV | 6.1 | 15700.2 | 6437.1 | 6437.1 | 225.6 | 1278.7 | 574.8 | 760.3 | 142.7 | 56.3 | 89.0 | 41.8 | | 31749.8 | 452.7 |
| V | | 1853.5 | 2090.1 | 2090.1 | 52.0 | 294.5 | 137.1 | 182.0 | 36.2 | 5.1 | | 6.2 | | 6747.0 | 84.9 |
| VI | 3.1 | 10172.0 | 3331.4 | 3331.4 | 95.1 | 538.8 | 272.0 | 179.2 | 45.4 | | | | | 17968.3 | 270.4 |
| VII | 18.1 | 1743.1 | 614.5 | 614.5 | 17.9 | 101.3 | 0.7 | 35.6 | 0.2 | 0.3 | | | | 3146.2 | 52.5 |
| VIII | 264.9 | 6028.7 | 1394.9 | 1394.9 | 804.5 | 456.2 | 150.5 | 131.2 | 49.1 | 2.3 | | | | 10677.2 | 231.7 |
| IX | 1621.8 | 51729.4 | 7786.9 | 7786.9 | 279.5 | 1583.9 | 979.0 | 490.9 | 140.1 | 143.5 | | | | 72542.0 | 1662.8 |
| Tonnes | 1914.0 | 94437.9 | 25755.3 | 25755.3 | 1655.4 | 5277.9 | 2390.6 | 1948.8 | 447.4 | 244.6 | 138.2 | 49.0 | 0.0 | 160014.3 | 2991.4 |
| % by age | 64.0 | 3156.9 | 861.0 | 861.0 | 55.3 | 176.4 | 79.9 | 65.1 | 15.0 | 8.2 | 4.6 | 1.6 | 0.0 | | |
| **Baltic spring spawners** | | | | | | | | | | | | | | | |
| I | | 741.8 | 3924.7 | 3924.7 | 689.2 | 3905.3 | 2503.5 | 1743.7 | 856.0 | 339.6 | 73.0 | 40.4 | 28.3 | 18770.1 | 174.8 |
| II | | 1000.0 | 4094.1 | 4094.1 | 605.9 | 3433.4 | 1848.4 | 1559.0 | 732.0 | 170.9 | 133.4 | | 33.5 | 17704.8 | 173.9 |
| III | | 144.4 | 671.8 | 671.8 | 114.1 | 646.4 | 265.3 | 165.9 | 145.0 | 55.4 | 17.0 | 22.2 | 5.4 | 2924.6 | 28.5 |
| IV | | 3525.9 | 10022.3 | 10022.3 | 1045.8 | 5926.2 | 3873.2 | 4192.7 | 1930.9 | 1064.2 | 438.9 | 428.3 | 43.3 | 42514.0 | 424.2 |
| V | | 1096.6 | 5499.1 | 5499.1 | 328.6 | 1862.3 | 1616.3 | 2296.4 | 488.2 | 391.6 | 78.3 | 208.1 | | 19364.6 | 193.0 |
| VI | | 2381.5 | 7158.3 | 7158.3 | 510.2 | 2891.2 | 2503.5 | 3045.5 | 899.8 | 607.0 | 264.2 | 296.6 | | 27716.2 | 280.4 |
| VII | | 300.5 | 1056.4 | 1056.4 | 68.0 | 385.1 | 165.2 | 259.9 | 189.6 | 85.0 | 13.1 | 9.5 | | 3588.7 | 37.1 |
| VIII | | 1387.8 | 2869.7 | 2869.7 | 239.6 | 1357.9 | 1245.3 | 977.5 | 174.2 | 90.9 | 86.7 | 54.2 | | 11353.4 | 120.3 |
| IX | | 48379.8 | 15974.4 | 15974.4 | 1031.9 | 5847.5 | 5427.3 | 3212.2 | 1254.0 | 999.2 | 383.1 | 270.0 | | 98753.7 | 1382.4 |
| Tonnes | 0 | 58958.4 | 51270.9 | 51270.9 | 4633.3 | 26255.3 | 19448.0 | 17452.9 | 6669.7 | 3803.6 | 1487.6 | 1329.2 | 110.4 | 242690.0 | 2814.7 |
| % by age | 0 | 2094.6 | 1821.5 | 1821.5 | 164.6 | 932.8 | 690.9 | 620.1 | 237.0 | 135.1 | 52.9 | 47.2 | 3.9 | | |

**Table 19**: The mean weight (g) of herring by subarea and age estimated during the acoustic survey of RV *Dana* in the period 19-30 July 1996

| Sub-area | Age | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ |
| I | | 57 | 95 | 122 | 142 | 144 | 165 | 140 | 169 | 171 | |
| II | | 56 | 93 | 128 | 143 | 150 | 170 | 156 | 171 | | |
| III | | 54 | 92 | 117 | 132 | 130 | 153 | 112 | 167 | 171 | |
| IV | | 59 | 108 | 129 | 150 | 177 | 185 | 197 | 208 | 234 | |
| V | | 61 | 116 | 138 | 149 | 178 | 200 | 216 | 241 | 223 | |
| VI | | 57 | 114 | 138 | 155 | 183 | 201 | 213 | 221 | 232 | |
| VII | | 61 | 93 | 104 | 97 | 109 | 94 | 178 | 264 | | |
| VIII | 2 | 53 | 95 | 107 | 119 | 130 | 126 | 139 | 159 | 158 | |
| IX | 2 | 48 | 74 | 86 | 100 | 108 | 109 | 110 | 159 | 167 | |

**Table 20**: Statistical information of length-weight relationship of the North Sea autumn and the Baltic spring spawning herring in Skagerrak and Kattegt during the acoustic survey of RV *Dana* in the period 19-30 July 1996

**ANOVAR of linear regression**

| Source of variation | North Sea autumn spawning herring | | | | Baltic spring spawning herring | | | |
|---|---|---|---|---|---|---|---|---|
| | df | SS | $S^2$ | F | df | SS | $S^2$ | F |
| Regression | 1 | 455.021 | 455.0207 | 45299.32 | 1 | 85.09719 | 85.09719 | 5732.514 |
| Residual | 360 | 3.61611 | 0.01005 | | 401 | 5.952707 | 0.01485 | |
| Total | 361 | 458.637 | | | 402 | 91.0499 | | |

**Linear regression**

| | | | S.E | t-value | 95% confidence limits | | R | number |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower | Upper | | |
| North Sea herring | Slope | 3.268 | 0.0153 | 212.836 | 3.238 | 3.298 | 0.996 | 362 |
| | Intercept | 0 | 0.0545 | -144.71 | 0 | 0 | | |
| Baltic herring | Slope | 3.252 | 0.0429 | 75.7133 | 3.168 | 3.337 | 0.966 | 403 |
| | Intercept | 0 | 0.1645 | -48.057 | 0 | 0 | | |

**Table 21**: Mean weight (g) and mean length (0.5 cm) of North Sea autumn and Baltic spring spawning herring by age in Skagerrak and Kattegat during the acoustic survey of RV *Dana* in the period 19-30 July 1996

| Age | Mean weight | | Mean length | |
|---|---|---|---|---|
| | North Sea herring | Baltic herring | North Sea herring | Baltic herring |
| 0 | 3.2 | | 15.2 | |
| 1 | 55.8 | 44.3 | 37.8 | 36.3 |
| 2 | 94.0 | 93.3 | 44.2 | 44.7 |
| 3 | | 112.3 | | 48.5 |
| 4 | | 128.7 | | 51.3 |
| 5 | | 141.8 | | 52.1 |
| 6 | | 159.9 | | 54.1 |
| 7 | | 178.3 | | 56.7 |
| 8 | 174.0 | 231.0 | 61.0 | 60.3 |
| 9 | | 216.8 | | 60.6 |
| 10 | | 179.0 | | |

**Table 22**: Number (*1,000) and biomass (tonnes) of sprat estimated by subarea during the survey of RV *Dana* in the period 19-30 July 1996

| Subarea | Biomass tonnes | Number *1000 | % of biomass |
|---|---|---|---|
| II | 0.009 | 0.93 | 0.0 |
| IV | 0.008 | 0.786 | 0.0 |
| VIII | 812.2 | 43330 | 5.7 |
| IX | 13455.4 | 749700 | 94.3 |
| Total | 14267.62 | 793031.72 | 100 |

**Table 23**: Catch composition by trawl haul. *Christina S* (13-30 July 1996)

| Haul no | Position | | Depth (m) | Numbers caught | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lat | Long | | Herring | Whiting | Haddock | Norway pout | Mackerel | Horse mackerel | Blue whiting | Sprat | Others |
| 1 | 58'21.51°N | 6'00.84°W | 100 | 47 | 199 | 54 | 449 | | | 4 | 118 | 12 spurdog |
| 2 | 58'03.22°N | 5'43.20°W | 95 | | | | | | | | | |
| 3 | 57'59.89°N | 6'09.62°W | 60 | | | | | | | | | |
| 4 | 57'06.31°N | 6'46.49°W | 130 | | | 564 | | | | | | |
| 5 | 56'42.61°N | 6'28.90°W | 85 | | | | | 3 | | | 3521 | |
| 6 | 56'07.87°N | 6'42.24°W | 60 | | | | | 4 | | | | |
| 7 | 05' 8.13°N | 8'40.45°W | 130 | | | | | | | | | |
| 8 | 56'23.17°N | 9'00.34°W | 146 | | | | | | | | | |
| 9 | 56'23.16°N | 8'11.60°W | 160 | 642 | 6 | | 1,026 | 30 | 2 | 2 | | 2 hake 2 pearlside |
| 10 | 56'23.00°N | 6'48.00°W | 85 | | 46 | | 56 | | | | | |
| 11 | 56'34.03°N | 7'39.61°W | 175 | 3,976 | 84 | | 616 | | 14 | | | |
| 12 | 56'33.96°N | 8'47.44°W | 150 | 3,128 | | 10 | 114 | 40 | | | | |
| 13 | 56'49.80°N | 7'29.17°W | 75 | 796 | 55 | 471 | | 896 | 35 | | | 2 saithe |
| 14 | 56'50.00°N | 8'45.37°W | 125 | 154 | | | | 3 | 1 | | | |
| 15 | 56'56.56°N | 8'20.06°W | 135 | 145 | 27 | 21 | 718 | 7 | | | | 1 skate 1 A. silus 2 gurnards 1 angler |
| 16 | 57'04.07°N | 8'30.86°W | 140 | 11,872 | | | | | | | | |
| 17 | 57'11.80°N | 8'31.00°W | 115 | 928 | | 9 | | | | | 12 | 6 gurnard |
| 18 | 57'19.18°N | 9'10.57°W | 160 | | | | 5 | 1 | | 28 | | 1 *S. viviparus* |
| 19 | 57'26.44°N | 9'15.81°W | 160 | 721 | | | 3 | 11 | 8 | | | |
| 20 | 57'41.51°N | 8'30.05°W | 150 | 9 | 28 | 1 | 25 | | | 1 | | |
| 21 | 57'41.46°N | 8'30.44°W | 150 | 736 | 374 | 52 | 973 | | | 7 | | 2 A. silus 4 poor cod 3 hake 2 gurnards |
| 22 | 57'41.45°N | 8'56.10°W | 150 | 2,256 | | | | 224 | | 48 | | |
| 23 | 57'56.49°N | 7'55.74°W | 80 | 758 | 252 | | 7 | 63 | | | | |
| 24 | 58'09.73°N | 7'39.66°W | 70 | | | | 1,568 | | | | | |
| 25 | 58'19.95°N | 7'50.65°W | 100 | 2 | | | | 5 | | | | |
| 26 | 58'20.05°N | 8'12.32°W | 150 | 165 | 7 | | 5 | 205 | | | | 1 gurnard |
| 27 | 58'34.02°N | 7'32.32°W | 130 | 596 | | | | 1718 | | | | |
| 28 | 58'34.12°N | 6'58.50°W | 80 | 26 | | | 1,825 | 19 | | | | |
| 29 | 58'51.87°N | 5'11.90°W | 80 | | | | *** | | | | | |
| 30 | 58'56.55°N | 6'56.85°W | 170 | 185 | 3 | 3 | 45 | 1 | 1 | 57 | | |
| 31 | 59'03.99°N | 7'13.16°W | 150 | 220 | | | 4 | | 69 | 37 | | 1 gurnard |
| 32 | 59'04.11°N | 4'32.96°W | 70 | | | | | | | | | me meshed pout |
| 33 | 59'11.42°N | 5'05.87°W | 85 | | | 1 | 127 | 8 | | | | 1 ling |
| 34 | 59'11.44°N | 6'17.73°W | 125 | 371 | 1 | | | 13 | | | | |
| 35 | 59'19.12°N | 4'59.00°W | 120 | 2,195 | | | | 100 | | | | |
| 36 | 59'18.87°N | 4'28.26°W | 85 | 924 | | 3 | 128 | 12 | | | | |
| 37 | 59'41.52°N | 4'51.84°W | 115 | | | | | 1 | 3 | *** | | |
| 38 | 59'41.62°N | 4'25.12°W | 105 | 315 | 21 | 45 | | 639 | 1 | | | 6 gurnard 1 ling |
| 39 | 59'56.31°N | 4'28.02°W | 135 | | | | +++ | | 744 | *** | | 2 angler fish |

*** - many meshed; +++ - some meshed

**Table 24**: Herring length frequency by trawl haul by sub area. *Christina S* (13-30 July 1996) mean length - cm, mean weight - g, target strength - dB)

| Haul No | Area I | | Area II | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | mean | 9 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 19 | 21 | 22 | 23 | 26 | 27 | mean |
| 15.0 | | | | | | | | | | | | | | | | | |
| 15.5 | 2.1 | 2.1 | | | | | | | | | | | | | | | |
| 16.0 | 12.8 | 12.8 | | | | | | | | | | | | | | | |
| 16.5 | 36.2 | 36.2 | | | | | | | | | | | | | | | |
| 17.0 | 12.8 | 12.8 | | | | | | | | | | | | | | | |
| 17.5 | 10.6 | 10.6 | | | | | | | | | | | | | | | |
| 18.0 | 10.6 | 10.6 | | | | | | | | | | | | | | | |
| 18.5 | 8.5 | 8.5 | | | | | | | | | | 0.3 | | | | | 0.0 |
| 19.0 | 4.3 | 4.3 | | | | | | | | | | 0.3 | | | | | 0.0 |
| 19.5 | 2.1 | 2.1 | | | | | | | | | | 0.4 | | | | | 0.0 |
| 20.0 | | | | | | | | | | | | 0.3 | | | | | 0.0 |
| 20.5 | | | | | | 0.3 | | | | | | | | | | | 0.0 |
| 21.0 | | | | | | | | | | | | | | 0.3 | | | 0.0 |
| 21.5 | | | | | | | | | | | | | | | | | |
| 22.0 | | | | | | | | | | | | 0.4 | | 0.7 | | | 0.1 |
| 22.5 | | | | | | 0.6 | | | | | | 0.7 | | 1.7 | | 0.3 | 0.2 |
| 23.0 | | | 0.6 | 0.4 | | 1.0 | | 0.7 | 0.3 | | | 2.6 | | 11.6 | | 0.3 | 1.2 |
| 23.5 | | | 0.6 | | | 0.3 | | 0.7 | 0.5 | 0.3 | | 3.5 | | 23.9 | | 1.5 | 2.2 |
| 24.0 | | | 1.2 | | 0.3 | 3.1 | 0.6 | 0.7 | 1.1 | 0.6 | | 8.4 | | 26.3 | 1.2 | 2.4 | 3.3 |
| 24.5 | | | 2.2 | 0.7 | 0.3 | 3.1 | | 11.0 | 0.3 | 12 | | 8.0 | | 20.2 | 1.2 | 0.8 | 3.5 |
| 25.0 | | | 1.9 | 0.4 | 0.9 | 5.7 | 3.9 | 9.7 | 2.2 | 1.7 | | 11.5 | 0.7 | 6.9 | 1.8 | 5.7 | 3.8 |
| 25.5 | | | 1.9 | 1.1 | 1.8 | 21.6 | 6.5 | 20.7 | 9.4 | 7.8 | | 12.6 | | 1.3 | 3.6 | 6.1 | 6.7 |
| 26.0 | | | 2.5 | 2.8 | 3.6 | 18.2 | 16.9 | 24.1 | 14.3 | 13.4 | | 14.8 | | 2.1 | 6.1 | 10.4 | 9.2 |
| 26.5 | | | 10.6 | 8.5 | 7.6 | 17.6 | 13.0 | 20.0 | 21.0 | 18.1 | 0.4 | 11.1 | 0.7 | 0.4 | 5.5 | 14.6 | 10.7 |
| 27.0 | | | 11.2 | 9.9 | 11.3 | 11.1 | 19.5 | 4.1 | 16.4 | 15.1 | 0.7 | 10.2 | 7.1 | 0.8 | 18.8 | 15.0 | 10.8 |
| 27.5 | | | 11.8 | 10.9 | 20.4 | 7.8 | 14.9 | 2.8 | 14.3 | 157 | 8.0 | 7.9 | 18.4 | 0.8 | 17.0 | 15.8 | 11.9 |
| 28.0 | | | 15.0 | 13.7 | 12.8 | 4.0 | 14.9 | 2.1 | 12.9 | 15.4 | 20.8 | 3.7 | 19.1 | 0.8 | 16.4 | 11.6 | 11.7 |

| Haul No | Area I | | Area II | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | mean | 9 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 19 | 21 | 22 | 23 | 26 | 27 | mean |
| 28.5 | | | 15.0 | 18.3 | 14.9 | 3.1 | 3.9 | 1.4 | 4.0 | 8.3 | 24.7 | 1.9 | 24.1 | 1.3 | 17.0 | 8.1 | 10.4 |
| 29.0 | | | 16.5 | 20.1 | 12.8 | 1.3 | 4.5 | | 2.4 | 2.0 | 22.5 | 1.1 | 24.1 | 0.8 | 5.5 | 4.7 | 8.4 |
| 29.5 | | | 7.2 | 10.9 | 8.2 | 1.0 | 1.3 | 1.4 | 0.3 | | 17.3 | | 2.8 | 0.3 | 4.2 | 1.9 | 4.1 |
| 30.0 | | | 0.9 | 1.4 | 3.6 | | | 0.7 | 0.5 | 0.3 | 3.5 | 0.3 | 2.8 | | 1.8 | | 1.1 |
| 30.5 | | | 0.9 | 0.7 | 1.5 | | | | | | 1.4 | | | | | 0.7 | 0.4 |
| 31.0 | | | | 0.4 | | 0.3 | | | | | 0.7 | | | | | | 0.1 |
| 31.5 | | | | | | | | | | | | | | | | | |
| 32.0 | | | | | | | | | | | | | | | | | |
| 32.5 | | | | | | | | | | | | | | | | | |
| 33.0 | | | | | | | | | | | | | | | | | |
| 33.5 | | | | | | | | | | | | | | | | | |
| 34.0 | | | | | | | | | | | | | | | | | |
| 34.5 | | | | | | | | | | | | | | | | | |
| No | 47 | | 642 | 3976 | 31280 | 796 | 154 | 145 | 11872 | 928 | 721 | 736 | 2256 | 758 | 165 | 594 | |
| mn lgt | 17.6 | 17.6 | 28.2 | 28.6 | 28.4 | 26.7 | 27.5 | 26.4 | 27.3 | 27.5 | 29.2 | 26.2 | 28.8 | 24.7 | 28.0 | 27.4 | 27.5 |
| mn wt | 45 | 45 | 198 | 206 | 203 | 166 | 182 | 160 | 179 | 181 | 219 | 157 | 209 | 129 | 194 | 181 | 183 |
| TS/ind | -46.3 | -46.3 | -42.2 | -42.1 | -42.1 | -42.7 | -42.4 | -42.8 | -42.5 | -42.4 | -41.9 | -42.8 | -42.0 | -43.4 | -42.2 | -42.4 | -42.4 |
| TS/kg | -32.8 | -32.8 | -35.1 | -35.2 | -35.2 | -34.9 | -35.0 | -34.8 | -35.0 | -35.0 | -35.3 | -34.8 | -35.2 | -34.5 | -35.1 | -35.0 | -35.0 |

| Haul No | Area III | | | | | Area IV | | |
|---|---|---|---|---|---|---|---|---|
| | 30 | 31 | 34 | 38 | mean | 35 | 36 | mean |
| 15.5 | | | | | | | | |
| 16.0 | | | | | | | | |
| 16.5 | | | | | | | | |
| 17.0 | | | | | | | | |
| 17.5 | | | | | | | | |
| 18.0 | | | | | | | | |
| 18.5 | | | | | | | | |
| 19.0 | | | | | | | 0.3 | 0.2 |
| 19.5 | | | | | | | | |
| 20.0 | | | | | | | | |
| 20.5 | | | | | | | | |
| 21.0 | | | | | | | 1.0 | 0.5 |
| 21.5 | | | | | | | 1.0 | 0.5 |
| 22.0 | | | 0.3 | | 0.1 | | 1.9 | 1.0 |
| 22.5 | | | 1.3 | | 0.3 | | 8.4 | 4.2 |
| 23.0 | | | 2.7 | | 0.7 | 0.5 | 15.9 | 8.2 |
| 23.5 | | | 6.5 | | 1.6 | 1.4 | 17.2 | 9.3 |
| 24.0 | | 0.4 | 8.6 | 0.3 | 2.3 | 7.5 | 19.5 | 13.5 |
| 24.5 | 0.5 | | 7.5 | 2.2 | 2.6 | 14.4 | 11.4 | 12.9 |
| 25.0 | 3.8 | | 9.4 | 1.3 | 3.6 | 17.8 | 7.8 | 12.8 |
| 25.5 | 4.9 | | 6.2 | 2.5 | 3.4 | 17.3 | 4.9 | 11.1 |
| 26.0 | 5.9 | 0.4 | 5.7 | 10.8 | 5.7 | 15.5 | 2.6 | 9.0 |

| Haul No | Area III | | | | | Area IV | | |
|---|---|---|---|---|---|---|---|---|
| | 30 | 31 | 34 | 38 | mean | 35 | 36 | mean |
| 26.5 | 10.3 | | 7.0 | 10.2 | 6.9 | 8.7 | 1.3 | 5.0 |
| 27.0 | 12.4 | 1.2 | 7.5 | 14.3 | 8.9 | 6.2 | 2.6 | 4.4 |
| 27.5 | 11.9 | 2.0 | 5.4 | 15.2 | 8.6 | 3.6 | 1.3 | 2.5 |
| 28.0 | 12.4 | 11.0 | 6.2 | 15.2 | 11.2 | 2.5 | 0.3 | 1.4 |
| 28.5 | 17.3 | 10.6 | 5.4 | 10.2 | 10.9 | 0.9 | 1.9 | 4.1 |
| 29.0 | 9.2 | 11.8 | 5.7 | 7.0 | 8.4 | 0.9 | 0.3 | 0.6 |
| 29.5 | 6.5 | 9.4 | 4.3 | 3.5 | 5.9 | 0.7 | | 0.3 |
| 30.0 | 2.7 | 4.1 | 1.9 | 4.4 | 3.3 | 0.2 | | 0.1 |
| 30.5 | 1.1 | 7.8 | 1.9 | 1.0 | 2.9 | 0.9 | | 0.5 |
| 31.0 | 0.5 | 9.4 | 2.4 | 1.3 | 3.4 | 0.2 | | 0.1 |
| 31.5 | | 8.2 | 0.8 | 0.3 | 2.3 | 0.2 | 0.3 | 0.3 |
| 32.0 | | 9.0 | 1.3 | 0.3 | 2.7 | | | |
| 32.5 | | 6.5 | 0.8 | | 1.8 | 0.5 | | 0.2 |
| 33.0 | | 3.3 | 0.8 | | 1.0 | | | |
| 33.5 | | 2.0 | 0.3 | | 0.6 | 0.2 | | 0.1 |
| 34.0 | | 1.6 | | | 0.4 | | | |
| 34.5 | 0.5 | 1.2 | | | 0.4 | | | |
| 35.0 | | | | | | | | |
| Number | 185 | 245 | 371 | 315 | | 2195 | 924 | |
| mean lgt | 28.2 | 30.7 | 27.1 | 28.1 | 28.5 | 26.2 | 24.6 | 25.4 |
| mean wt | 198 | 260 | 178 | 195 | 208 | 158 | 129 | 143 |
| TS/ind | -42.2 | -41.4 | -42.5 | -42.2 | -42.1 | -42.8 | -43.4 | -43.1 |
| TS/kg | -35.1 | -35.6 | -35.0 | -35.1 | -35.2 | -34.8 | -34.5 | -34.6 |

**Table 25:** Herring numbers and biomass by age, maturity and area. *Christina S* (13-30 July 1996)

| Category | Number x $10^{-6}$ | Mean length (cm) | Mean weight (g) | Biomass (tonnes $x10^{-3}$) |
|---|---|---|---|---|
| **Area I (Minch)** | | | | |
| 1 ring | 39.47 | 17.09 | 44.54 | 1.76 |
| 2 ring immature | 0.00 | | | 0.00 |
| 2 ring mature | 0.00 | | | 0.00 |
| 3 ring immature | 0.00 | | | 0.00 |
| 3 ring mature | 0.00 | | | 0.00 |
| 4 | 0.00 | | | 0.00 |
| 5 | 0.00 | | | 0.00 |
| 6 | 0.00 | | | 0.00 |
| 7 | 0.00 | | | 0.00 |
| 8 | 0.00 | | | 0.00 |
| 9+ | 0.00 | | | 0.00 |
| Total | 39.47 | 17.09 | 44.54 | 1.768 |
| **Area II (Hebrides)** | | | | |
| 1 ring | 1.31 | 19.49 | 66.33 | 0.09 |
| 2 ring immature | 89.25 | 24.26 | 130.73 | 11.67 |
| 2 ring mature | 130.51 | 25.02 | 144.07 | 18.80 |
| 3 ring immature | 43.04 | 26.58 | 173.39 | 7.46 |
| 3 ring mature | 508.98 | 26.70 | 175.77 | 89.46 |
| 4 | 212.71 | 28.00 | 203.40 | 43.27 |
| 5 | 60.40 | 28.57 | 216.68 | 13.09 |
| 6 | 45.31 | 28.64 | 217.99 | 9.88 |
| 7 | 58.25 | 28.78 | 221.11 | 12.88 |
| 8 | 47.32 | 28.82 | 222.33 | 10.52 |
| 9+ | 51.61 | 28.95 | 225.34 | 11.63 |
| Total | 1,248.70 | 26.99 | 183.19 | 228.75 |
| **Area III (Shelf break)** | | | | |
| 1 ring | 0.00 | | | 0.00 |
| 2 ring immature | 17.12 | 25.09 | 145.58 | 2.49 |
| 2 ring mature | 130.81 | 25.62 | 155.44 | 20.33 |
| 3 ring immature | 3.09 | 26.77 | 176.47 | 0.55 |
| 3 ring mature | 200.15 | 27.57 | 194.38 | 38.91 |
| 4 | 109.29 | 28.67 | 219.23 | 23.96 |
| 5 | 34.23 | 28.85 | 224.34 | 7.68 |
| 6 | 14.98 | 29.34 | 235.47 | 3.53 |
| 7 | 18.80 | 30.06 | 254.00 | 4.77 |
| 8 | 30.20 | 30.70 | 272.27 | 8.22 |
| 9+ | 62.90 | 31.52 | 295.38 | 18.58 |
| Total | 621.56 | 28.02 | 207.57 | 129.02 |

| Category | Number x $10^{-6}$ | Mean length (cm) | Mean weight (g) | Biomass (tonnes x$10^{-3}$) |
|---|---|---|---|---|
| **Area IV (North of Scotland)** | | | | |
| 1 ring | 0.43 | 19.00 | 61.13 | 0.03 |
| 2 ring immature | 29.38 | 22.88 | 108.90 | 3.20 |
| 2 ring mature | 179.40 | 24.60 | 136.45 | 24.48 |
| 3 ring immature | 0.43 | 22.00 | 96.09 | 0.04 |
| 3 ring mature | 46.85 | 26.62 | 174.40 | 8.17 |
| 4 | 7.12 | 28.36 | 214.19 | 1.52 |
| 5 | 0.72 | 28.26 | 208.84 | 0.15 |
| 6 | 0.30 | 30.50 | 264.53 | 0.08 |
| 7 | 0.33 | 29.00 | 226.16 | 0.07 |
| 8 | 0.67 | 32.40 | 320.36 | 0.21 |
| 9+ | 0.30 | 32.50 | 322.32 | 0.10 |
| Total | 265.93 | 24.90 | 143.11 | 39.06 |
| **Total Area** | | | | |
| 1 ring | 41.22 | 17.18 | 45.41 | 1.87 |
| 2 ring immature | 135.74 | 24.07 | 127.88 | 17.36 |
| 2 ring mature | 440.72 | 25.02 | 144.34 | 63.62 |
| 3 ring immature | 46.56 | 26.55 | 172.88 | 8.05 |
| 3 ring mature | 755.97 | 26.93 | 180.61 | 136.54 |
| 4 | 329.11 | 28.23 | 208.89 | 68.75 |
| 5 | 95.36 | 28.67 | 219.37 | 20.92 |
| 6 | 60.60 | 28.83 | 222.55 | 13.49 |
| 7 | 77.38 | 29.09 | 229.12 | 17.73 |
| 8 | 78.19 | 29.58 | 242.46 | 18.96 |
| 9+ | 114.81 | 30.37 | 263.97 | 30.31 |
| Total | 2,175.67 | 26.85 | 182.74 | 397.58 |

**Table 26**: Simrad EK500 settings used on the July 1996 herring acoustic survey. $S_A$ corrected for gain change according to $S_{A(survey)}=S_{A(cal)}$ 10^((2(Gain$_{(cal)}$-Gain$_{(survey)}$))/10). *Calibration factor uses $S_A$ corrected for TVG error function assuming targets at infinite range and an idealised TVG start delay of 0.89 ms (see Fernandes and Simmonds, 1996)

| | |
|---|---|
| **Transceiver 1 Menu** | |
| Absorption coefficient | 10 dB.km-1 |
| Pulse length | Medium: 1.0 ms |
| Bandwidth | Auto |
| Max power | 2000 W |
| Equivalent two-way beam angle | -21.2 dB |
| 3 dB Beamwidth | 6.7° |
| **Calibration details (from 3 October 1996, Ringaskiddy, Cork)** | |
| TS of sphere | -42.36 dB |
| Range to 1/2 peak amplitude | 10.49 |
| Range to sphere | 10.20 |
| Selected $S_A$ -measured value for calibration | 4002 |
| Corrected $S_A$-measured value for survey | 2525 |
| Calibration factor for $S_A$ values | 1.425* |
| Calibration constant for MILAP | 1.58 at -35 dB |
| **Log menu** | |
| Ping | 1125 pings |
| **Operation menu** | |
| Ping interval | 0.8 s at 50 m range |
| | 0.8 s at 100 m range |
| | 0.8 s at 250 m range |
| **Display/printer menu** | |
| TVG | 20 log R |
| Integration line | 100 |
| TS colour min | -50 dB |
| Sv colour min | -70 dB |

**Table 27:** Total numbers (millions of fish) and biomass (thousands of tonnes) at age for the July/August 1996 herring acoustic cruise

| Total area | | | | | | |
|---|---|---|---|---|---|---|
| Age | Mean length (cm) | Mean weight (g) | Number x $10^6$ | % | Biomass x $10^3$ T | % |
| 1A | 13.93 | 33.76 | 466.56 | 80.30 | 15.75 | 45.93 |
| 2I | 23.74 | 123.58 | 45.43 | 7.82 | 5.61 | 16.36 |
| 2M | 23.96 | 127.52 | 24.06 | 4.14 | 3.06 | 8.94 |
| 3I | 23.99 | 127.54 | 2.93 | 0.50 | 0.38 | 1.09 |
| 3M | 26.76 | 181.97 | 13.44 | 2.31 | 2.44 | 7.12 |
| 4A | 28.20 | 215.63 | 3.94 | 0.68 | 0.85 | 2.47 |
| 5A | 29.08 | 236.97 | 5.07 | 0.87 | 1.20 | 3.51 |
| 6A | 29.69 | 253.41 | 0.58 | 0.10 | 0.15 | 0.44 |
| 7A | 29.46 | 246.92 | 2.15 | 0.37 | 0.53 | 1.54 |
| 8A | 29.61 | 251.07 | 3.67 | 0.63 | 0.92 | 2.68 |
| 9+ | 29.86 | 258.05 | 13.18 | 2.27 | 3.40 | 9.91 |
| Mean | 16.23 | 59.04 | | | | |
| Total | | | 581.01 | 100.00 | 34.29 | 100.00 |
| Immature | | | 514.92 | 88.62 | 21.74 | 63.39 |
| Mature | | | 66.09 | 11.38 | 12.55 | 36.61 |

**Table 28**: Numbers (millions) of herring by ICES statistical rectangle and age class for the FRV *Solea* in July 1996

| Area | N(millions) | 0 | I | 2 |
|---|---|---|---|---|
| 42F4 | - | 0.0 | 0.0 | 0.0 |
| 42F5 | 4.9 | 1.4 | 3.0 | 0.5 |
| 42F6 | 375.5 | 304.5 | 64.2 | 6.8 |
| 42F7 | 750.9 | 750.9 | - | - |
| 41F4 | 10.0 | 2.9 | 6.1 | 1.0 |
| 41F5 | 234.6 | 66.9 | 142.2 | 25.6 |
| 41F6 | 16.1 | 11.5 | 4.1 | 0.4 |
| 41F7 | 296.6 | 253.8 | 43.0 | - |
| 40F4 | 64.1 | 41.2 | 19.4 | 3.5 |
| 40F5 | 481.0 | 309.3 | 145.7 | 26.0 |
| 40F6 | 150.7 | 14.3 | 122.8 | 13.6 |
| 40F7 | 107.8 | 31.2 | 68.9 | 7.8 |
| 39F4 | - | - | - | - |
| 39F5 | 330.5 | 330.5 | - | - |
| 39F6 | 297.9 | - | 292.8 | 5.1 |
| 39F7 | 507.5 | 292.8 | 214.7 | - |
| 38F4 | 483.3 | 244.1 | 239.2 | - |
| 38F5 | 15.2 | 7.6 | 7.6 | - |
| 38F6 | 211.8 | 0.9 | 209.9 | - |
| 38F7 | 131.3 | 36.5 | 95.3 | - |
| Total | 4469.7 | 2700.3 | 1678.9 | 90.3 |

**Table 29**: Average length (mm) of herring by ICES statistical rectangle and age class for the FRV *Solea* in July 1996

| Area | 0 | 1 | 2 |
|---|---|---|---|
| 42F4 | - | - | - |
| 42F5 | 7.03 | 16.11 | 18.44 |
| 42F6 | 7.03 | 16.11 | 18.44 |
| 42F7 | 6.19 | 16.11 | 18.44 |
| 41F4 | 7.03 | 17.54 | 18.30 |
| 41F5 | 6.62 | 19.37 | 19.81 |
| 41F6 | 7.03 | 16.11 | 18.44 |
| 41F7 | 7.03 | 16.11 | 18.44 |
| 40F4 | 7.03 | 16.11 | 18.44 |
| 40F5 | 7.03 | 16.11 | 18.44 |
| 40F6 | 7.03 | 16.11 | 18.44 |
| 40F7 | 7.03 | 16.11 | 18.44 |
| 39F4 | 7.03 | 16.11 | 18.44 |
| 39F5 | 7.41 | 16.11 | 18.44 |
| 39F6 | 7.03 | 15.46 | 17.90 |
| 39F7 | 7.88 | 14.57 | 18.44 |
| 38F4 | 7.03 | 16.11 | 18.44 |
| 38F5 | 7.03 | 16.11 | 18.44 |
| 38F6 | 7.03 | 15.21 | 17.77 |
| 38F7 | 7.03 | 14.51 | 18.44 |
| Average (mm) | 7.03 | 16.11 | 18.44 |

**Table 30**: Biomass (tonnes) of herring by ICES statistical rectangle and age class for the FRV *Solea* in July 1996

| Area | 0 | I | 2 |
|---|---|---|---|
| 42F4 | - | - | - |
| 42F5 | 3.84 | 106.90 | 27.06 |
| 42F6 | 834.79 | 2287.64 | 368.05 |
| 42F7 | 1392.31 | 0.00 | 0.00 |
| 41F4 | 7.95 | 282.74 | 52.84 |
| 41F5 | 152.66 | 8956.92 | 1728.40 |
| 41F6 | 31.53 | 146.10 | 21.65 |
| 41F7 | 695.79 | 1532.22 | 0.00 |
| 40F4 | 112.95 | 691.28 | 189.44 |
| 40F5 | 847.95 | 5191.73 | 1407.27 |
| 40F6 | 39.20 | 4375.73 | 736.11 |
| 40F7 | 85.54 | 2455.11 | 422.18 |
| 39F4 | 0.00 | 0.00 | 0.00 |
| 39F5 | 1068.49 | 0.00 | 0.00 |
| 39F6 | 0.00 | 9178.75 | 251.49 |
| 39F7 | 1144.75 | 5609.20 | 0.00 |
| 38F4 | 669.20 | 8523.41 | 0.00 |
| 38F5 | 20.84 | 270.81 | 0.00 |
| 38F6 | 2.47 | 6262.94 | 0.00 |
| 38F7 | 100.07 | 2458.24 | 0.00 |
| Total (tonnes) | 7210.31 | 58329.70 | 5204.50 |

**Table 31:** Numbers (millions) of autumn spawning herring (1996)

| | IIIa | IVa | IVb | Vb | VIan | VIas | VIIa | VIIb | VIIc | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 596.7 | 0.3 | 2701.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3298.3 |
| 1 | 1399.8 | 578.9 | 4219.1 | 0.0 | 41.2 | 228.3 | 0.0 | 238.2 | 0.0 | 6705.6 |
| 2i | 180.4 | 607.3 | 1012.9 | 0.0 | 135.8 | 45.5 | 0.0 | 0.0 | 0.0 | 1981.8 |
| 2m | 180.4 | 2212.3 | 364.0 | 0.0 | 440.7 | 24.1 | 0.0 | 0.0 | 0.0 | 3221.5 |
| 3i | 5.2 | 29.9 | 34.8 | 0.0 | 46.6 | 2.9 | 0.0 | 0.0 | 0.0 | 119.4 |
| 3m | 29.6 | 2452.4 | 271.7 | 0.0 | 756.0 | 10.7 | 0.0 | 2.7 | 0.0 | 3523.2 |
| 4 | 13.1 | 1016.4 | 57.6 | 0.0 | 329.1 | 1.9 | 0.0 | 2.0 | 0.0 | 1420.2 |
| 5 | 7.7 | 284.7 | 18.6 | 0.0 | 95.4 | 1.4 | 0.0 | 3.7 | 0.0 | 411.5 |
| 6 | 1.9 | 94.3 | 2.4 | 0.0 | 60.6 | 0.0 | 0.0 | 0.6 | 0.0 | 159.9 |
| 7 | 0.9 | 79.1 | 2.8 | 0.0 | 77.4 | 1.0 | 0.0 | 1.2 | 0.0 | 162.4 |
| 8 | 0.1 | 132.5 | 0.3 | 0.0 | 78.2 | 1.4 | 0.0 | 2.3 | 0.0 | 214.8 |
| 9+ | 0.1 | 203.3 | 2.6 | 0.0 | 114.8 | 4.8 | 0.0 | 8.5 | 0.0 | 334.1 |
| Immature | 2182.0 | 1216.4 | 7968.3 | 0.0 | 223.5 | 276.7 | 0.0 | 238.2 | 0.0 | 12105.1 |
| Mature | 233.7 | 6475.1 | 720.1 | 0.0 | 1952.1 | 45.3 | 0.0 | 21.0 | 0.0 | 9447.4 |
| Total | 2415.8 | 7691.5 | 8688.4 | 0.0 | 2175.7 | 322.0 | 0.0 | 259.2 | 0.0 | 21552.6 |

**Table 32:** Biomass ('000 tonnes) of autumn spawning herring (1996)

| | IIIa | IVa | IVb | Vb | VIan | VIas | VIIa | VIIb | VIIc | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 2.0 | 0.0 | 7.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 9.2 |
| 1 | 68.8 | 32.0 | 174.0 | 0.0 | 1.9 | 14.4 | 0.0 | 1.4 | 0.0 | 292.4 |
| 2i | 14.1 | 70.0 | 73.3 | 0.0 | 17.4 | 5.6 | 0.0 | 0.0 | 0.0 | 180.4 |
| 2m | 14.1 | 325.3 | 40.3 | 0.0 | 63.6 | 3.1 | 0.0 | 0.0 | 0.0 | 446.4 |
| 3i | 0.5 | 4.4 | 4.3 | 0.0 | 8.0 | 0.4 | 0.0 | 0.0 | 0.0 | 17.6 |
| 3m | 2.8 | 500.8 | 39.6 | 0.0 | 136.5 | 1.9 | 0.0 | 0.6 | 0.0 | 682.1 |
| 4 | 1.3 | 263.8 | 9.7 | 0.0 | 68.8 | 0.4 | 0.0 | 0.5 | 0.0 | 344.4 |
| 5 | 0.8 | 77.0 | 3.7 | 0.0 | 20.9 | 0.3 | 0.0 | 0.9 | 0.0 | 103.6 |
| 6 | 0.2 | 28.8 | 0.5 | 0.0 | 13.5 | 0.0 | 0.0 | 0.1 | 0.0 | 43.2 |
| 7 | 0.1 | 24.8 | 0.4 | 0.0 | 17.7 | 0.2 | 0.0 | 0.3 | 0.0 | 43.6 |
| 8 | 0.0 | 43.1 | 0.1 | 0.0 | 19.0 | 0.3 | 0.0 | 0.6 | 0.0 | 63.1 |
| 9+ | 0.0 | 68.6 | 0.5 | 0.0 | 30.3 | 1.2 | 0.0 | 2.2 | 0.0 | 102.8 |
| Immature | 83.4 | 106.4 | 251.5 | 0.0 | 27.3 | 20.4 | 0.0 | 1.4 | 0.0 | 490.3 |
| Mature | 19.3 | 1332.1 | 94.8 | 0.0 | 370.3 | 7.4 | 0.0 | 5.2 | 0.0 | 1829.1 |
| Total | 104.7 | 1438.5 | 353.6 | 0.0 | 397.6 | 27.8 | 0.0 | 6.6 | 0.0 | 2328.6 |

**Table 33**: Mean weight (grams) of autumn spawning herring (1996)

| | IIIa | IVa | IVb | Vb | VIan | VIas | VIIa | VIIb | VIIc | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 3.4 | 2.2 | 2.7 | | | | | | | 2.7 |
| 1 | 49.1 | 55.3 | 41.2 | | 45.4 | 63.0 | | 5.8 | | 43.3 |
| 2i | 78.1 | 115.3 | 72.3 | | 127.9 | 123.6 | | | | 103.4 |
| 2m | 78.1 | 147.0 | 110.8 | | 144.3 | 127.5 | | | | 121.6 |
| 3i | 94.4 | 146.7 | 122.4 | | 172.9 | 127.5 | | | | 132.8 |
| 3m | 94.2 | 204.2 | 145.7 | | 180.6 | 173.6 | | 215.3 | | 168.9 |
| 4 | 96.2 | 259.5 | 169.1 | | 208.9 | 205.2 | | 225.6 | | 194.1 |
| 5 | 105.8 | 270.3 | 199.1 | | 219.4 | 226.6 | | 241.1 | | 210.4 |
| 6 | 111.5 | 305.5 | 207.8 | | 222.5 | | | 253.4 | | 220.1 |
| 7 | 101.9 | 313.9 | 150.3 | | 229.1 | 241.1 | | 251.5 | | 214.6 |
| 8 | 256.1 | 325.1 | 256.1 | | 242.5 | 243.3 | | 256.0 | | 263.2 |
| 9+ | 256.1 | 337.2 | 181.4 | | 264.0 | 253.7 | | 260.5 | | 258.8 |
| Mean (i) | 73.9 | 105.8 | 78.7 | | 115.4 | 104.7 | | 5.8 | | 80.7 |
| Mean (m) | 137.5 | 270.3 | 177.5 | | 213.9 | 210.1 | | 243.3 | | 208.8 |
| Mean (all) | 110.4 | 206.9 | 138.2 | | 187.0 | 178.5 | | 213.6 | | 172.4 |

**Table 34**: Numbers (millions) of spring spawning herring (1996)

| | IIIa | IVa | IVb | Vb | VIan | VIas | VIIa | VIIb | VIIc | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 1 | 1009.8 | 23.3 | 42.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1075.1 |
| 2i | 375.8 | 55.8 | 75.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 507.3 |
| 2m | 375.8 | 54.1 | 75.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 505.6 |
| 3i | 21.7 | 9.4 | 7.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 38.5 |
| 3m | 123.1 | 45.7 | 41.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 210.5 |
| 4 | 92.7 | 25.5 | 22.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 140.4 |
| 5 | 76.4 | 22.9 | 20.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 119.6 |
| 6 | 21.8 | 8.1 | 8.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 38.3 |
| 7 | 13.7 | 2.9 | 3.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 20.1 |
| 8 | 4.0 | 0.6 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.9 |
| 9+ | 4.4 | 1.2 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.8 |
| Immature | 1407.3 | 88.5 | 125.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1620.8 |
| Mature | 712.0 | 161.2 | 174.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1047.2 |
| Total | 2119.4 | 249.7 | 299.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2668.2 |

**Table 35**: Biomass ('000 tonnes) of spring spawning herring (1996)

| | IIIa | IVa | IVb | Vb | VIan | VIas | VIIa | VIIb | VIIc | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1 | 47.9 | 1.5 | 2.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 52.3 |
| 2i | 31.7 | 5.2 | 7.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 44.1 |
| 2m | 31.7 | 5.1 | 7.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 43.9 |
| 3i | 2.3 | 1.1 | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.3 |
| 3m | 13.0 | 5.6 | 5.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 23.6 |
| 4 | 11.0 | 3.7 | 3.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 17.8 |
| 5 | 11.1 | 3.5 | 3.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 17.8 |
| 6 | 3.2 | 1.4 | 1.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.0 |
| 7 | 2.2 | 0.5 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.4 |
| 8 | 0.8 | 0.1 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.2 |
| 9+ | 1.0 | 0.3 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 |
| Immature | 82.0 | 7.9 | 10.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.7 |
| Mature | 73.9 | 20.2 | 21.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 115.2 |
| Total | 155.9 | 28.1 | 32.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 216.0 |

**Table 36**: Mean weight (grams) of spring spawning herring (1996)

| | IIIa | IVa | IVb | Vb | VIan | VIas | VIIa | VIIb | VIIc | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 58.5 | | | | | | | | | 58.5 |
| 1 | 47.5 | 65.5 | 67.8 | | | | | | | 60.3 |
| 2i | 84.5 | 93.8 | 94.4 | | | | | | | 90.9 |
| 2m | 84.5 | 93.4 | 94.4 | | | | | | | 90.8 |
| 3i | 105.3 | 119.9 | 120.3 | | | | | | | 115.2 |
| 3m | 105.3 | 122.7 | 120.3 | | | | | | | 116.1 |
| 4 | 118.2 | 145.3 | 142.2 | | | | | | | 135.3 |
| 5 | 144.6 | 154.4 | 159.1 | | | | | | | 152.7 |
| 6 | 146.1 | 168.2 | 171.1 | | | | | | | 161.8 |
| 7 | 161.1 | 171.1 | 187.2 | | | | | | | 173.1 |
| 8 | 201.9 | 206.6 | 215.4 | | | | | | | 207.9 |
| 9+ | 216.9 | 209.8 | 236.9 | | | | | | | 221.2 |
| Mean (i) | 79.1 | 93.1 | 94.2 | | | | | | | 88.8 |
| Mean (m) | 147.3 | 158.9 | 165.8 | | | | | | | 157.4 |
| Mean (all) | 122.9 | 141.0 | 146.3 | | | | | | | 136.7 |

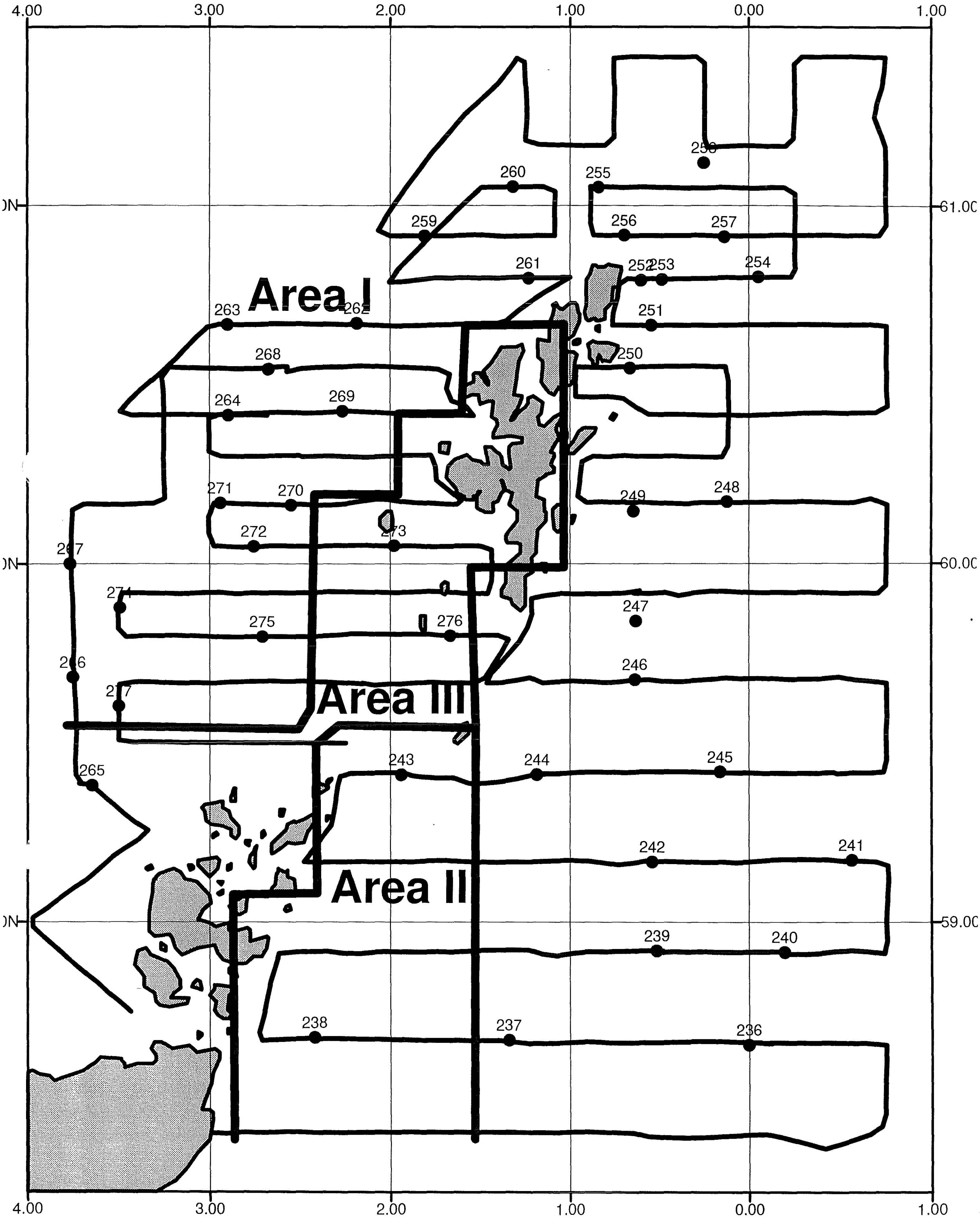



Figure 1 Cruise track and trawl positions SCOTIA 13-31 July 1996

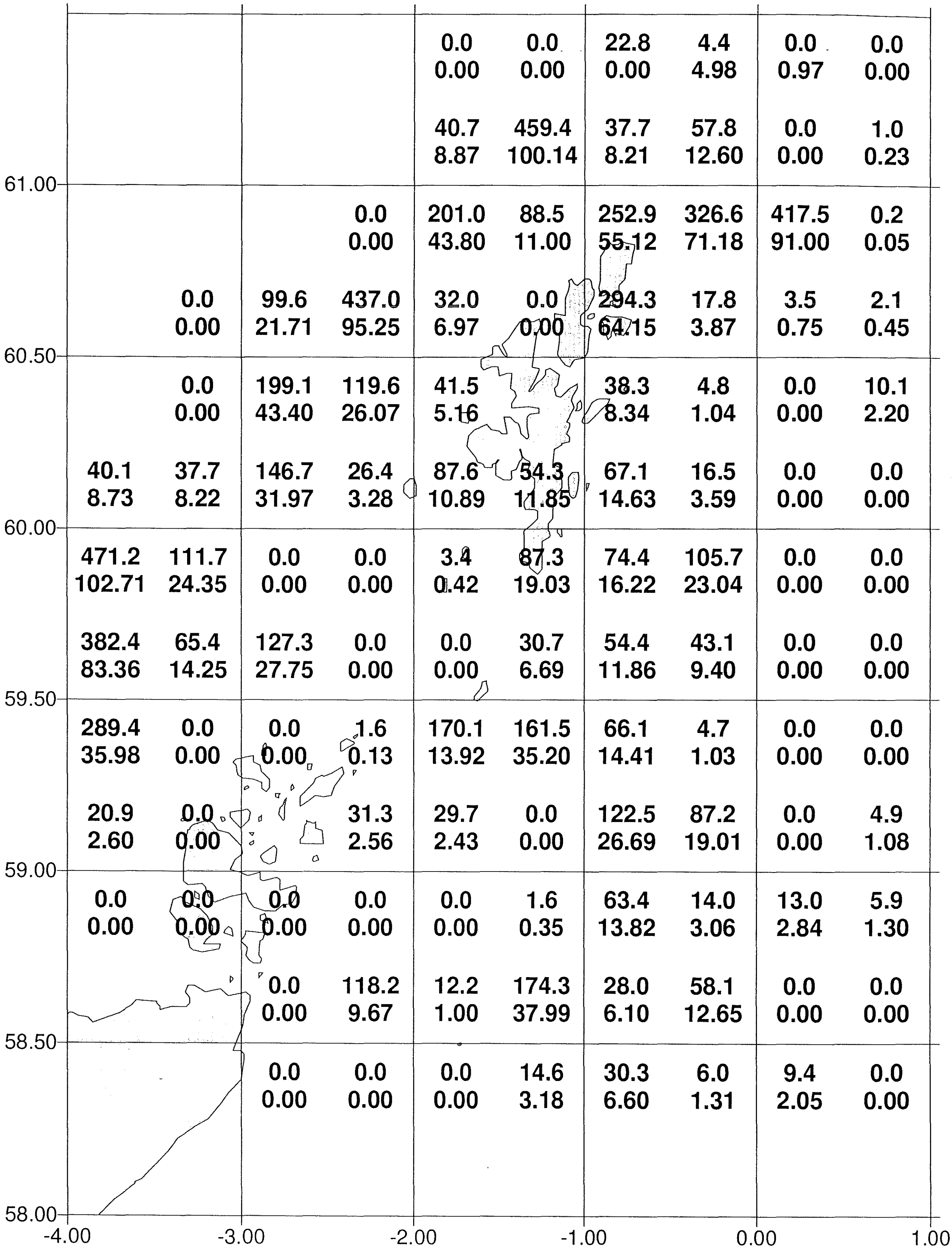
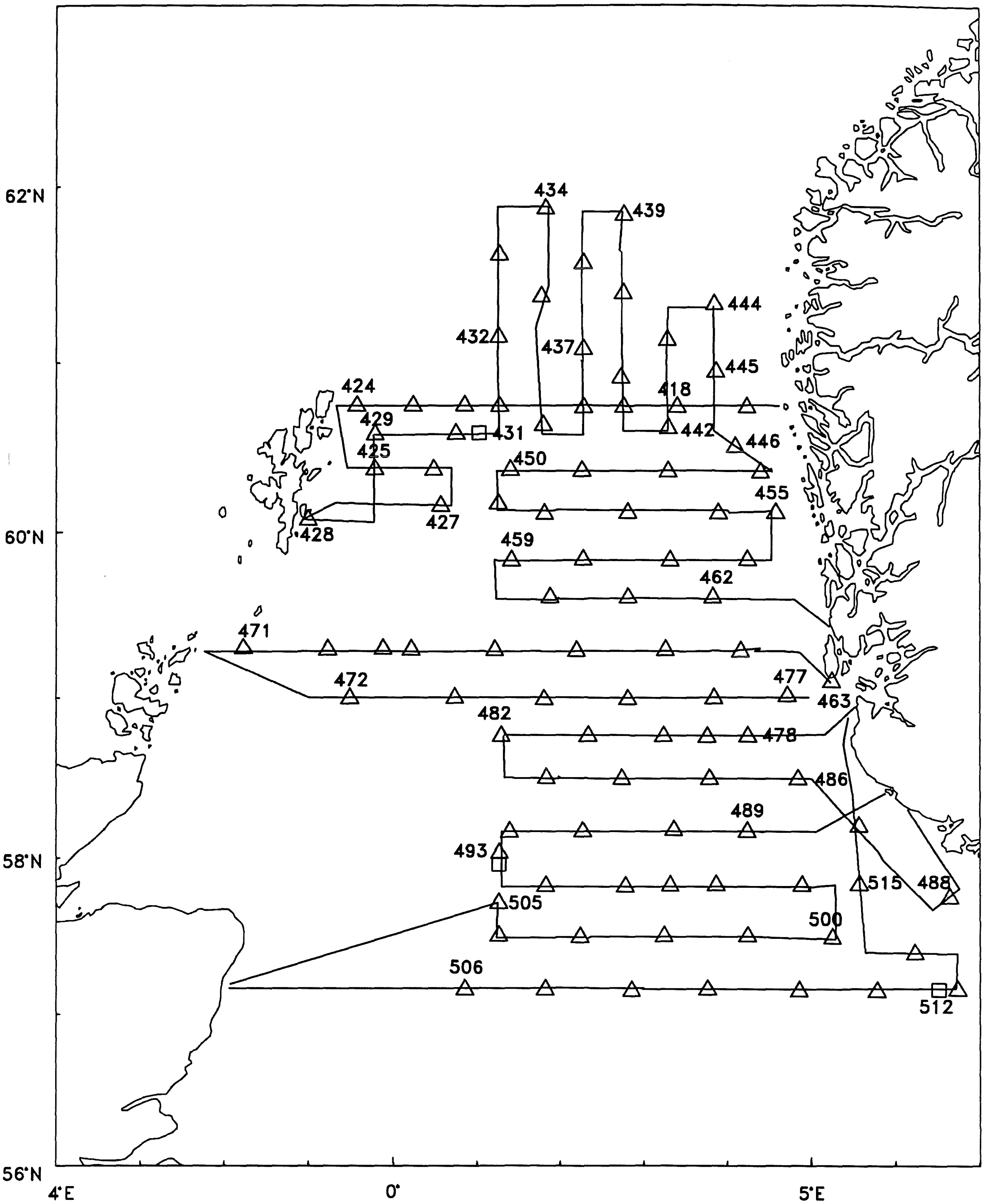



Figure 2. Numbers (millions) and Biomass (Thousands of tonnnes) from Scotia Survey 1996




25 Jun - 14 Jul 1996 □△TRAWL st.no 418-515 "G.O.Sars"

△ Pel tr.

Cruise no 1996009

□ Bottom tr.

Figure 3

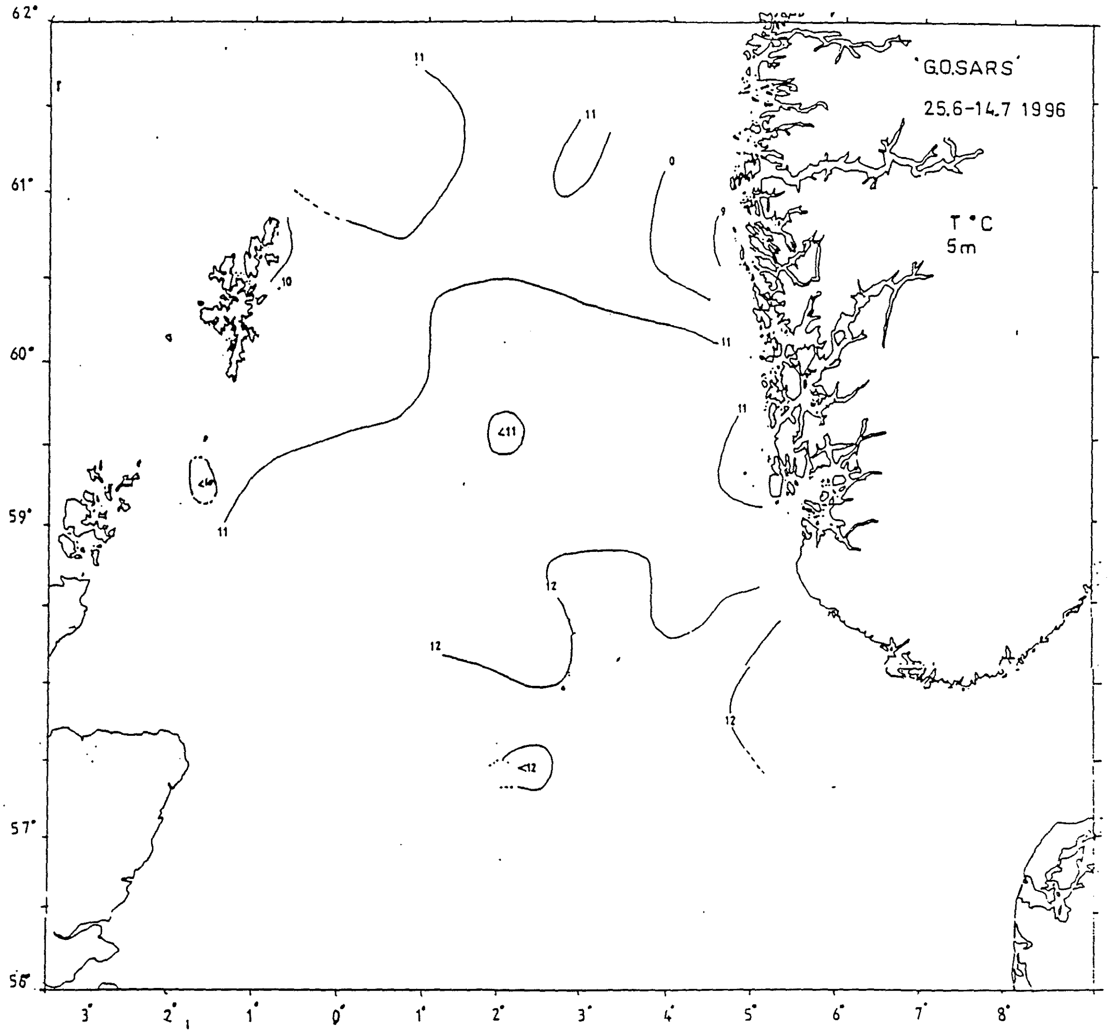



Figure 4 Distribution of temperature in 5m , 50m and at bottom.

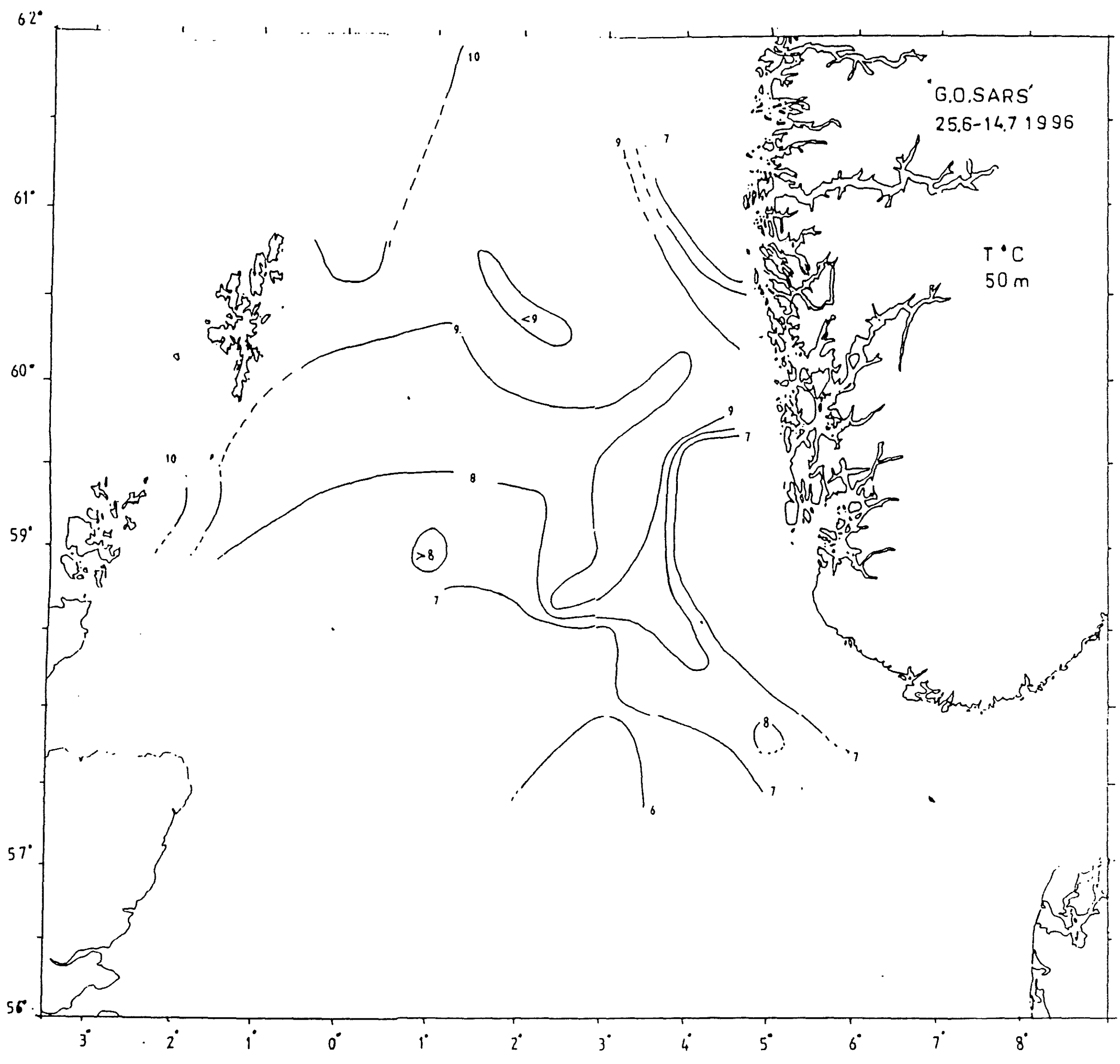



Figure 4 continued.

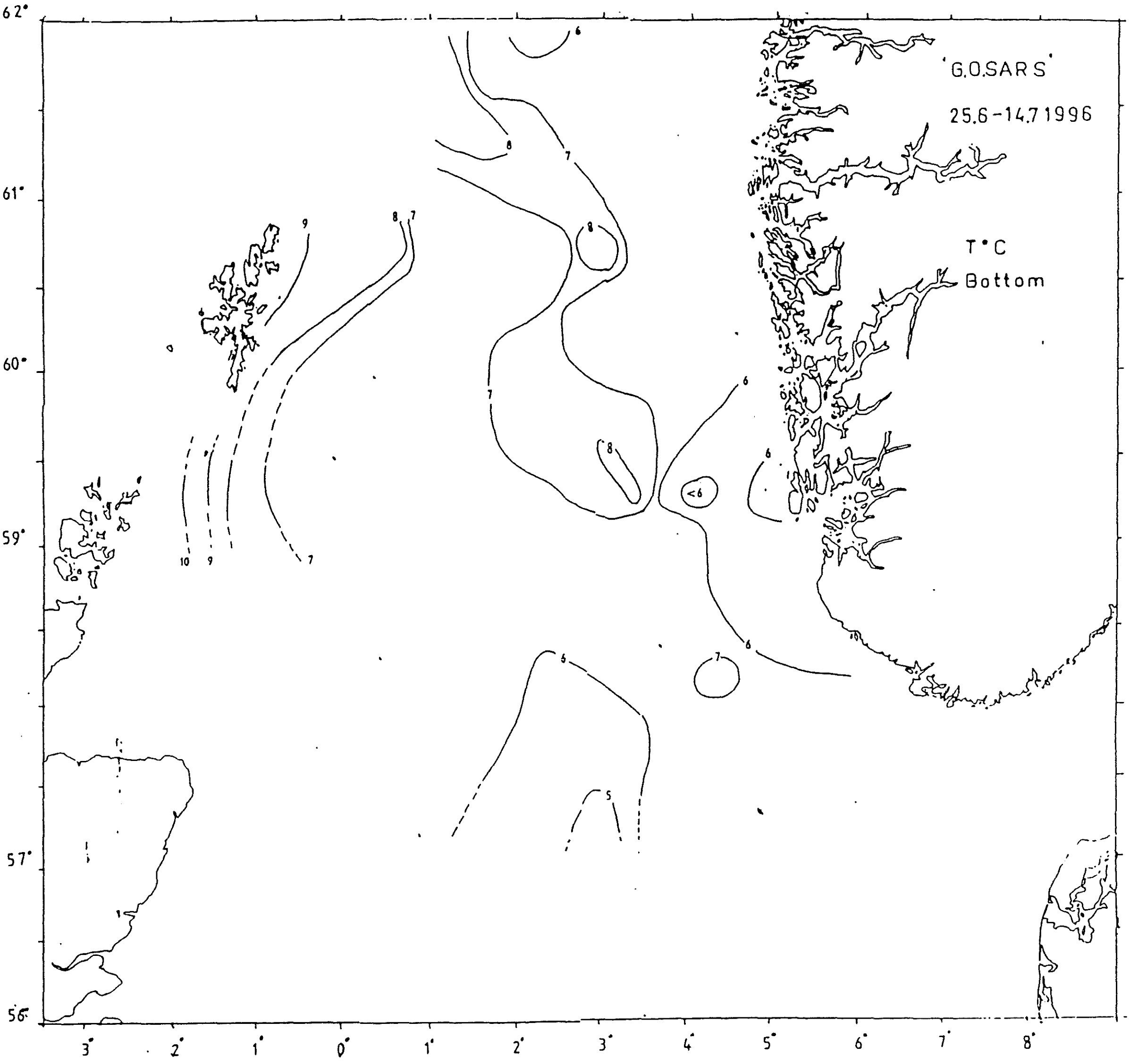



Figure 4 continued.

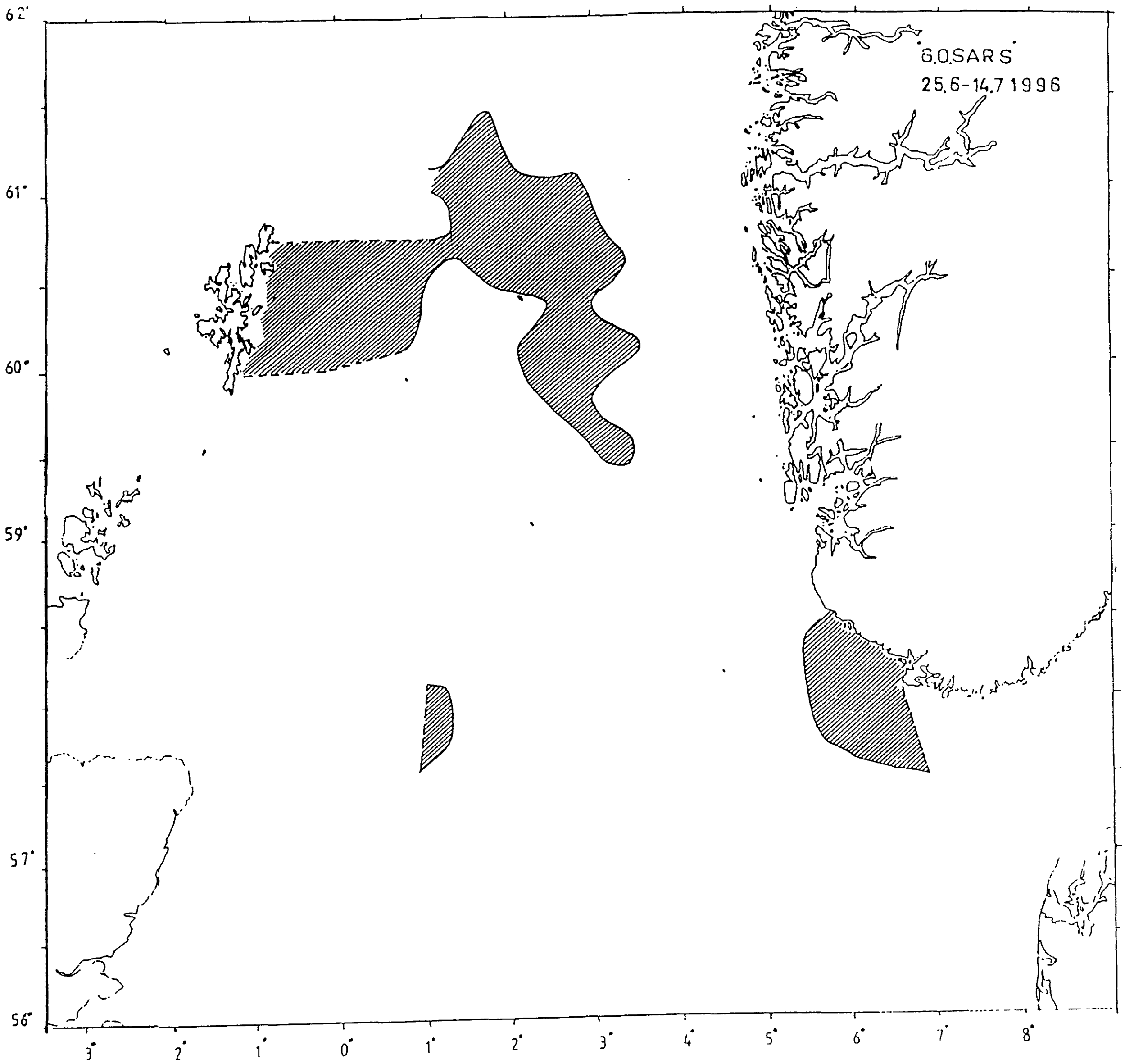



Figure 5 The horizontal distribution of herring, 25 June - 14 July 1996.

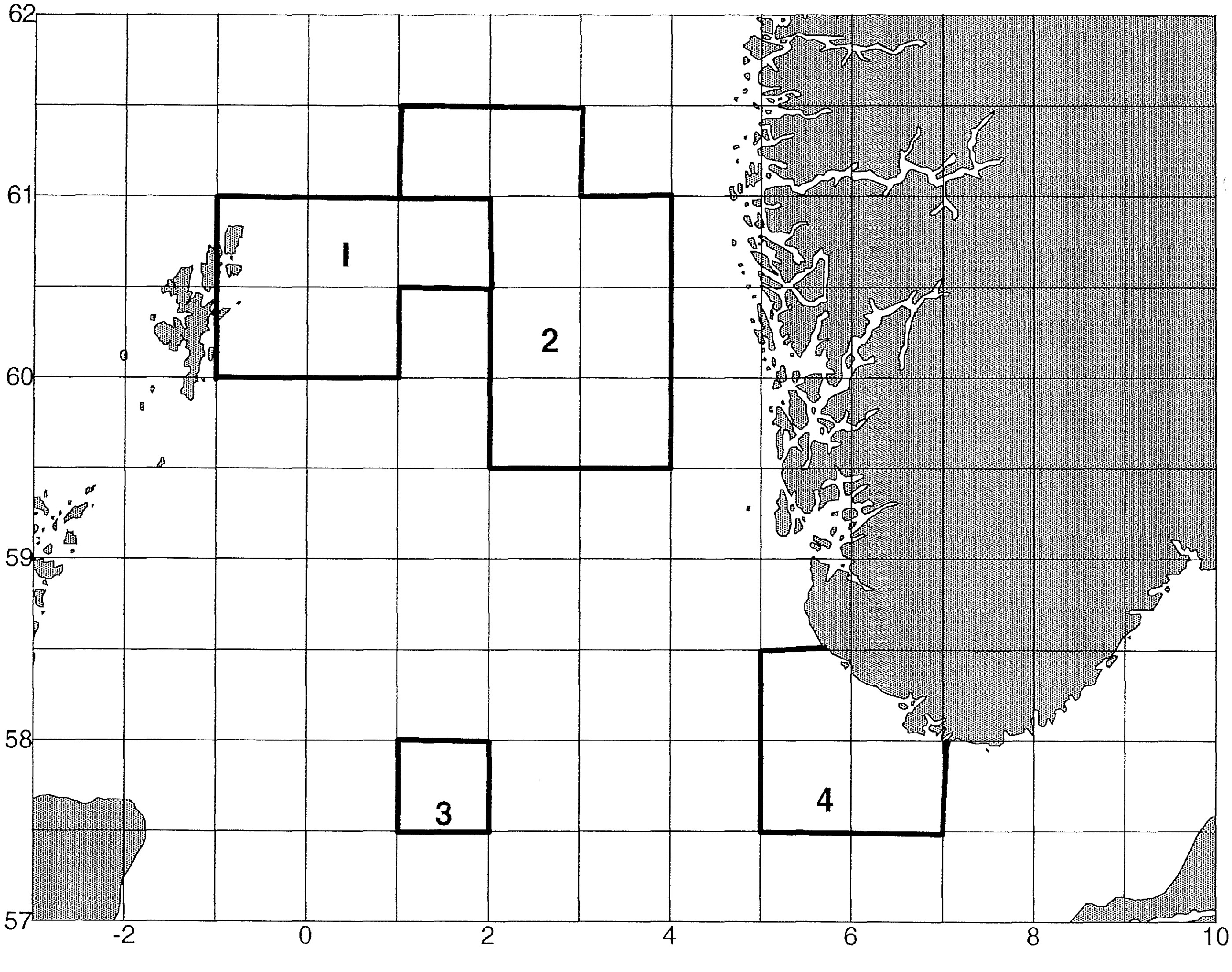



Figure 6 Sub-areas in which herring are estimated GO Sars July 1996

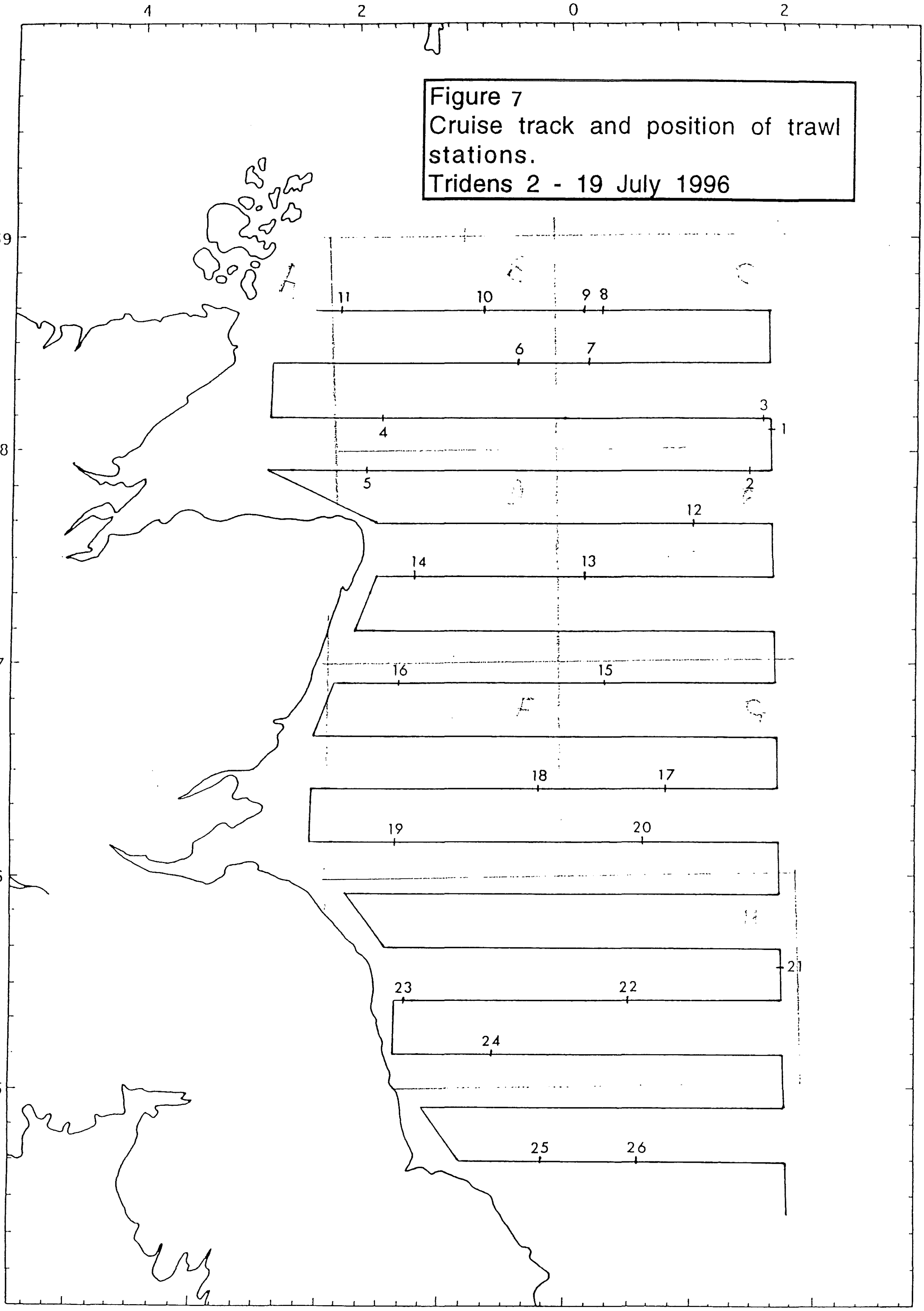


Figure 7
Cruise track and position of trawl stations.
Tridens 2 - 19 July 1996
4
2
0
2
59
58
57
56
55
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26

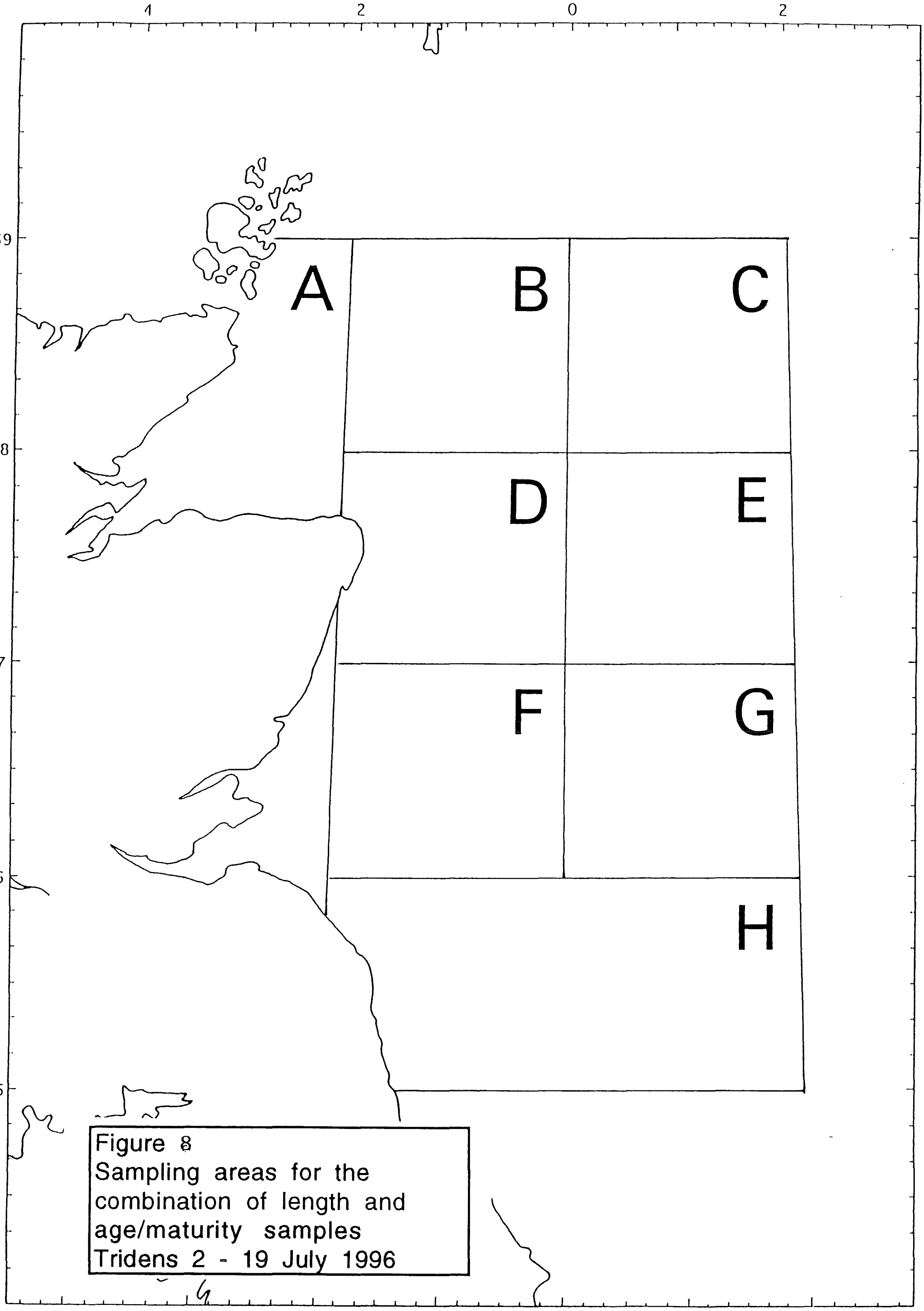



Figure 8
Sampling areas for the combination of length and age/maturity samples
Tridens 2 - 19 July 1996

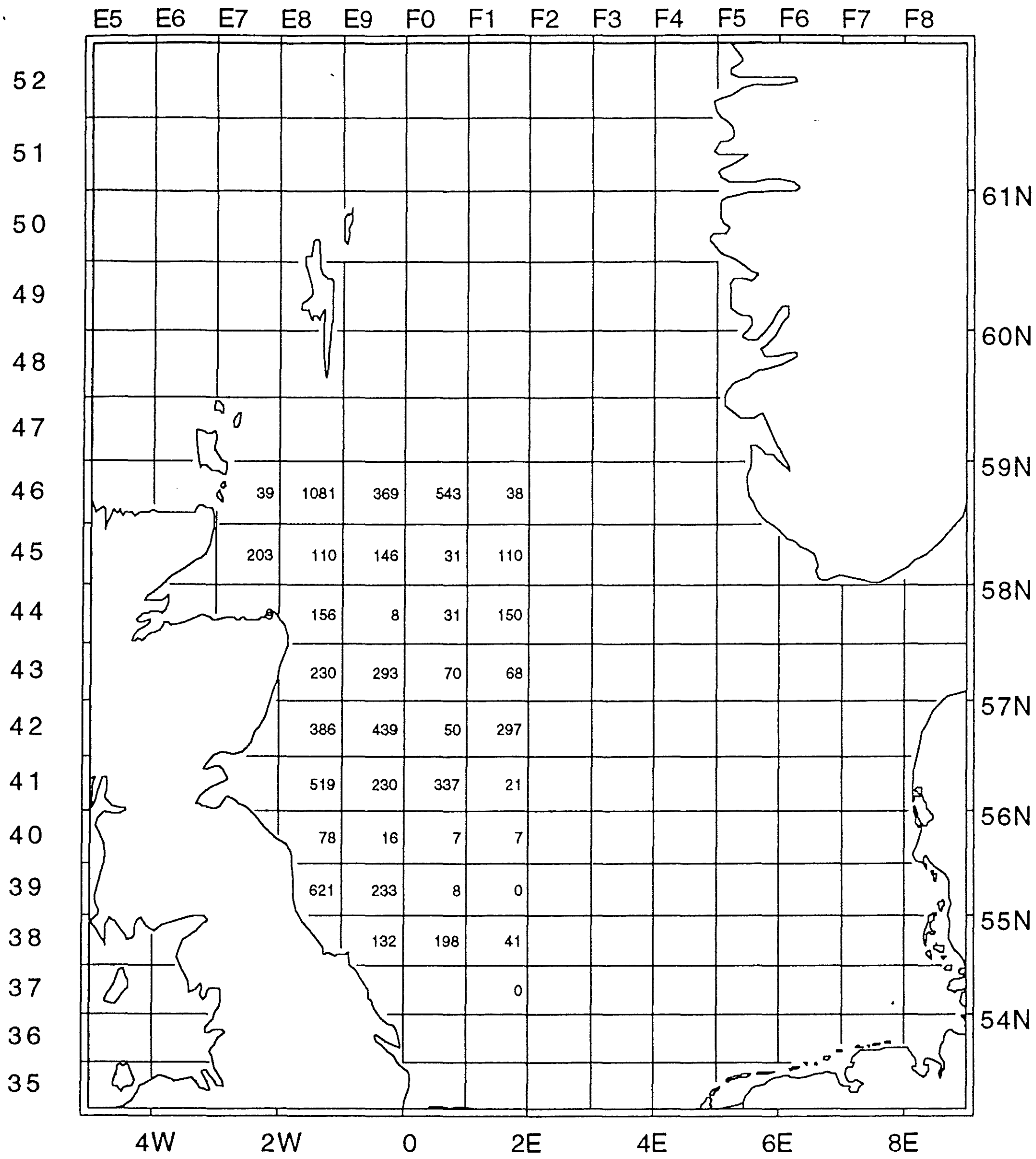



Figure 9
Numbers of herring (millions) per square - all ages.
Tridens 2 - 19 July 1996

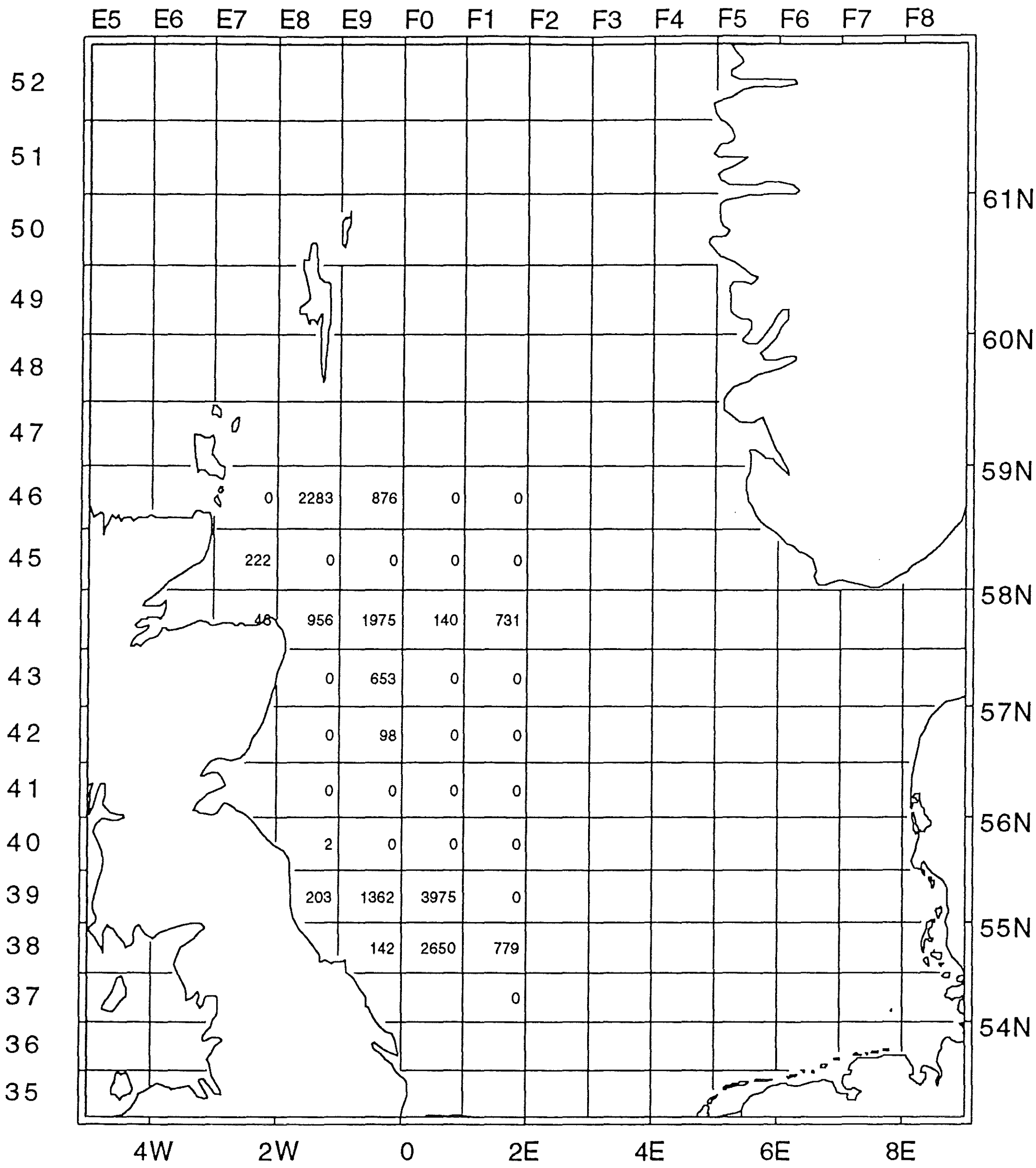



Figure 10
Numbers of sprat (millions) per square - all ages.
Tridens 2 - 19 July 1996

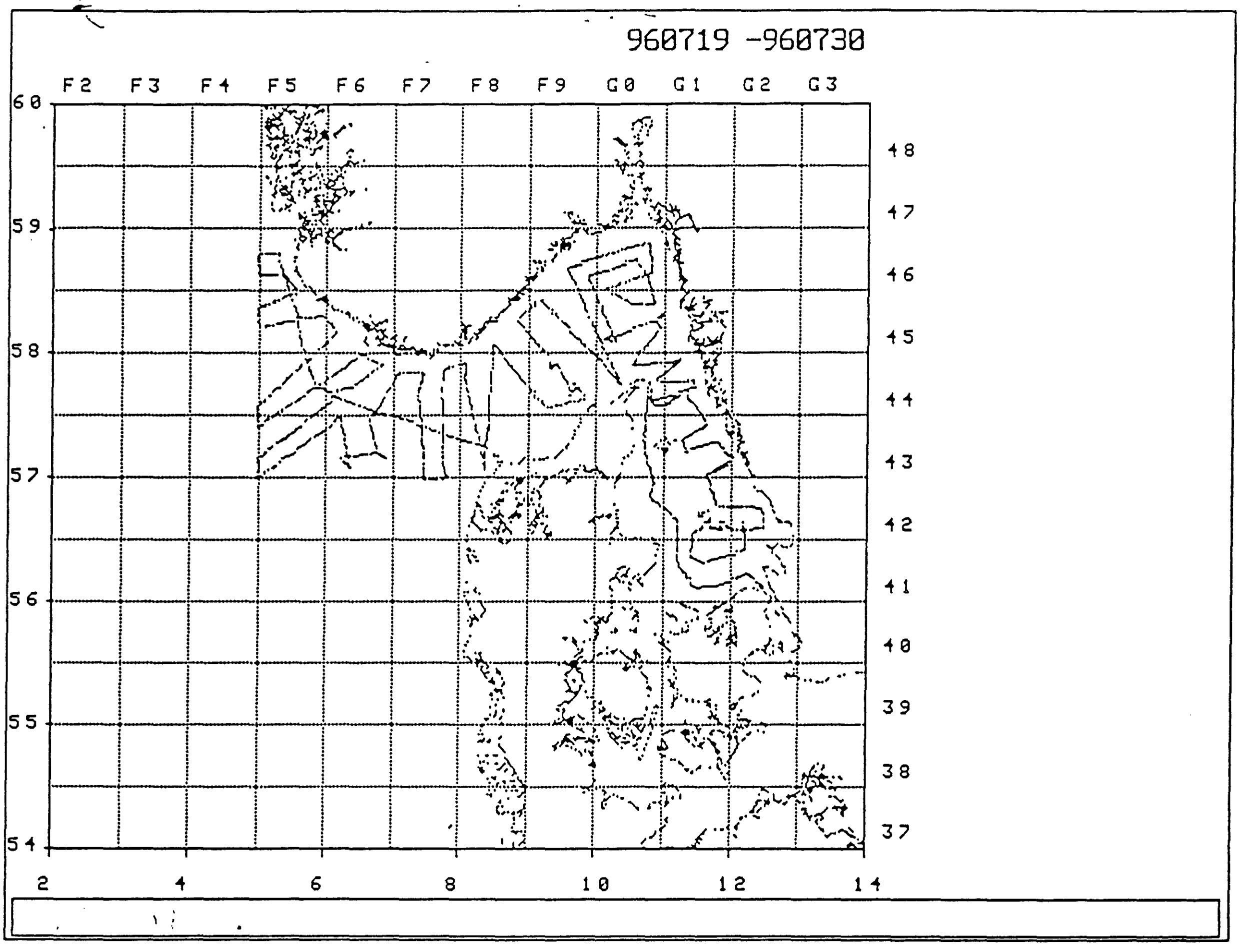



Figure 11 Cruise track during the acoustic survey of R/V DANA 19 July - 30 July 1996.

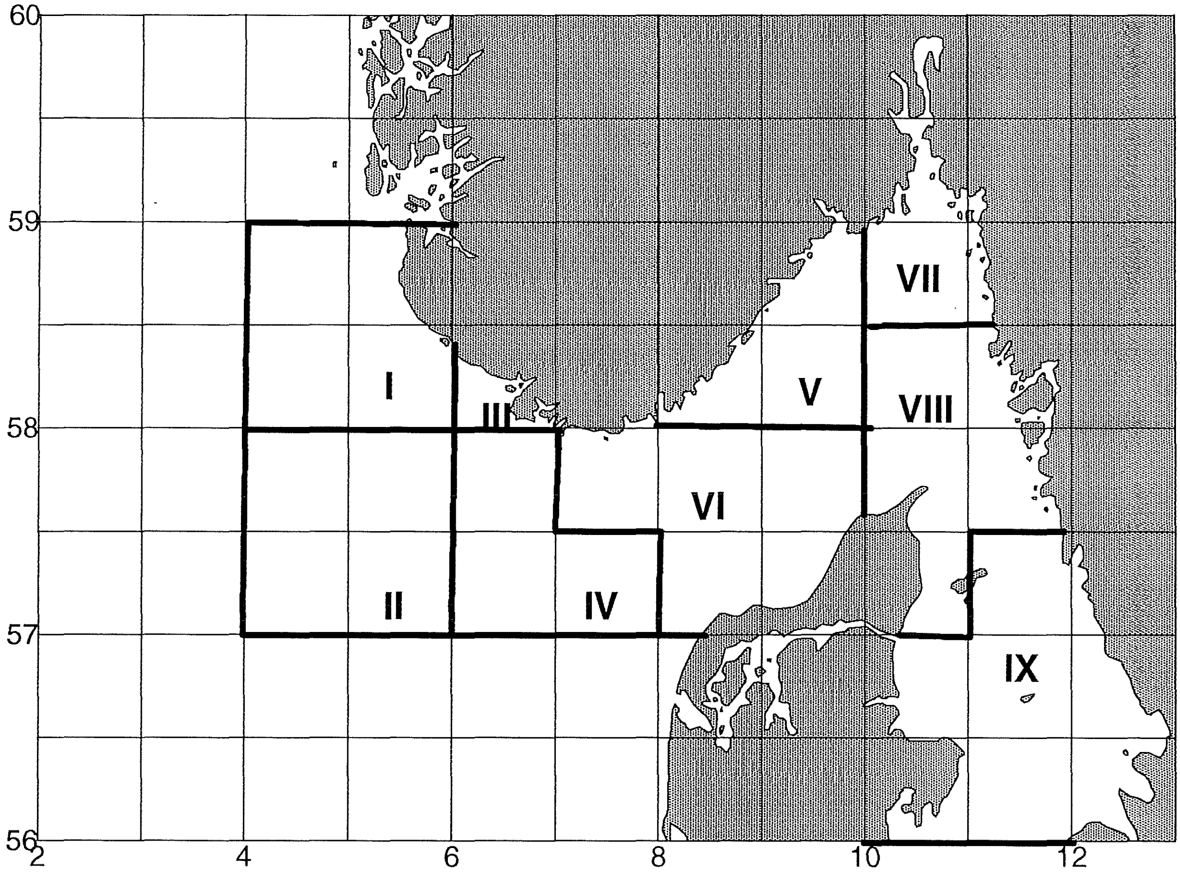



Figure 12 Sub-areas in which herring are estimated R/V DANA July 1996

## Figure 13 Survey track Christina S 13 - 30 July 1996

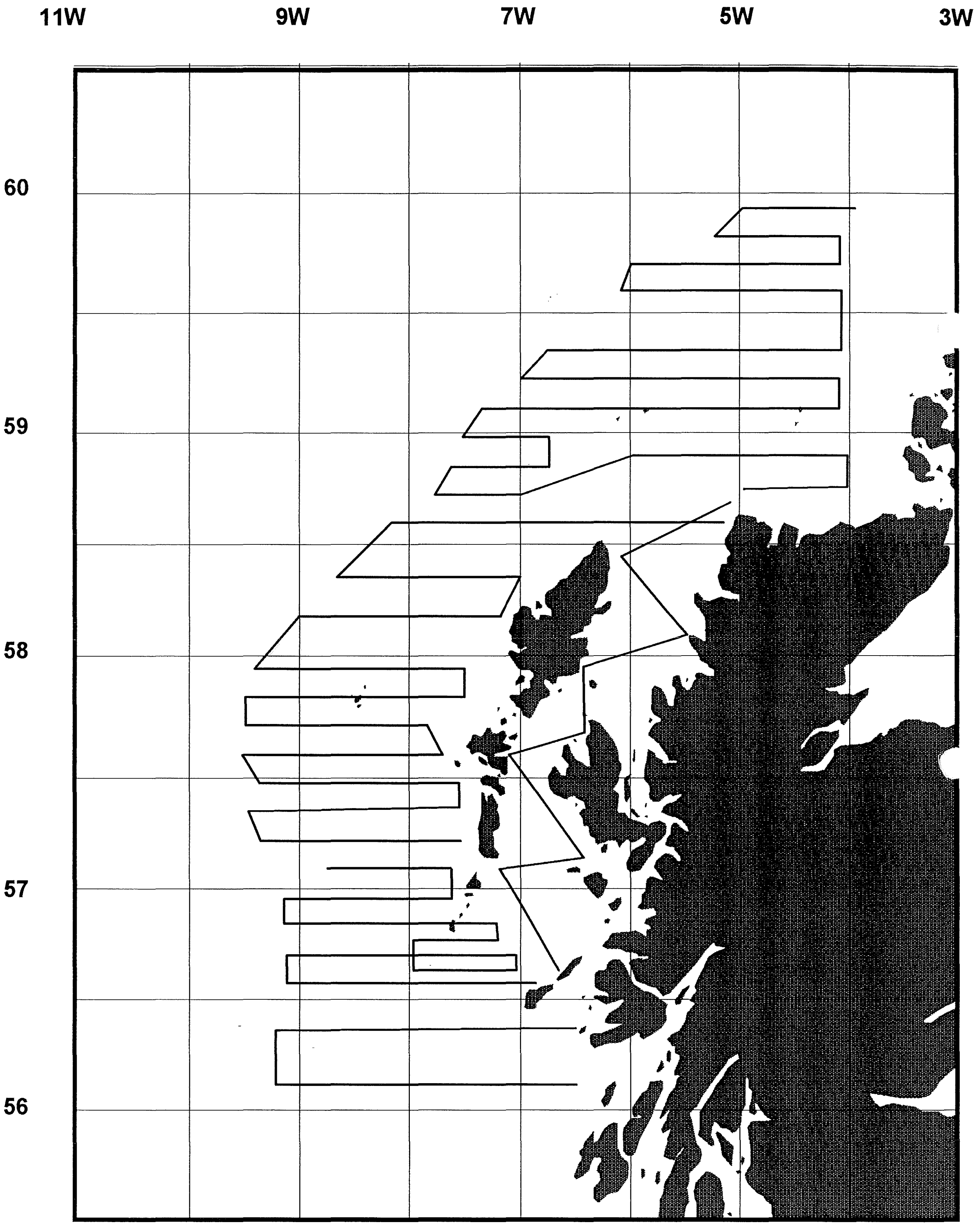


**Figure 14 Haul positions Christina S 1996 and Area sub-divisions**

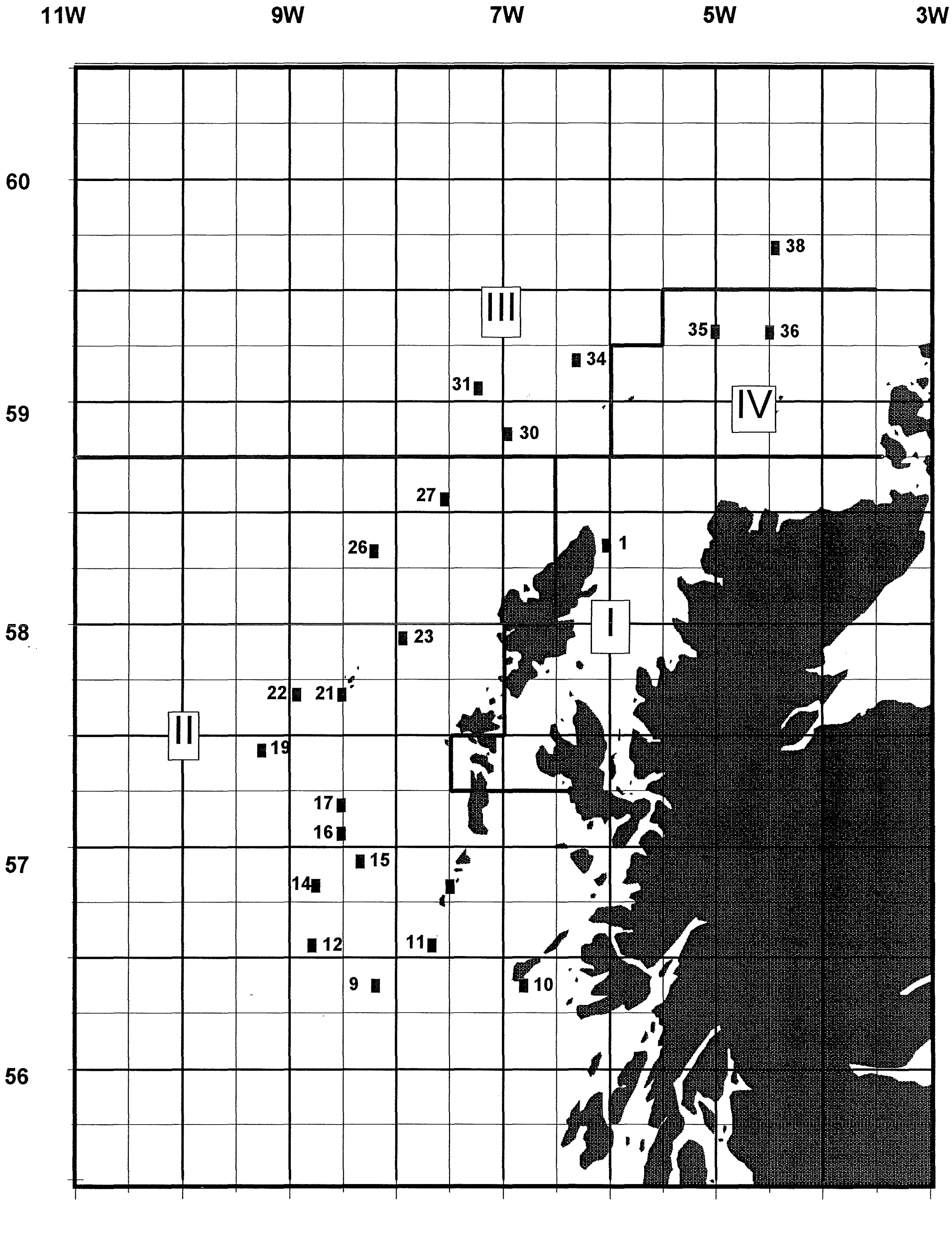


Figure 15
Herring numbers (millions) - top
Herring biomass (ktonnes) - bottom
Christina S 13 - 30 July 1996

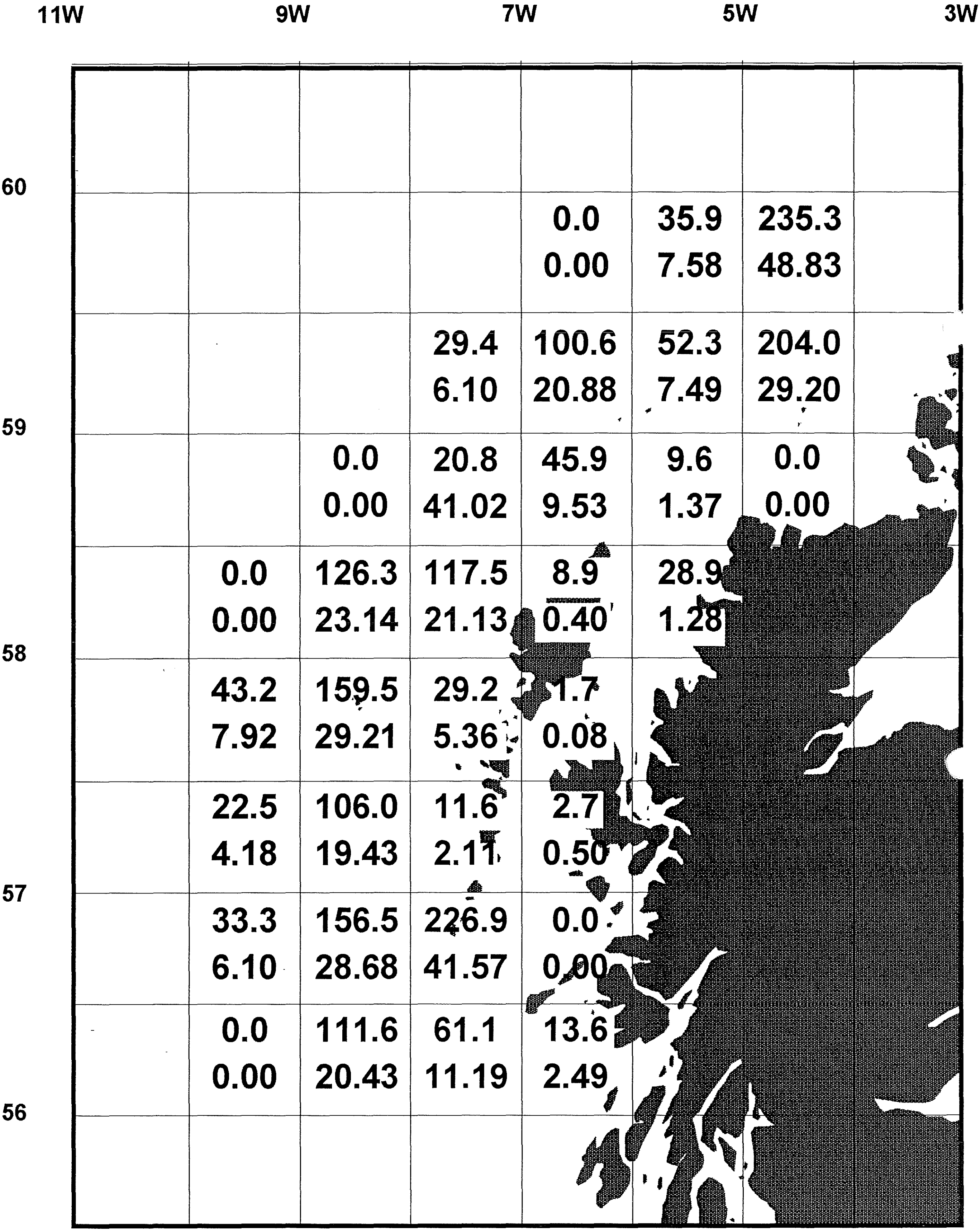
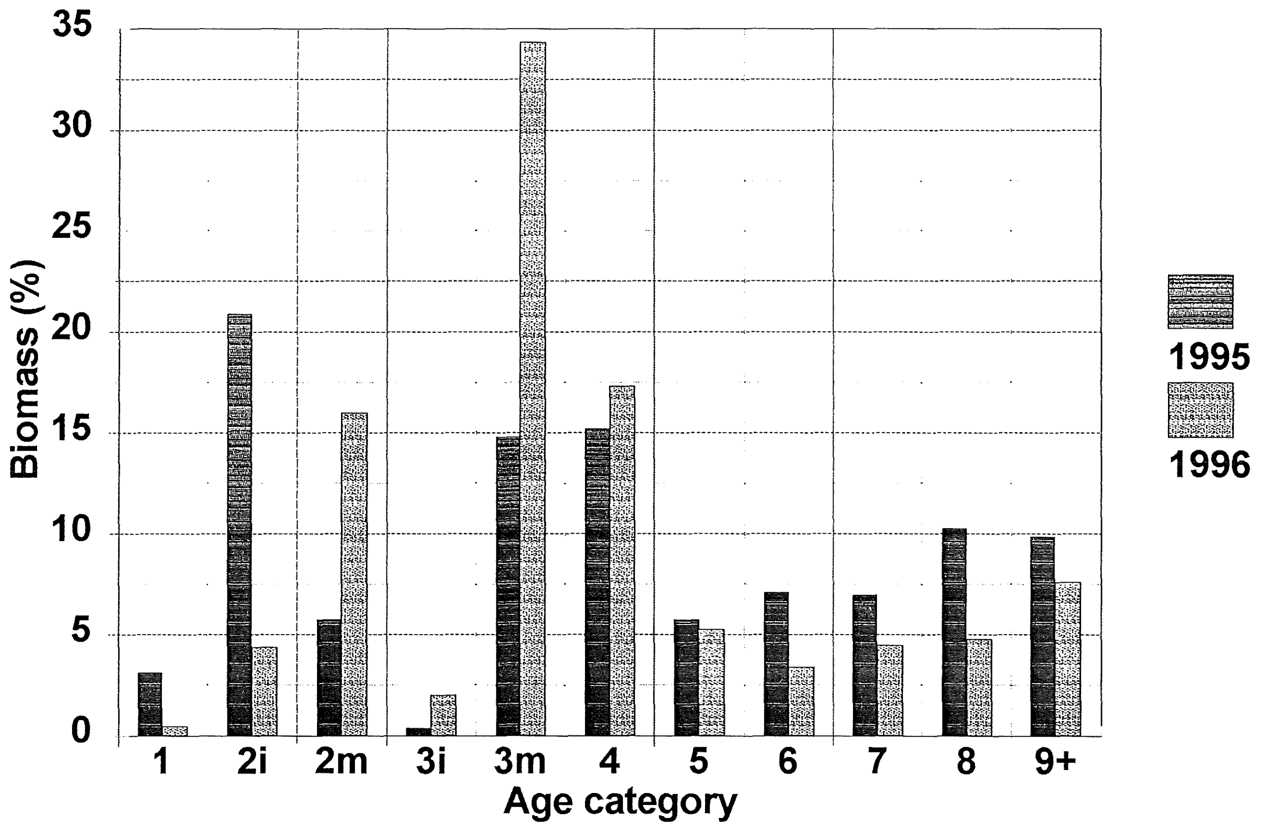


Fig. 16 Biomass (%) by age category
VIa(N) July 1996



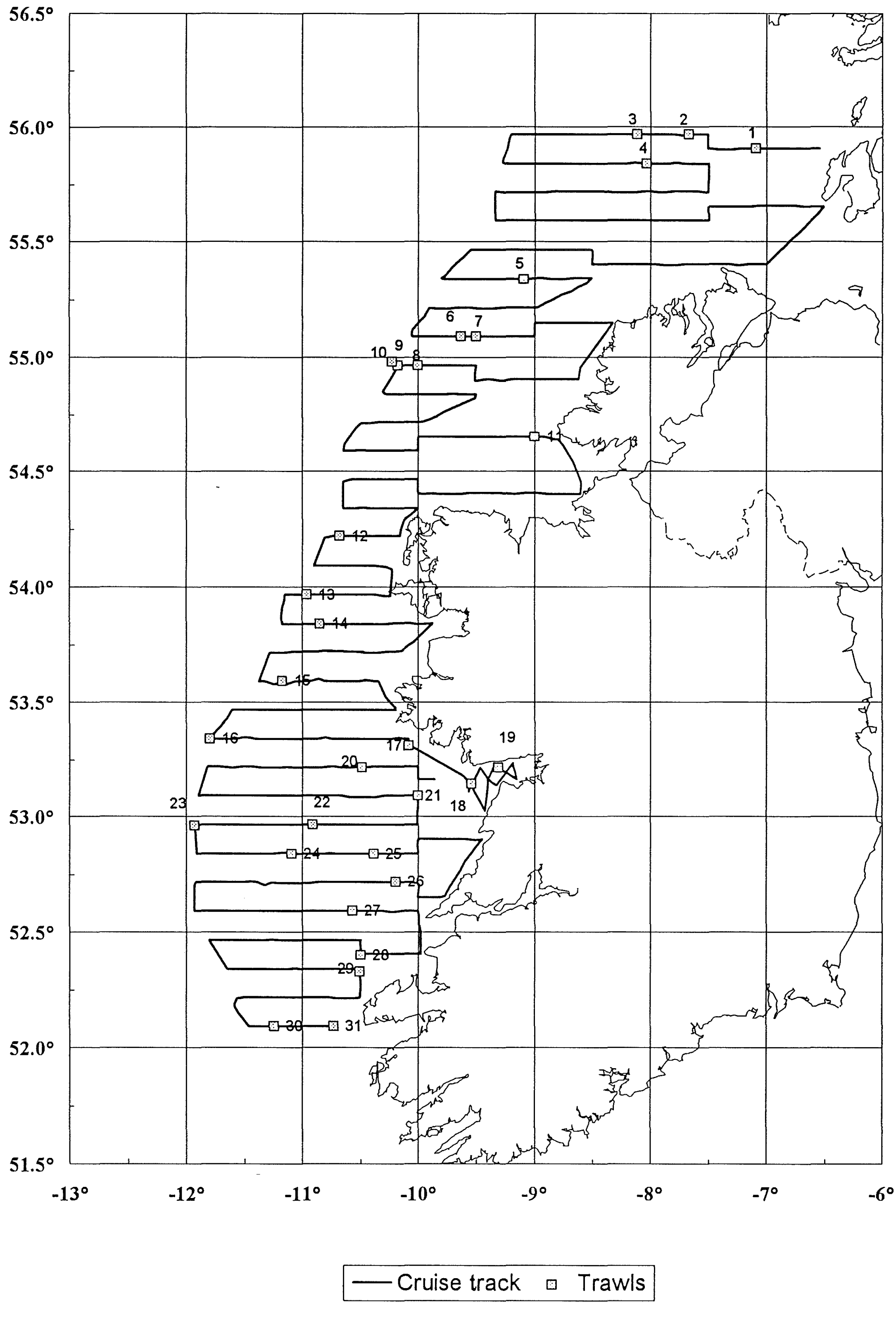



**Figure 17.** Map of the west coast of Ireland, showing cruise track and positions of fishing trawls during the July/August '96 herring acoustic cruise.

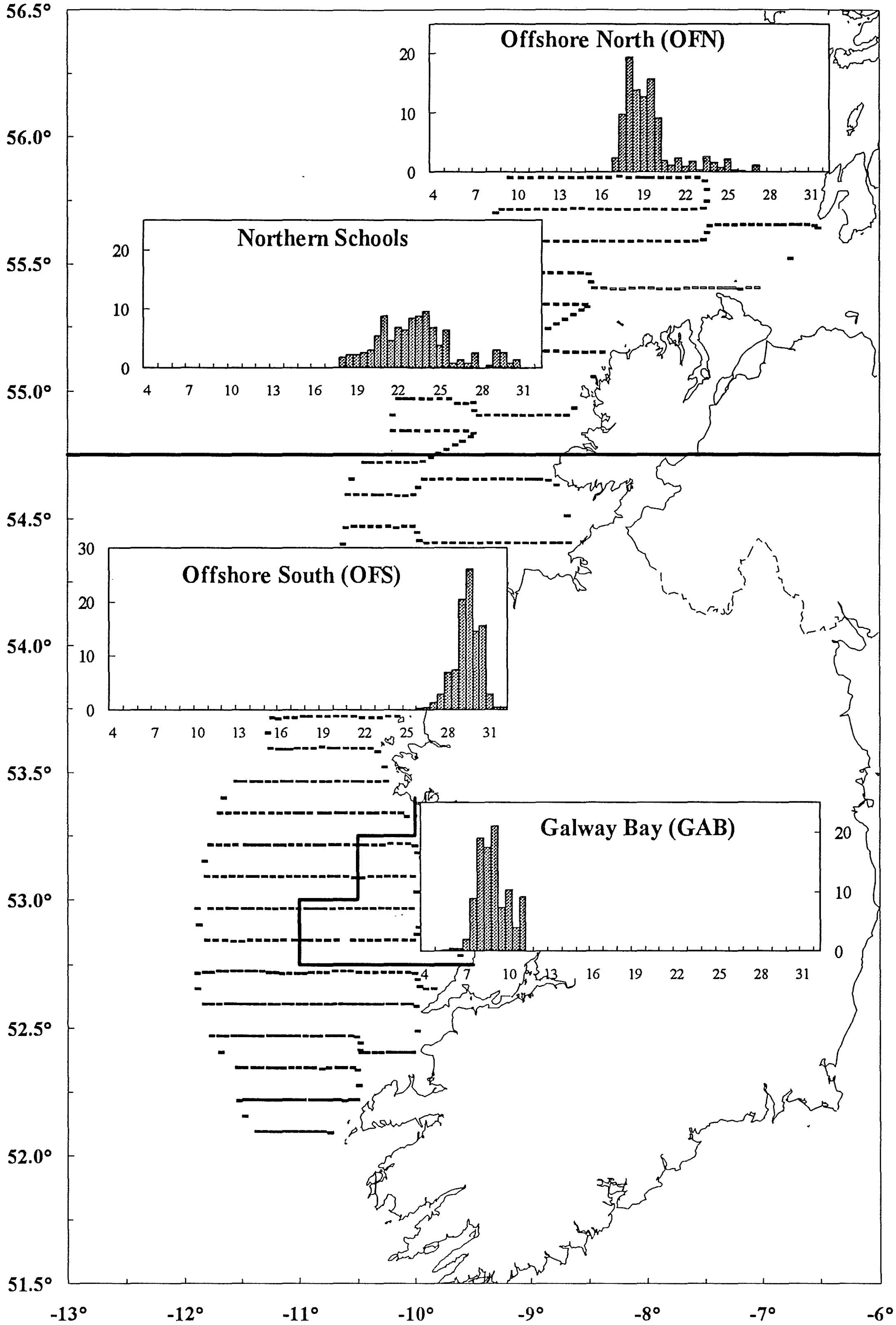



**Figure 18**. Map of the west coast of Ireland showing the area sub-divisions for trawl allocations used to qualify the acoustic data on the July/August '96 herring acoustic cruise; length frequency distributions of herring are on the same scale.

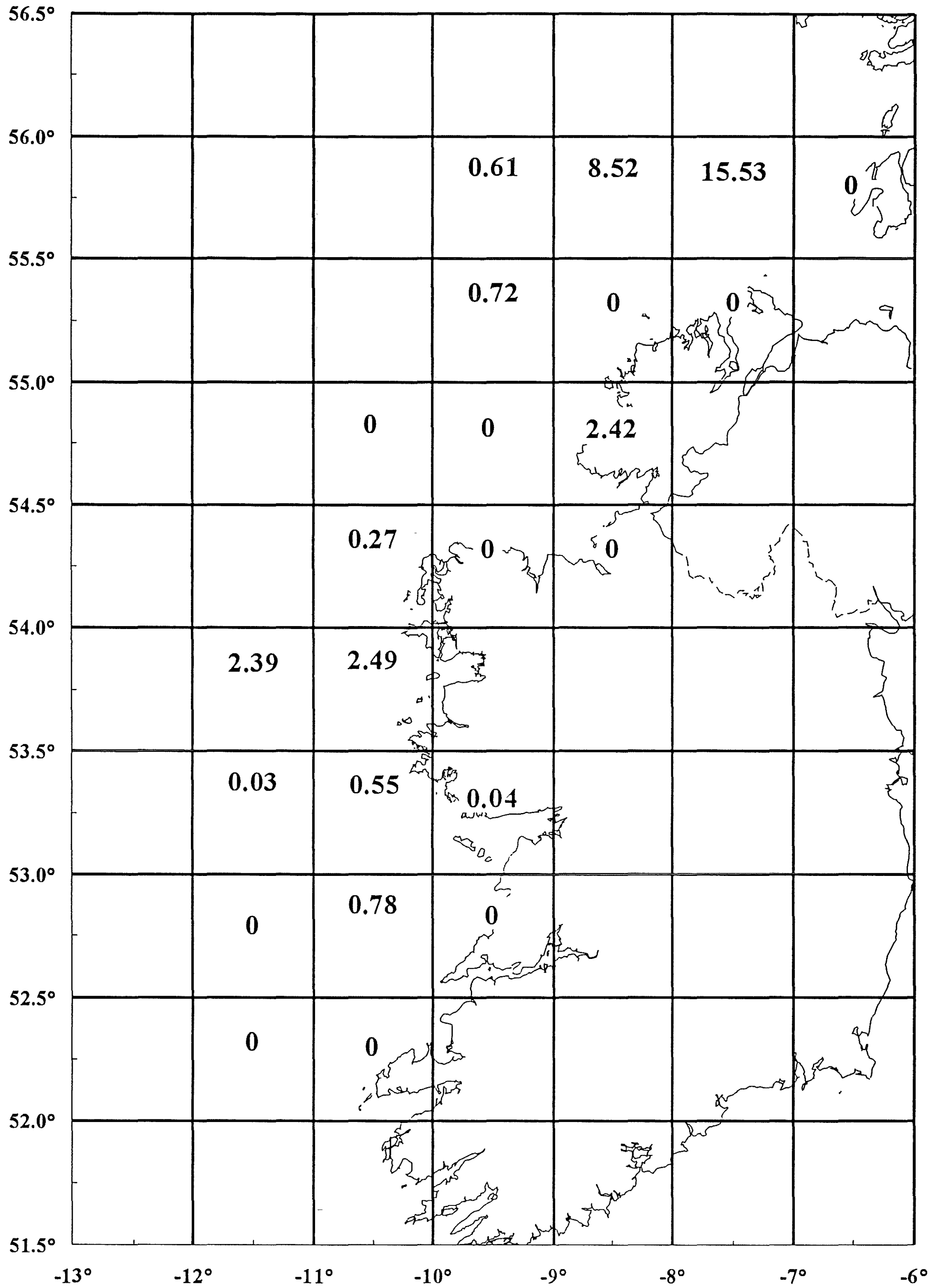



**Figure 19.** Estimates of probable herring biomass (tonnes) by ICES statistical rectangle for the July/August '96 herring acoustic cruise.

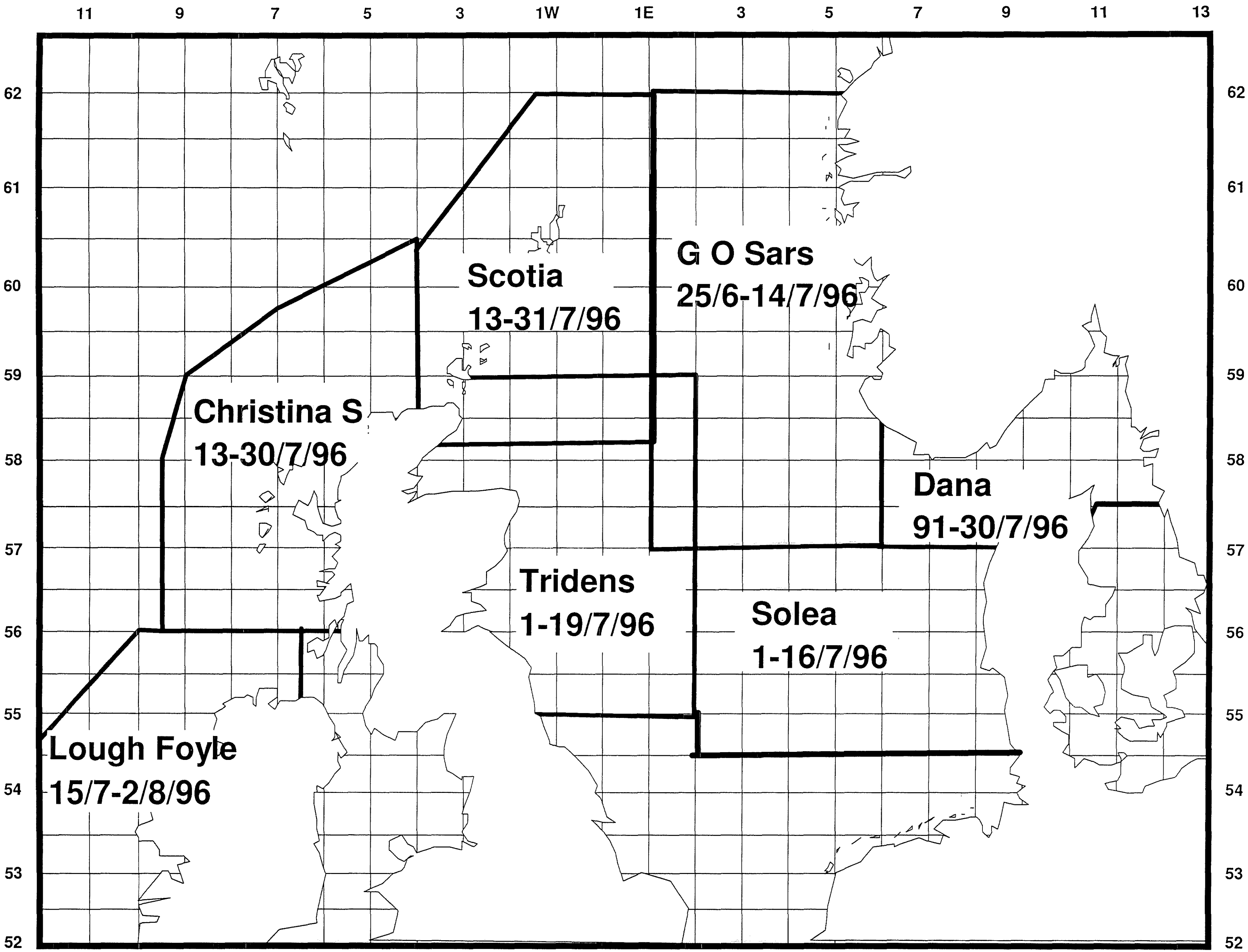



Figure 20. Survey areas and dates for the combined acoustic herring surveys June - August 1996

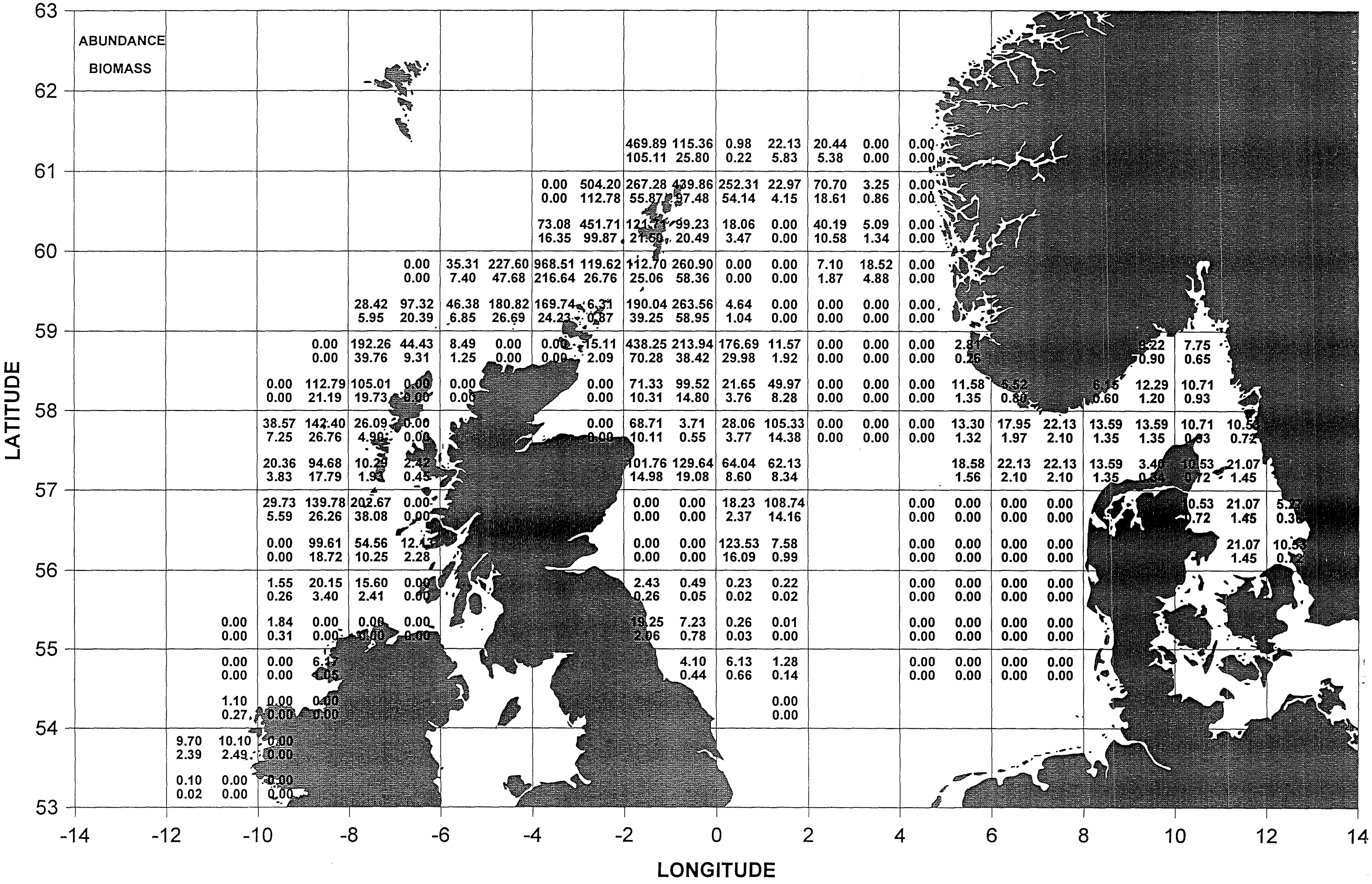



Figure 21. The distribution of abundance (numbers (millions) and biomass ('000 tonnes)) of all mature autumn spawning herring for all areas surveyed in 1996.

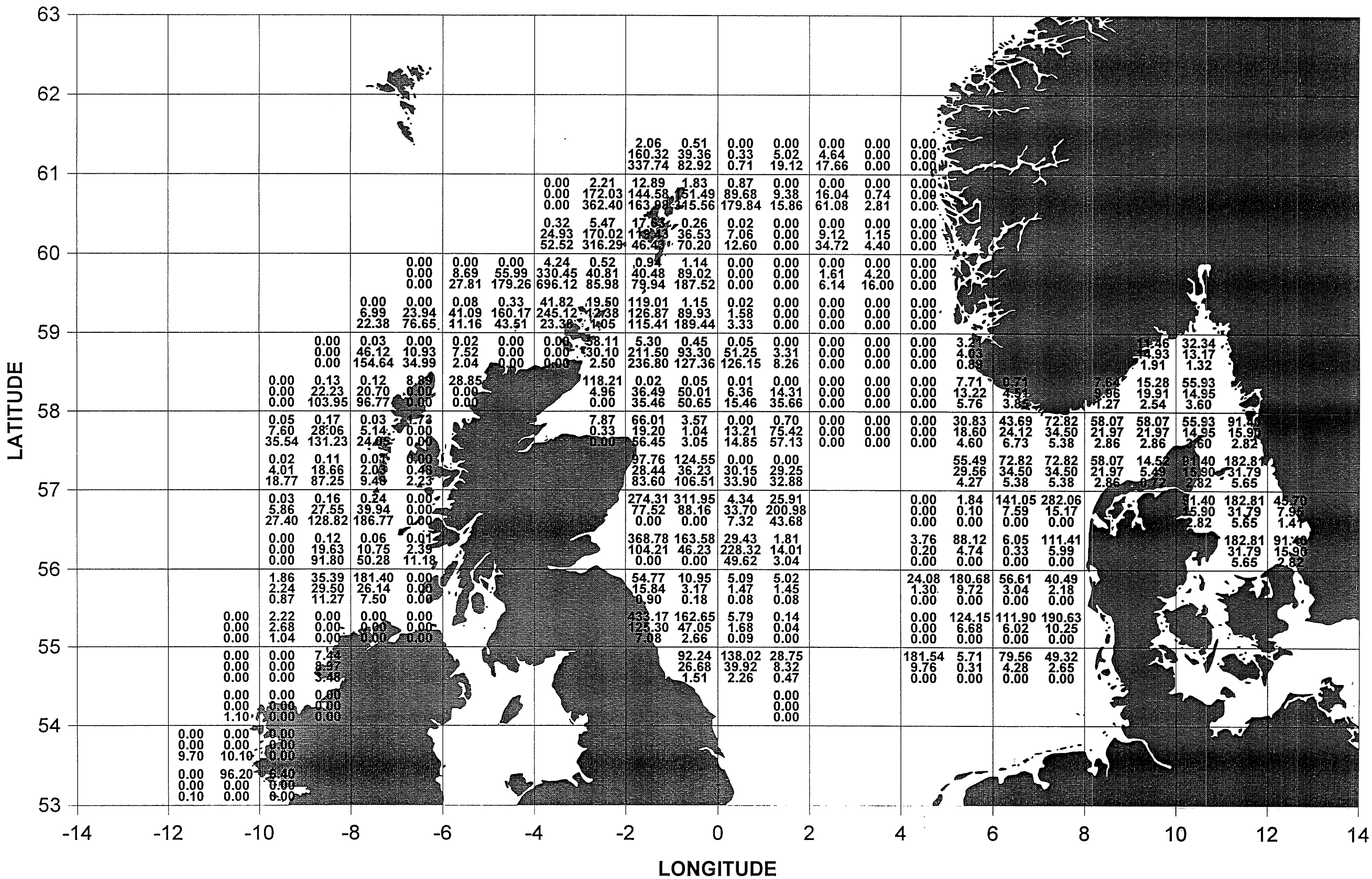



Figure 22. The distribution of numbers (millions) by age of 1 ring, 2 ring and 3+ ring autumn spawning herring for all areas surveyed in 1996.

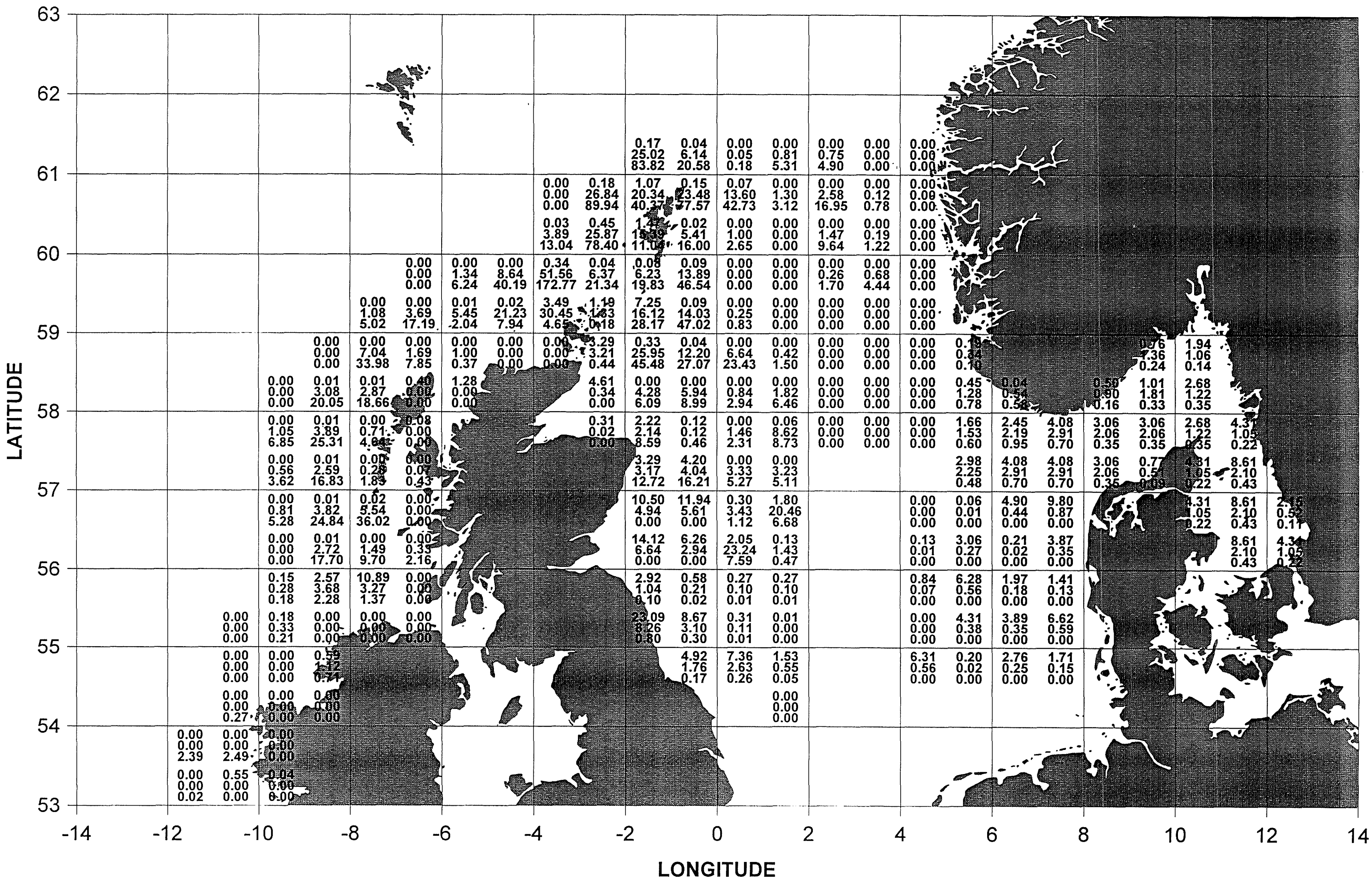



Figure 23. The distribution of biomass ('000's) by age of 1 ring, 2 ring and 3+ ring autumn spawning herring for all areas surveyed in 1996.

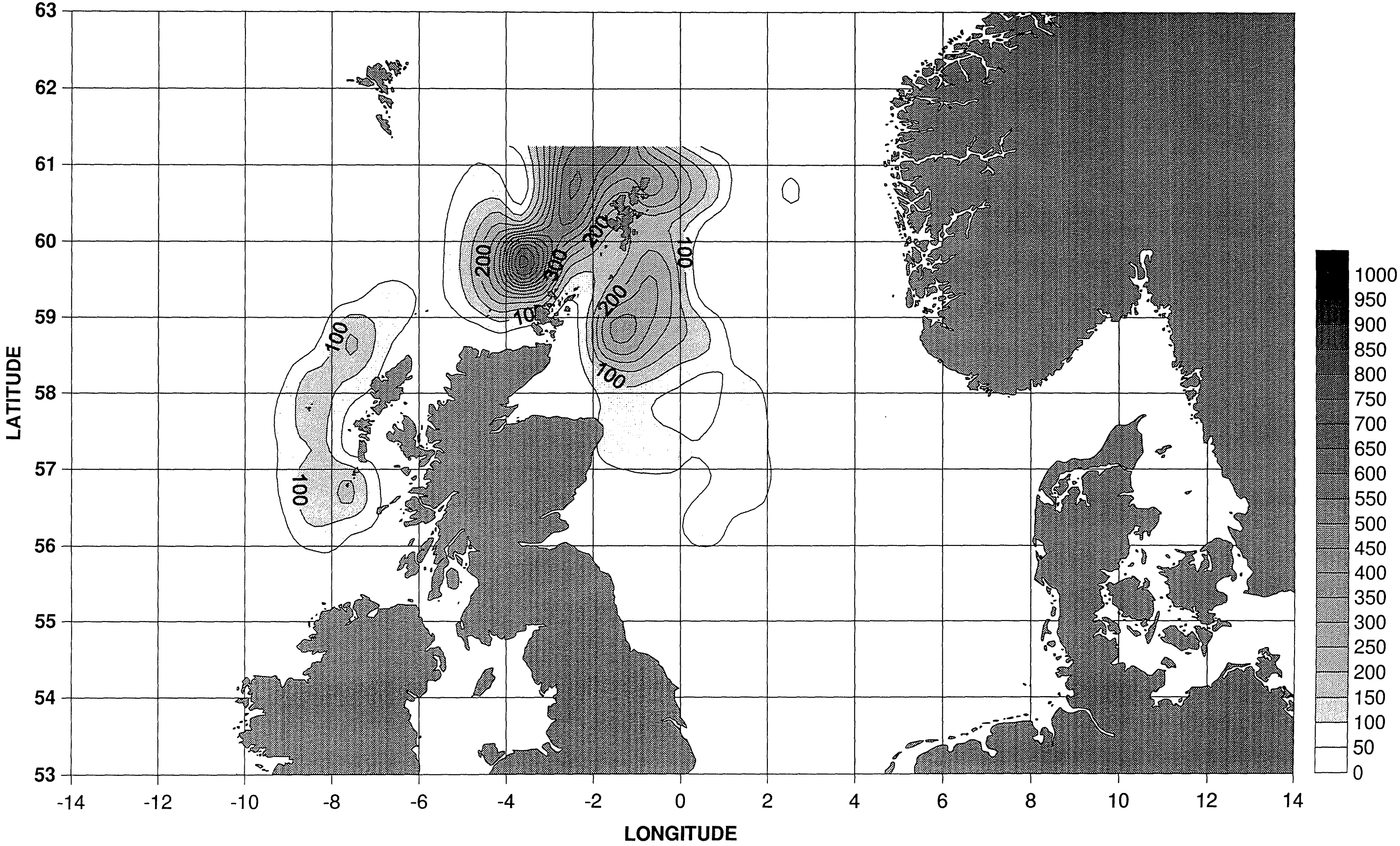



Figure 24. Density distribution of numbers ('000's) of spawning stock biomass for autumn spawning herring.