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Exploration of the Sea

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# *REPORT OF THE PLANNING GROUP ON ACOUSTIC SURVEYS IN SUB-AREA IV AND DIVISION IIIA*

Aberdeen, 9 - 10 January 1991



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# 1 INTRODUCTION

## 1.1 Participants

| | |
|---|---|
| A. Aglen | Norway |
| R.S. Bailey | UK (Scotland) |
| A. Corten | Netherlands |
| O. Hagström | Sweden |
| P.J. Hopkins | UK (Scotland) |
| E. Kirkegaard (Chairman) | Denmark |
| D.G. Reid | UK (Scotland) |
| E.J. Simmonds | UK (Scotland) |

## 1.2 Terms of Reference

In accordance with C.Res.1990/2:21, the Planning Group for Acoustic Surveys in Sub-area IV and Division IIIa met in Aberdeen from 9 - 10 January 1991 to:

a) discuss the re-allocation of sampling areas in the 1991 herring acoustic survey in view of the changing international participation, and a possible extension of the survey area into Divisions Vb and VIa;

b) investigate possibilities for a better synchronization of the cruises by different countries;

c) evaluate possibilities for exchange and reporting of acoustic estimates for species other than herring;

d) review the results of the 1990 survey.

# 2 REVIEW OF THE 1990 ACOUSTIC SURVEY

## 2.1 Report on the 1990 Herring Acoustic Survey by FRV "Scotia" in the Northern North Sea (E.J. Simmonds, DAFS Marine Laboratory, Victoria Road, Aberdeen, Scotland)

Methods

The acoustic survey by FRV "Scotia" was carried out using a Simrad EK400 38kHz sounder with echo-integration on a computer-based Aberdeen Echo Integrator.

The survey track (Figure 2.1.1) was selected to cover the area in two levels of sampling density based on densities found in previous years, an area with high density sampling with transect spacing 7.5 nautical miles and a lower density area with transect spacing of 15 nautical miles. The ends of the tracks were positioned at 1/2 the actual track from the area boundary, giving equal track length in any rectangle within each density area. The between-track data were then included in the data analysis.

Trawl hauls (Figure 2.1.1) 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 to 1/2 cm from each haul, otoliths were taken: 2 per 1/2 cm below 20 cm 5 per 1/2 cm from 20 to 25.5 cm and 10 per 1/2 cm 26 cm and above. Fish weights were collected at sea from a random sample of 50 fish per haul.

Data from the echo integrator were summed over quarter hour periods (2.5 Nm at 10 Knots). The echo integrator was set from 9 meters below the surface to 1 m above the seabed. The data were divided into three categories, by visual inspection of the echo-sounder paper record and the integrator cumulative output; "herring traces", "probably herring traces" and "probably not herring traces". For the 1990 survey, 91% of the stock by number was attributable to the "herring traces" and only 9% to the "probably herring traces". The third category was which gave 29% of total fish attributable mainly to mackerel, whiting, sprat, haddock and blue whiting in that order of importance. Most of these species were either easily recognizable or did not appear to occupy the same area as the herring.

Two calibrations were carried out during the survey, the results of these can be seen in Table 2.1.1.

To calculate integrator conversion factors the Target strength of herring was estimated using the TS/length relationship recommended by the acoustic survey planning group (Anon. 1982):

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

The weight of fish at length was determined by weighing fish from each trawl haul with more than 50 specimens. Lengths were taken by 1/2 cm to the nearest 1/2 cm below.

The resulting weight-length relationship from fish was:

$$W = 1.218\ 10^{-3}\ L^{3.604}\ g$$

L measured in cm.

Survey results

A total of 39 trawls hauls were carried out, the results of these are shown in Table 2.1.2. More than 100 herring were caught in 28 of these hauls and they were used to define 4 survey sub areas (Figure 2.1.2). The mean length keys, mean lengths, weights and target strengths for each haul and for each sub-area are shown in Table 2.1.3. 2,823 otoliths were taken to establish the four age-length keys. The numbers and weights of fish by quarter statistical rectangle are shown in Figure 2.1.3 along with the number of 2.5 Nm integration intervals. A total of 4,493 million herring or 800,000 t were estimated within the area, of which 728,000 were mature. Herring were found mostly in water deeper than 100 m with traces extending into waters with depths of about 250 m. The survey was extended to 300 m depth for most of the western and northern edge between 4W and 0 degrees. Fish were generally found over deeper water than previous years. Table 2.1.4 shows the numbers and weights of fish by sub-area by age class.

Discussion

The stock found in this area is dominated by 3- and 4-ring fish with an unexpected shortage of 2-ring fish, only 16% of the estimate by number. Fishing appeared to be successful after initial problems were solved. Catches were good with some hauls providing good samples from multiple shoals after fishing for less than 15 minutes. Identification of traces was not difficult, and although other species were found in the area, the major concentrations appeared to be herring with relatively small numbers of mackerel and whiting found as well. In addition to the 800,000 t, approximately 250,000 t of other fish were observed in mid water. Examination of the trawl data in Table 2.1.2 showing the catch by species shows the difficulty of allocating this between species so this has not been attempted. The proportions of mature 2-ring and 3-ring fish were estimated at 89% and 94% respectively. This is a larger proportion of mature 2-ring fish than in previous years.

2.2 Report on the 1990 Acoustic Survey by R/V "ELDJARN" in the Northern North Sea (A. Aglen and E. Bakken, Institute of Marine Research, Bergen, Norway)

Acoustic data were collected from a Simrad EK 400 echo sounder, calibrated during the survey. Technical data are given in Table 2.2.2. Fishing was made with a Fotø herring trawl and a G.O.V. trawl.

Figure 2.2.1 shows survey grid and trawl stations. A systematic grid of about 15 nautical mile distance between transects was applied. Table 2.2.1 shows the catch data. Most trawl hauls were made close to surface by aid of large buoys on the wings (Aglen and Misund, 1990). Figure 2.2.2 defines the sub-areas used for averaging of fish samples.

The integrator values allocated to "herring" in the upper 50 m were considered to be a mixture of herring and mackerel. The split between these species was based on the trawl catch compositions and the following target strength values (L is fish length in cm):

Herring: TS= 20*log L - 71.2 dB per individual
Mackerel: TS= 20*log L - 77.2 dB per individual

The estimated numbers of mackerel are shown in Table 2.2.3 and Figure 2.2.3 and those for herring in Table 2.2.4 and Figures 2.2.4-2.2.5. Table 2.2.5 gives mean weights of herring by age and sub-area.

The total estimates for the surveyed area are:

| | Number (millions) | Biomass ('000 t) |
|---|---|---|
| Mackerel ............................................ | 1,802 | 492 |
| Herring: North Sea autumn spawners, mature ......... | 6,453 | 1,280 |
| North Sea autumn spawners, immature ....... | 915 | 86 |
| Division IIIa Baltic spring spawners ............... | 772 | 93 |

The split between North Sea autumn spawners and Division IIIa Baltic spring spawners was based on vertebral counts. Within each sub-area all vertebral count samples were combined and the distribution of counts was split into two components by a model described by Mann *et al.* (1983). Components with mean counts between 56.35 and 56.60 were accepted as North sea autumn spawners and components between 55.65 and 56.00 were accepted as Division IIIa Baltic spring spawners. If the components did not match with these intervals, the mean value of one component was fixed to 56.44 (the average of a number of "pure" North Sea samples). Then the other component usually fell within one of the intervals. Table 2.2.6 shows mean vertebral count and estimated percentage of Division IIIa Baltic spring spawners by age group and sub-area. In sub-areas 1-5 there were no evidence of Division IIIa Baltic spring spawners, while in the south eastern sub-areas they tended to dominate the older age group. Sub-area 12 were also sampled during two coverages of the 1990 mackerel egg survey. The results included in Table 2.2.6 indicate an increasing proportion of Division IIIa Baltic spring spawners in that area during the period 20 June to 17 July. A minor component (1-2%) of Atlanto-Scandian herring were identified on the bases of otolith characters in the north east (sub-areas 5,6,9,10 and 11).These are included in the estimate of North Sea autumn spawners.

Discussion

Most of the herring were found in the upper 50 m in areas with bottom depths between 150 and 300 m. In shallower areas most of the herring were found along the bottom. This tendency has been found in the Northern North Sea during the three latest summer acoustic surveys. The proportion of fish staying in the upper 50 m has increased during this period. Sonar observations have been used to evaluate the risk of"loosing" schools above the echo sounder transducer depth (Aglen and Misund, 1990). Such losses seem most evident during the 1989 survey, and less evident in 1990 and 1988.

The weather conditions during the 1990 survey were satisfactory. In the most important herring areas very little plankton was recorded. O-group haddock and whiting were recorded over large areas but they were easy to distinguish from herring recordings. In the southern areas plankton was mixed with herring recordings during night. Night time observations represent a small proportion of the material, and the herring densities in these areas were generally low. Therefore, allocation errors due to plankton do not have a large impact on the total estimate of herring.

The largest likely allocation error is caused by the mackerel. The applied split assumes an equal catchability for the two species and a 6 dB lower target strength of mackerel compared to herring. Due to the target strength difference, any error in the estimated species proportion will make much less impact on the abundance estimates of herring compared to those of mackerel.

The catch figures (Table 2.2.1) show remarkably higher catches of mackerel close to surface compared to larger depths. The ratio between average catch close to surface (29 hauls at 5 m) and average catch at depths between 20 and 50 m (8 hauls) is 20 for mackerel and 2 for herring. Aglen and Misund (1990) report the same tendency during the 1989 survey; a ratio of 5 for mackerel and 2 for herring. They point out that with the applied rigging, the, trawl is catching more efficiently close to surface. The larger ratio observed for mackerel may indicate that a larger proportion of the mackerel tends to stay close to surface and above echo sounder transducer depth. This means that mackerel may have contributed less to the integrator values than indicated by the trawl catch composition. If the mackerel is neglected in the calculations, the total herring estimate increases by 123.000 t (10%).

## 2.3 Report on the Acoustic Survey by R/V "DANA" in the Central North Sea (P. Degnbol and E. Kirkegaard, Danish Institute for Fisheries and Marine Research, Denmark)

The acoustic survey on R/V "DANA" was carried out from 24 July to 12 August using a Simrad EK400 38 kHz sounder and a QD integrator.

The cruise track and positions of trawl hauls are shown in Figure 2.3.1. To cover the central North Sea in 18 days, a rather large spacing of approximately 30 Nm between transects was used.

The surveyed area was stratified in sub-areas (1° lat - 2° long) as shown in Figure 2.3.1. Sub-areas with a large variation in depth were divided into up to six strata according to depth: 1) 0-20 m, 2) 20-40 m, 3) 40-60, 4) 60-100 m, 5) 100-300 m, 6) >300 m.

For each stock, fishing was carried out on denser echo traces. During daytime an Expo bottom trawl was used, while the night fishery was performed by a Fotö pelagic trawl, both gears with a mesh size of 16 mm in the cod-end. A total of 44 trawl hauls were taken (16 Expo and 28 Fotö). The species composition per trawl haul is shown in Table 2.3.1.

The echo integrator output was divided into two categories by visual inspection of the echograms; "herring schools" and "mixed traces". For "herring schools" the number of herring per stratum was estimated using the TS-length relationship shown below and the length composition of herring in the trawl catches. For "mixed traces" the total number of fish per stratum was estimated using species and length compositions of the trawl catches and the following TS-length relationship:

Herring, sprat and horse mackerel
$$TS = 20 \log L - 71.2$$

Mackerel and dogfish
$$TS = 20 \log L - 77.2$$

Gadoids
$$TS = 20 \log L - 67.5$$

Results

As shown in Table 2.3.1 whiting, mackerel and herring accounted for more than 60% of the total catch in weight, with whiting as the most abundant. Mackerel and herring were caught in about 85% of all trawl hauls.

The estimated numbers, mean weights and biomass at age of herring are given per sub-area in Tables 2.3.2 - 2.3.4.

Compared with previous years surveys in the central North Sea, the abundance of juvenile herring was low in 1990. The estimated number of whiting has increased in the latest years.

Very high concentrations of jellyfish were observed in the eastern and northern part of the surveyed area, and this makes the results from these areas very uncertain.

2.4 Report of the 1990 Acoustic Survey by R/V "Argos" in the Northeastern North Sea, Skagerrak and Kattegat (O. Hagström and L-E. Palmén, Institute of Marine Research, Lysekil, Sweden)

Methods

The Swedish survey was carried out by R/V "ARGOS" during the period 30 July-18 August 1990. The survey area and cruise track with trawl stations are shown in Figure 2.4.1. The integration was carried out using a Simrad EK 400 38kHz echosounder and a Nord 10 computer with a Simrad QX as a interface. The software program for integration is developed by Institute of Marine Research in Bergen. A description of the system is given in Blindheim *et al.* (1982). The technical data and settings of the equipment are shown in Table 2.4.1.

The acoustic system was calibrated at the start of the survey. The results of the calibration and system calibration constant CI are given in the Table 2.4.2.

The method of calculation, stratification and TS-length relations used are given in the section on results of the Danish survey. The sub-areas used are shown in Figure 2.4.2. The acoustic energy was separated to species based on the catch composition in trawl hauls.

A model length analysis was used to separate the two main components, Division IIIa - Southwestern Baltic spring spawners and North Sea autumn spawners. Mean vertebral counts was calculated for each components to test the result of the separations.

Results

A total of 30 pelagic and 5 bottom-trawl hauls were carried out. The number of integrated miles was 2,007 and the survey area is estimated to be 228 square n. miles. The survey statistics are given in Table 2.4.2.

The estimated numbers of herring, mean weights and biomass at age and strata are shown in Tables 2.4.3 - 2.4.5. A total of 4.275 million herring or about 391,000 t were estimated in the surveyed area. The biomass were equally divided between Division IIIa and the eastern part of the North Sea whereas the estimated number were 2,695 and 1,580, respectively.

The mean vertebral counts per age group and rectangle are given in Figures 2.4.3a and b. The mean counts show that 3-group and older herring in Division IIIa were exclusively spring spawners. In Division IIIa, the spring spawners appear to be very dominant in the North Sea sub-area. The data suggest a dominance of local autumn spawners but some samples indicate a mixture of spring spawners in 2-group and older herring. The autumn spawners seems to be the major component in 0- and 1-group herring in all sub-areas. A model length analysis was applied on age-groups in those areas where a mixture was indicated. The results of analysis are summarized in Table 2.4.6. The calculated mean VS for the component indicates that the separation of 2-group and older fish in the North Sea sub-area is not complete. The vertebral counts for component 1 of the 0-group in the Skagerrak and 0-group and 1-group in the Kattegat still indicate a mixture of autumn and spring spawners. The result of using an alternative method based on the assumption of spring spawners having 55.80, which is the mean for age-group 2-5 in Division IIIa, and autumn spawners having 56.50 are shown in Table 2.4.7. The maturity stages for 2-group and older herring in the eastern North Sea are presented in Figure 2.2.4.

## 2.5 Report on the Acoustic Survey by RV "Tridens" in the Northern North Sea

The Dutch RV "Tridens" surveyed part of the Scotland/Orkney area from 26 June to 10 July. This was an experimental survey, designed to test the equipment, and to compare the results with those of the Scottish survey in the same area. Results from the Tridens survey have not been incorporated in the final stock estimates.

## 2.6 Combined Results

The surveyed area was divided into six areas as shown in Figures 2.6.1 - 2.6.2. For the North Sea the combined results for herring were taken as the sum of the results from the surveys, carried out by RV SCOTIA, ELDJARN and RV DANA. For the Skagerrak and Kattegat the results from RV ARGOS were used. No correction was made for uncovered areas.

The combined results for herring by area and age, split into spring and autumn spawners are given in Tables 2.6.1 - 2.6.2. The geographical distributions of 0-, 1-, 2- and 3+- ringers are shown in Figures 2.6.1 - 2.6.2.

The estimated size of the spawning stock of autumn spawners is 11,080 mill. fish or 2,174 mill. tonnes. The total number of 1-ringers and 0-ringers was found to be 6,247 millions and 2,279 millions, respectively.

For comparison the results of the surveys in the period 1987-1990 are given in Table 2.6.3. The results of the 1990 survey indicate a major increase in the SSB.

The quality of the results are discussed in section 2.7.

## 2.7 Evaluation of Survey Results

While it was not possible to provide quantitative measures of the accuracy and precision of the survey results, the Planning Group considered a number of potential sources of error.

Random error resulting from the distribution pattern of the herring and from the survey design has not been measured but from the results of earlier investigations it is likely to be in the order of 25% of the total estimate (Aglen, 1990, Pittegas, 1990, Bailey & Simmonds, in press). The possibility that systematic errors might have occurred in the 1990 survey was considered under the following headings:

a. Boundary problems.

b. Double counting due to migration during the survey.

c. A change in depth distribution.

d. A change in the degree to which echotraces were identifiable.

a. Boundary problems

On previous surveys there is some evidence that the northern and western boundaries of the survey area cut across concentrations of herring. To reduce the possibility of this occurring on the 1990 survey, the northern and western boundaries were extended into deep water and beyond the point at which echotraces attributable to herring concentrations occurred. Concentrations further offshore cannot be ruled out but this is not thought to be a major source of underestimation.

It is known that autumn spawning herring, probably from the North Sea and Division VIa, were present in Faroese waters in July (Jakobsen, 1990). It is understood, however, that a large proportion of these herring had migrated out of the Faroese area by about mid-July (Jakobsen, pers. comm.). It is, therefore thought unlikely that the North Sea survey missed a significant quantity of herring for this reason.

There is also the possibility that North Sea herring were present in Division VIa. This has not been evaluated, but there was no evidence of large concentrations of herring along the 4 degree W boundary.

The more complete coverage in 1990 may have resulted in a fuller estimate of the total North Sea population than in previous years. The extent of this is not known, but can be judged very approximately from the estimated quantity of herring recorded in the additional area surveyed in 1990. This figure is approximately 100.000 tonnes which is a negligible proportion of the total North Sea estimate.

b. Double counting

The possibility that some concentrations of herring may have been counted twice either by the same vessel or by different vessels as a result of migration within the survey period was investigated by examining the dates on which each part of the area were surveyed.

There is little *a priori* information about likely migration routes during July, except the belief that herring are likely to be moving in a general southwesterly direction towards the spawning areas. The herring in the Faroese area are likely to have moved southeast while herring feeding to the east of 0 degrees are likely to have moved southwest.

The main areas of concern are thus the boundary between the Scottish and Norwegian survey areas at 0 degree longitude north of 58 degrees north and the boundary between the Norwegian and Danish survey areas at 57 degrees 30' latitude. The coverage either side of the 0 degree line was less than four days apart between 58 and 59 degrees north. It is thus unlikely that migration resulted in double counting of the important concentration north of 60 degrees N, but this cannot be entirely ruled out. There is a greater potential for double counting of the concentration between 58 and 59 degrees N. At the most these areas could account for an overestimation of about 250 thousand tonnes, but this would imply a major westward movement within a space of 5-10 days.

The concentration found between 55 and 56 degrees N in early August could conceivably have been counted further north during July. However, the southerly concentration consisted predominantly of 2-3 ringers, whereas that north of the boundary was a mixture of roughly equal quantities of 3 and 4 ringers.

In summary, some double counting cannot be entirely ruled out but would imply a remarkable degree of coincidence, at least so far as more northerly concentrations are concerned.

c. Depth distribution

During the 1990 survey it was noted that a high proportion of the echotraces identified as those caused by herring were in the upper 50 m of the water column, particularly in the north of 61 degrees and in the Norwegian Trench.

In these areas, this pattern was observed in 1988 and 1989. In the period 1988-1990 an increasing proportion of the stock has been recorded in these areas. The possibility that target strength of herring may be affected by depth as a result of changes in swim bladder dimensions has been demonstrated (Halldorsson, 1984). If it occurs, then it would be expected to result in underestimation of fish living at greater depths (because the swim-bladder would be more compressed). The extent of a possible change in target strength compared with previous years cannot be quantified from present information.

d. Trace identification

From reports of earlier surveys there is some evidence that the behaviour of herring and other fish species may change from year to year thereby affecting the ease of identification. A large proportion of fish traces were identifiable in 1990 whereas in 1988 there were considerable difficulties in some areas. The effects of these changes have not been evaluated but could result in some imprecision.

Conclusion

The Planning Group is not in a position to quantify the possible bias arising from the factors discussed above, but found no evidence of any major source of bias on the 1990 survey compared previous years.

## 3 ACOUSTIC SURVEY IN 1991

### 3.1 Survey Programme

Five vessels will be available for the 1991 survey as shown in Figure 3.1. As mentioned in Section 2.7, two sources of errors could be related to the boundary of the surveyed area and to the migration of herring during the survey.

In 1990, autumn spawning herring were present in Faroese waters in June. A survey will carried out in this area in June 1991. For the July surveys the same boarder as in 1990 will be used in 1991 ($62^0$ N).

North Sea herring may be present in Division VIa and the survey will be extended westward in 1991 to cover Division VIa.

The Planning Group discussed the allocation of effort to different parts of the area. The highest abundance of mature autumn spawners has been found in the northern and western parts of the area. In the eastern part of Division IVb large quantities of juvenile herring have been found during previous years surveys, whereas the concentration of mature fish is normally very low.

As information on abundance of juveniles is available from other sources, e.g., trawl surveys, the Planning Group decided to allocate the effort by area according to the distribution of the mature part of the population.

In Section 2.7 the possibility of double counting some concentrations of herring in the North Sea because of migration within the survey period is discussed. To minimize this possibility, it was decided to work for as short a survey period as possible, and it was recommended that the North Sea part of the survey should take place in the first three weeks of July. As it is doubtful that it will be possible to get shiptime to survey Division IIIa in the same period, it is recommended that the Skagerrak and the Kattegat are covered in late July and early August.

The recommended areas to be covered by the different vessels are shown in Figure 3.2. The North Sea and Division VIa will be surveyed by RV "Johan Hjort", RV "Tridens" and RV "Scotia", Division IIIa by RV "Dana", and the Faroese waters by "M. Heinason".

### 3.2 Survey Strategy

It is proposed that the surveys should be carried out in the same way as in previous years. Counts of vertebral number will be made in the eastern parts of Divisions IVa,b and Division IIIa to provide a basis for distinguishing North Sea autumn spawners from spring spawners.

## 4 REPORTING OF ACOUSTIC ESTIMATES FOR SPECIES OTHER THAN HERRING

In the Terms of Reference, the Planning Group was asked to evaluate possibilities for exchange and reporting of acoustic estimates for species other than herring.

The Planning Group agreed that it may in principle be possible to report estimates for other species, as has been the practice for Danish and Swedish surveys.

The surveys are however targeted at herring and the results for other species may not be representative of the abundance and age/length composition of that species.

The Planning Group recommends that estimates of abundance, distribution and age/length composition are reported for all species for which the data are considered to be representative.

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Table 2.1.1

| | |
|---|---|
| Echo Sounder | EK400 |
| Frequency | 38kHz |
| Receiver gain | -10dB |
| TVG | 20 logR + 2 R .008dB/m |
| Pulse Length | 1.0 ms |
| Bandwidth | 3.3kHz |
| Range | 150m |
| Transducer | 15 by 30 degrees |
| Equivalent Beam angle | -17.75 (measured) |
| Integrator | Aberdeen |
| Threshold(effective) | 10mv |

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

| | |
|---|---|
| 5/7 | +52.45 dB//$1_{Vrms}$ |
| 13/7 | +52.93 dB//$1_{Vrms}$ |

VR + SL used for the survey = +52.69dB//$1_{Vrms}$

| Haul Number | Date | Time | Position Latitude | Longitude | Herring | Sprat | Whiting | Haddock | Mackerel | B. Whiting | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 217 | 5/7 | 13:30 | 59 12N | 01 24W | 34 | | 11 | | | 1 | 5 Gurnards |
| 218 | 5/7 | 18:35 | 59 12N | 02 06W | 32 | | 369 | 12 | 102 | | 1 Gurnard |
| 219 | 6/7 | 20:55 | 59 34N | 01 39W | | | 392 | | | | |
| 220 | 7/7 | 07:47 | 59 34N | 00 16W | | | | | | | Foul haul |
| 221 | 7/7 | 10:20 | 59 40N | 00 15W | 124 | | 2 | 4 | 1 | 13 | 1 Horse Mackerel |
| 222 | 7/7 | 17:45 | 59 42N | 01 19W | 57 | | | | | | 2 Gurnards |
| 223 | 7/7 | 18:55 | 59 42N | 01 21W | 3,328 | | | | | | repeat of 222 |
| 224 | 8/7 | 10:15 | 60 03N | 01 09W | | | | | | | 'O' Group pout meshed |
| 225 | 8/7 | 17:20 | 60 12N | 00 26W | 7,400 | | | | | | |
| 226 | 9/7 | 05:20 | 60 29N | 00 06W | 1,272 | | | | | | |
| 227 | 9/7 | 10:37 | 60 28N | 00 42W | 7,775 | | | | | | |
| 228 | 9/7 | 17:40 | 60 42N | 00 32W | 12,561 | | | | | | |
| 229 | 10/7 | 08:50 | 61 18N | 01 21W | | | | | | | No catch |
| 230 | 10/7 | 17:10 | 61 37N | 00 07W | 680 | | | | | | |
| 231 | 11/7 | 08:10 | 60 54N | 01 45W | 8,640 | | | | 100 | | |
| 232 | 11/7 | 14:30 | 60 49N | 02 10W | 31 | | | | 23 | | 1 Gurnard |
| 233 | 11/7 | 20:26 | 60 49N | 01 21W | 3,775 | | | | | | |
| 234 | 13/7 | 21:05 | 60 09N | 01 32W | 2,798 | | 60 | | 804 | | 12 Gurnards |
| 235 | 14/7 | 07:05 | 60 40N | 02 03W | 637 | | | | | | |
| 236 | 14/7 | 21:18 | 60 26N | 02 51W | 81 | | 2 | | 6 | | |
| 237 | 15/7 | 11:35 | 60 19N | 02 04W | 213 | | 2 | | 14 | | 7 Gurnards 1 Lumpsucker |
| 238 | 15/7 | 16:25 | 60 10N | 02 21W | 2,200 | | 8 | | 40 | | |
| 239 | 16/7 | 08:55 | 59 56N | 02 17W | 3,092 | | | | 200 | | |
| 240 | 16/7 | 14:15 | 59 56N | 03 34W | 1,883 | | | | 127 | | |
| 241 | 17/7 | 11:40 | 59 41N | 03 57W | 148 | | 1 | | 2 | | 11 Gurnards |
| 242 | 17/7 | 15:25 | 59 33N | 03 41W | 692 | | 125 | | 9 | | |
| 243 | 18/7 | 15:55 | 58 49N | 03 51W | 17,672 | | | | | | |
| 244 | 19/7 | 09:30 | 58 57N | 00 06W | 6,160 | | | | 20 | | |
| 245 | 19/7 | 15:45 | 58 49N | 01 37W | 3,180 | | | | 60 | | |
| 246 | 19/7 | 21:37 | 58 41N | 00 03W | | | | | | | |
| 247 | 20/7 | 05:30 | 58 41N | 00 05W | 7,197 | | | | | | |
| 248 | 20/7 | 11:32 | 58 33N | 01 23W | 6,150 | | | | 125 | | |
| 249 | 20/7 | 18:15 | 58 36N | 02 57W | | | | | | | Sandeels meshed |
| 250 | 21/9 | 07:18 | 58 26N | 00 56W | 3,292 | | | | 8 | | |
| 251 | 21/7 | 11:40 | 58 18N | 00 08W | 769 | | | | | | |
| 252 | 22/7 | 05:25 | 58 02N | 00 08W | 878 | | | | | | |
| 253 | 22/7 | 14:10 | 57 51N | 01 47W | 783 | | | | | | |
| 254 | 22/7 | 17:20 | 57 52N | 01 04W | 949 | | | | 8 | 2 | 1 Gurnard |
| 255 | 23/7 | 05:30 | 57 36N | 00 54W | 1,981 | 160 | | 8 | 16 | 4 | |

Table 2.1.2 Trawl hauls from FRV "Scotia" survey.

| | Area I | | | | Area II | | | | Area III | | | | Area IV | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 253 | 254 | 255 | mean | 243 | 245 | 248 | mean | 223 | 234 | 250 | mean | 221 | 225 | 226 | 227 | 228 | 230 | 231 | 233 | 235 | 237 | 238 | 239 | 240 | 241 | 242 | 244 | 247 | 251 | 252 | mean |
| 15.5 | | | 0.7 | 0.2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16.0 | 1.4 | | 0.7 | 0.7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16.5 | 6.9 | 0.3 | 0.4 | 2.5 | 0.2 | | | 0.1 | | | | | | | | | | | | | | | | | | | | | | | | |
| 17.0 | 12.9 | 0.9 | 0.7 | 4.9 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17.5 | 12.9 | 1.8 | 0.4 | 5.0 | 1.1 | | | 0.4 | | | | | | | | | | | | | | | | | | | | | | | | |
| 18.0 | 17.5 | 4.2 | 3.8 | 8.5 | 2.6 | | | 0.9 | | | | | | | | | | | | | | | | | | | | | | | | |
| 18.5 | 17.5 | 7.2 | 8.2 | 11.0 | 5.0 | | | 1.7 | | | | | | | | | | | | | | | | | | 0.7 | | | | | | 0.0 |
| 19.0 | 15.2 | 17.7 | 13.7 | 15.5 | 8.0 | | | 2.7 | | | | | | | | | | | | | | | | | | | | | | | | |
| 19.5 | 7.8 | 17.7 | 19.6 | 15.0 | 9.1 | | | 3.0 | | | | | | | | | | | | | | | | | | 0.7 | | | | | | 0.0 |
| 20.0 | 2.8 | 22.9 | 22.0 | 15.9 | 6.1 | | 0.4 | 2.2 | | | | | | | | | | | | | | | | | | | | | | | | |
| 20.5 | 3.7 | 14.1 | 15.1 | 11.0 | 7.1 | | 0.4 | 2.5 | | | | | | | | | | | | | | | | | | | | | | | | |
| 21.0 | 1.0 | 5.4 | 8.2 | 4.9 | 6.3 | | 0.4 | 2.2 | | | | | | | | | | | | | | | | | | | | | | | | |
| 21.5 | 0.1 | 3.1 | 2.7 | 2.0 | 2.0 | | 0.4 | 0.8 | | | | | | | | | | | | | | | | | | | | | | | | |
| 22.0 | 0.1 | 1.2 | 0.8 | 0.7 | 0.9 | | 0.4 | 0.4 | | | | | | | | | | | | | | | | | | | 0.4 | | | | | 0.0 |
| 22.5 | | 0.4 | 0.2 | 0.2 | 2.2 | | 1.6 | 1.3 | | | 0.2 | 0.1 | | | | | | | | | | | | 0.4 | | | | | | | | 0.0 |
| 23.0 | | 0.4 | 0.8 | 0.4 | 3.7 | 3.8 | 4.9 | 4.1 | | | 0.5 | 0.2 | | | | | | | | | | | | 0.8 | | | 1.7 | | | | 0.5 | 0.2 |
| 23.5 | | 0.4 | 0.6 | 0.3 | 4.3 | 8.7 | 6.5 | 6.5 | 0.4 | | 1.0 | 0.5 | | | | | | | | | | | | 0.8 | | | 2.6 | | | | 1.3 | 0.2 |
| 24.0 | 0.1 | 1.5 | 0.6 | 0.7 | 6.7 | 15.8 | 14.2 | 12.3 | 1.1 | 0.8 | 4.6 | 2.1 | | | | | | | | | | | | 1.2 | | | 2.2 | | | 1.0 | 1.3 | 0.3 |
| 24.5 | | 0.2 | | 0.1 | 6.3 | 23.8 | 16.3 | 15.4 | 5.0 | 3.8 | 8.7 | 5.8 | | 0.3 | | | | | | | | 0.5 | 0.9 | 1.2 | 0.5 | 1.3 | 4.3 | | 0.3 | 2.3 | 1.3 | 0.7 |
| 25.0 | | 0.2 | 0.4 | 0.2 | 7.1 | 25.3 | 21.5 | 18.0 | 16.0 | 14.6 | 17.2 | 15.9 | 0.8 | 3.4 | 2.6 | 0.3 | 1.5 | | | 0.4 | 0.8 | 1.4 | 1.3 | 1.9 | 0.5 | | 3.5 | 2.3 | 1.0 | 3.6 | 2.5 | 1.5 |
| 25.5 | | | 0.4 | 0.1 | 5.6 | 13.2 | 16.7 | 11.8 | 27.3 | 16.1 | 14.2 | 19.2 | 4.8 | 6.3 | 9.0 | 0.6 | 3.0 | | 0.8 | 1.6 | 2.2 | 3.3 | 3.5 | 4.6 | | 2.0 | 3.9 | 2.6 | 1.9 | 4.9 | 5.4 | 3.2 |
| 26.0 | | | | | 4.3 | 4.9 | 11.0 | 6.7 | 20.9 | 21.8 | 21.4 | 21.4 | 10.5 | 19.4 | 11.2 | 7.7 | 6.4 | | 2.6 | 6.8 | 6.0 | 3.8 | 3.1 | 7.3 | | 4.0 | 6.2 | 7.5 | 13.5 | 11.4 | 9.9 | 7.2 |
| 26.5 | | 0.2 | | 0.1 | 2.6 | 2.3 | 3.3 | 2.7 | 16.7 | 19.2 | 14.2 | 16.7 | 17.7 | 18.4 | 22.0 | 13.8 | 11.7 | 2.2 | 4.5 | 11.5 | 13.8 | 9.4 | 4.0 | 10.4 | 2.5 | 1.3 | 7.5 | 8.1 | 20.0 | 10.7 | 7.9 | 10.4 |
| 27.0 | | 0.2 | | 0.1 | 3.7 | 0.8 | 0.4 | 1.6 | 6.4 | 14.6 | 7.4 | 9.5 | 20.2 | 18.8 | 17.9 | 18.3 | 13.3 | 3.4 | 11.0 | 13.1 | 20.4 | 14.6 | 9.3 | 19.3 | 6.5 | 8.7 | 6.6 | 10.1 | 21.6 | 10.4 | 12.4 | 13.5 |
| 27.5 | | | | | 2.8 | 0.8 | 0.4 | 1.3 | 3.5 | 3.5 | 4.9 | 4.0 | 15.3 | 14.4 | 10.5 | 14.1 | 16.7 | 3.7 | 14.1 | 13.1 | 25.0 | 10.8 | 7.5 | 12.7 | 6.5 | 19.3 | 8.8 | 9.4 | 15.2 | 6.2 | 11.2 | 12.3 |
| 28.0 | | | | | 1.5 | 0.8 | | 0.7 | 1.4 | 2.3 | 1.8 | 1.8 | 12.9 | 7.2 | 7.1 | 12.2 | 15.5 | 10.6 | 14.4 | 10.3 | 15.2 | 9.4 | 11.5 | 15.0 | 10.9 | 10.7 | 11.4 | 11.7 | 10.6 | 6.5 | 14.0 | 11.4 |
| 28.5 | | | | | 0.2 | | 0.8 | 0.3 | 0.7 | 1.5 | 1.3 | 1.2 | 6.5 | 3.1 | 7.9 | 9.6 | 9.1 | 14.3 | 10.5 | 11.5 | 7.4 | 13.6 | 8.9 | 7.0 | 15.4 | 13.3 | 7.1 | 8.8 | 5.5 | 8.5 | 9.9 | 9.4 |
| 29.0 | | | | | 0.6 | | 0.4 | 0.3 | 0.7 | 0.8 | 1.5 | 1.0 | 4.0 | 2.5 | 4.5 | 6.4 | 5.7 | 9.3 | 9.2 | 6.4 | 6.0 | 6.1 | 10.2 | 7.0 | 18.4 | 12.0 | 10.1 | 11.4 | 2.6 | 6.8 | 5.4 | 7.6 |
| 29.5 | | | | | 0.2 | | | 0.1 | | 1.1 | 0.5 | 0.6 | 1.6 | 2.5 | 3.0 | 6.1 | 7.2 | 12.1 | 9.9 | 5.2 | 1.1 | 6.6 | 8.9 | 3.5 | 9.0 | 7.3 | 8.8 | 8.1 | 3.2 | 7.8 | 4.9 | 6.1 |
| 30.0 | | | | | | | | | | | 0.2 | 0.1 | 1.6 | 1.6 | 1.1 | 1.9 | 4.5 | 10.1 | 4.2 | 5.6 | 0.8 | 6.6 | 6.2 | 3.1 | 9.9 | 5.3 | 4.3 | 8.1 | 1.9 | 5.2 | 5.4 | 4.6 |
| 30.5 | | | | | | | | | | | 0.2 | 0.1 | 3.2 | 0.6 | 1.1 | 3.2 | 1.5 | 8.7 | 6.0 | 3.6 | 0.8 | 2.3 | 5.8 | 1.6 | 6.5 | 2.7 | 3.9 | 4.2 | 0.3 | 4.6 | 2.5 | 3.3 |
| 31.0 | | | | | | | | | | | | | | 0.6 | 1.5 | 2.6 | 0.8 | 8.4 | 5.8 | 2.8 | 0.3 | 4.2 | 8.9 | 1.2 | 4.0 | 2.7 | 3.0 | 4.2 | 0.6 | 4.6 | 2.5 | 3.1 |
| 31.5 | | | | | | | | | | | | | | 0.9 | 0.4 | 1.3 | 1.5 | 5.9 | 2.1 | 3.2 | | 4.7 | 3.1 | 0.4 | 3.5 | 3.3 | 0.9 | 2.6 | 0.6 | 2.0 | 1.3 | 2.0 |
| 32.0 | | | | | | | | | | | | | | | 0.4 | 0.6 | 0.8 | 6.8 | 2.6 | 1.2 | 0.3 | 1.4 | 2.7 | 0.8 | 3.5 | 3.3 | 0.9 | 0.6 | 0.6 | 2.6 | 0.8 | 1.6 |
| 32.5 | | | | | | | | | | | | | 0.8 | | | 1.0 | 0.4 | 2.2 | 1.0 | 1.2 | | 0.5 | 1.8 | | 2.0 | 1.3 | 0.4 | 0.3 | | 0.7 | | 0.7 |
| 33.0 | | | | | | | | | | | | | | | | | 0.4 | 2.2 | 1.0 | 2.4 | | 0.5 | 1.8 | | 0.5 | | 0.9 | | 0.3 | 0.3 | | 0.5 |
| 33.5 | | | | | | | | | | | | | | | | | | | 0.3 | 0.4 | | | | | | | 0.4 | | | | | 0.1 |
| 34.0 | | | | | | | | | | | | | | | | | | 0.3 | | | | | 0.5 | | | | | | | | | 0.0 |
| 34.5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 35.0 | | | | | | | | | | | | | | | | | | | | | | 0.5 | | | | | | | | | | 0.0 |
| Number | 783 | 949 | 1981 | | 17672 | 3180 | 6150 | | 3328 | 2798 | 3292 | | 124 | 7400 | 1272 | 7775 | 12561 | 680 | 8640 | 3775 | 637 | 213 | 2200 | 3092 | 1883 | 150 | 692 | 6160 | 7197 | 769 | 878 | |
| Mean length | 18.7 | 20.3 | 20.3 | 19.8 | 23.0 | 25.2 | 25.3 | 24.5 | 26.4 | 26.6 | 26.4 | 26.5 | 27.8 | 27.5 | 27.7 | 28.4 | 28.3 | 30.1 | 29.2 | 28.8 | 27.9 | 28.8 | 29.3 | 27.9 | 29.6 | 28.9 | 28.2 | 28.8 | 27.8 | 28.4 | 28.1 | 28.5 |
| Mean weight | 48 | 64 | 64 | 59 | 106 | 139 | 140 | 128 | 162 | 169 | 163 | 165 | 199 | 189 | 194 | 213 | 212 | 265 | 236 | 226 | 200 | 226 | 242 | 201 | 248 | 228 | 211 | 224 | 197 | 217 | 207 | 218 |
| TS/individual | -45.7 | -45.0 | -45.0 | -45.3 | -43.9 | -43.2 | -43.1 | -43.4 | -42.8 | -42.7 | -42.8 | -42.7 | -42.3 | -42.4 | -42.4 | -42.1 | -42.1 | -41.6 | -41.9 | -42.0 | -42.3 | -42.0 | -41.8 | -42.3 | -41.8 | -42.0 | -42.2 | -42.0 | -42.3 | -42.1 | -42.2 | -42.1 |
| TS/kilogramme | -32.5 | -33.1 | -33.1 | -32.9 | -34.2 | -34.6 | -34.6 | -34.5 | -34.9 | -35.0 | -34.9 | -34.9 | -35.3 | -35.2 | -35.2 | -35.4 | -35.4 | -35.8 | -35.6 | -35.5 | -35.3 | -35.5 | -35.7 | -35.3 | -35.7 | -35.6 | -35.4 | -35.5 | -35.3 | -35.5 | -35.4 | -35.5 |

Table 2.1.3 Percentage length keys for trawl hauls with greater than 100 herring, and mean length keys for each sub-area. Showing the total number of fish, the mean length, the mean weight, and calculated mean target strengths per individual and per unit weight at the base of the table.

| | Age (ring) | Number | Mean Length | Mean Weight | Biomass |
|---|---|---|---|---|---|
| AREA I | 1A | 745.60 | 19.16 | 57.15 | 42.61 |
| | 2I | 8.93 | 22.78 | 104.06 | 0.93 |
| | 2M | 8.18 | 24.04 | 125.36 | 1.03 |
| | 3I | 0.78 | 25.00 | 143.29 | 0.11 |
| | 3M | 0.00 | | | 0.00 |
| | 4A | 0.54 | 26.50 | 176.08 | 0.09 |
| | 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 | 764.03 | 19.25 | 58.56 | 44.74 |

| | Age (ring) | Number | Mean Length | Mean Weight | Biomass |
|---|---|---|---|---|---|
| AREA II | 1A | 66.60 | 19.72 | 62.91 | 4.19 |
| | 2I | 40.38 | 23.66 | 118.60 | 4.79 |
| | 2M | 227.78 | 24.68 | 137.53 | 31.33 |
| | 3I | 7.39 | 25.00 | 143.55 | 1.06 |
| | 3M | 48.36 | 25.89 | 163.26 | 7.89 |
| | 4A | 13.96 | 26.53 | 178.66 | 2.49 |
| | 5A | 1.60 | 27.03 | 190.75 | 0.31 |
| | 6A | 0.33 | 29.00 | 242.30 | 0.08 |
| | 7A | 0.00 | | | 0.00 |
| | 8A | 0.00 | | | 0.00 |
| | 9+ | 0.00 | | | 0.00 |
| | Total | 406.40 | 23.99 | 128.30 | 52.14 |

| | Age (ring) | Number | Mean Length | Mean Weight | Biomass |
|---|---|---|---|---|---|
| AREA III | 1A | 0.00 | | | 0.00 |
| | 2I | 5.09 | 23.87 | 122.07 | 0.62 |
| | 2M | 136.91 | 25.42 | 152.47 | 20.87 |
| | 3I | 0.66 | 24.00 | 124.05 | 0.08 |
| | 3M | 138.61 | 26.10 | 167.78 | 23.26 |
| | 4A | 70.11 | 26.69 | 181.53 | 12.73 |
| | 5A | 15.29 | 26.69 | 181.32 | 2.77 |
| | 6A | 0.41 | 29.50 | 257.44 | 0.10 |
| | 7A | 0.41 | 29.50 | 257.44 | 0.10 |
| | 8A | 0.00 | | | 0.00 |
| | 9+ | 0.00 | | | 0.00 |
| | Total | 367.48 | 25.95 | 164.75 | 60.54 |

| | Age (ring) | Number | Mean Length | Mean Weight | Biomass |
|---|---|---|---|---|---|
| AREA IV | 1A | 2.07 | 19.00 | 54.65 | 0.11 |
| | 2I | 25.32 | 24.33 | 131.36 | 3.33 |
| | 2M | 248.54 | 25.91 | 163.37 | 40.60 |
| | 3I | 73.30 | 27.47 | 201.69 | 14.78 |
| | 3M | 1069.69 | 27.35 | 198.17 | 211.98 |
| | 4A | 948.86 | 28.22 | 221.98 | 210.63 |
| | 5A | 379.09 | 29.31 | 255.00 | 96.67 |
| | 6A | 109.19 | 30.75 | 299.92 | 32.75 |
| | 7A | 69.33 | 31.39 | 323.15 | 22.41 |
| | 8A | 19.13 | 31.95 | 342.81 | 6.56 |
| | 9+ | 9.57 | 31.96 | 343.45 | 3.29 |
| | Total | 2954.10 | 28.00 | 217.70 | 643.10 |

| | Age (ring) | Number | Mean Length | Mean Weight | Biomass |
|---|---|---|---|---|---|
| TOTALS | 1A | 814.28 | 19.21 | 57.61 | 46.91 |
| | 2I | 79.73 | 23.79 | 121.25 | 9.67 |
| | 2M | 621.41 | 25.32 | 151.00 | 93.83 |
| | 3I | 82.12 | 27.20 | 195.28 | 16.04 |
| | 3M | 1256.66 | 27.16 | 193.47 | 243.13 |
| | 4A | 1033.48 | 28.09 | 218.63 | 225.94 |
| | 5A | 395.99 | 29.20 | 251.89 | 99.75 |
| | 6A | 109.92 | 30.74 | 299.59 | 32.93 |
| | 7A | 69.74 | 31.38 | 322.76 | 22.51 |
| | 8A | 19.13 | 31.95 | 342.81 | 6.56 |
| | 9+ | 9.57 | 31.96 | 343.45 | 3.29 |
| | Total | 4492.01 | 25.98 | 178.21 | 800.52 |

Table 2.1.4 Numbers ($10^{-6}$), mean length (cm), mean weight (g) and biomass (tonnes $10^{-3}$) by sub-area and for the total area by age and maturity state. All fish 4 ring and older were taken to be mature, 2 and 3 ring fish with a maturity state of 3 or greater were taken as mature and all 1 ring fish were taken as immature.

Table 2.2.1 Trawl catches R/V "Eldjarn", 3-20 July 1990. Station numbers refer to Figure 2.2.1.
b means bottom trawl. * means pure 0-group. Species dominating "others" are indicated by the abbrevations: Lum = Lumpsucker, Hor = Horse mackerel, Sei = Seith, Mau = Maurolicus, Dab = Long rough dab, Cod = Cod, Pou = Norway pout, Gob = Goby, Dog = Spiny dogfish.

| | | | | | | CATCH (Kg) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| St. no. | Position N | Position E | Date | Hour GMT | Depth m | Herring | Mackerel | Haddock | Whiting | Others | |
| 340 | 60°45′ | 4°02′ | 3 | 17 | 5 | 7.4 | 3.9 | 0.2* | 0.1* | 1.7 | Lum |
| 341 | 61°06′ | 3°15′ | 4 | 01 | 5 | 128.0 | 38.0 | - | - | 0.3 | Hor |
| 342 | 61°23′ | 2°19′ | 4 | 07 | 5 | 0.5 | 4.5 | 0.3* | 0.1* | 1.6 | Lum |
| 343 | 61°33′ | 3°46′ | 4 | 13 | 5 | 71.0 | 22.0 | 0.4* | 0.2* | 0.8 | Lum |
| 344 | 61°50′ | 4°10′ | 4 | 21 | 5 | 15.5 | 24.5 | 0.1* | 0.1* | 5.2 | Lum |
| 345 | 60°45′ | 1°36′ | 5 | 14 | 30 | - | - | + * | 0.1* | - | |
| 346 | 60°43′ | 0°20′ | 5 | 19 | 112 | 136.0 | - | - | - | - | |
| 347 | 61°07′ | 0°16′ | 6 | 03 | 130 | 465.0 | - | - | - | 3.2 | Sei |
| 348 | 61°39′ | 0°17′ | 6 | 09 | 25 | 124.0 | 13.2 | - | - | - | |
| 349 | 61°53′ | 2°04′ | 6 | 20 | 5 | 30.0 | 525.6 | - | - | 5.0 | Lum |
| 350 | 62°07′ | 2°38′ | 7 | 00 | 5 | 1.1 | - | + * | 0.2* | 6.0 | Lum |
| 351 | 61°36′ | 1°11′ | 7 | 10 | 150 | - | - | + * | - | 20.4 | Mau |
| 352 | 61°23′ | 1°06′ | 7 | 15 | 5 | 87.0 | 0.1 | - | - | - | |
| 353 | 60°34′ | 3°22′ | 8 | 12 | 5 | 121.0 | 6.3 | + * | + * | 1.4 | Lum |
| 354 | 60°34′ | 4°01′ | 8 | 15 | 5 | 69.7 | 20.7 | 0.1* | 0.1* | 1.7 | Lum |
| 355 | 60°10′ | 4°14′ | 8 | 21 | 5 | 372.0 | 6.5 | + * | + * | 1.5 | Lum |
| 356 | 60°22′ | 3°44′ | 9 | 02 | 5 | 384.0 | 116.0 | - | - | 1.5 | Lum |
| 357 | 60°07′ | 1°46′ | 9 | 13 | 5 | - | 0.5 | + * | 1.0* | - | |
| 358 | 60°13′ | 1°14′ | 9 | 17 | 118 | 990.0 | - | - | 0.6 | 13.2 | Sei |
| 359 | 59°55′ | 0°13′ | 10 | 02 | 5 | 6.5 | 0.8 | - | 2.0* | - | |
| 360b | 59°48′ | 0°45′ | 10 | 06 | 125 | 8.5 | - | 0.7 | 0.2 | 3.5 | Dab |
| 361b | 59°50′ | 0°44′ | 10 | 07 | 120 | 74.5 | 0.3 | 1.0 | 0.4 | 30.1 | Cod |
| 362 | 59°06′ | 0°45′ | 10 | 15 | 5 | 6.4 | - | + * | 0.2* | - | |
| 363 | 58°52′ | 0°25′ | 10 | 20 | 128 | 360.0 | - | - | - | - | |
| 364 | 58°19′ | 0°18′ | 11 | 02 | 20 | 80.0 | 1.6 | 1.0* | 1.0* | 0.6 | Lum |
| 365 | 57°51′ | 0°53′ | 13 | 02 | 100 | - | - | - | 3.2 | + | Pou |
| 366 | 58°04′ | 0°41′ | 13 | 05 | 130 | 210.0 | - | - | 0.2 | 3.4 | Sei |
| 367b | 59°16′ | 0°12′ | 13 | 17 | 100 | 1.3 | - | 83.0 | 10.5 | 51.6 | Cod |
| 368 | 59°46′ | 1°45′ | 13 | 23 | 30 | - | 0.2 | 0.5* | 10.4 | 2.0 | Lum |
| 369 | 59°25′ | 1°45′ | 14 | 02 | 100 | 305.0 | 0.4 | - | 2.4 | 3.5 | Sei |
| 370 | 57°38′ | 1°45′ | 14 | 13 | 67 | - | - | - | - | 1.0 | Pou |
| 371 | 57°37′ | 3°45′ | 14 | 20 | 62 | - | - | + * | 0.4 | + | Gob |
| 372 | 57°37′ | 3°53′ | 14 | 22 | 24 | - | - | 0.1* | 8.6 | 9.1 | Pou |
| 373 | 57°37′ | 5°06′ | 15 | 02 | 5 | 14.5 | 25.0 | - | - | 0.6 | Lum |
| 374 | 57°36′ | 6°02′ | 15 | 06 | 120 | 32.3 | - | 1.4 | + * | 8.0 | Lum |
| 375 | 57°53′ | 7°32′ | 15 | 14 | 100 | 30.0 | - | 0.7 | - | - | |
| 376 | 57°54′ | 6°10′ | 15 | 19 | 5 | 39.7 | 1.9 | - | 0.2* | 9.1 | Lum |
| 377 | 57°53′ | 4°27′ | 16 | 02 | 5 | 61.0 | 72.0 | 0.1 | 1.0* | - | |
| 378 | 57°53′ | 4°23′ | 16 | 03 | 77 | 96.0 | - | - | - | - | |
| 379 | 58°08′ | 2°23′ | 16 | 11 | 5 | - | 76.0 | - | - | - | |
| 380 | 58°06′ | 4°02′ | 16 | 17 | 81 | - | - | - | 2.8* | 0.4 | Sei |
| 381 | 58°23′ | 5°27′ | 17 | 02 | 5 | 28.0 | 20.0 | - | 0.1* | 0.2 | Sei |
| 382 | 58°23′ | 2°28′ | 17 | 12 | 5 | - | 46.5 | - | - | - | |
| 383 | 58°38′ | 2°55′ | 17 | 17 | 90 | - | - | - | 0.2* | 3.4 | Lum |
| 384 | 58°38′ | 2°51′ | 17 | 18 | 81 | 105.0 | - | + * | + * | 1.9 | Lum |
| 385 | 58°37′ | 3°10′ | 17 | 20 | 5 | 1.1 | 9.4 | - | 0.6* | 4.4 | Hor |
| 386 | 58°52′ | 4°08′ | 18 | 09 | 5 | 173.2 | 9.0 | - | 0.1* | 1.3 | Lum |
| 387 | 58°53′ | 3°04′ | 18 | 13 | 5 | 0.5 | 0.9 | - | + * | - | |
| 388 | 59°16′ | 2°17′ | 18 | 19 | 60 | - | - | - | 0.4 | 8.9 | Lum |
| 389b | 59°21′ | 2°18′ | 18 | 20 | 124 | 7.8 | - | 0.2 | 0.2 | 23.2 | Sei |
| 390 | 59°30′ | 2°16′ | 18 | 23 | 5 | 0.7 | 6.0 | - | 5.0* | 0.3 | Lum |
| 391 | 59°53′ | 2°31′ | 19 | 03 | 50 | - | - | - | 0.5* | 2.1 | Lum |
| 392 | 60°22′ | 3°38′ | 19 | 18 | 25 | 2.2 | - | 0.1* | 0.3* | - | |
| 393 | 59°39′ | 3°46′ | 19 | 23 | 5 | 22.5 | 3.9 | + * | 0.1* | 61.5 | Lum |
| 394 | 59°20′ | 4°46′ | 20 | 06 | 27 | 22.3 | - | - | + * | 0.2 | Dog |
| 395 | 59°37′ | 4°25′ | 20 | 11 | 5 | 170.0 | 0.5 | - | 0.1* | 0.1 | Dog |
| 396 | 59°53′ | 4°41′ | 20 | 15 | 5 | 0.8 | 41.0 | - | 0.1* | 2.5 | Hor |
| 397 | 60°08′ | 4°15′ | 20 | 19 | 5 | 42.3 | 5.0 | 0.1* | 0.2* | 7.1 | Lum |

Table 2.2.2 Settings and technical data of acoustic equipment, R/V "Eldjarn", July 1990.

| | |
|---|---|
| Echo sounder | EK 400 |
| Frequency | 38 kHz |
| Receiver gain | -20 dB |
| Time varied gain | $20 \cdot \log R + 2 \cdot 0.008 \cdot R$ |
| Pulse length | 1.0 millisecond |
| Bandwidth | 3.3 kHz |
| Range | 150 m |
| Transducer | $8^0 x 8^0$ (half value angles) |
| Equivalent beam angle | -19.6 dB // 1 steradian |
| Integrator | Inst. of Marine Research, Bergen (NORD computer) |
| Threshold | 14 millivolts (peak) |
| Calibration 3 July 1990 : | |
| SL+VR (incl. TVG) | 139.25 dB ref 0 dB receiver gain |
| Instrument constant | 1.88 (as defined by Foote et al. (1987)) |

Table 2.2.3 Estimated number of mackerel (N, millions) by sub-area, R/V "Eldjarn", July 1990. B = Biomass ('000 Tonnes).

| SUB -AREA | AGE (winter rings) | | | | | | | | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9+ | N | B |
| 1 | - | 282 | 423 | 47 | 16 | 6 | 6 | - | 6 | 784 | 217.2 |
| 2 | - | - | - | - | - | - | - | - | - | 0 | 0 |
| 3 | - | + | 1 | + | + | + | + | - | + | 1 | 0.3 |
| 4 | - | + | 1 | + | + | + | + | - | + | 1 | 0.3 |
| IVa W | - | 283 | 424 | 47 | 16 | 6 | 6 | - | 6 | 786 | 217.8 |
| 5 | - | 258 | 350 | 26 | 3 | - | 3 | - | 13 | 654 | 189.9 |
| 6 | 1 | 34 | 22 | 2 | 2 | - | - | - | 1 | 61 | 17.3 |
| 7 | 1 | 26 | 21 | 4 | 3 | 3 | - | + | + | 61 | 18.9 |
| 8 | 1 | 8 | 10 | 3 | 2 | 3 | + | 1 | 2 | 29 | 9.7 |
| 9 | - | 7 | 6 | + | 1 | + | - | - | + | 15 | 4.2 |
| 10 | 3 | 21 | 7 | 1 | 1 | 1 | 1 | 1 | 2 | 35 | 9.9 |
| 11 | 125 | 10 | 1 | - | - | - | - | - | - | 136 | 18.4 |
| 12 | - | 6 | 11 | 7 | 1 | + | + | + | + | 25 | 6.2 |
| IVa E | 131 | 370 | 428 | 43 | 11 | 6 | 4 | 1 | 18 | 1016 | 274.5 |
| TOTAL | 131 | 653 | 852 | 90 | 27 | 12 | 10 | 1 | 24 | 1802 | 492.3 |

Table 2.2.4 Estimated number (N, millions) of herring by age and sub-area, R/V "Eldjarn" 3-20 July 1990. B = Biomass ('000 Tonnes).

AUTUMN SPAWNERS, IVa West (between $0^{0}$ and $2^{0}$ East)

| winter rings | sub-area 1 | 2 | 3 | 4 | TOTAL |
|---|---|---|---|---|---|
| 1 | - | - | - | 38.7 | 38.7 |
| 2 imm | - | - | - | 74.0 | 74.0 |
| 2 mat | 43.1 | 10.1 | 53.1 | 296.0 | 402.3 |
| 3 imm | 4.6 | - | - | - | 4.6 |
| 3 mat | 507.7 | 159.8 | 154.8 | 458.8 | 1281.1 |
| 4 | 590.0 | 207.4 | 193.6 | 437.4 | 1428.4 |
| 5 | 355.4 | 62.4 | 48.5 | 110.4 | 576.7 |
| 6 | 100.1 | 30.2 | 7.4 | 18.6 | 156.3 |
| 7 | 62.1 | 10.1 | 2.3 | - | 74.5 |
| 8 | 48.3 | - | 2.3 | - | 50.6 |
| 9+ | 13.8 | - | - | - | 13.8 |
| Tot N | 1725.0 | 480.0 | 462.0 | 1434.0 | 4101.0 |
| Tot B | 379.1 | 99.5 | 87.0 | 244.2 | 809.8 |
| Mat N | 1720.4 | 480.0 | 462.0 | 1321.3 | 3983.7 |
| Mat B | 378.4 | 99.5 | 87.0 | 232.4 | 797.4 |

AUTUMN SPAWNERS, IVa East

| winter rings | sub-area 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.9 | - | 17.1 | 264.0 | 0.3 | 17.1 | 84.6 | 254.7 | 639.7 |
| 2 imm | 6.0 | - | 3.3 | 43.5 | 0.6 | 9.1 | 33.2 | 45.5 | 141.2 |
| 2 mat | 24.2 | 78.4 | 78.4 | 228.4 | 0.6 | 18.4 | 30.6 | 32.9 | 491.9 |
| 3 imm | - | - | - | 4.1 | 1.0 | 2.6 | 4.7 | 4.1 | 16.5 |
| 3 mat | 151.7 | 165.5 | 119.9 | 54.6 | 3.0 | 5.8 | 21.6 | 17.7 | 539.8 |
| 4 | 326.4 | 223.6 | 182.8 | 42.6 | 3.9 | 13.8 | 14.5 | - | 807.6 |
| 5 | 220.6 | 87.1 | 27.4 | 15.7 | 1.3 | 3.9 | 2.9 | - | 358.9 |
| 6 | 99.7 | 11.7 | 6.9 | 6.7 | 0.5 | 1.2 | 1.6 | - | 128.3 |
| 7 | 52.8 | 8.7 | 4.4 | - | 0.3 | 0.2 | - | - | 66.4 |
| 8 | 53.3 | 2.9 | - | - | 0.2 | 0.2 | 0.2 | - | 56.8 |
| 9+ | 16.4 | 2.9 | - | - | 0.1 | 0.2 | 0.2 | - | 19.8 |
| Tot N | 953.0 | 580.8 | 440.2 | 659.6 | 11.8 | 72.5 | 194.1 | 355.0 | 3266.9 |
| Tot B | 208.8 | 114.5 | 81.3 | 86.2 | 2.2 | 9.9 | 22.4 | 31.3 | 556.5 |
| Mat N | 945.1 | 580.8 | 419.8 | 348.0 | 9.9 | 43.7 | 71.6 | 50.7 | 2469.5 |
| Mat B | 208.1 | 114.5 | 79.1 | 55.6 | 2.0 | 6.9 | 10.1 | 6.5 | 482.9 |

SPRING SPAWNERS, IVa East

| winter rings | sub-area 6 | 7 | 8 | 9 | 10 | 11 | 12 | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 2 | 5.0 | 42.1 | 76.7 | 0.8 | 6.4 | 9.5 | 92.1 | 232.6 |
| 3 | 10.6 | 61.7 | 52.1 | 1.1 | 10.7 | 27.4 | 56.2 | 219.8 |
| 4 | 14.3 | 94.2 | 37.8 | 3.2 | 9.6 | 37.2 | 49.4 | 245.7 |
| 5 | 5.6 | 14.1 | 13.9 | 1.0 | 2.7 | 7.5 | 3.9 | 48.7 |
| 6 | 0.7 | 3.6 | 6.0 | 0.4 | 0.9 | 4.0 | 2.8 | 18.4 |
| 7 | 0.6 | 2.2 | - | 0.3 | 0.1 | - | 1.7 | 4.9 |
| 8 | 0.2 | - | - | 0.2 | 0.1 | 0.6 | - | 1.1 |
| 9+ | 0.2 | - | - | 0.1 | 0.1 | 0.6 | - | 1.0 |
| Tot N | 37.2 | 217.9 | 186.5 | 7.1 | 30.6 | 86.8 | 206.1 | 772.2 |
| Tot B | 5.6 | 31.9 | 23.1 | 1.1 | 3.4 | 9.6 | 18.5 | 93.2 |

Table 2.2.5 Estimated mean weights (g) of herring by age and sub-area, R/V "Eldjarn" 3-20 July 1990.

AUTUMN SPAWNERS, IVa West (between $0^0$ and $2^0$ East)

| winter rings | sub-area 1 | 2 | 3 | 4 | TOTAL |
|---|---|---|---|---|---|
| 1 | - | - | - | 90.5 | 90.5 |
| 2 imm | - | - | - | 111.8 | 111.8 |
| 2 mat | 170.8 | 173.7 | 157.7 | 146.4 | 151.2 |
| 3 imm | 148.0 | - | - | - | 148.0 |
| 3 mat | 204.9 | 182.2 | 177.0 | 165.5 | 184.6 |
| 4 | 219.0 | 205.1 | 192.1 | 189.4 | 204.3 |
| 5 | 224.6 | 238.2 | 226.5 | 234.8 | 228.2 |
| 6 | 237.1 | 268.3 | 238.3 | 235.0 | 242.9 |
| 7 | 268.9 | 311.2 | 290.0 | - | 275.3 |
| 8 | 275.3 | - | 280.0 | - | 275.5 |
| 9+ | 310.7 | - | - | - | 310.9 |

AUTUMN SPAWNERS, IVa East

| winter rings | sub-area 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 81.8 | - | 104.0 | 95.2 | 102.1 | 96.1 | 96.5 | 78.7 | 89.0 |
| 2 imm | 92.1 | - | 115.0 | 111.5 | 119.1 | 109.9 | 106.1 | 95.3 | 104.2 |
| 2 mat | 155.1 | 156.2 | 161.7 | 145.0 | 154.9 | 142.9 | 138.0 | 123.9 | 148.0 |
| 3 imm | - | - | - | 136.5 | 142.2 | 136.2 | 102.6 | 103.3 | 118.2 |
| 3 mat | 198.9 | 187.4 | 185.5 | 177.5 | 184.9 | 177.1 | 133.3 | 134.3 | 185.2 |
| 4 | 207.7 | 207.6 | 195.5 | 195.8 | 199.7 | 154.3 | 148.8 | - | 202.3 |
| 5 | 224.2 | 213.0 | 214.6 | 194.1 | 212.0 | 193.2 | 182.1 | - | 218.7 |
| 6 | 244.7 | 223.3 | 193.9 | 214.2 | 227.6 | 201.3 | 184.7 | - | 237.3 |
| 7 | 244.2 | 259.3 | 278.9 | - | 228.8 | 224.2 | - | - | 248.3 |
| 8 | 271.1 | 191.7 | - | - | 261.1 | 203.2 | 220.7 | - | 266.6 |
| 9+ | 316.7 | 281.9 | - | - | 405.1 | 290.0 | 290.0 | - | 311.6 |

SPRING SPAWNERS, IVa East

| winter rings | sub-area 6 | 7 | 8 | 9 | 10 | 11 | 12 | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 2 | 113.6 | 122.4 | 99.9 | 107.0 | 86.3 | 87.8 | 75.7 | 93.8 |
| 3 | 145.2 | 149.4 | 128.2 | 100.4 | 102.0 | 95.8 | 88.3 | 119.3 |
| 4 | 159.7 | 150.4 | 150.7 | 153.7 | 118.7 | 114.5 | 106.6 | 135.6 |
| 5 | 163.8 | 165.1 | 149.3 | 163.1 | 148.7 | 140.1 | 125.3 | 152.6 |
| 6 | 171.8 | 149.2 | 164.8 | 175.1 | 154.9 | 142.1 | 206.6 | 163.6 |
| 7 | 199.5 | 214.5 | - | 176.0 | 172.5 | - | 163.0 | 191.8 |
| 8 | 147.4 | - | - | 260.9 | 156.3 | 169.7 | - | 181.8 |
| 9+ | 216.9 | - | - | 311.6 | 220.0 | 220.0 | - | 220.0 |

Table 2.2.6 Number (n) of herring sampled for vertebral counts, mean count (v) and estimated percentage (p) of IIIa/ Baltic spring spawning herring by age and sub-area.

| sub-area | 2-ringers | | | 3-ringers | | | 4+ -ringers | | | remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | n | v | p | n | v | p | n | v | p | |
| 6 | 200[1] | 56.52[1] | 6[1] | 200[1] | 56.52[1] | 6[1] | 200[1] | 56.52[1] | 6[1] | dubious |
| 7 | 91[1] | 56.21[1] | 34[1] | 91[1] | 56.21[1] | 34[1] | 91[1] | 56.21[1] | 34[1] | |
| 8 | 82 | 56.30 | 22 | 54[2] | 56.28[2] | 47[2] | 54[2] | 56.28[2] | 47[2] | |
| 9 | 23 | 56.04 | 40 | 53 | 56.15 | 22 | 95 | 56.17 | 45 | |
| 10 | 116 | 56.27 | 19 | 64 | 55.98 | 56 | 113 | 56.13 | 41 | |
| 11 | 76 | 56.37 | 13 | 56 | 56.11 | 51 | 74 | 55.99 | 72 | |
| 12 | 46 | 56.33 | 20 | 28[2] | 56.21[2] | 32[2] | 28[2] | 56.21[2] | 32[2] | 20-22 June |
| 12 | 60 | 56.05 | 60 | 43 | 56.12 | 48 | 36 | 55.53 | 100 | 2-5 July |
| 12 | 216 | 56.14 | 54 | 91 | 55.91 | 72 | 62 | 55.89 | 100 | 15-17 July |

[1] represents 2-ringers and older
[2] represents 3-ringers and older

| STATION | POSITION | COD | H.M | HAD | HER | MAC | WHI | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 2079 | 57202N 292W | . | . | 4 | 178 | 58 | 16 | 257 |
| 2097 | 57208N 548W | . | . | 1 | 37 | 8 | 4 | 50 |
| 2228 | 56451N 257E | 5 | . | 37 | 6 | . | 222 | 324 |
| 2309 | 56555N 2417E | . | . | . | 65 | 93 | . | 166 |
| 2327 | 56559N 3125E | . | . | . | 250 | 60 | . | 310 |
| 2444 | 56394N 1243E | 11 | . | 8 | 2 | . | 3 | 557 |
| 2551 | 56294N 1231W | . | 0 | . | 2 | 7 | 11 | 31 |
| 2566 | 56296N 1581W | . | . | . | 1 | 1 | 0 | 7 |
| 2709 | 56047N 1110E | 29 | . | 276 | 8 | 1 | 298 | 732 |
| 2788 | 56051N 3234E | . | . | . | . | 120 | . | 218 |
| 2802 | 55598N 3399E | . | . | . | . | 90 | . | 90 |
| 2969 | 55489N 315W | 10 | . | 143 | 67 | . | 338 | 624 |
| 3023 | 55198N 1085E | . | . | . | 10 | 1 | 2 | 44 |
| 3042 | 55139N 499W | . | . | 15 | 11 | 2 | 18 | 125 |
| 3181 | 55175N 3123E | . | 4 | . | . | 9 | 8 | 205 |
| 3269 | 55151N 5338E | . | . | . | . | 427 | . | 427 |
| 3432 | 54418N 7416E | . | 5 | . | 0 | 0 | 2 | 164 |
| 3533 | 54196N 5207E | . | 2 | . | . | 492 | 14 | 517 |
| 3552 | 54211N 4497E | . | 2 | . | 0 | 708 | 27 | 737 |
| 3682 | 54266N 1140E | 1 | . | 0 | 0 | 4 | 824 | 894 |
| 3754 | 55299N 1116E | . | 4 | . | 1 | 80 | . | 88 |
| 3771 | 55252N 589E | . | 2 | . | 194 | 30 | . | 226 |
| 3924 | 54178N 331E | 44 | 23 | . | 9 | 5 | 2021 | 2316 |
| 3966 | 54468N 1015E | . | 3 | . | . | 55 | 16 | 91 |
| 3982 | 54534N 1106E | . | 32 | . | 0 | 220 | . | 264 |
| 4105 | 54485N 4305E | 1 | 1 | 1 | 0 | 1 | 274 | 340 |
| 4156 | 54500N 5594E | . | . | . | 0 | 82 | 2 | 84 |
| 4175 | 54503N 6301E | . | 1 | . | 43 | 448 | . | 620 |
| 4253 | 55362N 7051E | 87 | 0 | . | . | 0 | 319 | 1621 |
| 4357 | 55566N 5294E | . | . | . | 54 | 148 | . | 202 |
| 4375 | 55546N 5161E | . | 0 | . | 40 | 208 | . | 248 |
| 4483 | 56142N 5307E | 13 | 0 | 1 | 75 | . | 106 | 307 |
| 4553 | 56082N 7277E | . | . | . | 99 | 5 | . | 1423 |
| 4571 | 56150N 7454E | 0 | 2 | . | 131 | 56 | 2 | 218 |
| 4681 | 56264N 5050E | 2 | . | 11 | 36 | 1 | 198 | 400 |
| 4774 | 56365N 5415E | . | 0 | . | 18 | . | 0 | 70 |
| 4792 | 56358N 6160E | . | . | . | 1 | . | 0 | 40 |
| 4885 | 56554N 7151E | 4 | 1 | 14 | . | 8 | 25 | 235 |
| 4993 | 56515N 4163E | . | . | . | 0 | 26 | . | 26 |
| 5015 | 57019N 3585E | . | . | . | 3 | . | . | 49 |
| 5096 | 57177N 4497E | 34 | . | 88 | 0 | 4 | 11 | 200 |
| 5223 | 57214N 7476E | . | . | . | 11 | 86 | . | 97 |
| TOTAL | | 239 | 84 | 598 | 1351 | 3545 | 4760 | 15644 |

Table 2.3.1. Catch in kg of cod, horse mackerel, haddock, herring, mackerel and whiting by station.

Table 2.3.2. Estimated number (millions) of herring by age and strata. RV DANA.

| STRATA | AGE 0 | 1 | 2 | 3 | 4 | 5 | 6 | 8 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 540E00.0 | 1.5 | 1.0 | 2.0 | . | . | . | . | . | 4.5 |
| 540E02.0 | . | 0.1 | 0.0 | 0.0 | . | . | . | . | 0.1 |
| 540E04.0 | 0.7 | 1.6 | 0.1 | 0.1 | . | . | . | . | 2.5 |
| 540E06.0 | 323.5 | 5.6 | . | . | . | . | . | . | 329.1 |
| 540W02.0 | 5.5 | 2.9 | 1.7 | . | . | . | . | . | 10.2 |
| 550E00.0 | . | 61.1 | 432.5 | 281.7 | 64.3 | 7.1 | . | 7.1 | 853.9 |
| 550E04.0 | 23.3 | 1505.1 | 13.4 | . | . | . | . | . | 1541.8 |
| 550W02.0 | . | 12.1 | 15.5 | 16.8 | 2.1 | 0.2 | 0.2 | . | 46.9 |
| 560E00.0 | . | 0.2 | 0.3 | 0.2 | 0.1 | 0.0 | 0.0 | . | 0.8 |
| 560E02.0 | . | 501.4 | 174.9 | 12.2 | 3.4 | . | . | . | 691.9 |
| 560E04.0 | 4.4 | 937.5 | 20.6 | . | . | . | . | . | 962.4 |
| 560E06.0 | 2151.4 | 379.9 | 2.6 | . | . | . | . | . | 2534.0 |
| 560W02.0 | 0.4 | 6.2 | 1.3 | 1.4 | . | . | . | . | 9.3 |
| 570E00.0 | . | 425.7 | 150.2 | 32.6 | 25.0 | 7.5 | . | . | 641.0 |
| 570E06.0 | 44.6 | 237.7 | 440.8 | 14.9 | . | . | . | . | 738.0 |
| 570W02.0 | . | 561.8 | 255.0 | 31.9 | 35.9 | 12.0 | . | . | 896.5 |
| TOTAL | 2555.3 | 4639.9 | 1511.0 | 391.8 | 130.8 | 26.9 | 0.2 | 7.1 | 9263.0 |

Table 2.3.3. Estimated biomass (tonnes) of herring by age and strata. RV DANA.

| STRATA | AGE 0 | 1 | 2 | 3 | 4 | 5 | 6 | 8 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 540E00.0 | 25 | 63 | 254 | . | . | . | . | . | 343 |
| 540E02.0 | . | 4 | 2 | 3 | . | . | . | . | 9 |
| 540E04.0 | 31 | 94 | 5 | 9 | . | . | . | . | 139 |
| 540E06.0 | 9366 | 243 | . | . | . | . | . | . | 9609 |
| 540W02.0 | 92 | 184 | 215 | . | . | . | . | . | 491 |
| 550E00.0 | . | 5187 | 53420 | 44425 | 12716 | 1661 | . | 1465 | 118875 |
| 550E04.0 | 699 | 88111 | 1315 | . | . | . | . | . | 90125 |
| 550W02.0 | . | 772 | 2037 | 2612 | 382 | 62 | 57 | . | 5923 |
| 560E00.0 | . | 18 | 33 | 33 | 11 | 5 | 0 | . | 101 |
| 560E02.0 | . | 35114 | 15518 | 1627 | 295 | . | . | . | 52553 |
| 560E04.0 | 110 | 60900 | 2505 | . | . | . | . | . | 63515 |
| 560E06.0 | 34056 | 20568 | 299 | . | . | . | . | . | 54923 |
| 560W02.0 | 12 | 318 | 130 | 159 | . | . | . | . | 619 |
| 570E00.0 | . | 22771 | 8971 | 4744 | 4115 | 1628 | . | . | 42227 |
| 570E06.0 | 817 | 13828 | 37879 | 2575 | . | . | . | . | 55099 |
| 570W02.0 | . | 28267 | 30804 | 5474 | 6408 | 3042 | . | . | 73995 |
| TOTAL | 45207 | 276444 | 153386 | 61660 | 23927 | 6418 | 58 | 1465 | 568545 |

Table 2.3.4. Mean weight (g) of herring by age and strata. RV DANA.

| STRATA | AGE | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 8 |
| 540E00.0 | 16.7 | 62.5 | 126.3 | . | . | . | . | . |
| 540E02.0 | . | 65.0 | 45.0 | 85.0 | . | . | . | . |
| 540E04.0 | 12.2 | 57.8 | 45.0 | 85.0 | . | . | . | . |
| 540E06.0 | 29.0 | 43.3 | . | . | . | . | . | . |
| 540W02.0 | 16.7 | 62.5 | 126.3 | . | . | . | . | . |
| 550E00.0 | . | 85.0 | 123.5 | 157.7 | 197.7 | 232.5 | . | 205.0 |
| 550E04.0 | 30.0 | 58.5 | 98.1 | . | . | . | . | . |
| 550W02.0 | . | 64.0 | 131.1 | 155.6 | 185.0 | 270.0 | 250.0 | . |
| 560E00.0 | . | 96.4 | 130.8 | 142.7 | 159.6 | 200.8 | 151.6 | . |
| 560E02.0 | . | 70.0 | 88.7 | 133.5 | 86.1 | . | . | . |
| 560E04.0 | 25.0 | 65.0 | 121.9 | . | . | . | . | . |
| 560E06.0 | 15.8 | 54.1 | 115.0 | . | . | . | . | . |
| 560W02.0 | 32.4 | 51.5 | 97.8 | 112.4 | . | . | . | . |
| 570E00.0 | . | 53.5 | 59.7 | 145.7 | 164.3 | 216.7 | . | . |
| 570E06.0 | 18.3 | 58.2 | 85.9 | 173.3 | . | . | . | . |
| 570W02.0 | . | 50.3 | 120.8 | 171.6 | 178.5 | 253.5 | . | . |

Table 2.4.1. Technical data and settings of the acoustic equipment onboard R/V "Argos"

| Vessel | R/V "Argos" |
|---|---|
| Echosounder | EK400/ES400 |
| Frequency | 38 KHz |
| Transducer | 38-29/25 E |
| Beam angle | 9° x 9° |
| Integrator | QX + ND-10S |
| Calibration | Copper sphere |
| 10 Log Y | -19.3 dB |
| Attenuator coeff. | 0.00801 dB/m |
| TVG range | 581m |
| Pulse length | 1.0 ms |
| Band width | 3.3 KHz |
| Attenuator | -10 dB |
| Treshold | 7 mV increasing with depth |

Table 2.4.2. Calibration results and system calibration for R/V "Argos"

| System | Date | SL+VR (dB) | CI (m2/mile2) | Place |
|---|---|---|---|---|
| EK 400 38 KHz | 85-08-23 | 137.55 | 16.47 | Bornö |
| | 85-10-24 | 137.24 | 18.77 | Högön |
| | 86-09-10 | 137.17 | 18.63 | Bornö |
| | 86-10-13 | 136.89 | 20.06 | Högön |
| | 87-08-25 | 136.85 | 19.85 | Bornö |
| | 87-10-22 | 136.70 | 20.82 | Högön |
| | 88-09-13 | 136.91 | 18.17 | Bornö |
| | 88-10-24 | 136.30 | 22.04 | Högön |
| | 89-10-23 | 136.69 | 18.77 | Högön |
| | 90-07-31 | 136.37 | 20.33 | Bornö |

Table 2.4.3. Survey statistics R/V "Argos"

| Area | Stratum | Area sq.mile | No of mile integrated | Sa Values (pelagic) ref. 0 dB | No. of trawl hauls | % of herring in the trawl hauls |
|---|---|---|---|---|---|---|
| East part of Sub area IV | AB | 900 | 48 | 9,98 | 4 * | 20,59 |
| | AC | 1841 | 142 | 7,78 | 4 * | 44,66 |
| | Z | 1841 | 98 | 20,15 | 4 | 20,59 |
| | T | 1890 | 76 | 14,50 | 1 | 9,01 |
| | O | 3790 | 254 | 9,60 | 4 | 44,66 |
| | P | 3894 | 154 | 5,94 | 1 | 87,01 |
| | I | 3894 | 230 | 5,07 | 2 | 38,98 |
| | Total: | 18050 | 1002 | | 12 | |
| Skagerrak | A0 | 397 | 2 | 1,20 | 1 * | 52,29 |
| | A1 | 339 | 28 | 0,77 | 1 * | 52,29 |
| | A2 | 191 | 12 | 3,53 | 1 * | 52,29 |
| | A3 | 212 | 12 | 20,98 | 1 | 52,29 |
| | A4 | 523 | 30 | 5,37 | 1 * | 0,00 |
| | A5 | 655 | 68 | 2,66 | 1 | 0,00 |
| | B0 | 539 | 10 | 4,84 | 1 * | 13,25 |
| | B1 | 324 | 28 | 42,00 | 1 * | 13,25 |
| | B2 | 156 | 14 | 29,69 | 1 | 13,25 |
| | B3 | 278 | 28 | 17,84 | 2 * | 65,65 |
| | B4 | 490 | 26 | 22,22 | 2 | 65,65 |
| | B5 | 1124 | 70 | 6,27 | 2 * | 65,65 |
| | C3 | 200 | 18 | 11,48 | 1 | 8,23 |
| | C4 | 476 | 62 | 14,12 | 2 | 39,80 |
| | C5 | 127 | 4 | 16,30 | 2 * | 39,80 |
| | D1 | 71 | 8 | 30,28 | 1 * | 0,47 |
| | D2 | 169 | 14 | 41,53 | 1 * | 0,47 |
| | D3 | 433 | 66 | 28,75 | 1 | 0,47 |
| | D4 | 733 | 98 | 39,06 | 2 | 95,91 |
| | D5 | 295 | 26 | 16,07 | 1 | 89,38 |
| | Total: | 7732 | 624 | | 12 | |
| Kattegat | E0 | 3493 | 14 | 3,04 | 5 * | 61,54 |
| | E1 | 1216 | 248 | 26,51 | 5 | 61,54 |
| | E2 | 382 | 136 | 18,66 | 4 | 70,62 |
| | E3 | 137 | 42 | 23,72 | 4 * | 70,62 |
| | Total: | 5228 | 440 | | 9 | |

* = Trawl data from other area

Table 2.4.4. Estimated number of herring by age group and strata. Numbers in thousands. R/V "Argos"

| | Stratum | Number | Age 0 | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 | Age 7 | Age 8+ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | AB | 30664 | | | 1564 | 9935 | 11223 | 5642 | 552 | 1227 | 399 |
| | AC | 116940 | | 37070 | 28066 | 13448 | 24440 | 10408 | 1520 | 1520 | 117 |
| East part of Sub area IV | Z | 126705 | | | 6462 | 41052 | 46374 | 23314 | 2281 | 5068 | 1647 |
| | T | 57671 | | 40658 | 14072 | 865 | 1153 | 865 | | | |
| | O | 296296 | | 93926 | 71111 | 34074 | 61926 | 26370 | 3852 | 3852 | 296 |
| | P | 619804 | | 584475 | 31610 | 3099 | | | | | |
| | I | 114570 | | 36548 | 49838 | 13863 | 8593 | 3552 | 917 | 917 | |
| | Total: | 1362650 | | 792677 | 202723 | 116336 | 153709 | 70151 | 9122 | 12584 | 2459 |
| | Autumn sp. | 1225569 | | 792677 | 170287 | 74455 | 118356 | 51912 | 6750 | 9312 | 1820 |
| | Spring sp. | 134192 | | | 32436 | 41881 | 35353 | 18239 | 2372 | 3272 | 639 |
| | A0 | 4610 | | 4540 | 37 | 23 | | | | | |
| | A1 | 2624 | | 2585 | 21 | 13 | | | | | |
| | A2 | 6468 | | 6371 | 52 | 32 | | | | | |
| | A3 | 43077 | | 42431 | 345 | 215 | | | | | |
| | B0 | 17225 | 2446 | 12161 | 2480 | 121 | | | | | |
| | B1 | 90601 | 12865 | 63964 | 13047 | 634 | | | | | |
| | B2 | 30847 | 4380 | 21778 | 4442 | 216 | | | | | |
| | B3 | 90516 | | 17108 | 39918 | 26159 | 4164 | 2897 | | | |
| Skagerrak | B4 | 198981 | | 37607 | 87751 | 57505 | 9153 | 6367 | | | |
| | B5 | 129530 | | 24481 | 57123 | 37434 | 5958 | 4145 | | | |
| | C3 | 13878 | 6717 | 3914 | 2581 | 208 | 430 | | | | |
| | C4 | 36058 | 2632 | 4760 | 17452 | 7500 | 1406 | 1406 | 721 | | |
| | C5 | 11122 | 812 | 1468 | 5383 | 2313 | 434 | 434 | 222 | | |
| | D1 | 785 | 2 | 208 | 470 | 71 | 19 | 3 | 3 | 4 | 2 |
| | D2 | 2559 | 5 | 678 | 1533 | 230 | 61 | 10 | 10 | 13 | 5 |
| | D3 | 4550 | 9 | 1206 | 2725 | 410 | 109 | 18 | 18 | 23 | 9 |
| | D4 | 650656 | 1301 | 172424 | 389743 | 58559 | 15616 | 2603 | 2603 | 3253 | 1301 |
| | D5 | 96592 | | 12074 | 33711 | 27722 | 15841 | 6568 | 386 | | |
| | Total: | 1430679 | 31169 | 429758 | 658815 | 219364 | 53191 | 24452 | 3964 | 3292 | 1317 |
| | Autumn sp. | 518435 | 16208 | 429758 | 72470 | | | | | | |
| | Spring sp. | 906886 | 14961 | | 586345 | 219364 | 53191 | 24452 | 3964 | 3292 | 1317 |
| | E0 | 184099 | 2209 | 69405 | 88920 | 17858 | 4602 | 184 | 184 | 184 | |
| | E1 | 566124 | 6793 | 213429 | 273438 | 54914 | 14153 | 566 | 566 | 566 | |
| Kattegat | E2 | 177407 | 25369 | 104315 | 38320 | 6387 | 1419 | 1242 | | | |
| | E3 | 80637 | 11531 | 47414 | 17418 | 2903 | 645 | 564 | | | |
| | Total: | 1008267 | 45902 | 434563 | 418096 | 82062 | 20819 | 2556 | 750 | 750 | |
| | Autumn sp. | 329226 | 29377 | 299848 | | | | | | | |
| | Spring sp. | 676272 | 16525 | 134715 | 418096 | 82062 | 20819 | 2556 | 750 | 750 | |

Table 2.4.5. Mean weight of herring by age group and strata. Mean weights by age. R/V "Argos"

| | Stratum | Mean weight | Age 0 | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 | Age 7 | Age 8+ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | AB | 210,87 | | | 169,46 | 198,47 | 206,54 | 229,45 | 247,89 | 291,57 | 306,55 |
| | AC | 133,92 | | 83,62 | 129,72 | 152,36 | 174,52 | 190,86 | 202,97 | 185,84 | 240,00 |
| East part of Sub area IV | Z | 210,87 | | | 169,46 | 198,47 | 206,54 | 229,45 | 247,89 | 291,57 | 306,55 |
| | T | 94,99 | | 80,98 | 111,38 | 192,67 | 244,25 | 197,00 | | | |
| | O | 133,92 | | 83,62 | 129,72 | 152,36 | 174,52 | 190,86 | 202,97 | 185,84 | 240,00 |
| | P | 77,21 | | 74,89 | 108,35 | 213,00 | | | | | |
| | I | 109,19 | | 87,10 | 111,35 | 120,73 | 133,27 | 183,59 | 158,73 | 175,50 | |
| | A0 | 57,48 | | 56,75 | 91,67 | 169,00 | | | | | |
| | A1 | 57,48 | | 56,75 | 91,67 | 169,00 | | | | | |
| | A2 | 57,48 | | 56,75 | 91,67 | 169,00 | | | | | |
| | A3 | 57,48 | | 56,75 | 91,67 | 169,00 | | | | | |
| | B0 | 52,55 | 20,15 | 56,10 | 66,00 | 82,82 | | | | | |
| | B1 | 52,55 | 20,15 | 56,10 | 66,00 | 82,82 | | | | | |
| | B2 | 52,55 | 20,15 | 56,10 | 66,00 | 82,82 | | | | | |
| | B3 | 98,16 | | 83,40 | 100,53 | 100,82 | 105,77 | 126,90 | 145,86 | 145,86 | |
| Skagerrak | B4 | 98,16 | | 83,40 | 100,53 | 100,82 | 105,77 | 126,90 | 145,86 | 145,86 | |
| | B5 | 98,16 | | 83,40 | 100,53 | 100,82 | 105,77 | 126,90 | 145,86 | 145,86 | |
| | C3 | 38,13 | 11,18 | 59,88 | 66,83 | 80,74 | 70,66 | | | | |
| | C4 | 72,86 | 15,00 | 63,40 | 73,10 | 86,98 | 106,56 | 109,51 | 74,60 | | |
| | C5 | 72,86 | 15,00 | 63,40 | 73,10 | 86,98 | 106,56 | 109,51 | 74,60 | | |
| | D1 | 90,29 | 9,00 | 85,26 | 88,13 | 114,37 | 100,27 | 142,18 | 152,58 | 147,93 | 136,35 |
| | D2 | 90,29 | 9,00 | 85,26 | 88,13 | 114,37 | 100,27 | 142,18 | 152,58 | 147,93 | 136,35 |
| | D3 | 90,29 | 9,00 | 85,26 | 88,13 | 114,37 | 100,27 | 142,18 | 152,58 | 147,93 | 136,35 |
| | D4 | 90,29 | 9,00 | 85,26 | 88,13 | 114,37 | 100,27 | 142,18 | 152,58 | 147,93 | 136,35 |
| | D5 | 109,56 | | 93,17 | 92,52 | 108,51 | 140,19 | 158,21 | 183,00 | | |
| | E0 | 65,04 | 19,23 | 49,32 | 71,91 | 88,07 | 100,93 | 138,80 | 155,50 | 126,59 | |
| | E1 | 65,04 | 19,23 | 49,32 | 71,91 | 88,07 | 100,93 | 138,80 | 155,50 | 126,59 | |
| Kattegat | E2 | 50,59 | 19,86 | 50,69 | 65,02 | 75,33 | 94,34 | 61,88 | | | |
| | E3 | 50,59 | 19,86 | 50,69 | 65,02 | 75,33 | 94,34 | 61,88 | | | |

Table 2.4.6. Estimated biomass in metric tonnes by age group and strata. R/V "Argos"

| | Stratum | Biomass | Age 0 | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 | Age 7 | Age 8+ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| East part of Sub area IV | AB | 6466 | | | 265 | 1972 | 2318 | 1295 | 137 | 358 | 122 |
| | AC | 15660 | | 3100 | 3641 | 2049 | 4265 | 1986 | 309 | 283 | 28 |
| | Z | 26718 | | | 1095 | 8148 | 9578 | 5349 | 565 | 1478 | 505 |
| | T | 5478 | | 3292 | 1567 | 167 | 282 | 170 | | | |
| | O | 39679 | | 7854 | 9225 | 5191 | 10807 | 5033 | 782 | 716 | 71 |
| | P | 47857 | | 43772 | 3425 | 660 | | | | | |
| | I | 12510 | | 3183 | 5549 | 1674 | 1145 | 652 | 145 | 161 | |
| | Total | 154368 | | 61201 | 24767 | 19861 | 28395 | 14485 | 1938 | 2996 | 726 |
| | Autumn sp. | 131488 | | 61201 | 20804 | 12711 | 21864 | 10719 | 1434 | 2217 | 537 |
| | Spring sp. | 22881 | | | 3963 | 7150 | 6531 | 3766 | 504 | 779 | 189 |
| Skagerrak | A0 | 265 | | 258 | 3 | 4 | | | | | |
| | A1 | 151 | | 147 | 2 | 2 | | | | | |
| | A2 | 372 | | 362 | 5 | 5 | | | | | |
| | A3 | 2476 | | 2408 | 32 | 36 | | | | | |
| | B0 | 905 | 49 | 682 | 164 | 10 | | | | | |
| | B1 | 4761 | 259 | 3588 | 861 | 53 | | | | | |
| | B2 | 1621 | 88 | 1222 | 293 | 18 | | | | | |
| | B3 | 8885 | | 1427 | 4013 | 2637 | 440 | 368 | | | |
| | B4 | 19531 | | 3136 | 8821 | 5798 | 968 | 808 | | | |
| | B5 | 12714 | | 2042 | 5742 | 3774 | 630 | 526 | | | |
| | C3 | 529 | 75 | 234 | 173 | 17 | 30 | | | | |
| | C4 | 2627 | 39 | 302 | 1276 | 652 | 150 | 154 | 54 | | |
| | C5 | 810 | 12 | 93 | 394 | 201 | 46 | 48 | 17 | | |
| | D1 | 71 | 0 | 18 | 41 | 8 | 2 | 0 | 0 | 1 | 0 |
| | D2 | 231 | 0 | 58 | 135 | 26 | 6 | 1 | 2 | 2 | 1 |
| | D3 | 411 | 0 | 103 | 240 | 47 | 11 | 3 | 3 | 3 | 1 |
| | D4 | 58751 | 12 | 14701 | 34349 | 6697 | 1566 | 370 | 397 | 481 | 177 |
| | D5 | 10587 | | 1125 | 3119 | 3008 | 2221 | 1039 | 71 | | |
| | Total | 125698 | 534 | 31905 | 59664 | 22993 | 6070 | 3317 | 544 | 487 | 179 |
| | Autumn sp. | 38746 | 278 | 31905 | 6563 | | | | | | |
| | Spring sp. | 86948 | 256 | | 53101 | 22993 | 6070 | 3317 | 544 | 487 | 179 |
| Kattegat | E0 | 11974 | 42 | 3423 | 6394 | 1573 | 465 | 26 | 29 | 23 | |
| | E1 | 36822 | 131 | 10525 | 19663 | 4837 | 1429 | 79 | 88 | 72 | |
| | E2 | 8975 | 504 | 5288 | 2492 | 481 | 134 | 77 | | | |
| | E3 | 4079 | 229 | 2403 | 1132 | 219 | 61 | 35 | | | |
| | Total | 61850 | 906 | 21639 | 29681 | 7110 | 2089 | 217 | 117 | 95 | 0 |
| | Autumn sp. | 15511 | 580 | 14931 | | | | | | | |
| | Spring sp. | 46343 | 326 | 6708 | 29681 | 7110 | 2089 | 217 | 117 | 95 | |

Table 2.4.7. Estimated number of species and strata. Numbers in thousands. Mackerel and Dogfish: TS=20log l -77.2 R/V"Argos".

| | Stratum | Sprat | Cod | Haddock | Hake | Whiting | Blue Whiting | Mackerel | Saithe | Horse Mackerel | Norway Pout |
|---|---|---|---|---|---|---|---|---|---|---|---|
| East part of Sub area IV | AB | | | | 11 | 36189 | 40843 | 12949 | | 238 | |
| | AC | | | | | 12306 | 239892 | 11771 | 1235 | | 212 |
| | Z | | | | 47 | 149536 | 261466 | 53507 | | 984 | |
| | T | | 290 | 2318 | 290 | 47528 | 2676 | 1159 | 12751 | | 486146 |
| | O | | | | | 31179 | 346018 | 29824 | 3129 | | 538 |
| | P | | | | | 63139 | 28633 | | | | 29403 |
| | I | | | | 448 | 35440 | 242116 | 8070 | | | |
| | **Total:** | | 290 | 2318 | 796 | 375317 | 1161645 | 117280 | 17115 | 1222 | 516299 |
| Skagerrak | A0 | | 165 | 764 | 5 | 2749 | | | 11 | | 324 |
| | A1 | | 94 | 434 | 3 | 1565 | | | 6 | | 185 |
| | A2 | | 232 | 1072 | 7 | 3857 | | | 16 | | 455 |
| | A3 | | 1546 | 7136 | 49 | 25688 | | | 104 | | 3031 |
| | A4 | | | | | 758 | 13428 | | | 2729 | 17282 |
| | A5 | | | | | 475 | 19549 | | | 1709 | 10822 |
| | B0 | | | | | 56682 | | 184 | | 61 | 55783 |
| | B1 | | | | | 298134 | | 967 | | 322 | 293405 |
| | B2 | | | | | 101507 | | 329 | | 110 | 99897 |
| | B3 | | | 207 | | 39267 | 7485 | 529 | | | |
| | B4 | | | 455 | | 86321 | 63406 | 1163 | | | |
| | B5 | | | 296 | | 56192 | 68274 | 757 | | | |
| | C3 | | | | | 1108 | | 97 | 117 | | 153342 |
| | C4 | | | | | 10527 | 43907 | 60 | | | 10453 |
| | C5 | | | | | 3247 | 14513 | 18 | | | 3224 |
| | D1 | | | 523 | | 165477 | | | | | |
| | D2 | | | 1706 | | 539476 | | | | | |
| | D3 | | | 3033 | | 959219 | 543 | | | | |
| | D4 | | | | | 10888 | 50678 | 490 | 704 | | |
| | D5 | | | | | 9386 | 29277 | 174 | | 174 | |
| | **Total:** | 0 | 2037 | 15626 | 64 | 2372523 | 311061 | 4768 | 958 | 5105 | 648203 |
| Kattegat | E0 | 15084 | 323 | 68 | 629 | 79333 | | 8 | 7 | 272 | |
| | E1 | 46385 | 993 | 208 | 1935 | 243956 | | 26 | 20 | 836 | |
| | E2 | 27356 | 940 | 102 | 99 | 33067 | | 15 | | 3 | 710 |
| | E3 | 12434 | 427 | 46 | 45 | 15030 | | 7 | | 1 | 323 |
| | **Total:** | 101259 | 2683 | 424 | 2708 | 371386 | 0 | 56 | 27 | 1112 | 1033 |

Table 2.4.8. Mean weight of species and strata. R/V"Argos".

| | Stratum | Sprat | Cod | Haddock | Hake | Whiting | Blue Whiting | Mackerel | Saithe | Horse Mackerel | Norway Pout |
|---|---|---|---|---|---|---|---|---|---|---|---|
| East part of Sub area IV | AB | | | | 800,00 | 7,41 | 63,32 | 225,41 | | 310,00 | |
| | AC | | | | | 16,93 | 61,37 | 177,78 | 426,32 | | 20,00 |
| | Z | | | | 800,00 | 7,41 | 63,32 | 225,41 | | 310,00 | |
| | T | | 100,00 | 25,00 | 4100,00 | 31,10 | 63,32 | 175,00 | 818,18 | | 18,18 |
| | O | | | | | 16,93 | 61,37 | 177,78 | 426,32 | | 20,00 |
| | P | | | | | 2,94 | 61,37 | | | | 1,58 |
| | I | | | | 833,33 | 6,93 | 84,86 | 202,47 | | | |
| Skagerrak | A0 | | 333,33 | 286,62 | 1055,56 | 66,67 | | | 342,11 | | 27,27 |
| | A1 | | 333,33 | 286,62 | 1055,56 | 66,67 | | | 342,11 | | 27,27 |
| | A2 | | 333,33 | 286,62 | 1055,56 | 66,67 | | | 342,11 | | 27,27 |
| | A3 | | 333,33 | 286,62 | 1055,56 | 66,67 | | | 342,11 | | 27,27 |
| | A4 | | | | | 19,60 | 218,52 | | | 394,44 | 5,26 |
| | A5 | | | | | 19,60 | 218,52 | | | 394,44 | 5,26 |
| | B0 | | | | | 15,79 | | 166,67 | | 300,00 | 2,86 |
| | B1 | | | | | 15,79 | | 166,67 | | 300,00 | 2,86 |
| | B2 | | | | | 15,79 | | 166,67 | | 300,00 | 2,86 |
| | B3 | | | 12,00 | | 3,87 | 75,00 | 200,00 | | | |
| | B4 | | | 12,00 | | 3,87 | 75,00 | 200,00 | | | |
| | B5 | | | 12,00 | | 3,87 | 75,00 | 200,00 | | | |
| | C3 | | | | | 66,67 | | 190,00 | 908,33 | | 3,82 |
| | C4 | | | | | 13,64 | 155,38 | 200,00 | | | 3,17 |
| | C5 | | | | | 13,64 | 155,38 | 200,00 | | | 3,17 |
| | D1 | | | 75,00 | | 4,35 | | | | | |
| | D2 | | | 75,00 | | 4,35 | | | | | |
| | D3 | | | 75,00 | | 4,35 | 98,46 | | | | |
| | D4 | | | | | 3,47 | 98,46 | 200,00 | 2100,00 | | |
| | D5 | | | | | 5,56 | 128,57 | 150,00 | | 450,00 | |
| Kattegat | E0 | 16,47 | 237,34 | 10,00 | 52,05 | 54,26 | | 700,00 | 24,00 | 1,29 | |
| | E1 | 16,47 | 237,34 | 10,00 | 52,05 | 54,26 | | 700,00 | 24,00 | 1,29 | |
| | E2 | 17,15 | 221,28 | 8,00 | 116,40 | 23,72 | | 280,00 | | 400,00 | 20,00 |
| | E3 | 17,15 | 221,28 | 8,00 | 116,40 | 23,72 | | 280,00 | | 400,00 | 20,00 |

Table 2.4.9. Estimated biomass metric tonnes of species and strata. R/V"Argos".

| | Stratum | Sprat | Cod | Haddock | Hake | Whiting | Blue Whiting | Mackerel | Saithe | Horse Mackerel | Norway Pout |
|---|---|---|---|---|---|---|---|---|---|---|---|
| East part of Sub area IV | AB | | | | 9 | · 268 | 2586 | 2919 | | 74 | |
| | AC | | | | | 208 | 14722 | 2093 | 527 | | 4 |
| | Z | | | | 38 | 1108 | 16556 | 12061 | | 305 | |
| | T | | 29 | 58 | 1189 | 1478 | 169 | 203 | 10433 | | 8838 |
| | O | | | | | 528 | 21235 | 5302 | 1334 | | 11 |
| | P | | | | | 186 | 1757 | | | | 46 |
| | I | | | | 373 | 246 | 20546 | 1634 | | | |
| | Total: | | 29 | 58 | 1609 | 4022 | 77572 | 24211 | 12293 | 379 | 8900 |
| Skagerrak | A0 | | 55 | 219 | 5 | 183 | | | 4 | | 9 |
| | A1 | | 31 | 124 | 3 | 104 | | | 2 | | 5 |
| | A2 | | 77 | 307 | 7 | 257 | | | 5 | | 12 |
| | A3 | | 515 | 2045 | 52 | 1713 | | | 36 | | 83 |
| | A4 | | | | | 15 | 2934 | | | 1076 | 91 |
| | A5 | | | | | 9 | 4272 | | | 674 | 57 |
| | B0 | | | | | 895 | | 31 | | 18 | 160 |
| | B1 | | | | | 4708 | | 161 | | 97 | 839 |
| | B2 | | | | | 1603 | | 55 | | 33 | 286 |
| | B3 | | | 2 | | 152 | 561 | 106 | | | |
| | B4 | | | 5 | | 334 | 4755 | 233 | | | |
| | B5 | | | 4 | | 217 | 5121 | 151 | | | |
| | C3 | | | | | 74 | | 18 | 106 | | 586 |
| | C4 | | | | | 144 | 6822 | 12 | | | 33 |
| | C5 | | | | | 44 | 2255 | 4 | | | 10 |
| | D1 | | | 39 | | 720 | | | | | |
| | D2 | | | 128 | | 2347 | | | | | |
| | D3 | | | 227 | | 4173 | 53 | | | | |
| | D4 | | | | | 38 | 4990 | 98 | 1478 | | |
| | D5 | | | | | 52 | 3764 | 26 | | 78 | |
| | Total: | | 679 | 3102 | 68 | 17781 | 35528 | 895 | 1632 | 1977 | 2170 |
| Kattegat | E0 | 248 | 77 | 1 | 33 | 4305 | | 6 | 0 | 0 | |
| | E1 | 764 | 236 | 2 | 101 | 13237 | | 18 | 0 | 1 | |
| | E2 | 469 | 208 | 1 | 12 | 784 | | 4 | | 1 | 14 |
| | E3 | 213 | 94 | 0 | . 5 | 357 | | 2 | | 0 | 6 |
| | Total: | 1695 | 615 | 4 | 150 | 18683 | 0 | 30 | 1 | 3 | 21 |

Table 2.4.10. Mean length of species and strata. R/V"Argos".

| | Stratum | Sprat | Cod | Haddock | Hake | Whiting | Blue Whiting | Mackerel | Saithe | Horse Mackerel | Norway Pout |
|---|---|---|---|---|---|---|---|---|---|---|---|
| East part of Sub area IV | AB | | | | 48,50 | 8,32 | 21,83 | 28,84 | | 33,30 | |
| | AC | | | | | 9,59 | 21,95 | 27,99 | 36,71 | | 14,90 |
| | Z | | | | 48,50 | 8,32 | 21,83 | 28,84 | | 33,30 | |
| | T | | 22,50 | 13,25 | 82,50 | 10,41 | 21,83 | 27,87 | 41,45 | | 14,39 |
| | O | | | | | 9,59 | 21,95 | 27,99 | 36,71 | | 14,90 |
| | P | | | | | 7,59 | 21,95 | | | | 6,34 |
| | I | | | | 47,83 | 9,24 | 23,75 | 29,06 | | | |
| Skagerrak | A0 | | 28,87 | 28,49 | 51,72 | 17,60 | | | 34,08 | | 15,03 |
| | A1 | | 28,87 | 28,49 | 51,72 | 17,60 | | | 34,08 | | 15,03 |
| | A2 | | 28,87 | 28,49 | 51,72 | 17,60 | | | 34,08 | | 15,03 |
| | A3 | | 28,87 | 28,49 | 51,72 | 17,60 | | | 34,08 | | 15,03 |
| | A4 | | | | | 10,70 | 32,17 | | | 35,11 | 9,45 |
| | A5 | | | | | 10,70 | 32,17 | | | 35,11 | 9,45 |
| | B0 | | | | | 11,63 | | 28,25 | | 33,50 | 8,07 |
| | B1 | | | | | 11,63 | | 28,25 | | 33,50 | 8,07 |
| | B2 | | | | | 11,63 | | 28,25 | | 33,50 | 8,07 |
| | B3 | | | 10,50 | | 7,46 | 22,44 | 30,08 | | | |
| | B4 | | | 10,50 | | 7,46 | 22,44 | 30,08 | | | |
| | B5 | | | 10,50 | | 7,46 | 22,44 | 30,08 | | | |
| | C3 | | | | | 17,42 | | 28,35 | 43,75 | | 8,25 |
| | C4 | | | | | 11,05 | 28,74 | 31,50 | | | 8,58 |
| | C5 | | | | | 11,05 | 28,74 | 31,50 | | | 8,58 |
| | D1 | | | 12,25 | | 8,42 | | | | | |
| | D2 | | | 12,25 | | 8,42 | | | | | |
| | D3 | | | 12,25 | | 8,42 | | | | | |
| | D4 | | | | | 7,78 | 25,05 | 29,75 | 60,50 | | |
| | D5 | | | | | 8,44 | 26,79 | 29,25 | | 36,50 | |
| Kattegat | E0 | 12,89 | 27,84 | 11,50 | 20,02 | 18,21 | | 44,75 | 14,50 | 5,21 | |
| | E1 | 12,89 | 27,84 | 11,50 | 20,02 | 18,21 | | 44,75 | 14,50 | 5,21 | |
| | E2 | 14,89 | 24,35 | 10,30 | 13,50 | 11,78 | | 31,55 | | 38,50 | 14,84 |
| | E3 | 14,89 | 24,35 | 10,30 | 13,50 | 11,78 | | 31,55 | | 38,50 | 14,84 |

Table 2.4.11. Mean length, vertebral count and proportions of seperated herring components in eastern North Sea and Div. IIIa 1990.

| Area | Component | Age-group | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|
| Eastern North Sea | 1 | Mean length | | 22,05 | 24,70 | 27,30 | 28,50 | 29,03 |
| | | Mean VS | | 56,50 | 56,39 | 56,24 | 56,39 | 56,32 |
| | | Proportion | | 1,00 | 1,00 | 0,90 | 0,82 | 1,00 |
| | 2 | Mean length | | | | 23,40 | 25,80 | |
| | | Mean VS | | | | 55,99 | 56,00 | |
| | | Proportion | | | | 0,10 | 0,18 | |
| Skagerrak | 1 | Mean length | 13,80 | 20,20 | | | | |
| | | Mean VS | 56,21 | 56,50 | | | | |
| | | Proportion | 0,88 | 1,00 | | | | |
| | 2 | Mean length | 10,10 | | 22,80 | 23,90 | 24,70 | 26,10 |
| | | Mean VS | 55,86 | | 55,88 | 55,68 | 55,91 | 55,86 |
| | | Proportion | 0,12 | | 1,00 | 1,00 | 1,00 | 1,00 |
| Kattegat | 1 | Mean length | 14,40 | 19,30 | | | | |
| | | Mean VS | 56,25 | 56,28 | | | | |
| | | Proportion | 1,00 | 1,00 | | | | |
| | 2 | Mean length | | | 21,50 | 22,80 | 24,20 | |
| | | Mean VS | | | 55,75 | 55,78 | 55,68 | |
| | | Proportion | | | 1,00 | 1,00 | 1,00 | |

Table 2.4.12. Proportions of herring components and initial mean vertebral. count per age-group. Separation based on assumption of mean VS: spring spawners 55.80 and autumn spawners 56.50

| Area | Age-group | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| Eastern North Sea | Mean VS | | 56,50 | 56,39 | 56,25 | 56,34 | 56,32 |
| | Proportion autumn | | 1,00 | 0,84 | 0,64 | 0,77 | 0,74 |
| | Proportion spring | | | 0,16 | 0,36 | 0,23 | 0,26 |
| Skagerrak | Mean VS | 56,16 | 56,49 | 55,88 | 55,68 | 55,91 | 55,86 |
| | Proportion autumn | 0,52 | 1,00 | 0,11 | | 0,16 | 0,09 |
| | Proportion spring | 0,48 | | 0,89 | 1,00 | 0,84 | 0,91 |
| Kattegat | Mean VS | 56,25 | 56,28 | 55,75 | 55,78 | 55,68 | |
| | Proportion autumn | 0,64 | 0,69 | | | | |
| | Proportion spring | 0,36 | 0,31 | 1,00 | 1,00 | 1,00 | |

Table 2.6.1. Estimated numbers of herring at age (millions) per spawning stock and area. N = numbers; B = biomass ('000 t); I = immature; M = matur SS = spawning stock; TS = total stock.

| Age | IVa W | IVa E | | IVb W | IVb E | | SKAGERRAK | | KATTEGAT | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| winter | | | | | | | | | | | | |
| rings | au | sp | au | au | sp | au | sp | au | sp | au | sp | au |
| 0 | 0 | 0 | 0 | 7 | 0 | 2526 | 15 | 16 | 17 | 29 | 31 | 2579 |
| 1 | 853 | 0 | 640 | 828 | 0 | 3199 | 0 | 430 | 135 | 300 | 135 | 6249 |
| 2I | 154 | 233 | 141 | 188 | 115 | 258 | 586 | 72 | 418 | 0 | 1352 | 813 |
| 2M | 1024 | | 492 | 555 | | 87 | | 0 | | 0 | 0 | 2158 |
| 3I | 87 | 220 | 17 | 3 | 0 | 2 | 219 | 0 | 82 | 0 | 521 | 108 |
| 3M | 2538 | | 540 | 334 | | 10 | | 0 | | 0 | 0 | 3422 |
| 4 | 2462 | 246 | 808 | 99 | 0 | 2 | 53 | 0 | 21 | 0 | 320 | 3370 |
| 5 | 973 | 49 | 359 | 17 | 0 | 0 | 24 | 0 | 3 | 0 | 76 | 1349 |
| 6 | 266 | 18 | 128 | 0 | 0 | 0 | 4 | 0 | 1 | 0 | 23 | 395 |
| 7 | 144 | 5 | 66 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 9 | 211 |
| 8 | 70 | 1 | 57 | 7 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 134 |
| 9+ | 23 | 1 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 43 |
| TSN | 8593 | 772 | 3267 | 2038 | 115 | 6084 | 907 | 518 | 676 | 329 | 2470 | 20829 |
| SSN | 7500 | - | 2470 | 1012 | - | 99 | - | 0 | - | 0 | - | 11080 |
| TSB | 1610 | 93 | 557 | 227 | 10 | 259 | 87 | 39 | 46 | 16 | 236 | 2707 |
| SSB | 1525 | - | 483 | 154 | - | 12 | - | 0 | - | 0 | - | 2174 |

Table 2.6.2. Mean weight at age (g) per spawning stock and area. I = immature; M = mature.

| Age | IVa W | IVa E | | IVb W | IVb E | | SKAGERRAK | | KATTEGAT | | MEAN | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| winter | | | | | | | | | | | | |
| rings | au | sp | au | au | sp | au | sp | au | sp | au | sp | au |
| 0 | - | - | - | 17 | - | 16 | 17 | 17 | 19 | 20 | 18 | 16 |
| 1 | 59 | - | 89 | 62 | - | 61 | - | 74 | 50 | 49 | 50 | 64 |
| 2I | 117 | 94 | 104 | 107 | 84 | 92 | 91 | - | 71 | - | 85 | 94 |
| 2M | 151 | - | 148 | 135 | - | 122 | - | - | - | - | - | 145 |
| 3I | 193 | 119 | 118 | 129 | - | 110 | 104 | - | 87 | - | 108 | 178 |
| 3M | 189 | - | 185 | 169 | - | 154 | - | - | - | - | - | 186 |
| 4 | 210 | 136 | 202 | 186 | - | 95 | 114 | - | 101 | - | 130 | 208 |
| 5 | 238 | 153 | 219 | 211 | - | - | 132 | - | 87 | - | 144 | 232 |
| 6 | 266 | 164 | 237 | 250 | - | - | 129 | - | 155 | - | 157 | 257 |
| 7 | 298 | 192 | 248 | - | - | - | 132 | - | 127 | - | 164 | 282 |
| 8 | 294 | 182 | 267 | 205 | - | - | 145 | - | - | - | 162 | 278 |
| 9+ | 324 | 220 | 312 | - | - | - | - | - | - | - | 220 | 318 |

| Age | Year 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|
| 1 | 13,736 | 6,431 | 6,333 | 6,249 |
| 2 | 4,303 | 4,202 | 3,726 | 2,971 |
| 3 | 955 | 1,732 | 3,751 | 3,530 |
| 4 | 657 | 528 | 1,612 | 3,370 |
| 5 | 368 | 349 | 488 | 1,349 |
| 6 | 77 | 174 | 281 | 395 |
| 7 | 38 | 43 | 120 | 211 |
| 8 | 11 | 23 | 44 | 134 |
| 9+ | 20 | 14 | 22 | 43 |

Table 2.6.3 Estimates of North Sea autumn spawners (millions) at age from acoustic surveys, 1987-1990.

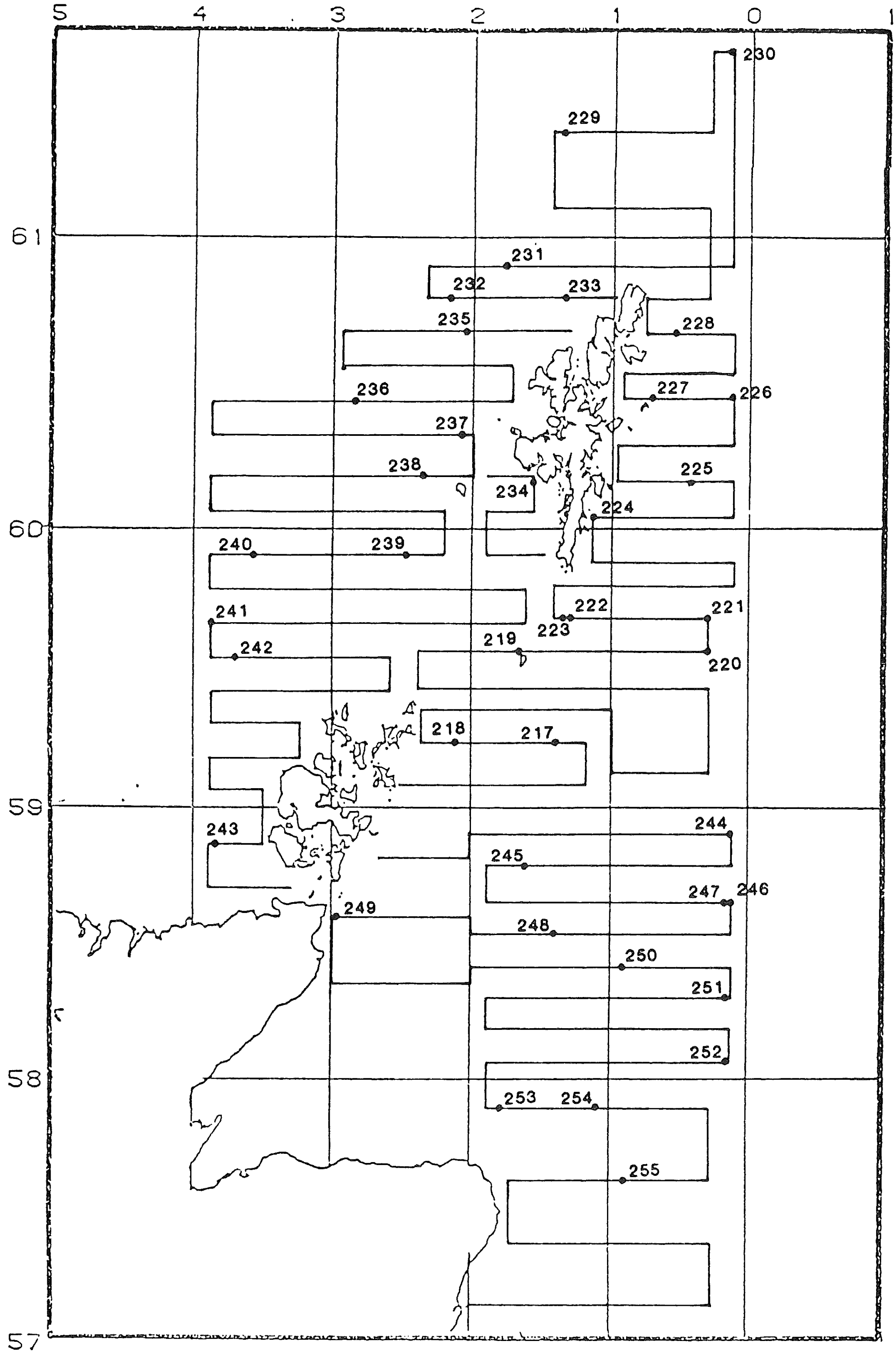



Figure 2.1.1 Cruise track and positions of trawl hauls for FRV "Scotia" 4-24 July 1990.

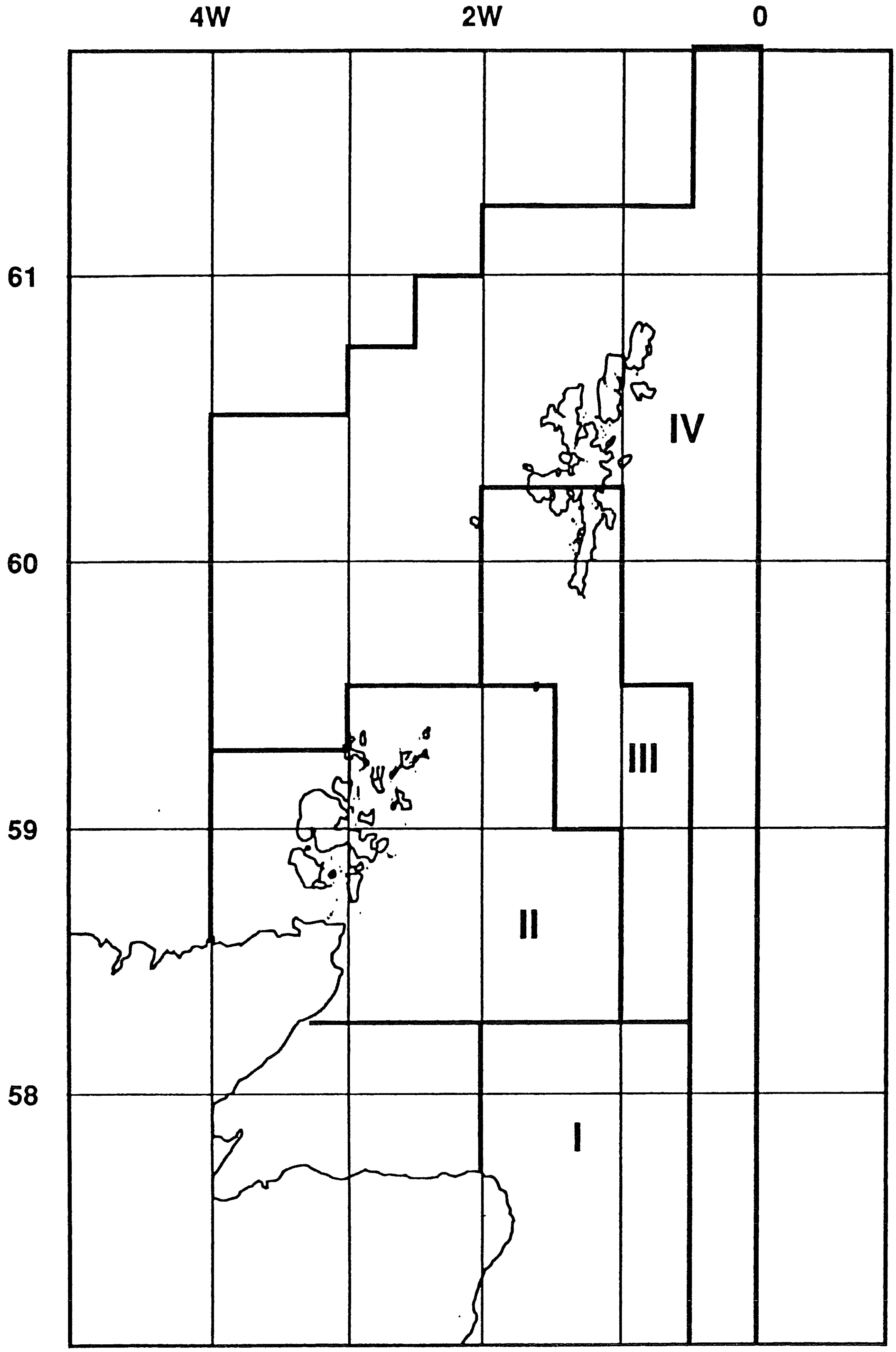



Figure 2.1.2 Sub-areas of consistent length composition.

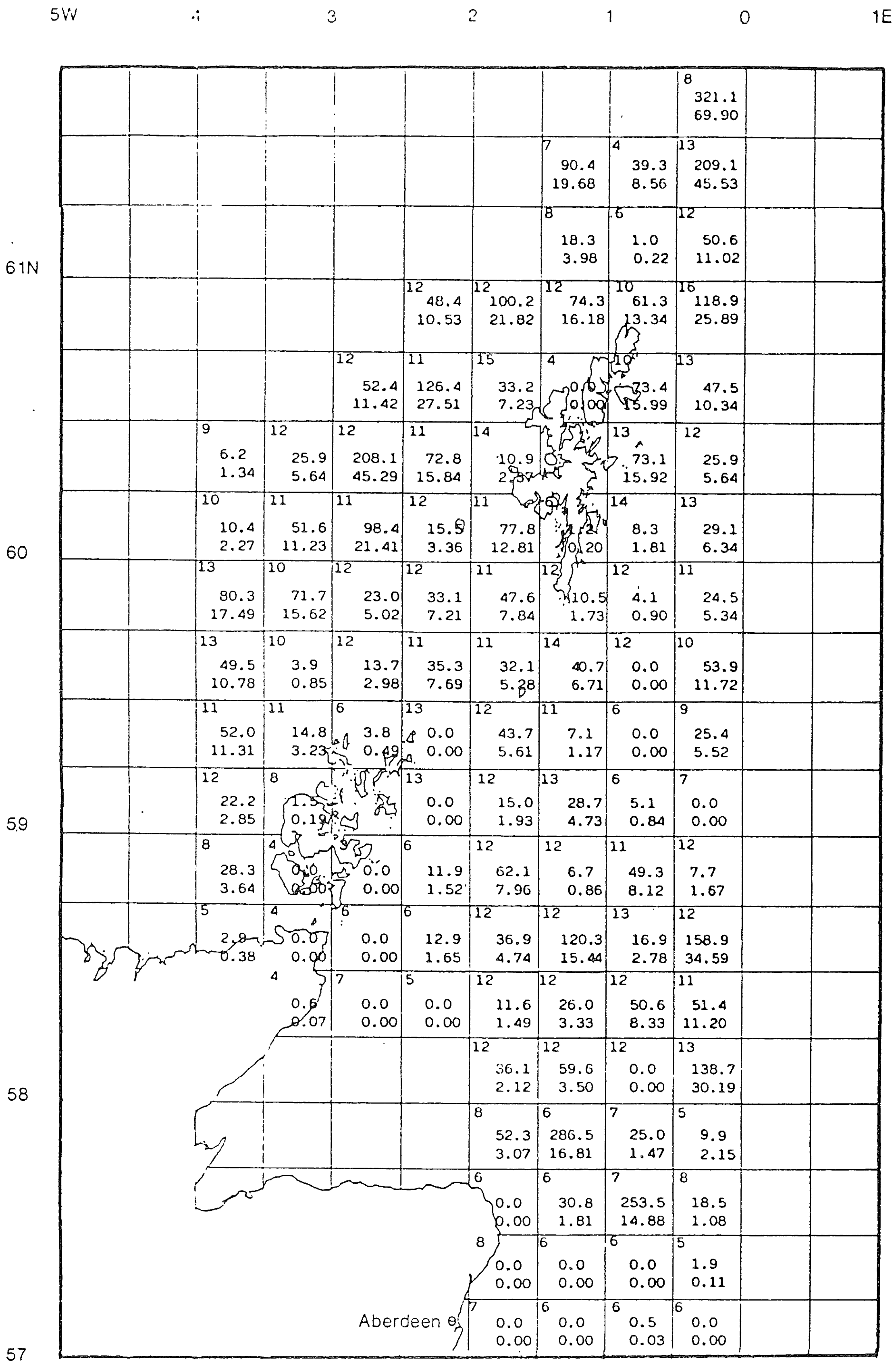



Figure 2.1.3 Results of FRV "Scotia" survey showing the number of 15 minute (2.5 N mile) echo-integrator runs top left, number of fish ($10^{-6}$) centre and weight of fish (tonnes $10^{-3}$) bottom for each quarter statistical rectangle surveyed.

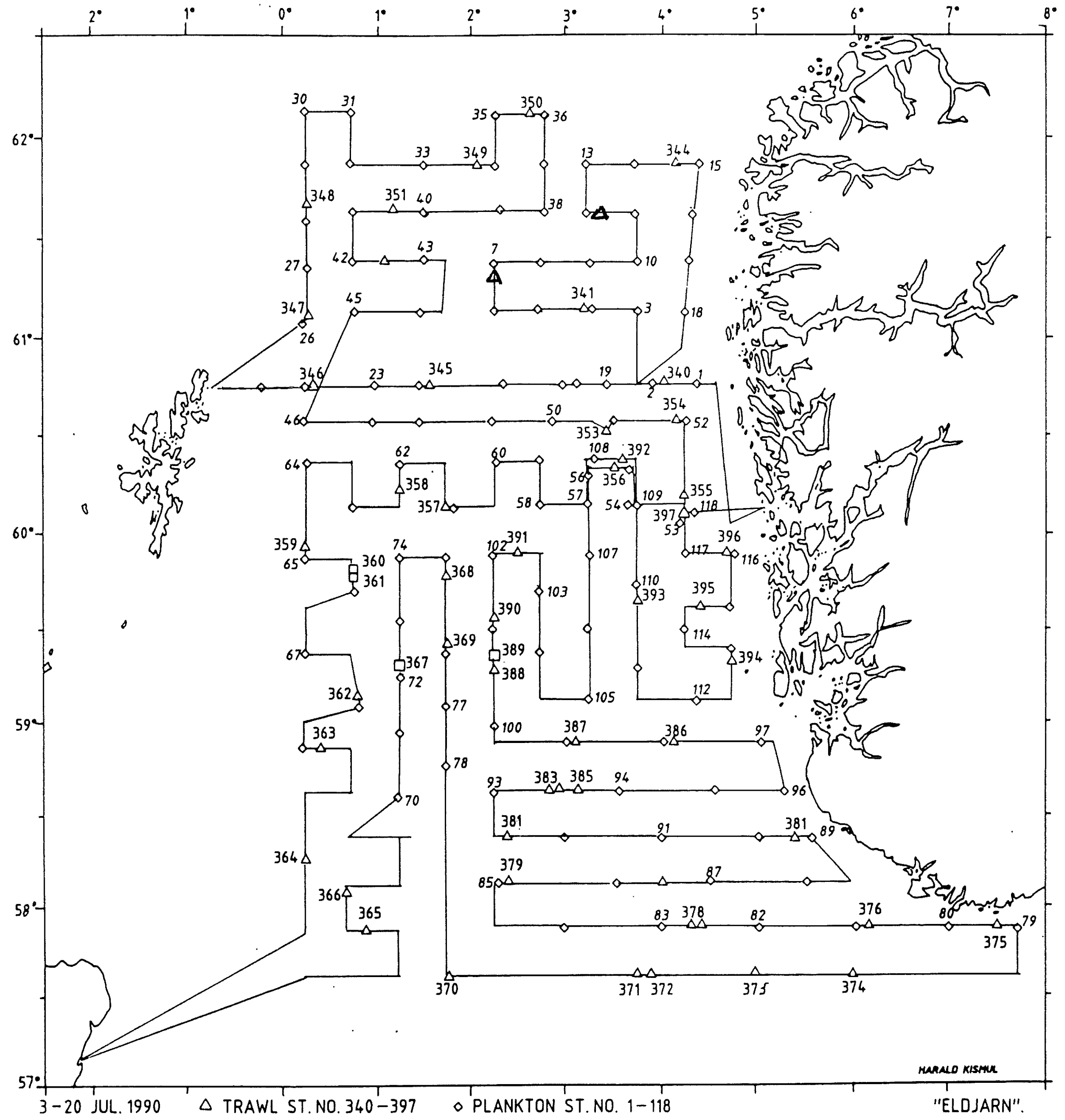



Figure 2.2.1 Survey grid and trawl stations, R/V "Eldjarn".
△ : Pelagic trawl
□ : Bottom trawl
◇ : Plankton station

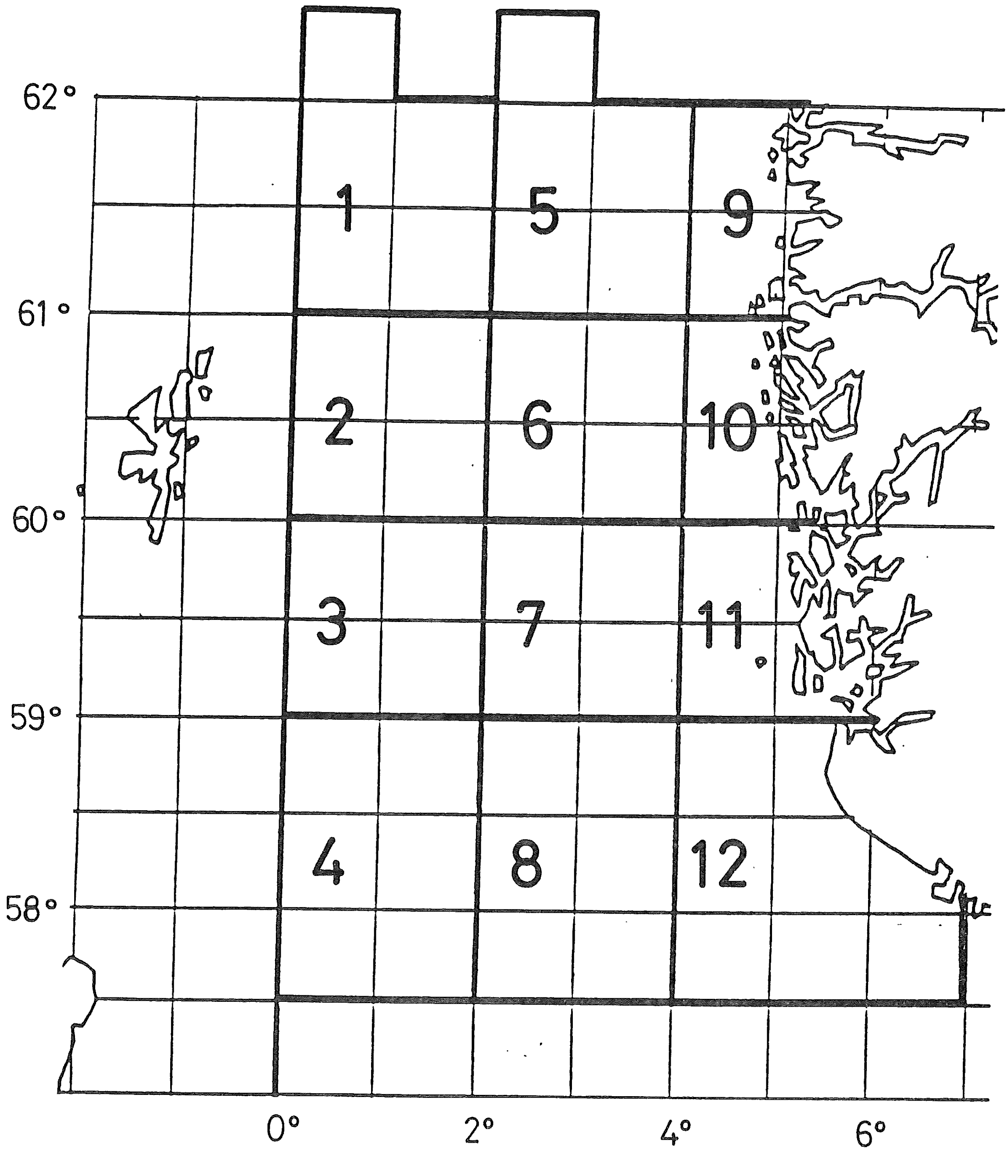



Figure 2.2.2 Definition of sub-areas.

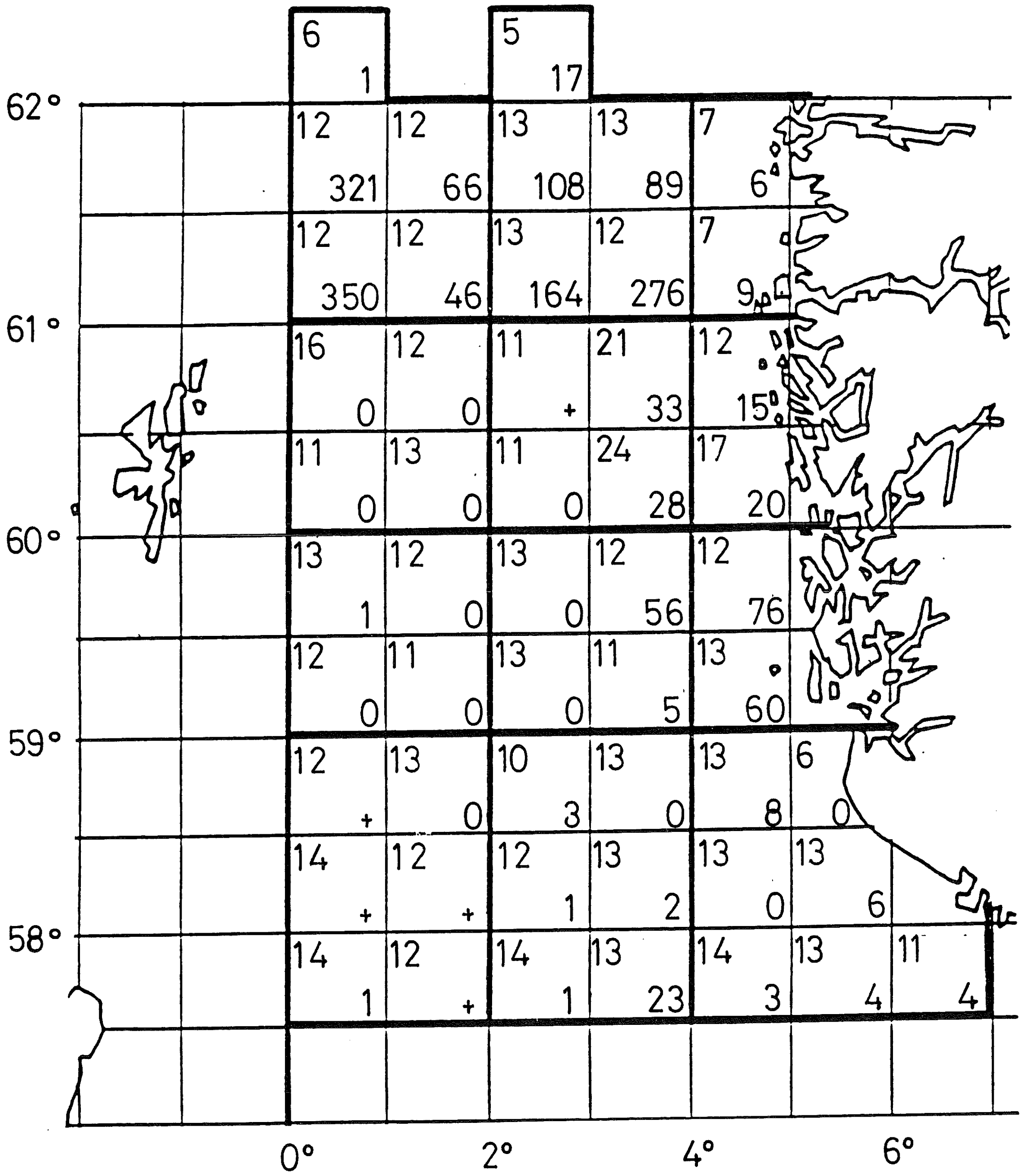



Figure 2.2.3 Estimated number (millions) of mackerel (lower, right figures) by rectangle. Upper, left figure: number of 5-mile integrals per rectangle. R/V "Eldjarn", July 1990.

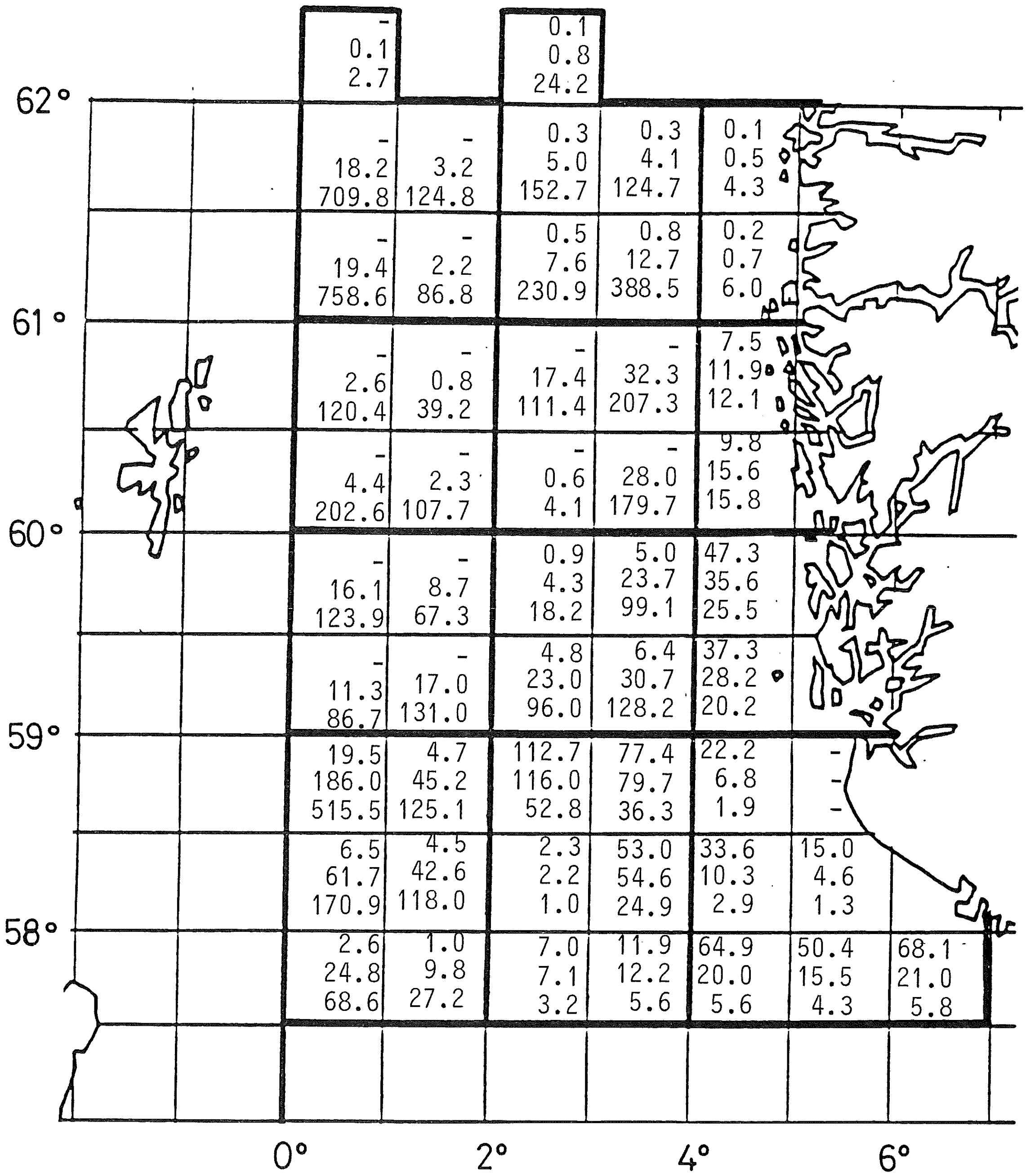



Figure 2.2.4 Estimated number (millions) of North Sea autumn-spawning herring by rectangle. R/V "Eldjarn", July 1990.

Upper figures: 1-ringers.
Middle figures: 2-ringers.
Bottom figures: 3-ringers and older.

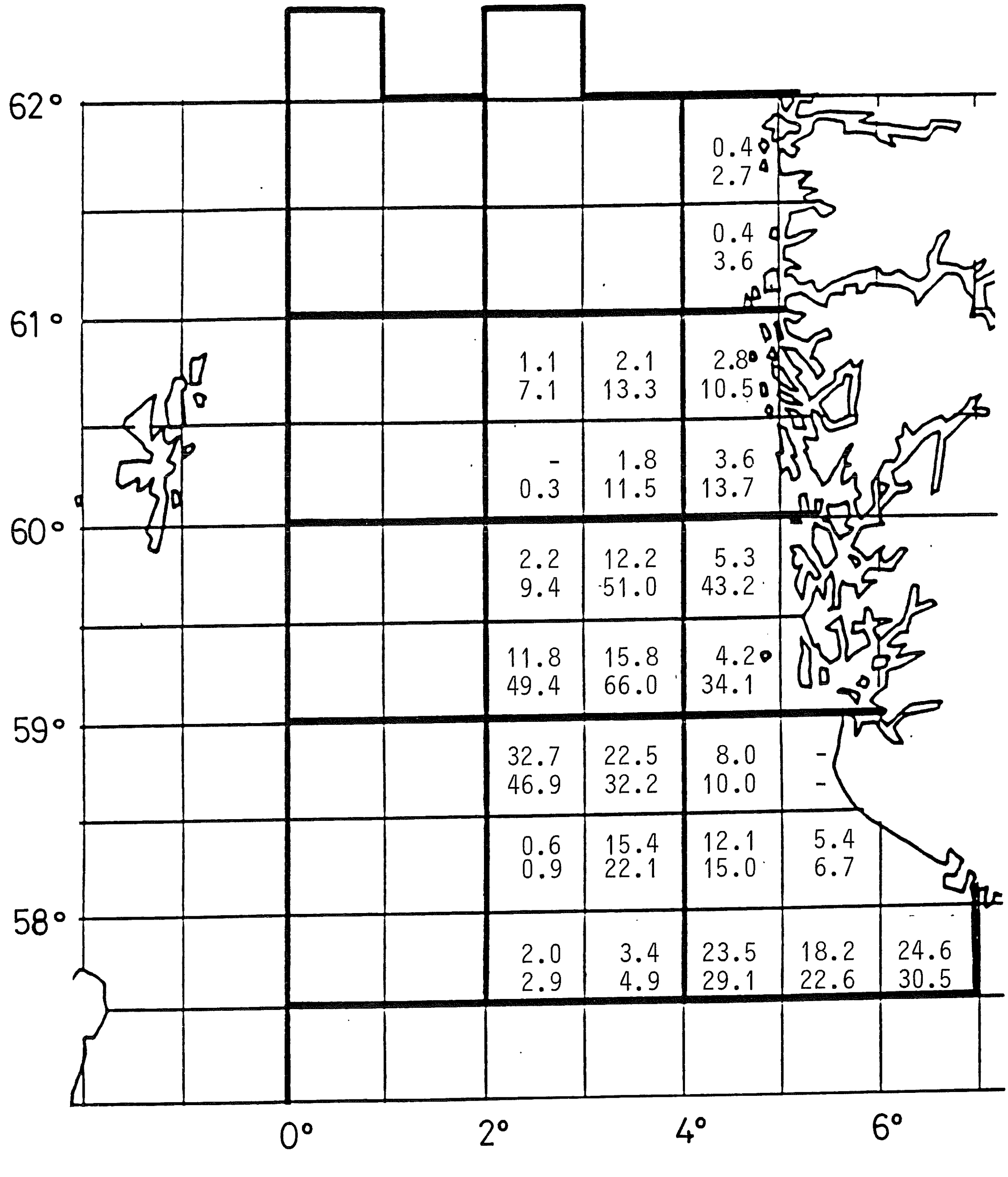



Figure 2.2.5 Estimated number (millions) of Division IIIa/Baltic spring-spawning herring by rectangle. No figure or - means zero. R/V "Eldjarn", July 1990.

Upper figures: 1-ringers.
Bottom figures: 2-ringers.

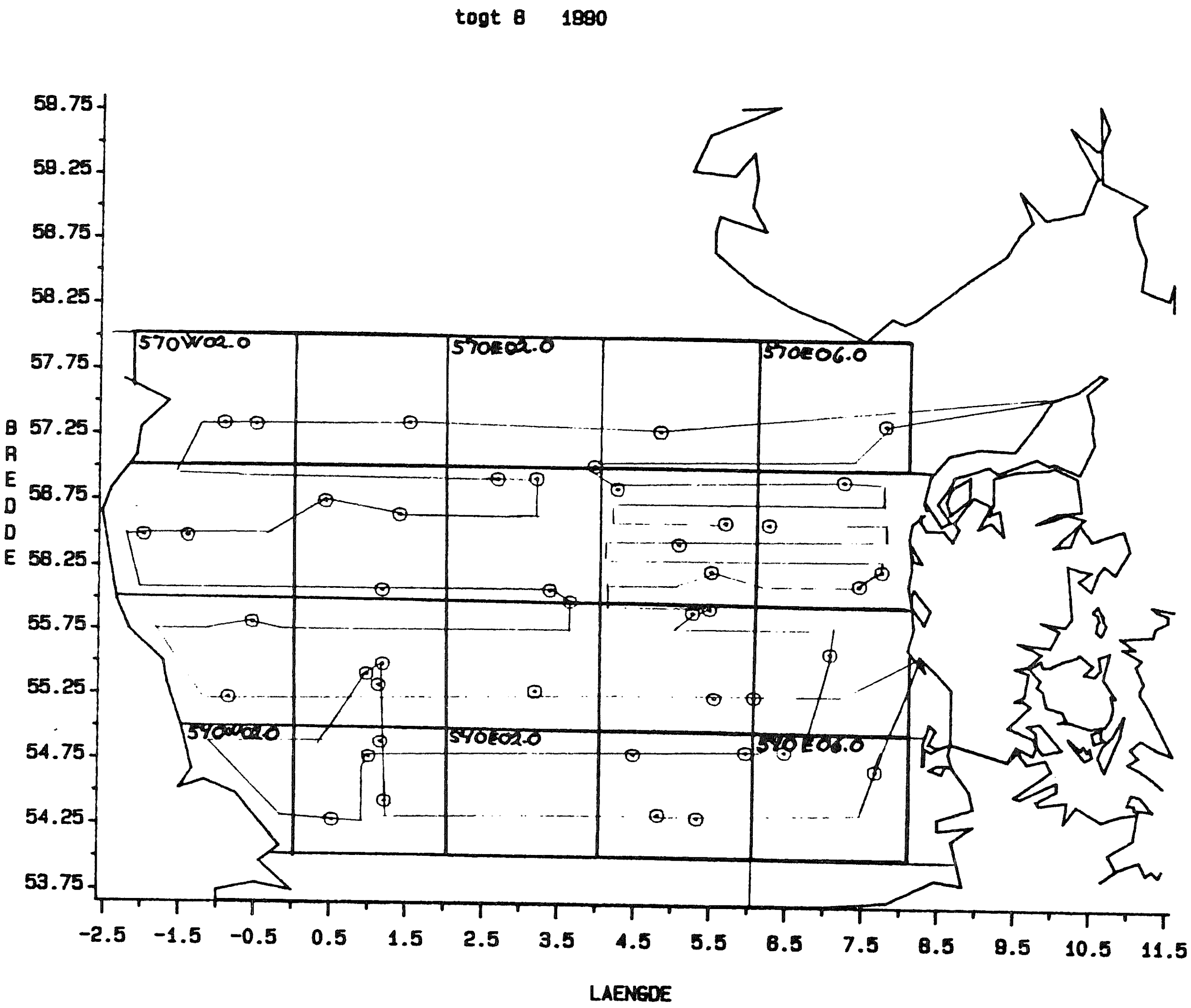
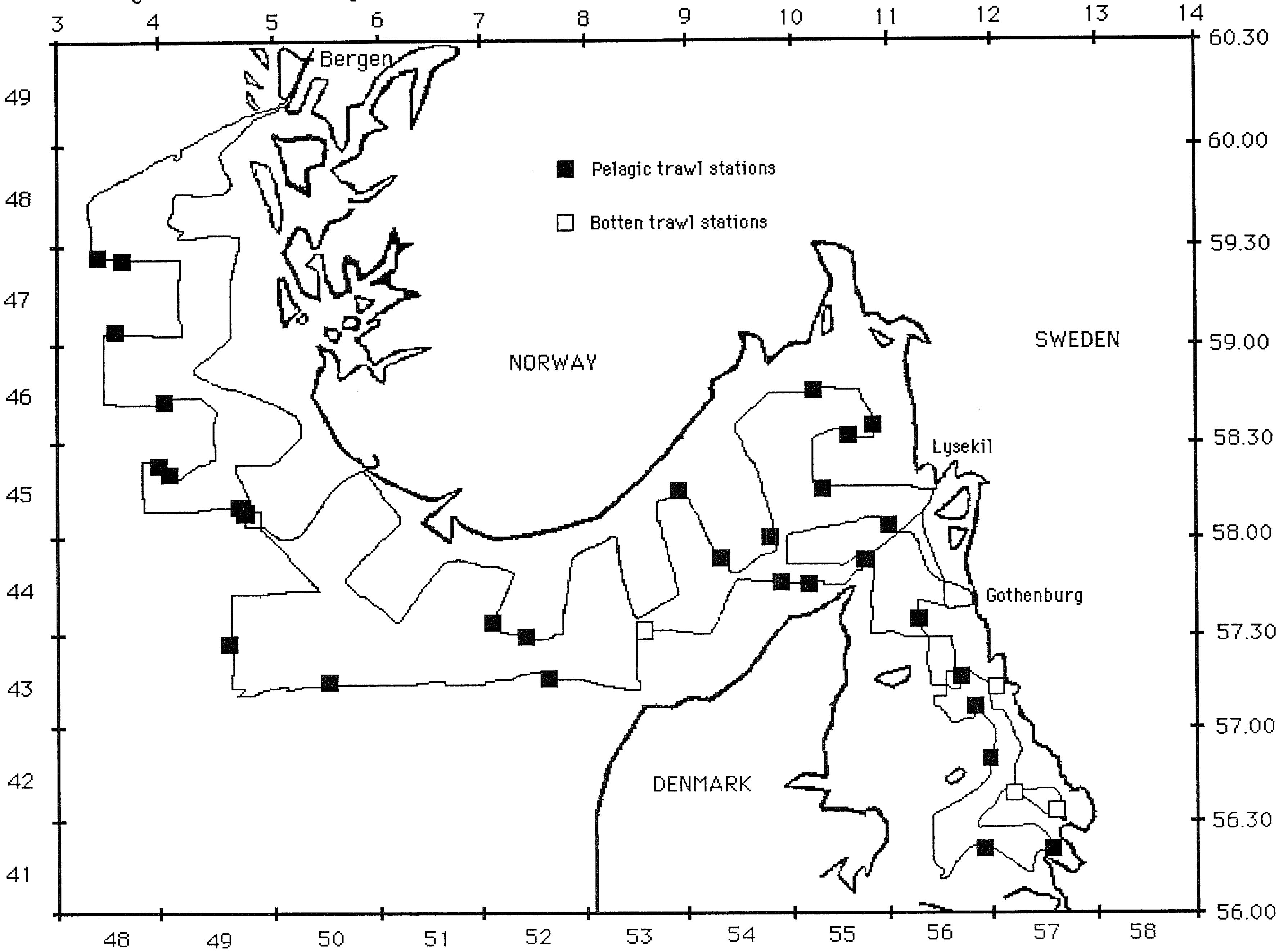



Figure 2.3.1 Cruise track and trawl positions, RV DANA.

Fig. 2.4.1.

R/V "Argos" Acoustic Survey 900731-900816




41

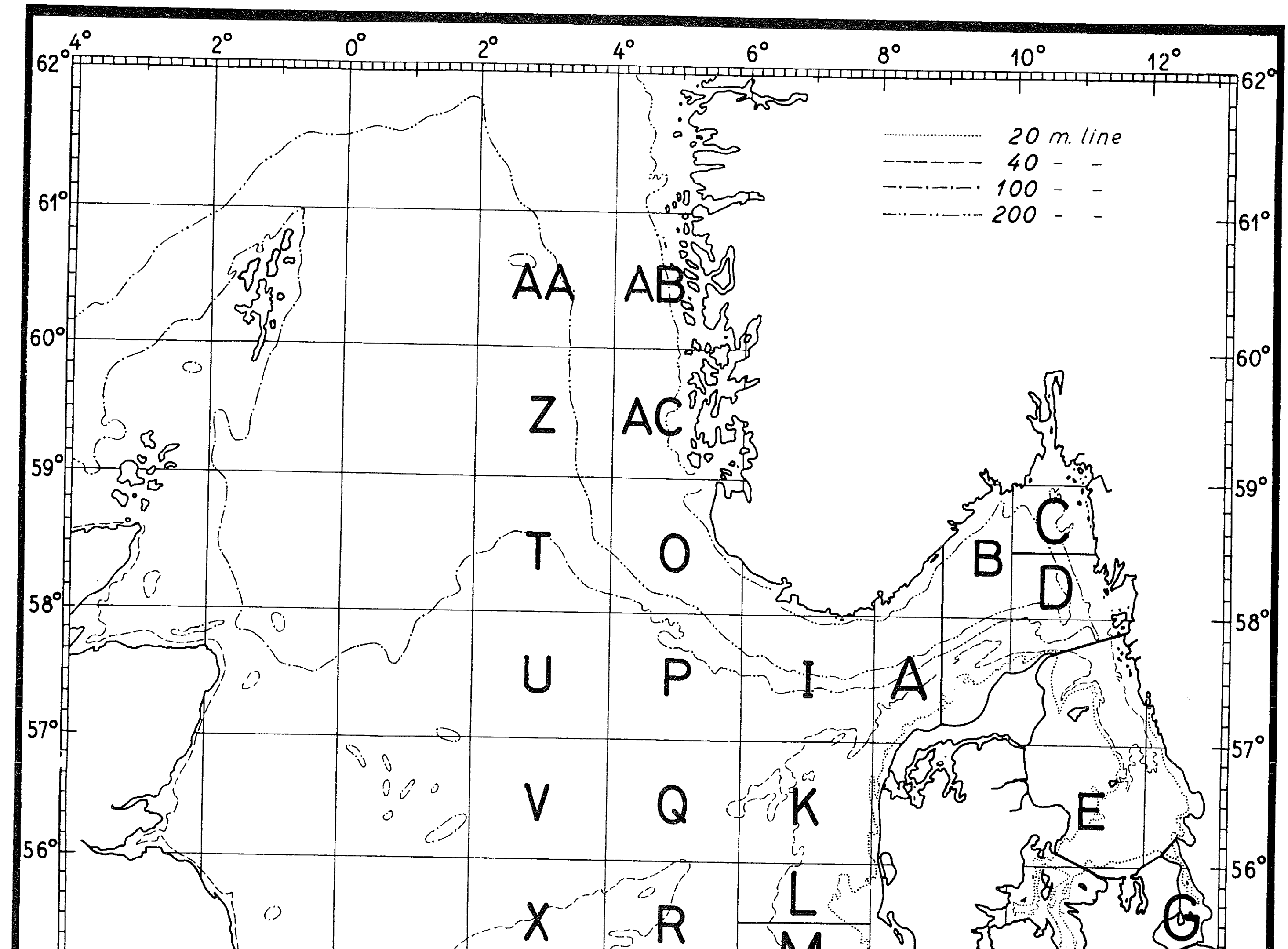



Figure 2.4.2 The strata used for survey evaluation in the Swedish survey.

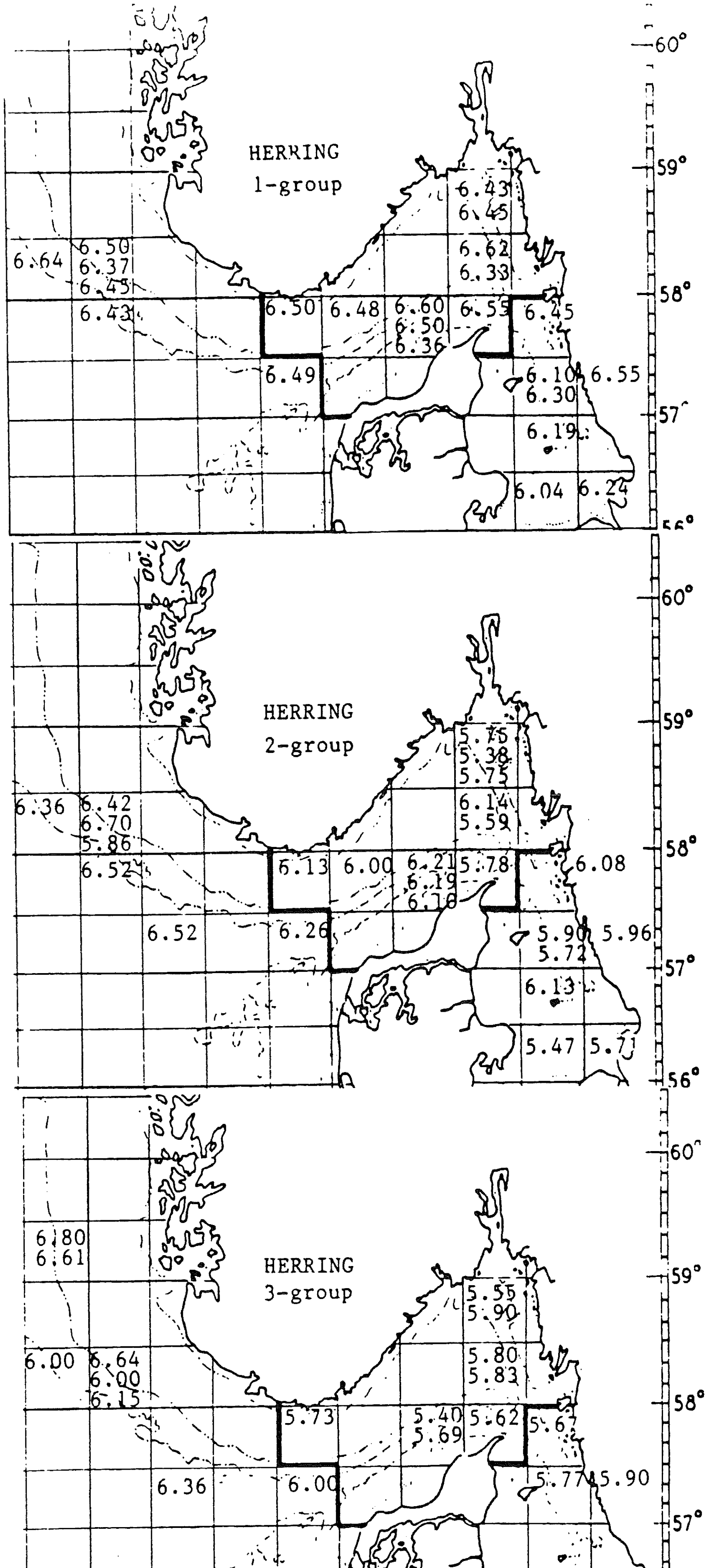



Figure 2.4.3a Mean vertebral count per age group and statistical rectangle. To the numbers illustrated 50 should be added.

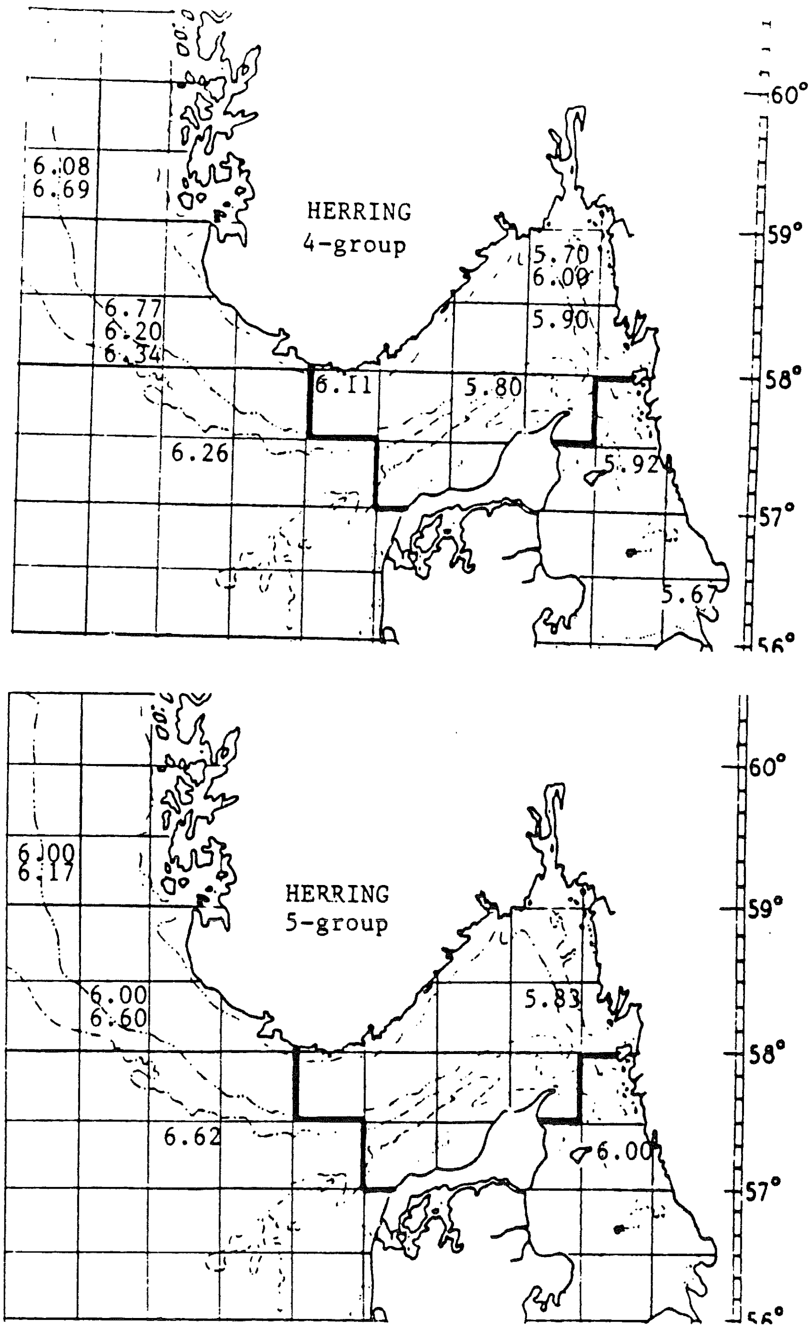
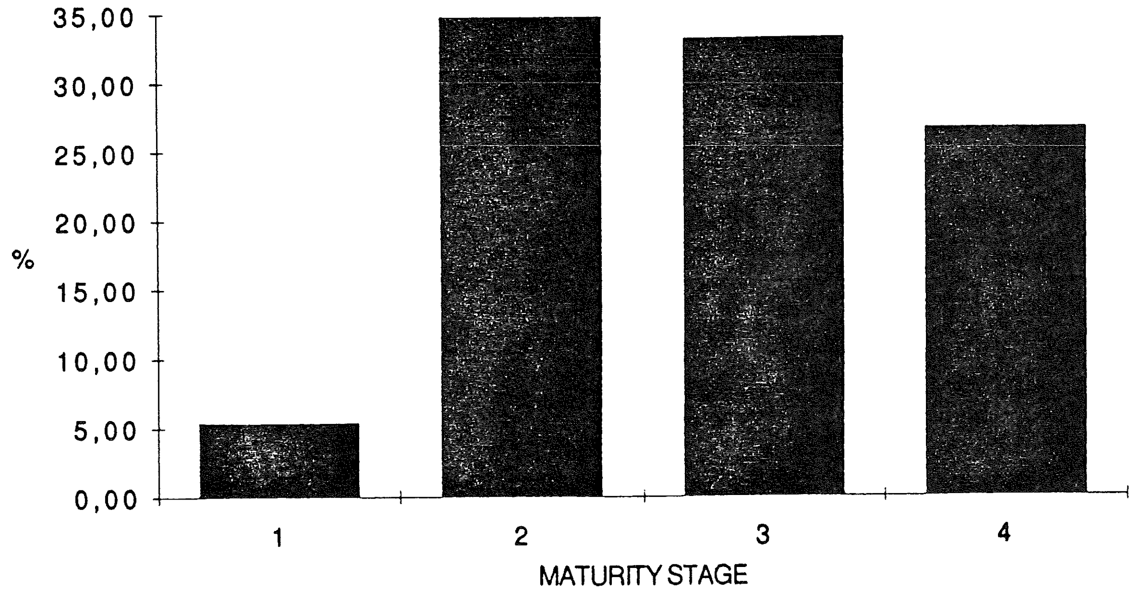



Figure 2.4.3b Mean vertebral count per àge group and statistical rectangle. To the numbers illustrated 50 should be added.

Figure 2.4.4 Maturity stages ≥2-group herring in North Sea.



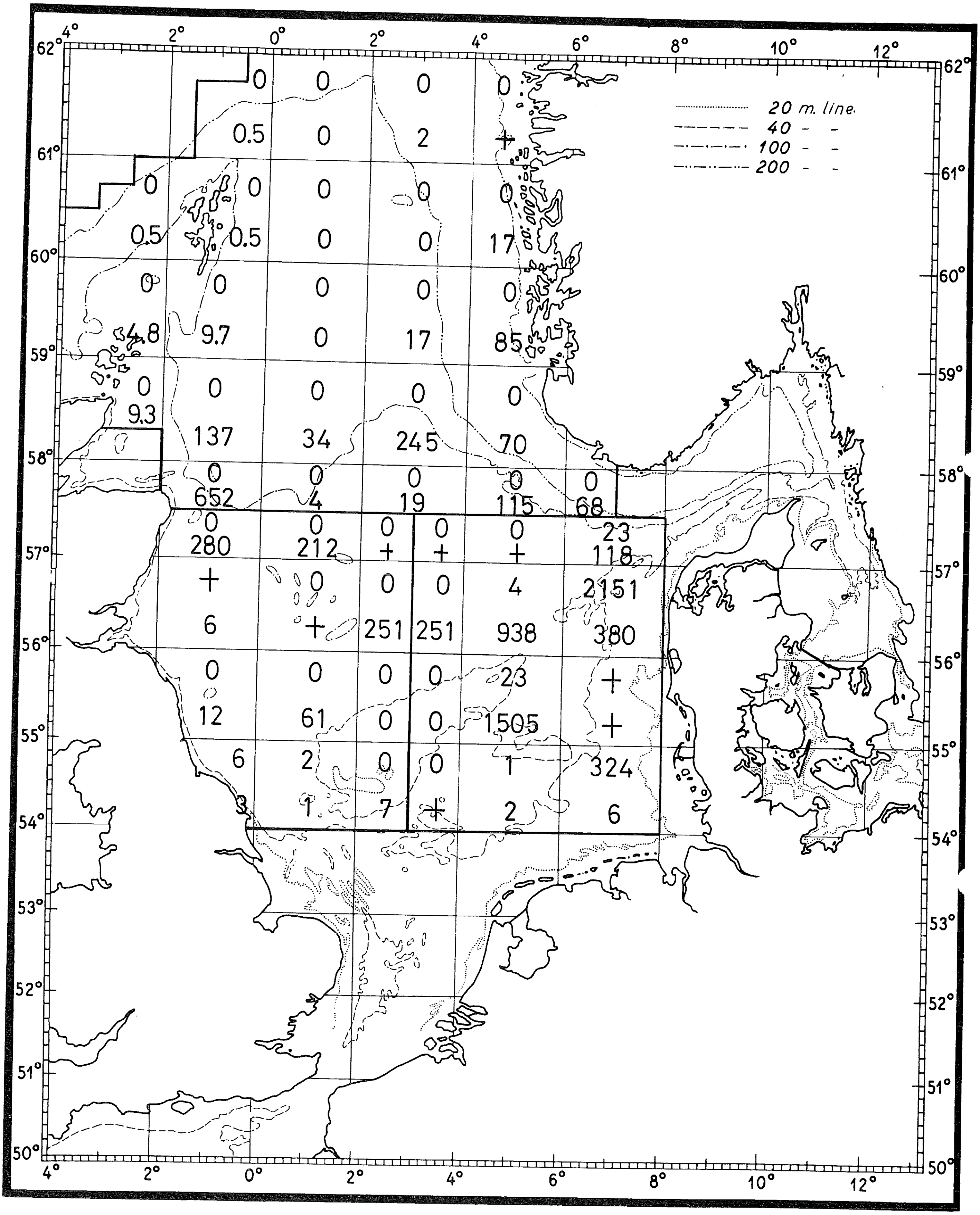



Figure 2.6.1 Estimated numbers (millions) of 0-(top) and 1-(bottom) ring herring.

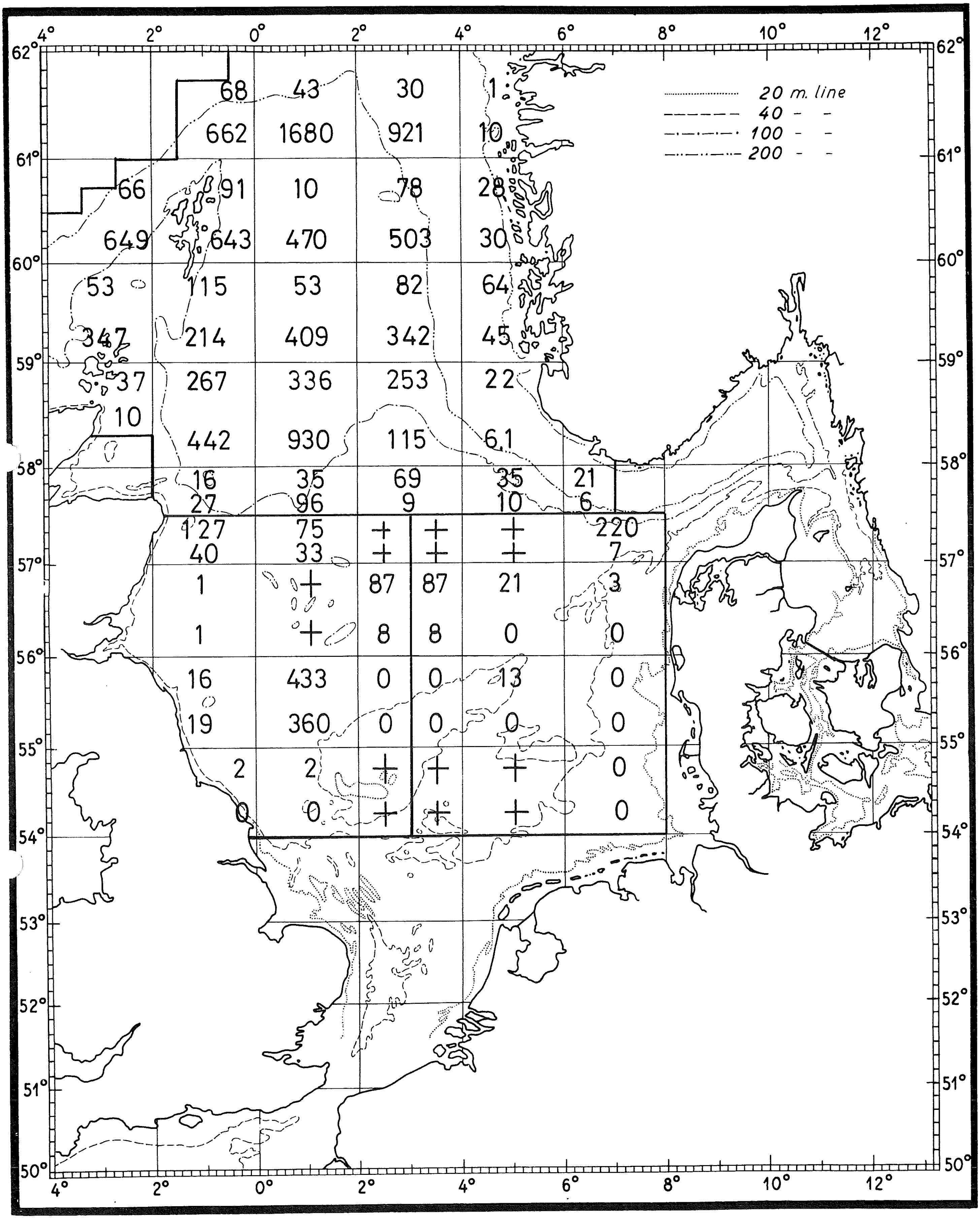



Figure 2.6.2 Estimated numbers (millions) of 2-(top) and 3+-ringers (bottom) herring.

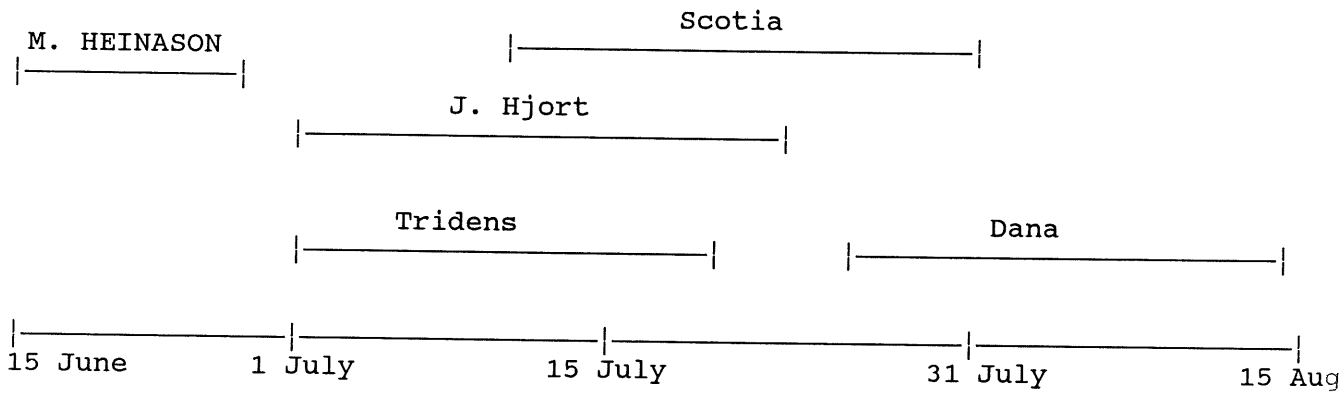



Fig. 3.1 Research vessels participating in the 1991 survey.

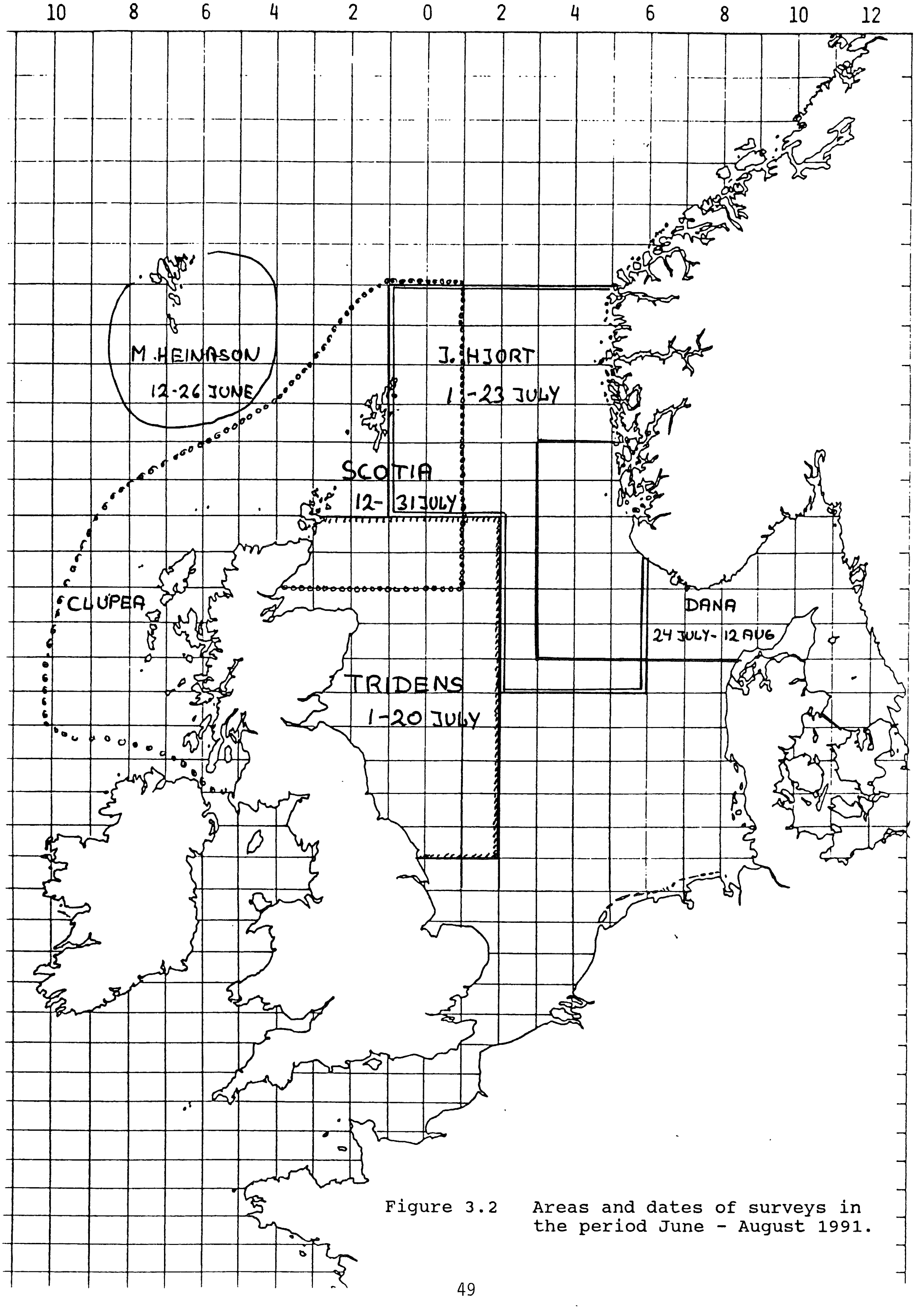



Figure 3.2 Areas and dates of surveys in the period June - August 1991.