Living Resources Committee **ICES CM 2001/G:02**
Ref. D

REPORT OF THE

PLANNING GROUP FOR HERRING SURVEYS

Ijmuiden, the Netherlands

11 – 15 December 2000

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1 TERMS OF REFERENCE

According to C.Res. 2000/2G01 the **Planning Group for Herring Surveys** [PGHERS] (Chair: P. Fernandes, U.K., Scotland) met in IJmuiden, the Netherlands from 11–15 December 2001 to:

a) coordinate the timing, area allocation and methodologies for acoustic and larval surveys for herring in the North Sea, Divisions VIa and IIIa and the Western Baltic;

b) combine the survey data to provide estimates of abundance for the population within the area;

c) take into account the findings of WGFAST and examine aspects of the depth dependence of target strength for herring, specifically:

i. review the available literature on the depth dependence of target strength in herring;

ii. report on investigations on the depth distribution of herring schools around Shetland for the years 1991-1997;

iii. determine methods to evaluate the depth distribution of herring in past surveys for the whole of the North Sea.

PGHERS will make its report available to HAWG and to the Resource Management and Living Resources Committee at the 2001 Annual Science Conference.

2 PARTICIPANTS

Kees Bakker (part time)	The Netherlands
Bram Couperus	The Netherlands
Peter Faber (part time)	Denmark
Paul Fernandes (Chair)	UK (Scotland)
Eberhard Götze	Germany
Soenke Jansen	Germany
Torben Filt Jensen (part time)	Denmark
Dave Reid	UK (Scotland)
John Simmonds	UK (Scotland)
Karl-Johan Stæhr	Denmark
Else Torstensen	Norway
Christopher Zimmermann	Germany

Contact details for each participant are given in Appendix I.

3 HERRING LARVAL SURVEY

3.1 Review of Larvae Surveys in 2000

3.1.1 North Sea

At the time of meeting, a full review of the larvae surveys was not possible because the surveys had not yet been completed. Of the seven units and time periods planned for the 2000 period, four had successfully been carried out. Three surveys in the southern North Sea remain and will be carried out in December 2000 and January 2001:

Area / Period	**1–15 September**	**16–30 September**	**1–15 October**
Orkney / Shetland	--	Germany + Norway	
Buchan	Germany	Netherlands + Norway	
Central North Sea	--	Netherlands	--
	16–31 December	**1–15 January**	**16–31 January**
Southern North Sea	Netherlands	Germany	Netherlands

The participation of Norway for the first time since the late 1970s, allowed duplicate sampling to be carried out in two areas (Orkney / Shetland and Buchan). To date, only the results of the Norwegian surveys are available, but once all surveys are analysed it is expected that this sampling strategy should give better estimates of larvae abundance than single sampling surveys. Furthermore, duplicate surveys can be used for comparison of sampling efficiency and catchability between the involved nations as well as spatial and temporal changes in larvae distribution within one sampling period and unit.

Analysis is ongoing and will be ready in time for the Herring Assessment Working Group (HAWG) meeting in March 2001.

3.1.2 Western Baltic

The herring larvae survey in the Greifswalder Bodden (Baltic Sea) around the Rugen Island took place in the period from 17 April to 30 June during 10×5 day cruises. Plans are underway to change the mode of index calculation from a recruitment index towards an SSB index. This would make the analysis procedure similar to that which is currently applied to the North Sea IHLS data thus making the estimates comparable and the calculations more straightforward. This change may also lead to reconsideration of the survey design of the western Baltic HLS to optimise spatial coverage and time.

3.2 Coordination of Larvae Surveys for 2001/2002

In the 2001/2002 period, only the Netherlands and Germany will participate in the larvae surveys. They will cover the same areas and time periods as in the 2000/2001 period.

Area / Period	**1–15 September**	**16–30 September**	**1–15 October**
Orkney / Shetland	--	Germany	
Buchan	Germany	Netherlands	
Central North Sea	--	Netherlands	--

Area / Period	**16–31 December**	**1–15 January**	**16–31 January**
Southern North Sea	Netherlands	Germany	Netherlands

Survey results, including hydrographic data, should be sent, in the standard format, to IfM Kiel for inclusion into the IHLS database. IfM Kiel will report the summarised results and the updated series of MLAI-values to the HAWG.

The herring larvae survey in the Greifswalder Bodden (Baltic Sea) will be conducted from 19 April to 29 June.

4 ACOUSTIC SURVEYS

4.1 Review of acoustic surveys in 2000

4.1.1 North Sea and west of Scotland

Six surveys were carried out during late June and July covering most of the continental shelf north of 54EN in the North Sea and 56^{o}N to the west of Scotland to a northern limit of 62EN. The eastern edge of the survey area was bounded by the Norwegian, Danish and German coasts, and to the west by the shelf edge at approximately 200 m depth. The areas covered and dates of surveys are shown in Figure 1. The surveys are reported individually in appendices IIa-f and data were combined at the planning group meeting to produce a global estimate. Estimates of numbers at age, maturity stage and mean weights at age were calculated as weighted means of individual survey estimates by ICES statistical rectangle. The weighting applied was proportional to the survey track for each vessel that covered each statistical rectangle. Estimates of the three stocks surveyed are shown in Tables 1a-c by stock for North Sea autumn spawning herring, Western Baltic spring spawning herring, and west of Scotland (VIa_{north}) herring respectively. A full report including distribution maps will be prepared for the herring assessment Working Group and prepared as an ICES paper.

The estimates of North Sea spawning stock biomass (SSB) are 1.7 million tonnes and 8,400 million herring. The North Sea survey is consistent with previous years, giving a total adult mortality of about 0.4 over the last 2 years, which is similar to the estimates from the assessment (0.5). The SSB rose from 1999 to 2000. The survey also shows exceptional numbers of 1 ring herring (the 1998 year class) in the North Sea, which is consistent with the observation of an exceptionally large year class observed in the MIK and IBTS surveys (ICES 2000a). The acoustic survey indicates that the abundance of this year class is four times that of the preceding (1997) year class.

The estimates of Western Baltic spring spawning herring SSB are 190,000 tonnes and 2,000 million, and show a similar pattern to previous years, with a slight increase in SSB over 1999. The west of Scotland survey estimates of SSB are 440,000 tonnes and 2,400 millions, and indicates that the 1995 year class is large once again. Total adult mortality is low (0.14) which is consistent with the 2000 assessment in that the stock is lightly exploited (ICES 2000a).

4.1.2 Western Baltic

A joint German-Danish acoustic survey was carried out with R/V "SOLEA" from 29 September to 20 October 2000 in the Western Baltic. The survey covered ICES Sub-divisions 22, 23, 24 and the southern part of the Kattegat. As in previous years the survey was only carried out during the night. An EK500 echosounder and BI500 Bergen-Integrator software were used to collect acoustic data. The specific settings of the hydroacoustic equipment were used as described in the 'Manual for the Baltic International Acoustic Surveys (BIAS)' (ICES 2000b). A 38 kHz transducer was deployed in a towed body at a lateral distance of about 30 m to reduce escape reactions of fish. The transducer was calibrated prior to the survey in Warnemünde and during the cruise in Abenrade, Denmark.

The cruise track (Fig. 2) covered a total length of 996 n.mi.. A total of 50 trawl hauls were carried out and from each haul, sub-samples were taken to determine length and weight of fish. Further sub-samples of herring and sprat were collected in order to get age-structured population sizes and distributions. In general the catch composition was dominated by herring and to a lower extent by sprat.

The total number of herring was 3929 million fish and the total for sprat 1864 million. For both herring and sprat, the contribution of the new incoming year class is less pronounced compared to the result from last year. The total abundance is, therefore, lower, especially for sprat. The herring numbers in the sub-divisions 23 and 24 are comparable to the results in the year before. An area breakdown is given in Table 2; a full survey report is given in Appendix III.

4.1.3 Intercalibrations and survey overlaps

Intercalibration between FRV Scotia and FRV G.O.Sars

The fisheries research vessels *Scotia* (Scotland, UK) and *G.O.Sars* (Norway) met on 16 July, at ICES rectangle 49E9 for the intership calibration of acoustic equipment. A single transect was surveyed with *Scotia* ahead on the first leg for 15 n.mi. and *G.O.Sars* taking the lead in the second leg for 10 n.mi. Fish concentrations were made up of sparsely located medium sized schools. The integration interval was 2.5 n.mi. and the S_v threshold was –70 dB.

The aligned sequence of s_A values is shown in Figure 3 and the comparative scatterplot is given in Figure 4. Values of s_A detected by *Scotia* ranged from 452 to 4966; whilst those of *G.O.Sars* ranged from 489 to 2725. The mean s_A values over the 25 n.mi. was 2613 for *Scotia* and 1827 for *G.O.Sars*. A students t-test (assuming unequal variances) on these data indicates that these two mean values are not significantly different ($p>0.05$). This suggests that the two systems on board these ships are not operating in an inconsistent manner. However, this intercalibration suffers from a small number of observations and, in future, more time should be allocated to obtain more reliable conclusions.

Intercalibration between FRV *Tridens* and FRV *Walter Herwig III.*

The fisheries research vessels *Tridens* (Netherlands) and *Walther Herwig III* (Germany) met on 12 July 2000 at ICES rectangle 37F3 for an intercalibration of the acoustic equipment. Both ships were equipped with the echosounder EK500 and the postprocessing system BI500. A single transect was surveyed with *Walther Herwig III* ahead on the first leg for 20 n.mi. and *Tridens* taking the lead in the second leg for 20 n.mi.

The main targets were small shoals (5 to 10 m diameter) of small clupeids. For such small targets it is unlikely that both ships record exactly the same information. This is demonstrated by the aligned sequence of measured s_A values integrated over a distance of 0.5 n.mi (Figure 5). Single shoals with high backscattering strength are indicated by sharp spikes and the correlation of these values are very poor. The correlation is improved by averaging these data over five intervals forming sampling distance units of 2.5 n.mi (Figure 6). This results in a slope in the fitted regression on the scatterplot close to one, with an intercept of 1.9 $m^2/n.mi.^2$ indicating a similar performance of both ships. This is verified by examining the overall mean value for all 2.5 n.mi. intervals (233.7 for *Walther Herwig III* and 233.9 for *Tridens*). A students t-test (assuming unequal variances) on these data indicates that these two mean values are not significantly different (p>>0.05). This suggests that the two systems on board these ships are not operating in an inconsistent manner.

Survey overlaps

The acoustic surveys have been organised with a number of overlapping statistical rectangles covered by two or more vessels on the boundaries of the survey area. Data from overlapping areas were extracted from the combined survey database for years 1991 to 2000. The data were linked for pairs of vessels where the same rectangle was covered by two different vessels in the same year. Estimates of total biomass by statistical rectangle were chosen as the most appropriate measure for comparative analysis; this value depends less on the biological sampling than any other measure of abundance estimation on the surveys.

The paired estimates of total biomass from overlapping surveys of statistical rectangles can be seen by country as a scatterplot in Figure 7. These paired estimates show the spread of data covering four decades on both axes. The scatterplot illustrates some of the differences between estimates. The estimated mean biomass +- 2 standard errors are shown for each country by pairs for overlapping survey areas in Figure 8.

The analysis of this data is preliminary and more work is required before final conclusions can be drawn. There are only four sets of vessel pairs with sufficient observations to draw any conclusions (Table 3 and Figure 8). However, there are some initial indications that there may be differences between countries.

There are only small differences between The Netherlands and Scotland in the North Sea (HS). There are differences in the estimates between Norway and Denmark (DN), Scotland and Norway (NS), and The Netherlands and Norway (HN). In these three cases Denmark, Scotland and The Netherlands all reported higher densities than Norway. These differences were discussed and the group thought that they were most likely to be due to differences in scrutinising procedures. In all other cases there was insufficient data to estimate the ratio of mean abundance. To facilitate further investigation the study group recommends that, where possible, survey overlap should be increased in areas of high fish density (east of Orkney and Shetland) and there should be an exchange of staff among surveys.

4.1.4 Biological sampling

ACFM request

Biological data from the 2000 acoustic survey were examined in detail in response to a technical minute from ACFM on the HAWG 2000 report which read as follows: “The appearance of very small light 1 and 2 ring herring in the acoustic surveys in the south eastern part of the area needs to be substantiated. These should be checked in this year survey.”

It has become apparent that there is some ambiguity in the terminology used for ageing fish. The calculations in the combined estimates are based on fish being aged in winter rings, however, there are cases in some documentation where age classes are mentioned. This has led to fish being reported in age classes, as oppose to winter rings (where age class 2 = winter ring 1), in the south eastern part of the area. This problem did not occur prior to 1998 and has now been corrected for 1998 and 1999. A revised time series will be made available to the HAWG. An assessment has been carried out using the same parameterisation as that used by HAWG and the percentage changes are given in Table 4. This results in an increase in SSB (1%) and fishing mortality (7%); this change is expected to have little impact on the management of the stock.

To avoid this problem in future, the acoustic survey manual and data spreadsheets will be revised to ensure that age data is reported as winter rings.

Maturity determination

The percentage of mature herring per age-class is one of the outputs of the North Sea coordinated acoustic survey. These are ultimately used in the assessment process as spawning fractions at age. The planning group compared these percentages from the contributions of the five participating countries and very large differences were apparent. There is a tendency for the percentages for the age-class 3 (2 winter ring) to be higher in the north and west. This coincides with a higher weight at age for these areas, but the observed differences are not thought to be completely due to this. Some reasons for the differences were pinpointed during the discussion.

Different maturity keys have been used in the different national sampling schemes. For the past 3 years German maturity readings had a strong tendency towards counting fish as mature, which coincided with a change in personnel and the switch from an 8-point to a 4-point maturity key. The planning group has estimated a relationship between mean weight at age and fraction mature (Figure 9). This relationship provides an estimate of fraction mature to compensate for the missing information. The results of applying this affects less than 0.1% of 2 ring herring numbers in 2000. A similar correction will be applied to data from 1999 and 1998 in time for the HAWG.

In the Norwegian samples, a differentiation of the percentage mature per age-class can not be done separately for North Sea Autumn Spawners and Western Baltic Spring Spawners as the differentiation between the two stocks is done on the basis of vertebrate counts and thus does not offer stock information on a single fish basis. As a result the measured proportion of mature fish is applied equally to both North Sea Autumn Spawners and Western Baltic Spring Spawners.

In the Danish samples the percentage mature of age-class 3 (2wr) was fixed at 50%. This is also due to the problems associated with differentiating Autumn and Spring Spawners in the earlier years of the surveys and has remained. However, as it is now possible to differentiate between individual Autumn and Spring Spawners (by means of otolith microstructure analysis), data is available to estimate maturity fractions in the two groups. A revised time series will be made available to the HAWG.

The Planning Group agreed that it would be desirable to standardise the reading and estimation of maturity stage in herring. This would be particularly with reference to the separation between mature and immature fish. The usual protocol for establishing common practice would be to adopt an approach similar to the many otolith exchange programmes. However, in the case of herring maturity, the observations need to made on fresh specimens. It was agreed that the best approach would be for personnel on each survey to collect a series of photographs of herring gonads at different maturity stages. The fish used would also be weighed, measured and otoliths taken.

Precise protocols will be communicated to participants prior to the surveys. Briefly, the photographs should ideally be taken with a digital camera or slides. Colour code strips and scales will be provided. Slides will be scanned to produce digital images after the surveys. The digital pictures will be compiled and standardised for colour. It is anticipated that a workshop similar to the egg or otolith reading workshops will then be held to standardise staging and produce a library of holotypes for each maturity stage. D. Reid (FRS Marine Laboratory Aberdeen) has agreed to coordinate this programme.

Age determination

There is no evidence to suggest that there are differences in ageing of herring among participants in the North Sea surveys. However, it is more than 8 years since age estimation procedures were compared and so the group thought that an otolith exchange program should be carried out to in 2001 to examine consistency amongst age readers. The procedures and methods used will be those described in Eltink *et al.* (2000).

In the light of increasing numbers of mature 1 ring fish appearing in some parts of the survey it was decided that the 1 ring category should be split into an immature (1i) and mature component (1m) in a similar fashion to 2 and 3 ringers. The combined survey report will also include estimates of 0 ring fish. The acoustic survey manual has been edited to reflect this change.

Presentation of clupea.net

During the Herring 2000 symposium held in Anchorage, Alaska, earlier this year, it was noted that herring stocks in different regions showed remarkably similar stock dynamics over the course of the last four decades. Easy access to characteristic parameters describing the state of the stocks would facilitate the understanding of the fluctuations as driven by natural phenomena and/or fisheries impact. This in turn would significantly support the development of appropriate management models.

In response to this Chris Zimmerman (Germany) and colleagues have developed an open access website describing the various aspects of herring population ecology (http://www.clupea.net). The website was briefly presented to the group and a discussion was held regarding its aims, content and possible further contributions (particularly by members of the group). Currently the site includes mostly data on European stocks, using information readily available from three Working Groups within the ICES environment (HAWG, NPBW-WG and BFAS-WG). Basic information on all stocks in the ICES environment are now entered in a form intended for any audience (i.e. the general public).

The site is also intended to be a platform to briefly describe ongoing research on herring world-wide. Future developments should focus on short descriptions of recent research, herring biology (possibly by simply linking to respective pages on national lab's web servers), herring related projects and finally on the inclusion of data from outside

Europe. Members of the group are strongly encouraged to submit appropriate text (or hyperlinks/URLs) on the mentioned topics. More specifically it would be advantageous if members could take over responsibilities for single stocks (checking and updating of data).

4.1.5 Sprat

Data on sprat were available from *FRV Walther Herwig III*, *FRV Tridens* and *FRV Dana*. No sprat were reported by *FRV Scotia* and *FRV G.O. Sars* from the northern areas. The distribution of sprat (numbers in mill.) in the North Sea obtained during the acoustic survey 2000 is shown in Figure 10. This year the survey was extended by 30 n.mi. to the south and covered for the first time the south-eastern area considered to have the highest abundance of sprat in the North Sea. By doing so, the biomass estimate for sprat was significantly increased. However, the distribution pattern demonstrates that the southern distribution border was still not reached. Further extension to the south is impossible as the water is either too shallow (the 20 m depth contour was reached) or because of problems with fishing in the traffic control zone in the Southern German Bight. However, the group recommends that the coverage in the south be maintained as it expects this to be a precondition for a sprat biomass index in the future.

In Skagerrak/Kattegat low values of sprat were measured in the statistical rectangles 44F9, 43G0, 42G1, 42G2. The bulk of abundance and biomass was obtained from the Tyne area and off the East Friesian coast. The 1999-year class contributed almost 60% of the biomass in the eastern area, while the 1997-year class dominated in the western area. The total sprat biomass estimated by area was 342,000 t in the North Sea and 2,000 t in the Skagerrak/Kattegat.

Members of the group expressed some concern about the ageing of sprat and decided to collect samples in order to conduct an otolith age verification workshop prior to the next meeting. Protocols for the workshop will be drawn up and distributed later in 2001.

4.2 Coordination of acoustic surveys in 2001

4.2.1 North Sea

Acoustic surveys in the North Sea and west of Scotland in 2001 will be carried out in the periods and areas given in the following table and Figure 11.

Vessel	Period	Area
Charter	15-20 days in July	56°- 60°N, 4° - 10° W
G.O. Sars	29 June – 24 July	57°- 61°30 N, 2° - 8° E
Scotia	3 July – 23 July	58°- 61°30 N, 4° W - 2° E
Tridens	25 June – 20 July	54°30 - 59° N, west of 3° E
Solea	29 June – 20 July	54° - 57° N, east of 3° E
Dana	30 June – 11 July	North of 57° N, east of 6° E

An intercalibration between Scotia – G.O. Sars will take place around 5 July 2001 along 58°30' N. Detailed appointments as regards timing and position will be made during the survey by radio communication.

The results from the national acoustic surveys in June-July 2001 will be collected and the result of the entire survey will be combined prior to the next PGHERS. Survey results for sprat should be sent to Else Torstensen (Norway). Survey results for herring should be sent to John Simmonds, U.K. (Scotland) in the format specified in the manual for the International Acoustic Survey in the North Sea and west of Scotland. Data for both sprat and herring should be with the coordinators by **31 November 2001**.

4.2.2 Western Baltic

In the western Baltic and southern part of Kattegat, the following survey will be carried out:

Vessel	Period	Area
Solea	1 October – 24 October	Sub-division 21 south, 22 to 24

An intercalibration between Solea and Walter Herwig III will take place on July 10 2001 in an area south of Helgoland. Although these vessels regularly conduct hydroacoustic surveys, previously there has not been an opportunity for an intercalibration. Detailed appointments as regards timing and position will be made during the survey by radio communication.

5 DEPTH DEPENDENCE IN THE TARGET STRENGTH OF HERRING

5.1 Literature review on depth dependence of target strength in herring

The results of a literature review were presented to the group (Appendix IV). The review aimed at exploring the possible influence of changes in the depth distribution of herring on the target strength (TS) obtained during the North Sea herring echo survey.

Although herring is probably the best investigated fish species in the world, and there is a long tradition of research on hydroacoustic topics, a significant amount of information is contradictory. Factors in favour of a depth dependency of TS are the physical properties of the swimbladder (compression with increasing pressure according to Boyle's law), and a possible increase of the tilt angle at depth to compensate for a negative buoyancy. The latter perception is based on the common belief that herring, as a physostome, is not able to regulate the swimbladder filling. However, recent work raised doubt about the validity of this belief. TS depth dependency may be further influenced by fish anatomy (irregular reduction of swimbladder volume and shape) and physiological state (namely maturity, fat content, stomach fullness), as well as fish behaviour (vessel or predator avoidance, feeding). The group discussed extensively the different experimental approaches and arguments corroborating the contrary findings. It concluded that, while there is evidence from recent investigations for a depth dependence of TS, still too little is known about the exact influence of the different parameters. As a consequence of this uncertainty in the exact depth dependency of TS in herring, and the relatively small impact of the corrections on the perception of spawning stock biomass (see below), the group concluded that there was no rationale for using depth corrections until more reliable data become available.

5.2 Variability in herring depth distribution and the impact of TS depth dependence on survey results.

It is known that, in theory, herring should have a variable target strength with depth. This is due to herring having a vented swim bladder without a gas gland. The background to this is discussed in Section 5.1 (above). Given that the acoustic surveys produce an index of stock size rather than an absolute estimate, the most important consequence of TS depth dependence would be if the depth distributions of herring altered markedly between years. A study of herring depth distribution for the Scottish acoustic survey in July 1991-97 was carried out to determine the scale of variability and it's potential impact on the accuracy of the abundance index. The full results are presented in the working document attached as Appendix V. Briefly, the study showed that there were variations in depth distribution between years. Median depth varied between 85 and 125m. However, there was no evidence of a trend in depth distribution over years. A preliminary equation developed for TS depth dependency was applied to these data. This analysis suggested that depth distribution changes would result in a maximum change of ∀4% in the calculated index value. It was thus concluded that, provided the survey estimate was used as an index, depth variation between years was not a major source of inaccuracy.

6 HERSUR

The HERSUR II project is a European Union funded study (contract no. 99/006) aimed at developing an international database for acoustic and biological data for North Sea and west of Scotland herring. Specific tasks for the project include:

- *Further development and maintenance of an international database for acoustic data and biological sampling data from hydroacoustic surveys;*

- *Exchange of national historical data as well as newly obtained data into the international database;*

- *Analysis of the national need for data and reports from the international database for studies and analyses at the national institutes. Development of software for export of reports from the international database to national institutes;*

- *Investigation of the possibilities for an international abundance estimation system based on all the international data stored in the database and if possible requirement specification of the system.*

The HERSUR database is now operational on a dedicated server at the Danish Institute for Fisheries Research (DIFRES). The website for entering and validating data was demonstrated at the meeting (http://ff07.dfu.min.dk /hersur). The last revision of the exchange format and a users manual for the international acoustic database were handed out at the meeting and will be distributed to participants in an electronic format.

To date, only Germany and Denmark have tried to enter acoustic and biological data into the database. It was, therefore, decided that all participating countries should try to convert the data sets from the acoustic survey in 2000 into the XML format and export the data into the database. This should be carried out in the first quarter of 2001. A username and password for the HERSUR database can be obtained directly from Peter Faber at DIFRES (pf@dfu.min.dk). Examples of the 6 record types in the flat files used as input are given in Table 5. DIFRES personnel will visit participating institutes in April-May 2001 to discuss and solve possible difficulties in entering national data into the database.

Each participating country assessed the status of its historical data in order that it may be entered into the database. The data sets available by country are as follows:

Scotland, North Sea: since 1989 (except for 1991)

west of Scotland: since 1992 (except for 1997)

Netherlands: since 1991

Germany: since 1995

Denmark: since 1991 (except 1998)

Norway: since 1990

It was decided that all available data back to 1991 should be entered to the HERSUR database. Data from the surveys in 1999 and 2000 should be entered as a priority in 2001 and the rest of the datasets will follow as soon as possible.

At the meeting DIFRES, presented the first reports made on data stored in the database. The planning group discussed the needs and wishes of participants for data export and reports from data stored in the database. Based on these discussions, DIFRES will continue to develop the facilities for data export and presentation from the database.

The planning group discussed the need for an international abundance estimation system based on all the international data stored in the database. The group found that it would be important in the long run to establish an international estimation system in addition to the database. It was decided that a sub-group should specify the requirements for this abundance estimation system. This group will consist of K-J. Staehr and P. Faber (Denmark), E.J. Simmonds (UK, Scotland) and S. Jansen (Germany). At the beginning of January 2001 the sub-group will ask all participating institutes to describe national procedures used in the calculation of abundance and biomass of herring in acoustic surveys (K-J Staehr responsible). In mid February 2001 a description of a framework for an estimation system will be sent to participating institutes for comments (J. Simmonds responsible). The sub-group will then meet at the HAWG (1 day in March 2001 in Hamburg, Germany) to start work on a requirement specification for an estimation system.

HERSUR II project funding will cease at the end of 2001. Implementation and coordination of the international larvae and acoustic herring surveys may be financed through the new EU funding system for national monitoring. However, the two tasks of collecting historical herring tagging data and the construction of an international global abundance estimation system, can not be included in the latter funding system. The planning group therefore recommends that an EU study/project should be proposed in the coming year to continue the work with historical herring tagging data and construction of an international global abundance estimation system based on the HERSUR database.

7 RECOMMENDATIONS

The Planning Group for Herring Surveys recommends that:

- The Planning Group for Herring Surveys should meet in Hamburg, Germany, from 14 to 18 January 2002 under the Chairmanship of P.G. Fernandes (UK, Scotland) to:

a) coordinate the timing, area allocation and methodologies for acoustic and larvae surveys for herring and sprat in the North Sea, Division VIa and IIIa and Western Baltic;

b) combine the survey data to provide estimates of abundance for the population within the area;

c) examine consistency in the measurement of biological parameters, specifically:

   i. verification of maturity stage measurements of herring and sprat;

   ii. age reading of herring and sprat;

d) investigate the effect of time of day on the detection of herring during the acoustic survey. Members should prepare a brief statistical evaluation of their acoustic data to present at the next meeting.

Justification

Term of reference a) and b)

The surveys are currently carried out by five different countries, covering the whole of the North Sea, Western Baltic and the west coast of Scotland. Effective coordination and quality control for these surveys is essential and while data combination can be managed by mail, a meeting is required to ensure that the larvae database is being used correctly and that the acoustic surveys are being carried out and analysed on a consistent basis.

Term of reference c)

A number of minor inconsistencies in the reporting of ages and maturity stages in individual survey reports have come to light. The results are used as indices at age and so it is vital that these are reported in an entirely consistent manner. During next years coordinated survey, samples of herring and sprat will be taken and kept such that an otolith exchange programme can be set up. A photographic record will also be kept of the various maturity stages of herring to confirm the consistency of the staging process. The results of both of these exercises will be examined at the 2002 meeting.

Term of reference d)

There are many examples of herring dispersing and rising into surface waters at night. This behaviour makes them unavailable to the acoustic apparatus used in the coordinated acoustic survey. To mitigate for this, some of the acoustic surveys suspend operations at night. However, the amount of time and the start and end points varies amongst participants. The aim of this TOR is to examine the influence of time of day on the abundance estimation of herring such that consistent appropriate timings to the start and end of the survey day can be implemented.

- The Planning Group recommends that additional biological samples be taken from the national acoustic surveys:

   i) A random sample of 10 herring from each trawl station should be frozen and retained in national laboratories at least until 31 January 2002.

   ii) Six herring (across all size and maturity ranges) from 5 different areas should be photographed for maturity verification and a pair of otoliths should be taken from each fish. Otoliths and digital photographs should be sent to John Simmonds by 31 August 2001.

   iii) Three frozen samples of about 1 kg of various sizes of sprat from the whole survey are for maturity verification. These samples should be sent to Chris Zimmermann by 15 December.

iv) 50 pairs of sprat otoliths should be collected from different sized fish throughout the survey area. These should be sent to Else Torstensen as soon as possible.

- The Planning Group recommends that nations participating in the acoustic surveys should try, where possible, to exchange staff between surveys, to ensure a consistent scrutinizing and evaluation approach, and consistent quality.

- The Planning Group recommends that the area overlap between *Scotia* and *Michael Sars* be extended to include ICES rectangles 46E9, 47E9, 49E9 and 50E9 with a spacing of no more than 7.5 n.mi.. If necessary the area in the north eastern part of that covered by *Michael Sars* (north of 60°30'N) could be covered at 30 n.mi. spacing as this has consistently contained very few fish.

- The Planning Group recommends that results from the acoustic survey and the larvae survey be posted on the "Clupea.net" website.

- The Planning Group recommends that due consideration be given to sprat and 0 ring herring in the acoustic survey. 1 ring fish should be examined closely for maturity to be reported as immature and mature. Survey boundaries should be maintained as in the current report to cover the areas where these smaller fish occur.

- The Planning Group recommends that acoustic survey data from 1991 onwards be archived into the HERSUR database. Members should aim to have data from at least 1999 and 2000 prepared in an appropriate format by May 2001 such that data from these years can be archived by June 2001.

- The Planning Group recommends that the global abundance estimation method specified within the HERSUR project be developed to use the data archived in the HERSUR database to produce the annual biomass estimates and indices at age from the coordinated herring acoustic survey.

- The Planning Group recommends that a database be set up to incorporate existing historical tagging data into an accessible format. This would contribute to improved understanding of migration patterns with a view to improving survey design, and enhancing stock assessment and management advice.

- The Planning Group notes that despite recommendations from this group over the past two years, efforts are not being made to cover the whole Sub-division IIIa during the October survey on Baltic Spring Spawning Herring. If there is a need for this survey to deliver an index to the HAWG, that group must endorse these recommendations.

- The Planning Group recommends that a review be made of existing documentation on larvae survey methods, including data collection and analysis.

- The Planning Group recommends that the format of individual acoustic survey reports from the coordinated North Sea herring acoustic survey be rationalised such that the same type of figures and tables are presented for each individual (national) survey. The Chairman will circulate a proposal and attach examples (templates) for members to consider. The final format will be decided upon at the meeting in 2002.

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Eltink, A.T.G.W., Newton, A.W. Morgado, C., Santamaria M.T.G. and Modin, J. (2000). Guidelines and tools for age reading comparisons. European Fish Ageing Network Report 3-2000 available from http:\www.efan.no

ICES (2000a). Report of the herring assessment Working Group for the area south of 62°N. *ICES CM 2000*/ACFM:10.

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Table 1a. Total numbers and biomass of North Sea autumn spawning herring in the area surveyed in the acoustic surveys June-July 2000, with mean weights and fraction mature by winter ring.

North Sea	Numbers (millions)	Biomass (Tonnes $*10^6$)	Maturity (fraction)	mean weight (g)
0	7549.5	39.1	0.00	5
1	24509.2	1139.4	0.00	46
2	2773.2	326.1	0.66	118
3	1995.9	360.2	0.96	180
4	2871.0	626.6	1.00	218
5	923.5	214.4	1.00	232
6	442.8	115.4	1.00	261
7	243.9	71.9	1.00	295
8	111.5	33.5	1.00	300
9+	91.9	25.8	1.00	280
Immature	33101.0	1230.9		
Mature	8411.5	1682.4		
Total	41512.5	2952.5		

Table 1b. Total numbers and biomass of Western Baltic spring spawning herring in the area surveyed in the acoustic surveys July 2000, with mean weights and fraction mature by winter ring.

Baltic Spring Spawners	Numbers (millions)	Biomass (Tonnes $*10^6$)	Maturity (fraction)	mean weight (g)
0	0.0	0.0	0.00	
1	1509.2	61.4	0.00	40.7
2	1891.1	138.1	0.42	73.1
3	673.6	68.8	0.80	102.2
4	363.9	42.6	1.00	117.1
5	185.7	25.1	1.00	135.4
6	55.6	6.8	1.00	122.6
7	6.9	1.4	1.00	208.8
8	9.6	0.1	1.00	11.8
9+	0.0	0.0		
Immature	2736.0	155.2		
Mature	1959.5	189.3		
Total	4695.5	344.5		

Table 1c. Total numbers and biomass of autumn spawning of west of Scotland herring in the area surveyed in the acoustic surveys July 2000, with mean weights and fraction mature by winter ring.

west of Scotland	Numbers (millions)	Biomass (Tonnes $*10^6$)	Maturity (fraction)	mean weight (g)
0	0.0	0.0	0.00	
1	447.6	27.8	0.00	62
2	316.2	44.6	0.45	141
3	337.1	58.3	0.92	173
4	899.5	164.6	1.00	183
5	393.4	76.4	1.00	194
6	247.6	50.5	1.00	204
7	199.5	42.2	1.00	211
8	95.0	21.1	1.00	222
9+	65.0	15.0	1.00	230
Immature	648.7	55.5		
Mature	2352.0	444.9		
Total	3000.8	500.5		

Table 2. Preliminary results of the acoustic survey in the Western Baltic, October 2000

Sub-division	Herring numbers (millions)	Sprat numbers (millions)
21	498	7
22	493	419
23	560	7
24	2378	1431
Sum	3929	1864

Table 3. Number of pairs of estimates of herring abundance and ratios of mean abundance from overlapping survey areas (1991 to 2000). Countries: D=Denmark, G=Germany, H=Netherlands, N=Norway, S=Scotland North Sea, W=west of Scotland.

Country pairings	**DG**	**DN**	**GH**	**GN**	**GS**	**HN**	**HS**	**NS**	**SW**
Number of squares	4	62	5	7	3	53	47	69	14
Ratio of means	4.11	4.09	2.33	17.19	2.59	2.79	0.90	0.44	1.29

Table 4. Percentage changes in the 2000 assessment of North Sea herring due to changes in reported mean weights and spawning proportions in the south-western North Sea.

Year	**Recruits**	**Stock**	**SSB**	**Landings**	**Yield**	**F2-6**
1993	-4	-5	0	0	0	-8
1994	-5	-7	-5	0	5	4
1995	-3	-4	-4	0	5	1
1996	-1	1	-2	0	2	5
1997	-3	3	-2	0	2	3
1998	-2	10	5	0	-5	6
1999	-2	-1	1	0	-1	7

Table 5. HERSUR database entry files. Examples of the 6 record types: one cruise, one s_A, and four fisheries (the last CA being German). Note: The first record type is quite long and hence is subject here to a carriage return (making the record two lines long): this carriage return is NOT part of the record.

```
CIDENDAN208199806260716+5841200+1217500+5619900+0357900          Jens          Pedersen                    jp@dfu.min.dk          Person
ukendt                    N/A@dfu.min.dk2B

SADENDAN2081998 701   800      000453000630038D000001+0358100+5826700          0159MMMMMMMMMM0000000018    0008    04580

HH2DENDAN2Fot06000      650029806282247034 56380733E005V       110204630

HE2DENDAN2Fot06000      650029856410733E34740            22055      0020003008  077

HL2DENDAN2Fot06000      65002988747010201010105579325782920140001085 0000001000001

CA3GFR SOL  H20          0459787470117012141G1    0125    3001
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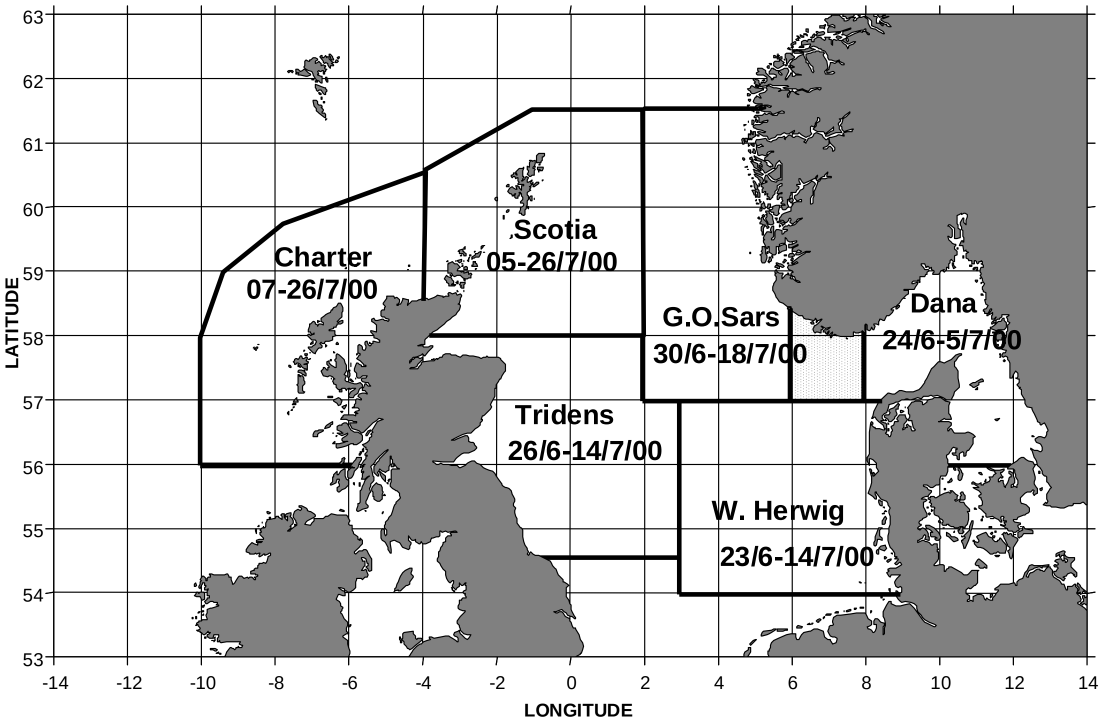

Figure 1. Survey area layouts and dates for all participating vessels in the 2000 North Sea and west of Scotland herring acoustic survey. Shaded areas indicate areas of overlap.

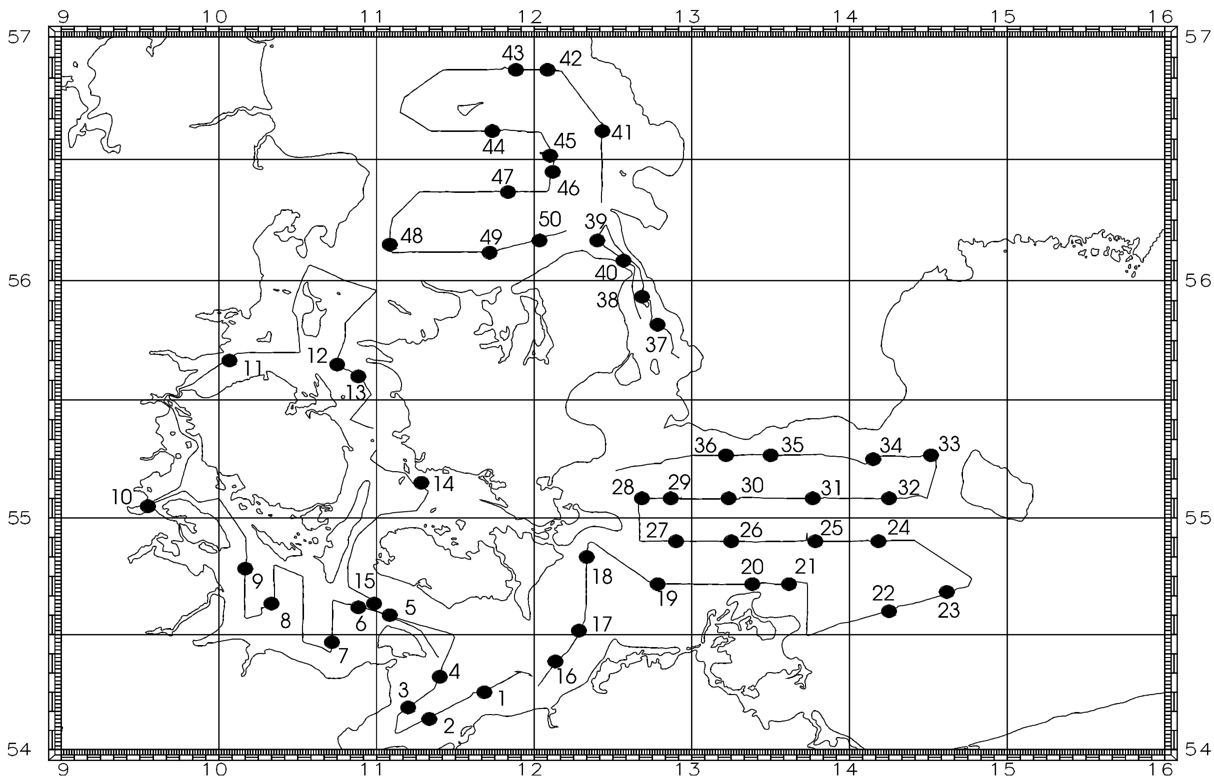

Figure 2. Cruise track of the Western Baltic acoustic survey 2000.

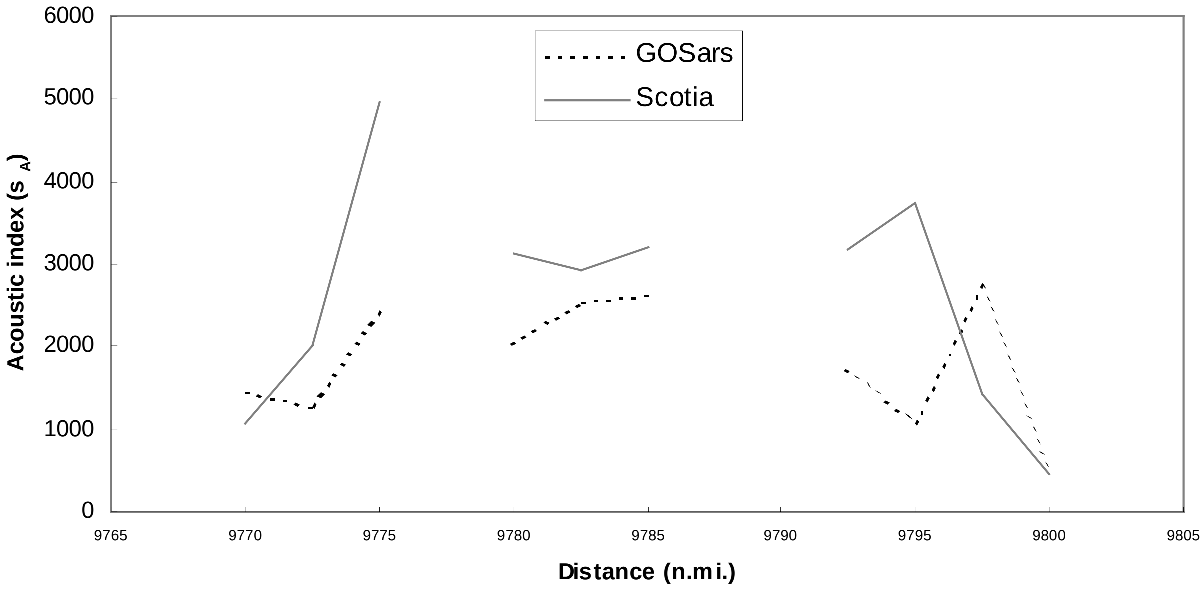

Figure 3. The aligned sequence of s_A values from the intercalibration between *FRV Scotia* and *FRV G.O.Sars* July 2000.

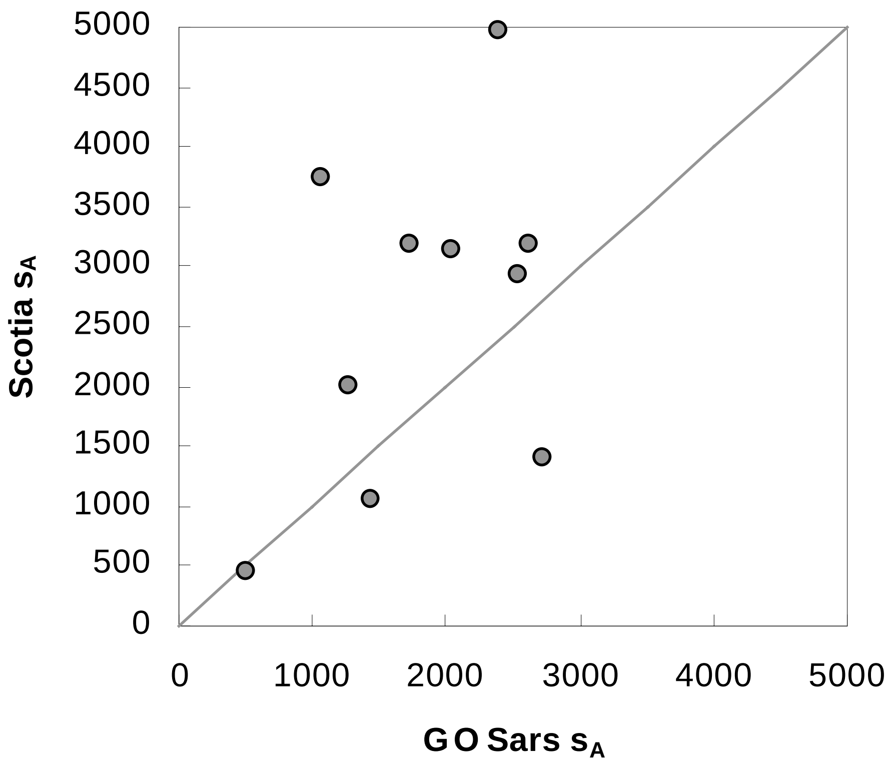

Figure 4. Scatterplot of integrated (s_A) values from 15 minute (2.5 n.mi.) sampling intervals from the intercalibration between *FRV Scotia* and *FRV G.O.Sars* July 2000. Solid line indicates 1:1 relationship.

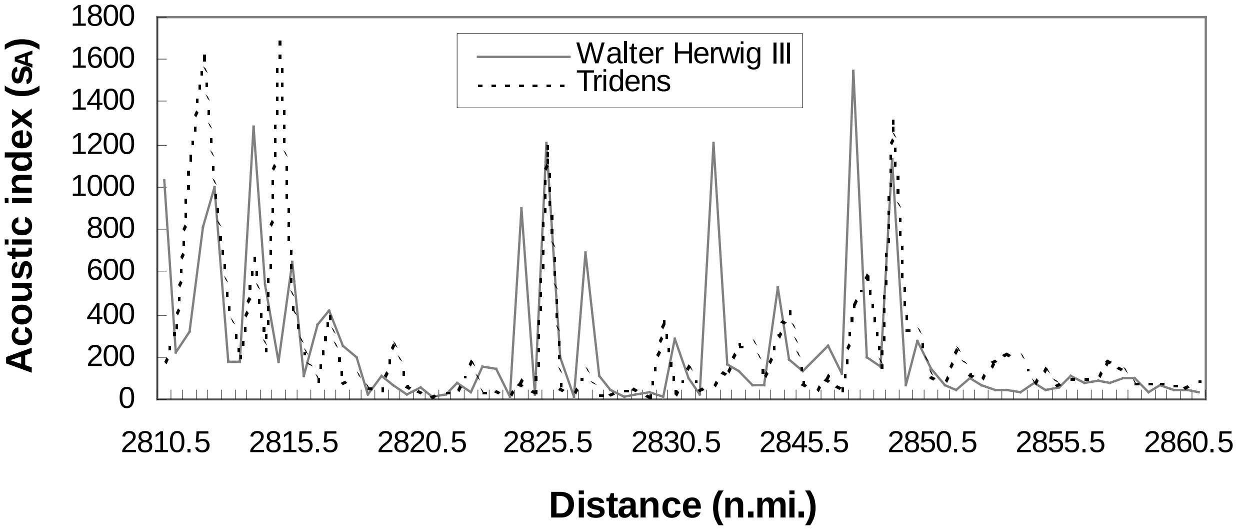

Figure 5. The aligned sequence of s_A values from the intercalibration between *FRV Tridens* and *FRV Walter Herwig III* July 2000.

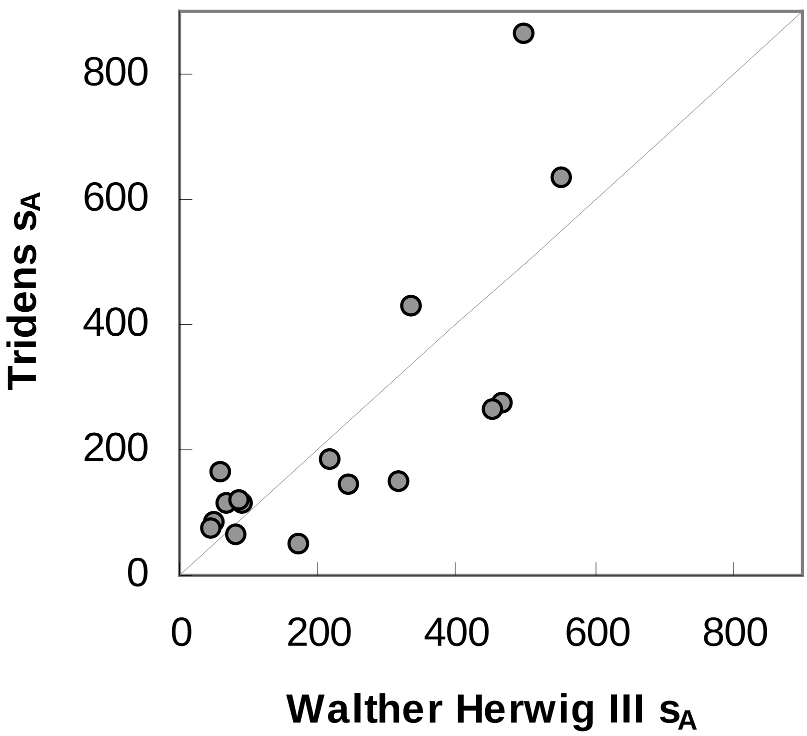

Figure 6. Scatterplot of integrated (s_A) values from 15 minute (2.5 n.mi.) sampling intervals from the intercalibration between *FRV* Tridens and *FRV Walter Herwig III* July 2000. Solid line indicates 1:1 relationship.

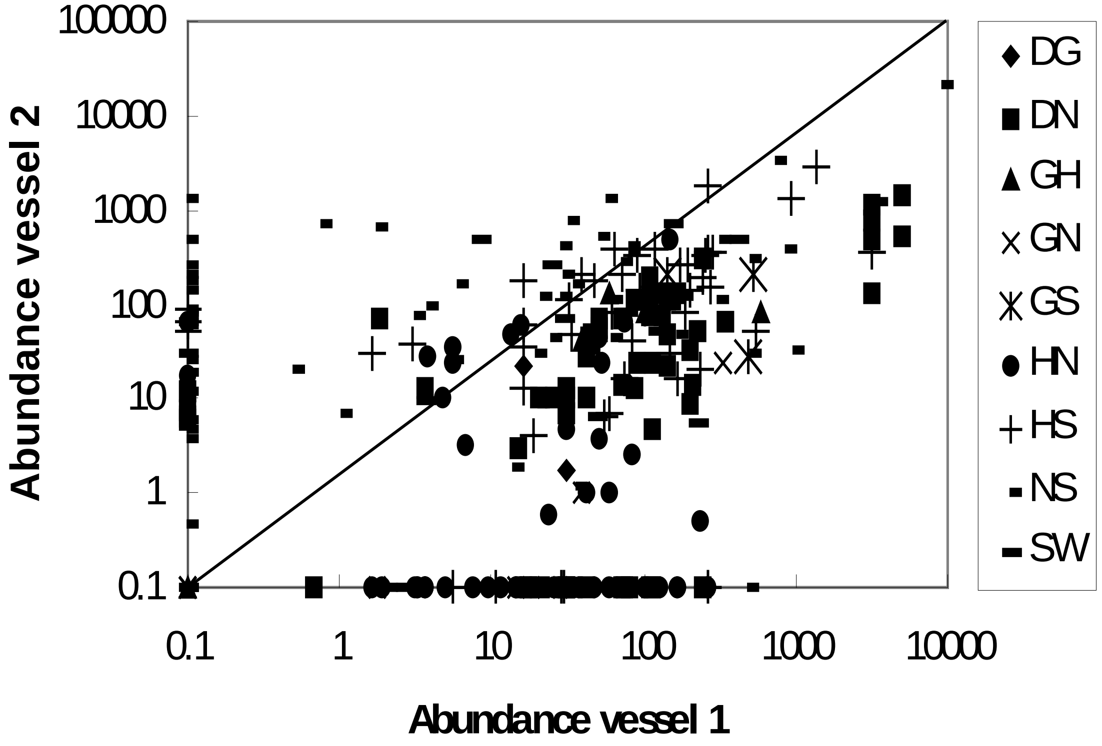

Figure 7. Scatterplot of paired estimates of biomass by statistical rectangle for overlapping survey areas in acoustic surveys 1991-2000. Countries: D=Denmark, G=Germany, H=Netherlands, N=Norway, S=Scotland North Sea, W=Scotland west coast.

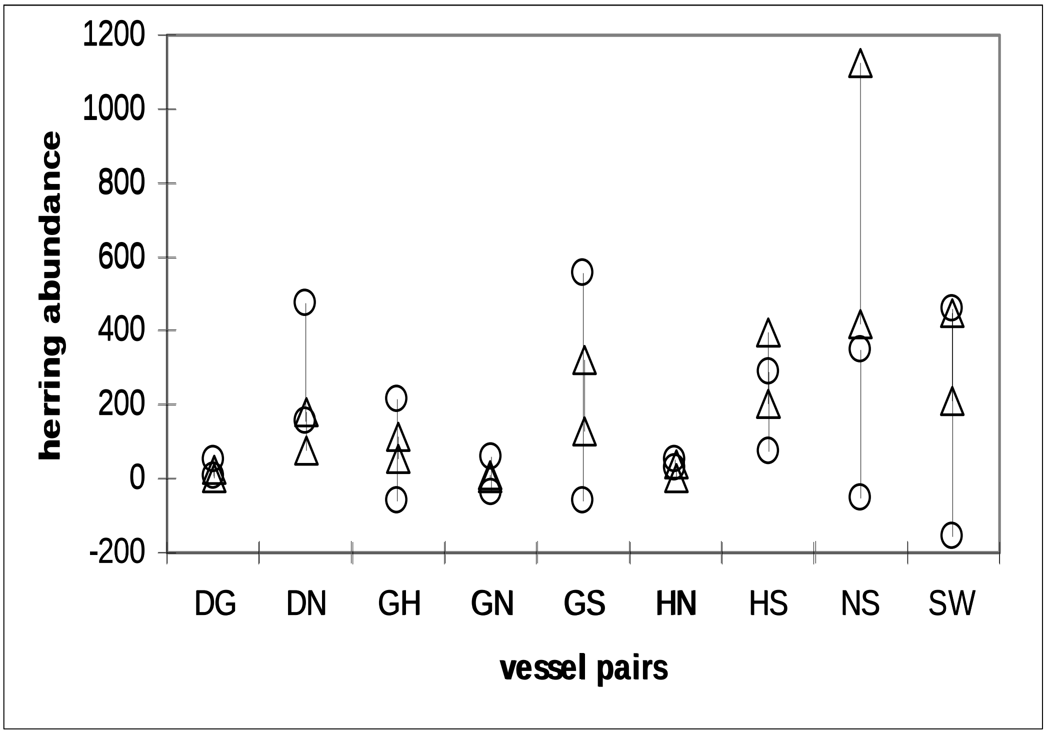

Figure 8. Mean catch rate for overlapping areas ±2 standard errors for pairs of estimates. Countries: D=Denmark, G=Germany, H=Netherlands, N=Norway, S=Scotland North Sea, W=Scotland west coast.

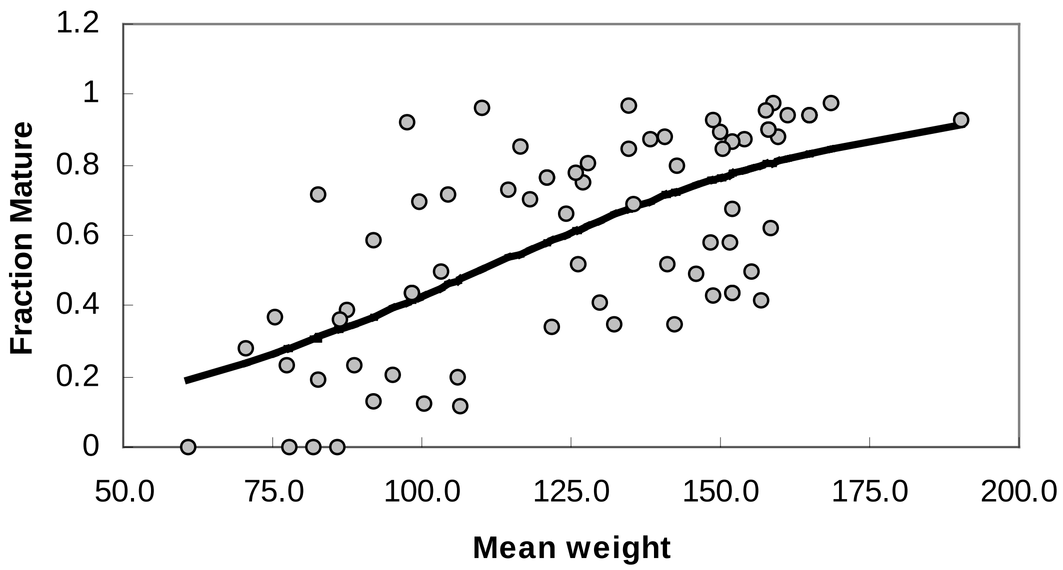

Figure 9 Fraction mature of 2-ring herring against mean weight from 1997-2000 and fitted logistic function for estimating fraction mature from mean weight for 2-ring herring.

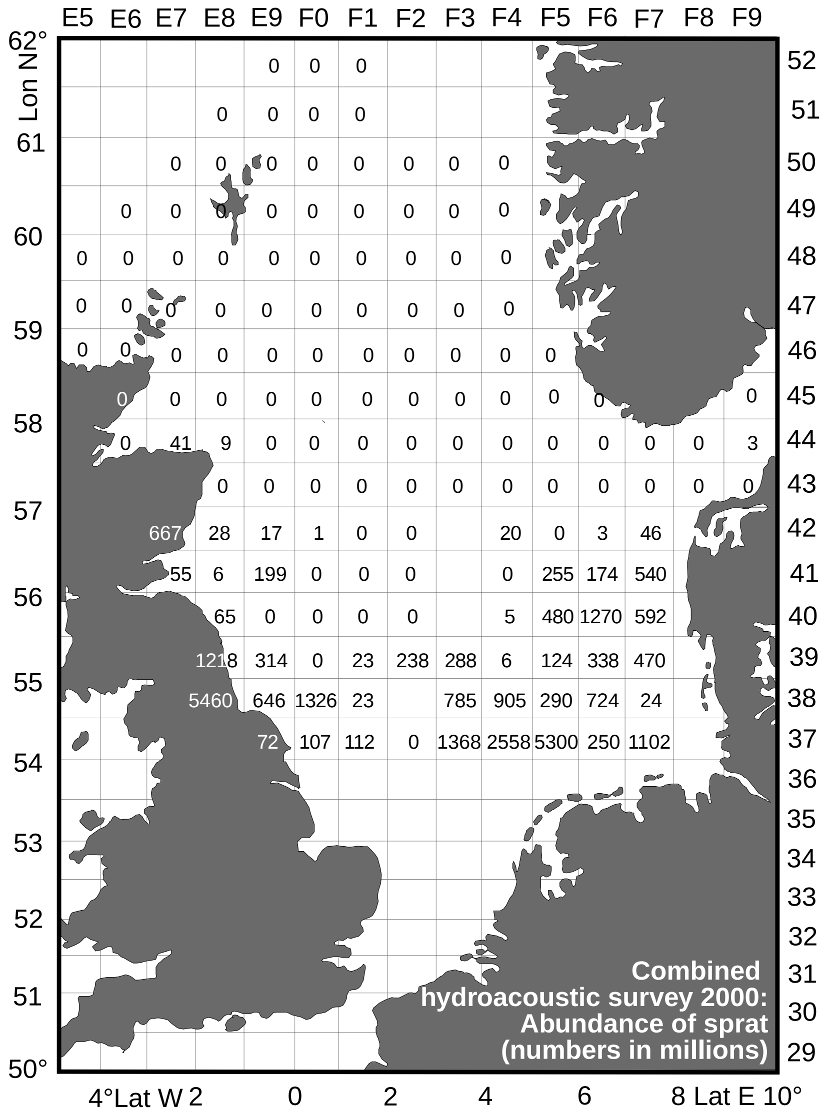

Figure 10. Abundance of sprat (numbers in millions) as obtained from the herring hydroacoustic survey in 2000.

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APPENDIX II THE NORTH SEA ACOUSTIC SURVEYS: INDIVIDUAL REPORTS

APPENDIX IIA WEST OF SCOTLAND

SURVEY REPORT FOR MFV *CHRISTINA S.* IN ICES AREA VIA(N)

7 July - 26 July 2000

D.G. Reid, FRS Marine Laboratory, Aberdeen, UK (Scotland).

Methods

The acoustic survey on the Marine Laboratory Aberdeen charter vessel MFV *Christina S* (7 July to 26 July 2000) was carried out using a Simrad EK500 38 kHz sounder echo-integrator. Further data analysis was carried out using Sonardata Echoview and Marine Laboratory Analysis systems. The survey track (Fig. IIa.1) was selected to cover the area in three levels of sampling intensity based on herring densities found in 1991-99. Areas with highest intensity sampling had a transect spacing of 4.0 n.mi., areas with medium intensity sampling had a transect spacing of 7.5 n.mi. and lower intensity areas a transect spacing of 15 n.mi.. 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^o 45' and 58^o 00'N, along the coast of the Outer Hebrides.

50 trawl hauls (Figure IIa.2 & Table IIa.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 2 per 0.5 cm class below 22 cm, 5 per 0.5 cm class from 20 to 27 cm and 10 per 0.5 cm class for 27.5 cm and above. Fish weights were collected at sea from a random sample of 50 fish per haul.

Data from the echo integrator were summed over quarter hour periods (2.5 n.mi. at 10 knots). Echo integrator data was collected from 9 metres below the surface (transducer at 5m depth) to 1m 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” which were presumed to be mainly gadoids, "sprat traces", and a species mixture category.

The total estimated stock was 523,580 tonnes. The spawning stock biomass (mature herring only) was estimated at 464,240 tonnes. The survey area extended into ICES Sub-area IVa. The observed tonnage in this area was approximately 23,000 tonnes giving a total of 500,580 tonnes in VIa(N). Based on the split between mature and immature for the whole area this would give an SSB estimate of 443,850 tonnes. 64.4% of the stock by number was attributable to the "herring traces", 26.8% to the "probably herring traces", and 8.8% to herring in species mixtures.

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 in three hauls (hauls 5,6 & 30). All three hauls were taken in the Minch and were dominated by young fish. Norway pout and blue whiting which were found commonly throughout the north of the survey area in some previous years were relatively uncommon in 2000. Blue whiting were not caught in any quantity. Isolated hauls showed good catches of pout, however these were usually isolated from herring schools. Mackerel was again relatively common across the area, but posed no identification problems. The fish scored in category 3 were considered as probably not herring. In most cases these were considered to be young gadoids. If they were in fact herring, they would contribute an additional 140,000 tonnes to the overall biomass estimate.

Two calibrations were carried out during the survey, at the beginning and end of the survey. Both calibrations were carried out in ideal conditions, and the constants agreed to within 0.1dB.

To calculate integrator conversion factors the target strength of herring was estimated using the TS/length relationship for clupeoids recommended by the acoustic survey planning group (ICES 2000). 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: $W = 0.008943 \ L^{2.9825}$ g (L measured in cm).

Survey Results

A total of 38 trawl hauls were carried out, the results of these are shown in Table IIa.1. 38 hauls contained more than 50 herring and these hauls were used to define 8 survey sub-areas (Figure IIa.3). The sub-areas were defined as:

I. Minch
II. South
III. Barra Head
IV. South West Hebrides
V. Shelf Break South
VI. Shelf Break North
VII. North VIa(N)
VIII. Lewis

The stock estimate for VIa(N) is up by approximately 7.5% from 1999 (466,000 to 500,580 tonnes). Given the known difficulties of quantifying young fish on this survey, the SSB estimate is likely to give a better index of change. This increased by 5.5% (420,750 to 443,850 tonnes) from 1999 to 2000. There was little evidence of change in distribution. The main concentrations were again at Barra Head, off the coast of Lewis and along the shelf edge North and west of Lewis (Figures IIa.4 & IIa.5). The only major change was that there were more, large fish seen along the shelf break in the southern part of the survey area. Very few herring were seen south of 56^{o} 30'N in contrast to 1998, but similar to 1999. The abundance seen between 4 and 5^{o}W were lower than in 1999.

There are also continued indications of changes in the age and maturity structure of the stock (see Table IIa.3). In 1998, 87% of the two ringers were mature, in 1999 64% were mature and in 2000 only 46% were mature. The proportion of older fish (4+) in the stock increased from 34% in 1998 and 41% in 1999 to 62.5% in 2000. This can be compared with 55% in 1995, 43% in 1996 and 16.6% in 1997. The very strong 4 ring group was seen as a strong 3 ring group in the 1999 survey. It should be noted that the 1997 survey was carried out one month earlier than the other years surveys The stock estimates in the last two years are consistent with the pattern up to 1996. This suggests that the stock situation is relatively stable, and that the 1997 survey can be considered as an underestimate.

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ICES (2000). Report of the planning group for herring surveys. *ICES CM 2000*/G:02 106 pp.

Table IIa.1 Catch composition by trawl haul. *Christina S* (7 – 26 July 2000)

	Position			Numbers caught								
	Latitude (°N)	Longitude (°W)		Herring	Whiting	haddock	pout	mackerel	horse mackerel	blue whiting	sprat	others
1	58 10.87	5 42.30	75	42	84	13	198			3	381	
2	58 02.85	6 13.14	110	104	41	11	1	5		19	9	42 Spurdog
3	57 16.34	7 10.45	80					244			244	
5	56 40.62	7 35.59	90	8864								
6	56 13.92	7 11.45	80	12443								
7	56 06.99	7 33.94	125	1478				4			34747	
8	56 22.61	8 43.88	150	169				50				
9	56 30.92	7 30.98	165	1434	81	36	2790	198		24		12 Hake
10	56 35.41	7 40.78	160	749				10				
11	56 43.69	7 34.00	90	32100								
12	56 35.25	9 00.84	195	650				1785				
13	56 41.65	8 23.31	125	3180								
14	56 47.41	9 00.62	135									Basket of *Sebastes viviparous*
15	56 51.46	8 16.32	130	25575				1650				
16	57 11.61	8 02.91	130	6			Many meshed					
17	57 18.60	8 47.11	140	8670	30	90		3240				
18	57 18.00	9 20.22	300									
19	57 19.50	9 17.04	170	1368		12	168	552				
20	57 38.00	9 02.38	150	1404				70				
21	57 37.70	9 23.13	180	4636				808				
22	57 56.94	8 52.67	155	21970				1558				
23	58 11.35	8 01.15	125	1806				286				
24	58 11.59	7 10.93	130	2477				49				1 salmon
25	58 19.00	7 54.43	125	12540								
26	58 26.47	7 16.98	100	1085				30				
27	58 31.24	6 06.72	65	29	402	271		338				
28	58 08.56	5 40.48	140		Some meshed	Some meshed						
29	58 11.31	5 41.00	60	3			486				6105	
30	58 26.90	6 03.33	75	26026								
31	58 35.22	6 34.89	90	83			Many meshed					
32	58 33.94	7 48.96	140	2535				233				
33	58 41.43	6 48.53	103	225				15				
33	59 02.86	4 59.09	60				620	42				

Table IIa.1. Catch composition by trawl haul. *Christina S* (7 – 26 July 2000)

	Position			Numbers caught								
	Latitude (°N)	Longitude (°W)		Herring	Whiting	haddock	pout	mackerel	horse mackerel	blue whiting	sprat	others
34	58 41.58	6 08.61	125	2941	63		287	70			63	
35	58 48.50	5 43.16	125	2664				84				
36	58 48.59	7 22.63	100	6195				560				
37	58 56.24	7 12.20	125	217				1062				
38	58 56.55	6 46.80	170	2502				532				
39	59 04.05	5 08.39	58									
40	59 03.88	5 19.49	110	7905				150				
41	59 11.38	6 45.70	170	6299				2150				
42	59 10.14	6 56.73	180									
43	59 11.60	6 43.50	130	896				9				
44	59 11.54	4 32.46	100	924				2178				
45	59 19.05	4 51.95	100	10			66	35				
46	59 19.09	6 13.38	160	1412				18				
47	59 26.56	6 05.05	150	1555				240				
48	59 34.48	4 14.75	100	114	2	2	7					38 Gurnard
49	59 34.00	5 49.57	125	376				10				
50	59 22.39	3 46.75	150	1804				35			19	

Table IIa.2. Herring length frequency by trawl haul by sub- area. *Christina S* (7 – 26 July 2000) mean length - cm, mean weight - g, target strength - dB)

Haul No	Area I				Area II	Area III					Area IV				Area V						
	2	30	34	Mean	7	5	9	10	11	Mean	13	15	17	Mean	8	12	19	20	21	22	Mean
13.0																					
13.5																					
14.0																					
14.5																					
15.0	1.0			0.3																	
15.5	1.0			0.3																	
16.0	14.4	0.7		5.0	0.5																
16.5	21.2	1.4		7.5	0.8																
17.0	33.7	0.7		11.4	10.7		0.4			0.1											
17.5	14.4	1.4	0.5	5.4	17.2		0.4			0.1											
18.0	11.5	7.6	5.7	8.3	21.1		0.9			0.2											
18.5	1.9	8.9	14.1	8.3	18.3		0.2			0.1											
19.0		19.9	19.9	13.3	12.9		0.2		0.2	0.1											
19.5	1.0	24.1	19.4	14.8	5.6	0.2	0.2		0.7	0.2											
20.0		18.5	17.8	12.1	5.6	0.2	0.4		1.0	0.4											
20.5		8.9	10.5	6.5	2.2		0.7		1.2	0.5											
21.0		1.4	4.7	2.0	1.7		0.4		1.9	0.6											
21.5		2.1	4.2	2.1	1.7				1.0	0.2											
22.0		0.4	0.1	0.2	0.5		0.4		1.2	0.4											
22.5		0.4	0.5	0.3		0.2	0.4		0.5	0.3											
23.0		0.9	0.3	0.4	0.3	0.8	1.5		3.1	1.3											
23.5		0.6	0.5	0.4	0.3	1.8	10.3		5.5	4.4		0.3		0.1							
24.0		0.8	0.7	0.5	0.3	4.8	17.0	0.7	11.1	8.4	0.5	0.6		0.4							
24.5		0.6	0.2	0.3		7.4	20.7	1.1	11.6	10.2	0.5	0.6	0.3	0.5	0.6						0.1
25.0		0.2	0.2	0.2		8.6	15.4	1.3	9.9	8.8	1.4	5.3	1.7	2.8							
25.5		0.3		0.1		7.1	4.9	1.1	5.5	4.7	2.8	4.4	2.8	3.3	1.2						0.2
26.0		0.1		0.0		6.6	2.8	1.6	6.5	4.4	8.5	11.1	14.2	11.3	2.4		1.3	2.8	0.6		1.2
26.5		0.1		0.0		6.9	3.3	4.3	7.2	5.4	9.9	15.2	16.3	13.8	4.7	1.5	5.7	10.7	2.6	2.4	4.6
27.0						13.0	4.4	9.3	12.1	9.7	23.6	21.7	26.0	23.7	17.2	2.3	18.4	28.2	11.7	16.6	15.7
27.5		0.0		0.0		12.4	4.1	16.7	5.9	9.8	17.9	18.2	20.8	19.0	18.3	10.5	20.6	18.1	17.5	29.0	19.0
28.0		0.0	0.1	0.1		11.2	4.4	19.0	8.0	10.6	17.9	14.7	13.8	15.5	20.1	15.4	16.7	18.1	23.9	23.1	19.5
28.5			0.2	0.1		7.1	2.0	14.4	2.9	6.6	9.4	5.9	2.8	6.0	13.6	17.7	13.6	11.5	19.7	14.2	15.1
29.0			0.1	0.0		4.8	1.1	13.4	1.9	5.3	4.2	1.5	1.4	2.4	13.6	26.2	14.0	6.0	15.5	10.7	14.3
29.5					0.3	3.0	2.0	7.3	0.5	3.2	1.9	0.3		0.7	6.5	16.9	7.0	4.6	6.8	3.0	7.5
30.0		0.0		0.0		2.5	0.7	6.4	0.5	2.5	1.4	0.3		0.6	1.8	8.5	1.8		1.0	1.2	2.4
30.5						1.0	0.4	2.7		1.0						0.8	0.4		0.6		0.3
31.0						0.2	0.2	0.3		0.2						0.3	0.4				0.1
31.5								0.3		0.1											
32.0								0.3		0.1											
32.5																					
33.0																					
33.5																					
34.0																					
34.5																					
Number	104	25827	2941		1478	8864	1374	749	31100		3180	25575	8670		169	650	1368	1404	4635	21970	
mean lgt	17.5	20.0	20.2	19.2	19.0	27.2	25.5	28.6	25.9	26.8	27.9	27.5	27.5	27.6	28.4	29.2	28.5	28.1	28.6	28.4	28.5
mean wt	45	69	70	62	59	172	142	199	150	166	183	175	176	178	194	210	195	187	198	193	196
TS/ind	-46.4	-45.1	-45.1	-45.5	-45.6	-42.5	-43.0	-42.1	-42.9	-42.6	-42.3	-42.4	-42.4	-42.4	-42.1	-41.9	-42.1	-42.2	-42.1	-42.1	-42.1
TS/kg	-32.9	-33.5	-33.6	-33.4	-33.3	-34.8	-34.6	-35.0	-34.6	-34.8	-34.9	-34.9	-34.9	-34.9	-35.0	-35.1	-35.0	-34.9	-35.0	-35.0	-35.0

Table IIa.2 (cont.). Herring length frequency by trawl haul by sub area. *Christina S* (7 to 26 July 2000) mean length - cm, mean weight - g, target strength - dB)

Haul No	Area VI											Area VIII						
	23	25	32	36	37	41	43	46	47	49	Mean	35	38	40	44	48	50	Mean
15.5																		
16.0																		
16.5																		
17.0																		
17.5																		
18.0																		
18.5																		
19.0												0.5						0.1
19.5																		
20.0																		
20.5													0.6					0.1
21.0												0.5			0.3			0.1
21.5												0.9						0.2
22.0												0.5						0.1
22.5												0.9			0.3			0.2
23.0												2.3						0.4
23.5												4.1			0.7		0.6	0.9
24.0		0.5						0.6			0.1	18.9	0.6	0.6	2.0		1.1	3.9
24.5												23.0	4.5	0.6	3.3	0.9	1.1	5.5
25.0	0.3	1.4		4.0	0.5	0.4				0.5	0.7	14.4	8.9	4.6	4.9	7.0	3.9	7.3
25.5	1.3	5.3		3.4				0.6	1.3	1.1	1.3	8.1	10.1	3.4	11.4	3.5	5.5	7.0
26.0	8.6	15.3	1.8	6.2	1.4	0.4	0.3	0.6	1.9	0.5	3.7	8.1	15.6	6.8	14.4	12.3	7.8	10.8
26.5	23.9	23.9	4.7	11.9	3.7	3.2	2.7	4.5	8.4	5.3	9.2	6.3	17.9	15.9	19.3	13.2	13.3	14.3
27.0	29.9	23.9	11.8	25.4	18.9	7.9	13.1	22.1	16.7	14.4	18.4	5.0	18.4	31.9	22.5	26.3	24.4	21.4
27.5	17.3	17.2	13.6	22.0	22.1	19.8	14.7	26.6	21.2	17.6	19.2	2.3	11.2	14.8	8.8	18.4	13.3	11.5
28.0	10.6	10.5	26.0	15.3	24.4	19.8	17.1	21.5	16.1	21.8	18.3	2.0	8.4	10.2	8.2	9.6	12.2	8.4
28.5	4.3	1.4	21.3	6.8	13.4	9.9	11.0	11.9	11.6	18.6	11.0	1.6	2.8	5.7	3.6	5.3	6.7	4.3
29.0	1.7	0.5	11.8	3.4	6.9	9.9	10.7	7.4	14.1	8.5	7.5	0.5	1.1	1.5	0.3	3.5	6.1	2.2
29.5	1.0		7.1	1.1	3.7	6.4	6.7	1.4	2.6	6.4	3.6	0.2		1.3			1.2	0.5
30.0	0.7		0.6		2.8	5.6	6.0	1.1	1.9	1.9	2.1	0.2		1.1			1.2	0.4
30.5	0.3		0.6		0.5	5.6	4.7	0.7	1.9	0.8	1.5			0.6			1.0	0.3
31.0				0.6	1.4	5.2	4.7	0.6	0.6	1.3	1.4			0.6			0.4	0.2
31.5						2.4	4.4		0.3	1.1	0.8			0.4				0.1
32.0			0.6			1.6	1.0			0.3	0.3						0.1	0.0
32.5					0.5	0.8	0.7	0.3			0.2							
33.0						0.6	1.0		0.6		0.2							
33.5						0.2	0.2		0.3		0.1							
34.0						0.2	0.3				0.1						0.1	0.0
34.5									0.3		0.0							
35.0						0.2	0.2				0.0							
35.5								0.1			0.0							
36.0							0.2				0.0							
36.5							0.2				0.0							
37.0																		
Number	1806	12540	2535	6195	217	6299	896	1412	1555	376		2664	2506	7905	918	114	1804	
Mean lgt	27.6	27.3	28.6	27.7	28.4	29.2	29.2	28.3	28.5	28.6	28.3	25.5	27.0	27.6	27.0	27.4	27.7	27.0
Mean wt	178	172	197	180	194	210	212	191	195	197	193	141	166	178	166	175	179	168
TS/ind	-42.4	-42.5	-42.1	-42.3	-42.1	-41.9	-41.9	-42.2	-42.1	-42.1	-42.1	-43.1	-42.6	-42.4	-42.6	-42.4	-42.4	-42.6
TS/kg	-34.9	-34.8	-35.0	-34.9	-35.0	-35.1	-35.1	-35.0	-35.0	-35.0	-35.0	-34.6	-34.8	-34.9	-34.8	-34.8	-34.9	-34.8

Table IIa.2 (cont.). Herring length frequency by trawl haul by sub-area. *Christina S* (7 to 26 July 2000) mean length - cm, mean weight - g, target strength - dB)

Haul No	Area VI				
	24	26	31	36	Mean
15.5					
16.0					
16.5					
17.0					
17.5					
18.0					
18.5				0.9	0.2
19.0				13.8	3.4
19.5	0.6			20.0	5.1
20.0	0.3			23.1	5.8
20.5	1.1		1.2	12.9	3.8
21.0				11.1	2.8
21.5	0.6	0.5		6.7	1.9
22.0	0.3	1.4	1.2	3.1	1.5
22.5		0.5	2.4	1.8	1.2
23.0	0.8	2.3	10.8	1.3	3.8
23.5	1.4	5.1	10.8	1.3	4.7
24.0	2.8	5.5	13.3	1.8	5.8
24.5	2.0	6.9	8.4	0.4	4.4
25.0	2.5	9.7	4.8		4.3
25.5	1.1	9.7	1.2	0.4	3.1
26.0	5.0	10.6	2.4		4.5
26.5	23.5	11.1	4.8	0.9	10.1
27.0	29.8	14.3	3.6	0.4	12.0
27.5	15.8	9.7	7.2		8.2
28.0	9.5	8.3	9.6		6.9
28.5	1.7	2.3	4.8		2.2
29.0	0.6	2.3	2.4		1.3
29.5	0.6		7.2		1.9
30.0			1.2		0.3
30.5			2.4		0.6
31.0					
31.5					
32.0					
32.5					0.5
33.0					
33.5					
34.0					
34.5					
35.0					
35.5					
36.0					
36.5					
37.0					
Number	2477	1085	83	225	
mean lgt	27.1	26.5	26.2	20.9	25.2
mean wt	169	158	156	79	140
TS/ind	-42.5	-42.7	-42.8	-44.8	-43.1
TS/kg	-34.8	-34.7	-34.7	-33.7	-34.6

Table IIa.3. Herring numbers and biomass by age, maturity and area. *Christina S* (7 to 26 July 2000)

Category	Number x 10^{-6}	Mean Length (cm)	Mean weight (g)	Biomass (tonnes x10^{-3})
Area I (Minch)				
1 ring	373.85	18.57	59.81	22.36
2 ring immature	10.26	22.39	103.49	1.06
2 ring mature	1.33	24.15	127.68	0.17
3 ring immature	0.10	23.50	116.75	0.01
3 ring mature	0.18	25.67	151.12	0.03
4	0.49	27.70	189.63	0.09
5	0.35	28.41	203.70	0.07
6	0.00			0.00
7	0.00			0.00
8	0.00			0.00
9+	0.06	30.00	238.60	0.01
Total	386.62	18.72	61.58	23.81
Area II (South)				
1 ring	12.60	18.38	57.58	0.73
2 ring immature	0.14	22.36	101.52	0.01
2 ring mature	0.03	24.00	124.16	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+	0.03	29.50	227.12	0.01
Total	12.81	18.46	58.70	0.75
Area III (Barra Head)				
1 ring	3.32	20.61	80.99	0.27
2 ring immature	24.13	24.34	129.79	3.13
2 ring mature	12.85	24.81	137.13	1.76
3 ring immature	1.14	26.49	165.87	0.19
3 ring mature	8.45	26.49	166.03	1.40
4	13.28	27.32	181.67	2.41
5	11.18	27.81	191.44	2.14
6	10.58	28.17	198.78	2.10
7	5.82	28.80	212.17	1.24
8	2.80	29.13	219.50	0.61
9+	3.49	29.82	165.70	0.82
Total	97.03	26.32	165.70	16.08

Table IIa.3 (continued)

Category	Number x 10^{-6}	Mean Length (cm)	Mean weight (g)	Biomass (tonnes x10^{-3})
Area IV (South West Hebrides)				
1 ring	0.00			0.00
2 ring immature	11.52	25.46	147.87	1.70
2 ring mature	16.00	25.84	154.39	2.47
3 ring immature	2.04	25.92	155.54	0.32
3 ring mature	41.86	26.90	173.72	7.27
4	90.45	27.06	176.69	15.98
5	33.51	27.71	189.30	6.34
6	16.06	27.89	192.82	3.10
7	12.71	28.34	202.27	2.57
8	4.34	28.22	199.80	0.87
9+	0.63	29.52	227.76	0.14
Total	229.13	27.11	177.93	40.77
Area V (Shelf Break South)				
1 ring	0.00			0.00
2 ring immature	3.80	25.74	152.66	0.58
2 ring mature	6.27	26.27	161.77	1.01
3 ring immature	7.36	26.77	171.08	1.26
3 ring mature	121.80	27.21	179.61	21.88
4	264.09	27.55	186.06	49.14
5	230.21	27.94	194.08	44.68
6	157.37	28.40	203.49	32.02
7	144.41	28.63	208.52	30.11
8	71.70	29.17	220.06	15.78
9+	44.67	29.27	222.30	9.93
Total	1051.68	28.04	196.25	206.39
Area VI (Shelf Break North)				
1 ring	0.00			0.00
2 ring immature	11.00	25.91	155.74	1.71
2 ring mature	7.78	26.08	158.80	1.23
3 ring immature	4.13	26.80	171.58	0.71
3 ring mature	48.79	26.93	174.36	8.51
4	280.86	27.47	184.67	51.87
5	87.75	28.11	197.56	17.34
6	51.69	28.75	211.42	10.93
7	31.11	29.50	228.11	7.10
8	13.08	30.05	241.10	3.15
9+	11.72	30.80	260.07	3.05
Total	547.90	27.84	192.72	105.59

Table IIa.3 (continued)

Category	Number x 10^{-6}	Mean Length (cm)	Mean weight (g)	Biomass (tonnes x10^{-3})
Area VII (North VIa(N))				
1 ring	3.52	21.17	86.79	0.31
2 ring immature	97.74	24.86	138.12	13.50
2 ring mature	95.50	25.78	153.75	14.68
3 ring immature	14.54	26.42	164.66	2.39
3 ring mature	104.56	26.49	166.04	17.36
4	245.70	27.35	182.43	44.82
5	19.92	28.19	199.64	3.98
6	3.60	28.87	214.38	0.77
7	2.20	29.98	238.91	0.53
8	0.34	31.05	264.07	0.09
9+	0.42	31.41	275.04	0.11
Total	588.03	26.52	167.58	98.54
Area VIII (Lewis)				
1 ring	55.10	20.20	75.57	4.16
2 ring immature	37.45	23.93	123.74	4.63
2 ring mature	25.67	24.82	138.27	3.55
3 ring immature	2.13	25.06	141.50	0.30
3 ring mature	7.93	26.49	166.18	1.32
4	62.16	26.89	173.42	10.78
5	15.15	27.55	186.29	2.82
6	9.11	27.97	195.73	1.78
7	3.75	28.51	205.88	0.77
8	2.79	28.90	214.55	0.60
9+	4.06	29.47	226.47	0.92
Total	225.30	24.68	140.45	31.64

Category	Number x 10^{-6}	Mean Length (cm)	Mean weight (g)	Biomass (tonnes x10^{-3})
Total Area				
1 ring	448.38	18.80	62.05	27.82
2 ring immature	196.03	24.60	134.35	26.34
2 ring mature	165.44	25.58	150.45	24.89
3 ring immature	31.43	26.42	164.80	5.18
3 ring mature	333.57	26.87	173.17	57.77
4	957.03	27.38	182.95	175.09
5	398.08	27.95	194.36	77.37
6	248.41	28.42	204.12	50.71
7	200.00	28.77	211.56	42.31
8	95.06	29.25	222.01	21.10
9+	65.08	29.61	230.44	15.00
Total	3138.50	26.17	166.82	523.58

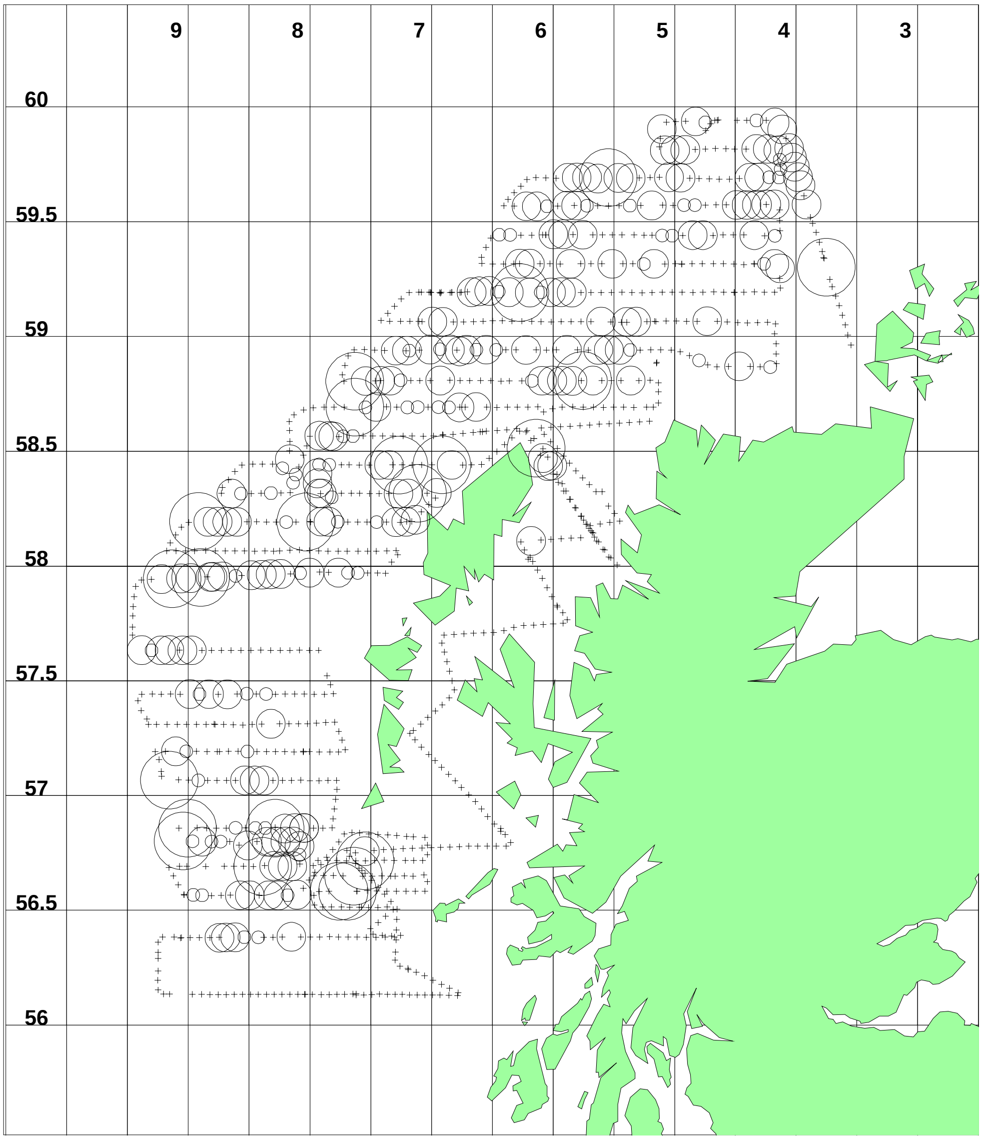


Figure IIa.1. Map of the survey area showing the cruise track for Christina S (7 to 26 July 2000). Circles are proportional to herring integral on a log scale. Crosses represent EDSU where no herring were observed.

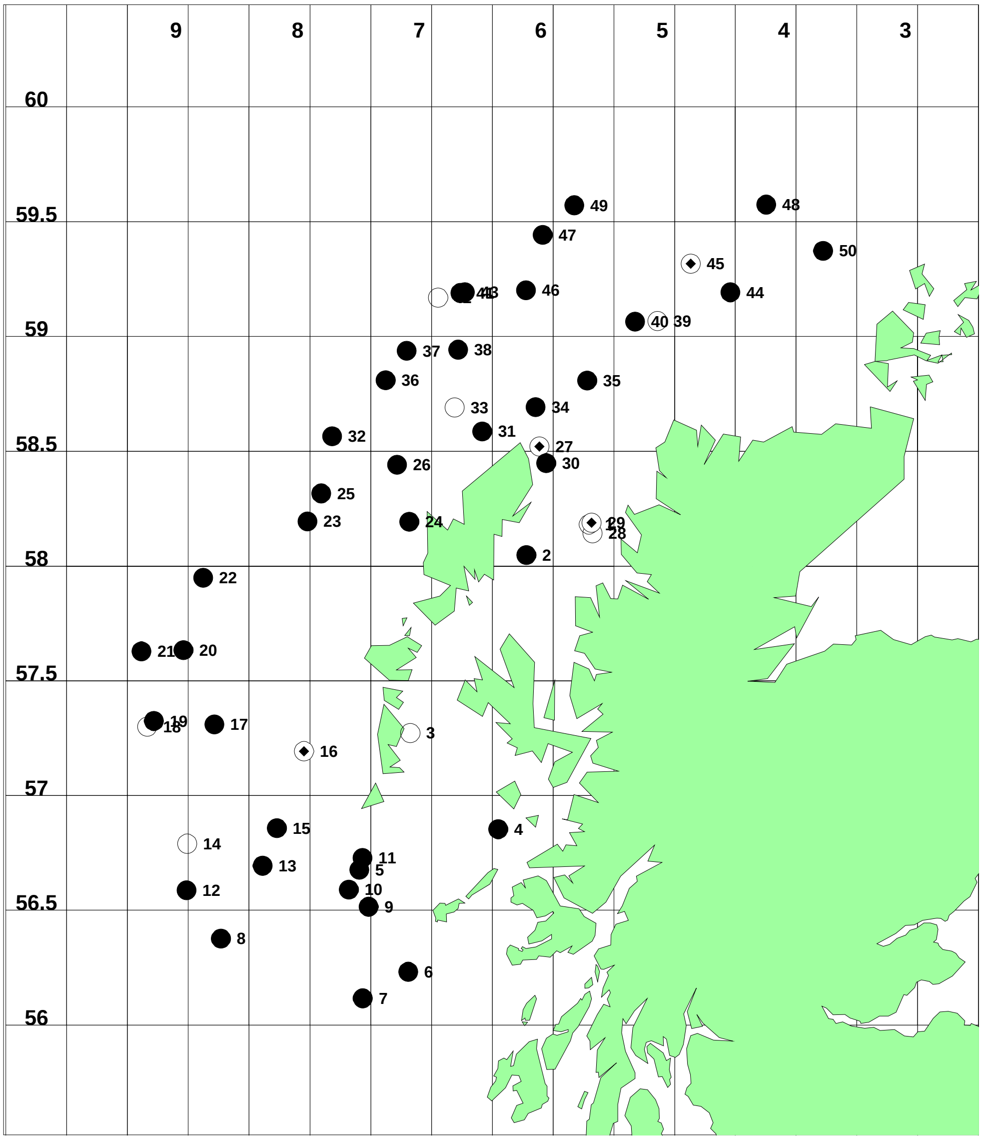


Figure IIa.2. Map of the survey area showing the haul locations for Christina 7 to 26 July 2000). Closed circles represent hauls with more than 50 herring, marked open circles represent hauls with less than 50 herring, and plain open circles represent hauls with no herring.

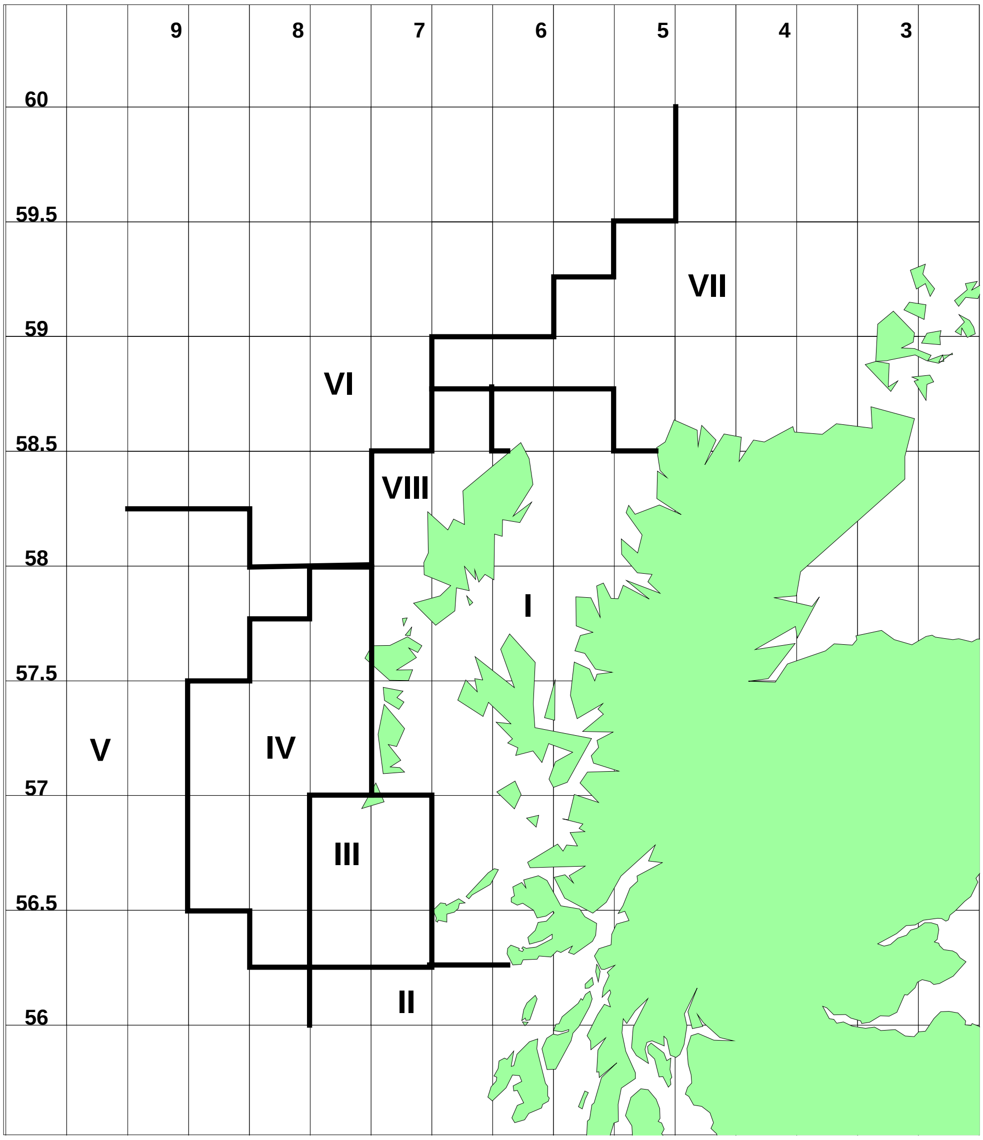


Figure IIa.3. Map of the survey area showing herring strata subdivisions based on analysis of length frequency patterns from trawl hauls.

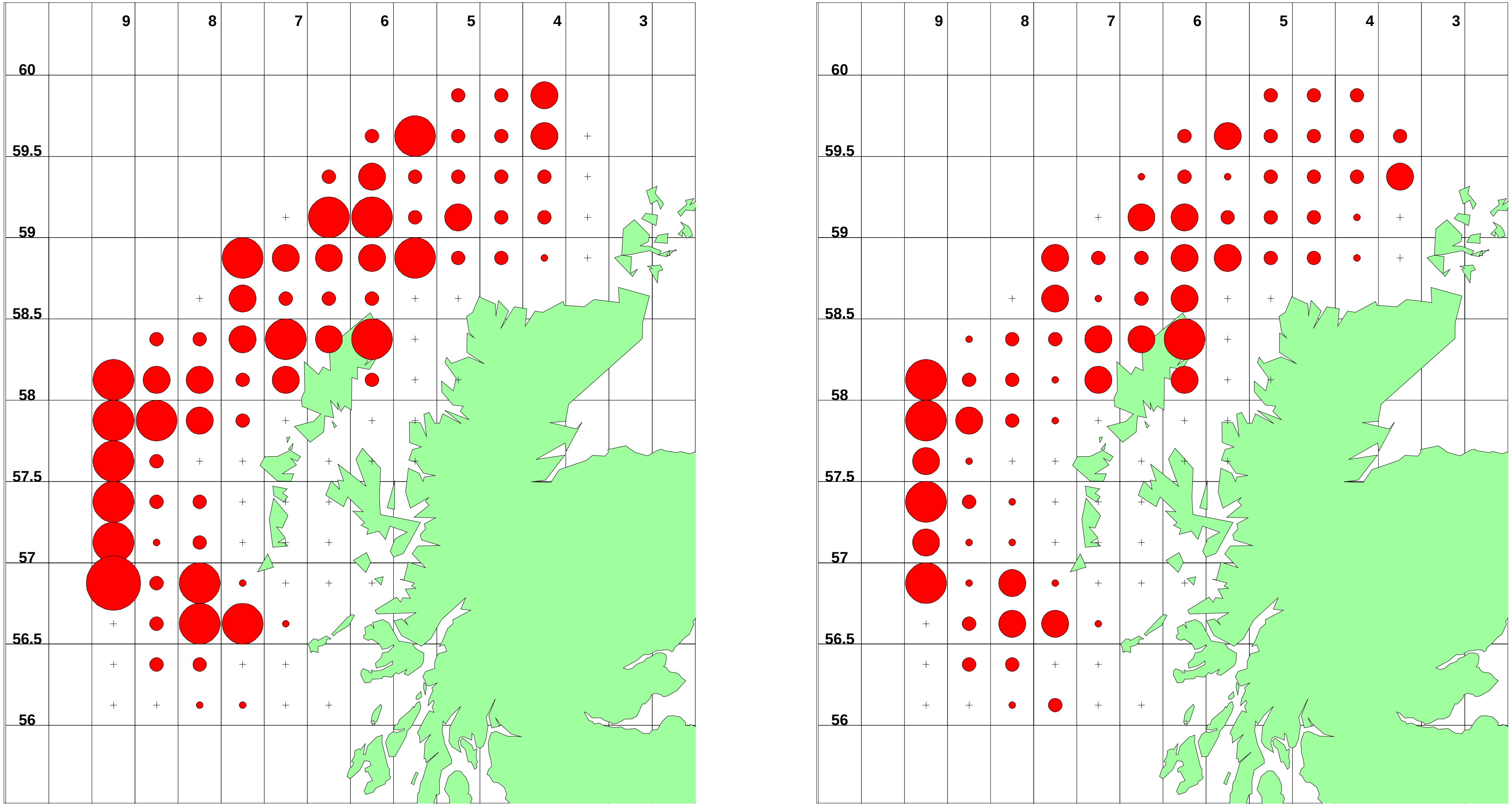
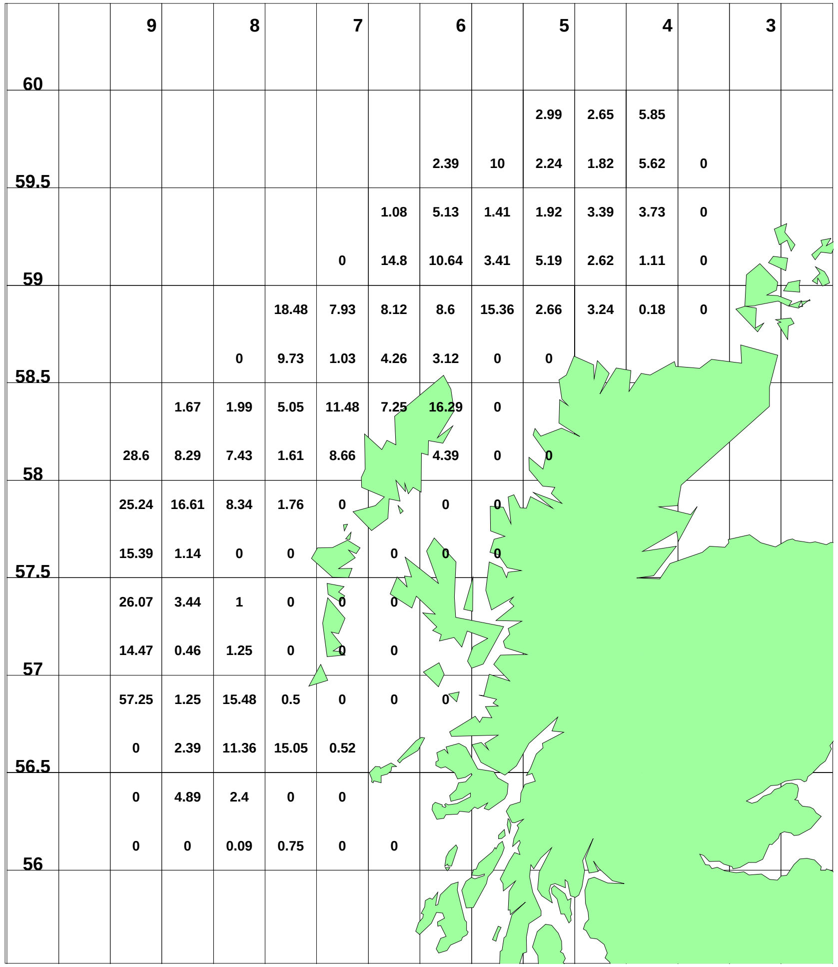


Figure IIa.4. Distribution of herring by biomass (left) and numbers (right) from Christina S survey (7 to 26 July 2000). Circles are proportional to abundance.



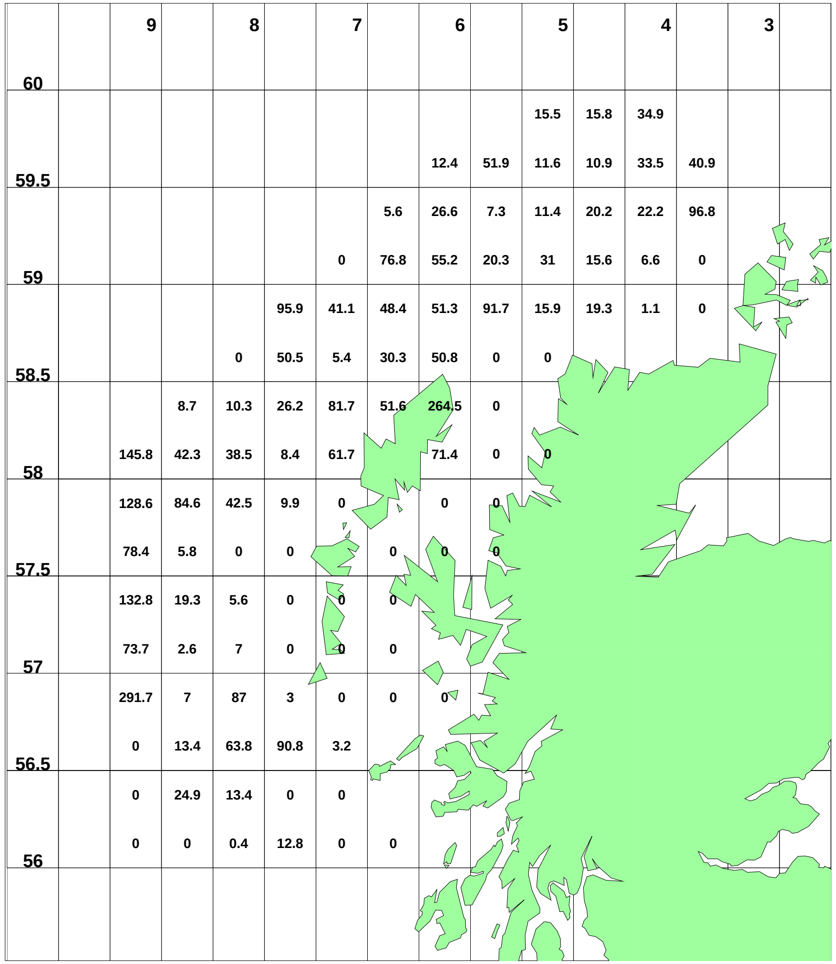


Figure IIa.5. Distribution of herring by biomass (left) and numbers (right) from Christina S survey (7 to 26 July 2000). Biomass is in thousands of tonnes and numbers in millions of herring.

APPENDIX IIB DENMARK

SURVEY REPORT FOR R/V DANA IN THE SKAGERRAK AND KATTEGAT 24 June to 5 July 2000.

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Introduction

Since 1991 the Danish institute for Fisheries research has participated in the ICES coordinated international hydroacoustic survey on herring in the North Sea, Skagerrak and Kattegat. In 2000, the survey with R/V DANA covered the Skagerrak and Kattegat from 24 June to 5 July. Inter-ship calibrations were planned with R/V Walther Herwig III and R/V G.O. Sars but had to be cancelled due to poor weather in the first part of the survey.

Methods

The survey was carried out in the Skagerrak, east of 6° E, and Kattegat (Fig. IIb.1). The area was split into 6 subareas (Fig. IIb.2). The survey was started in the north-west corner of the area but due to poor weather, had to be stopped after 1 day of work and it was decided to try to start from 10°E and work west in order not to lose to many survey days. This resulted in an unusual survey track in the western part of Skagerrak. Along the Swedish coast the transects were made east-west with a spacing of 10 n.mi.

Acoustic data were sampled using a Simrad EY500 38 kHz echo sounder with the transducer in a towed body (Type ES 38-29). The towed body was deployed at approx. 3 m depth. The speed of the vessel during acoustic sampling was 8 – 12 knots. The hydroacoustic equipment was calibrated just before the survey using a standard copper sphere at Bornö, Gulllmarn Fjord, Sweden.

Trawl hauls were carried out during the survey for species identification. Pelagic hauls (Fig. IIb.3) were carried out using a FOTÖ trawl (16 mm in the codend) while demersal hauls (Fig. IIb.4) were carried out using an EXPO trawl (16 mm in the codend). Trawling was carried out between 1000 and 1600h, and 2000 and 0400h UTC (Table IIb.1). Trawl haul duration was 1 hour.

Fish, sorted by species, were measured for length (to nearest 0.5 cm total length) and weight (to nearest 0.1g wet weight). In each trawl haul 10 herring per 0.5 cm length class were sampled for determination of age, race (North Sea autumn spawners or Baltic Sea spring spawners) and maturity. Micro-structure formed during the larval period was used for the discrimination of herring race. A total of 2858 otoliths of herring were examined.

Scrutiny of the acoustic data was done for each mile. Herring and sprat were not observed at depths below 150 m. Therefore, layers below 150 m were excluded during the estimation.

For each subarea the mean back scattering cross section was estimated for herring, sprat, gadoids and mackerel by the TS relationships given in the Manual for Herring Acoustic Surveys in ICES Division III, IV, and IVa (ICES 2000). The number of fish per species was assumed to be in proportion to the contribution of the given species in the trawl hauls. Therefore, the density of a given species was estimated by subarea using the species composition in the trawl hauls. The nearest trawl hauls were allocated to subareas with uniform depth strata. The length-race and length-age distributions for herring were assumed to be in accordance with the length-race and length-age distributions in the allocated trawl hauls.

Current maturity of North Sea and Baltic herring was below 10%. Therefore, 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

Results

Approximately 1700 n.mi. were surveyed (Fig. 1) and 34 trawl hauls (17 surface hauls, 8 mid-water hauls and 9 bottom hauls) were conducted (Fig. IIb.3 and IIb.4, Table IIB.1). The total catch was 32,677 kg and the mean catch was 961 kg, which is approximately double the mean catch in 1998. The mean catch for the surface hauls was 1,195 kg which is 77% higher than for the survey in 1998. Catches were dominated by herring (Table IIb.2). Only a single larger catch of mackerel was seen in the most western part of Skagerrak.

The mean catch for the bottom hauls was 1,334 kg which is 165% higher than for the survey in 1998. Haddock and Norway pout were the dominant species (Table IIb.2) and the very big difference in mean catch is due to a very large catch of small haddock in relatively shallow water.

The total estimated abundance in the survey area was 15,640.9 million herring or 815,716.5 tonnes (Table IIb.3 and IIb.4). The biomass for North Sea autumn and Western Baltic spring spawning herring was estimated at 472,953.8 and 342,762.7 tonnes respectively (Table IIb.4). The biomass and mean weight by age groups (Table IIb.3 and IIb.5) were calculated from estimated number per length group using the length-weight and length-age keys from the raced fish sampled from the trawl hauls. The main density of herring was found in the western part of Skagerrak (subareas 4 and 6) and in the northern Kattegat (subarea 9) (Fig. IIb.5).

The total estimated stock of herring in Skagerrak and Katteget in 2000 at 815,716.5 tonnes was 65 % higher than in the survey in 1998 (496,777.6 tonnes). This is compatible with the 77% higher catches in the surface hauls which were dominated by herring catches.

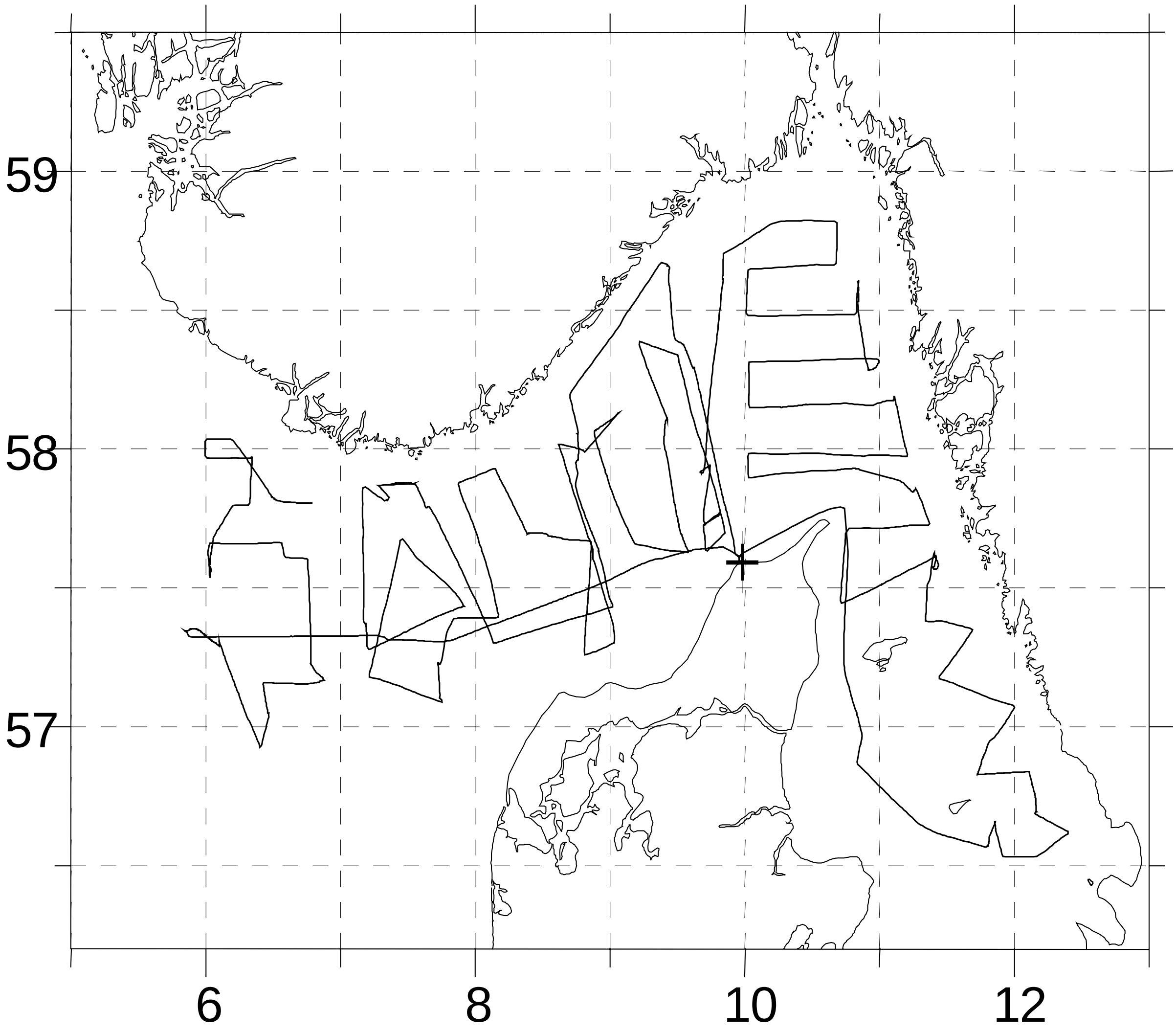

Figure IIb.1. Cruise track for the acoustic survey carried out by R/V Dana in the Skagerrak and Kattegat 24 June to 5 July 2000.

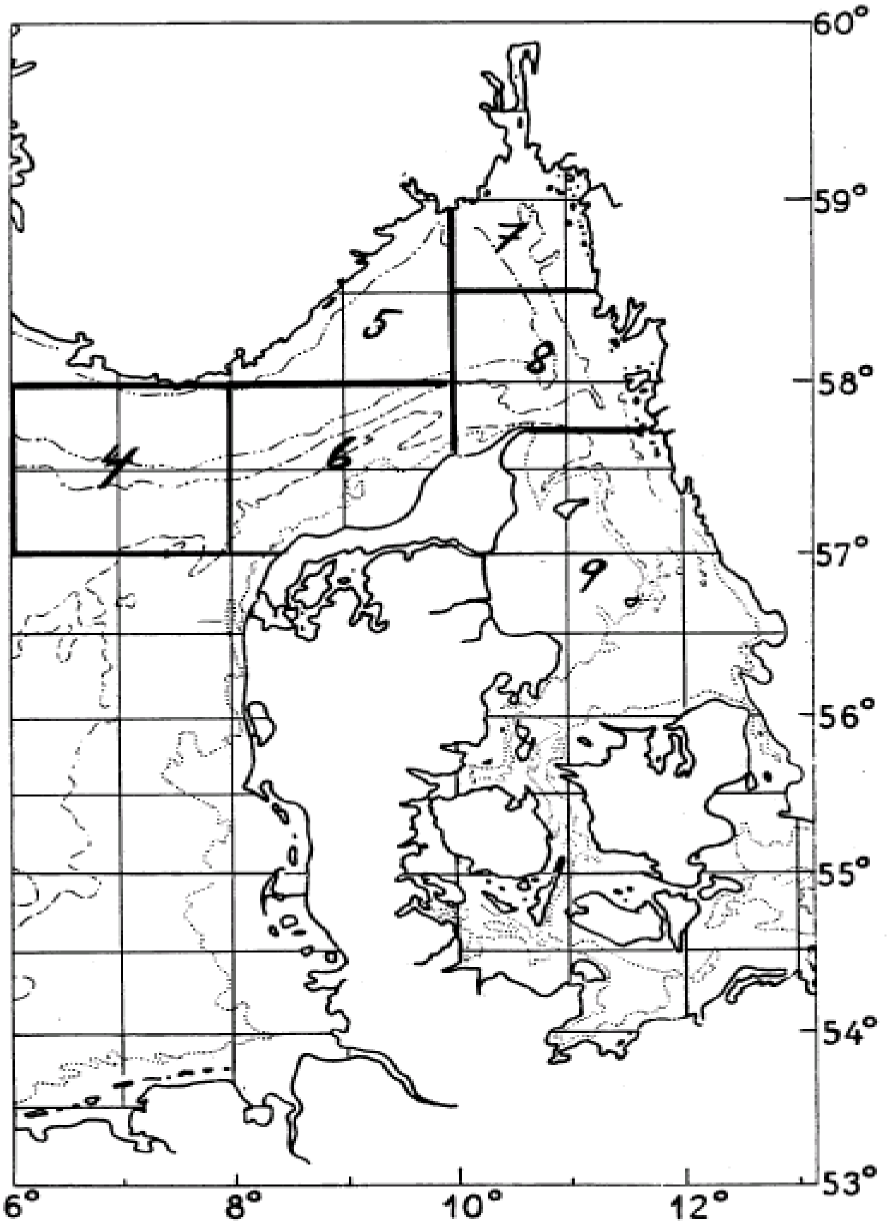

Figure IIb.2. Sub-areas used in the estimation for the acoustic survey carried out by R/V Dana 24 June to 5 July 2000

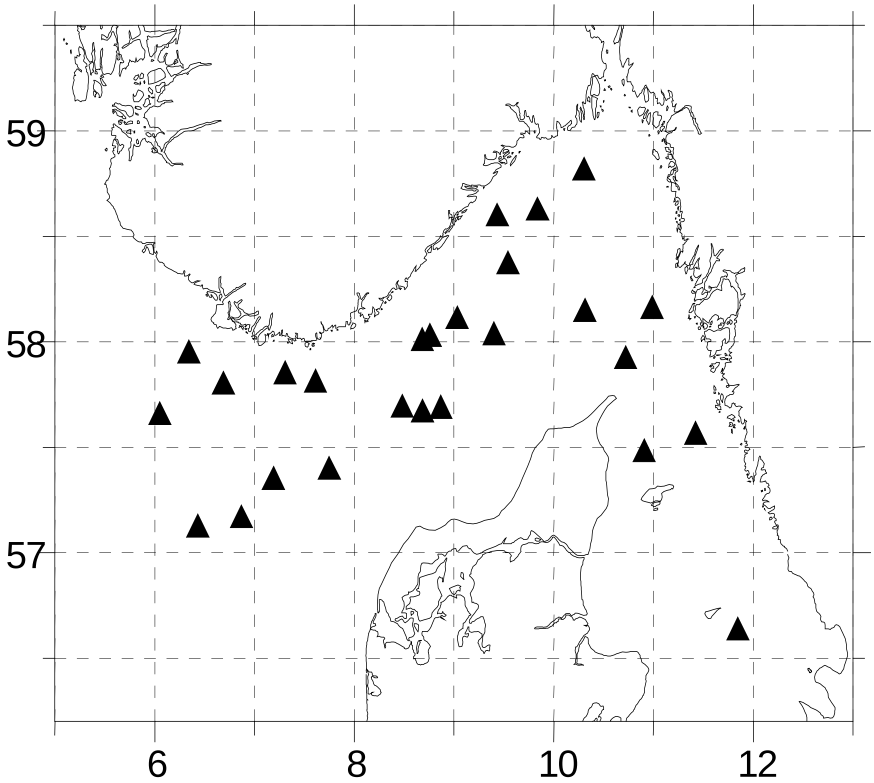

Figure IIb.3. Pelagic haul locations during the acoustic survey carried out by R/V DANA 2000.

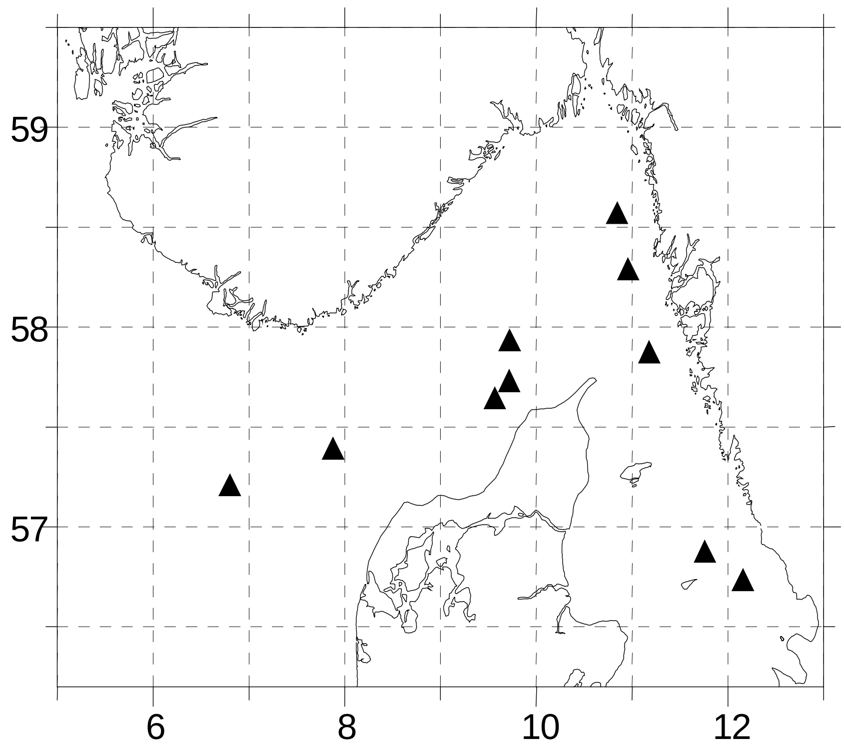

Figure IIb.4. Demersal haul locations during the acoustic survey carried out by R/V DANA 2000.

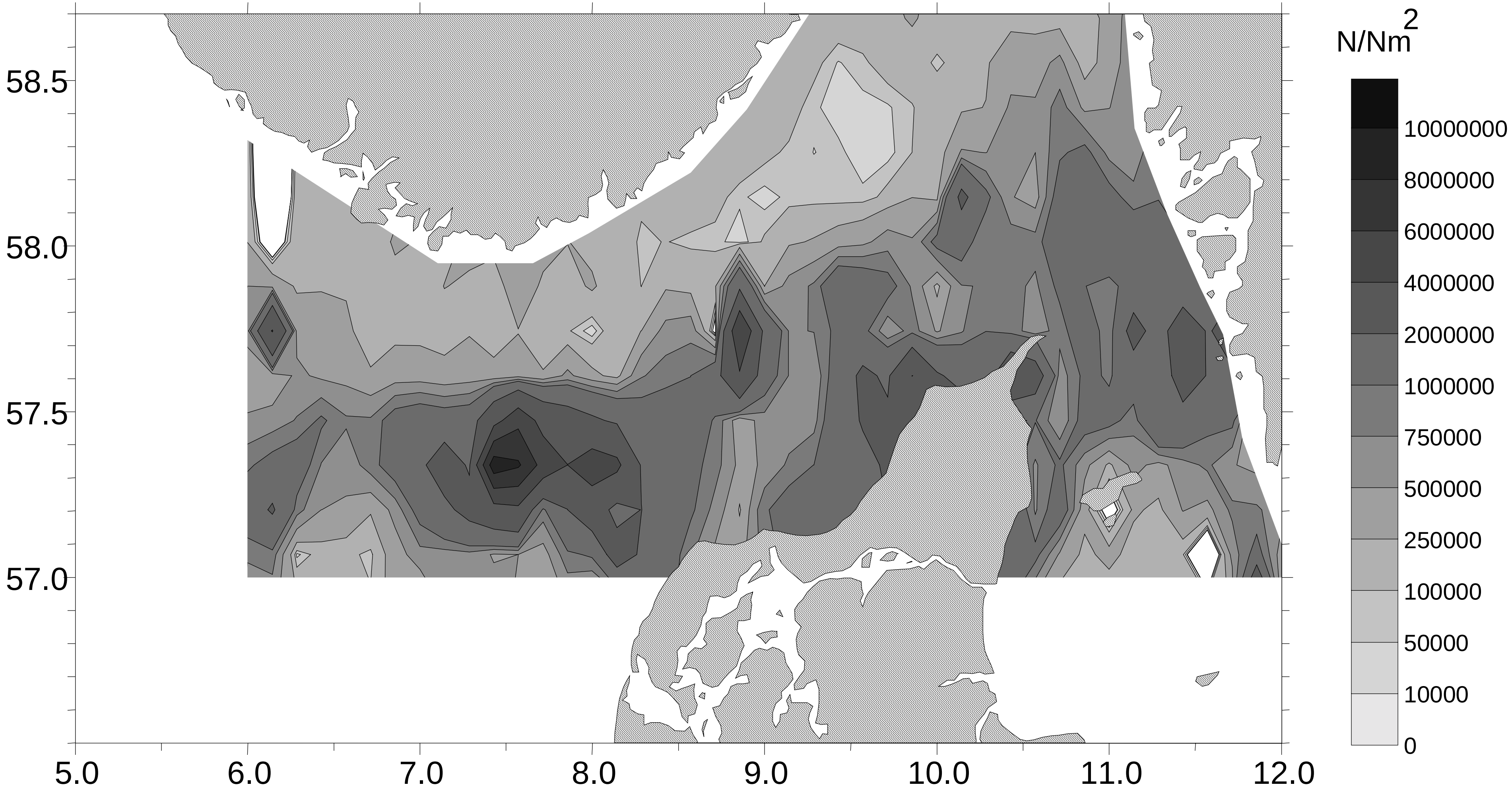

Figure IIb.5. Density (numbers per square nautical mile) of herring during the Acoustic Survey of RV Dana 2000

Table IIb.1. Trawl haul information from acoustic survey of R/V Dana 24 June to 5 July 2000

Date yy/mm/dd	Haul no.	Time local	ICES Square	Position N	E	Trawl	Catch depth m	Mean depth m	Total catck kg	Main Species	Trawling speed Kn	Trawling duration min,	Wind speed m/s	Sea state
000624	69	1539	44F6	57 48.37	006 41.35	Fotö	196-206	325	19		4.5	60	0	1
000624	112	2243	44F6	57 57.25	006 20.47	Fotö	Surface	335	400	Herring, jellyfish	3.6	60	3	1
000625	135	216	44F6	57 39.69	006 03.05	Fotö	Surface	150	1132	Herring, mackerel, blue whitting	4.1	60	10	3
000625	199	1223	43F6	57 12.63	006 48.10	Expo	Bottom	65	354	Norway pout, cod	3.2	60	10	3
000625	220	1619	43F3	57 07.73	006.25.93	Fotö	15	65	34	Jellyfish	3.7	60	15	6
000627	451	1252	45F9	58 19.41	009 35.38	Fotö	285-300	681	7	Pandalus sp.	3.5	60	5	2
000627	462	1611	46F9	58 36.20	009 26.00	Fotö	110-150	329	11	Jellyfish, saith	3.1	60	3	1
000627	512	2258	45F8	58 01.96	008 45.66	Fotö	Surface	580	452	Herring,jellyfish, (mackerel)	4	60		
000628	531	218	44F9	57 41.59	008 53.12	Fotö	Surface	107	1774	Herring	4	60	5	3
000628	611	1243	44F7	57 48.96	007 36.78	Fotö	145	447	12	Haddoch, saith, lumpsukker	4	60	6	2
000628	632	1629	44F7	57 51.40	007 18.40	Fotö	177-185	470	46	Blue Whitting	2.4	60	6	3
000628	672	2236	43F7	57 21.31	007 11.46	Fotö	Surface	78	1320	Herring,(jellyfish)	4.1	60	2	2
000629	694	221	43F7	57 24.20	007 44.95	Fotö	Surface	110	1015	Herring,(jellyfish)	4.5	60	3	2
000629	790	1345	43F7	57 23.50	007 52.60	Expo	Bottom	84	342	Norway pout, herring	3.9	60	2	0
000630	864	208	44F8	57 40.50	008 40.80	Fotö	Surface	120	1953	Herring	4.9	60	1	1
000630	948	1247	45F8	58 00.70	008 41.00	Fotö	200-224	560	56	Blue Whitting	4	60	5	3
000630	966	1551	46F9	58 06.98	009 01.89	Fotö	120-135	600	18	Krill, saith	3.4	60		
000630	1012	2232	44F9	57 38.70	009 34.10	Fotö	Surface	35	623	Herring, (jellyfish)	3.2	60	3	2
000701	1036	216	45F9	58 02.30	009 24.11	Fotö	Surface	575	215	Jellyfish,herring, (mackerel)	4	62	2	1
000701	1120	1229	44F9	57 44.00	009 43.00	Expo	Bottom	38	6053	Haddoch, herring	3.3	61	3	2
000701	1141	1552	44F9	57 56.11	009 43.40	Expo	Bottom	102	714	Norway pout, jellyfish	1.9	60	3	3
000701	1187	2251	46F9	58 37.90	009 50.20	Fotö	Surface	350	485	Herring, mackerel, jellyfish	3.9	60	3	0
000702	1208	216	46G0	58 49.24	010 18.15	Fotö	Surface	140	1291	Herring	3.1	60	0	0
000702	1292	1240	46G0	58 34.30	010 50.62	Expo	Bottom	83	1623	Picked dogfish, jellyfish, herring	2.7	51	0	0
000702	1312	1652	45G0	58 17.50	010 57.50	Expo	Bottom	107	792	Norway pout	3.2	29	5	2
000702	1363	2300	45G0	58 09.13	010 18.68	Fotö	Surface	194	528	Herring	4	60	1	1
000703	1384	221	45G0	58 09.85	010 59.16	Fotö	Surface	133	711	Herring	4.1	60	4	1
000703	1466	1221	44G0	57 55.64	010 43.20	Fotö	85-120	164	173	Pandalus sp.	4	60	6	2
000703	1481	1502	44G1	57 52.60	011 10.80	Expo	Bottom	60	791	Herring, Norway pout, haddock	3.2	56	4	2
000703	1536	2230	43G0	57 29.11	010 54.36	Fotö	Surface	39	3049	Herring	4	60	1	0
000704	1559	222	44G2	57 34.10	011 25.36	Fotö	Surface	47	4500	Jellyfish, herring	4	30	0	0
000704	1634	1224	42G1	56 52,70	011 45.70	Expo	Bottom	50	705	Jellyfish,herring, whitting	3.1	60	0	0
000704	1655	1610	42G2	56 44.19	012 09.46	Expo	Bottom	36	634	Jellyfish, herring	3	60	2	1
000704	1695	2239	42G1	56 38.44	011 50.67	Fotö	Surface	33	835	Jellyfish, (herring)	3.9	60	3	0

Table IIb.2. Species distribution in trawl hauls R/V Dana 24 June to 5 July 2000.

Haul		69	112	135	199	220	451	462	512	531	611	632	672	694
Trawl catch, kg		8	400	1132	354	34	7	11	452	1774	14	60	1320	1015
	Enchelyopus cimbrius													
Eel	*Anguilla anguilla*													
	Lycodes vahli													
Anchovy	*Engraulis encrasicolus*													
Squid	*Loligo spp.*												1.7	
Blue whiting	*Micromesistius poutassou*	0.7		110.7			0.4		0.2		1.2	36.8		
Sprat	*Sprattus sprattus*													
Dragonet	*Calllionymus spp.*													
Gurnard	*Trigala spp.*				0.1									
Greater argentina	*Argentina spp.*	0.8										1.9		
Catfish	*Anarhichas lupus*				4.4									
Monkfish	*Lophius piscatorius*													
Hallibut	*Reinhardtius hippoglossides*													
Horse mackerel	*Trachurus trachurus*													
Long rough dab	*Hippoglosides plattessoides*				0.2									
Garfish	*Belone belone*			0.2										
Whiting	*Merlangius merlangus*	*	0.2		5.7									
Invertebrates		1.3	177.7	32.4	30.5	34.2	0.8	5.7	83.8	35.0			250.2	138.1
Dab	*Limanda limanda*				0.2									
Norway lobster	*Nephrops norvegicus*													
	Notoscopelus kroeyeri											0.1		
Haddock	*Melanogrammus aeglefinus*	*	0.9		142.0						3.1		0.3	1.3
Hake	*Merluccius merluccius*				0.7									
Pearlsides	*Maurolicus muelleri*	0.2					0.2				0.5	0.3		
	Lumpenus lampretaeformis													
	Leptoclinus maculatus													
krill		2.1												
Mackerel	*Scomber scombrus*		9.7	292.7	1.4				26.6	39.0	0.3		13.4	22.4
Whelk	*Buccinum undantum*													
Spurdog	*Squalus acanthias*													
Prawn	*Pandalus spp.*						4.2					4.7		
Plaice	*Pleuronectes platessa*				1.8									
Pilchard	*Sardina Pilchardus*													1.0
Saithe	*Pollachius virens*				1.6			2.4			3.1			
Herring	*Clupea harengus*	1.2	157.8	695.5	2.0		0.7		325.2	1700.0	0.2	*	1041.7	841.2
Roundnose grenadier	*Coryphaenoides rupestris*						0.6							
Flounder	*Platichthys flesus*													
Hagfish	*Myxine glutinosa*													
Norway pout	*Trisopterus esmarki*	0.1			107.9		1.2					2.0		
Lumpsucker	*Cyclopterus lumpus*	1.4	12.9	1.5				1.0	16.2		3.7		12.2	10.9
Dragonet	*Callionymus lyra*													
Starry ray	*Raja radiata*													
Sandeels	*Ammodytes spp.*				0.4									
Greater sandell	*Hyperoplus lanceolatus*													
Cod	*Gadus Morhua*				49.3									
Sole	*Solea vulgaris*				1.5									

Table IIb.2. Continued

Haul		790	864	948	966	1012	1036	1120	1141	1187	1208	1292	1312	1363
Trawl catch, kg		342	1953	57	22	623	215	6053	714	485	1291	1623	792	528
	Enchelyopus cimbrius												2.5	
Eel	*Anguilla anguilla*													
	Lycodes vahli												0.6	
Anchovy	*Engraulis encrasicolus*													
Squid	*Loligo spp.*													
Blue whiting	*Micromesistius poutassou*		87.3	56.0			15.5							0.8
Sprat	*Sprattus sprattus*					1.7								
Dragonet	*Calllionymus spp.*							1.1						
Gurnard	*Trigala spp.*							0.7						
Greater argentina	*Argentina spp.*													
Catfish	*Anarhichas lupus*											1.9		
Monkfish	*Lophius piscatorius*								7.8					
Hallibut	*Reinhardtius hippoglossides*												3.8	
Horse mackerel	*Trachurus trachurus*					1.5								
Long rough dab	*Hippoglosides plattessoides*							6.6						
Garfish	*Belone belone*		0.6			0.4				0.3				
Whiting	*Merlangius merlangus*	0.4				0.4		311.6				11.5	11.6	
Invertebrates		3.6	121.2		2.0	105.7	102.1		149.5	153.2	100.8	397.2	84.8	107.3
Dab	*Limanda limanda*							293.4						
Norway lobster	*Nephrops norvegicus*											2.0		
	Notoscopelus kroeyeri													
Haddock	*Melanogrammus aeglefinus*	35.1	0.9				0.3	4307.5	10.0			16.9	69.9	
Hake	*Merluccius merluccius*							32.6	2.7					
Pearlsides	*Maurolicus muelleri*				0.6							11.4		
	Lumpenus lampretaeformis								*			0.9	0.6	
	Leptoclinus maculatus													
krill				*	8.3									
Mackerel	*Scomber scombrus*		11.9			2.6	21.1			152.7	49.5			4.4
Whelk	*Buccinum undantum*							9.2	2.0					
Spurdog	*Squalus acanthias*											571.0	12.0	
Prawn	*Pandalus spp.*											207.2		
Plaice	*Pleuronectes platessa*							60.8						
Pilchard	*Sardina Pilchardus*													
Saithe	*Pollachius virens*	21.1			7.1				8.8				19.0	
Herring	*Clupea harengus*	105.6	1721.2			509.4	58.6	946.2	11.7	176.6	1140.7	227.5	57.4	404.7
Roundnose grenadier	*Coryphaenoides rupestris*													
Flounder	*Platichthys flesus*													
Hagfish	*Myxine glutinosa*												*	
Norway pout	*Trisopterus esmarki*	148.9						0.2	460.5			137.5	503.0	
Lumpsucker	*Cyclopterus lumpus*		9.4			0.9	17.0			2.2				10.8
Dragonet	*Callionymus lyra*													
Starry ray	*Raja radiata*													
Sandeels	*Ammodytes spp.*													
Greater sandell	*Hyperoplus lanceolatus*	2.2												
Cod	*Gadus Morhua*	23.9						64.5	54.1				22.9	
Sole	*Solea vulgaris*	0.8						12.2	7.0				3.4	

Table II.b.2 Continued

Haul		1384	1466	1481	1536	1559	1634	1655	1695	Total survey catch	Mean survey catch	Max survey catch	Min survey catch
Trawl catch, kg		711	173	791	3049	4500	705	634	835	32677	961.09	6053	7
	Enchelyopus cimbrius			3.7						6.2	0.18	3.7	2.5
Eel	*Anguilla anguilla*			0.6						0.6	0.02	0.6	0.6
	Lycodes vahli									0.6	0.02	0.6	0.6
Anchovy	*Engraulis encrasicolus*				2.8					2.8	0.08	2.8	2.8
Squid	*Loligo spp.*	0.8								2.5	0.07	1.7	0.8
Blue whiting	*Micromesistius poutassou*									309.6	9.11	110.7	0.2
Sprat	*Sprattus sprattus*				3.8		4.8	0.2	10.0	20.5	0.60	10	0.2
Dragonet	*Calllionymus spp.*									1.1	0.03	1.1	1.1
Gurnard	*Trigala spp.*			1.1			0.8			2.7	0.08	1.1	0.1
Greater argentina	*Argentina spp.*									2.7	0.08	1.9	0.8
Catfish	*Anarhichas lupus*						1.5	2.3		10.1	0.30	4.4	1.5
Monkfish	*Lophius piscatorius*									7.8	0.23	7.8	7.8
Hallibut	*Reinhardtius hippoglossides*									3.8	0.11	3.8	3.8
Horse mackerel	*Trachurus trachurus*	1.7								3.2	0.09	1.7	1.5
Long rough dab	*Hippoglosides plattessoides*			31.3			6.1	0.9		45.1	1.33	31.3	0.2
Garfish	*Belone belone*				4.4					5.9	0.17	4.4	0.2
Whiting	*Merlangius merlangus*			64.7	0.7		133.1	30.0		569.9	16.76	311.6	0.2
Invertebrates		90.9		140.0	199.6	3929.3	219.1	377.6	634.1	7707.7	226.70	3929.3	0.8
Dab	*Limanda limanda*			1.4			32.0			327	9.62	293.4	0.2
Norway lobster	*Nephrops norvegicus*									2	0.06	2	2
	Notoscopelus kroeyeri									0.1	0.00	0.1	0.1
Haddock	*Melanogrammus aeglefinus*			113.8			7.7			4709.7	138.52	4307.5	0.3
Hake	*Merluccius merluccius*									36	1.06	32.6	0.7
Pearlsides	*Maurolicus muelleri*		1.3							14.5	0.43	11.4	0.2
	Lumpenus lampretaeformis							0.1		1.6	0.05	0.9	0.1
	Leptoclinus maculatus			0.2						0.2	0.01	0.2	0.2
krill										10.4	0.31	8.3	2.1
Mackerel	*Scomber scombrus*	1.6			46.9	59.4			3.6	759.23	22.33	292.7	0.3
Whelk	*Buccinum undantum*			3.3			20.0	1.6		36.1	1.06	20	1.6
Spurdog	*Squalus acanthias*	38.3								621.3	18.27	571	12
Prawn	*Pandalus spp.*		159.1							375.2	11.04	207.2	4.2
Plaice	*Pleuronectes platessa*			6.2			64.3	6.2		139.3	4.10	64.3	1.8
Pilchard	*Sardina Pilchardus*									1	0.03	1	1
Saithe	*Pollachius virens*	5.0	10.5							78.6	2.31	21.1	1.6
Herring	*Clupea harengus*	566.2		200.2	2790.8	511.3	160.8	192.8	186.4	14733.6	433.34	2790.8	0.2
Roundnose grenadier	*Coryphaenoides rupestris*									0.6	0.02	0.6	0.6
Flounder	*Platichthys flesus*						4.3			4.3	0.13	4.3	4.3
Hagfish	*Myxine glutinosa*									0	0.00	0	0
Norway pout	*Trisopterus esmarki*			167.7			1.7			1530.7	45.02	503	0.1
Lumpsucker	*Cyclopterus lumpus*	4.3	2.1						0.7	107.2	3.15	17	0.7
Dragonet	*Callionymus lyra*			0.3						0.3	0.01	0.3	0.3
Starry ray	*Raja radiata*						3.0			3	0.09	3	3
Sandeels	*Ammodytes spp.*									0.4	0.01	0.4	0.4
Greater sandell	*Hyperoplus lanceolatus*									2.2	0.06	2.2	2.2
Cod	*Gadus Morhua*			1.3			43.1	21.4		280.5	8.25	64.5	1.3
Sole	*Solea vulgaris*			0.2			2.7			27.8	0.82	12.2	0.2

Table IIb.3. Biomass of herring by age, stock and sub area during the acoustic survey of R/V Dana 24 June to 5 July 2000

subarea	WR										Total biomass tonnes
	0	1	2 Im	2Mat	3 Im	3 Mat	4	5	6	7	
	NORTH SEA AUTUMN										
4	5044.9	122373.6	4118.1	4118.1	3.8	21.4	226.4				135906.2
5		4337.6	320.7	320.7	9.1	51.5	40.7				5080.3
6	84.3	144622.2	3142.4	3142.4	88.1	499.5	438.9				152017.8
7		5059.3	148.0	148.0	1.5	8.3	5.2				5370.4
8	67.1	39231.6	1736.1	1736.1	59.9	339.6	271.7				43442.1
9	44.4	130566.2	263.3	263.3							131137.1
Tonnes	5240.6	446190.5	9728.6	9728.6	162.4	920.3	982.9				472953.8
% by age	1.1	94.3	2.1	2.1	0.0	0.2	0.2				100.0

subarea	WR										Total biomass tonnes
	0	1	2 Im	2 Mat	3 Im	3 Mat	4	5	6	7	
	WESTERN BALTIC SEA SPRING										
4		6703.4	19825.7	19825.7	2568.6	14555.6	8304.3	4885.7	1022.3	635.8	78327.3
5		663.4	2030.9	2030.9	403.2	2284.6	1921.7	1126.8	272.0	47.2	10780.4
6		7967.7	22309.9	22309.9	4731.7	26813.1	22905.5	13672.2	3429.2	588.2	124727.4
7		610.2	1391.1	1391.1	170.1	964.1	520.6	227.3	9.3		5283.9
8		5194.4	11745.7	11745.7	1874.3	10620.9	7960.7	4602.9	1106.9	200.9	55052.4
9		43608.4	9370.4	9370.4	649.1	3678.3	1386.0	528.6			68591.3
Tonnes		64747.5	66673.8	66673.8	10397.0	58916.5	42998.9	25043.5	5839.7	1472.0	342762.7
% by age		18.9	19.5	19.5	3.0	17.2	12.5	7.3	1.7	0.4	100.0

Table IIb.4. Number of herring by age, stock and sub area during the acoustic survey of R/V Dana 24 June to 5 July 2000

subarea	WR										Total
	0	1	2 Im	2Mat	3 Im	3 Mat	4	5	6	7	number
	NORTH SEA AUTUMN										*1000000
4	367.9	2586.5	51.4	51.4	0.0	0.1	1.6				3059.1
5		86.9	3.9	3.9	0.1	0.4	0.3				95.5
6	20.6	3002.7	40.5	40.5	0.7	4.1	3.6				3112.7
7		111.9	1.8	1.8	0.0	0.1	0.0				115.7
8	7.2	869.6	21.1	21.1	0.5	2.8	2.2				924.6
9	5.1	3323.2	3.6	3.6							3335.5
Number	400.9	9980.8	122.3	122.3	1.3	7.6	7.7				10643.1
% by age	3.8	93.8	1.1	1.1	0.0	0.1	0.1				100.0

subarea	WR										Total
	0	1	2 Im	2 Mat	3 Im	3 Mat	4	5	6	7	number
	WESTERN BALTIC SEA SPRING										*1000000
4		126.7	273.9	273.9	27.1	153.5	70.6	37.6	5.7	2.3	971.3
5		12.9	27.0	27.0	3.9	22.1	15.6	8.3	1.5	0.2	118.5
6		166.6	292.1	292.1	45.4	257.5	184.0	100.1	18.7	2.5	1359.1
7		12.7	19.4	19.4	1.8	10.3	4.9	2.1	0.1		70.6
8		109.9	160.7	160.7	18.9	107.3	65.8	34.7	6.0	0.9	664.9
9		1143.8	152.3	152.3	7.0	39.8	13.1	5.1			1513.4
Number		1572.5	925.4	925.4	104.2	590.6	353.9	187.8	32.0	6.0	4697.8
% by age		33.5	19.7	19.7	2.2	12.6	7.5	4.0	0.7	0.1	100.0

APPENDIX IIC NORWAY

SURVEY REPORT FOR RV "G.O. SARS"

30 June - 18 July 2000

E.Torstensen and R.Toresen, Institute of Marine Research, Bergen, Norway

Objectives: Abundance estimation of herring and sprat in the area between latitudes 57°00'N and 62°00'N and east of 02°00'E. Map the general hydrographical regime and monitor the standard profiles Oksøy-Hanstholm, Hanstholm-Aberdeen, Utsira - Start Point and Feie - Shetland.

Participation: V. Anthonypillai, K. Gjertsen, A.-L. Johnsen, R. Johannesen (30.6.-4.7.), B.V. Svendsen, R. Toresen (cr.l.), Ø. Torgersen (4.-18.7), E. Torstensen, J. Wangensten.

Guest: Romas Statkus, Lithuania

NARRATIVE

This report presents the results from the Norwegian coverage of the International Herring Acoustic Survey for 2000. The time series of this survey extends back to 1984. Five countries cooperate to survey the North Sea and the Skagerrak for an acoustic abundance estimation of herring and sprat. The surveys are planned in the Planning Group for Herring Surveys (ICES 2000), a sub-group under the ICES Herring Assessment Working Group for the Area South of 62^{o}N. In recent years, the total survey area has been divided between the participating countries, represented by the vessels, as shown in Figure 1.

RV "G.O.Sars" departed from Bergen 30 June 2000. This was a delay of 3 days according to the plan, due to technical problems. A call was made in Aberdeen on 4 July, Egersund on 8 July, Haugesund on 11 July and in Lerwick, Shetland on 15 July. Intership calibration of acoustic equipment was carried out east of Shetland on 16 July with RV Scotia. A denser coverage (the horizontal transects about 7 n.mi. apart) of the ICES rectangles 49E9 and 50E9 were done as part of an intercalibration exercise between the two vessels. The survey was finished in Bergen on 18 July.

The survey started on the hydrographic transect off Kristiansand and continued with systematic parallel transects in the east-west direction from south to north with a distance of 15-20 n.mi. between transects. The hydrographic transect Utsira-Start Point was not carried out due to shortage of time.

SURVEY EFFORT

The cruise track with fishing stations and the hydrographic profiles is shown in Fig. IIc.1a-b. Nearly 3000 n.mi. was surveyed and the total number of trawl hauls was 70: 61 pelagic and 9 bottom trawls. The number of CTD stations for temperature, salinity and density measures was 99.

METHODS

The catches were sampled for species composition, by weight and numbers. Biological samples, i.e. length and weight compositions, were taken of the most important species. Otoliths of target species were taken for age determination.

Herring were also examined for fat content and maturity stage in the whole area. In herring sampled east of 2°00'E, vertebral counts were taken for separation of autumn spawning herring and Baltic spring spawners.

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	2,000 W
Angle Sensitiv.	21.9
2-Way Beam Angle	-21.0 dB
Sv Transd. Gain	27.00 dB
TS Transd. Gain	27.11 dB
3 dB Beamwidth	7.1/6.9 deg
Alongship Offset	-0.10 deg
Athw. ship Offset	0.06 deg

Sounder: ES 38 B.

The weather conditions during the survey were acceptable for acoustic registrations. 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, demersal fish, plankton. The following target strength (TS) function was applied to convert s_A-values of herring and sprat to number of fish:

$$TS = 20 \log L - 71{,}2 \text{ dB} \quad (1)$$

or on the form:

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

where L is total length. Toresen *et al* (1998) describe the acoustic method used for the abundance estimation in this survey.

In the Skagerrak and off the south west coast of Norway, North Sea autumn spawners and Western Baltic spring spawners mix during summer. No system for routine stock discrimination on individual herring during the survey is available. The proportion of Baltic spring spawners and North Sea autumn spawners by age were calculated by applying the formula, WBaltic=((56,5-VS(sample))/(56.5-55.8)) (ICES 1999). To calculate the maturing part of the two stocks in each age group, the observed maturity stages were applied for both stocks

RESULTS

The horizontal distributions of temperature at 5m, 50m and at the bottom in the surveyed area are shown in Fig. IIc.2a-c. The surface water in the eastern North Sea had temperatures ranging from 12^{o}C in the open, mid areas to 15°C off the south west coast of Norway. The temperatures at 5 m depth along the Norwegian west coast were 2-3^{o}C lower than last year. However, the temperature regime in 50m depths seems much the same as that of last year.

Figure IIc.3 gives the horizontal distribution of herring. Herring in the North Sea was mostly found in the southwestern part of the area. The registrations were very scattered in the whole surveyed area and the recorded herring were mainly found close to the surface. Only few "real" herring schools were detected, mainly in 45F2. Most of the trawling positions were regularly chosen, by trawling every 20-30 n.mi., and not based on echo registration. Due to this behaviour herring may have been under-estimated during the survey.

The abundance by ICES statistical rectangles, divided in Western Baltic spring spawners and North Sea autumn spawners, is given in Table IIc.1. The numbers are given age disaggregated. The numbers in age groups 2 and 3 are split in mature/immature parts. Surveyed squares with no herring recordings are not presented in the tables. Table IIc.2 present the mean weights at age applied for biomass estimations. Total estimated number of herring by age and length are given in Table IIc.3. The total estimated biomass per age group and stock is also shown in these tables.

The estimates of spawning stock biomass of North Sea herring and Baltic spring spawners, in the North Sea, are shown in the text table below. The total biomass estimate of herring in the area covered by the Norwegian vessel is about 290 000 t. The estimated spawning stock biomass of North Sea herring was about 13 000 t which is significantly lower than last year. The estimated biomass of Baltic spring spawners in the North Sea, 50 000 tonnes, was lower than the estimates from 1999 and 1998 which were in the range of 75-90 000 tonnes.

Year	Herring Biomass	(10^3 tonnes)
	North Sea herring SSB	Baltic Spring
1999	259	74
2000	13	51

No juvenile or adult sprat was observed or caught in trawl catches No s_A-values were thus allocated to sprat.

REFERENCES

ICES (1999). Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1999/ACFM: 12

ICES (2000). Report of the planning group for herring surveys. *ICES CM 2000*/G:02 106 pp.

Toresen, R., Gjøsæter, H. and de Barros, P. (1998). The acoustic method as used in the abundance estimation of capelin (Mallotus villosus Müller) and herring (Clupea harengus Linné) in the Barents Sea. *Fisheries Research*, **34**: 27-37.

Table IIc.1. Acoustic survey R/V 'G.O. Sars', 30 June - 18 July 2000. Estimated herring numbers by ICES stat. rect. in stocks and age groups.

43F3	North Sea Autumn spawners											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	14.06	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.10
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10

43F6	North Sea Autumn spawners											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	382.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	382.63
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
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

43F7	North Sea Autumn spawners											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	260.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	260.34
			Baltic Spring Spawner									
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
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

Table IIc.1 (contd.).

44F2 **North Sea Autumn spawners**

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
0.00	375.99	15.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	391.66

Baltic Spring Spawner

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
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

44F3 **North Sea Autumn spawners**

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
0.00	83.15	3.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	86.62

Baltic Spring Spawner

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
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

44F4 **North Sea Autumn spawners**

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
0.00	307.28	37.26	0.00	1.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	346.16

Baltic Spring Spawner

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
0.00	0.00	91.23	0.00	3.97	0.00	11.17	0.00	11.17	0.00	5.59	0.00	123.13

Table IIc.1 (contd.).

44F5	North Sea Autumn spawners											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	187.06	22.69	0.00	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	210.74
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	0.00	55.54	0.00	2.41	0.00	6.80	0.00	6.80	0.00	3.40	0.00	74.96

44F6	North Sea Autumn spawners											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	35.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35.85
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	0.00	59.15	0.60	5.91	12.01	1.19	1.19	0.00	0.00	1.19	0.00	81.26

44F7	North Sea Autumn spawners											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	41.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	41.96
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
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

Table IIc.1 (contd.).

45F2	**North Sea Autumn spawners**											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	1522.92	30.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1553.87
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
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

45F3	**North Sea Autumn spawners**											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	629.50	12.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	642.29
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	0.00	0.00	0.00	0.00	2.56	0.00	0.00	0.00	0.00	0.00	0.00	2.56

45F4	**North Sea Autumn spawners**											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	53.09	4.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	57.31
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
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

Table IIc.1 (contd.).

45F5	North Sea Autumn spawners											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	18.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.00
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	0.00	9.22	0.00	0.43	0.21	0.86	0.00	0.00	0.00	0.00	0.00	10.72

45F6	North Sea Autumn spawners											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	1.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.59
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	0.00	1.14	0.01	0.08	0.13	0.08	0.01	0.02	0.00	0.02	0.00	1.51

46F3	North Sea Autumn spawners											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	0.16	0.50	4.51	0.00	5.64	5.79	3.13	0.63	0.31	0.31	0.16	21.14
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
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

Table IIc.1 (contd.).

46F4	**North Sea Autumn spawners**											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	85.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	85.60
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	0.00	37.56	0.00	1.76	0.86	3.49	0.00	0.00	0.00	0.00	0.00	43.67

46F5	**North Sea Autumn spawners**											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	5.16	0.29	0.01	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	5.62
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	0.00	6.48	0.20	0.72	0.18	0.12	0.18	0.00	0.00	0.00	0.00	7.88

47F2	**North Sea Autumn spawners**											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	0.02	0.05	0.48	0.00	0.60	0.61	0.33	0.07	0.03	0.03	0.02	2.23
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
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

Table IIc.1 (contd.).

47F3 **North Sea Autumn spawners**

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
0.00	0.32	1.03	9.26	0.00	11.58	11.90	6.43	1.29	0.64	0.64	0.32	43.42

Baltic Spring Spawner

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
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

47F4 **North Sea Autumn spawners**

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
0.00	1.44	0.06	0.00	-0.01	0.00	0.11	0.08	0.00	0.00	0.00	0.00	1.67

Baltic Spring Spawner

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
0.00	0.00	3.83	0.12	0.47	0.13	0.08	0.06	0.00	0.00	0.00	0.00	4.70

48F3 **North Sea Autumn spawners**

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
0.00	13.06	13.26	2.16	3.78	1.62	0.00	0.00	0.00	0.00	0.00	0.00	33.87

Baltic Spring Spawner

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
0.00	0.00	38.30	6.24	18.25	7.82	12.47	8.90	4.75	1.19	0.00	0.00	97.91

Table IIc.1 (contd.).

48F4	North Sea Autumn spawners											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	2.20	2.24	0.36	0.64	0.27	0.00	0.00	0.00	0.00	0.00	0.00	5.71
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	0.00	6.46	1.05	3.08	1.32	2.10	1.50	0.80	0.20	0.00	0.00	16.51

49F2	North Sea Autumn spawners											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
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
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
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

49F3	North Sea Autumn spawners											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	6.71	6.81	1.11	1.94	0.83	0.00	0.00	0.00	0.00	0.00	0.00	17.40
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	0.00	19.67	3.20	9.37	4.02	6.40	4.57	2.44	0.61	0.00	0.00	50.29

Table IIc.1 (contd.).

49F4	**North Sea Autumn spawners**											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	1.18	1.20	0.19	0.34	0.15	0.00	0.00	0.00	0.00	0.00	0.00	3.05
	Baltic Spring Spawner											
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
0.00	0.00	3.45	0.56	1.65	0.71	1.12	0.80	0.43	0.11	0.00	0.00	8.83

Table IIc.2.. Acoustic survey R/V 'G.O. Sars', 30 June - 18 July 2000. Weight (g) by age group and mature/immature herring by ICES rect.

49F4

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
	80.40	91.80	133.00	117.10	153.20	141.50	155.50	175.60	136.00			111.80

49F3

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
	80.40	91.80	133.00	117.10	153.20	141.50	155.50	175.60	136.00			111.80

48F4

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
	80.40	91.80	133.00	117.10	153.20	141.50	155.50	175.60	136.00			111.80

48F3

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
	80.40	91.80	133.00	117.10	153.20	141.50	155.50	175.60	136.00			111.80

47F4

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
	80.40	82.50	128.00	86.40	141.50	125.00	119.00					86.50

47F3

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
	60.00	111.30	163.40		197.40	193.20	203.40	222.30	261.50	252.00	250.00	189.80

Table IIc.2 (contd).

47F2												
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
	60.00	111.30	163.40		197.40	193.20	203.40	222.30	261.50	252.00	250.00	189.80

46F5												
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
	72.70	81.90	128.00	90.40	141.50	125.00	119.00					81.80

46F4												
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
	64.40	77.40		107.00	106.00	126.30						70.70

46F3												
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
	60.00	111.30	163.40		197.40	193.20	203.40	222.30	261.50	252.00	250.00	189.80

45F6												
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
	61.00	71.80	74.00	88.40	96.00	126.90	103.00	175.20		157.50		70.80

45F5												
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
	64.40	77.40		107.00	106.00	126.30						70.70

Table IIc.2 (contd).

45F4												
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
	48.50	81.80			130.00							52.10

45F3												
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
	44.80	86.00			130.00							44.80

45F2												
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
	44.80	86.00			130.00							44.80

44F7												
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
	51.20											51.20

44F6												
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
	58.30	70.20	74.00	89.40	95.00	89.00	103.00			183.00		71.30

44F5												
0	**1**	**2I**	**2M**	**3I**	**3M**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
	57.80	69.70		76.00	147.00		175.00		132.00			67.10

Table IIc.2 (contd).

44F4

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
	57.80	69.70		76.00	147.00		175.00		132.00			67.10

44F3

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
	57.80	78.00										58.60

44F2

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
	57.80	78.00										58.60

43F7

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
	51.20											51.20

43F6

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
	51.20											51.20

43F3

0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
	37.30	42.00										37.40

Table IIc.3. Acoustic survey R/V 'G.O. Sars', 30 June - 18 July 2000. Estimated herring numbers and biomass by age and length groups. Totals also divided in stocks.

Length (cm)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9+**	**N (mill)**	**Ton (10^3)**
6.0-6.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00
7.0-7.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00
8.0-8.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00
9.0-9.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00
10.0-10.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00
11.0-11.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00
12.0-12.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00
13.0-13.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00
14.0-14.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00
15.0-15.9	0.00	106.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	106	2.74
16.0-16.9	0.00	385.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	386	12.31
17.0-17.9	0.00	747.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	747	28.85
18.0-18.9	0.00	919.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	920	42.24
19.0-19.9	0.00	790.06	5.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	796	43.15
20.0-20.9	0.00	893.08	115.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1008	62.89
21.0-21.9	0.00	152.65	160.25	1.21	0.00	0.00	0.00	0.00	0.00	0.00	314	22.35
22.0-22.9	0.00	32.28	134.57	12.47	0.00	0.00	0.00	0.00	0.00	0.00	179	14.68
23.0-23.9	0.00	2.31	48.14	16.22	2.26	0.00	0.00	0.00	0.00	0.00	69	7.05
24.0-24.9	0.00	0.00	11.05	21.38	1.21	1.05	0.00	0.00	0.00	0.00	35	3.85
25.0-25.9	0.00	0.00	25.46	21.81	7.95	2.26	9.00	1.05	9.00	0.00	77	10.73
26.0-26.9	0.00	0.00	4.40	7.24	19.65	6.56	0.00	1.05	0.00	0.00	39	5.66
27.0-27.9	0.00	0.00	6.93	14.51	19.92	6.68	0.00	0.00	0.00	0.00	48	8.06
28.0-28.9	0.00	0.00	2.54	8.10	6.43	2.97	3.65	0.00	1.21	0.00	25	4.88
29.0-29.9	0.00	0.00	0.00	4.58	5.50	4.02	11.60	0.00	0.00	0.00	26	5.45
30.0-30.9	0.00	0.00	0.00	0.49	1.55	1.55	1.55	0.49	0.49	0.49	7	1.62
31.0-31.9	0.00	0.00	0.00	0.00	0.00	0.00	2.10	0.00	0.49	0.00	3	0.62
32.0-32.9	0.00	0.00	0.00	0.00	0.00	2.10	0.00	0.00	0.00	0.00	2	0.45
N (mill)	0	4029	515	108	64	27	28	3	11	0	4786	278
NS herring	0	4029	171	30	19	10	2	1	1	0		
Baltic spr	0	0	344	78	46	17	26	2	10	0		

NS herring (millions)	4262.84
SSB, NS herring (tonnes 10^3)	13.48
Baltic spr (tonnes ^3)	51.60

30 June - 18 July 2000 TRAWL st.no 287 - 356 "G.O. Sars"
Cruise no 2000007

□ Bottom tr.
△ Pel tr.

Figure IIc.1a. Cruise track and trawl locations for the acoustic survey R/V 'G.O. Sars', 30 June - 18 July 2000.

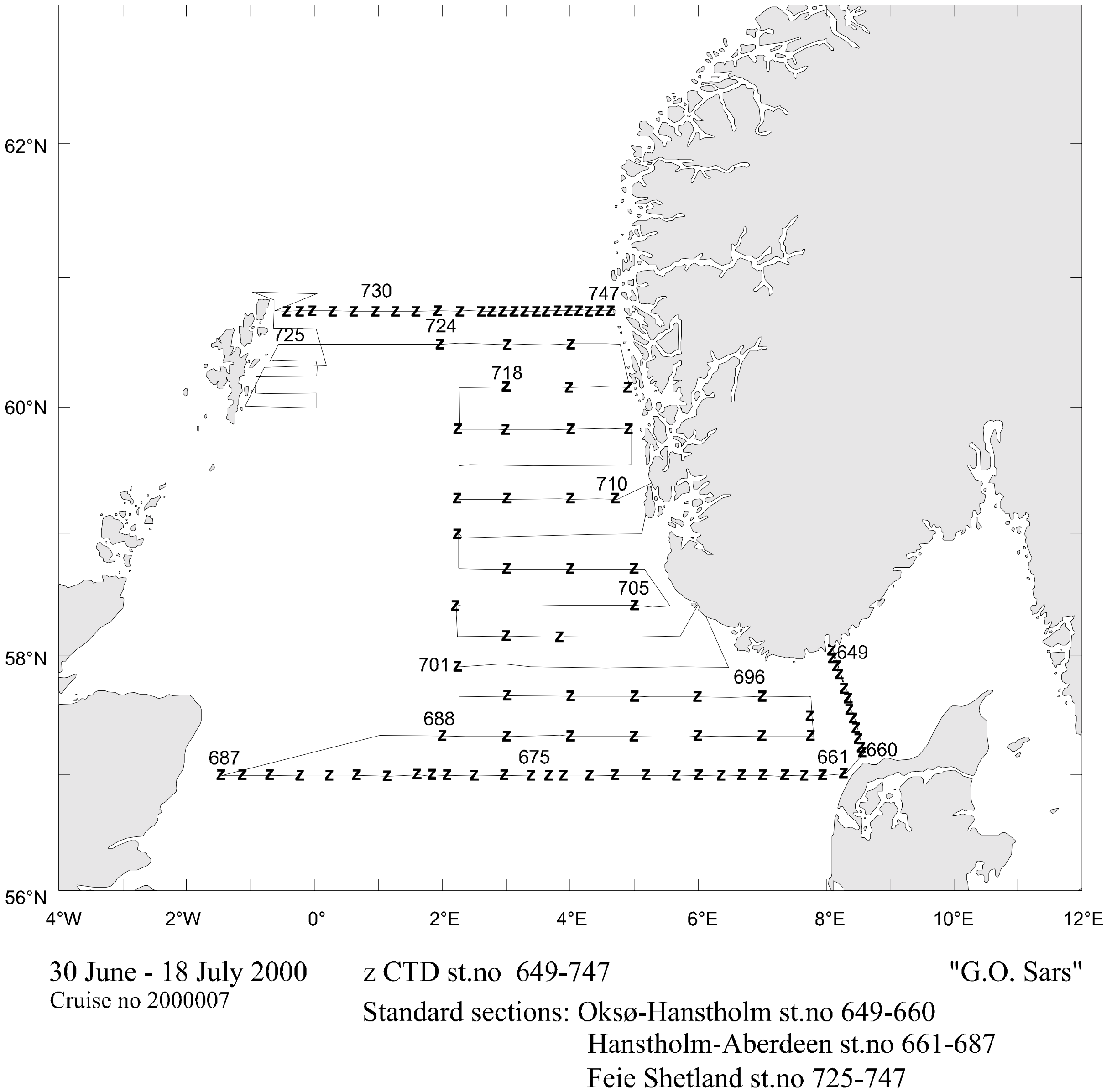

Figure IIc.1b. Cruise track and CTD locations for the acoustic survey R/V 'G.O. Sars', 30 June - 18 July 2000.

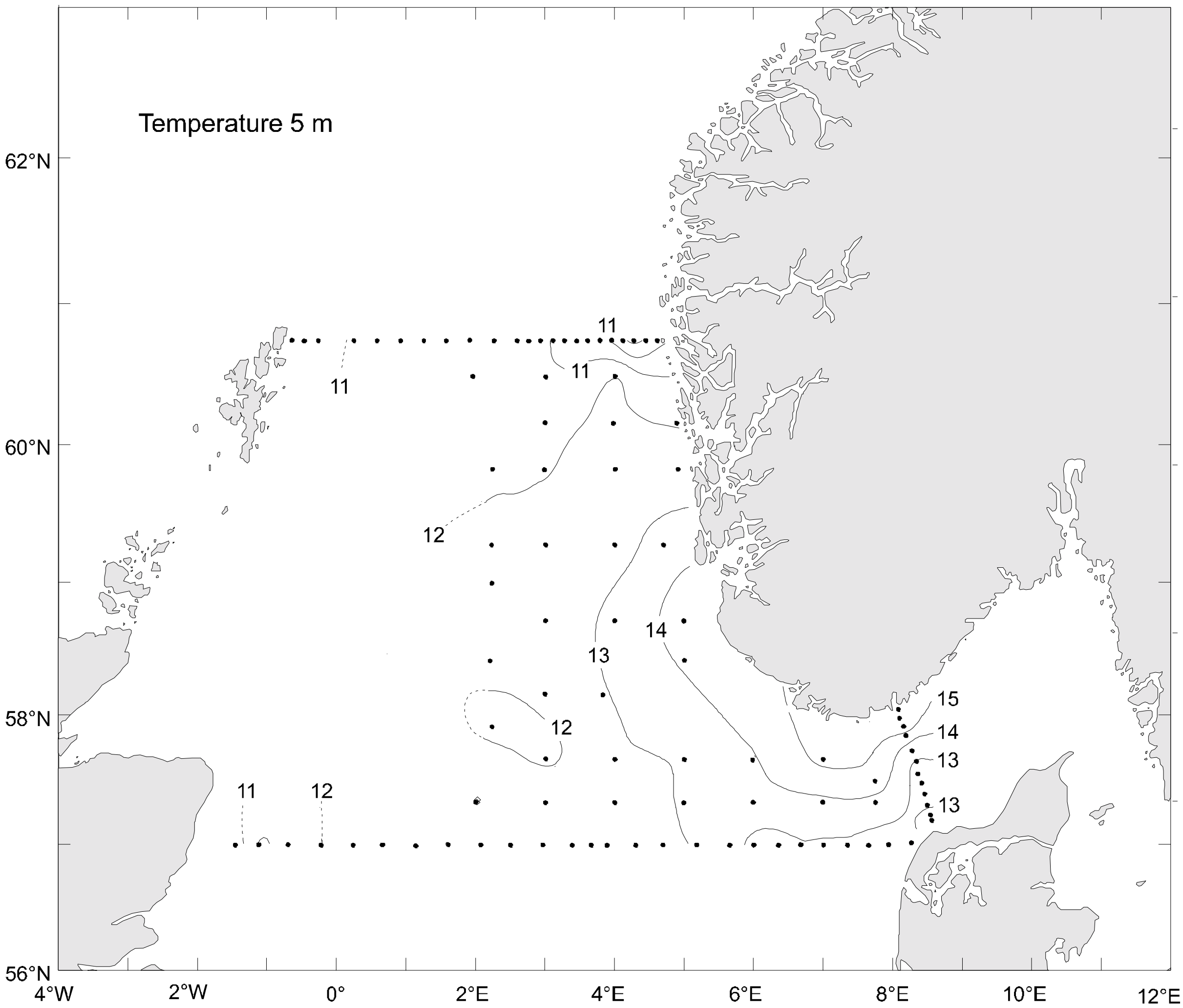

Figure IIc.2a. Contour plot of sea temperature at 5 m depth during the acoustic survey R/V 'G.O. Sars', 30 June - 18 July 2000.

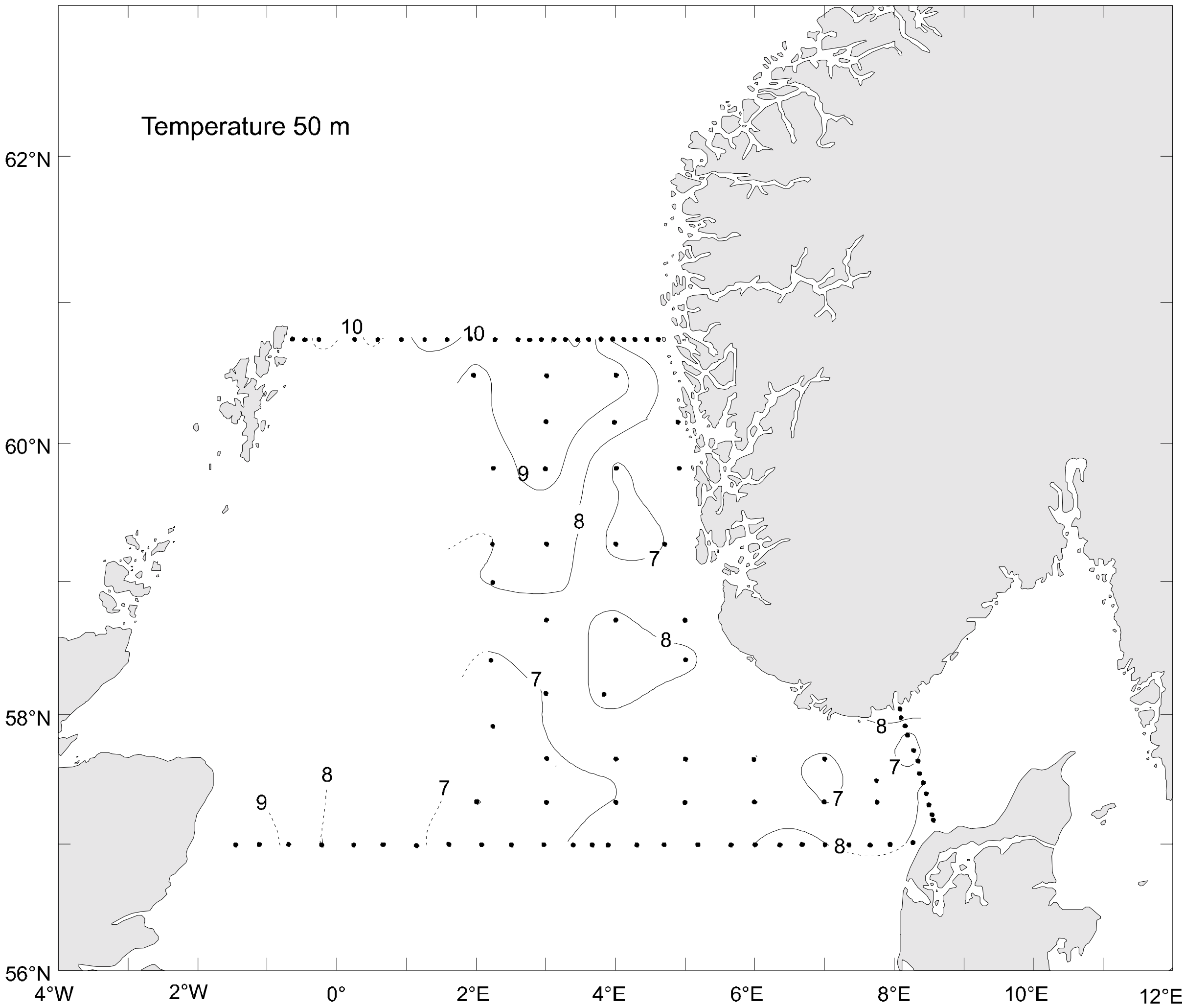

Figure IIc.2b. Contour plot of sea temperature at 50 m depth during the acoustic survey R/V 'G.O. Sars', 30 June - 18 July 2000.

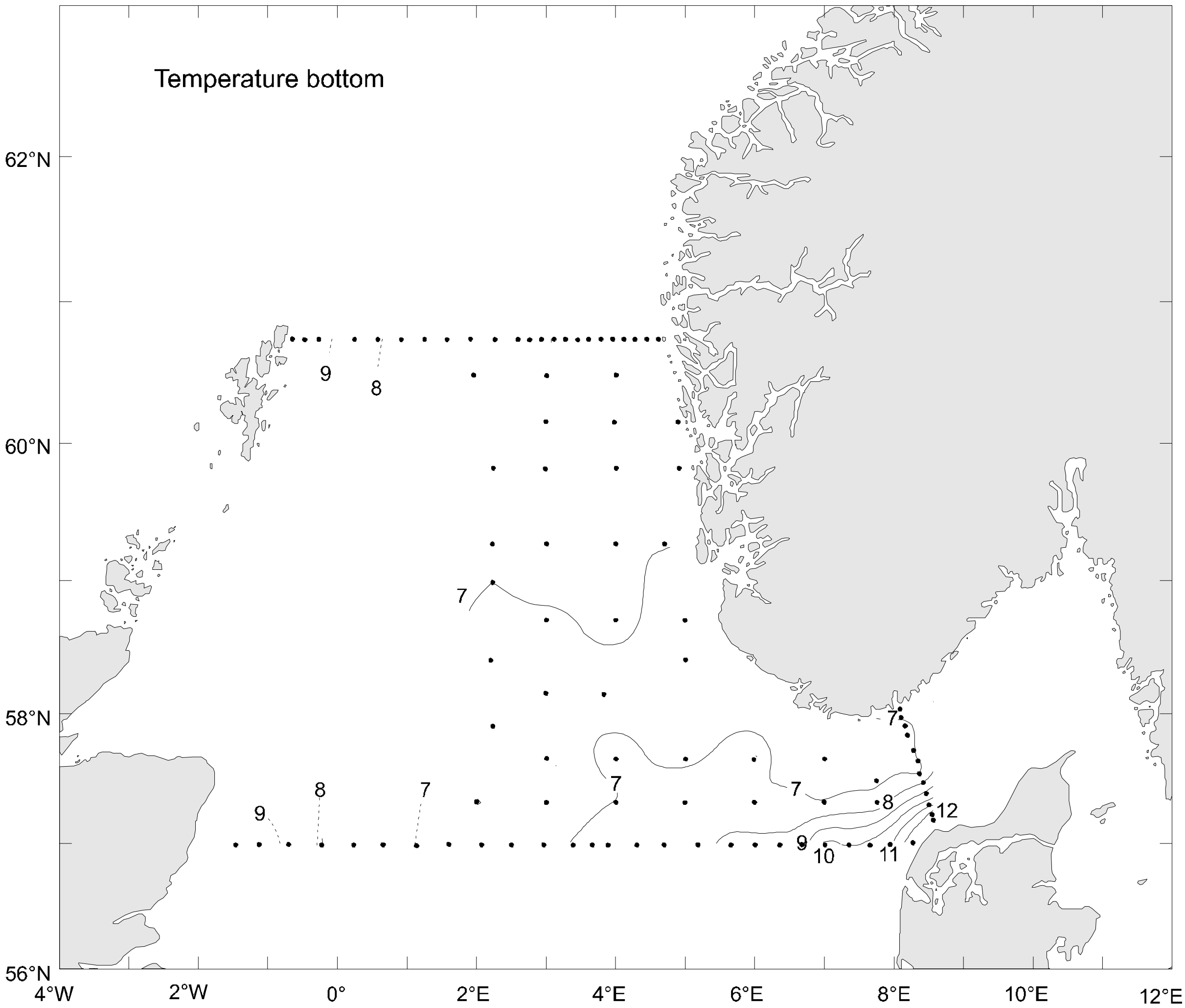

Figure IIc.2c. Contour plot of sea temperature at the sea bottom during the acoustic survey R/V 'G.O. Sars', 30 June - 18 July 2000.

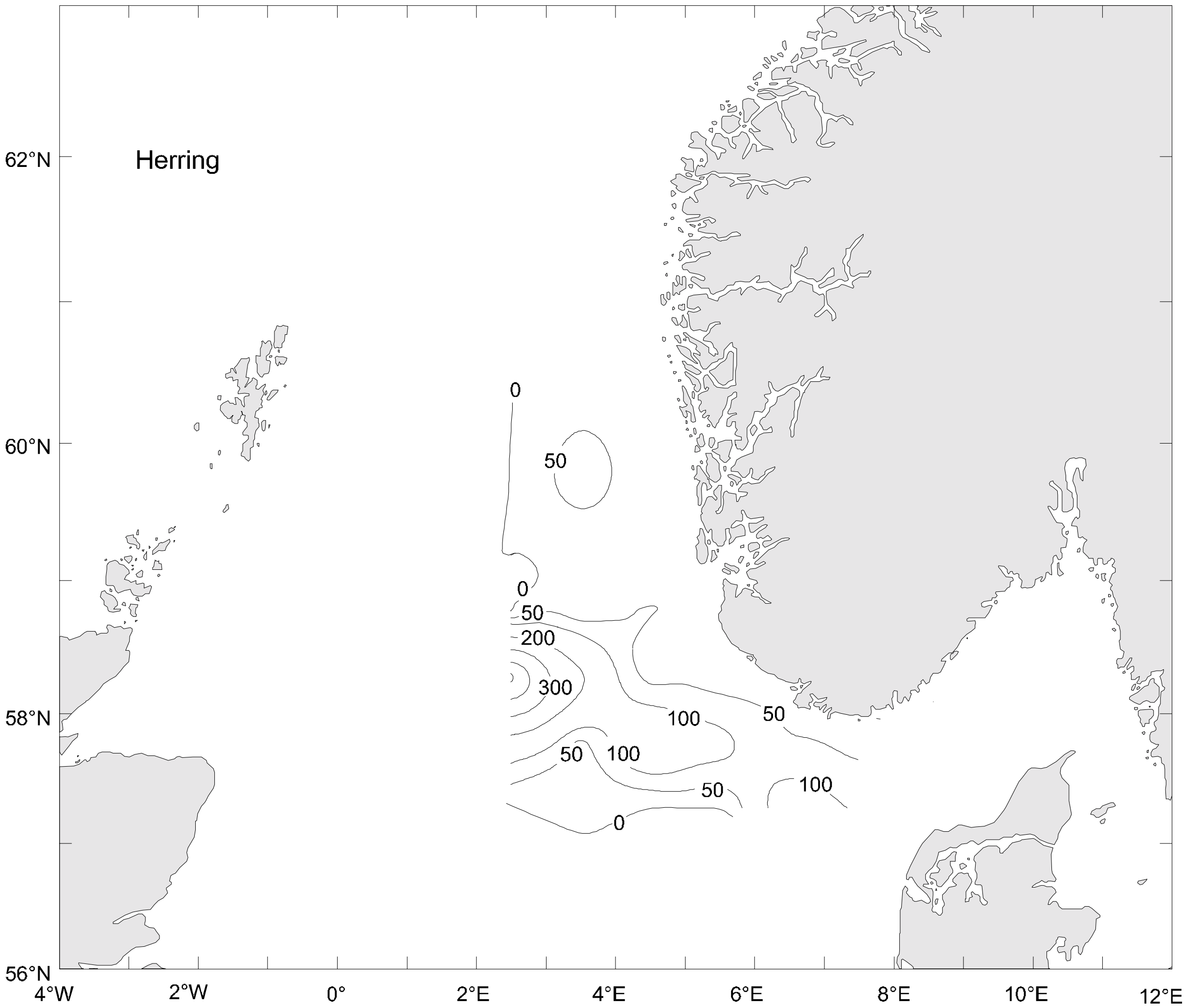

Figure IIc.3. Contour plot of herring s_A from the acoustic survey R/V 'G.O. Sars', 30 June - 18 July 2000.

APPENDIX IID SCOTLAND (NORTH SEA)

Survey report for FRV Scotia in the northern North Sea (ICES area IVa)

5 – 26 July 2000

P. G. Fernandes, FRS Marine Laboratory, Scotland

Introduction

FRS Marine Laboratory have carried out acoustic surveys for herring in the northern North Sea (ICES Division IVa) in July of each year since 1984. Since 1991, this survey has been part of an ICES international coordinated effort, aiming to provide an abundance estimate for the whole North Sea herring population. The estimate is then used by the Herring Assessment Working Group (HAWG) as a tuning index to determine the population size. This report details the results of the survey in the northern North Sea carried out on the *FRV Scotia*. A stock estimate is provided encompassing a breakdown by numbers and biomass into age groups and maturity stages.

Methods

The survey was carried out on from 5 to 26 July 2000 and covered the area north and east of Scotland from longitude 2° East to 4° West (or to the shelf edge at 200 m), and from latitude 58° - 61°45' North. The survey design (Fig. IId.1) was stratified according to the expected herring distribution based on the results from previous years surveys. Regular parallel transects were used along lines of latitude. The transect spacing was set at 15, or 7.5 n.mi., giving 2 or 4 transects per ICES statistical rectangle respectively. Transect length was variable to extend from close inshore to the shelf edge (200 m). The start point of the parallel transects was randomised within an ICES rectangle sample block, with a 10 % buffer on each side. A zig-zag design was adopted for a small inshore area north east of Shetland. The total cruise track length was 2806 n.mi. (5196 km) surveying an area approximately 30,825 n.mi.^{2}, giving a degree of coverage of 16%.

Acoustic data were collected with a Simrad EK500 scientific echo-sounder interfaced to a PC running Sonardata Echoview software. Simrad ES-38B (38 kHz), ES120-7 (120 kHz) and ES200-28 (200 kHz) transducers were operated from the drop keel of *FRV Scotia*; in addition, data were also collected from the ships ES500 operating at 18 kHz from the hull of the vessel. Data from the echo-integrator were summed over 15 minute periods using a "ping" log option set to 600 pings at 250 m (ping rate of 1.5 seconds) and 360 pings at 500 m (3 seconds at 500 m range).

The equipment was calibrated in Scapa Flow on 6 and 25 July, using a tungsten carbide standard target (Foote *et al*., 1987). No alterations to the EK500 transducer gains were made for the first half of the survey (Sv gain of 26.5 dB). At the start of the second half of the survey the Sv gain was changed to the calibrated value of 26.68 for the purposes of intercalibration (see below). No TVG error function correction was applied (this is assumed to be incorporated into the new versions of EK500), although a range to target compensation was carried out (Fernandes and Simmonds 1996). The two calibrations were very similar (approximately 0.02 dB difference); results and details are given in Table IId.1.

Fishing was carried out using a 12 × 20 m rectangular pelagic trawl (Marine Laboratory code PT160), with a mesh size of 160 cm in the wings, through to 4.0 cm mesh in the cod-end. It commonly fished to its rectangular dimensions, as seen on the colour display of the Simrad scanning netsonde. On one occasion a bottom trawl was used (Marine Laboratory code BT101m). Other facilities included the ships' SR240 multibeam sonar which was used on occasion to hunt for large pelagic schools.

Fish samples were broken into species composition by number. Measurements of lengths were taken to the nearest 0.5 cm, and in the case of herring, length stratified samples were taken for maturity, age (otolith extraction), and weight (2 per 0.5 cm class below 20 cm, 5 per 0.5 cm class from 20-27 cm, and 10 per 0.5 cm class for 27.5 cm and above).

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) "Possibly herring"; 4) "Herring in surface waters". The biomass/numbers estimate for herring was composed of categories 1, 2 & 4. Their breakdown serves merely as a relative indication of certainty within the most subjective process of integral partitioning. Allocated integrator counts (s_A values) from these categories were used to calculate herring numbers using the MILAP software program. For the purposes of finer scale evaluation, the actual analysis areas were 30 minutes of longitude by 15 minutes of latitude. The TS/length relationships used were those recommended by the acoustic survey planning group (ICES 2000). Biomass of herring was calculated from numbers using a length-weight relationship determined from the trawl samples taken during the survey according to:

Herring weight (grams) = $0.00204 * L^{3.448}$ (L = length in cm)

Results

The cruise track over which acoustic data was collected is given in Figure IId.1. In the acoustic estimate, a total of 976 Equivalent Distance Sampling Units (EDSU) were taken, of which 359 had at least one of the three categories assigned to herring (and consequently a total of 617 zero values). There were 78 samples allocated to "definitely herring"; 271 to "probably herring"; and 38 to the “herring in surface waters” category.

The geographical distribution of s_A values attributed to herring is given as a post plot in Figure IId.2. Large concentrations of herring were seen in the middle of the area south east and east of Shetland. Occasional large marks were seen north east of Shetland. A large number of continuous traces were seen close to the bottom in the southern part of the area. Some marks were seen on the west of Shetland and to the north west of Orkney.

A total of 45 trawl hauls were taken. The positions of these hauls are indicated in Figure IId.1. Herring was the most ubiquitous fish species, being present in 31 of the trawl hauls (Table IId.2). Small herring were found in the southern part of the area and tended to increase in size northwards or with increasing distance from the coast. The mean length of herring caught in each trawl is given as a post plot in Figure IId.3. Of the trawl hauls which contained herring, 30 captured sufficient numbers to provide adequate samples to qualify the acoustic data. Selected trawl length frequency distributions were averaged into 5 area sub-divisions in MILAP after comparison using a Kolmogorov-Smirnov test. The locations of these 5 areas are given in Figure IId.3. The length frequency compositions of trawls used and averages for the areas are given in Table IId.3.

The remaining species were dominated by Norway pout (*Trisopterus esmarkii*), whiting (*Merlangius merlangus*) and mackerel (*Scomber scombrus*). Haddock (*Melanogrammus aeglefinus*) were also abundant, forming large midwater schools in the south central part of the area.

A total of 3419 fish were aged and their maturity state recorded. These data were combined as recommended in ICES (2000) to give an age/maturity-length key for herring with 11 classes.

The total biomass estimates for the survey area are:

Definitely herring	1014 tonnes	59%
Probably herring	663 tonnes	39%
Herring in surface waters	38 tonnes	2%
Total herring	**1,715 tonnes**	
Spawning stock biomass	1,564 tonnes	91%

The estimate in numbers of herring is 9,941 million. The distribution of numbers and biomass by ¼ ICES statistical rectangle is given in Figure IId.4. The breakdown of herring numbers by age and length is given in Table IId.4. Herring mean lengths, mean weights, biomass, and numbers estimates, broken down by age and maturity are given in Table IId.5. Four ring fish comprise the dominant year class by biomass (36% of the total biomass) and by numbers (28% of total numbers). Three ringers comprise the next largest group with 18% of the biomass and 17% of total numbers. A very large one ring year class is present with 2286 million fish representing 23% of total numbers. No estimates of biomass are given for other species as they were inappropriately sampled by both the acoustic and net apparatus.

Discussion

The biomass estimate for the current survey (1,714,800 t) is significantly larger than last years (1,378,000 t). However the year class structure is similar with this years 4 ringers comprising the dominant group which is in keeping with last years dominant 3 ringers. The qualification of acoustic traces was good, with 45 trawls taken, of which 30 had good quantities of herring. A large proportion of the biomass estimate (59 %) was derived from the “definitely herring” category, i.e. from marks which were large, very distinct, and more importantly, from which good fishing samples were taken. Many of these marks were very dense with 39 calibrated s_A values in excess of 1000. Of the remaining 41% of biomass, 39% was derived from the “probably herring” category, with only a small amount from the less certain “herring in surface waters” category. The biomass estimate, therefore, has plenty of evidence to suggest that it is an accurate representation of the amount of fish in the area at the time.

Herring were found in places where they might expect to occur such as the south east of Shetland and east of Shetland. This would seem to justify the current survey stratification design, although little was found close inshore east of Shetland. Of the five subdivisons, area IV (OFN – Offshore North) had the largest biomass (847,000 t) due to the large number of large fish found there. Area IV incorporated both the eastern part of Shetland and north west of Orkney (Figure IId.3) and is where many of the 4 ring fish were found. Most of the young fish (1,456 million 1 ringers) were found in area II (INS – Inshore South) and a large number (666 million 1 ringers) were found in area I (MOR – Moray coast).

A notable feature was the state of maturity: of a total of 576 sampled three ring fish only 1 was immature (< 1%); only 6% of two ring fish were immature; and of 464 1 ringers, 64 were mature (14%). This would indicate that herring are maturing earlier and merits further investigation (e.g. maturity and age verification).

References

Fernandes, P. G. and E. J. Simmonds (1996). Practical approaches to account for receiver delay and the TVG start time in the calibration of the Simrad EK500. *ICES CM 1996*/**B:** 8 pp.

Foote, K. G., H. P. Knudsen, et al. (1987). “Calibration of acoustic instruments for fish density estimation: a practical guide.” ICES Cooperative Research Report **144**: 57 pp.

ICES (2000). Report of the planning group for herring surveys. *ICES CM 2000*/G:02 106 pp.

Table IId.1. Simrad EK500 settings used on the *FRV Scotia* July 2000 herring acoustic survey.

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	-21.0 dB
3 dB Beamwidth	7.1°
Calibration details	
TS of sphere	-42.36 dB
Range to sphere in calibration	10.8 m
Selected s_A value for calibration	2922
Calibration factor for s_A values	0.92
Calibration constant for MILAP	0.99 at -35 dB (after applying 0.93 for 1st half)
Log Menu	
Ping	600 at 250 m range
Operation Menu	
Ping interval	1.5 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 IId.2. Trawl haul location and species composition (raised numbers) from the *FRV Scotia* July 2000 herring acoustic survey.

Haul No	Date	Time	Latitude	Longitude	ICES Rect	Water depth	Headlin depth	Herring	Mackerel	Sprat	NPout	Bl whiting	Haddock	Whiting	Argentine	L sole	G gurnard	C Dab	T minutus	HMackerel	Sandeels
222	6/7/00	12:20	58°08.64'N	002°21.69'E	45E7	62	30							1							105
223	6/7/00	16:05	58°08.59'N	001°46.59'E	45E8	70	58	20006		78	625										
224	6/7/00	20:26	58°08.89'N	000°55.40'E	45E9	113	101	2116		24	11			4							
225	7/7/00	05:15	58°08.52'N	000°05.31'E	45F0	134	122	287			22						1				
226	7/7/00	15:28	58°28.64'N	000°56.28'W	45F1	132	120	1533			74			8							
227	7/7/00	20:10	58°23.72'N	000°03.79'W	45F0	140	128	954			315			9							
228	8/7/00	07:24	58°23.77'N	001°47.12'E	45E8	106	94	1557		3			3				1				
229	8/7/00	15:44	58°38.66'N	002°35.43'E	46E7	68	15			7				5							37
230	8/7/00	19:41	58°38.65'N	001°59.14'E	46E7	90	78	1374						2							
231	9/7/00	05:05	58°38.60'N	000°52.27'E	46E8	123	111	1350			10		75								
232	9/7/00	10:08	58°38.00'N	000°03.00'E	46E9	142	130	3413			53										
233	9/7/00	14:11	58°38.70'N	000°47.60'W	46F0	141	65						36								
234	9/7/00	15:15	58°38.70'N	000°41.90'W	46F0	140	128	8380													
235	10/7/00	05:15	58°53.00'N	000°08.00'E	46E9	120	108														
236	11/7/00	03:00	59°09.30'N	001°00.80'E	47E8	125	113	2610	30		108		36	6							
237	11/7/00	11:13	59°09.40'N	000°36.80'W	47E9	145	60														
238	12/7/00	06:50	59°11.80'N	000°09.30'E	47E9	140	60						18	2							
239	12/7/00	12:34	59°19.34'N	000°52.55'E	47E9	130	118	24826			100		25	25							
240	12/7/00	16:48	59°19.24'N	000°07.47'E	47E9	140	128	4638			13		13								
241	13/7/00	04:27	59°23.80'N	001°30.10'E	47E8	85	73	59	87		733		396	3608	20	10					
242	13/7/00	13:12	59°38.60'N	001°51.60'E	48E8	90	84		13				950	170		112	26	15	4		
243	13/7/00	18:22	59°38.67'N	000°27.00'E	48E7	126	114	1			4		236	79	2	4	5	2			
244	13/7/00	20:33	59°38.60'N	000°18.90'E	48E9	125	113	3963					13	26							
245	14/7/00	14:31	59°53.70'N	000°00.00'W	4EF0	130	118	3713													
246	15/7/00	07:00	60°11.70'N	000°36.70'E	49E9	120	108	2			2860		30	24	1		1		1		
247	16/7/00	12:12	60°18.90'N	000°41.40'E	49E9	100	88				10416										
248	17/7/00	08:30	60°23.70'N	000°18.25'W	49F0	140	128	3			65		5	1							
249	17/7/00	10:58	60°23.60'N	000°03.80'W	49F0	145	132	8480													
250	17/7/00	15:55	60°31.00'N	000°55.00'E	50E9	101	89	307	3	1	27360		51	21	3						
251	18/7/00	03:33	60°46.60'N	000°44.80'E	50E9	80	68														

Table IId.2. (contd.)

Haul No	Date	Time	Latitude	Longitude	ICES Rect	Water depth	Headlin depth	Herring	Mackerel	Sprat	NPout	Bl whiting	Haddock	Whiting	Argentine	L sole	G gurnard	C Dab	T minutus	HMackerel	Sandeels
252	18/7/00	07:14	60°49.40'N	000°19.50'E	50E9	140	128	1848	127		471		28	2	1						
253	18/7/00	20:15	60°53.70'N	-001°01.87'W	50F1	146	134	8100													
254	19/7/00	03:57	60°52.50'N	000°29.70'W	50F0	135	123	28000													
255	19/7/00	17:01	61°08.70'N	000°59.90'W	51F0	160	148	890	19		1002	46	12	7							
256	20/7/00	12:42	61°23.70'N	000°05.40'W	51F0	180	168	4296			36	240		2							
257	21/7/00	05:33	60°56.00'N	001°08.00'E	50E8	130	118	12060													
258	22/7/00	05:00	60°34.00'N	001°59.00'E	50E7	145	132	1743	35		105	7		14							
259	22/7/00	09:53	60°24.00'N	001°49.80'E	49E8	105	60	5052	180												
260	22/7/00	16:01	60°18.00'N	003°29.00'E	49E6	120	95														
261	23/7/00	04:45	60°08.50'N	002°20.80'E	49E7	115	103	636	70		117		7	5					2		
262	23/7/00	09:41	60°06.10'N	001°24.70'E	49E8	100	88	4390	120												
263	23/7/00	18:50	59°53.70'N	003°40.80'E	48E6	130	118	146			168	11	2		1		1			1	
264	24/7/00	03:17	59°41.90'N	003°59.90'E	48E6	110	96	405	3								9				
265	24/7/00	16:00	59°24.90'N	003°01.80'E	47E6	75	63														5
266	25/7/00	06:03	58°53.60'N	003°30.50'E	46E6	100	88														

Table IId.3a. Percentage length frequencies of herring in each trawl and mean for subdivisions (see Figure IId.3 for geographical location of subdivisions) from the *FRV Scotia* July 2000 herring acoustic survey.

Length	MOR			INS								OFS						
(cm)	224	223	mean	228	236	231	230	241	239	225	mean	262	227	226	234	232	240	mean
14.50		0.00	0.00															
15.00		0.00	0.00															
15.50		0.03	0.02															
16.00		0.12	0.06															
16.50	0.01	0.20	0.10	0.01						0.00	0.00							
17.00	0.08	0.21	0.15	0.07		0.00					0.01							
17.50	0.15	0.14	0.15	0.09		0.00	0.01	0.04			0.02							
18.00	0.20	0.12	0.16	0.09	0.01	0.02	0.06	0.02		0.00	0.03							
18.50	0.16	0.09	0.12	0.10	0.05	0.06	0.14	0.08		0.04	0.07	0.00		0.00				0.00
19.00	0.12	0.05	0.08	0.09	0.12	0.12	0.17	0.13	0.01	0.06	0.10	0.00			0.00			0.00
19.50	0.08	0.02	0.05	0.12	0.19	0.12	0.22	0.13	0.04	0.07	0.13		0.00	0.00	0.00	0.00		0.00
20.00	0.06	0.02	0.04	0.17	0.24	0.14	0.22	0.06	0.15	0.13	0.16	0.03				0.01		0.01
20.50	0.05	0.01	0.03	0.14	0.14	0.12	0.11	0.06	0.20	0.14	0.13	0.03		0.01	0.00	0.01		0.01
21.00	0.05		0.02	0.08	0.04	0.12	0.05	0.02	0.19	0.17	0.10	0.05		0.01	0.00	0.02	0.00	0.01
21.50	0.01		0.01	0.02	0.02	0.06	0.01	0.02	0.11	0.11	0.05	0.06		0.01		0.03		0.02
22.00	0.00		0.00	0.01	0.01	0.08			0.04	0.07	0.03	0.06		0.02	0.01	0.05	0.02	0.03
22.50				0.01	0.02	0.04			0.02	0.05	0.02	0.03	0.00	0.02	0.00	0.05	0.03	0.02
23.00	0.01		0.00		0.02	0.03		0.08	0.02	0.03	0.02	0.04	0.01	0.06	0.01	0.08	0.02	0.04
23.50	0.00		0.00		0.01	0.02		0.06	0.03	0.02	0.02	0.03	0.03	0.07	0.02	0.08	0.02	0.04
24.00					0.02	0.02		0.04	0.02	0.03	0.02	0.03	0.03	0.11	0.01	0.08	0.02	0.05
24.50					0.02	0.02		0.09	0.02	0.02	0.03	0.05	0.05	0.13	0.02	0.09	0.03	0.06
25.00	0.00		0.00		0.02	0.00		0.08	0.03	0.00	0.02	0.08	0.11	0.16	0.07	0.11	0.04	0.09
25.50					0.03	0.01	0.00	0.02	0.04	0.01	0.01	0.07	0.13	0.12	0.09	0.09	0.04	0.09
26.00				0.00	0.03			0.04	0.04	0.02	0.02	0.10	0.18	0.11	0.18	0.08	0.11	0.13
26.50				0.00	0.02	0.00		0.04	0.04	0.01	0.02	0.09	0.14	0.07	0.18	0.07	0.14	0.12
27.00					0.01			0.02	0.01	0.01	0.01	0.09	0.11	0.05	0.19	0.06	0.18	0.11
27.50				0.00	0.00				0.01	0.00	0.00	0.07	0.08	0.03	0.11	0.03	0.12	0.07
28.00					0.01					0.00	0.00	0.05	0.05	0.01	0.07	0.02	0.09	0.05
28.50												0.02	0.03	0.00	0.03	0.01	0.06	0.03
29.00												0.00	0.01	0.00	0.01	0.01	0.03	0.01
29.50												0.01	0.01		0.00	0.00	0.01	0.01
30.00													0.01		0.00	0.00	0.01	0.00
30.50													0.01		0.00	0.00	0.01	0.00
31.00													0.00			0.00	0.01	0.00
31.50																	0.01	0.00
32.00																		
32.50																		
33.00																		
33.50																		
34.00																		
34.50																		
35.00																		
35.50																		
Number	270	266		338	304	402	205	53	308	287		441	318	438	419	455	371	
Mean Length	19.2	17.7	18.5	19.8	21.3	21.1	20.0	22.2	22.4	21.7	21.2	25.2	26.7	25.3	26.9	25.1	27.1	26.1
Mean weight	55.3	41.9	48.6	62.0	81.6	76.9	63.2	96.0	95.4	85.7	80.1	144.5	170.7	142.9	174.9	141.0	180.5	159.1
TS Individual	-45.5	-46.2	-45.8	-45.2	-44.6	-44.7	-45.2	-44.2	-44.2	-44.4	-44.6	-43.1	-42.7	-43.1	-42.6	-43.2	-42.5	-42.9
TS kg	-32.9	-32.4	-32.7	-33.2	-33.7	-33.6	-33.2	-34.0	-34.0	-33.8	-33.7	-34.7	-35.0	-34.7	-35.0	-34.7	-35.1	-34.9

Table IId.3b. Percentage length frequencies of herring in each trawl and mean for subdivisions (see Figure IId.3 for geographical location of subdivisions) from the *FRV Scotia* July 2000 herring acoustic survey.

Length	OFN												NED				
(cm)	250	252	254	257	258	259	261	264	249	245	244	mean	253	255	256	263	mean
14.50																	
15.00																	
15.50																	
16.00																	
16.50																	
17.00																	
17.50																	
18.00																	
18.50																	
19.00	0.00											0.00					
19.50																	
20.00	0.00										0.00	0.00					
20.50	0.01					0.01						0.00					
21.00	0.00					0.00	0.01				0.01	0.00					
21.50	0.01	0.00				0.01	0.01			0.00	0.02	0.01	0.00				0.00
22.00	0.01					0.02	0.03		0.01		0.01	0.01	0.01				0.00
22.50	0.00	0.00	0.00			0.01	0.02		0.00	0.01	0.00	0.01	0.01				0.00
23.00	0.01	0.01				0.01	0.02		0.00		0.01	0.01	0.01				0.00
23.50	0.01	0.00	0.00		0.00	0.01	0.04	0.00	0.01	0.00	0.01	0.01	0.00				0.00
24.00	0.01	0.01	0.01	0.00		0.01	0.02		0.00		0.00	0.01	0.01				0.00
24.50	0.01	0.01	0.01	0.00		0.01	0.01	0.00	0.00		0.01	0.01	0.01				0.00
25.00	0.01	0.00	0.00	0.00		0.01	0.02	0.01	0.00	0.00	0.01	0.01	0.00			0.01	0.00
25.50	0.04	0.01	0.01	0.01	0.00	0.02	0.03	0.02	0.01	0.02		0.01	0.01	0.00			0.00
26.00	0.04	0.01	0.02	0.00	0.01	0.01	0.04	0.05	0.03	0.02	0.05	0.03	0.01		0.00		0.00
26.50	0.04	0.03	0.05	0.01	0.02	0.03	0.05	0.10	0.05	0.04	0.10	0.05	0.02			0.02	0.01
27.00	0.09	0.09	0.07	0.04	0.08	0.07	0.10	0.13	0.08	0.13	0.14	0.09	0.02	0.01		0.05	0.02
27.50	0.15	0.12	0.08	0.08	0.10	0.10	0.08	0.18	0.10	0.18	0.14	0.12	0.05	0.03	0.01	0.09	0.04
28.00	0.16	0.14	0.15	0.14	0.19	0.16	0.14	0.20	0.13	0.20	0.15	0.16	0.08	0.07	0.02	0.05	0.05
28.50	0.11	0.15	0.15	0.14	0.17	0.13	0.10	0.11	0.13	0.14	0.12	0.13	0.09	0.12	0.06	0.11	0.10
29.00	0.13	0.17	0.15	0.14	0.15	0.12	0.10	0.09	0.13	0.11	0.09	0.12	0.15	0.16	0.14	0.14	0.14
29.50	0.06	0.11	0.09	0.10	0.08	0.08	0.06	0.04	0.08	0.07	0.07	0.08	0.12	0.15	0.15	0.14	0.14
30.00	0.06	0.05	0.09	0.10	0.07	0.07	0.06	0.02	0.08	0.03	0.03	0.06	0.13	0.16	0.14	0.10	0.13
30.50	0.02	0.04	0.06	0.07	0.05	0.04	0.04	0.01	0.06	0.03	0.01	0.04	0.09	0.09	0.11	0.11	0.10
31.00	0.01	0.02	0.02	0.05	0.03	0.04	0.02	0.02	0.03	0.01	0.01	0.02	0.07	0.08	0.12	0.08	0.09
31.50	0.01	0.02	0.02	0.03	0.02	0.02	0.02	0.01	0.02		0.01	0.02	0.04	0.05	0.08	0.05	0.06
32.00	0.01	0.02	0.00	0.03	0.02	0.01	0.01	0.01	0.02	0.01		0.01	0.04	0.02	0.06	0.03	0.04
32.50	0.00		0.00	0.02	0.01	0.00	0.01	0.00	0.01	0.01		0.01	0.01	0.02	0.05	0.01	0.02
33.00		0.00	0.00	0.02	0.00	0.00			0.00			0.00	0.01	0.01	0.04	0.01	0.02
33.50					0.00				0.00	0.00		0.00	0.00	0.01	0.02		0.01
34.00				0.00								0.00	0.00	0.01	0.00		0.00
34.50														0.01	0.01		0.00
35.00																	
35.50						0.00						0.00		0.00	0.00		0.00
Number	307	422	420	402	390	421	382	405	424	297	317		405	377	358	146	
Mean length	28.2	28.9	29.0	29.6	29.2	28.5	28.0	28.3	29.0	28.6	28.0	28.7	29.6	30.3	30.9	29.9	30.2
Mean weight	208.2	225.3	227.6	245.2	233.3	217.7	204.3	209.3	227.5	216.1	203.7	219.8	247.0	262.6	282.4	251.9	261.0
TS individual	-42.2	-42.0	-41.9	-41.8	-41.9	-42.1	-42.2	-42.1	-41.9	-42.1	-42.2	-42.0	-41.7	-41.6	-41.4	-41.7	-41.6
TS Kg	-35.4	-35.5	-35.5	-35.6	-35.6	-35.4	-35.3	-35.4	-35.5	-35.4	-35.3	-35.5	-35.7	-35.8	-35.9	-35.7	-35.8

Table IId.4. . Estimated herring numbers and biomass by age and length groups from the *FRV Scotia* July 2000 herring acoustic survey.

Length	1A	2I	2M	3I	3M	4A	5A	6A	7A	8A	9+	Total
14.5	1.3											1.3
15	1.3											1.3
15.5	10.2											10.2
16	42.0											42.0
16.5	71.3											71.3
17	119.8											119.8
17.5	137.1											137.1
18	162.6											162.6
18.5	211.2											211.2
19	244.2	5.7										249.9
19.5	275.6	7.2										282.8
20	335.9	9.1										345.1
20.5	278.4	5.9	7.7									292.0
21	215.4	10.9	15.9									242.2
21.5	100.7	25.0	31.9	1.0								158.5
22	54.9	8.9	78.0			2.7						144.4
22.5	15.1	19.4	78.3									112.8
23	6.3	3.7	128.0		15.7	2.0						155.7
23.5	1.3		144.8		14.3							160.4
24		1.6	126.3		41.4	3.8						173.1
24.5			151.7		46.3	12.6	0.9					211.5
25			149.1		90.3	37.1	2.7					279.2
25.5			124.2		116.4	34.4	13.9	3.5				292.3
26			121.0		159.2	87.0	49.2	9.8				426.2
26.5	1.3		120.4		195.8	111.0	58.1	1.8				488.4
27			86.5		221.7	284.2	26.1	23.6				642.1
27.5			56.0		252.3	301.4	67.0	6.8				683.6
28			22.6		200.0	479.5	66.5	19.5	5.6			793.8
28.5			4.6		137.4	425.9	84.1	28.1	2.7			682.8
29					89.2	413.5	138.1	35.9	6.6	1.1	1.1	685.4
29.5					45.0	297.0	82.2	42.3	17.6			484.0
30					28.9	170.3	104.9	45.8	26.0	11.5	10.5	397.7
30.5					7.2	81.9	75.9	51.8	45.5	9.7	4.7	276.7
31					1.1	26.1	51.8	59.2	39.2	10.7	5.7	193.8
31.5						12.6	18.9	42.4	34.1	17.2	7.2	132.4
32						9.4	9.0	19.4	31.1	14.9	5.4	89.2
32.5							7.0	14.8	14.2	10.9	3.3	50.1
33							4.1	5.8	5.8	8.7	8.7	33.1
33.5							0.8	1.6	0.8	6.0	3.5	12.8
34									2.5	0.8	2.4	5.7
34.5							0.8		0.8	0.8	1.7	4.2
35												
35.5									1.7		0.8	2.5
Total	2285.8	97.4	1447.1	1.0	1662.0	2792.4	861.9	412.0	234.2	92.3	55.1	9941.2
N aged	464.0	42.0	676.0	1.0	575.0	848.0	319.0	215.0	155.0	78.0	46.0	3419.0

Table IId.5. Total numbers (millions), biomass (thousands of tonnes), mean length and mean weight breakdown by age and maturity obtained during the *FRV Scotia* July 2000 herring acoustic survey.

Area	Numbers	Biomass	Mean Length	Mean Weight
1A	2285.8	142.1	19.3	62.2
2I	97.4	8.3	21.3	84.9
2M	1447.1	202.1	24.6	139.6
3I	1.0	0.1	21.5	86.8
3M	1662.0	314.3	27.0	189.1
4A	2792.4	615.2	28.3	220.3
5A	861.9	204.6	28.8	237.3
6A	412.0	110.4	29.9	267.9
7A	234.2	70.1	31.0	299.4
8A	92.3	29.7	31.6	322.2
9+	55.1	18.0	31.8	327.6
Mature	7557.0	1564.3		
Total	9941.2	1714.8	25.6	172.5

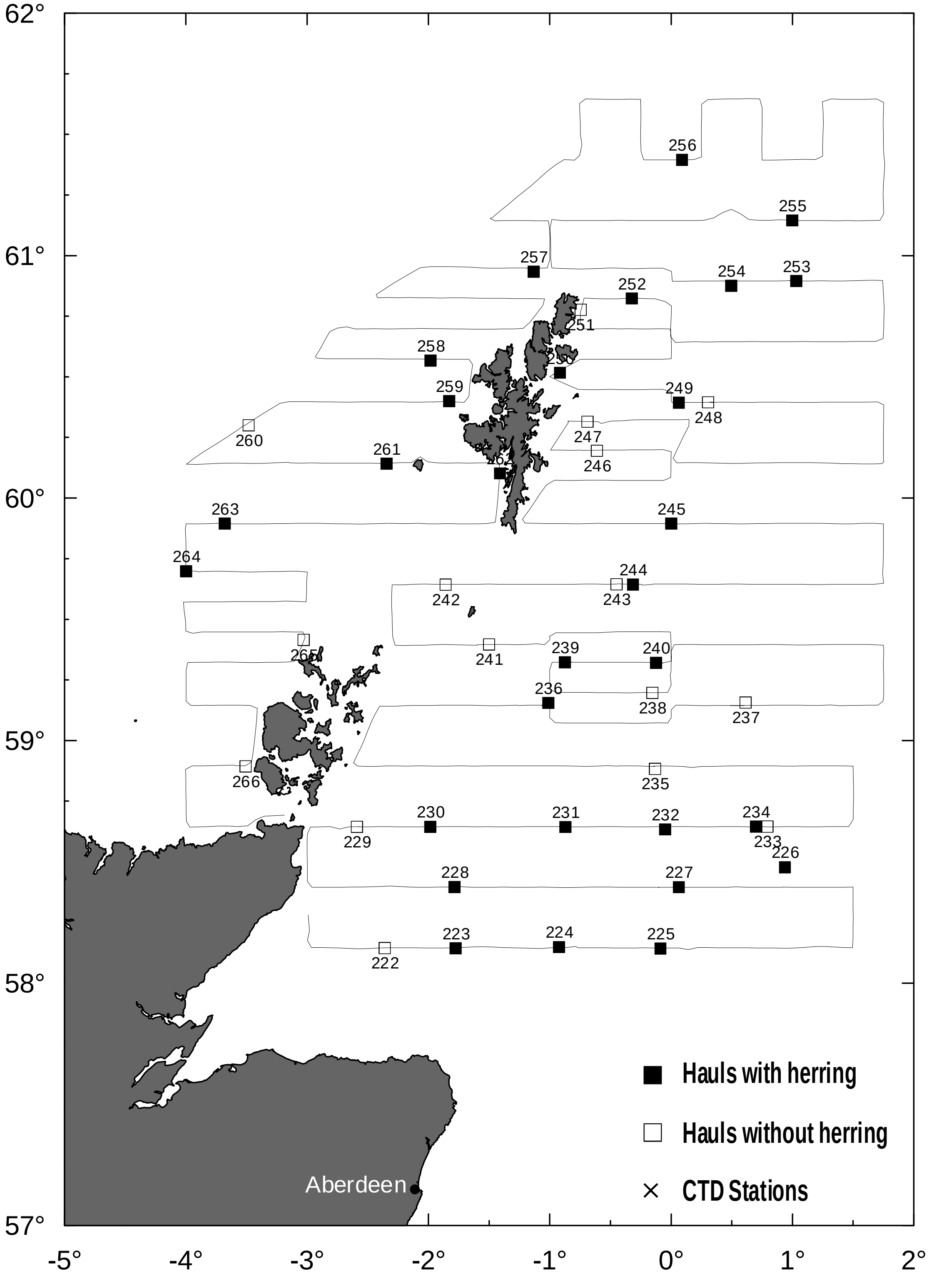

Figure IId.1. Map of the east of Scotland showing cruise track and positions of fishing trawls undertaken during the July 2000 North Sea acoustic survey. Filled squares indicate trawls in which herring were caught, whilst open squares indicate trawls with no herring.

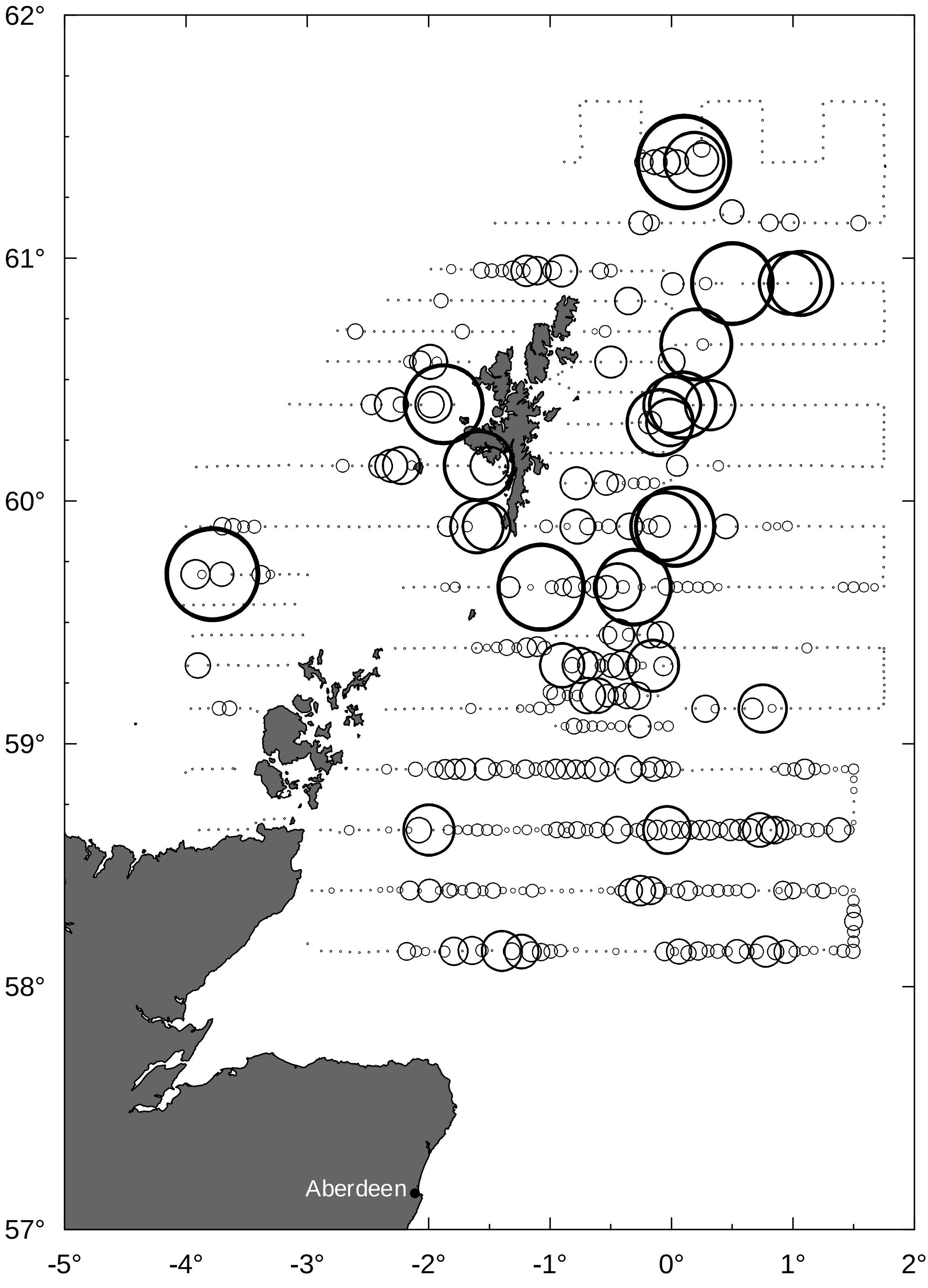

Figure IId.2. Post plot showing the distribution of total herring calibrated s_A values (on a proportional square root scale relative to the largest value of 8900) obtained during the July 1998 herring acoustic survey.

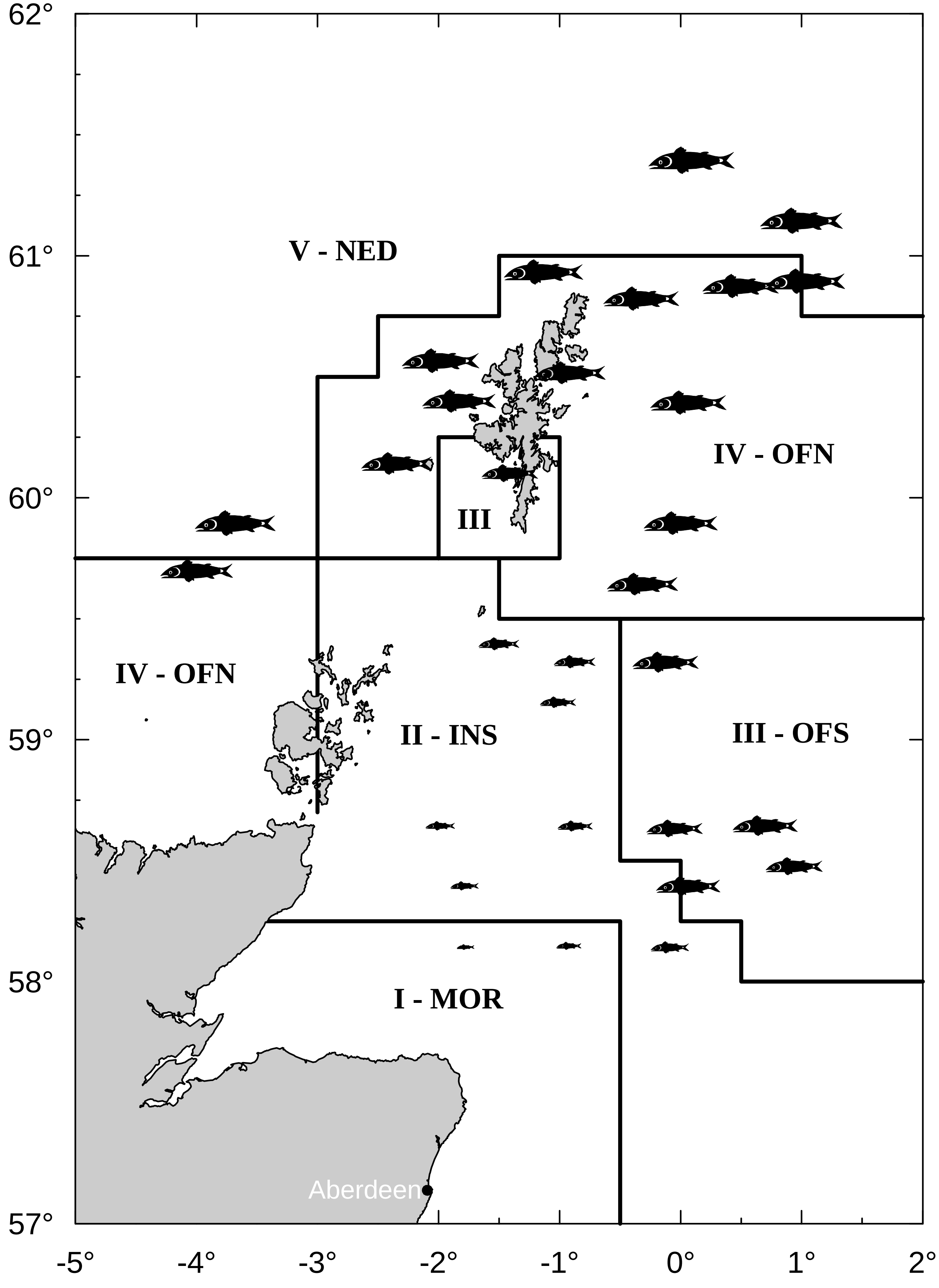

Figure IId.3. Post plot of herring mean length from the *FRV Scotia* North Sea acoustic survey. Symbols size proportional to length from trawl hauls used to qualify the acoustic data. Lines indicate subdivision areas I (MOR – Moray) to V (NED – Northern Edge).

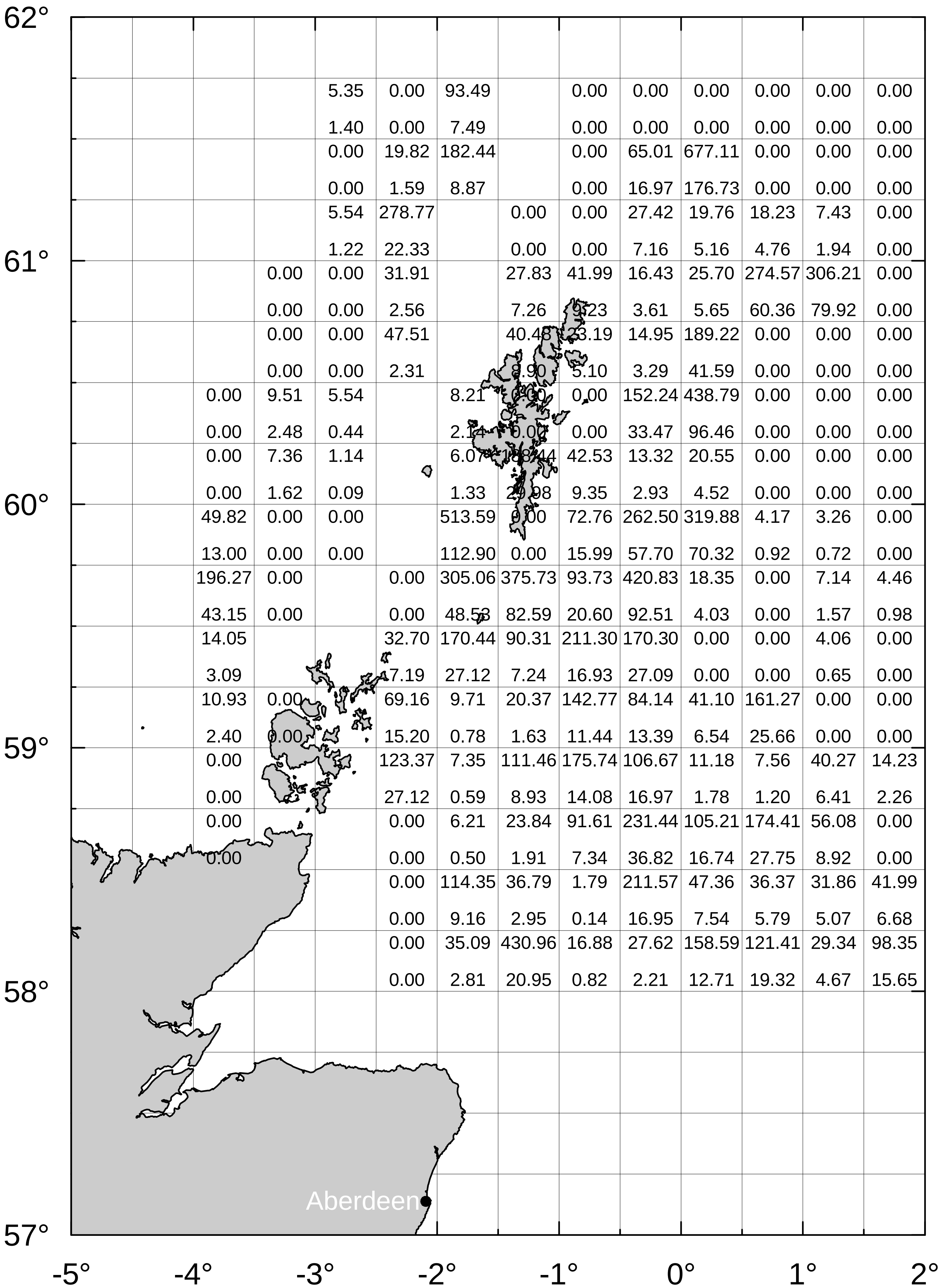

Figure IId.4. Results of the *FRV Scotia* North Sea herring acoustic survey: estimated numbers (number in millions in the top half of each square) and biomass (in thousands of tonnes in the lower half of each square).

APPENDIX IIE NETHERLANDS

Survey report for RV Tridens in the south western North Sea

26 June - 14 July 2000

Bram Couperus, RIVO, IJmuiden, The Netherlands.

Calibration

The planned calibration session at Kristiansand in the week prior to the survey was cancelled, due to problems with Tridens. Tridens left on 26 June at 9:00 UTC from the port of IJmuiden. On the evening of 27 June, the vessel arrived at Scapa Flow, Orkneys and anchored at 58°55.71N - 003°01.97W for the calibration. The newly obtained software *Calibrate* did not run properly. At 21:00 it was decided to stop in order to continue calibration the next morning. The next morning the calibration was conducted quickly in the conventional way.

Survey

On the afternoon of 28 June Tridens started with the survey at 57°55N - 002°50W proceeding east. During the first week, the 57°55N, 57°40N, 57°25 and the 57°10 transects were surveyed. The weekend (until Sunday night) was spent in Aberdeen. On Monday 3 July at 04:00 the survey was resumed at the 56°55 transect. In the afternoon it was decided to switch from the towed body transducer to the hull mounted transducer, because of suspected damage to the cable between the echosounder and the towed body. The cable needed to be repaired, therefore until Thursday 6 July, the hull mounted transducer was used. On Saturday morning the 55°40 transect was finished. The second weekend was spent in Sunderland. During the first two days of the last week the weather was bad (7-8 beaufort, N-NW). To be able to cover the planned area, the 54°55N and the 54°40N transect were cut short. Also the 54°25N and the 54°10 transect were replaced by one transect 54°15N. This transect was adjusted, in order to cover part of the Silverpit area. On Thursday 13 July an intercalibration was held together with the German research vessel Walther Herwig in the outer Silverpit (start position: 54°22 - 000°16E), after which Tridens sailed to IJmuiden. Arrival at IJmuiden 7:00 on 14 July.

Methods

A SIMRAD EK500 system was used. The 38 kHz splitbeam transducer was mounted in a towed body. A hull-mounted transducer of the same type was used as a back-up in case of problems with the towed body transducer. Integration of the echo recordings was done by the BI500 post processing system. This system was also used to allocate s_A values to species. Ship’s speed was 12.5 knots (weather allowing) and the survey was carried out from 4.00 to 21.00 UTC. During the hours of darkness, the survey was interrupted because results from previous surveys had shown that herring at this time of the day may rise close to the surface and may not be detected by the transducer. Due to lack of time however, in low density areas the survey was continued during darkness until some kind of traces showed up. In total an estimated 23% of the survey-time was conducted during darkness, which is more than in previous years due to lack of time.

Figure 1 shows the survey track and the trawl stations. Trial fishing was done with a 2000 meshes pelagic trawl with a 20 mm cod end lining. During the survey 22 hauls were conducted. A total of 16 samples of herring (740 specimens) and 4 sprat samples (332 specimens) were collected and 25 CTD-profiles were taken.

Results

Herring

Comparatively large numbers of one-ringers were found off the coast of Scotland and England and to a lesser extent scattered over the whole area. Schools of adult herring were encountered at the Devil Holes and within a radius of 30 miles of that area. The herring schools were often mixed with Norway pout, especially close to the Devil Holes.

The hauls have been grouped in 6 strata (A-F, Figure IIe.2). Results on herring are presented in Tables IIe.3 and IIe.4 and in Figure IIe.3. Distribution by length and age for each strata is presented in Table IIe.7.

Sprat

Some minor concentrations of sprat were found along the British coast. The hauls have been grouped in 4 strata (A - D, Figure IIe.2). Results on sprat are presented in Table IIe.5 and IIe.6 and in Figure IIe.4.

Table IIe.1a. Calibration report for the RV Tridens acoustic survey 26 June - 14 July 2000; Simrad EK-500, 38 kHz transducer - Towed Body.

date and time: 28 June 2000,	position: Scapa Flow 58°55.71N - 003°.01.97W
bottom depth: 30 m	wind: 3 BF
salinity: 34.9$^{o}/_{oo}$	wave height: 0.25 m
water temperature: 10.7 °	transducer: 38 kHz

Transceiver menu before calibration

pulse length: medium	bandwidth: wide
max. power: 2000 W	angle sensitivity: 21.9
2-way beam angle: -20.83	Sv transducer gain: 26.5
TS transducer gain: -26.5	3 dB beam width: 7.0
alongship offset: 0.03	athw. ship offset: - 0.12
ping interval: 1.0	transmitter power: normal

standard target: copper sphere, -33.6 dB

distance transducer - target: 9.6

TS values measured: -33.0

new transducer gain: 26.8

new TS values measured: -33.6

SA values measured: 28176

SA value calculated: 26334

default transducer gain: 26.5

correction factor: 0.93

Table IIe.1b. Calibration report for the RV Tridens acoustic survey 26 June - 14 July 2000; Simrad EK-500, 38 kHz transducer - Hull Mounted.

date and time: 28 June 2000,	position: Scapa Flow 58°55.71N - 003°.01.97W
bottom depth: 30 m	wind: 3 BF
salinity: 34.9 $^{o}/_{oo}$	wave height: 0.25 m
water temperature: 10.7 °	transducer: 38 kHz

Transceiver menu before calibration

pulse length: medium	bandwidth: wide
max. power: 2000 W	angle sensitivity: 21.9
2-way beam angle: -20.7	Sv transducer gain: 26.5
TS transducer gain: -26.5	3 dB beam width: 7.1
alongship offset: -0.05	athw. ship offset: 0.07
ping interval: 1.0	transmitter power: normal

standard target:	copper sphere, -33.6 dB
distance transducer - target:	19.6
TS values measured:	-33.9
new transducer gain:	26.35
new TS values measured:	-33.6
SA values measured:	5491
SA value calculated:	5921
default transducer gain:	26.5
correction factor:	1.08

Table IIe.2. Trawl station list and catches per species in kg from the RV Tridens survey, 26 June - 14 July 2000.

haul no	Date	time UTC	latitude(N)	longitude	E/W	depth meters	duration min.	herring	N. pout	other gadoids	mackerel	sprat	others	comments
1	28-Jun-00	18.35	57.55	002.24	W	59	48	10		15	38	1	0	
2	29-Jun-00	08.55	57.55	000.43	W	90	30	13	5	6	6		1	
3	30-Jun-00	06.32	57.40	001.14	W	107	35	771	25	23	1	1	1	
4	30-Jun-00	15.00	57.25	000.02	W	70	30	170	90	13			22	
5	30-Jun-00	19.35	57.25	001.10	E	87	35	154	75	1			2	
6	03-Jul-00	07.30	56.55	001.00	W	70	55		0	1			2	surface haul, sandeel (in meshes)
7	03-Jul-00	12.00	56.55	000.24	W	77	25	262	11	14	0	3	0	
8	03-Jul-00	15.55	56.55	000.24	E	87	40	720	1200	193	19		1	
9	04-Jul-00	08.58	56.40	001.47	E	81	62	3000	27	0	2			
10	04-Jul-00	13.35	56.40	000.45	E	86	60	70	470	323	270		0	
11	04-Jul-00	17.25	56.40	000.14	E	79	15	74	446					
12	05-Jul-00	09.50	56.25	000.58	W	63	85	500	56	1265	7	31	4	sandeel in meshes
13	05-Jul-00	19.29	56.25	001.32	E	91	15	1920	40	4	13		1	
14	06-Jul-00	06.41	56.10	000.54	E	71	14	16		49	4		2	
15	06-Jul-00	12.35	56.10	000.44	W	84	50	17		664	75	68	2	
16	07-Jul-00	11.40	55.40	002.09	E	78	55	0		45	4		8	
17	07-Jul-00	16.35	55.40	000.57	E	77	60	0	727	7	2		9	
18	10-Jul-00	07.22	55.25	000.53	W	92	25	1		400	0	1	11	
19	10-Jul-00	11.41	55.25	000.05	W	70	64	0	20	172	8		0	
20	11-Jul-00	16.50	55.10	001.00	W	84	45	1600	7	285		23		
21	12-Jul-00	07.50	54.40	000.30	E	69	25	570		2	4	1720	7	
22	12-Jul-00	13.15	54.39	000.42	W	54	15	3		4	1	218	1	

Table IIe. 3. Length distribution herring from the RV Tridens survey, 26 June - 14 July 2000.

length (cm)	haul 1	haul 2	haul 3	haul 4	haul 5	haul 6	haul 7	haul 8	haul 9	haul 10	haul 11	haul 12	haul 13	haul 14	haul 15	haul 16	haul 17	haul 18	haul 19	haul 20	haul 21	haul 22
13.5	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	0.00	0.00	33.33
14.0	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	0.00	0.00	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14.5	3.81	0.00	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.32	0.00	0.00	0.46	0.00	0.00	0.00	0.00	0.00	0.78	0.00
15.0	8.57	0.00	6.33	0.00	0.00	0.00	0.42	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	6.20	0.00
15.5	25.71	0.49	17.30	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.00	0.66	0.00	0.00	0.46	0.00	0.00	0.00	0.00	0.00	5.43	0.00
16.0	27.62	0.98	12.66	0.00	0.00	0.00	2.54	0.00	0.00	0.00	0.00	0.66	0.00	0.00	1.38	0.00	0.00	14.29	0.00	0.63	11.63	0.00
16.5	19.05	2.44	11.39	0.00	0.00	0.00	3.39	0.00	0.00	0.00	0.00	0.66	0.00	0.00	6.42	0.00	0.00	0.00	0.00	0.00	11.63	0.00
17.0	10.48	1.95	8.44	0.00	0.00	0.00	4.66	0.52	0.00	0.00	0.00	1.97	0.00	0.00	16.51	100.00	0.00	0.00	0.00	0.63	13.18	66.67
17.5	1.90	0.98	10.55	0.00	0.00	0.00	10.17	0.52	0.00	0.00	0.00	2.63	0.00	0.55	31.19	0.00	0.00	7.14	0.00	0.63	18.60	0.00
18.0	0.95	2.44	10.97	1.56	0.00	0.00	12.29	2.08	0.00	0.00	0.00	12.50	0.93	0.55	16.97	0.00	0.00	7.14	0.00	0.00	12.40	0.00
18.5	0.00	4.88	4.22	7.03	0.00	0.00	16.53	6.25	2.00	0.81	1.06	13.16	2.33	1.10	10.09	0.00	0.00	0.00	0.00	0.63	10.85	0.00
19.0	0.00	10.24	5.91	17.97	1.27	0.00	18.64	7.81	2.67	4.03	2.13	15.79	6.98	1.66	1.38	0.00	0.00	0.00	0.00	3.16	6.20	0.00
19.5	0.00	14.15	5.06	28.13	3.18	0.00	13.98	10.94	7.33	2.42	2.66	15.79	6.98	6.08	2.29	0.00	0.00	14.29	0.00	3.80	3.10	0.00
20.0	0.00	21.46	2.95	12.50	3.82	0.00	8.47	14.58	8.00	6.45	8.51	16.45	16.28	9.94	3.67	0.00	33.33	7.14	0.00	3.80	0.00	0.00
20.5	0.00	16.10	1.69	12.50	3.18	0.00	4.24	13.02	14.00	5.65	11.17	3.29	11.63	12.71	2.29	0.00	0.00	0.00	0.00	5.70	0.00	0.00
21.0	0.00	11.71	1.69	12.50	12.74	0.00	1.69	8.85	5.33	8.87	17.02	5.92	11.16	11.05	2.29	0.00	66.67	0.00	0.00	3.16	0.00	0.00
21.5	0.00	3.41	0.00	3.13	12.10	0.00	0.42	10.42	8.67	8.87	13.30	3.29	5.58	11.05	1.38	0.00	0.00	7.14	0.00	3.80	0.00	0.00
22.0	0.00	3.41	0.00	0.78	13.38	0.00	0.42	3.65	7.33	12.10	11.17	1.32	8.37	9.94	0.92	0.00	0.00	21.43	0.00	3.16	0.00	0.00
22.5	0.00	1.95	0.00	2.34	7.64	0.00	0.42	4.17	5.33	5.65	8.51	1.32	2.79	4.97	0.00	0.00	0.00	0.00	0.00	7.59	0.00	0.00
23.0	0.00	0.00	0.00	0.78	10.83	0.00	0.42	4.17	2.00	8.06	6.91	1.32	6.51	9.39	0.92	0.00	0.00	0.00	0.00	8.23	0.00	0.00
23.5	0.00	0.98	0.00	0.00	5.10	0.00	0.00	3.65	3.33	8.87	2.66	0.00	4.65	5.52	0.00	0.00	0.00	0.00	0.00	3.80	0.00	0.00
24.0	0.00	0.49	0.00	0.00	5.73	0.00	0.00	2.60	7.33	4.03	3.72	0.66	2.79	4.42	0.00	0.00	0.00	0.00	0.00	5.06	0.00	0.00
24.5	0.00	1.46	0.00	0.78	3.18	0.00	0.00	1.04	6.00	4.03	1.60	0.66	1.40	2.76	0.00	0.00	0.00	14.29	0.00	1.90	0.00	0.00
25.0	0.00	0.49	0.00	0.00	1.91	0.00	0.00	3.13	4.67	4.03	1.06	0.00	2.79	1.66	0.46	0.00	0.00	0.00	0.00	5.06	0.00	0.00
25.5	0.00	0.00	0.00	0.00	5.10	0.00	0.85	1.56	3.33	4.03	0.53	0.00	1.40	0.55	0.00	0.00	0.00	7.14	0.00	6.33	0.00	0.00
26.0	0.00	0.00	0.00	0.00	2.55	0.00	0.00	0.52	2.67	3.23	2.66	0.00	4.19	1.66	0.00	0.00	0.00	0.00	0.00	3.80	0.00	0.00
26.5	0.00	0.00	0.00	0.00	1.91	0.00	0.00	0.00	4.67	4.03	2.13	0.00	1.40	1.10	0.00	0.00	0.00	0.00	0.00	5.06	0.00	0.00
27.0	0.00	0.00	0.00	0.00	2.55	0.00	0.00	0.00	2.00	3.23	1.06	0.00	0.93	1.66	0.46	0.00	0.00	0.00	0.00	6.33	0.00	0.00
27.5	0.00	0.00	0.00	0.00	0.64	0.00	0.00	0.00	2.00	0.81	1.60	0.00	0.47	0.55	0.00	0.00	0.00	0.00	0.00	6.96	0.00	0.00
28.0	0.00	0.00	0.00	0.00	2.55	0.00	0.00	0.52	1.33	0.00	0.53	0.00	0.47	1.10	0.00	0.00	0.00	0.00	0.00	5.70	0.00	0.00
28.5	0.00	0.00	0.00	0.00	0.64	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	2.53	0.00	0.00
29.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00
29.5	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	1.90	0.00	0.00
mean length	15.94	19.99	17.09	19.91	22.77		18.72	20.91	22.46	22.70	21.95	19.28	21.56	21.88	18.01	17.00	20.67	20.61		23.95	17.18	15.83
TS mean l.	-47.02	-45.08	-46.42	-45.11	-43.96		-45.64	-44.69	-44.08	-43.98	-44.27	-45.39	-44.43	-44.30	-45.97	-46.46	-44.79	-44.81		-43.52	-46.37	-47.07
mean weight	28.08	63.18	37.28	62.09	97.63		53.42	72.24	96.05	102.66	97.20	60.24	90.76	85.04	44.88			70.46		123.69	43.20	

Table IIe.4. Summarized results all sampling areas for herring from the RV Tridens survey, 26 June - 14 July 2000.

(im = immature, ad = adult)

summary all sampling areas	**numbers in millions**													
	autumn spawners													
	98im	97im	97ad	96im	96ad	95	94	93	92	91	90	89	<89	totals
A	1111.6	23.3	14.8	6.4	4.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1160.9
B	200.6	228.8	32.1	0.0	72.9	14.9	0.5	0.5	0.0	0.0	0.5	0.0	0.0	550.9
C	1222.4	60.1	17.9	1.0	2.2	0.6	0.0	0.5	0.5	0.0	0.0	0.0	0.0	1305.2
D	453.1	171.4	171.9	3.4	74.1	18.6	2.6	4.2	0.0	1.2	2.4	0.0	1.2	904.0
E	194.7	117.6	17.0	64.0	67.4	25.2	52.9	26.4	9.9	17.6	28.2	0.0	4.5	625.3
F	3272.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3272.0
totals	64.54.4	601.2	253.7	74.8	221.2	59.7	56.0	31.5	10.4	18.8	31.1	0.0	5.6	7818.3

summary all sampling areas	**weight in '000 tons**													
	autumn spawners													
	98im	97im	97ad	96im	96ad	95	94	93	92	91	90	89	<89	totals
A	53.8	1.8	1.5	0.6	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58.3
B	14.7	22.0	4.2	0.0	12.2	2.6	0.1	0.1	0.0	0.0	0.1	0.0	0.0	55.9
C	60.9	4.8	2.1	0.1	0.3	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	68.6
D	30.7	15.1	20.3	0.3	11.7	2.8	0.5	0.7	0.0	0.2	0.5	0.0	0.3	83.1
E	10.1	10.2	2.1	6.2	8.6	3.6	8.5	4.5	2.0	3.5	5.9	0.0	1.0	66.0
F	141.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	141.4
totals	311.5	54.0	30.2	7.1	33.4	9.1	9.0	5.3	2.1	3.7	6.5	0.0	1.2	473.2

Table IIe.5. Length distribution for sprat from the RV Tridens survey, 26 June -14 July 2000.

length	haul 1	haul 2	haul 3	haul 4	haul 5	haul 6	haul 7	haul 8	haul 9	haul 10	haul 11	haul 12	haul 13	haul 14	haul 15	haul 16	haul 17
8.5	0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.0	0.00	0.00	0.00	0.00	0.00	0.00	3.45	0.00	0.00	0.00	0.00	5.45	0.00	0.00	0.00	0.00	0.00
9.5	7.81	0.00	28.57	0.00	0.00	0.00	12.64	0.00	0.00	0.00	0.00	10.91	0.00	0.00	0.00	0.00	0.00
10.0	31.25	0.00	42.86	0.00	0.00	0.00	12.64	0.00	0.00	0.00	0.00	23.64	0.00	0.00	0.00	0.00	0.00
10.5	46.88	0.00	0.00	0.00	0.00	0.00	10.34	0.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00
11.0	10.94	0.00	14.29	0.00	0.00	0.00	31.03	0.00	0.00	0.00	0.00	12.73	0.00	0.00	0.00	0.00	0.00
11.5	0.00	0.00	14.29	0.00	0.00	0.00	25.29	0.00	0.00	0.00	0.00	21.82	0.00	0.00	1.54	0.00	0.00
12.0	1.56	0.00	0.00	0.00	0.00	0.00	3.45	0.00	0.00	0.00	0.00	1.82	0.00	0.00	4.62	0.00	0.00
12.5	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.82	0.00	0.00	10.77	0.00	0.00
13.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.82	0.00	0.00	38.46	0.00	0.00
13.5	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	18.46	0.00	0.00
14.0	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	18.46	0.00	0.00
14.5	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	4.62	0.00	0.00
15.0	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	3.08	0.00	0.00
15.5	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
16.0	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
16.5	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
17.0	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
17.5	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
18.0	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
mean length	10.38		10.21				10.70					10.58			13.28		
TS mean length	-50.67		-50.81				-50.42					-50.51			-48.57		
mean weight	7.89						10.44					10.17			18.64		

Table IIe.6. Summarized results all sampling areas for sprat from the RV Tridens survey, 26 June - 14 July 2000.
(im = immature, ad = adult)

summary all sampling areas		**numbers in millions**												
	99im	99ad	98im	98ad	97	96	95	94						totals
A	0.0	0.0	0.8	49.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.5
B	3.7	0.0	98.7	507.7	245.9	85.5	31.6	0.0	0.0	0.0	0.0	0.0	0.0	973.2
C	234.3	0.0	108.6	102.9	958.0	205.9	9.0	0.0	0.0	0.0	0.0	0.0	0.0	1618.7
D	0.0	0.0	1435.6	1365.3	3708.2	1201.8	35.0	0.0	0.0	0.0	0.0	0.0	0.0	7745.9
totals	238.0	0.0	1643.7	2024.8	4912.9	1493.3	75.6	0.0	0.0	0.0	0.0	0.0	0.0	10388.3

summary all sampling areas		**weight in '000 tons**												
	99im	99ad	98im	98ad	97	96	95	94						totals
A	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
B	0.0	0.0	0.8	5.4	4.1	1.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	12.8
C	0.8	0.0	0.9	1.2	14.9	3.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	21.8
D	0.0	0.0	10.2	14.5	63.1	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111.7
totals	0.8	0.0	11.9	21.4	82.1	29.5	0.9	0.0	0.0	0.0	0.0	0.0	0.0	146.7

Table IIe.7 Age-length tables from the RV Tridens acoustic survey, 26 June - 14 July 2000.

Tridens 28-Jun - 12-Jul 2000 **sampling area A** im = immature
ad = adult

Age/length composition by sampling area Herring - best estimate

length	autumn spawners 98im	97im	97ad	96im	96ad	95	94	93	92	91	90	89	<89	totals
13.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
14.5	1	0	0	0	0	0	0	0	0	0	0	0	0	1
15.0	7	0	0	0	0	0	0	0	0	0	0	0	0	7
15.5	15	0	0	0	0	0	0	0	0	0	0	0	0	15
16.0	14	0	0	0	0	0	0	0	0	0	0	0	0	14
16.5	8	0	0	0	0	0	0	0	0	0	0	0	0	8
17.0	8	0	0	0	0	0	0	0	0	0	0	0	0	8
17.5	10	0	0	0	0	0	0	0	0	0	0	0	0	10
18.0	4	0	0	0	0	0	0	0	0	0	0	0	0	4
18.5	10	0	0	0	0	0	0	0	0	0	0	0	0	10
19.0	22	0	0	0	0	0	0	0	0	0	0	0	0	22
19.5	14	0	0	0	0	0	0	0	0	0	0	0	0	14
20.0	24	0	0	0	0	0	0	0	0	0	0	0	0	24
20.5	18	0	0	0	0	0	0	0	0	0	0	0	0	18
21.0	5	1	0	0	0	0	0	0	0	0	0	0	0	6
21.5	4	1	0	0	0	0	0	0	0	0	0	0	0	5
22.0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
22.5	0	0	1	1	0	0	0	0	0	0	0	0	0	2
23.0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
23.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24.5	0	0	1	0	1	0	0	0	0	0	0	0	0	2
25.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
millions	1111.6	23.3	14.8	6.4	4.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1160.9
mean w	48.4	77.1	103.3	90.7	116.0	149.0								
000 tons	53.8	1.8	1.5	0.6	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58.3

Table IIe.7 (contd.) Age-length tables from the RV Tridens acoustic survey, 26 June - 14 July 2000.

Tridens 28-Jun - 12-Jul 2000 **sampling area B** im = immature
ad = adult

Age/length composition by sampling area Herring - best estimate

	autumn spawners													
length	98im	97im	97ad	96im	96ad	95	94	93	92	91	90	89	<89	totals
13.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19.0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
19.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
20.5	1	0	0	0	0	0	0	0	0	0	0	0	0	1
21.0	5	2	0	0	0	0	0	0	0	0	0	0	0	7
21.5	8	1	0	0	0	0	0	0	0	0	0	0	0	9
22.0	1	4	0	0	0	0	0	0	0	0	0	0	0	5
22.5	1	2	0	0	0	0	0	0	0	0	0	0	0	3
23.0	0	5	0	0	0	0	0	0	0	0	0	0	0	5
23.5	0	4	1	0	0	0	0	0	0	0	0	0	0	5
24.0	0	3	0	0	0	0	0	0	0	0	0	0	0	3
24.5	0	0	1	0	0	0	0	0	0	0	0	0	0	1
25.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25.5	0	0	0	0	1	0	0	0	0	0	0	0	0	1
26.0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
26.5	0	0	1	0	1	0	0	0	0	0	0	0	0	2
27.0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
27.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28.0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
28.5	0	0	0	0	1	0	0	0	0	0	0	0	0	1
29.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
millions	200.6	228.8	32.1	0.0	72.9	14.9	0.5	0.5	0.0	0.0	0.5	0.0	0.0	550.9
mean w	73.1	96.1	129.6		167.0	177.4	162.9	167.1			209.2			
000 tons	14.7	22.0	4.2	0.0	12.2	2.6	0.1	0.1	0.0	0.0	0.1	0.0	0.0	55.9

Table IIe.7 (contd.) Age-length tables from the RV Tridens acoustic survey, 26 June - 14 July 2000.

Tridens 28-Jun - 12-Jul 2000 **sampling area C** im = immature
ad = adult

Age/length composition by sampling area Herring - best estimate

length	autumn spawners 98im	97im	97ad	96im	96ad	95	94	93	92	91	90	89	<89	totals
13.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
14.5	1	0	0	0	0	0	0	0	0	0	0	0	0	1
15.0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
15.5	2	0	0	0	0	0	0	0	0	0	0	0	0	2
16.0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
16.5	9	0	0	0	0	0	0	0	0	0	0	0	0	9
17.0	9	0	0	0	0	0	0	0	0	0	0	0	0	9
17.5	21	0	0	0	0	0	0	0	0	0	0	0	0	21
18.0	20	0	0	0	0	0	0	0	0	0	0	0	0	20
18.5	23	0	0	0	0	0	0	0	0	0	0	0	0	23
19.0	17	0	0	0	0	0	0	0	0	0	0	0	0	17
19.5	11	1	0	0	0	0	0	0	0	0	0	0	0	12
20.0	12	0	0	0	0	0	0	0	0	0	0	0	0	12
20.5	8	1	0	0	0	0	0	0	0	0	0	0	0	9
21.0	3	1	0	0	0	0	0	0	0	0	0	0	0	4
21.5	1	2	0	0	0	0	0	0	0	0	0	0	0	3
22.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.5	0	0	1	0	0	0	0	0	0	0	0	0	0	1
23.0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
23.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24.5	0	0	2	0	0	0	0	0	0	0	0	0	0	2
25.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25.5	0	0	1	0	0	0	0	0	0	0	0	0	0	1
26.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
millions	1222.4	60.1	17.9	1.0	2.2	0.6	0.0	0.5	0.5	0.0	0.0	0.0	0.0	1305.2
mean w	49.9	80.5	116.1	94.9	152.9	149.0		167.1	200.3					
000 tons	60.9	4.8	2.1	0.1	0.3	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	68.6

Table IIe.7 (contd.) Age-length tables from the RV Tridens acoustic survey, 26 June - 14 July 2000.

Tridens 28-Jun - 12-Jul 2000 **sampling area D** im = immature
ad = adult

Age/length composition by sampling area Herring - best estimate

length	autumn spawners 98im	97im	97ad	96im	96ad	95	94	93	92	91	90	89	<89	totals
13.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.5	1	0	0	0	0	0	0	0	0	0	0	0	0	1
18.0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
18.5	11	0	0	0	0	0	0	0	0	0	0	0	0	11
19.0	15	0	0	0	0	0	0	0	0	0	0	0	0	15
19.5	22	0	0	0	0	0	0	0	0	0	0	0	0	22
20.0	31	1	0	0	0	0	0	0	0	0	0	0	0	32
20.5	29	5	0	0	0	0	0	0	0	0	0	0	0	34
21.0	20	9	0	0	0	0	0	0	0	0	0	0	0	29
21.5	15	11	0	0	0	0	0	0	0	0	0	0	0	26
22.0	8	10	4	1	0	0	0	0	0	0	0	0	0	23
22.5	2	11	6	0	0	0	0	0	0	0	0	0	0	19
23.0	1	6	8	0	0	0	0	0	0	0	0	0	0	15
23.5	0	1	13	0	0	0	0	0	0	0	0	0	0	14
24.0	0	0	10	0	1	0	0	0	0	0	0	0	0	11
24.5	0	0	6	0	1	1	0	0	0	0	0	0	0	8
25.0	0	0	3	0	7	1	0	0	0	0	0	0	0	11
25.5	0	0	1	0	3	1	0	0	0	0	0	0	0	5
26.0	0	0	1	0	4	2	0	1	0	0	0	0	0	8
26.5	0	0	1	0	3	1	0	0	0	0	0	0	0	5
27.0	0	0	0	0	3	0	0	0	0	0	0	0	0	3
27.5	0	0	2	0	2	0	1	1	0	0	0	0	0	6
28.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
millions	453.1	171.4	171.9	3.4	74.1	18.6	2.6	4.2	0.0	1.2	2.4	0.0	1.2	904.0
mean w	67.7	88.3	118.2	91.2	157.8	151.1	178.5	164.4		196.2	209.2		213.6	
000 tons	30.7	15.1	20.3	0.3	11.7	2.8	0.5	0.7	0.0	0.2	0.5	0.0	0.3	83.1

Table IIe.7 (contd.) Age-length tables from the RV Tridens acoustic survey, 26 June - 14 July 2000.

Tridens 28-Jun - 12-Jul 2000 **sampling area E** im = immature
ad = adult

Age/length composition by sampling area Herring - best estimate

	autumn spawners													
length	98im	97im	97ad	96im	96ad	95	94	93	92	91	90	89	<89	totals
13.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.5	1	0	0	0	0	0	0	0	0	0	0	0	0	1
16.0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
16.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
17.5	1	0	0	0	0	0	0	0	0	0	0	0	0	1
18.0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
18.5	2	0	0	0	0	0	0	0	0	0	0	0	0	2
19.0	3	0	0	0	0	0	0	0	0	0	0	0	0	3
19.5	2	1	0	0	0	0	0	0	0	0	0	0	0	3
20.0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
20.5	3	2	0	0	0	0	0	0	0	0	0	0	0	5
21.0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
21.5	0	1	0	1	0	0	0	0	0	0	0	0	0	2
22.0	0	4	0	2	0	0	0	0	0	0	0	0	0	6
22.5	0	1	0	1	0	0	0	0	0	0	0	0	0	2
23.0	0	1	1	1	0	1	0	0	0	0	0	0	0	4
23.5	0	0	0	1	2	1	0	0	0	0	0	0	0	4
24.0	0	0	2	0	0	1	0	0	0	0	0	0	0	3
24.5	0	0	0	0	2	0	1	0	0	0	0	0	0	3
25.0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
25.5	0	0	0	0	0	0	3	1	0	0	0	0	0	4
26.0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
26.5	0	0	0	0	0	2	0	0	0	1	0	0	0	3
27.0	0	0	0	0	0	0	0	2	2	0	0	0	0	4
27.5	0	0	0	0	0	0	0	0	0	0	1	0	0	1
28.0	0	0	0	0	0	0	1	0	0	1	1	0	1	4
28.5	0	0	0	0	0	0	0	0	0	1	0	0	0	1
29.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
millions	194.7	117.6	17.0	64.0	67.4	25.2	52.9	26.4	9.9	17.6	28.2	0.0	4.5	625.3
mean w	51.8	86.9	125.5	96.2	127.9	140.9	159.7	169.0	200.3	196.2	209.2		213.6	
000 tons	10.1	10.2	2.1	6.2	8.6	3.6	8.5	4.5	2.0	3.5	5.9	0.0	1.0	66.0

Table IIe.7 (contd.) Age-length tables from the RV Tridens acoustic survey, 26 June - 14 July 2000.

Tridens 28-Jun - 12-Jul 2000 **sampling area F** im = immature
ad = adult

Age/length composition by sampling area Herring - best estimate

	autumn spawners													
length	98im	97im	97ad	96im	96ad	95	94	93	92	91	90	89	<89	totals
13.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.5	1	0	0	0	0	0	0	0	0	0	0	0	0	1
15.0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
15.5	2	0	0	0	0	0	0	0	0	0	0	0	0	2
16.0	6	0	0	0	0	0	0	0	0	0	0	0	0	6
16.5	7	0	0	0	0	0	0	0	0	0	0	0	0	7
17.0	7	0	0	0	0	0	0	0	0	0	0	0	0	7
17.5	7	0	0	0	0	0	0	0	0	0	0	0	0	7
18.0	8	0	0	0	0	0	0	0	0	0	0	0	0	8
18.5	5	0	0	0	0	0	0	0	0	0	0	0	0	5
19.0	4	0	0	0	0	0	0	0	0	0	0	0	0	4
19.5	1	0	0	0	0	0	0	0	0	0	0	0	0	1
20.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
millions	3272.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3272.0
mean w	43.2													
000 tons	141.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	141.4

Table IIe.7 (contd.) Age-length tables from the RV Tridens acoustic survey, 26 June - 14 July 2000.

Tridens 28-Jun - 12-Jul 2000 **sampling area A** im = immature
ad = adult

Age/length composition by sampling area Sprat - best estimate

length	99im	99ad	98im	98ad	97	96	95	94					totals
5.5	0	0	0	0	0	0	0	0	0	0	0	0	0
6.0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.5	0	0	0	0	0	0	0	0	0	0	0	0	0
7.0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.5	0	0	0	0	0	0	0	0	0	0	0	0	0
8.0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.5	0	0	0	0	0	0	0	0	0	0	0	0	0
9.0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.5	0	0	1	4	0	0	0	0	0	0	0	0	5
10.0	0	0	0	6	0	0	0	0	0	0	0	0	6
10.5	0	0	0	11	0	0	0	0	0	0	0	0	11
11.0	0	0	0	2	0	0	0	0	0	0	0	0	2
11.5	0	0	0	0	0	0	0	0	0	0	0	0	0
12.0	0	0	0	1	0	0	0	0	0	0	0	0	1
12.5	0	0	0	0	0	0	0	0	0	0	0	0	0
13.0	0	0	0	0	0	0	0	0	0	0	0	0	0
13.5	0	0	0	0	0	0	0	0	0	0	0	0	0
14.0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.5	0	0	0	0	0	0	0	0	0	0	0	0	0
15.0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.5	0	0	0	0	0	0	0	0	0	0	0	0	0
16.0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.5	0	0	0	0	0	0	0	0	0	0	0	0	0
17.0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.5	0	0	0	0	0	0	0	0	0	0	0	0	0
18.0	0	0	0	0	0	0	0	0	0	0	0	0	0
millions	0.0	0.0	0.8	49.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.5
mean w			6.0	8.0	16.4	19.7							
000 tons	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4

Table IIe.7 (contd.) Age-length tables from the RV Tridens acoustic survey, 26 June - 14 July 2000.

Tridens 28-Jun - 12-Jul 2000 **sampling area B** im = immature
ad = adult

Age/length composition by sampling area Sprat - best estimate

length	99im	99ad	98im	98ad	97	96	95	94					totals
5.5	0	0	0	0	0	0	0	0	0	0	0	0	0
6.0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.5	0	0	0	0	0	0	0	0	0	0	0	0	0
7.0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.5	0	0	0	0	0	0	0	0	0	0	0	0	0
8.0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.5	0	0	0	0	0	0	0	0	0	0	0	0	0
9.0	0	0	2	1	0	0	0	0	0	0	0	0	3
9.5	0	0	5	4	0	0	0	0	0	0	0	0	9
10.0	0	0	1	8	1	0	0	0	0	0	0	0	10
10.5	0	0	1	9	1	0	0	0	0	0	0	0	11
11.0	0	0	1	16	0	0	0	0	0	0	0	0	17
11.5	0	0	1	18	1	0	0	0	0	0	0	0	20
12.0	0	0	0	2	4	0	0	0	0	0	0	0	6
12.5	0	0	0	1	12	0	0	0	0	0	0	0	13
13.0	0	0	0	0	8	3	0	0	0	0	0	0	11
13.5	0	0	0	0	9	2	1	0	0	0	0	0	12
14.0	0	0	0	0	2	6	1	0	0	0	0	0	9
14.5	0	0	0	0	1	0	2	0	0	0	0	0	3
15.0	0	0	0	0	0	0	1	0	0	0	0	0	1
15.5	0	0	0	0	0	0	0	0	0	0	0	0	0
16.0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.5	0	0	0	0	0	0	0	0	0	0	0	0	0
17.0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.5	0	0	0	0	0	0	0	0	0	0	0	0	0
18.0	0	0	0	0	0	0	0	0	0	0	0	0	0
millions	3.7	0.0	98.7	507.7	245.9	85.5	31.6	0.0	0.0	0.0	0.0	0.0	973.2
mean w	3.4		7.7	10.7	16.8	20.1	23.1						
000 tons	0.0	0.0	0.8	5.4	4.1	1.7	0.7	0.0	0.0	0.0	0.0	0.0	12.8

Table IIe.7 (contd.) Age-length tables from the RV Tridens acoustic survey, 26 June - 14 July 2000.

Tridens 28-Jun - 12-Jul 2000 **sampling area C** im = immature
ad = adult

Age/length composition by sampling area Sprat - best estimate

length	99im	99ad	98im	98ad	97	96	95	94					totals
5.5	0	0	0	0	0	0	0	0	0	0	0	0	0
6.0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.5	0	0	0	0	0	0	0	0	0	0	0	0	0
7.0	2	0	0	0	0	0	0	0	0	0	0	0	2
7.5	2	0	0	0	0	0	0	0	0	0	0	0	2
8.0	4	0	0	0	0	0	0	0	0	0	0	0	4
8.5	4	0	0	0	0	0	0	0	0	0	0	0	4
9.0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.5	0	0	1	0	0	0	0	0	0	0	0	0	1
10.0	0	0	1	0	0	0	0	0	0	0	0	0	1
10.5	0	0	1	0	1	0	0	0	0	0	0	0	2
11.0	0	0	2	2	2	0	0	0	0	0	0	0	6
11.5	0	0	0	2	5	1	0	0	0	0	0	0	8
12.0	0	0	0	0	5	0	0	0	0	0	0	0	5
12.5	0	0	0	1	11	0	0	0	0	0	0	0	12
13.0	0	0	0	0	15	2	0	0	0	0	0	0	17
13.5	0	0	0	0	10	3	0	0	0	0	0	0	13
14.0	0	0	0	0	0	3	0	0	0	0	0	0	3
14.5	0	0	0	0	0	0	0	0	0	0	0	0	0
15.0	0	0	0	0	0	0	1	0	0	0	0	0	1
15.5	0	0	0	0	0	0	0	0	0	0	0	0	0
16.0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.5	0	0	0	0	0	0	0	0	0	0	0	0	0
17.0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.5	0	0	0	0	0	0	0	0	0	0	0	0	0
18.0	0	0	0	0	0	0	0	0	0	0	0	0	0
millions	234.3	0.0	108.6	102.9	958.0	205.9	9.0	0.0	0.0	0.0	0.0	0.0	1618.7
mean w	3.4		8.4	11.3	15.6	18.7	22.4						
000 tons	0.8	0.0	0.9	1.2	14.9	3.9	0.2	0.0	0.0	0.0	0.0	0.0	21.8

Table IIe.7 (contd.) Age-length tables from the RV Tridens acoustic survey, 26 June - 14 July 2000.

Tridens 28-Jun - 12-Jul 2000 **sampling area D** im = immature
ad = adult

Age/length composition by sampling area Sprat - best estimate

length	99im	99ad	98im	98ad	97	96	95	94					totals
5.5	0	0	0	0	0	0	0	0	0	0	0	0	0
6.0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.5	0	0	0	0	0	0	0	0	0	0	0	0	0
7.0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.5	0	0	0	0	0	0	0	0	0	0	0	0	0
8.0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.5	0	0	0	0	0	0	0	0	0	0	0	0	0
9.0	0	0	1	0	0	0	0	0	0	0	0	0	1
9.5	0	0	15	0	0	0	0	0	0	0	0	0	15
10.0	0	0	5	5	1	0	0	0	0	0	0	0	11
10.5	0	0	1	2	1	0	0	0	0	0	0	0	4
11.0	0	0	0	5	4	0	0	0	0	0	0	0	9
11.5	0	0	0	3	2	0	0	0	0	0	0	0	5
12.0	0	0	0	0	8	2	0	0	0	0	0	0	10
12.5	0	0	0	0	12	2	0	0	0	0	0	0	14
13.0	0	0	0	0	13	5	0	0	0	0	0	0	18
13.5	0	0	0	0	4	3	0	0	0	0	0	0	7
14.0	0	0	0	0	1	3	0	0	0	0	0	0	4
14.5	0	0	0	0	1	0	0	0	0	0	0	0	1
15.0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.5	0	0	0	0	0	0	0	0	0	0	0	0	0
16.0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.5	0	0	0	0	0	0	0	0	0	0	0	0	0
17.0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.5	0	0	0	0	0	0	0	0	0	0	0	0	0
18.0	0	0	0	0	0	0	0	0	0	0	0	0	0
millions	0.0	0.0	1435.6	1365.3	3708.2	1201.8	35.0	0.0	0.0	0.0	0.0	0.0	7745.9
mean w			7.1	10.6	17.0	19.9	23.0						
000 tons	0.0	0.0	10.2	14.5	63.1	24.0	0.8	0.0	0.0	0.0	0.0	0.0	112.5

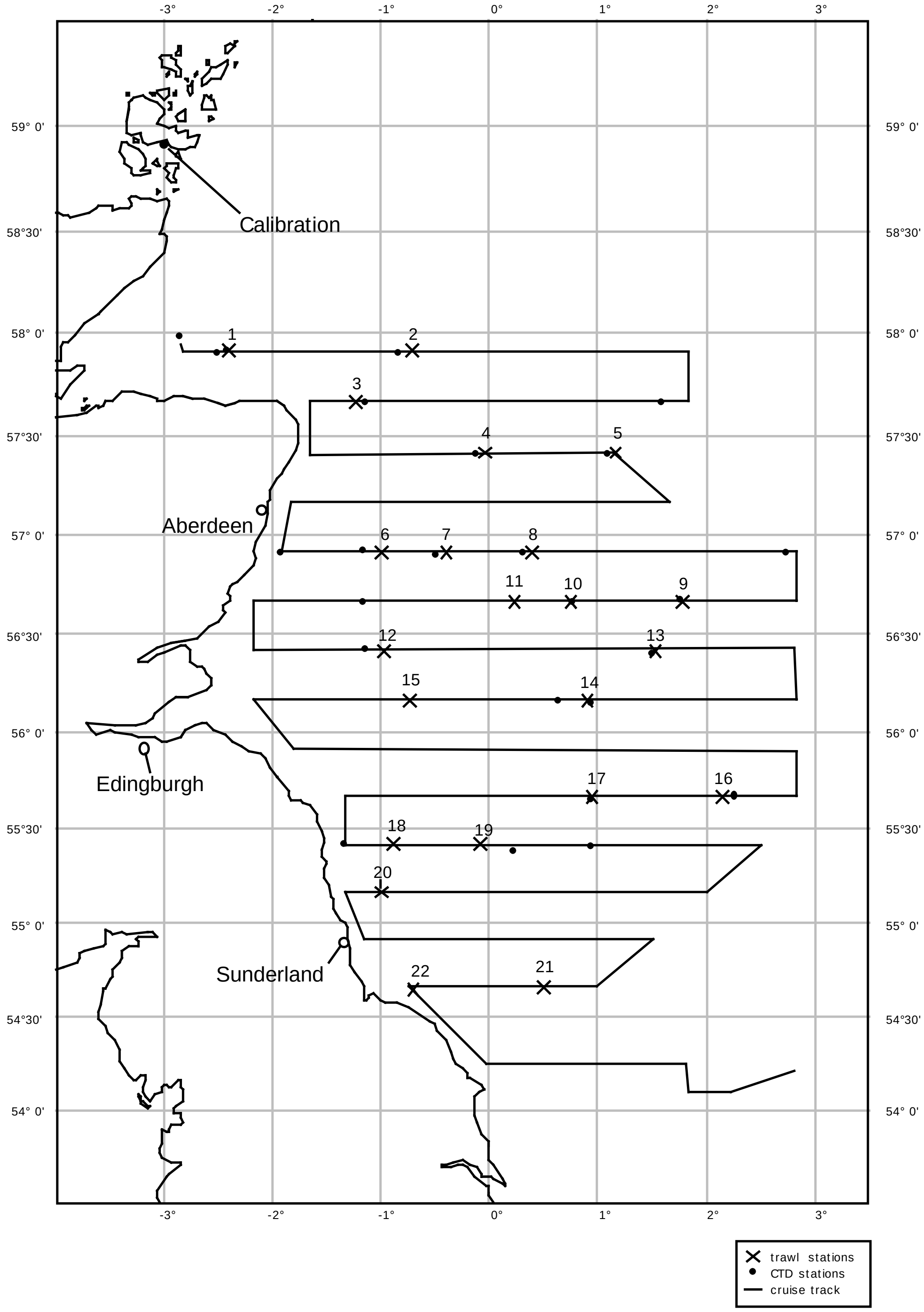

Figure IIe.1. Cruise track and trawl stations during the RV Tridens survey, 26 June - 14 July 2000

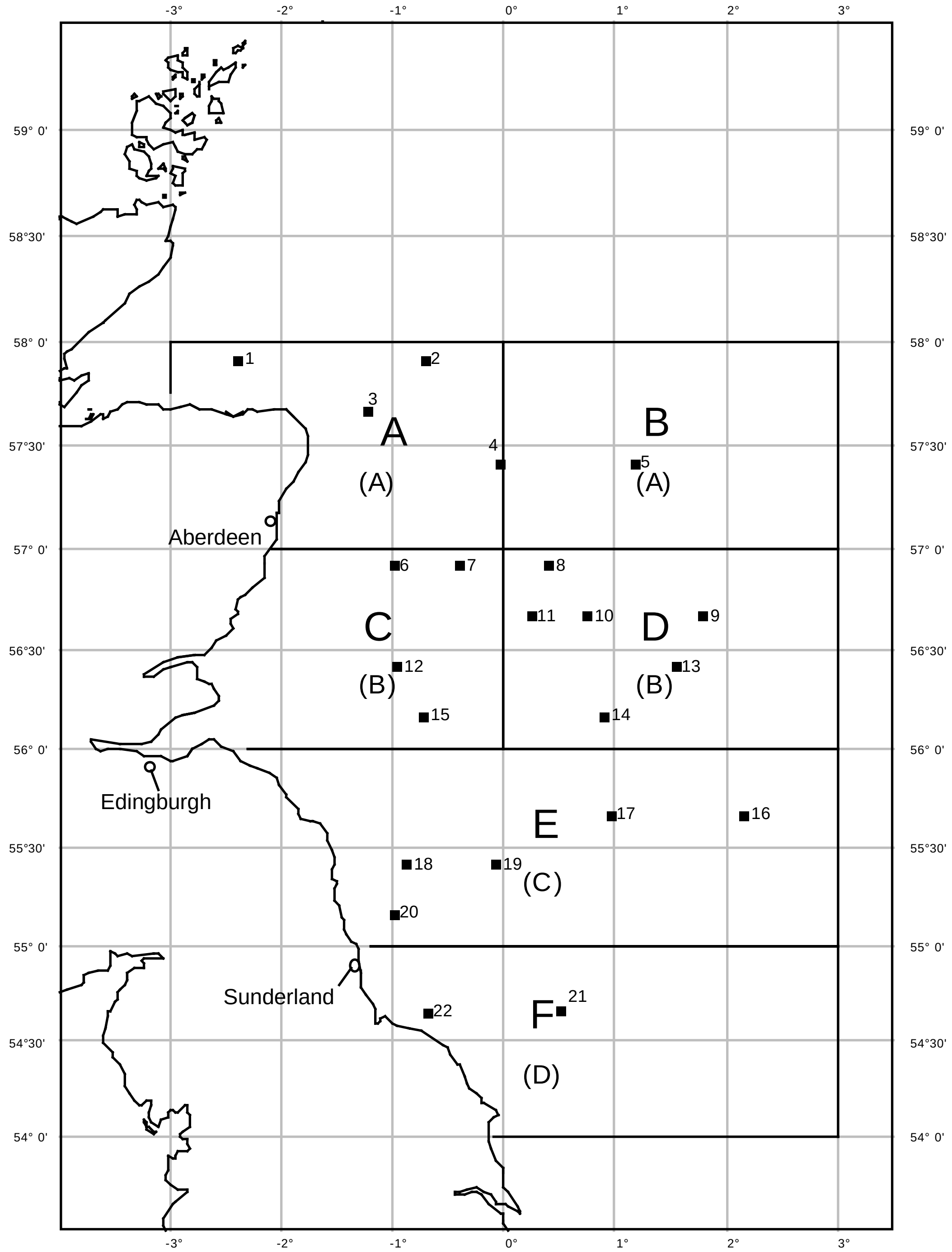

Figure IIe.2. Sampling areas for the combination of length and maturity samples of herring (and sprat in brackets) from the RV Tridens survey, 26 June - 14 July 2000.

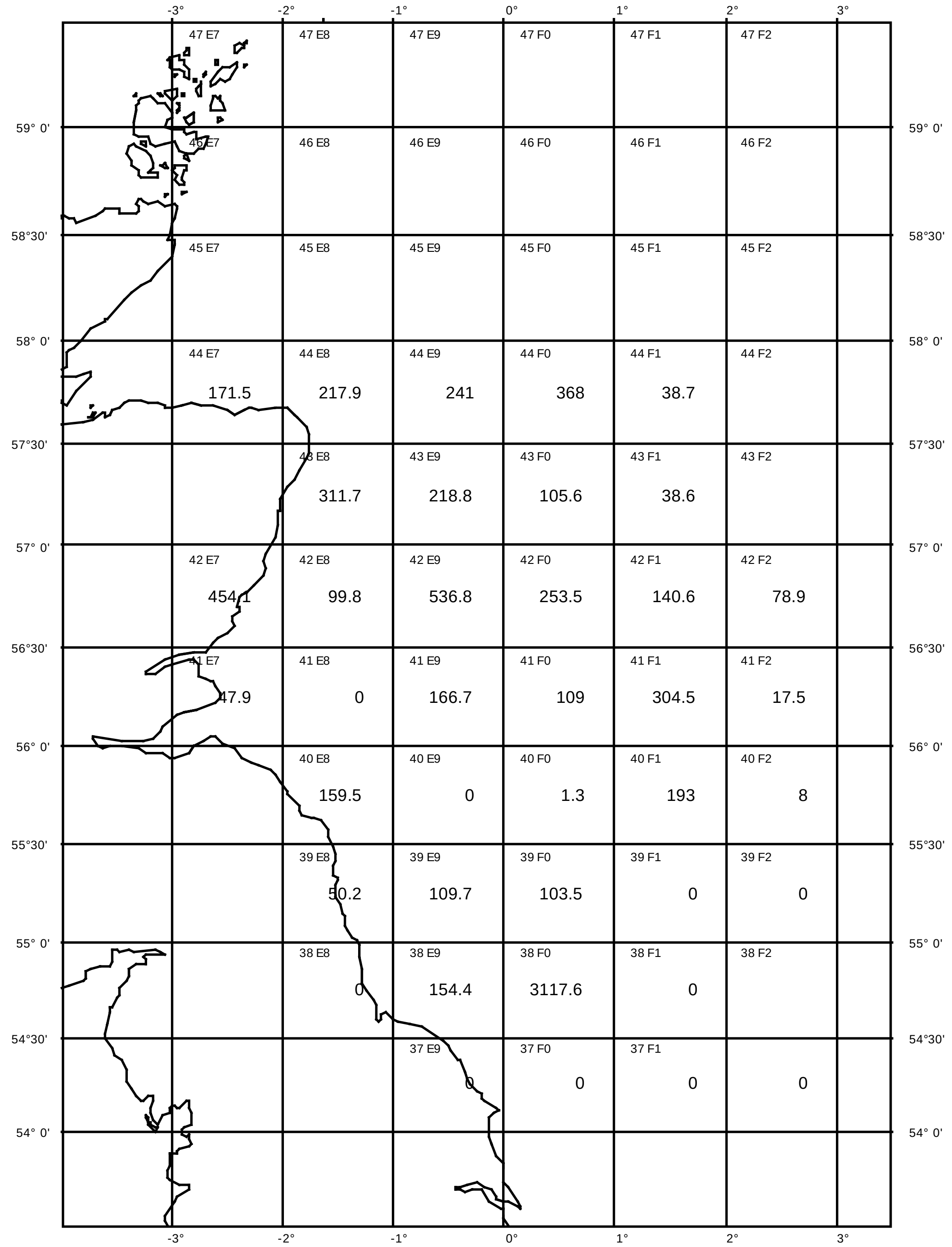

Figure IIe.3. Numbers of herring (millions) per ICES rectangle - all ages from the RV Tridens survey, 26 June - 14 July 2000.

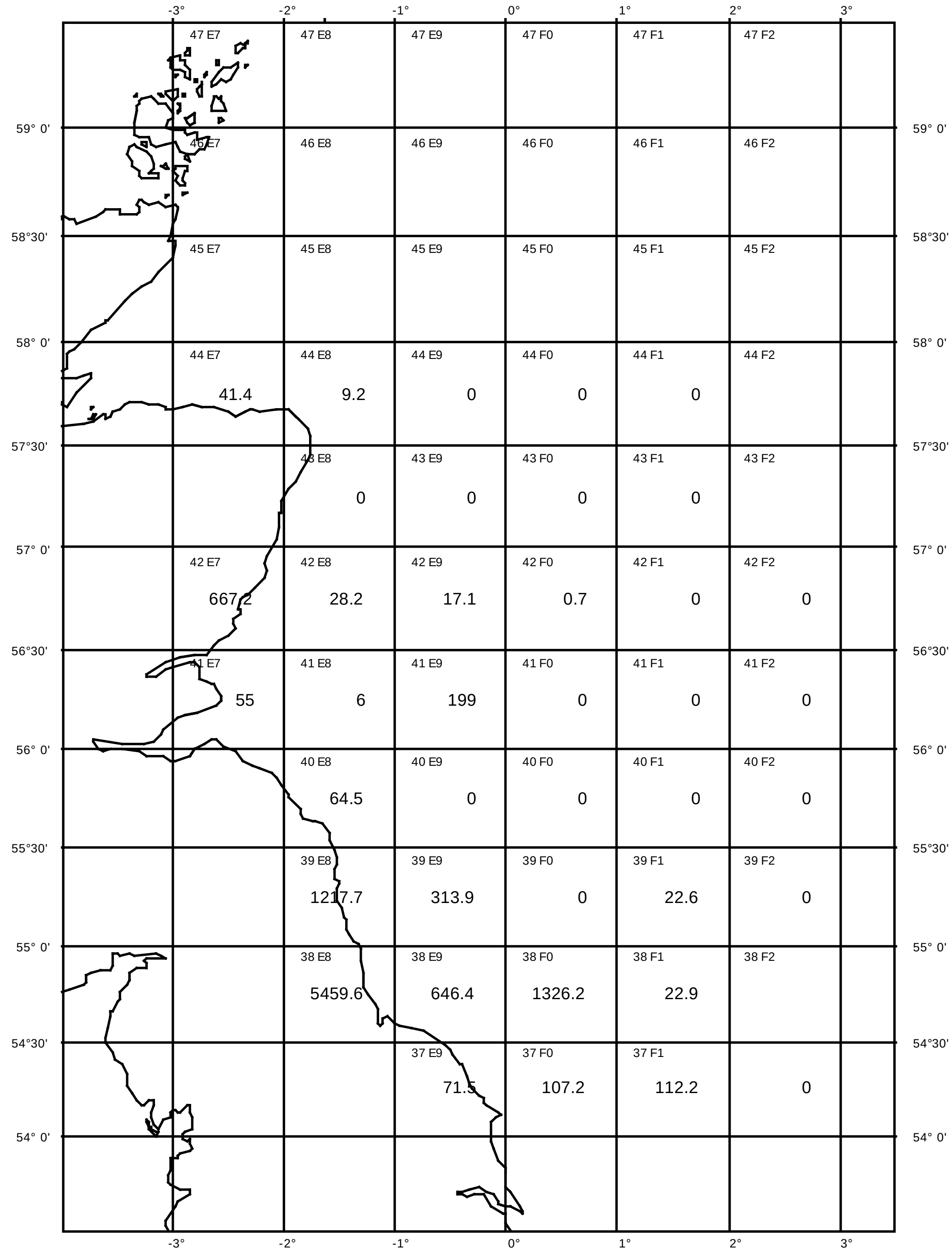

Figure IIe.4. Numbers of sprat (millions) per ICES rectangle - all ages from the RV Tridens survey, 26 June - 14 July 2000.

APPENDIX IIF WALTER HERWIG

Survey report for FRV Walther Herwig III in the south eastern North Sea (DBFR)

Cruise WH 218: International hydroacoustic survey on herring in the North Sea,

23 June to 14 July 2000

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Context/summary

Cruise WH218 was conducted in the framework of the international hydroacoustic survey on pelagic fish in the North Sea, which is coordinated by an ICES planning group, and partly financed by the EU (CFP study 99/006 Hersur II). Further contributors to the quasi-synoptic survey are the national fisheries research institutes of Scotland, Norway, Denmark and The Netherlands. The results are delivered to the ICES herring assessment Working Group, they represent since 1984 the most important fishery independent data for the assessment of herring stocks in the area.

The working area for "Walther Herwig III" was confined to the South-Eastern North Sea between 57°N and 54°N, and 2°E to the 20 m depth line off the Danish and German coast. Acoustic measurements were conducted between 0600 and 2200 (0400-2000 UTC) on East-West transects with 15 n.mi. distance in between. 2100 n.mi. could be used for echo integration. For the identification of echo traces and further biological sampling, 39 hauls with a pelagic net were conducted. After each haul and at 18 additional stations, CTD profiles were recorded. This year, it was possible to extend the survey area southwards to 54° latitude. This region is expected to be a major distribution area for sprat in the North Sea (Fig. IIf.1).

Objectives

Hydroacoustic recording of pelagic fish stocks, biological sampling for the verification of echoes, calibration of the hydroacoustic equipment, intercalibration with other vessels participating in the survey, hydrographic investigations, biological sampling of horse mackerel within the EU-project HOMSIR.

Narrative

FRV "Walther Herwig III" left the port of Cuxhaven in the evening of June 23rd, and headed for Kristiansand (Norway). The calibration of the hydroacoustic equipment took place on June 25th in the sheltered bight of Kristiansand. The survey commenced at June 28th after two days had been lost due to severe weather conditions. On July 4th, part of the crew was exchanged off Esbjerg, and the survey continued as planned until July 13th, interrupted only by one more day of heavy weather (July 11th). The last day of the cruise, July 13th, was used for an extensive intercalibration with FRV "Tridens" (NL). "Walther Herwig III" reached Wilhelmshaven at 14th July 2000 at noon, having sailed 3363 n.mi.

Preliminary results

a. Hydroacoustic measurements

For hydroacoustic measurements, the Simrad EK500 echograph was used. Settings were chosen according to the Manual for Herring Acoustic Surveys (ICES 2000), with a standard frequency of 38 kHz. The hull-mounted starboard blister was used as transducer, and echo telegrams were continuously recorded with the Bergen integrator BI500.

The results of previous surveys had shown that herring is concentrated in dense schools during daytime and rather dispersed at night. Furthermore, the occurrence of plankton scattering layers during night make an evaluation more complicated. Recording of echograms was therefore limited to daytime. The identification of echo recordings was made by means of targeted fishing hauls. Herring and sprat was exclusively found in characteristic “pillars”. Other echoes like diffuse layers were occasionally sampled, but clupeids were never found.

b. Biological investigations

39 fishing hauls were conducted during the 218th cruise of FRV Walther Herwig III, using the pelagic net PSN205 (Fig. IIf.1). From 29 statistical rectangles surveyed, only 2 could not be sampled with fishing hauls. In 18 rectangles (29 stations), more than 100 clupeids per 30 min hauls were caught. As in previous years, the highest abundance of herring was found in the centre of the survey area, while sprat showed the highest numbers at the southern border close to the East-Friesian coast (Fig. IIf.2).

On all stations, 27 fish species were caught (Table IIf.1). Highest presence was recorded for gurnard (in all 39 hauls), whiting (36), herring (29), dab (27) and sprat (25). In terms of biomass, the major share of the total catch of 11.5 tonnes had sprat (48%), herring (40%) and horse mackerel (2.4%) (Table IIf.2).

According to the manual of the ICES Working Group coordinating the acoustic survey, length distributions were plotted for herring and sprat on each station. Figure IIf.3 shows the length distribution of herring and sprat for the total survey area. 1714 otolith pairs of herring and 1194 pairs of sprat were taken for age determination. Most of the animals investigated belonged to age group 1 and 2 (0 and 1 wr).

During the course of the cruise, 120 samples of horse mackerel were taken in the framework of the EU-Project HOMSIR for genetical and enzymological studies and stored in ethanol and liquid nitrogen, respectively.

c. Intercalibration

This years’ intercalibration was conducted on 13.07.00 with the Dutch FRV Tridens. Investigations required more than 5 h, a total distance of 40 n.mi. was covered. The results are reported in Section 4.1.3.

d. Hydrography

A vertical profile of temperature and salinity was taken after each haul by means of a CTD probe. Surface temperatures varied between 11.0° C and 15.0° C with the usual increase towards the coast.

References

ICES (2000). Report of the planning group for herring surveys. *ICES CM 2000*/G:02 106 pp.

Table IIf.1 See below for legend.

Tab 1: FRV Walther Herwig III, 218th cruise:
International hydroacoustic survey on herring in the North Sea
Stations and numbers of herring and sprat in the catches

Stat	Haul	Rect	Date	Total catch kg	No of species	Herring n	Her%	Spratt n	Spr%	Haul duration (min)	Sum clupeids /30 min
477/2	1	42F5	28.06.2000	278.2	8	6556	100%	0	0%	19	10352
478/3	2	42F4	29.06.2000	9.5	7	5	100%	0	0%	18	8
479/4	3	42F5	29.06.2000	6.1	10	1	100%	0	0%	22	1
480/5	4	42F6	29.06.2000	25.4	5	739	97%	21	3%	26	877
482/7	5	42F7	30.06.2000	95.7	7	2529	82%	540	18%	30	3069
483/8	6	41F5	30.06.2000	8.5	5	152	100%	0	0%	45	101
485/10	7	41F4	01.07.2000	194.3	7	22	100%	0	0%	27	24
486/11	8	41F5	01.07.2000	787.3	8	31781	66%	16417	34%	44	32862
487/12	9	41F6	01.07.2000	486.6	6	71834	84%	13717	16%	18	142585
489/14	10	41F4	02.07.2000	27.0	8	0		0		10	0
490/15	11	40F6	02.07.2000	58.7	13	381	50%	375	50%	31	732
491/16	12	40F6	02.07.2000	58.3	12	1190	88%	158	12%	22	1838
493/18	13	40F6	03.07.2000	343.4	3	19994	51%	19164	49%	31	37895
494/19	14	40F5	03.07.2000	858.1	10	21745	100%	0	0%	23	28363
495/20	15	40F4	03.07.2000	5.5	12	1	33%	2	67%	19	5
496/21	16	40F4	03.07.2000	57.2	6	0		0		29	0
498/23	17	40F5	04.07.2000	524.1	6	25019	49%	26431	51%	30	51450
500/25	18	39F5	05.07.2000	179.5	8	3244	62%	1960	38%	30	5204
501/26	19	39F4	05.07.2000	9.5	9	0		0		30	0
503/28	20	39F2	06.07.2000	25.0	12	0	0%	65	100%	34	57
504/29	21	39F3	06.07.2000	76.3	11	0	0%	59	100%	35	51
505/30	22	39F3	06.07.2000	129.4	9	5	0%	7124	100%	31	6899
507/32	23	39F4	07.07.2000	106.2	6	2495	94%	160	6%	30	2655
508/33	24	39F6	07.07.2000	68.2	9	0		0		25	0
509/34	25	39F6	07.07.2000	37.3	14	139	37%	236	63%	37	304
512/37	26	38F4	08.07.2000	9.3	8	40	100%	0	0%	31	39
513/38	27	38F3	08.07.2000	296.2	9	384	2%	19085	98%	30	19469
515/40	28	38F3	09.07.2000	1322.6	8	9154	13%	63077	87%	11	196994
516/41	29	38F4	09.07.2000	585.1	8	17248	34%	33295	66%	32	47384
517/42	30	38F5	09.07.2000	105.6	11	834	40%	1233	60%	30	2067
518/43	31	38F6	09.07.2000	26.9	9	0	0%	219	100%	21	313
520/45	32	37F7	10.07.2000	111.8	8	0		0		30	0
521/46	33	37F6	10.07.2000	97.6	7	68	2%	3510	98%	30	3578
523/48	34	37F5	11.07.2000	572.6	6	30	0%	65645	100%	20	98513
524/49	35	37F5	11.07.2000	46.9	9	0		0		28	0
525/50	36	37F6	11.07.2000	90.0	7	0		0		30	0
527/52	37	37F4	12.07.2000	85.2	10	671	7%	8400	93%	30	9071
528/53	38	37F3	12.07.2000	84.5	7	274	5%	5301	95%	20	8363
529/54	39	37F3	12.07.2000	296.0	12	1353	8%	15228	92%	30	16581

Table IIf.2 See below for legend.

Tab 2: FRV Walther Herwig III, 218th cruise: International hydroacoustic survey on North Sea herring
Catch per rectangle (kg)

		Frequency of	Stat. square											
No	Species	occurrence	37F3	37F4	37F5	37F6	37F7	38F3	38F4	38F5	38F6	39F2	39F3	39F4
1	Agonus cataphractus	1										0.0		
2	Alosa fallax	1			0.2									
3	Ammodytes marinus	15										0.7	0.1	
4	Callionymus lyra	2											0.1	
5	Clupea harengus	29	57.9	4.1	0.6	2.2		947.7	116.5	47.8			0.5	140.7
6	Echiichthys vipera	6	0.0		0.1							0.3	0.0	
7	Eutrigla gurnardus	39	5.0	1.2	2.2	1.9	2.5	7.5	9.6	3.1	3.5	7.2	25.6	16.3
8	Gadus morhua	19		0.3				1.7	6.0	1.0		3.2	0.0	0.6
9	Hippoglossoides platessoi	9		0.0				0.0				0.4		
10	Limanda limanda	27	0.4	0.1	0.1	0.5	10.0	1.8	0.1	0.9	0.5	4.3	12.6	2.1
11	Melanogrammus aeglefinus	23	0.8		1.3		0.1	0.1	0.3			2.6	0.6	0.5
12	Merlangius merlangius	36	24.9	7.0	8.8	13.0	38.6	4.1	1.8	13.4	4.7	1.9	12.4	0.6
13	Merluccius merluccius	6								1.2				
14	Microstomus kitt	9					0.0		0.3				0.2	0.8
15	Mullus surmuletus	5	0.3				0.1	0.7		0.3				
16	Myoxocephalus scorpius	1												
17	Pleuronectes platessa	23	1.1	0.6	0.9		5.5	3.3	1.3	2.8	0.8	0.4	1.8	4.7
18	Psetta maxima	2									2.5			
19	Raja radiata	1												
20	Salmo salar	1									3.3			
21	Sardina pilchardus	1					5.0							
22	Scomber scombrus	24	18.1	0.4	32.3	4.9	36.7		3.0	20.2	10.0	0.6	51.2	16.4
23	Sprattus sprattus	25	311.1	68.6	851.1	55.0		2936.5	415.8	43.0	5.2	0.5	159.7	3.1
24	Squalus acanthias	1												
25	Trachurus trachurus	21	3.2	2.8	11.5	20.2	102.8		2.9	25.0	8.0		3.2	3.1
26	Trigla lucerna	2					0.4		0.1					
27	Trisopterus minutus	1	0.1											
	Total		423.0	85.2	909.1	97.6	201.8	3903.3	557.5	158.4	38.5	22.1	267.9	188.8

		Stat. square												
No	Species	39F5	39F6	40F4	40F5	40F6	41F4	41F5	41F6	41F7	42F4	42F5	42F6	42F7
1	Agonus cataphractus													
2	Alosa fallax													
3	Ammodytes marinus		16.1	1.6	0.1	0.8		0.5	0.0	3.6		1.0		1.4
4	Callionymus lyra		0.0											
5	Clupea harengus	128.4	1.6	0.1	1427.8	239.3	1.1	435.7	577.3		0.3	410.7	26.8	82.0
6	Echiichthys vipera		0.1	0.0										
7	Eutrigla gurnardus	9.1	13.8	6.0	8.6	25.2	5.0	3.7	5.4	7.8	0.8	2.5	1.5	2.9
8	Gadus morhua	0.1	1.3		0.1	0.1	2.8	0.1		1.2	0.2	0.8	0.2	
9	Hippoglossoides platessoides			0.1	0.1	0.3					0.5	0.1		
10	Limanda limanda	0.2	2.2	4.5	0.3	13.1	0.2			6.9	1.7	1.4	0.5	
11	Melanogrammus aeglefinus		1.0	5.8	0.3	0.2	198.9	1.4			7.3	8.0		0.2
12	Merlangius merlangius	5.6	8.2	38.7	0.7	4.0	7.1	0.8	0.1	3.9	5.0	2.2		0.0
13	Merluccius merluccius	5.3			1.0	2.7						0.6		
14	Microstomus kitt		0.1	0.6	0.3		0.8	0.3						
15	Mullus surmuletus		0.1											
16	Myoxocephalus scorpius		0.1											
17	Pleuronectes platessa		2.0	0.3	0.5	23.4				18.0		0.7		
18	Psetta maxima		2.7											
19	Raja radiata											1.9		
20	Salmo salar													
21	Sardina pilchardus													
22	Scomber scombrus	1.6	1.4	0.3		7.0		1.2	0.4	8.4		15.8		0.2
23	Sprattus sprattus	29.3	3.1	0.0	202.8	145.3		98.8	185.0				0.4	9.0
24	Squalus acanthias											1.9		
25	Trachurus trachurus		58.3	1.2	0.9	7.3				31.3				
26	Trigla lucerna													
27	Trisopterus minutus													
	Total	179.5	112.0	59.2	1643.4	468.7	215.9	542.5	768.2	81.1	15.8	447.5	29.3	95.7

Table IIf.3 See below for legend.

Tab 3 FRV Walther Herwig III, 218th cruise: International hydroacoustic surv
on North Sea herring in 2000
Hydroacoustics results and estimated numbers of herring and sprat

Rect	Area (nm^2)	Sa (m^2 nm^-2)	Sigma (cm^2)	n total (millions)	Herring (%)	Sprat (%)	n Herring (millions)	n Sprat (millions)
37F3	1052	207.0	1.469	1482.3	7.7	92.3	114.0	1368.3
37F4	1052	266.4	1.014	2762.7	7.4	92.6	204.4	2558.4
37F5	1052	532.5	1.056	5302.4	0.0	100.0	2.4	5300.0
37F6	1052	36.0	1.489	254.4	1.9	98.1	4.8	249.5
37F7	1052	158.7	1.488	1122.0	1.7	98.3	19.6	1102.4
38F3	1039	145.9	1.691	896.2	12.4	87.6	111.1	785.1
38F4	1039	160.2	1.212	1373.3	34.1	65.9	468.6	904.6
38F5	1039	98.8	2.114	485.5	40.3	59.7	195.9	289.6
38F6	1039	107.2	1.539	723.5	0.0	100.0	0.0	723.5
38F7	1039	3.6	1.503	24.9	3.5	96.5	0.9	24.0
39F2	1026	33.6	1.449	238.0	0.0	100.0	0.0	238.0
39F3	1026	43.2	1.538	288.3	0.1	99.9	0.2	288.1
39F4	1026	27.6	2.702	104.8	94.0	6.0	98.5	6.3
39F5	1026	73.0	2.280	328.6	62.3	37.7	204.8	123.7
39F6	1026	81.0	1.546	537.6	37.1	62.9	199.3	338.3
39F7	1026	97.2	1.057	943.5	50.1	49.9	473.0	470.5
40F4	1013	1.8	1.617	11.3	58.7	41.3	6.6	4.7
40F5	1013	184.9	1.624	1153.0	58.3	41.7	672.6	480.4
40F6	1013	271.6	1.059	2598.0	51.1	48.9	1328.1	1269.8
40F7	1013	214.4	0.852	2549.2	76.8	23.2	1957.2	592.1
41F4	1000	0.2	1.636	1.2	64.3	35.7	0.8	0.4
41F5	1000	108.3	1.445	749.5	65.9	34.1	494.2	255.3
41F6	1000	89.4	0.825	1083.7	84.0	16.0	909.9	173.8
41F7	1000	278.0	0.826	3367.1	84.0	16.0	2827.5	539.6
42F4	987	17.4	1.763	97.4	79.1	20.9	77.0	20.4
42F5	987	14.4	2.941	48.3	100.0	0.0	48.3	0.0
42F6	987	26.1	2.285	112.7	97.2	2.8	109.6	3.1
42F7	987	58.4	2.184	263.9	82.4	17.6	217.5	46.4
Total							10746.9	18156.4

Table IIf.4 See below for legend.

Tab 4: FRV Walther Herwig III, 218th cruise: International hydroacoustic survey on North Sea herring
Herring numbers and mass at age/maturity
Yellow cells indicate interpolated squares

ICES Rect		F2		F3		F4		F5		F6		F7	
	Age	w /age	n	w /age	n	w /age	n	w /age	n	w /age	n	w /age	n
42	total					1670	77.0	1686	48.3	3709	109.6	7591	217.5
	1i					156	33.4	0	0.0	15	3.2	0	0.0
	1m					1	0.1	0	0.0	0	0.0	0	0.0
	2i					3	0.1	0	0.0	0	0.0	0	0.0
	2m					1506	43.4	1672	48.2	3694	106.4	7521	216.6
	3m					3	0.0	13	0.2	0	0.0	70	0.9
	4					0	0.0	0	0.0	0	0.0	0	0.0
41	total					17	0.8	9444	494.2	4324	909.9	33865	2827.5
	1i					2	0.4	1195	256.3	4230	907.2	9923	2128.1
	1m					0	0.0	7	0.5	0	0.0	268	19.2
	2i					0	0.0	26	0.8	93	2.7	143	4.2
	2m					16	0.4	8216	236.6	0	0.0	23424	674.7
	3m					0	0.0	0	0.0	0	0.0	107	1.3
	4					0	0.0	0	0.0	0	0.0	0	0.0
40	total					164	6.6	16221	672.6	16688	1328.1	22481	1957.2
	1i					10	2.2	1106	237.3	4484	961.6	7082	1518.8
	1m					0	0.0	0	0.0	350	25.1	536	38.4
	2i					0	0.0	0	0.0	0	0.0	79	2.3
	2m					154	4.4	15114	435.3	11854	341.4	14741	424.6
	3m					0	0.0	0	0.0	0	0.0	44	0.5
	4					0	0.0	0	0.0	0	0.0	0	0.0
39	total	0	0.0	14	0.2	3418	98.5	7111	204.8	2165	199.3	5758	473.0
	1i	0	0.0	0	0.0	0	0.0	0	0.0	427	91.5	1462	313.6
	1m	0	0.0	0	0.0	0	0.0	0	0.0	1342	96.3	831	59.6
	2i	0	0.0	0	0.0	44	1.3	0	0.0	0	0.0	0	0.0
	2m	0	0.0	4	0.1	3375	97.2	7111	204.8	396	11.4	3464	99.8
	3m	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	4	0	0.0	10	0.1	0	0.0	0	0.0	0	0.0	0	0.0
38	total			3856	111.1	3247	468.6	6801	195.9	0	0.0	10	0.9
	1i			0	0.0	2021	433.3	0	0.0	0	0.0	2	0.4
	1m			0	0.0	0	0.0	0	0.0	0	0.0	6	0.4
	2i			102	3.0	0	0.0	0	0.0	0	0.0	1	0.0
	2m			3753	108.1	1226	35.3	6801	195.9	0	0.0	2	0.1
	3m			1	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	4			0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
37	total			3169	114.0	1255	204.4	50	2.4	137	4.8	554	19.6
	1i			122	26.2	906	194.3	5	1.1	4	0.9	17	3.7
	1m			0	0.0	0	0.0	0	0.0	1	0.1	4	0.3
	2i			0	0.0	0	0.0	0	0.0	131	3.8	533	15.6
	2m			3047	87.8	349	10.1	45	1.3	0	0.0	0	0.0
	3m			0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	4			0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

Age	mean wt (kg)
1i	0.0047
1m	0.0139
2i	0.0342
2m	0.0347
3	0.0811
4	0.1260
5	---

biomass per age group (tonnes)

1i	33'170
1m	3'346
2i	1'155
2m	117'485
3m	239
4	10

total biomass (herring) of all rectangles in the German sector 2000

155'406 tonnes
155 ktonnes

Table IIf.5 See below for legend

Tab 5: FRV Walther Herwig III, 218th cruise: International hydroacoustic survey on North Sea herring
Sprat numbers and mass at age/maturity
Yellow cells indicate interpolated squares

ICES Rect		F2		F3		F4		F5		F6		F7	
	Age	w /age	n	w /age	n	w /age	n	w /age	n	w /age	n	w /age	n
42	total					168	20.4	0	0.0	44	3.1	665	46.4
	1 i					42	7.5	0	0.0	0	0.0	0	0.0
	1m					98	11.1	0	0.0	4	0.4	54	6.0
	2m					27	1.8	0	0.0	40	2.7	611	40.4
	3m					0	0.0	0	0.0	0	0.0	0	0.0
	4					0	0.0	0	0.0	0	0.0	0	0.0
41	total					3	0.4	2100	255.3	1564	173.8	5060	539.6
	1 i					0	0.1	525	94.3	23	4.2	172	30.8
	1m					3	0.3	1232	138.3	1465	164.6	4018	451.3
	2m					0	0.0	343	22.7	75	5.0	870	57.5
	3m					0	0.0	0	0.0	0	0.0	0	0.0
	4					0	0.0	0	0.0	0	0.0	0	0.0
40	total					48	4.7	4361	480.4	11563	1269.8	5678	592.1
	1 i					2	0.3	59	10.7	499	89.5	198	35.6
	1m					29	3.2	4012	450.7	9715	1091.2	4212	473.1
	2m					17	1.1	289	19.1	1349	89.1	1239	81.8
	3m					0	0.0	0	0.0	0	0.0	29	1.6
	4					0	0.0	0	0.0	0	0.0	0	0.0
39	total	3416	238.0	4101	288.1	91	6.2	1583	123.7	4576	338.3	5589	470.5
	1 i	0	0.0	0	0.0	0	0.0	3	0.5	0	0.0	88	15.8
	1m	297	33.3	371	41.7	5	0.6	416	46.7	813	91.3	2021	227.0
	2m	2988	197.4	3730	246.4	86	5.7	1126	74.4	3612	238.6	3269	215.9
	3m	131	7.3	0	0.0	0	0.0	39	2.2	152	8.5	212	11.8
	4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
38	total			11223	785.1	10112	904.6	4394	289.6	11004	723.5	352	24.0
	1 i			0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	1m			946	106.2	5116	574.6	178	20.0	127	14.3	22	2.5
	2m			10278	678.9	4997	330.1	3408	225.1	9976	659.0	304	20.1
	3m			0	0.0	0	0.0	628	35.0	900	50.2	25	1.4
	4			0	0.0	0	0.0	180	9.5	0	0.0	0	0.0
37	total			16179	1368.3	23386	2558.4	49333	5300.0	3227	249.5	15742	1102.4
	1 i			24	4.4	0	0.0	183	32.9	5	1.0	10	1.7
	1m			6458	725.3	21911	2460.9	43676	4905.6	817	91.8	1589	178.4
	2m			9507	628.0	1475	97.4	5473	361.5	2204	145.6	12971	856.8
	3m			189	10.6	0	0.0	0	0.0	200	11.2	1173	65.5
	4			0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

Age	mean wt (kg)
1 i	0.0056
1m	0.0089
2m	0.0151
3m	0.0179
4	0.0190

biomass per age group (tonnes)

1 i	1'834
1m	109'604
2m	80'266
3m	3'679
4	180

total biomass (sprat) of all rectangles in the German sector 2

195'564 tonnes
196 ktonnes

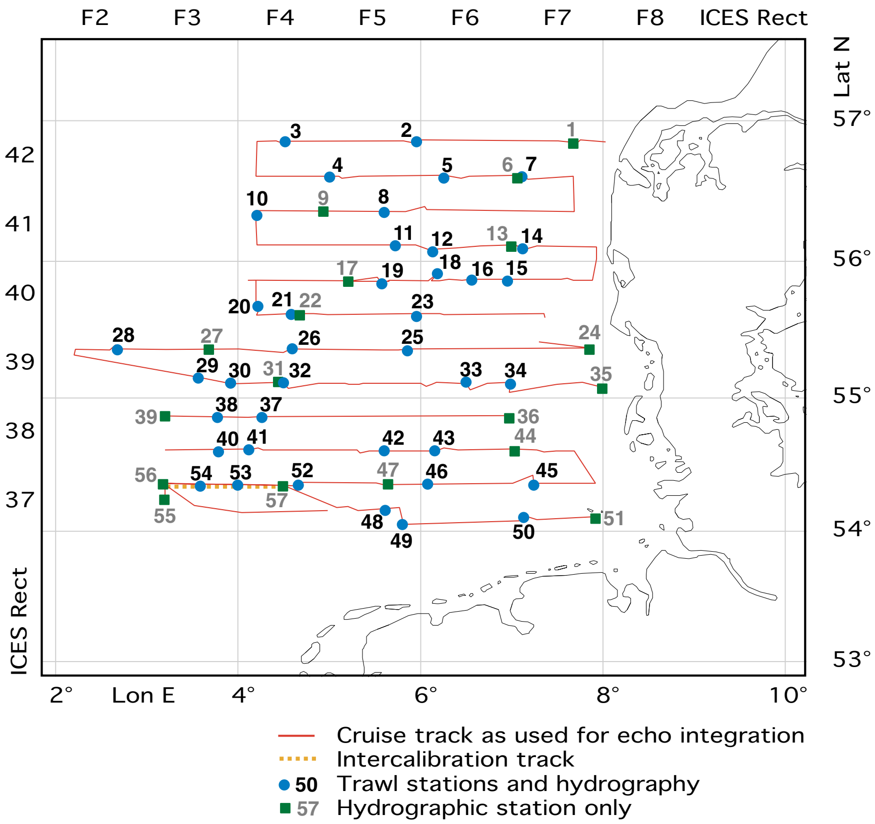

Fig 1: FRV Walther Herwig III, 218th cruise:
International hydroacoustic survey on herring in the North Sea
23 June 2000 -14 July 2000: **cruise track**

Figure IIf.1 See figure for legend.

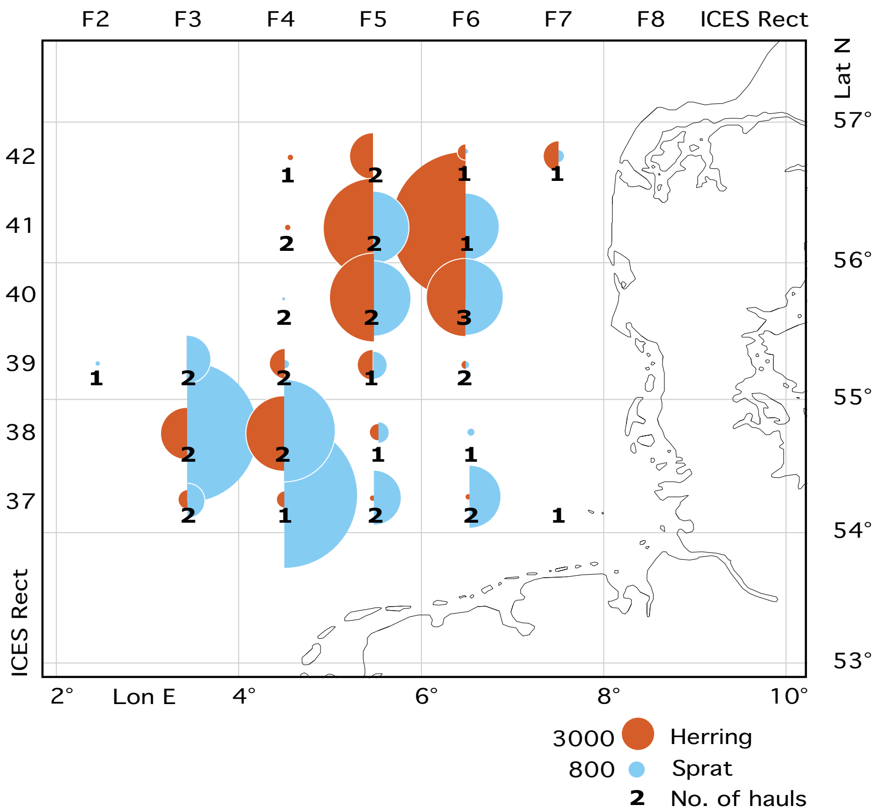

Fig 2: FRV Walther Herwig III, 218th cruise:
International hydroacoustic survey on herring in the North Sea
23 June 2000 -14 July 2000: **abundance of herring and sprat (catch per 30 min),** circle diameter is proportional to square root of abundance

Figure IIf.2 See figure for legend.

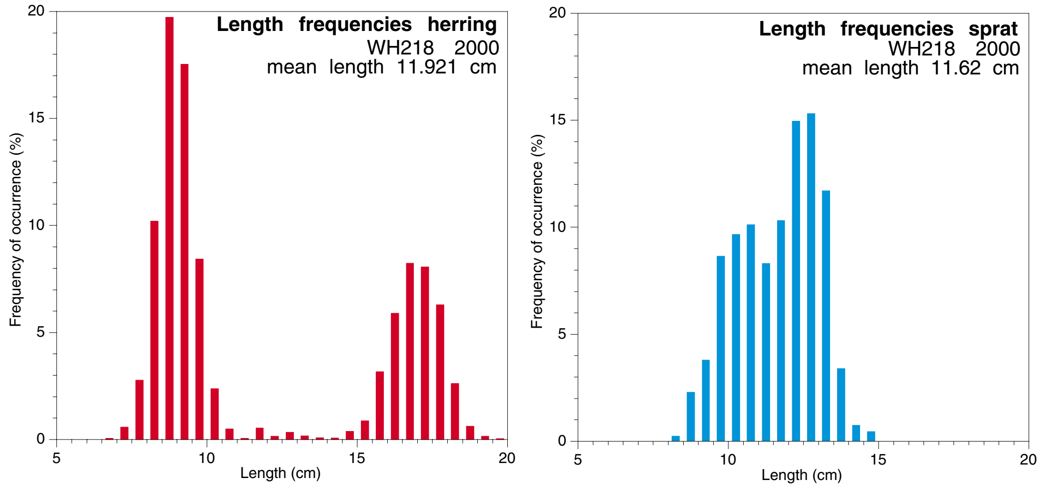

Fig 3: FRV Walther Herwig III, 218th cruise:
International hydroacoustic survey on herring in the North Sea
23 June 2000 -14 July 2000: **length frequencies for herring and sprat**

Figure IIf.3 See figure for legend.

APPENDIX III. BALTIC SEA SURVEY

Survey report R/V SOLEA

International Acoustic Survey for Pelagic Fish Stocks in the Baltic Sea

01.10-19.10.2000

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Objective

The main objective has been to assess clupeoid resources in the Baltic Sea. The joint German/Danish survey in September/October is traditionally coordinated with other international surveys in the Baltic. The reported acoustic survey is conducted every year to supply:

the ‘Herring Assessment Working Group for the Area South of 62°N (HAWG)’ with an index value for the stock size of herring and the

‘Baltic Fisheries Assessment Working Group’ with an index value for the stock size of sprat

in the Western Baltic area (Sub-division 21, 22, 23 and 24).

Narrative

RV ”SOLEA” left the port of Rostock/Warnemünde on 01.10.2000. The acoustic survey covered the whole Sub-divisions 22, 23, 24 and the southern part of the Kattegat (Sub-division 21). The acoustic investigations were performed during night time. The main pelagic species of interest were herring and sprat.

The acoustic equipment was an EK500 echosounder connected to the BI500 Bergen-Integrator. The specific settings of the hydroacoustic equipment were used as described in the ‘Manual for the Baltic International Acoustic Surveys (BIAS)’ (Annex 4 in the ‘Report of the Baltic International Fish Survey Working Group’, ICES CM 2000/H:2). A 38kHz transducer 38-26 was deployed in a towed body. The towed body had a lateral distance of about 30 m to reduce escape reactions of fish. The transducer was calibrated before this survey in Warnemünde and during the cruise in Abenrade/Denmark.

Pelagic trawl hauls were carried out to identify the targets. From each haul sub-samples were taken to determine length and weight of fish. Further sub-samples of herring and sprat were collected in order to get age-structured population sizes and distributions. After each trawl haul the hydrographic condition was investigated by a XCTD-probe. The survey ended on 19 October in Rostock/Marienehe.

Results

The cruise track (Figure 2) reached in total a length of 996 n.mi.. 50 trawl hauls were carried out. 1478 herring and 532 sprat were frosted for further age determination in the lab. The results of the catch composition by Sub-division are presented in Table III.1-4. In general the catch composition was dominated by herring and to a lower extent by sprat.

The length distributions of herring and sprat of the years 1999 and 2000 are presented by Sub-division in Figures III.1 and III.2. Both for herring and sprat the contribution of the new incoming year class is less pronounced compared to last years results.

The herring stock in Sub-divisions 21 to 24 was estimated to be $3.9x10^9$ individuals or 180 000 tonnes (Tables III.5-7), which represents a reduction of 38 % and of 82 %, respectively, compared to last years results. The decrease was mainly caused by the low abundance of the 0-year class (see Figure III.2). Low herring densities were found in the Belt Sea and the southern Kattegat (Sub-divisions 21 and 22), while the biomass in the Arkona basin exceeded the estimates of the last years.

The overall estimate of the sprat stock in the covered area was $1.9x10^9$ individuals or 27 000 tonnes biomass (Tables III.9-11). This years results are on the lowest level recorded during the last years. The main reason for the drastic decrease is the very low abundance of young sprat in all areas. The present estimate of 0-group sprat was 1790 tonnes. Last years biomass estimates of juvenil sprat was more than 30 times higher.

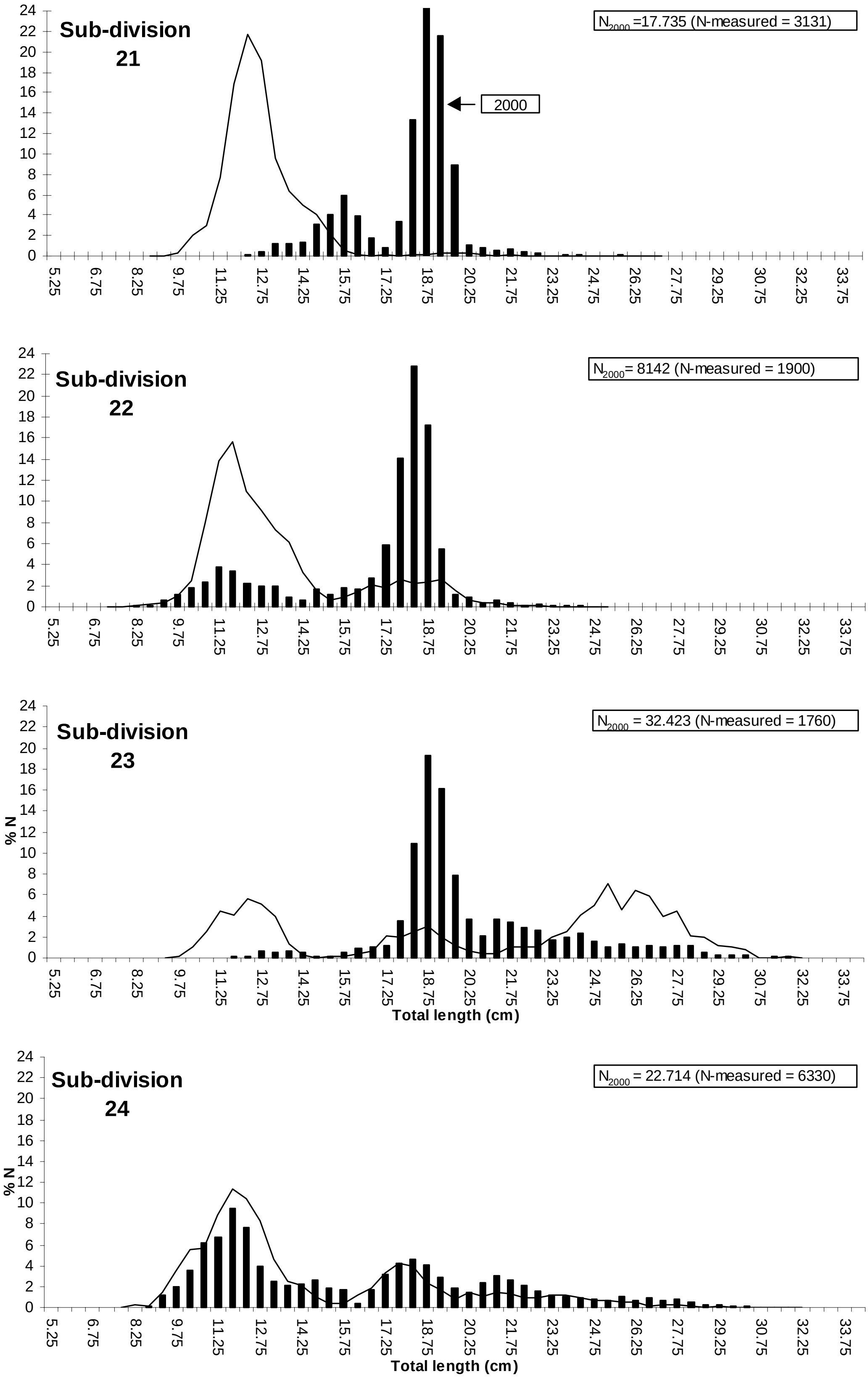

Figure III.1. Length distribution of herring in Sub-divisions 21, 22, 23 and 24 for 1999 (line) and 2000 (bars) from the Baltic Sea acoustic survey.

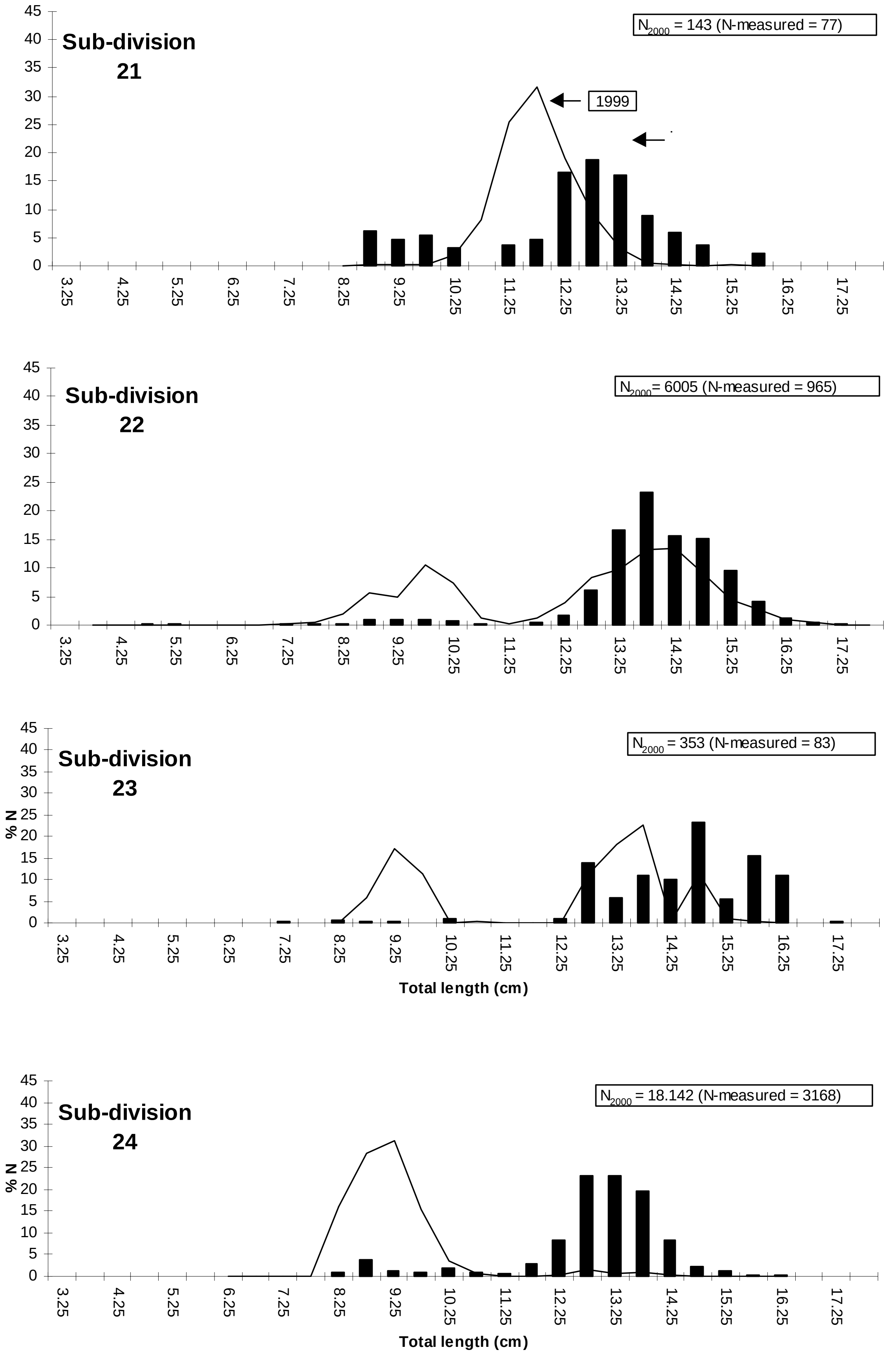

Figure III.2. Length distribution of sprat in Sub-divisions 21, 22, 23 and 24 for 1999 (line) and 2000 (bars) from the Baltic Sea acoustic survey.

Table III.1: Catch composition (kg/0.5 h) per trawl No. in Sub-division 21

Fish species/Haul	41	42	43	44	45	46	47	48	49	50	41-50
AGONUS CATAPHRACTUS				0.01							**0.01**
APHIA MINUTA				+							+
CLUPEA HARENGUS	140.10	314.14	15.39	10.94	164.17	38.85	7.53	0.04	9.10	2.67	**702.93**
CRANGON								+			+
CYCLOPTERUS LUMPUS		0.28									**0.28**
ENGRAULIS ENCRASICOLUS			0.58	0.03	0.11	0.05			0.04	0.02	**0.83**
EUTRIGLA GURNARDUS							0.03				**0.03**
GADUS MORHUA					2.60						**2.60**
LIMANDA LIMANDA	0.08							0.38	0.07		**0.53**
LOLIGO	0.01		0.04	0.08	0.01	0.10	0.33	0.21	0.31	0.14	**1.23**
MERLANGIUS MERLANGUS	5.48	0.46	0.66	5.45	0.63	0.14	0.57	0.11	0.15	0.01	**13.66**
OCTOPODIDAE				0.01					+		**0.01**
OSMERUS EPERLANUS							0.01				**0.01**
POMATOSCHISTUS MINUTUS			+			+	0.01	0.01	0.01	+	**0.03**
SCOMBER SCOMBRUS				0.33	0.28						**0.61**
SPRATTUS SPRATTUS	1.11				0.51	0.10	0.37		0.04		**2.13**
TRACHINUS DRACO	0.05	0.12	0.14	0.79	3.39	0.32	2.60	0.28	0.19		**7.88**
TRACHURUS TRACHURUS			0.01	0.05	0.04	0.01	0.06	0.01	0.04	0.05	**0.27**
Total	**146.83**	**315.00**	**16.82**	**17.69**	**171.74**	**39.57**	**11.51**	**1.04**	**9.95**	**2.89**	**733.04**
Medusae	1.17		0.96						1.45		3.57

Table III.2: Catch composition (kg/0.5 h) per trawl No. in Sub-division 22 + = < 0.01 Kg

Fish species/Haul	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	1-15
AGONUS CATAPHRACTUS											0.02	0.02				**0.04**
CLUPEA HARENGUS	13.82	3.36	20.30	23.48	0.24	2.97	15.45	5.89	0.80			0.05	173.25	0.08	5.66	**265.35**
CRANGON											+	+		+		**+**
GADUS MORHUA	+	10.73	4.92	5.32	4.47	1.82	8.63				0.02				10.29	**46.20**
GASTEROSTEUS ACULEATUS	+		0.01	0.02		0.03	0.01		+	0.01	1.27				0.01	**1.36**
GOBIUS NIGER										0.01	+					**+**
LIMANDA LIMANDA			0.03	0.01	0.77	0.32	0.11		0.05		0.13	0.03		0.02	0.29	**1.76**
LOLIGO											+		+	+		+
MERLANGIUS MERLANGUS	0.01	0.39	0.87	0.03		+	0.03				0.08	0.05			0.01	**1.47**
PNo.IS GUNELLUS														0.02		**0.02**
POMATOSCHISTUS MINUTUS				0.01	0.01	+	0.01		+	+	+	0.03	0.01	0.06	0.01	**0.14**
SPRATTUS SPRATTUS	0.77	73.61	33.38	4.93	0.08	0.06	0.26	0.09	0.04	0.06			2.94		0.10	**116.32**
SYNGNATHUS ROSTELLATUS											+	+		+		+
TRACHURUS TRACHURUS												+	0.03			**0.03**
Total	**14.60**	**88.09**	**59.51**	**33.80**	**5.57**	**5.20**	**24.50**	**5.98**	**0.89**	**0.08**	**1.52**	**0.18**	**176.23**	**0.18**	**16.37**	**432.69**
Medusae	28.19	25.32	16.50	9.70	7.53	5.27	3.73	3.42	2.51		0.41	2.03		0.32	2.42	107.32

Table III.3: Catch composition (kg/0.5 h) per trawl No. in Sub-division 23

Fish species/Haul	37	38	39	40	37-40
ANGUILLA ANGUILLA	0.61				**0.61**
CLUPEA HARENGUS	1050.62	833.45	10.20	103.50	**1997.77**
GADUS MORHUA	31.84	6.18		5.47	**43.49**
LIMANDA LIMANDA			0.05		**0.05**
LOLIGO			0.03		**0.03**
MERLANGIUS MERLANGUS	3.61	10.64	0.25	8.10	**22.60**
POMATOSCHISTUS MINUTUS			0.00		**0.00**
SPRATTUS SPRATTUS	0.99	4.73	0.03	1.52	**7.27**
TRACHINUS DRACO	0.33		0.02		**0.35**
Total	**1088.00**	**855.00**	**10.58**	**118.59**	**2072.17**
Medusae					0.00

Table III.4: Catch composition (kg/0.5 h) per trawl No. in Sub-division 24

Fish species/Haul	16	17	18	19	20	21	22	23	24	25	26	27	28
ANGUILLA ANGUILLA									1.34				
CLUPEA HARENGUS	8.56	3.76	60.16	139.59	42.56	64.77	15.71	31.80	49.57	58.66	65.51	35.92	129.66
CRANGON							+	+					
GADUS MORHUA	8.17	13.28	7.59	1.71	16.30	3.24	1.59	0.70	16.31	10.08	1.54		3.29
GASTEROSTEUS ACULEATUS	0.03	0.02		0.01			0.15	0.02					
HYPEROPLUS LANCEOLATUS				0.06									
MERLANGIUS MERLANGUS	22.87		0.09	0.33	0.80	1.81			0.64	4.36	4.20		
OSMERUS EPERLANUS		+				0.13			0.25				
POMATOSCHISTUS MINUTUS	+	+	0.01		0.17	0.18	+	0.01	0.00	0.28	0.15	+	0.01
SALMO SALAR													
SPRATTUS SPRATTUS	1.84	0.47	2.32	5.30	0.28	260.83	2.69	3.48	0.52	26.17	3.11	0.74	2.82
Total	**41.47**	**17.53**	**70.17**	**147.00**	**60.11**	**330.96**	**20.14**	**36.01**	**68.63**	**99.55**	**74.51**	**36.66**	**135.78**
Medusae	4.23	4.94	8.84		12.75	14.52	10.11	0.60	7.16	3.45	6.05	2.55	1.23

Fish species/Haul	29	30	31	32	33	34	35	36	16-36
ANGUILLA ANGUILLA				0.46					1.80
CLUPEA HARENGUS	27.82	20.90	9.76	9.21	3.69	28.37	5.48	3.06	814.52
CRANGON									+
GADUS MORHUA	5.96		1.78		0.02		1.57		93.13
GASTEROSTEUS ACULEATUS									0.23
HYPEROPLUS LANCEOLATUS									0.06
MERLANGIUS MERLANGUS	0.29		0.16				0.12		35.67
OSMERUS EPERLANUS									0.38
POMATOSCHISTUS MINUTUS	0.10	0.01			0.01				0.93
SALMO SALAR		13.50							13.50
SPRATTUS SPRATTUS	1.63	11.06	0.72	14.37	0.02	84.03	28.57	20.84	471.81
Total	**35.80**	**45.47**	**12.42**	**24.04**	**3.74**	**112.40**	**35.74**	**23.90**	**1432.03**
Medusae	5.35	12.16	93.50	12.16	3.67	31.11	4.37	25.46	264.18

+ = < 0.01 Kg

Table III.5 Survey statistics r/v "Solea" October 2000

Sub-division	ICES Rectangle	Area (nm²)	Sa (m²/NM²)	Sigma (cm²)	N total (million)	Herring (%)	Sprat (%)	NHerring (million)	NSprat (million)
21	41G1	946.8	26	1.82	135.6	52.0	2.5	70.4	3.5
21	41G2	432.3	20	2.39	36.2	94.3	0.3	34.1	0.1
21	42G1	884.2	39	3.62	95.2	64.2	0.0	61.1	0.0
21	42G2	606.8	162	3.23	304.1	97.9	0.9	297.7	2.6
	Total	2870.1			571.1			463.3	6.1
22	37G0	209.9	83	2.42	71.9	87.5	8.1	62.9	5.8
22	37G1	723.3	187	2.05	659.7	49.1	50.3	324.0	331.6
22	38G0	735.3	33	2.23	108.7	81.4	6.5	88.5	7.0
22	38G1	173.2	20	1.15	30.1	25.0	21.4	7.5	6.5
22	39F9	159.3	19	0.27	110.2	0.0	86.2	0.0	95.0
22	39G0	201.7	18	1.16	31.4	24.7	1.0	7.7	0.3
22	39G1	250.0	14	0.25	137.5	1.8	0.0	2.5	0.0
22	40F9	51.3	26	1.48	9.0	32.3	1.3	2.9	0.1
22	40G0	538.1	29	1.48	105.2	32.3	1.3	34.0	1.4
22	41G0	173.1	9	1.48	10.5	32.3	1.3	3.4	0.1
	Total	3215.2			1274.3			533.5	447.8
23	40G2	164.0	1017	4.31	386.9	99.0	0.8	382.9	3.1
23	41G2	72.3	471	2.93	116.1	94.9	2.3	110.2	2.7
	Total	236.3			503.0			493.1	5.8
24	37G2	192.4	117	6.51	34.6	40.8	21.0	14.1	7.3
24	38G2	832.9	206	2.36	726.5	88.3	8.5	641.6	61.9
24	38G3	865.7	378	2.61	1255.7	50.0	33.2	627.9	416.6
24	38G4	1034.8	193	2.79	714.7	75.9	20.2	542.8	144.6
24	39G2	406.1	136	4.27	129.5	68.9	15.9	89.1	20.6
24	39G3	765.0	192	2.23	658.5	33.7	66.0	222.2	434.3
24	39G4	524.8	255	2.19	609.7	36.7	55.9	223.7	340.6
	Total	4621.7			4129.2			2361.5	1425.8

Table III.6 Estimated numbers (millions) of herring r/v "Solea" October 2000

SD	Rect	0	1	2	3	4	5	6	7	8	9	total
21	**41G1**	27.09	42.85	0.46	0.03							70.43
21	**41G2**	18.86	14.69	0.51	0.06							34.12
21	**42G1**	5.31	54.58	1.19	0.02							61.10
21	**42G2**	70.56	216.85	8.54	1.13	0.38	0.19					297.66
	total	121.82	328.97	10.70	1.24	0.38	0.19					463.31
22	**37G0**	15.89	45.77	1.22		0.06						62.94
22	**37G1**	142.35	146.52	17.75	4.38	6.58	5.49	0.95				324.02
22	**38G0**	28.36	57.53	2.20	0.18	0.16		0.06				88.49
22	**38G1**	1.08	6.45									7.53
22	**39F9**											
22	**39G0**	0.04	6.75	0.65	0.29							7.74
22	**39G1**		2.50									2.50
22	**40F9**	0.02	2.35	0.36	0.16							2.90
22	**40G0**	0.28	27.50	4.27	1.92	0.01						33.99
22	**41G0**	0.03	2.74	0.43	0.19							3.39
	total	188.05	298.11	26.88	7.12	6.81	5.49	1.01				533.50
23	**40G2**	13.35	200.73	106.93	34.70	15.83	6.96	3.13	0.97	0.32		382.91
23	**41G2**	46.38	51.95	10.53	1.22	0.10	0.02	0.02				110.22
	total	59.73	252.68	117.46	35.92	15.93	6.98	3.15	0.97	0.32		493.13
24	**37G2**	2.99	7.69	1.50	1.21	0.53	0.14	0.04		0.02		14.12
24	**38G2**	337.34	178.13	52.70	39.56	21.15	8.01	3.31	0.17	1.05	0.14	641.56
24	**38G3**	151.84	134.73	96.08	104.74	85.88	29.88	17.60	2.59	3.93	0.66	627.94
24	**38G4**	169.24	160.65	86.29	78.50	28.50	11.95	5.16	0.18	2.32		542.79
24	**39G2**	3.26	6.22	11.82	25.48	25.09	9.09	5.59	1.41	0.84	0.34	89.14
24	**39G3**	71.95	77.63	31.70	23.60	11.01	4.23	1.30	0.09	0.63	0.05	222.19
24	**39G4**	36.82	91.72	49.20	29.00	10.64	4.47	1.07		0.78		223.71
	total	773.44	656.77	329.29	302.09	182.80	67.77	34.07	4.44	9.57	1.19	2361.45

Table III.7 Herring mean weight (g) per age group r/v "Solea" October 2000

SD	Rect	0	1	2	3	4	5	6	7	8	9	total
21	**41G1**	17.3	40.1	60.2	66.9							31.5
21	**41G2**	16.0	41.8	58.3	66.9							27.8
21	**42G1**	24.8	42.7	59.1	66.9							41.5
21	**42G2**	23.4	43.3	65.3	86.6	119.7	118.0					39.5
22	**37G0**	15.8	35.2	46.4		56.0						30.6
22	**37G1**	12.5	35.2	56.4	70.4	75.3	85.0	76.4				28.6
22	**38G0**	11.7	37.7	51.9	62.1	66.1		76.4				29.9
22	**38G1**	14.7	38.2									34.8
22	**39F9**											
22	**39G0**	24.5	42.0	48.5	48.4	56.0						42.7
22	**39G1**		40.3									40.3
22	**40F9**	24.5	43.1	48.5	48.4	56.0						43.9
22	**40G0**	24.5	43.1	48.5	48.4	56.0						43.9
22	**41G0**	24.5	43.1	48.5	48.4	56.0						43.9
23	**40G2**	21.8	43.2	79.3	119.9	168.7	184.5	214.5	214.5	268.5		69.2
23	**41G2**	17.6	41.8	60.1	67.4	172.5	185.0	185.0				33.8
24	**37G2**	13.6	38.1	54.9	72.1	72.4	68.8	83.5		63.4		39.4
24	**38G2**	11.2	38.1	55.8	75.6	100.9	97.2	118.8	180.4	69.0	177.8	31.1
24	**38G3**	10.6	40.6	58.1	86.7	126.6	125.7	153.3	195.5	111.3	177.8	63.9
24	**38G4**	13.4	38.2	58.4	73.8	89.7	75.7	109.2	209.6	68.6		43.2
24	**39G2**	13.7	41.3	62.3	94.2	135.6	142.4	159.6	211.7	127.5	177.8	106.5
24	**39G3**	13.9	39.3	56.4	73.7	94.8	87.8	100.3	183.1	73.0	177.8	41.4
24	**39G4**	16.5	40.2	56.0	69.9	78.0	71.7	75.9		63.4		46.3

Table III.8 Herring total biomass (t) per age group r/v "Solea" October 2000

SD	Rect	0	1	2	3	4	5	6	7	8	9	total
21	**41G1**	468.7	1718.3	27.5	2.1							2216.6
21	**41G2**	301.7	614.1	29.7	4.1							949.6
21	**42G1**	131.6	2330.7	70.2	1.5							2534.0
21	**42G2**	1651.2	9389.7	557.7	97.7	46.0	22.7					11765.0
		2553.2	14052.8	685.1	105.4	46.0	22.7					17465.2
22	**37G0**	251.1	1611.0	56.6	0.0	3.5						1922.2
22	**37G1**	1779.3	5157.6	1001.2	308.1	495.7	466.4	72.7				9281.0
22	**38G0**	331.8	2169.0	114.4	11.2	10.3		4.3				2641.0
22	**38G1**	15.8	246.6									262.4
22	**39F9**											0.0
22	**39G0**	1.0	283.7	31.4	14.1	0.1						330.3
22	**39G1**		100.8									100.8
22	**40F9**	0.6	101.1	17.7	7.9	0.1						127.4
22	**40G0**	6.9	1185.3	207.1	93.1	0.8						1493.2
22	**41G0**	0.7	118.2	20.7	9.3	0.1						149.0
		2387.2	10973.3	1449.1	443.7	510.6	466.4	77.0				16307.3
23	**40G2**	291.0	8671.5	8479.2	4160.1	2671.2	1284.2	670.3	207.4	86.5		26521.4
23	**41G2**	816.3	2171.5	633.1	82.1	17.9	3.2	3.2				3727.3
		1107.3	10843.0	9112.3	4242.2	2689.1	1287.4	673.5	207.4	86.5		30248.7
24	**37G2**	40.6	292.9	82.1	87.5	38.5	9.9	3.7		1.0		556.2
24	**38G2**	3778.2	6786.9	2940.9	2990.6	2133.9	778.3	393.4	31.1	72.1	25.0	19930.4
24	**38G3**	1609.5	5470.2	5582.2	9081.2	10872.8	3756.3	2698.4	506.6	436.9	117.4	40131.5
24	**38G4**	2267.8	6137.0	5039.2	5793.3	2556.3	904.7	563.8	37.7	159.0	0.0	23458.8
24	**39G2**	44.6	256.9	736.7	2400.4	3401.8	1294.3	892.3	298.4	106.7	61.3	9493.4
24	**39G3**	1000.1	3051.0	1788.0	1739.5	1043.8	371.5	130.0	15.9	45.8	9.6	9195.2
24	**39G4**	607.5	3687.2	2755.4	2027.2	830.2	320.4	81.5		49.4		10358.8
		9348.3	25682.1	18924.5	24119.7	20877.3	7435.4	4763.1	889.7	870.9	213.3	113124.3

Table III.9 Estimated numbers (millions) of sprat r/v "Solea" October 2000

SD	Rect	0	1	2	3	4	5	6	7	8	9	total
21	41G1	0.10	1.08	1.10	0.74	0.43						3.45
21	41G2		0.04	0.04	0.01							0.09
21	42G1											
21	42G2	0.40	1.43	0.42	0.33	0.02						2.59
		0.50	2.55	1.56	1.08	0.45	0.00	0.00	0.00	0.00	0.00	6.13
22	37G0	5.23	0.44	0.12								5.79
22	37G1	82.76	76.70	79.54	42.48	43.25	6.90					331.63
22	38G0	3.72	0.98	0.85	0.43	1.00	0.06					7.04
22	38G1	2.02	1.96	1.40	0.54	0.54						6.46
22	39F9	94.97										94.97
22	39G0	0.03	0.13	0.08	0.03	0.03						0.30
22	39G1											
22	40F9	0.01	0.05	0.03	0.01	0.01						0.12
22	40G0	0.13	0.58	0.37	0.13	0.12	0.01					1.35
22	41G0	0.01	0.06	0.04	0.01	0.01						0.13
		188.88	80.90	82.43	43.63	44.96	6.97	0.00	0.00	0.00	0.00	447.79
23	40G2		0.78	1.41	0.56	0.33	0.04					3.12
23	41G2	1.38	0.30	0.64	0.24	0.14	0.01					2.70
		1.38	1.08	2.05	0.80	0.47	0.05	0.00	0.00	0.00	0.00	5.82
24	37G2	0.78	2.08	1.01	2.02	0.98	0.36	0.04				7.27
24	38G2	15.52	21.50	5.64	10.57	5.82	2.75	0.10				61.91
24	38G3	118.85	171.17	30.86	58.49	25.96	11.19	0.11				416.64
24	38G4	44.36	50.90	12.53	21.09	10.34	5.28	0.07				144.57
24	39G2	0.35	7.88	3.35	5.49	2.29	1.24					20.60
24	39G3	0.05	205.39	59.60	98.08	44.99	25.79	0.40				434.30
24	39G4	7.70	210.24	32.09	47.69	25.46	17.30	0.06				340.55
		187.61	669.16	145.08	243.43	115.84	63.91	0.78	0.00	0.00	0.00	1425.84

Table III.10 Sprat mean weight (g) per age group r/v "Solea" October 2000

SD	Rect	0	1	2	3	4	5	6	7	8	9	total
21	**41G1**	7.2	17.1	20.3	22.9	24.5						20.0
21	**41G2**		18.4	20.5	20.9							19.7
21	**42G1**											
21	**42G2**	5.9	15.3	19.2	19.1	24.5						15.0
22	**37G0**	4.9	8.5	15.9								5.4
22	**37G1**	6.2	16.5	19.8	21.0	21.9	22.7					16.1
22	**38G0**	4.4	17.0	20.2	19.9	24.2	21.7					12.0
22	**38G1**	3.7	17.2	17.9	19.1	19.1						13.5
22	**39F9**	1.1										1.1
22	**39G0**	6.7	16.9	18.6	19.3	19.8	20.1					16.9
22	**39G1**											
22	**40F9**	6.7	16.9	18.6	19.3	19.8	20.1					16.9
22	**40G0**	6.7	16.9	18.6	19.3	19.8	20.1					16.9
22	**41G0**	6.7	16.9	18.6	19.3	19.8	20.1					16.9
23	**40G2**		16.3	20.2	21.2	23.0	24.9					19.8
23	**41G2**	4.5	16.7	20.0	20.2	23.8	24.9					12.0
24	**37G2**	5.5	16.2	19.0	19.4	20.1	18.7	23.2				17.0
24	**38G2**	5.2	14.9	18.2	18.5	18.9	18.5	23.2				13.9
24	**38G3**	5.5	14.3	17.4	17.7	16.8	17.5	23.2				12.7
24	**38G4**	5.7	14.8	17.5	17.9	18.0	17.9	23.2				13.1
24	**39G2**	4.1	16.1	18.3	18.5	18.4	17.8					17.2
24	**39G3**	9.1	15.4	17.8	18.0	17.7	17.4	23.2				16.7
24	**39G4**	9.0	13.9	17.4	17.2	16.8	16.9	23.2				15.0

Table III.11 Sprat total biomass (t) per age group r/v "Solea" October 2000

SD	rect	0	1	2	3	4	5	6	7	8	9	total
21	41G1	0.7	18.5	22.4	16.8	10.6						69.0
21	41G2		0.7	0.9	0.2							1.8
21	42G1											0.0
21	42G2	2.3	21.8	8.1	6.3	0.4						38.9
		3.0	41.0	31.4	23.3	11.0						109.7
22	37G0	25.6	3.7	1.8								31.1
22	37G1	513.1	1265.6	1574.8	892.1	947.1	156.6					5349.3
22	38G0	16.3	16.7	17.1	8.5	24.3	1.4					84.3
22	38G1	7.5	33.7	25.1	10.3	10.3						86.9
22	39F9	104.5										104.5
22	39G0	0.2	2.2	1.5	0.6	0.5						5.0
22	39G1											0.0
22	40F9	0.1	0.9	0.6	0.2	0.2						2.0
22	40G0	0.9	9.8	6.9	2.6	2.3	0.2					22.7
22	41G0	0.1	0.9	0.7	0.2	0.2						2.1
		668.3	1333.5	1628.5	914.5	984.9	158.2					5687.9
23	40G2		12.8	28.5	11.9	7.5	1.0					61.7
23	41G2	6.2	5.0	12.7	4.8	3.3	0.4					32.4
		6.2	17.8	41.2	16.7	10.8	1.4					94.1
24	37G2	4.3	33.6	19.3	39.1	19.8	6.8	1.0				123.9
24	38G2	80.7	320.3	102.7	195.6	110.1	50.9	2.2				862.5
24	38G3	653.7	2447.8	537.0	1035.3	436.2	195.8	2.6				5308.4
24	38G4	252.9	753.3	219.2	377.4	186.2	94.6	1.5				1885.1
24	39G2	1.4	126.9	61.3	101.6	42.2	22.0					355.4
24	39G3	0.5	3163.0	1060.9	1765.5	796.3	448.7	9.3				7244.2
24	39G4	69.3	2922.4	558.4	820.3	427.7	292.4	1.3				5091.8
		1062.8	9767.3	2558.8	4334.8	2018.5	1111.2	17.9				20871.3

APPENDIX IV. A REVIEW OF DEPTH DEPENDENCE IN HERRING TARGET STRENGTH

WD to the ICES Planning Group on Herring Surveys (PGHERS),

IJmuiden, Dec 2000

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Introduction

The purpose of this literature survey was to give a brief overview of the published work and different hypotheses on the function of the herring swim bladder, a likely compression of the bladder with increasing water depth and its influence on the target strength of herring as obtained during hydroacoustic surveys. As these surveys contribute the most important fishery independent abundance and biomass estimates for the stock assessments (MacLennan & Simmonds 1992), any change of the evaluation strategy is likely to have an influence on the stock perception.

In common practice of survey data evaluation, the target strength (TS) is currently set to constant over the whole depth range and dependent only on the fish length (at a fixed frequency, see MacLennan & Simmonds 1992 for a review):

TS= m *lg* l+b, with m and b = constants and l = mean length of the fish.

Physical properties of the swim bladder

The swim bladder is responsible for about 90% of the backscattering strength of fish (Foote 1980), caused by the reflection on the layer between different densities. It is believed to be proportional to fish length. According to Boyle's law (pressure* volume = constant), one would expect a significant compression of the swim bladder of fish (to about 10 % of the volume and 21 % of the cross section at 100 m depth increase). This would result in a decrease in TS with increasing ambient pressure and thus water depth. Any tilt angle of the fish would further reduce the TS due to a reduction in cross section area (Olsen 1987).

Anatomy

A number of biological parameters also have significant influence on target strength. Some investigations have shown that the swim bladder is not behaving like an ideal ellipsoid. I.e., the volume of this organ is reduced irregularly with increasing pressure, rather in y than in x-axis (Blaxter et al. 1979). The remaining of the shape over a wide depth range will lead to a rather stable cross section. As the swim bladder often fills the dorsal space between inner organs of the fish, it could be feather shaped (e.g. cod, Ona 1990), and stomach and gut filling or gonad development are likely to have an additional influence on its shape (Ona 1990). However, none of these parameters and not even the direction of their influence on TS is predictable. In the case of herring, the swim bladder itself has a slight (positive) tilt angle in the fish's body (Blaxter et al. 1979, Blaxter & Batty 1990). This may increase TS with increasing (negative) tilt angle of the herring to a certain degree.

Physiology

It is common belief that the most important function of a swim bladder is to remain neutral buoyancy. If so, the fat content would have a significant impact on buoyancy and thus on swim bladder filling and TS at a given depth (Ona 1984, Ohlsen & Ahlquist 1989).

Physoclistous fishes like gadoids have a swim bladder that has no direct connection to the environment. These fishes are able to resorb gas from or excrete gas into the bladder over the course of hours or days to adapt to different water depths (e.g. Blaxter & Tytler 1978). Their target strength should be largely independent of water depth, at least if the fish is not forced to change depth during the measurement (see "behaviour" below). However, herring is a physostome (Brawn 1962, Blaxter et al. 1979, Blaxter & Batty 1984, Ona 1984, 1990): Its bladder has connecting pneumatic ducts to the gut and the exterior. Valve-like structures or sphincters exist to avoid gas loss, but as no glands or *rete mirabile)* could be found in connection with the swim bladder, it is believed that herring cannot actively regulate the gas content (Brawn

1962). These findings were supported by the phenomenon of gas release during diel vertical migration (Brawn 1962, Thorne & Thomas 1990), which resulted in a “boiling surface” and extended areas covered with white foam over large herring schools (Nøttestad 1998). Early investigations on tank-reared fish led to the “big gulp” hypothesis to explain the gas origin: herring would swallow air at the surface before descending to gain neutral buoyancy at greater depth (Brawn 1962, Blaxter & Batty 1984). Other hypotheses proposed a gas production during digestion in the gut and its subsequent transfer to the herring swim bladder as the main source of gas in the latter (Brawn 1962).

However, both hypothesis have a number of shortcomings. Firstly, if the fish would swallow air at the surface, it would have to overcome additional buoyancy during descent, and it could regulate the buoyancy only once per dive. This is highly inefficient from the physiological point of view. Secondly, fish would seriously increase the risk of predation by sea birds at the surface. Thirdly, gas release during ascent was also observed in populations which neither had access to the surface (min. depth ca. 40 m) nor were feeding over an extended period (Norwegian Spring Spawners during spawning time, Nøttestad 1998). At this point, the source of gas in the herring swim bladder and its capacity to regulate the filling has to be regarded as still unknown, in spite of numerous investigations on one of the best investigated fish species in the world.

Behaviour

One additional topic that introduces a large but hardly quantifiable variation in TS of herring is its behaviour. The latter is reflected in different tilt angles, which may either reduce TS additionally or conversely reduce or even compensate the influence of depth.

Compensation for reduced buoyancy (Fig. 1a): if herring is neutrally buoyant at the surface (and has no means to refill its swim bladder), then it has to compensate the negative buoyancy at greater depth with slightly upwards directed permanent swimming movements (Olsen 1987). This behaviour would reduce TS with increasing depth even further.

Feeding behaviour (Fig. 1b): herring feed visually on small prey items (Klinkhardt 1996), at least if sufficient light is available. One can imagine different adaptive behaviour at different depths: herring could exhibit a positive tilt angle at the surface, as prey items are easier to spot against the light surface. At greater depth, in darkness, it would not need to show this tilt angle, as the fish would have to rely on other than the visual senses. This behaviour would reduce the influence of depth on TS. On the other hand, one could find the opposite situation: There might be enough light in the surface waters to detect prey while swimming straight on, whereas reduced light at depth would force herring to approach food items from below, i.e. increase the tilt angle at depth and thus increase the assumed negative influence of depth on TS. This leaves the question of the influence of feeding behaviour on TS at depth completely unanswered.

Vessel avoidance (Fig. 1c): The problem of escape behaviour of herring when research or fishing vessels approach schools is well known in hydroacoustics (e.g. Olsen & Ahlquist 1989, MacLennan et al. 1990), and led to attempts in reducing the submarine noise of research vessels involved in the surveys. Fish is expected to show a negative tilt angle at the surface when the vessel comes close. No response would occur at greater depth. This behaviour would significantly increase TS with increasing depth.

Summing up (Fig. 1d), it can be stated that behaviour has an influence on TS at different depths. It might be possible that the different counteracting parameters rather result in an increase of TS with increasing depth, which could completely compensate for the influence depth has on TS due to the increase in pressure.

It was stated above that the main function of a swim bladder is to gain neutral buoyancy, and thus to save energy that otherwise would have to be spent for the compensation of negative buoyancy. However, this might not necessarily be valid for herring as a pelagic, permanently swimming fish. Other pelagic fish like mackerel completely lack a swim bladder. As the evolutionary sense in maintaining a physostome swim bladder seems unclear, one might speculate about other functions of this organ, that have meanwhile become more important. Blaxter et al. (1979) propose that the swim bladder mainly acts as a gas reservoir for the acoustico-lateral system, and Blaxter (1985) discusses the advantage of making rapid vertical movements in response to predators, if the swim bladder is not completely closed. Herring is known to release gas during predator attacks, which might reduce its detectability (Nøttestad 1998). So one possible purpose might be defence, analogous to the ink bladder in cephalopods. The gas content of the swim bladder might then be independent of depth – at least to a certain amount.

Experiments to quantify the influence of depth on swim bladder volume or TS

Early experiments were conduced mainly on aquaria or tank reared (Brawn 1962, Blaxter & Batty 1984) (and possibly highly stressed, Zhao 1996) or anaesthetised (Nakken & Olsen 1977) individual fish, which makes results hardly transferable to field situations (e.g. due to an unknown effect on the relaxation of the sphincters closing the swim bladder ducts). Some work was conducted *in situ* on herring groups, and it was carefully tried to reduce any kind of stress to the animals (Edwards & Armstrong 1983, Edwards et al. 1984, MacLennan et al. 1990), but still they were kept in rather narrow cages and acclimatisation time after a change of depth might have been too short to verify the different hypotheses on swim bladder regulation. Recent investigations focussed on fish either in large net cages (Zhao 1996) or on completely free-living fish in defined areas (like sheltered parts of fjords), by means of divers and underwater video cameras (Ona 1984) or special hydroacoustic equipment (Vaboe et al. 1999a, b, Ona et al. subm.).

Some authors found a clear depth dependency of TS and none of the behaviour (e.g. Halldórsson 1983), others stated the opposite (e.g. Olsen & Ahlquist 1989). A number of authors tried to construct equations to provide correction factors for the influence of depth on TS: Barange et al. (1994) for horse mackerel (no clear result), Halldórsson (1983) and Reynisson (1993) for Icelandic Summer Spawners, Olsen (1987), Huse & Ona (1995), Olsen & Ahlquist (1996), Zhao (1996), Vabø (1999a, b), Vabø & Huse (1999) and Vabø et al. (1999a, b) for Norwegian Spring Spawning herring (which might show differences in behaviour and physiology as compared with North Sea or Baltic herring). However, the influence of parameters that could balance or increase this influence of depth was rarely estimated comprehensively, and the results are still contradictory.

The most recent and promising results are not yet published: Ona et al (submitted) lowered a narrow-beam transducer into dense herring schools from a stopped (noiseless) and darkened ship during winter in a Norwegian fjord. Some thousand individual fish could be tracked with this method at different depth, and simultaneous observations of behaviour and tilt angle were possible. Length, body mass, age and gonado-somatic index were obtained from directed control hauls. The authors found that the directivity (tilt angle) of the fish did not dramatically change with depth, but also no clear reduction in TS with increasing depth could be observed. A graph showing the mean acoustic cross section as a function of depth (fitted to the non-linear regression of the swim bladder compression model) as well as an updated equation for the target strength including a correction factor for depth (valid for the whole depth range, 40-300 m) is provided in the paper; it will not be repeated here as the work is still under review. The compression rate was found to be significantly different from 0, but much smaller than expected from the compression model and with wide confidence intervals, mostly attributable to a high regional variability.

Conclusions

For the time being, different influences on TS seem to counteract and seem to reduce or even compensate each other. Ona (pers. com.) estimates, that each of the parameters may introduce an error in the order of 30% to the herring stock calculations. It is therefore recommended to continue the present practice of evaluating hydroacoustic survey data until there are more precise estimates of the influence of the different parameters available. A correction of one of the parameters (i.e. the reduction of backscattering strength with increasing depth of the target) without taking the counteracting parameters into account could even increase the possible error.

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Note that this list is far from being a complete register of the abundant literature published on this topic, but it contains a few additional references not cited in the text.

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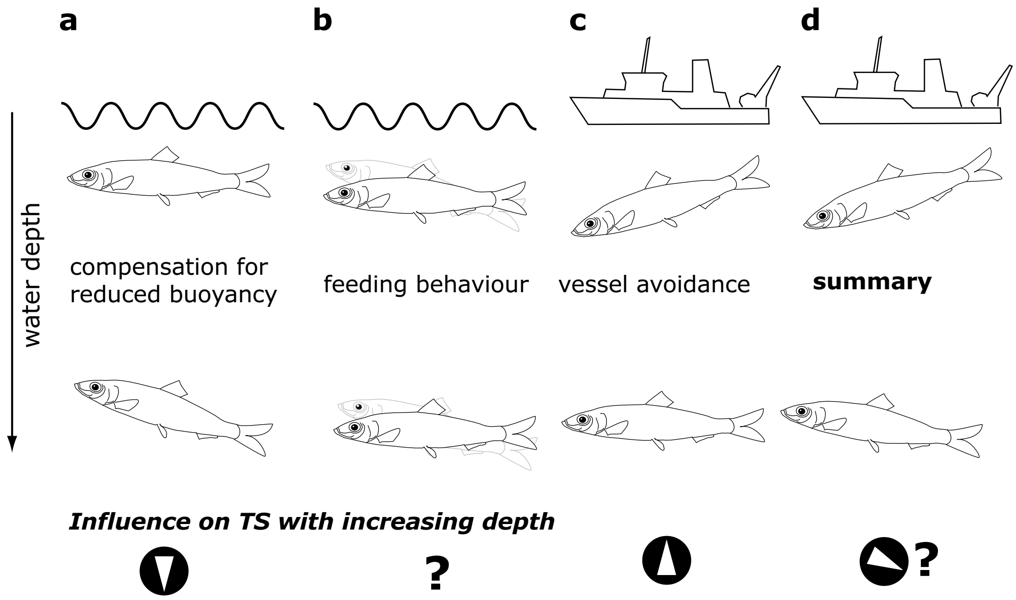

Fig 1: Possible influence of behaviour on target strength with increasing depth

Figure IV.1 See figure for legend.

APPENDIX V. A STUDY OF THE DEPTH DISTRIBUTION OF HERRING IN ORKNEY SHETLAND

Working Document to PGHERS Ijmuiden, Netherlands, December 2001

Not to be cited without prior reference to the author

Depth Distributions of herring in the North Western North Sea 1991-97

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Introduction

Following discussions at the meeting of PGHERS in Bergen January 2000, it was agreed that the problem of herring target strength (TS) variation with depth should be considered as a potential source of bias or variance. The abundance calculated from the acoustic surveys is used as an index rather than an absolute estimate. Therefore, it follows that provided there are no major or systematic changes in the depth distributions of the herring from year to year, there should be no major impact of depth on the abundance index. As a first step, I set out to determine if there was any evidence in recent years for important differences in the depth distribution of the herring. To quantify the impact of any differences observed I used the current best information on TS depth dependence (Ona *pers. comm*.) to estimate the scale of changes in the stock estimate which might be produced.

Materials and Methods

The data used in this analysis were from six years of surveys (1991 & 1993-97) by the Marine Laboratory on FRV *Scotia* in the Orkney Shetland area. The details of the surveys and their results are given in the combined survey reports. The surveys all covered approximately similar areas and were carried out with the same survey design (see Figs V.4-9). Acoustic data were collected using a Simrad EK500 38KHz. The digital data were archived in BI500 format. As part of the EU funded CLUSTER project the data were analysed using image processing methodology (Reid & Simmonds 1993) to extract a database of the herring schools and their associated descriptors (Reid *et al* 2000). These included, among others, school S_a, school depth and water depth.

The school database was then queried to provide the number of schools and the total S_a of those schools by 10m depth bins for each year. The query also provided water depth and position in the water column, as well as longitude and latitude. The data were also binned at one metre intervals to allow individual large S_a schools to be more obvious. Cumulative frequency distributions were then produced for each year along with the basic descriptive statistics for:

- S_a by school depth
- S_a by water depth
- S_a by school position in the water column.
- School number by school depth

The distribution of the schools and their associated S_a values were also post-plotted against bathymetry to provide a geographical context.

Any conclusions about the impact of differences in depth distribution between years can only be seen in context when considered together with the variation in TS with depth. No definitive data are available on the relationship between depth and TS for herring *in situ*. However, I was provided with some preliminary results from an EU project on variability of TS in herring.

The proposed equation (Ona pers. comm.) was:

$$TS = 20\log L - 64.3 - 2.9\log(1+ z/10)$$

Where:

TS is Target Strength in dB

L is fish length in cm

Z is the depth of the fish in metres

In terms of acoustic cross section (Φ) the equation becomes:

$$\sigma = X.10^{(-0.29\log 10(1+ z/10))}$$

Where:

X is equal to 20logL-64.3

From this it is possible to produce a scaling factor for depth, which can be used to correct the S_a values to show the impact of such a depth correction. The equation would thus become:

$$S_a corr = S_a,(1+ z/10)^{-0.2.9}$$

Where:

S_a is the pooled S_a for schools in a particular depth band

$S_a$corr is the S_a corrected for depth

This equation allows the production of a new survey integral scaled according to the depth distribution in each year.

Results & Discussion

The cumulative frequency distribution (in 10m bins) of the school S_a values is presented in Figure V.1. The bulk of the schools were found between around 60 to 160m deep. There were considerable differences in the pattern of depth distribution between years. The fish were found distinctly shallower in 1993 (median depth of 85m) than in 1991 or 1996 (median depths of 126.5 & 130m respectively). This represents a difference of 45m between extremes. There was no sign of trend in the time series over years.

A related question was whether this difference in depth distribution between years could be explained in terms of the behaviour of the schools. Figure V.2 shows the depth distribution pattern of the schools themselves (in 10m bins). A similar, though less marked pattern to that for the S_a values can be seen. Again, the schools are shallowest in 1993 (median = 103.5m) but were deepest in 1991 & 1997 (median = 128m). The year with the shallowest *fish* distribution (1993) also had the shallowest *schools*. The years with the deepest fish distribution (1991 & 1996) did not completely match the years with the deepest school distribution (1991 & 1997). 1997 had the deepest median school depth (128m), but a relatively shallow median fish (S_a) depth (99.5). The inference from this would be that, in relative terms, the deeper schools in 1997 tended to be smaller, and the shallower schools were larger than in other years.

Herring schools in this area tend to be found in the deeper part of the water column, close to or in contact with the seabed. One possible cause for the differences in depth distribution would be changes in the *spatial* distribution, with the fish being found in areas of deeper water, and so actually deeper, in some surveys. Figure V.3 shows pattern of distribution of herring S_a in relations to the water depth rather than the depth of the schools themselves. The pattern is very similar to that for S_a depth distribution. In 1993 the fish were in shallower water and in 1991 & 1996 they were in deeper water. This suggests that generally the herring will aggregate at the bottom of the water column, and if the water is deeper, then so will the fish be. This was borne out by an examination of the spatial distribution of the schools and their S_a values presented in Figures V.4 – V.9. In 1993 (Fig V.5) there were a lot of fish inside the 100m contour, particularly in the area south and west of Shetland. In 1991 (Fig.V.4) there were very few schools seen in this area or inside the 100m contour. A similar pattern was seen in 1996.

While it is clearly generally true that herring aggregate close to the seabed , there are variations between years. Figure V.10 shows the distribution of S_a in relation to the depth of the school in the available water column. In four years (1991, 1993, 1994 & 1996) the fish showed a very similar pattern, with the bulk of the fish occupying the lowest 20% of the water column. In the other two years (1995 & 1997) the fish were distributed higher up the water column. 1995 appeared as a median year in most other respects, but 1997 was the year in which the schools had a median depth distinctly shallower than the median depth of the fish.

The median values for the distributions presented in Figs V.1-3 & V.10 are given in Table V.1 below.

Table V.1 Median values by year for the depth distribution of herring

Median values	1991	1993	1994	1995	1996	1997
S_a by School depth	126.5	85.0	101.5	109.0	130.0	99.5
School count by school depth	128.0	103.5	106.0	111.0	123.0	128.0
S_a by water depth	128.0	85.0	107.0	120.0	133.0	108
S_a by water column position	0.962	0.923	0.941	0.875	0.942	0.875

The main purpose of the present analysis was to determine if there was any substantial evidence of depth distribution changes in these surveys, and whether this might have a major impact on their precision. The above analysis has shown that there are substantial differences in depth distribution between years (median values between 85 and 130m). The preliminary equations for TS depth dependency (above) were used to determine the potential impact of these changes on the stock estimate from the survey. The results are presented in table 2 and against year in Figure V.11. The results were scaled to the long-term mean for the six surveys, and suggest that variation in fish depth would introduce a maximum variability of ∀4% to the stock estimate. It should be emphasised that the equations used were preliminary. They were calculated for a different herring stock, and the equation used here was a preliminary result from ongoing studies.

Table 2 Results of depth correction for S_a

	1991	1993	1994	1995	1996	1997
Total S_a (uncorrected for depth)	331401	374005	277816	382409	963168	494856
Total S_a (corrected for depth)	157018	191779	138625	191951	460841	246776
Total S_a (mean depth corrected)	163611	184644	137156	188793	475510	244307
In year deviation from mean (%)	4.03	-3.86	-1.07	-1.67	3.09	-1.01

Conclusion

There were distinct differences in the pattern of depth distribution of the herring seen on the acoustic survey over the years studied, in terms of:

- Biomass (S_a)
- School depth.
- Water depth
- Water column position

Based on preliminary TS depth dependence equations provided by Egil Ona, the impact of the interannual differences would be in the range of plus or minus 4% of the stock estimate.

Acknowledgements

I am grateful to Dr Egil Ona for providing the TS depth dependence equation and Mr John Simmonds for interpreting it for me. The data used in this analysis were collected and archived as part of the EU funded CLUSTER project.

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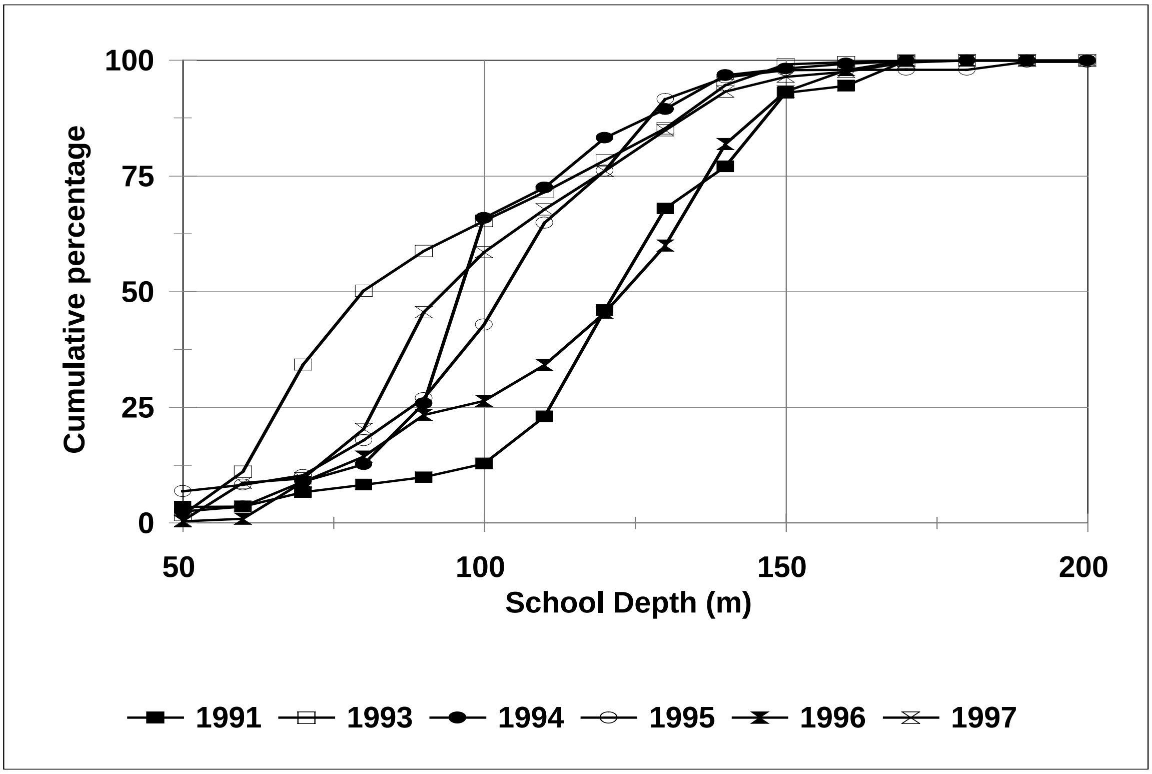

Figure V.1. Cumulative frequency distribution for S_a against depth of school in 10m bins 1991-1997.

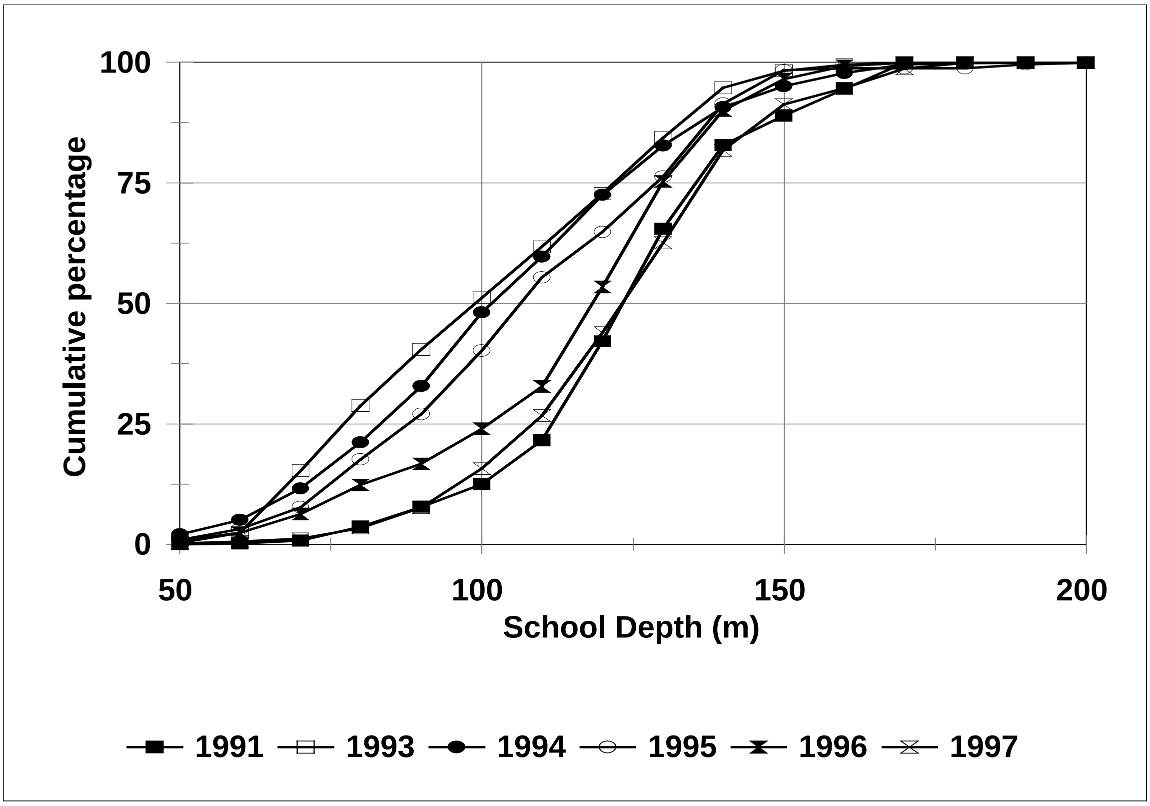

Figure V.2. Cumulative frequency distribution for school number against water depth in 10m bins 1991-1997.

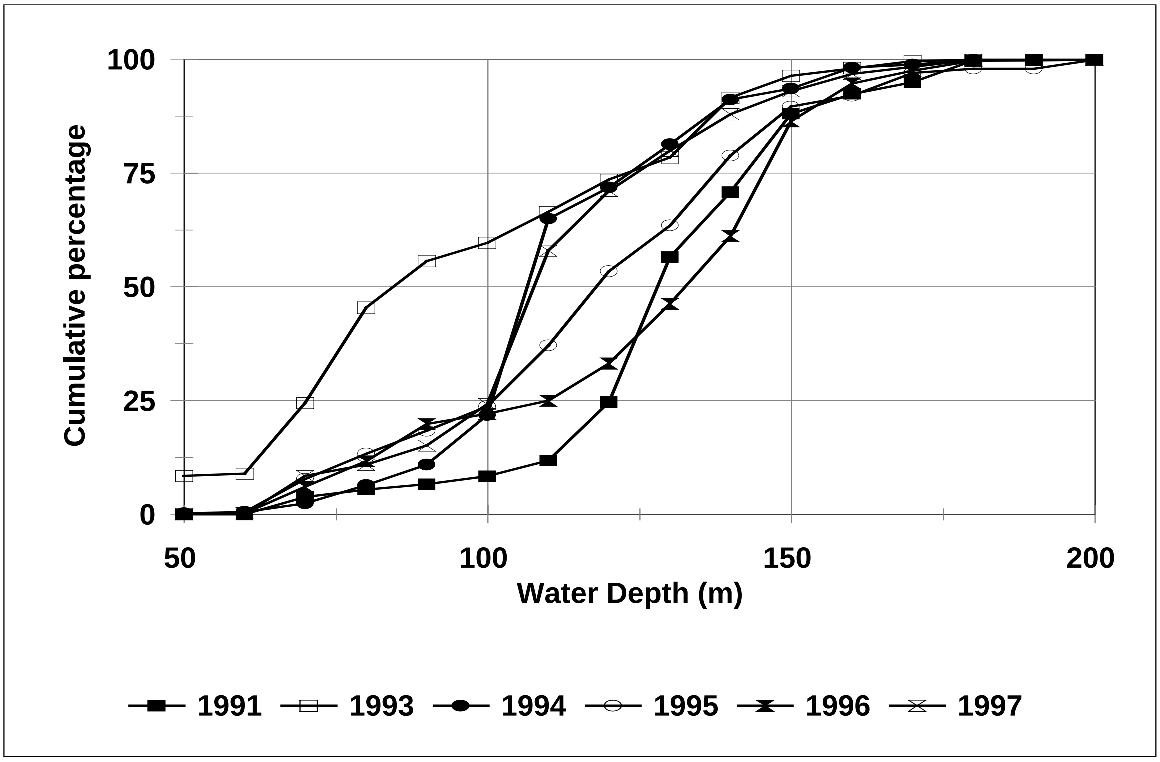

Figure V.3. Cumulative frequency distribution for S_a against seabed depth 1991-1997.

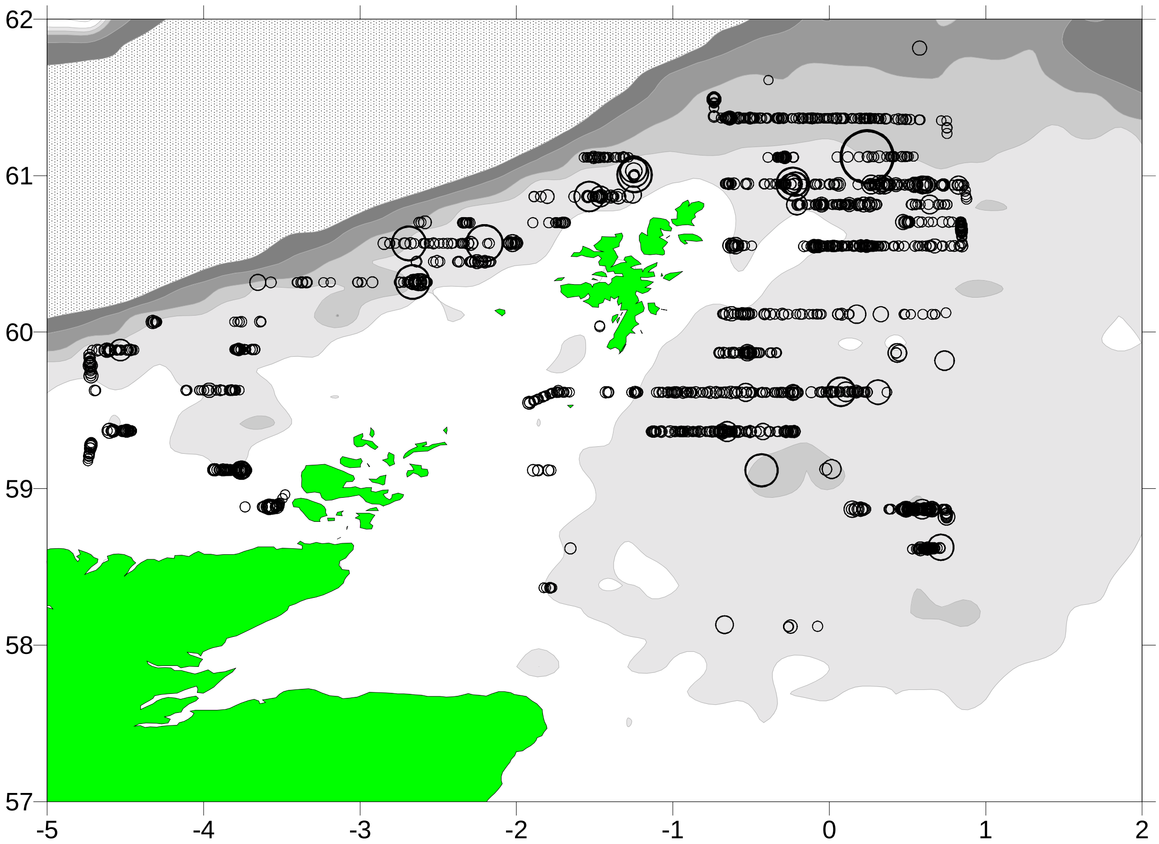

Figure V.4. Herring school distribution from the acoustic survey July 1991. Circles are root scaled to the maximum value.

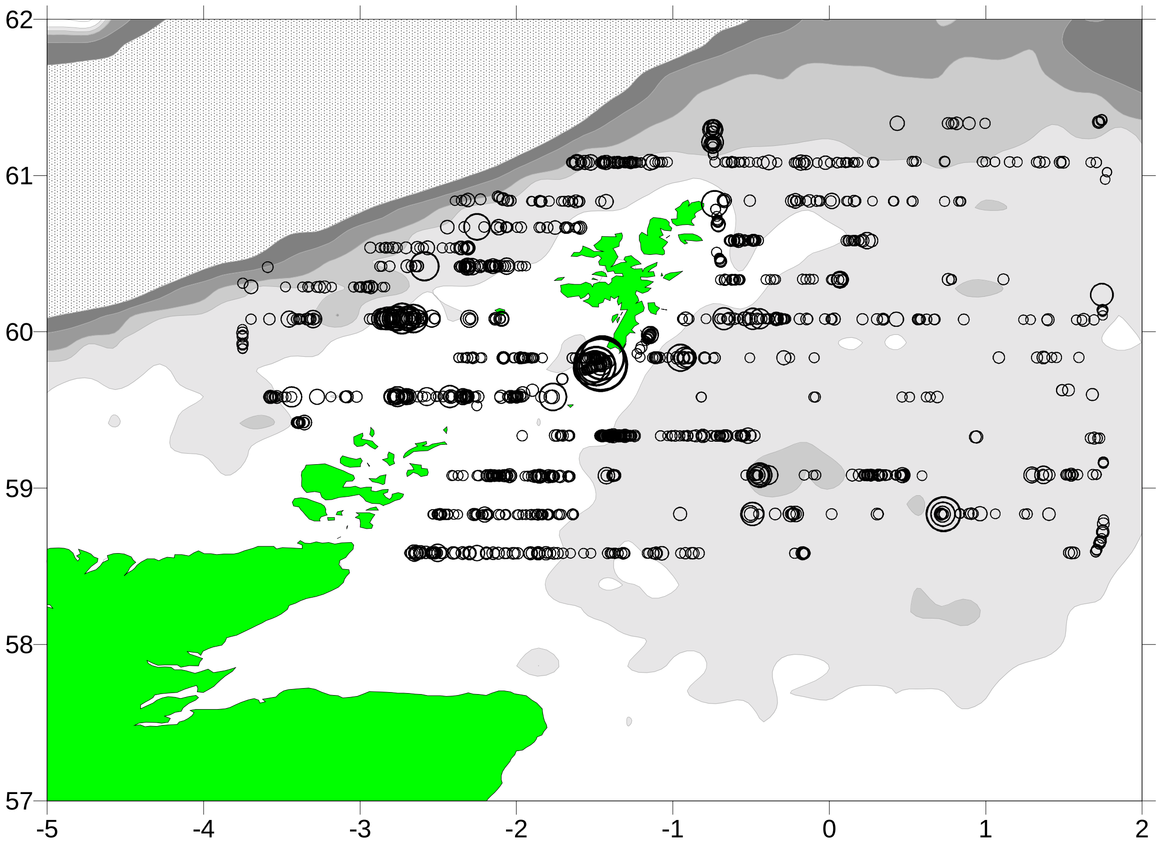

Figure V.5. Herring school distribution from the acoustic survey July 1993 Circles are root scaled to the maximum value.

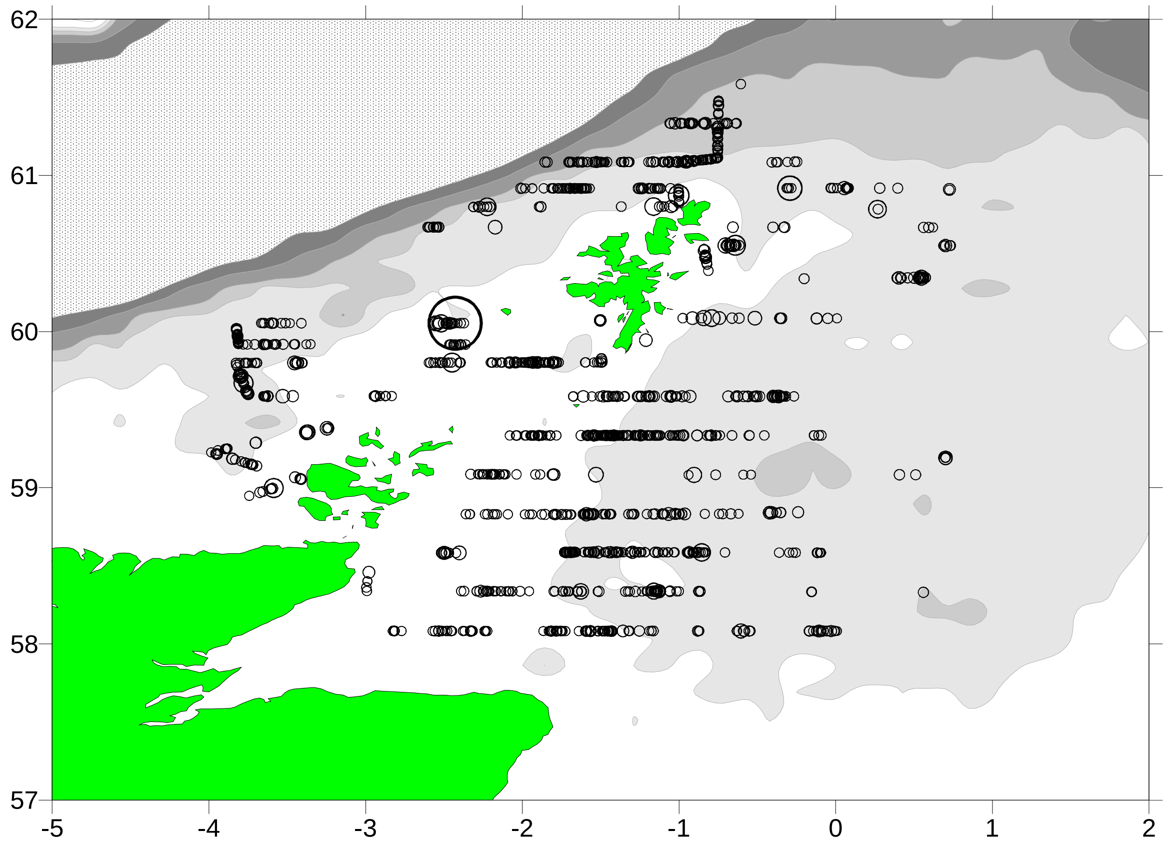

Figure V.6. Herring school distribution from the acoustic survey July 1994 Circles are root scaled to the maximum value.

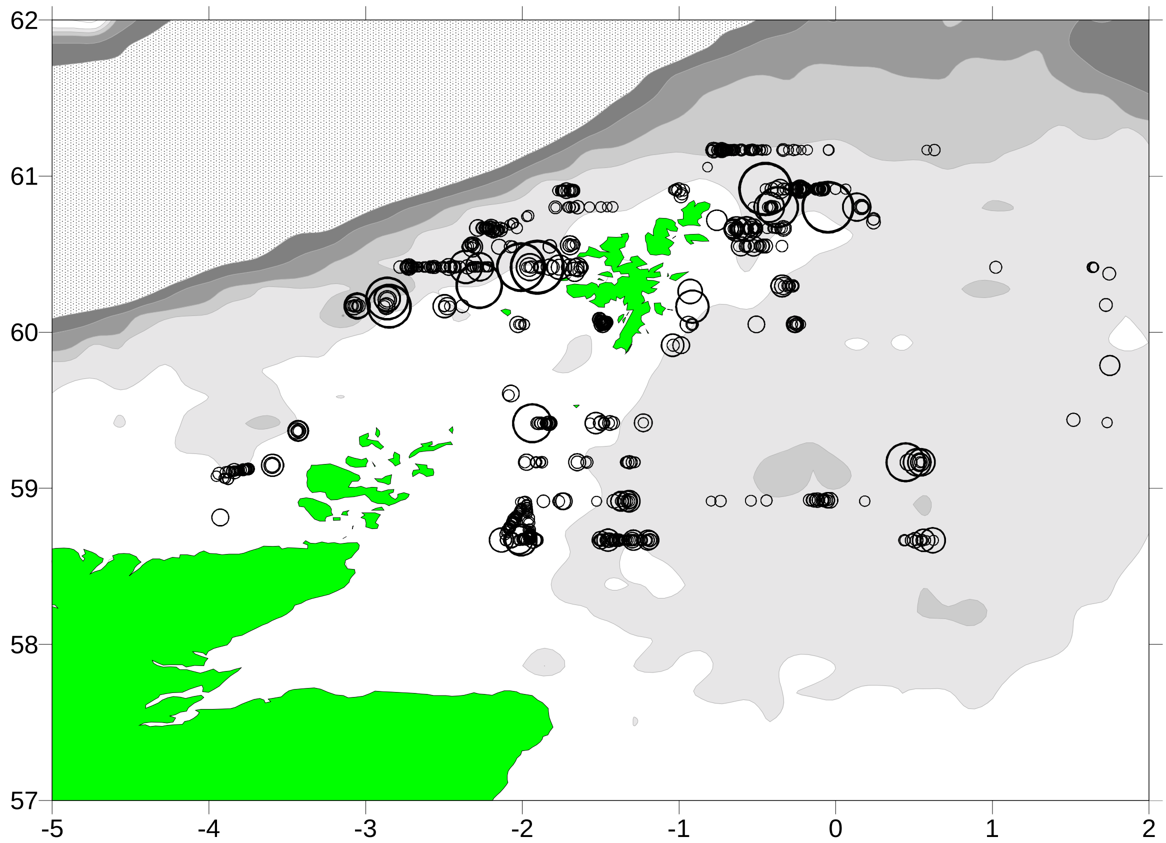

Figure V.7. Herring school distribution from the acoustic survey July 1995 Circles are root scaled to the maximum value.

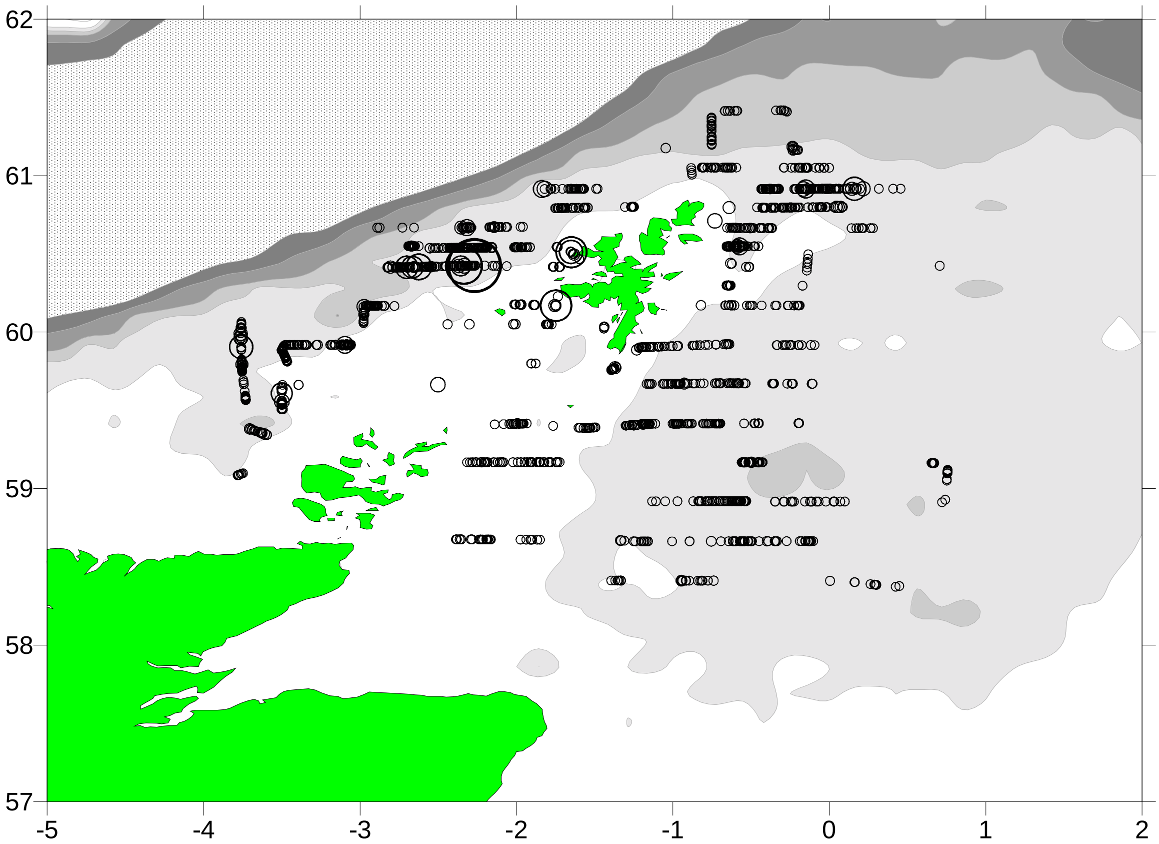

Figure V.8. Herring school distribution from the acoustic survey July 1996 Circles are root scaled to the maximum value.

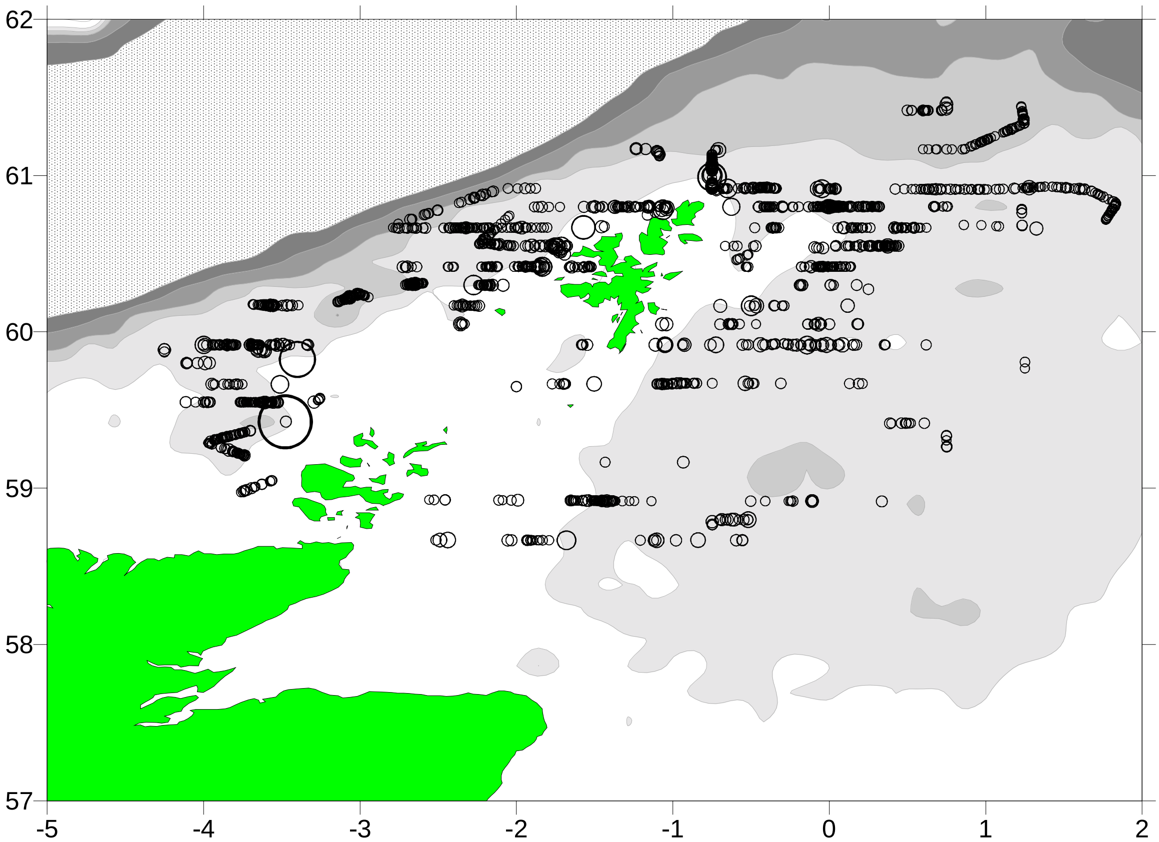

Figure V.9 Herring school distribution from the acoustic survey July 1997. Circles are root scaled to the maximum value.

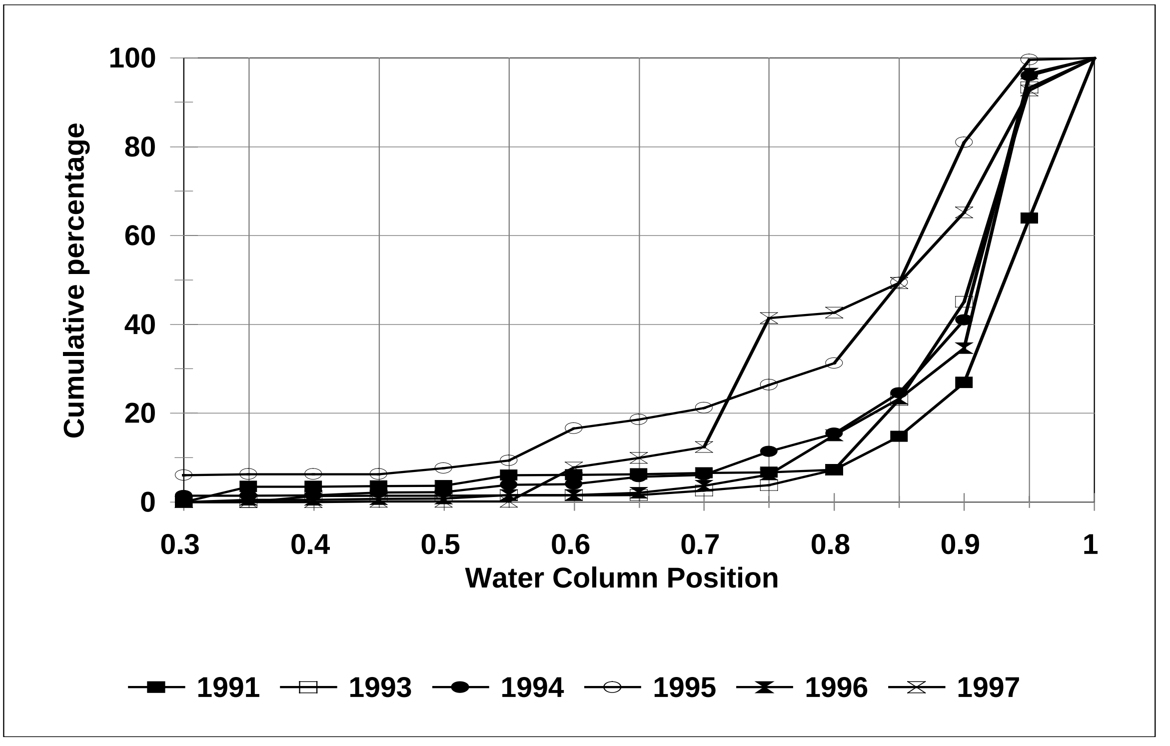

Figure V.10. Cumulative frequency distribution for S_a against water column position 1991-1997. Water column position is represented as a proportion of the school depth to the seabed depth under the school.

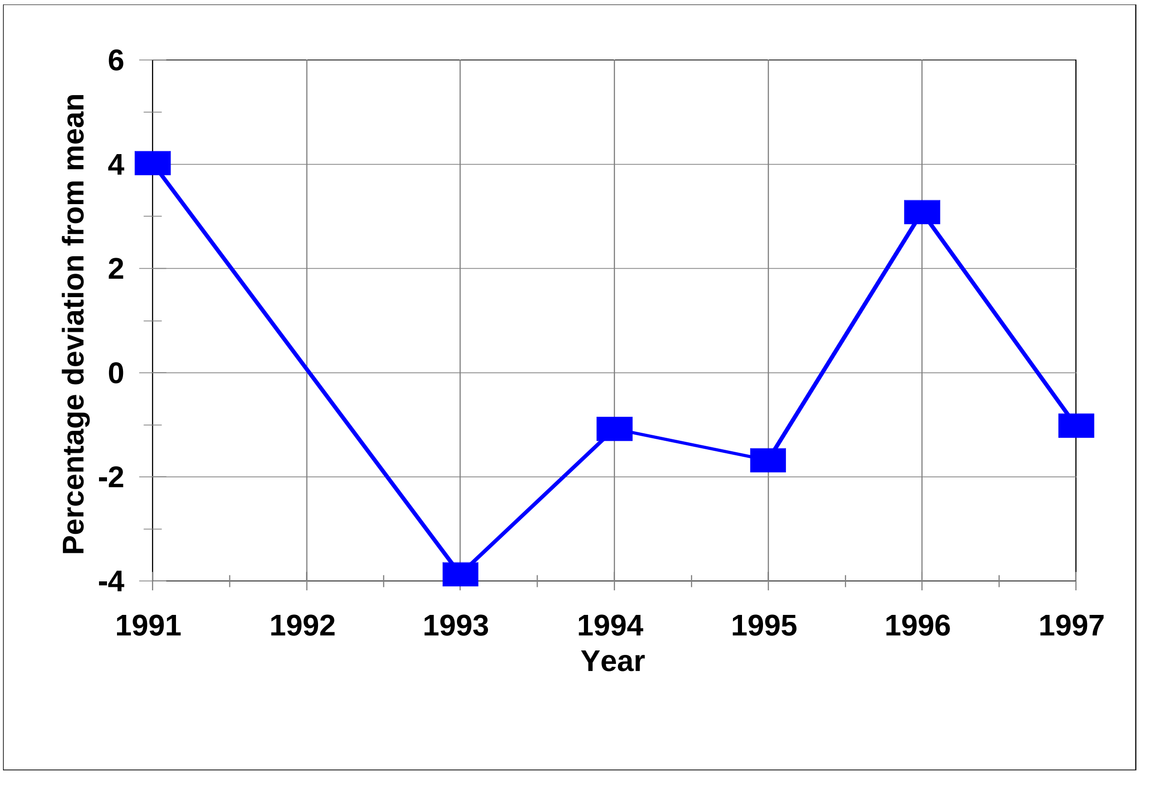

Figure V.11. Deviation of year by year corrected values for total S_a from mean corrected values (expressed as a percentage of the corrected value for that year).