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REPORT OF THE

Planning Group for Herring Surveys

Hamburg, Germany
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International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

PGHERS 2002 EXECUTIVE SUMMARY

1. **TERMS OF REFERENCE.** According to C.Res. 2001/2G01 the Planning Group for Herring Surveys [PGHERS] (Chair: P. Fernandes, U.K., Scotland) met in Hamburg, Germany from 10–14 December 2001 to:

a) co-ordinate 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 in 2002;

b) combine the survey data from 2001 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.

2. **REVIEW OF LARVAE SURVEYS IN 2001/2002.** At the time of writing three of the six surveys in the North Sea remained to be carried out in December 2001 and January 2002. Results will be ready for the Herring Assessment Working Group (HAWG) meeting in March 2002. Estimates from Western Baltic larvae survey in the Greifswalder Bodden area are given from 1992-2000.

3. **OUTCOME OF DOUBLE AREA COVERAGE ON LARVAE ABUNDANCE ESTIMATION.** In the 2000 period, double area coverage was undertaken in some areas of the North Sea. The assumption that double sampling would result in a more stable estimate of LAI was not valid in this particular case due to the absence of newly hatched larvae in the second survey. As a general conclusion it would seem preferable to cover the whole spawning period and to sample during major peaks in spawning instead of double sampling within the same period.

4. **CO-ORDINATION OF LARVAE SURVEYS FOR 2002/2003.** In the 2002 period, the Netherlands and Germany will undertake 7 larvae surveys in the North Sea from 1 September 2002 to 31 January 2003. The herring larvae survey in the Greifswalder Bodden (Baltic Sea) will be conducted from 23 April to 28 June using the FRV *Clupea*.

5. **NORTH SEA ACOUSTIC SURVEYS IN 2001.** Six acoustic surveys were carried out during late June and July 2001 covering the North Sea and west of Scotland. A small part of the area was not surveyed in 2001: abundance in this area was estimated from a linear interpolated value from adjacent rectangles. The total combined estimates of North Sea spawning stock biomass (SSB) are 2.4 million t, an increase from 1.7 million t in 2000. The survey shows exceptional numbers of 2-ring herring (the 1998 year-class). The estimate of Western Baltic spring spawning herring SSB is 99,000 t, a decrease since 2000 (196,000 t). The west of Scotland SSB estimate is 327,500 t (down from 443,850 t). The surveys are reported individually in Appendix II.

6. **WESTERN BALTIC ACOUSTIC SURVEY IN 2001**. A joint German-Danish acoustic survey was carried out with R/V *Solea* from 28 September to 15 October in the Western Baltic. The total number of herring was 9,800 million and the total for sprat 8,700 million. A full survey report is given in Appendix III.

7. **INTERCALIBRATION BETWEEN FRV *SOLEA* AND FRV *WALTER HERWIG III*.** These fisheries research vessels conducted an intercalibration of acoustic equipment on 11 July 2001. The main targets were very small but dense shoals of sprat. Acoustic values for the two vessels were not significantly different, suggesting that the systems on board these ships are not operating in an inconsistent manner.

8. **SURVEY OVERLAP BETWEEN FRV *SCOTIA* AND FRV *MICHAEL SARS*.** A provisional analysis of acoustic data from an extended area overlap between these vessels indicated that the Scotland/Norway ratio of acoustic values allocated to herring in these areas was about 2 in the northern area and 1.50 in the southern area. This is most likely due to differences in scrutinising, as the two sets of results are based on data from different fishing patterns. Additional survey overlaps will take place in the Shetland area in 2002 to conduct an intercalibration of pelagic and bottom trawls.

9. **SPRAT.** Data on sprat were only available from *RV Solea*, *RV Tridens* and *RV Dana*. The total sprat biomass estimated was 200,000 t in the North Sea and 8,000 t in the Kattegat. The distribution pattern demonstrates that the southern border was still not reached. The group recommends that the coverage in the south be maintained as it expects this to be a precondition for a sprat index in the future.

10. **CLUPEA.NET.** The clupea website (http://www.clupea.net) has been updated with stock specific data for north east Atlantic stocks following the ACFM spring session. A new brief Biology section was also added. A number of additions are planned.

11. **ACOUSTIC SURVEY MANUAL REVISION**. A review was made of the current acoustic survey manual to cover recent changes in definitions and symbols, acoustic survey reporting formats, gear details, and confirmation that age of autumn spawning herring should be expressed as winter rings, whereas spring spawning herring and sprat should be expressed as age class. The revised manual is attached as Appendix IV.

12. **HERSUR DATABASE.** An update on the status of the HERSUR project was presented to the group. During 2001 the conversion of data from national acoustic survey formats to HERSUR Formats was carried out and data has now been uploaded to the HERSUR database. It is now possible to send data by e-mail. The HERSUR website has been restructured and the exchange format has been revised. A number of report types are now available (sample reports are given in Appendix V).

13. **MEASUREMENT OF THE BAND FILTER DELAY OF THE EK500**. During the 2001 survey of FRV *Walther Herwig III* the filter delay of the Simrad EK500 echosounder was measured. The study demonstrates that the necessary delays have not been introduced to the EK500 despite previous identification and assurance that they would be dealt by the manufacturers. This issue remains one of concern and merits further thought and investigation by PGHERS over the course of the coming year.

14. **CO-ORDINATION OF ACOUSTIC SURVEYS IN 2002**. Six acoustic surveys will be carried out in the North Sea and west of Scotland in 2002 between 21 June and 26 July. Participants are referred to Figure 12 for indications of survey boundaries. *Scotia* and *G.O. Sars* will survey an overlapping area to the east of Shetland. *Walther Herwig III* and *Tridens* will intercalibrate. A survey of the western Baltic and southern part of Kattegat, will be carried out by *Solea* from 26 September to 17 October.

15. **FUTURE PLANNING OF ACOUSTIC SURVEYS IN THE NORTH SEA**. In recent years participating nations in the North Sea acoustic survey have been restricted to national waters or areas close by. As a result, some areas have a much higher biomass to sampling ratio than others. The survey should be redesigned to make the best use of the vessel resources available and the first implementation should be in the summer of 2003. In addition, it was noted that areas not surveyed in recent years may actually need to be covered in 2002 due to the substantial expansion of the stock.

16. **MATURITY DETERMINATION.** There are at least two different maturity scales used by participants in the North Sea acoustic survey: an 8 and a 4-point scale. A conversion table for these scales is given in Table 7. Small mistakes in maturity determination highlighted the need for consistent measurements between participants. In the 2001 surveys digital photographs of herring were collected to show the various maturity stages, but images were only comparable under ideal conditions. The best approach to harmonising maturity determination would be by means of a workshop. The possibility of organising this at sea in conjunction with the 2002 surveys will be investigated.

17. **HERRING OTOLITH EXCHANGE**. A herring otolith exchange was carried out with at least 150 otoliths circulated among 8 readers from 6 nations. The measured ages were analysed using modal length as the reference age with no prior allocation of reader performance and equal weight for all readers. The accuracy revealed relatively good results: while there were statistically significant differences between readers there was only one reader with statistically significant differences between the modal age and estimated age. Intra-national variation was very much less than the inter-national variation, suggesting that there is scope for improvement by increasing the contact between staff who age herring. The HAWG should consider whether an ageing workshop is required.

18. **SPRAT OTOLITH EXCHANGE.** A sprat otolith exchange is in progress and some preliminary results of readings were presented. There are indications of disagreements in the ageing of larger and older sprat and it is recommended that age readings of sprat otoliths be part of a combined herring/sprat age-reading workshop next year. In a separate exercise, 717 herring otoliths were circulated among 7 readers from 4 nations with the objective of verifying the species. Uniform agreement on the species origin of the otolith occurred for only 67% of otoliths.

19. **THE EFFECT OF TIME OF DAY ON THE ACOUSTIC DETECTION OF HERRING**. In the North Sea during summer, herring generally occur as schools by day near the seabed and at night disperse, rising into surface waters. Image analysis of six years of acoustic data from the Orkney-Shetland survey was used to extract the number of schools and descriptors such as length and height. A model describing how these parameters vary with time of day was devised. The times of school dispersal (upward migration) and school aggregation (downward migration) derived from the model were within 7 minutes of sunset and sunrise times (respectively) calculated from astronomical algorithms. The survey data were truncated to contain only values collected when the herring were fully available to the survey and the abundance recalculated. The results indicate that the behaviour does not have a consistent effect on the estimation of abundance from the survey. Examination of the acoustic data attributed to herring reveals that herring can be detected in those hours adjacent to the start and end of the DVM, although at these times values are lower than average. Further such analyses are required and PGHERS will carry this item onto next years meeting by which time other participants will prepare similar analyses on their acoustic data.

20. **RECOMMENDATIONS - 2003 MEETING.** PGHERS should meet, at a venue to be decided, from 21 to 24 January 2003 under the Chairmanship of P.G. Fernandes (UK, Scotland) to:

a) combine the 2002 survey data to provide estimates of abundance for the population within the area;

b) consider a re-allocation of effort by participating countries in the acoustic survey of the North Sea and adjacent waters in 2003;

c) co-ordinate 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 in 2003;

d) evaluate the outcome of a maturity staging workshop with a view to harmonising the determination of maturity in herring and sprat;

e) evaluate investigations on the effect of time of day on the allocation of herring to acoustic data.

21. **OTHER RECOMMENDATIONS:**

a) Strong efforts should be made to exchange staff between nations in the North Sea acoustic survey.

b) An area overlap between *Scotia* and *G.O. Sars* should be surveyed in 2002 to include ICES rectangles 49E9, 49F0, 50E9 and 50F0 with a spacing of no more than 7.5 n.mi.

c) Maturity determination in herring and sprat should be standardised (perhaps through a workshop).

d) Due consideration should be given to establishing a sprat, herring 0-ring and herring 1-ring index from the acoustic survey. A preliminary justification study will be prepared for the 2002 HAWG.

e) A review should be made of existing documentation on practical aspects of larvae survey methods.

f) The issue of inadequate survey coverage during the October survey on Baltic spring spawning herring needs to be addressed by the HAWG.

g) A workshop to determine the age of herring and sprat from otoliths should be held in summer 2002. This recommendation will be submitted to the HAWG for further consideration and to invite any other interested parties (e.g. Republic of Ireland and Northern Ireland).

h) The Planning Group recommends that a revised series of herring autumn spawning stock biomass from the acoustic survey be submitted to the HAWG 2002 to account for the (small) differences in maturity reading in 1998-1999.

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   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.

PGHERS will make its report available to HAWG and to the Resource Management and Living Resources Committee at the 2002 Annual Science Conference.

2 PARTICIPANTS

Eckhard Bethke	Germany
Bram Couperus	The Netherlands
Paul Fernandes (Chair)	UK (Scotland)
Eberhard Götze	Germany
Soenke Jansen	Germany
Dave Reid	UK (Scotland)
Norbert Rohlf	Germany
John Simmonds	UK (Scotland)
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Else Torstensen	Norway
Christopher Zimmermann	Germany

Contact details for each participant are given in Appendix I.

3 HERRING LARVAE SURVEYS

3.1 Review of Larvae Surveys in 2001/2002

3.1.1 North Sea larvae survey

At the time of writing it was not possible to give a full review of the larvae surveys, because they had not been completed. Three surveys in the southern North Sea remained to be carried out in December 2001 and January 2002. In the reporting period, only The Netherlands and Germany participated in the larvae surveys. A total of six units and time periods will be covered in the North Sea during the 2001 period. They are given in the following table:

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

* these periods remain in the reporting period 2001

In a change to the original plan, the first unit in the Buchan area, which should have been sampled during the autumn survey of Germany, was cancelled. Due to severe engine trouble the scheduled research vessel was not ready for action and the available ship time on a replacement vessel was only a few days. The programme had to be cut down and therefore only the Orkney/Shetland area could be covered sufficiently. As the surveys are still in progress, analysis is ongoing in order to be ready for the Herring Assessment Working Group (HAWG) meeting in March 2002.

3.1.2 Western Baltic larvae survey

The most important spawning ground of spring-spawning herring in the western Baltic Sea is the Greifswalder Bodden area in German coastal waters. This is located in ICES Sub-division 24 and has an area of 510.2 km^2 and a mean depth of 5.8 m. In 1977 a German effort to monitor the herring larvae started in this area with the aim of delivering an index of year class strength for this stock which then migrates into sub-divisions 22-24 and Division IIIa. Since then the same sampling method, strategy and station grids have been used to provide an index of year class strength of the spring-spawning herring stock in the western Baltic Sea. Each year up to 10 cruises are carried out during the whole spawning season. Currently the FRV *Clupea* typically samples 35 standard stations from March/April to June during daylight. Samples are taken with a bongo net (diameter: 600 mm; mesh size of both nets: 0.315 mm, since 1996 Hydro-Bios bongo nets with a mesh size of 0.335 mm have been used) using double oblique tows at a speed of 3 knots. For each cruise the number of larvae per length-class is estimated for the total area according to Müller & Klenz (1994). To estimate year class strength, the number of larvae with a mean total length >= 30 mm (related to the number of age group 0 of the herring stock in Sub-divisions 22-24 and Division IIIa) were calculated, taking growth and mortality of the larvae cohorts into consideration (Klenz 2000).

The estimated numbers of larvae for the period 1992 to 2000 are summarised in Table 1. Compared to the previous two years of very high estimates, the 2000 estimate of the larvae index dropped to a very low level.

3.2 Outcome of double area coverage on larvae abundance estimation

In the 2000 period, double area coverage waas undertaken in the Orkney/Shetland (Germany and Norway) and Buchan (Netherlands and Norway) areas in the second half of September 2000. The abundance of small larvae (less than 10 mm) in the Buchan area was low and their distribution pattern did not, at first, seem useful for comparative purposes. However, in the Orkney/Shetland area the German survey took place from 17 September to 27 September whilst the Norwegian survey was carried out from 23 September to 28 September. The abundance of larvae in the relevant size range for the estimation of LAI (total length <10 mm) is significantly different between surveys (Table 1) and the distribution pattern of these small larvae is also different (Figure 1). The corresponding length-frequency distribution shows lower quantities of small-sized larvae in the Norwegian survey, indicating that spawning may have been completed and that no more newly hatched larvae contributed to the distribution (Figure 2).

If the time lag between both surveys is considered, continuous growth will shift the larvae to different size groups. The distribution pattern of larger larvae (Figure 3) shows a generally better spatial overlap, regardless of the difference in total numbers. To account for the temporal shift, the time lag between the double sampling was calculated for each specific station (range of 0 to 11 days). The general assumption was made that growth and mortality is the same for all size classes and stations: mortalities (z) and growth rates (k) were chosen as the mean values from 1980 – 1992 ($z = 0.14$, $k = 0.35$ $mm.day^{-1}$). These factors were added to the catch of the German survey and the resulting length-frequency distribution was calculated (Figure 4). This distribution was in good agreement with the Norwegian one indicating that there was no general bias in the field sampling, e.g. underestimation of small-sizes larvae. The differences reflect the impact of growth and mortality taken place between both samplings and particularly the fact that that there is no upcoming component of newly hatched larvae.

An artificial distribution pattern was calculated for the “grown” larvae, derived from the German survey, and compared to the Norwegian one (Figure 5). The patterns still do not show a good overlap, only the peaks are located in the same area. This is, however, not surprising given the likely influence of drift and currents on the larvae distribution, which are not included in the estimations.

The difference in the LAI between the surveys is likely to be explained to a large extent by the impact of growth and mortality. The assumption that double sampling would result in a more stable estimate of LAI is not valid in this particular case due to the absence of newly hatched larvae in the second survey. This shows the importance of complete coverage of the spawning period. As a general conclusion it would seem preferable to cover the whole spawning period and to sample during major peaks in spawning instead of double sampling within the same period.

3.3 Co-ordination of Larvae Surveys for 2002/2003

In the 2002 period only the Netherlands and Germany will participate in the larvae surveys. At the time of writing the cruise plans of the institutes involved are not fixed, a preliminary survey schedule for the 2002 period is presented in the following table:

Area / Period	**1–15 September**	**16–30 September**	**1–15 October**
Orkney / Shetland	--	Germany	
Buchan	Germany	Netherlands	
Central North Sea	--	--	Netherlands
	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 23 April to 28 June using the FRV *Clupea*.

4 ACOUSTIC SURVEYS

4.1 Review of acoustic surveys in 2001

4.1.1 North Sea and west of Scotland acoustic survey

Six surveys were carried out during late June and July covering most of the continental shelf north of 54°N in the North Sea and 56°N to the west of Scotland to a northern limit of 62°N. The eastern edge of the survey area was bounded by the Norwegian, 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 6. The surveys are reported individually in Appendices IIa-f. 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.

A part of the area comprising the five rectangles 45E7, 45E8, 45E9, 45F0 & 45F1 from 4°W to 2°E and latitude 58° to 58°30' N was not surveyed in 2001 (Fig. 7). While this is not a critical part of the area, an analysis of historical data (1988-2000) indicated that it could contribute up to 5% to the total biomass of the combined survey. On previous occasions, unsurveyed areas were thought to contribute less than 1% of the total and were, therefore, ignored. This year there is potential for the unsurveyed area to cause bias and so it was deemed important to fill in the area with an estimate of abundance. However, as there is no established method for filling in missing in data, the following set of alternatives were examined:

1. An average proportion of abundance in the missing area relative to that of the whole area. In this area, the average biomass over the 12-year period is 4.6% of the total biomass. Applying the same proportion gives an estimate of 154,000 t in 2001.

2. A median factor of the mean density in the area to the mean density derived from adjacent connecting rectangles (5 north, 5 south and one to the east) over the 12-year period. The median density factor is 1.18 which gives an estimate of 211,000 t in 2001.

3. A linear interpolated value from the adjacent 4 connecting rectangles in 2001. This is similar to kriging when the data is on a regular grid and gives an estimate of 178,000t in 2001.

Option 3 lies almost exactly half way between the other two options so has been chosen as a compromise. This result contributes an additional 5.5% to the overall North Sea abundance for the remaining fully surveyed area. The immature and mature proportions are similar at 5.5 and 5.6% respectively.

Provisional estimates of the three stocks surveyed (including the fill in) are shown in Tables 3a-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 later prepared as an ICES paper. The estimates of North Sea spawning stock biomass (SSB) are 2.4 million t and 15,000 million herring, an increase from 1.7 million and 8,400 in 2000. The North Sea survey is consistent with previous years, giving a total adult mortality of about 0.4 over the last 3 years, which is similar to the estimates from the assessment (0.5). The survey also shows exceptional numbers of 2-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 2001a). The acoustic survey indicates that the abundance of this year class is four times that of the preceding (1997) year class. This ratio was also observed last year when these were 2 and 1 wr herring. The estimates of Western Baltic spring spawning herring SSB are 99,000 t and 774 million, a decrease in SSB since 2000 from 196,000 t; this is typical of the survey estimates of this stock which have shown fluctuations with a general increasing trend. The west of Scotland survey estimates of SSB are 327,500 t and 1.9 million, and indicates that the 1995 year class is large once again. The incoming 2 wr recruiting year class is relatively large.

4.1.2 Western Baltic

A joint German-Danish acoustic survey was carried out with R/V *Solea* from 28 September to 15 October in the Western Baltic. This survey is traditionally co-ordinated in the International Acoustic Survey for Pelagic Fish Stocks in the Baltic Sea. It was planned to cover the whole sub-divisions 21, 22, 23 and 24, however, permission to enter the Swedish 12-mile zone was not given despite early application. As a result sub-division 23 and parts of sub-division 21 and 24 could not be surveyed. As in previous years, the survey was carried out during the night. An EK500 echosounder and BI500 Bergen Integrator software were used to collect acoustic data. The cruise track covered a length of 882 nautical miles. A total of 47 trawl hauls were carried out and from each haul sub-samples were taken to determine length, weight and age of fish. In general the catch composition was dominated by herring and to a lower extent by sprat. The total number of herring was 9,800 million and the total for sprat 8,700 million. An area breakdown is given in Table 4. A full survey report is given in Appendix III.

4.2 Intercalibrations and survey overlaps

4.2.1 Intercalibration between FRV Solea and FRV Walter Herwig III

The fisheries research vessels *Solea* (Germany) and *Walther Herwig III* (Germany) conducted an intercalibration of acoustic equipment on 11 July 2001 at ICES rectangles 37F7 and 37F8. Both ships were equipped with a SIMRAD EK500 echosounder with a hull mounted split beam transducer on *Walther Herwig III* and a side shifted towed body with a single beam transducer on *Solea*. A number of zig-zag transects were surveyed, with *Solea* ahead for 22.5 n.mi. The exercise was abandoned at this point due to deteriorating weather conditions.

The main targets were very small dense shoals of sprat. For such small targets it was unlikely that both ships would record exactly the same information, as demonstrated by the aligned sequence of measured NASCs integrated over a distance of 0.5 n.mi. (Figure 8). Single shoals with high backscattering strength are indicated by sharp spikes and the scatterplot of these data therefore have a number of significant deviations from the one to one line (Figure 9). The fitted regression on the scatterplot has a slope of 0.89, with an intercept of zero. The mean NASC value for the *Walther Herwig III* was 2503 $m^2/n.mi.^2$ and the mean for *Solea* was 2924 $m^2/n.mi.^2$. 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.

4.2.2 Survey overlap between FRV Scotia and FRV Michael Sars

Analyses of abundance estimates between two or more countries in experimental overlapping survey areas have indicated that Norway has the tendency to report lower fish densities than other countries (ICES 2001b), with the biggest differences occurring between Scotland and Norway. An extended area overlap between RV *Scotia* and RV *Michael Sars* was therefore included in the 2001 survey, covering ICES rectangles 46E9, 47E9, 49E9 and 50E9.

The overlapping areas were surveyed using systematic parallel transects in the east-west direction proceeding from south to north at an intertransect distance of 7.5 n.mi. apart. The area, considered as southern rectangles (46E9 and 47E9) and northern rectangles (49E9 and 50E9), was sampled biologically s follows:

North: Scotland: 4 pelagic trawls
Norway: 10 trawls (5 pelagic and 5 bottom)

South: Scotland: 10 pelagic trawls
Norway: 11 (8 pelagic and 3 bottom)

The Scottish pelagic hauls and four of the Norwegian pelagic hauls in the northern area were shot close to the bottom. Both countries had nearly pure catches of herring in these hauls. However, much higher catches of herring were taken in the Scottish trawls (Table 5). The Norwegian bottom trawl hauls had much higher catch rates of ground fish, as expected. The mean catch of herring in the bottom trawl was higher in the southern area than in north but mean catches of Norway pout and haddock were nearly the same in both areas.

The mean NASC attributed to herring and other species in the two areas is given in Table 6. The table shows the mean allocated NASC in statistical rectangles 46E9 & 47E9 (South) and 49E9 & 50E9 (North) by herring and other species. It also gives the percentages allocated among herring and other species by area and by country, as well as the ratio of Scotland/Norway for herring, other species and total fish by area. As the scrutinising of acoustic data is based mainly on the catch compositions in the trawl hauls, the different fishing strategies may explain some of the differences in the species allocation between the two countries. Trawl duration was about 30 minutes for both countries.

The Scotland/Norway ratio of NASC allocated to herring in the overlapping areas was about 2 in the north and 1.50 in the south. The group discussed the differences in these estimates which are similar to in previous analyses of overlapping areas. It was thought that they were most likely due to differences in scrutinising without any firmer conclusions. As the two sets of results are based on data from different fishing patterns, it was recommended that the two countries make an additional survey overlap in the Shetland area in 2002 to conduct an intercalibration of pelagic and bottom trawls. An exchange of acoustic data between Scotland and Norway will take place next year for scrutinising and analyses. The results will be presented at the next PGHERS meeting.

4.3 Sprat

Data on sprat were available from *RV Solea*, *RV Tridens* and *RV Dana*. No sprat were reported by *RV Scotia* and *RV Michael Sars* in the northern areas. The distribution of sprat (numbers in millions) in the North Sea obtained during the acoustic survey in 2001 is shown in Figure 10. This year the survey of the south-eastern North Sea was further extended to the south in the western part as this area is considered to have the highest abundance of sprat. Again, the distribution pattern demonstrates that the southern border was still not reached. The group recommends that the coverage in the south be maintained as it expects this to be a precondition for a sprat index in the future.

In the east of the survey area sprat were present in the Kattegat, but none were found in the Skagerrak. The bulk of abundance and biomass was found in the German Bight. The 2000-year class contributed almost 80% of the biomass in eastern part, while the 1999-year class made up about 65% in the west. The total sprat biomass estimated was 200,000 t in the North Sea and 8,000 t in the Kattegat. A full report will be made available to the HAWG in March 2002.

4.4 Update on clupea.net

The webmaster of the clupea website (http://www.clupea.net) informed the group of developments during the past year. Apart from occasional updates in the News section and the annual update of stock specific data for north east Atlantic stocks following the ACFM spring session, a new brief Biology section was added. Any additional input would be most welcome. Despite increased efforts to acquire collaborators especially from North America, no detailed information on north west Atlantic and north east Pacific stocks could be obtained. The group is therefore encouraged to seek collaborators working in this area using their personal scientific contacts.

The group decided to post the latest versions of the manuals for herring acoustic surveys and herring larvae surveys on the site. Additionally, possibilities will be explored to use the clupea-website as a (user-friendly) portal to the HERSUR database physically located at DFU in Denmark.

A future development which is already in an advanced state is the implementation of a web-accessible database holding the basic data (assessment inputs and outputs) for stocks described so far. This will replace the static html tables used so far and not only ease the annual update of these data (they can then be transferred from the published ICES report almost automatically), but also allow users to define specific queries among different stocks, years and parameters. The output will, in the first instance, be an html table displaying e.g. the mean weight at age and proportion mature for 3 different stocks in the period 1982-1996. The database can hold TACs and quota, references and contact details at a later stage.

4.5 Acoustic survey manual

A review was made of the current acoustic survey manual (version 2, ICES 2000) and the following revisions were applied:

1. Definitions and symbols have in the text have been changed according to (MacLennan *et al.* in press). The section on Data Analysis however, requires a significant rethink in the light of the new definitions and terms, and has **not** been amended accordingly: this is an item for next year.

2. PGHERS agreed that a standard format should be adhered to in the submission of individual acoustic survey reports. An example of the standard format can be seen in Appendix IIA.

3. A column containing mesh sizes in the codends used in the surveys has been added in the table with trawl descriptions.

4. A paragraph "Representative or length stratified samples" has been replaced by a paragraph "Biological sampling procedure".

5. A few sentences have been added explaining that age of autumn spawning herring should be expressed as winter rings, whereas spring spawning herring and sprat should be expressed as age class.

6. A table containing the different maturity scales in use has been added.

7. The new practice of splitting 1 winter ring autumn spawning herring into immature and mature has been changed accordingly in the text.

8. An example of the old excel worksheet used to submit survey data broken down by age/sub area (the 'proportions sheet') has been replaced by an updated example, containing also a mean length at age table.

The revised manual is attached as Appendix IV. All changes in the text of the new version of the manual are printed in bold.

4.6 HERSUR database

An update on the status of the HERSUR project was presented to the group. During 2001 visits to all participating countries were carried out by the projects database manager, primarily to assist with the conversion of data from national acoustic survey formats to Hersur Formats (extended IBTS to XML). Data has now been uploaded to the HERSUR database by:

- Denmark (1992-2001)
- Germany (1995-2000)
- Scotland North Sea (1999-2000)
- Scotland west coast (1999-2000)
- Holland (only 2000 NASC values)

The HERSUR website has been restructured and the exchange format has been revised. It is now possible to send data by e-mail to hersur@dfu.min.dk. The Country Code (e.g. DEN for Denmark) should be put in the e-mail subject line and Hersur XML datafiles can then be attached. Datafiles will then be validated and if verified will be uploaded to the database automatically. The sender will receive an e-mail to confirm data has been uploaded. If data is found not to be valid the sender will receive an e-mail with an error description (as in the online validation system).

An investigation of the need for reporting facilities was also carried out. The following report types have been implemented and will be on the internet webserver before December 31 2001:

- Mean herring length per square
- Mean NASC per square
- Species distribution per cruise (with piechart)
- Herring mean length per haul per cruise
- Sprat mean length per haul per cruise
- NASC values on maps

Data can be downloaded from all table reports in various formats (XML, Text comma separated, or straight to a printer). Samples reports are given in Appendix V.

An investigation of options for an international abundance estimation system was carried out. A specification of requirements has been made which may be suitable for a project proposal for further development. This and other documentation will be available in the HERSUR final report.

It was noted that the database has a 5-point maturity scale, due to its adaptation from the IBTS format. This will be changed to a system with possibility for entering both an 8-point and a 4-point scale in separate columns. The weight of single fish will also be added together with race. These changes will be included in the new version of the exchange format.

4.7 Measurement of the band filter delay of the EK500.

During the 2001 survey of FRV *Walther Herwig III* the filter delay of the Simrad EK500 echosounder was measured. An uncompensated delay time of the output of the band filter leads to errors in the measured distance, errors in the TVG function and, therefore, also to errors in the integration values. For these measurements an indirect procedure was used. According to the calibration formula, the measured NASCs of the calibration sphere are range dependent. From the theoretical viewpoint there should be a linear dependence of the NASCs in relation to the inverse squared distance. However the measured values did not show a linear dependence (Figure 11). Therefore a range error, Δr, was introduced to the calibration formula.

$$s_A = \frac{4\pi r_0 \;\; \sigma_{bs} \;\; 1852^2}{\Psi\,(r + \Delta r)^2} \;\; ; \;\; \sigma_{bs} = 10^{TS_{sphere}/10} \; ; \;\; \Psi = 10^{dB-value/10}$$

An iteration procedure was used to obtain a best fit value for the range error and depending on that, the filter delay was calculated. Values measured when the sphere was very close to the transducer, were excluded from the calculation.

In the case of long pulses and a narrow bandwidth, the measured range error was 1.43 m and the uncompensated filter delay was 1.94 ms. For short pulses and wide bandwidth, the range error was 0.08 m and the uncompensated filter delay was 0.11 ms. The accuracy of the latter result is not as large as the accuracy for the first one, because the series of the measured values was not as log as before.

The study demonstrates that the necessary delays have not been introduced to the EK500 despite previous identification (Fernandes and Simmonds 1996) and assurance that they would be dealt with in all versions of software after 5.2. This issue remains one of concern and merits further thought and investigation by PGHERS over the course of the coming year.

4.8 Co-ordination of acoustic surveys in 2002

4.8.1 North Sea

Acoustic surveys in the North Sea and west of Scotland in 2002 will be carried out in the periods and areas given in the following Table and Figure 12.

Vessel	Period	Area
Charter west Scotland	15-20 days in July	56°- 60°N, 3° - 10° W
G.O. Sars	27 June – 21 July	56°30'- 62° N, 2° - 6° E
Scotia	26 June – 17 July	58°- 62° N, 2/4° W - 2° E
Tridens	24 June – 21 July	54°30 – 58° N, west of 3° E
Walther Herwig III	21 June – 12 July	53°30' - 57° N, east of 3° E
Dana	25 June – 8 July	North of 57° N, east of 6° E

An overlap between *Scotia* and *G.O. Sars* will take place around 12 July 2002 after the half landing at Lerwick. Detailed appointments as regards timing and position will be made during the half landing.

An intercalibration between *Walther Herwig III* and *Tridens* will take place at an agreed date and location in an area off the Friesland coast. 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 2002 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 (Appendix IV). Data for both sprat and herring should be with the co-ordinators by **31 November 2002**.

4.8.2 Western Baltic

In the western Baltic and southern part of Kattegat, the following survey will be carried out in 2002:

Vessel	Period	Area
Solea	26 September – 17 October	Sub-division 21, 22 to 24

4.9 Future planning of acoustic surveys in the North Sea and adjacent waters

4.9.1 Effort (re)allocation

Over recent years the acoustic survey for herring in the North Sea and adjacent waters has followed a general pattern of allocating vessels to particular areas. The tendency has been for each nation to survey the same general geographic area every year. These areas are largely chosen to be in, or close to, national waters. Within their allocated areas each country have allocated effort (i.e. effort stratification) according to the biomass distribution encountered historically in that specific area. PGHERS recognised that a better approach would be for the effort stratification to be carried out in relation to the overall stock abundance distribution, rather than within sub-areas. As a first approach to this, the relationship between survey effort (expressed as nautical miles surveyed per ICES rectangle) and historic abundance distribution (mean tonnage per rectangle 1989-2001) was examined. The outcome of this examination is presented in Figure 13. It is clear from this plot that some areas have a high biomass to sampling ratio (e.g. Shetland and the Skagerrak/Kattegat area) while in others this is much lower. Following the principle that variance increases with amplitude, and that one should sample more in areas of high abundance, it can be argued that the current survey design is not completely appropriate to the distribution of the stock.

In the light of these findings, it was agreed that the survey could and should be redesigned to make the best use of the vessel resources available in relation to the abundance distribution of the stock(s). It should be recognised that the analysis presented in Figure 13 only represents the effort in terms of long-term mean biomass. Any new survey design will also have to consider the adequacy of age sampling and the relative importance of individual stocks e.g. Baltic spring spawners and herring in VIa_{north}. In addition, any changes in distribution over the time period will also have to be considered as the analysis presented here considered only long term means. One model for a new survey design would be that used in the acoustic surveys in the Norwegian Sea for the Norwegian spring spawning herring. In this case, in addition to effort stratification, the vessels are used in an interlaced design, with two vessels surveying alternate transects. This makes comparisons between vessels easier, and makes the survey less dependent on individual vessels.

It was agreed that a redesigned survey would entail considerable work prior to implementation. Additionally, as described in this report (Sections 4.2.2. and 5.1) there are outstanding questions on the compatibility of different countries approach to their surveys and analysis. Therefore, it was agreed that the redesign should be a major item on the agenda for the next PGHERS meeting after appropriate studies have been carried out. The first implementation should be in the summer of 2003.

4.9.2 Survey Area Definition

During the course of the study described above (Section 4.8.1) it became apparent that there were some areas in the North Sea where herring had been found historically but which were not included in current surveys. These areas are presented along with the effort data in Figure 14. It should be recognised that these areas were surveyed in the past but had subsequently been excluded due to the absence of herring. However, given the substantial expansion of the stock documented in this report, it was concluded that some of these areas should again be included in the survey area. The most obvious example was in the area between 61° to 62°N and 1 to 4°E. This area will now be included in the 2002 survey.

The area south of 56°N on the Scottish west coast was also unsurveyed. This area was originally surveyed by the Republic of Ireland. Currently, there is no suitable vessel for this survey but this situation may change in the near future, and may again be surveyed, possibly to coincide with the new design in the North Sea. The area in the central North Sea (55-57°N to 3-4°E) was also excluded due to low numbers of herring. These rectangles will also be surveyed again in 2002, although there is little expectation of major change.

5 MEASUREMENT OF BIOLOGICAL PARAMETERS

5.1 Maturity determination

There are at least two different maturity scales used by participants in the North Sea acoustic survey: Norway, Scotland and Denmark use an 8-point scale (Bowers and Holliday 1961); Germany uses a 4-point scale (adapted from the 8-point scale); whilst the Netherlands uses an 8-point scale, but reports this as a 4 point scale in a similar manner to the Germans. The IBTS database employs a 5-point scale, hence its previous appearance in the HERSUR database format. A conversion table for these scales is given in Table 7. Some small mistakes in the determination of maturity where discovered last year (ICES 2001b). These mistakes were associated with a change in application of the two scales by one of the survey participants. This had very slight repercussions for the 1998 and 1999 indices of spawning stock biomass (SSB), of the order of less than 0.1%. Nevertheless, the revised SSB estimates have been prepared for submission to the HAWG in 2002. The error, however small, highlighted the need for consistent maturity measurements between participants. In the 2001 surveys PGHERS recommended that participants should investigate the collection of digital photographs of herring showing the various maturity stages.

Photographs were collected by Denmark, Germany and Scotland. These highlighted the potential use and drawbacks of a photographic approach. When a suitably high quality camera was used, the pictures were suitable for comparison. However, very small differences in lighting and sample preparation had significant impacts on the comparability of images. A more specific preparation protocol was described, with the gonad being dissected out of the body cavity but being left attached at the anal region. The gonad should then be laid out on light grey card, and photographed along with the fish body. The camera should be used on a fixed mount (tripod, or ideally, a frame) and the lighting should be from the side using appropriate photographic spotlights.

Given the difficulties of obtaining genuinely comparable images, PGHERS agreed that the best approach to harmonising maturity determination would be by means of a workshop. The workshop should include participants from all nations collaborating in acoustic surveys in the North Sea and adjacent waters. To ensure the collection of suitable fresh samples it was agreed that, if possible, the workshop should be held on board a research vessel at sea. FRS agreed to investigate the possibility of providing a vessel for such a workshop in August 2002 after the completion of the surveys. The workshop would then comprise: the collection and preparation of samples; open forum discussions of maturity to arrive at a consistent approach; and the preparation of a library of photographs for subsequent use on surveys and in other sampling tasks. It was agreed by PGHERS that a shore-based workshop using material obtained e.g. from market samples, would not be appropriate as it would tend to provide specimens that were not fresh, and would be unlikely to provide samples of young fish. It was agreed that, if possible, the workshop should also include otolith reading, and an examination of maturity determination in sprat.

5.2 Herring otolith exchange

A herring otolith exchange was organised through September to December 2001. A total of 210 otoliths were circulated among 7 of 8 readers with one receiving only 150. The results were assembled and analysed using a spreadsheet designed by Eltink *et al*. (2000) "AGE COMPARISONS.XLS" Version 1.0. This tool provides an exceptionally useful framework for analysis. The measured ages were analysed using modal length as the reference age with no prior allocation of reader performance and equal weight for all readers. The numbers at age (modal age) and length are shown in Table 8.

The percentage success rates at length and age are shown in Table 9. The accuracy is summarised in Table 10, which shows relatively good results for ageing of herring. Table 11 shows an evaluation of reader difference both between readers and from the modal value. While there are statistically significant differences between readers there is only one reader (4) with statistically significant differences between the modal age and estimated age. Readers 1 to 4 all have some difficulties with older herring, reader 3 also has differences at ages 2 & 3 and all readers appear to have some problems at age 6.

While the results are generally good and show reasonably reliable reading among the readers who participated, the intra-national variation was very much less than the inter-national variation. This suggests that there is scope for improvement by increasing the contact between staff who age herring. The only reader showing systematic bias is a relatively new reader from Germany who does not read older herring where the bias occurs. However, in common with the survey, catch at age market sample otoliths are also usually aged by the same readers and in the latter case biases at the older ages may be more serious. The HAWG should consider whether an ageing workshop is required.

5.3 Sprat otolith exchange

From concerns in the group about the ageing of sprat, otoliths were sampled by *RV Tridens* and *RV Solea*. An exchange of otoliths is in progress and some preliminary results of readings (55 pairs of otoliths) were presented. This work will continue during the next few months. There are indications of disagreements in the ageing of larger and older sprat and it is recommended that age readings of sprat otoliths be part of a combined herring/sprat age-reading workshop next year.

5.4 Results of an exchange of otoliths for species determination

In 1999 and 2000 in the south-eastern part of the acoustic survey small peaks in the length frequency distribution of herring were detected right in the middle between age 1 (0 winter ring) and age 2. In order to establish the origin of these fish, the trays containing their otoliths were sent to the Institute in Flødevigen for scrutiny. Otolith readers detected what they regarded as sprat otoliths in these trays. In order to clear up the emerging confusion, it was decided to circulate these trays between a number of institutes with the specific task of deciding for each of the 717 otoliths whether it belonged to either a herring or sprat, a task that most readers agreed should be very easy.

The participating institutions were IMR-Norway (3 readers), IMR-Sweden (2), DIFRES-Copenhagen (1), BFA-Germany (1). Not all readers read all otoliths. Despite the fact that the specimens had been verifiably identified as herring, uniform agreement on the species origin of the otolith occurred for only 67% of otoliths (Figure 15a). Of the remaining third with disagreement, the most common pattern was that 3 readers determined the otolith to originate from sprat while the others decided it was a herring otolith (Figure 15b). This pattern applied to 9 out of 10 cases of disagreement.

The implications of this brief study may be more widespread than the obvious ones for the acoustic survey. If due care and attention is not given to differentiating small herring from sprat, it implies that misidentification may not be spotted by the otolith reader and an age may therefore be given to a fish misidentified as herring which would be much older than its length would imply. This would apply to market samples as well as survey data, but is more likely to occur in the latter where small herring are more common.

6 INVESTIGATION OF THE EFFECT OF TIME OF DAY ON THE DETECTION OF HERRING DURING THE NORTH SEA ACOUSTIC SURVEY

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 co-ordinated 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 surveys in the Orkney-Shetland area and the west of Scotland (carried out by Scotland) are suspended from 22:00 to 02:00 GMT; the Dutch suspend the survey from 21:00 to 04:00; and the Germans from 20:00 to 04:00. The Danes do not suspend acoustic surveying but do restrict trawling to the pelagic zone from 21:00 to 03:00; whilst the Norwegians survey 24 hours a day. PGHERS examined data from past acoustic surveys to investigate the influence of time of day on the abundance estimation of herring.

A presentation was given on a paper submitted to the ICES 2001 ASC (Fernandes *et al*. 2001). The diurnal vertical migration (DVM) behaviour of Atlantic herring is a well-known and well-documented phenomenon. In the North Sea during summer, herring generally occur as well defined schools by day, either near the sea bed or in midwater. These schools disperse and the fish rise into surface waters at night. Consequently, acoustic surveys for herring are suspended during the short period of darkness when the fish become more difficult to distinguish at best, or more significantly, totally unavailable to the acoustic apparatus. However, the exact timing and nature of this behaviour may vary according to location and, or, any individual year. An analysis of six years of acoustic survey data (1991, 1993-1997) was carried out to determine the variability and exact timing of the diurnal migration. A herring school database, derived from image analysis techniques applied to the echo traces from survey data, was examined to investigate schooling as a function of time of day. Parameters studied include the number of schools, depth of schools, and school descriptors such as length and height. A model describing how these parameters vary with time of day was developed in order to pinpoint times at which key points in the pattern of migration occur. The average midpoint of school dispersal and upward migration times was calculated from the DVM model as 21:07. This compares with calculations from astronomical algorithms for sunset at the midpoint of the survey area as 21:14. The average midpoint of school aggregation and downward migration times was calculated from the DVM model as 03:07. This compares with calculations from astronomical algorithms for sunrise at the midpoint of the survey area as 03:04. The close relationship between the two sets of values reinforces the well-known phenomenon of the behaviour occurring in conjunction with the onsets of day and night.

The acoustic survey data were modified according to the modelled behaviour to produce truncated datasets containing only values collected when the herring were fully available to the survey. Abundance estimates were then recalculated based on the modified datasets. In five of the six years, the fully available datasets produced higher abundance estimates (by up to 14%); in one year a lower abundance estimate was obtained (by 15%). These results indicate that the behaviour does not have a consistent effect on the estimation of abundance from the survey. Examination of the relationship between the NASC attributed to herring from all six years and time of day reveals that herring can be detected in those hours adjacent to the start and end of the DVM. However, there is evidence to suggest that in the hours immediately adjacent to current suspension periods NASC values are lower than average: a Locally Weighted Scatterplot Smoother (LOWESS) was used to fit to bin-averaged NASC data from all six years combined was significantly different from the average value (Fig. 16). Examination of similar data from the Netherlands 2001 survey indicate that the three lowest hour bin-averaged NASC values occur in those hour bins immediately adjacent to the suspension period (Figure 17). A similar (provisional) analysis from the 2001 Norwegian survey is not as conclusive (Fig. 18), perhaps justifying the lack of a suspension period in this nations survey.

Further such analyses are required and PGHERS will carry this item onto next years meeting by which time other participants will prepare similar analyses on their NASC data.

7 RECOMMENDATIONS

The Planning Group for Herring Surveys recommends that:

- The Planning Group for Herring Surveys should meet, at a venue to be decided, from 21 to 24 January 2003 under the Chairmanship of P.G. Fernandes (UK, Scotland) to:

a) combine the 2002 survey data to provide estimates of abundance for the population within the area;

b) consider a re-allocation of effort by participating countries in the acoustic survey of the North Sea and adjacent waters in 2003;

c) co-ordinate 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 in 2003;

d) evaluate the outcome of a maturity staging workshop with a view to harmonising the determination of maturity in herring and sprat;

e) evaluate investigations on the effect of time of day on the allocation of herring to acoustic data.

Justification

Terms of reference a) and c)

Surveys for herring are currently carried out by five different countries, covering the whole of the North Sea, Western Baltic and the west coast of Scotland. Effective co-ordination 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 b)

In recent years the acoustic survey for herring in the North Sea and adjacent waters has followed a general pattern of allocating vessels to particular areas. The tendency has been for each nation to survey the same general geographic area every year and the areas chosen are generally in, or close to, national waters. Within their allocated areas each country have allocated effort (i.e. effort stratification) according to the biomass distribution encountered historically in that specific area. PGHERS has recognised that a better approach would be for the effort stratification to be carried out in relation to the overall stock distribution, rather than within national sub-areas. Analyses of the survey time series have indicated that there are certain areas which have a high biomass to sampling ratio (e.g. Shetland and the Skagerrak/Kattegat area) while in others this ratio is much lower. As survey variance increases with abundance, it follows that areas of high abundance should be sampled more intensively, and so it would be prudent to attempt to reduce the aforementioned biomass to sampling ratio.

In the light of these findings, it was agreed that the survey could and should be redesigned to make the best use of the vessel resources available in relation to the distribution of the stock(s). Any new survey design will also have to consider the adequacy of age sampling and the relative importance of individual stocks e.g. Baltic spring spawners and herring in VIa_{north}. In addition, any changes in distribution over the time period will also have to be considered. One model for a new survey design would be that used in the acoustic surveys in the Norwegian Sea for the Norwegian spring spawning herring stock. In this case, in addition to effort stratification, the vessels are used in an interlaced design, with two vessels surveying alternate transects. This makes comparisons between vessels easier, and makes the survey less dependent on individual vessels.

Such a redesign of the survey would entail considerable work prior to implementation and it was agreed at the 2001 PGHERS meeting that this should be a major item on the agenda for the next PGHERS meeting after appropriate studies have been carried out. The first implementation would then be carried out in the summer of 2003.

Term of reference d)

There are at least two different maturity scales used by participants in the North Sea acoustic survey: Norway, Scotland and Denmark use an 8-point scale; Germany uses a 4-point scale (adapted from the 8-point scale); whilst the Netherlands uses an 8-point scale, but reports this as a 4 point scale in a similar manner to the Germans. In addition, small mistakes in the determination of maturity have been made in the past with regard to maturity determination. These mistakes were associated with a change in application of the two scales by one of the survey participants. The error, which had only small implications for the assessment process, nonetheless highlighted the need for consistent maturity measurements between participants.

In the 2001 surveys, PGHERS recommended that participants should investigate the collection of digital photographs of herring showing the various maturity stages. These highlighted the potential use and drawbacks of a photographic approach. Given the difficulties of obtaining genuinely comparable images, PGHERS agreed that the best approach to harmonising maturity determination would be by means of a workshop. The workshop should include participants from all nations collaborating in acoustic surveys in the North Sea and adjacent waters. To ensure the collection of suitable fresh samples it was agreed that, if possible, the workshop should be held on board a research vessel at sea. The UK (Scotland) agreed to investigate the possibility of providing a vessel for such a workshop in August 2002 after the completion of the surveys. It was agreed that, if possible, the workshop should also include otolith reading, and an examination of maturity determination in sprat.

Term of reference e)

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 co-ordinated 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. An initial investigation presented to the 2001 PGHERS suggested a number of techniques for analysing the acoustic survey data for examining the diurnal vertical migration of herring and its effect on the survey. It was agreed that similar analyses should be carried out by all participants on their own datasets. The results will be presented and discussed at the 2003 meeting with a view to reassessing the start and end times of the surveying day.

- The Planning Group recommends that nations participating in the acoustic surveys should make strong efforts to exchange staff between surveys. This is essential prior to any re-evaluation of survey effort allocation where scientists may survey unfamiliar areas, to ensure that consistent scrutinising and evaluation methods are applied. Scientists of Scotland and Norway in particular are encouraged to attempt to exchange personnel for at least half of the 2002 survey.

- The Planning Group recommends that an area overlap between *Scotia* and *G.O. Sars* be surveyed to include ICES rectangles 49E9, 49F0, 50E9 and 50F0 (shaded region Figure 12) with a spacing of no more than 7.5 n.mi.

- The Planning Group recommends that a workshop to establish common practise in the estimation of maturity stages in herring and sprat be carried out. This workshop should produce a photographic guide and concluded by deciding on an appropriate key for use in the acoustic surveys.

- The Planning Group recommends that due consideration be given to establishing a sprat, herring 0-ring and herring 1-ring index from the acoustic survey. A preliminary study for young herring should be prepared for the 2002 HAWG. In this context, it is strongly recommended that survey boundaries be maintained as in the current report or even extended to the south 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.

- The Planning Group recommends that the global abundance estimation method specified within the HERSUR project be formulated into a new project proposal which will aim to use the data archived in the HERSUR database to produce the annual biomass estimates and indices at age from the co-ordinated herring acoustic survey.

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

- The Planning Group recommends that all survey reports and manuals (for larvae and acoustic surveys) relevant to the group be posted on the “clupea.net” website. Furthermore, possibilities should be explored to use “clupea.net” as a portal site to access historic acoustic survey data from the North Sea, which is stored on the HERSUR database.

- 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. Furthermore, efforts should be made to survey the Swedish 12 mile zone in the Baltic acoustic survey: permission should be sought well in advance and, if required, further assistance should requested from the Swedish marine laboratory in Lysekil.

- The Planning Group recommends that a workshop to determine the age of herring and sprat from otoliths be held in summer 2002. This recommendation will be submitted to the HAWG for further consideration and to invite any other interested parties (e.g. Republic of Ireland and Northern Ireland). Age readings of sprat otoliths, which are part of the current sprat otolith exchange, should be evaluated at this combined herring/sprat age-reading workshop.

- The Planning Group recommends that biological samples from the Danish survey be examined more closely to investigate maturity in 4 and 5 yr olds: more samples from these ages should be collected in the 2002 survey.

- The Planning Group recommends that a revised series of herring autumn spawning stock biomass from the acoustic survey be submitted to the HAWG 2002 to account for the (small) differences in maturity reading in 1998-1999.

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Table 1 Larval abundance index for Orkney/Shetland area, 2nd half of September 2000, from larvae surveys carried out by Germany and Norway.

LAI	Germany	Norway	Both
L < 10 mm	3943	192	3352
L > 10 mm	2533	329	2198

Table 2 Results of the German herring larvae surveys in the Greifswalder Bodden and adjacent waters in the western Baltic, 1992-2000. S = Total survival rate; S1 = Survival rate of the youngest larvae. N 30 = estimated number of herring larvae which will grow up to the total length of TL >= 30 mm

Year	Total number of herring larvae caugh	Mean larvae abundance per station (number/m^2)	Number of herring larvae in the total area (N 30)l(millions)	Mean survival rates per day (S / S1) (%)	Mean growth rate (mm.day^{-1})
1992	33 944	6,60	18	80 / 71	0,48
1993	81 433	14,35	199	79 / 75	0,53
1994	286 951	41,86	788	92 / 92	0,47
1995	235 600	31,68	171	90 / 64	0,53
1996	304 783	77,05	31	81 / 77	0,44
1997	157 978	26,16	54	76 / 73	0,43
1998	128 977	25,42	2553	92 / 96	0,63
1999	195 163	34,30	1945	91 / 95	0,59
2000	34 997	6,29	151	87 / 91	0,68

Table 3a Results of the 2001 North Sea acoustic survey for North Sea autumn spawning herring.

North Sea	Numbers (millions)	Biomass (×10^3 tonnes)	Proportion mature	Mean weight (g)	Mean length (cm)
0	14052.7	113.0	0.00	8	10.6
1	6830.2	342.3	0.00	50	18.4
2	11561.6	1460.6	0.76	126	24.1
3	2893.2	466.2	0.92	161	25.9
4	1351.5	275.5	1.00	204	27.7
5	1539.4	349.7	1.00	227	28.7
6	414.3	98.1	1.00	237	29.0
7	156.9	39.8	1.00	254	29.7
8	90.0	25.6	1.00	285	30.6
9+	54.5	15.9	1.00	291	31.6
Immature	23848.2	755.2			
Mature	15096.1	2431.5			
Total	38944.3	3186.7			

Table 3b Results of the 2001 North Sea acoustic survey for Western Baltic spring spawning herring.

Baltic	Numbers (millions)	Biomass ($\times 10^3$ tonnes)	Proportion mature	Mean weight (g)	Mean length (cm)
0	0.0	0.0	0.00		
1	65.5	3.5	0.10	54	19.3
2	641.2	55.6	0.33	87	22.0
3	452.3	51.2	0.52	113.2	23.8
4	153.1	21.5	1.00	140.5	25.2
5	96.4	17.9	1.00	185.2	27.3
6	37.6	6.9	1.00	182.6	27.6
7	23.0	4.8	1.00	206.3	28.4
8.00	8.5	1.9	1.00	222.2	30.0
9+	3.4	0.8	1.00	238.8	30.5
Immature	707.0	64.4			
Mature	774.0	99.6			
Total	1481.0	164.0			

Table 3c Results of the 2001 North Sea acoustic survey for west of Scotland autumn spawning herring.

West Scotland	Numbers (millions)	Biomass ($\times 10^3$ tonnes)	Proportion mature	Mean weight (g)	Mean length (cm)
0	64.1	0.2	0.00	3	7.5
1	285.4	17.8	0.00	62	19.2
2	968.7	127.4	0.93	132	24.3
3	198.4	33.8	0.99	170	26.4
4	157.5	29.9	1.00	190	27.3
5	398.8	79.0	1.00	198	27.7
6	120.9	25.6	1.00	212	28.2
7	93.7	20.6	1.00	220	28.6
8	47.7	11.2	1.00	236	29.2
9+	31.6	8.0	1.00	254	29.9
Immature	421.3	26.2			
Mature	1945.6	327.5			
Total	2366.9	353.7			

Table 4 Preliminary results of the acoustic survey in the Western Baltic, October 2001.

Sub-division	Herring numbers (millions)	Sprat numbers (millions)
21	4979	1186
22	724	1656
24	4096	5841
Sum	9798	8683

Table 5a. Results of the survey overlap between FRV *Scotia* and FRV *Michael Sars,* July 2001: mean catches (numbers of fish) in the northern area (49E9 and 50E9).

	Michael Sars (Norway)		Scotia (Scotland)
Gear type	Demersal	Pelagic	Pelagic
Herring	54	152	2473
Sprat			
Norway pout	1795	17	60
Whiting	35	57	15
Haddock	238	1	
Saith	23		
Cod	4		
Flatfish			
Mackerel		1	38
Other fish	317	1	

Table 5b. Results of the survey overlap between FRV *Scotia* and FRV *Michael Sars* July 2001: mean catches in the southern area (46E9 and 47E9).

	Michael Sars (Norway)		Scotia (Scotland)
Gear type	Demersal	Pelagic	Pelagic
Herring	234	41	1924
Sprat		2	
Norway pout	1612		3
Whiting	37	3	9
Haddock	395	1	12
Saith	2		2
Cod	4		
Flatfish	8		
Mackerel	1	2	
Other fish	87	4	1

Table 6 NASCs from the survey overlap area derived from FRV *Scotia* and FRV *Michael Sars* July 2001.

NASC and allocations			
Scotland	Herring	Other	Total fish
North	1034.7	73.3	1108.1
South	75.3	1.1	76.4
Norway	Herring	Other	Total fish
North	534.3	242.0	776.3
South	49.7	51.8	101.5
Scotland	Herring	other	
North	93%	7%	
South	99%	1%	
Norway	Herring	Other	
North	69%	31%	
South	49%	51%	
Scotland/Norway	Herring	Other	Total fish
North	1.94	0.30	1.43
South	1.52	0.02	0.75

Table 7 Maturity scales used in the North Sea acoustic survey.

Reporting state	**8 point scale (Scotland, Norway, Denmark)**	**5 point scale (HERSUR)**	**4 point scale (Germany, Netherlands)**
Immature	1. Virgin	1. Virgin	1. Virgin
	2. Small gonads		
Mature	3. Gonads half cavity	2. Maturing	2. Maturing
	4. Gonads long cavity		
	5. Gonads fill cavity		
	6. Ripe & running	3. Spawning	3. Spawning
	7. Spent	4. Spent	4. Spent
	8. Recovering spents	5. Resting	

Table 8 Modal Age and length of otolith readings for herring otolith exchange September – December 2001. (Note that the age of the 8cm herring indicated on the first row is correctly allocated by all readers who believe that the length is wrongly specified and should be 18cm.)

Count of age	age								
LENGTH	0	1	2	3	4	5	6	7	8	Grand Total
8		1								1
9	1									1
9.5	1									1
10	1									1
10.5	1									1
11	2									2
11.5	1									1
12	1									1
12.5	1									1
14.5		1								1
15.5		2								2
16		2								2
16.5		3								3
17		4								4
17.5		5								5
18		3								3
18.5		3								3
19		7	1							8
19.5		4								4
20		3	3							6
20.5		3	1							4
21		2	3							5
21.5			5							5
22		3	4	3						10
22.5			6							6
23		1	5	2						8
23.5			3	2						5
24			6	3	2					11
24.5			4	5						9
25			6	2						8
25.5			2	4	2	1				9
26			5	4						9
26.5			1	2	3					6
27			1	1	3	3		1		9
27.5			2	2		4	4	1		13
28					5	8	1			14
28.5					1	4	1			6
29					5	3	1	1	1	11
29.5							1	1		2
30					1	1	2		1	5
30.5						1				1
31									1	1
31.5									1	1
33								1		1
Grand Total	9	47	58	30	22	25	10	5	4	210

Table 9 Percentage agreement with modal age among 8 readers.

Average of agreement	age									
LENGTH	0	1	2	3	4	5	6	7	8	Grand Total
8		100%								100%
9	100%									100%
9.5	100%									100%
10	100%									100%
10.5	100%									100%
11	100%									100%
11.5	100%									100%
12	100%									100%
12.5	100%									100%
14.5		100%								100%
15.5		100%								100%
16		100%								100%
16.5		100%								100%
17		100%								100%
17.5		97%								97%
18		100%								100%
18.5		100%								100%
19		100%	100%							100%
19.5		96%								96%
20		90%	86%							88%
20.5		95%	100%							96%
21		86%	71%							77%
21.5			84%							84%
22		87%	80%	77%						81%
22.5			87%							87%
23		86%	84%	93%						86%
23.5			95%	88%						92%
24			98%	69%	71%					85%
24.5			100%	93%						96%
25			96%	100%						97%
25.5			100%	96%	75%	88%				91%
26			97%	100%						98%
26.5			86%	100%	88%					91%
27			100%	88%	88%	77%		63%		83%
27.5			88%	100%		89%	78%	63%		85%
28					90%	95%	63%			91%
28.5					88%	78%	38%			73%
29					86%	71%	88%	88%	63%	80%
29.5							71%	75%		73%
30					75%	63%	75%		88%	75%
30.5						88%				88%
31									50%	50%
31.5									50%	50%
33								38%		38%
Grand Total	100%	97%	90%	91%	85%	85%	72%	65%	63%	89%

Table 10a The number of age readings, the coefficient of variation (CV), the percent agreement and the RELATIVE bias are presented by MODAL age for each age reader and for all readers combined. A weighted mean CV and a weighted mean percent agreement are given by reader and all readers combined. The CV's by MODAL age for each individual age reader and all readers combined indicate the precision in age reading by MODAL age. The weighted mean CV's over all MODAL age groups combined indicate the precision in age reading by reader and for all age readers combined.

3a	**NUMBER OF AGE READINGS**									
	MODAL	Norway1	Norway2	Netherland	Germany	Sweden1	Sweden2	Denmark	Scotland	
	age	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	**TOTAL**
	0	9	9	9	9	9	9	9	9	**72**
	1	47	47	44	47	47	47	38	46	**363**
	2	58	58	53	56	58	58	39	58	**438**
	3	30	30	28	30	29	29	14	30	**220**
	4	22	22	22	22	22	22	13	22	**167**
	5	25	25	25	25	25	25	20	25	**195**
	6	10	10	10	10	10	10	8	10	**78**
	7	5	5	5	5	5	5	5	5	**40**
	8	4	4	4	4	4	4	4	4	**32**
Total	**0-15**	**210**	**210**	**200**	**208**	**209**	**209**	**150**	**209**	**1605**
3b	**COEFFICIENT OF VARIATION (CV)**									
	MODAL	Norway1	Norway2	Netherland	Germany	Sweden1	Sweden2	Denmark	Scotland	**ALL**
	age	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	**Readers**
	0	0%	0%	0%	0%	0%	0%	0%	0%	**0.0%**
	1	0%	0%	34%	20%	0%	0%	0%	0%	**7.7%**
	2	13%	13%	35%	12%	14%	15%	8%	7%	**10.2%**
	3	6%	6%	18%	14%	8%	8%	9%	9%	**5.8%**
	4	11%	11%	12%	12%	8%	8%	7%	5%	**6.6%**
	5	4%	4%	10%	14%	8%	7%	5%	5%	**6.2%**
	6	12%	12%	23%	9%	7%	7%	7%	8%	**10.8%**
	7	14%	14%	17%	7%	0%	0%	7%	10%	**10.4%**
	8	7%	7%	46%	12%	0%	0%	10%	0%	**12.7%**
Wted mean	**0-15**	**7.2%**	**7.2%**	**24.3%**	**13.3%**	**7.0%**	**7.2%**	**4.9%**	**4.9%**	**7.8%**
3c	**PERCENTAGE AGREEMENT**									
	MODAL	Norway1	Norway2	Netherland	Germany	Sweden1	Sweden2	Denmark	Scotland	
	age	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	**ALL**
	0	100%	100%	100%	100%	100%	100%	100%	100%	**100%**
	1	100%	100%	80%	96%	100%	100%	100%	100%	**97%**
	2	93%	93%	70%	95%	91%	90%	97%	98%	**91%**
	3	97%	97%	82%	83%	93%	93%	93%	93%	**91%**
	4	77%	77%	77%	77%	91%	91%	92%	95%	**84%**
	5	96%	96%	72%	56%	84%	88%	95%	92%	**85%**
	6	80%	80%	80%	30%	80%	80%	75%	70%	**72%**
	7	60%	60%	40%	20%	100%	100%	80%	60%	**65%**
	8	25%	25%	75%	25%	100%	100%	50%	100%	**63%**
Wted mean	**0-15**	**91.4%**	**91.4%**	**76.0%**	**80.8%**	**92.8%**	**92.8%**	**94.0%**	**94.7%**	**89.2%**

Table 10b Shaded cells show mean biases of magnitude greater than 0.25.

	RELATIVE BIAS									
	MODAL	Norway1	Norway2	Netherland	Germany	Sweden1	Sweden2	Denmark	Scotland	
	age	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	**ALL**
	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
	1	0.00	0.00	0.20	0.04	0.00	0.00	0.00	0.00	**0.03**
	2	-0.07	-0.07	0.42	0.02	0.09	0.10	0.03	0.02	**0.06**
	3	-0.03	-0.03	0.07	-0.03	0.07	0.07	0.07	0.00	**0.02**
	4	-0.23	-0.23	-0.05	-0.14	0.00	0.00	0.08	0.05	**-0.07**
	5	-0.04	-0.04	-0.20	-0.40	0.08	0.04	-0.05	0.08	**-0.07**
	6	-0.30	-0.30	-0.30	-0.70	0.20	0.20	0.25	0.30	**-0.09**
	7	0.80	0.80	-0.40	-0.80	0.00	0.00	-0.20	0.00	**0.03**
	8	-0.75	-0.75	-1.50	-1.00	0.00	0.00	0.00	0.00	**-0.50**
	9	-	-	-	-	-	-	-	-	**-**
Wted mean	**0-15**	**-0.06**	**-0.06**	**0.08**	**-0.13**	**0.05**	**0.05**	**0.02**	**0.03**	**-0.00**

Table 11 Results of significance tests for reader bias between readers and between reader and modal age.

– - no bias, (p>.05)

– * possibility of bias (0.05>p>0.01,

– ** certainty of bias (p<.01)

Inter-reader bias test and reader against MODAL age bias test								
	Norway1	Norway2	Netherland	Germany	Sweden1	Sweden2	Denmark	Scotland
	Reader 1	**Reader 2**	**Reader 3**	**Reader 4**	**Reader 5**	**Reader 6**	**Reader 7**	**Reader 8**
Reader 1		~	•	~	•	•	~	•
Reader 2	~		•	~	•	•	~	•
Reader 3	•	•		•	~	~	~	~
Reader 4	~	~	•		•	•	•	•
Reader 5	•	•	~	•		~	~	~
Reader 6	•	•	~	•	~		~	~
Reader 7	~	~	~	•	~	~		~
Reader 8	•	•	~	•	~	~	~	
MODAL age	•	•	•	•	•	•	~	~

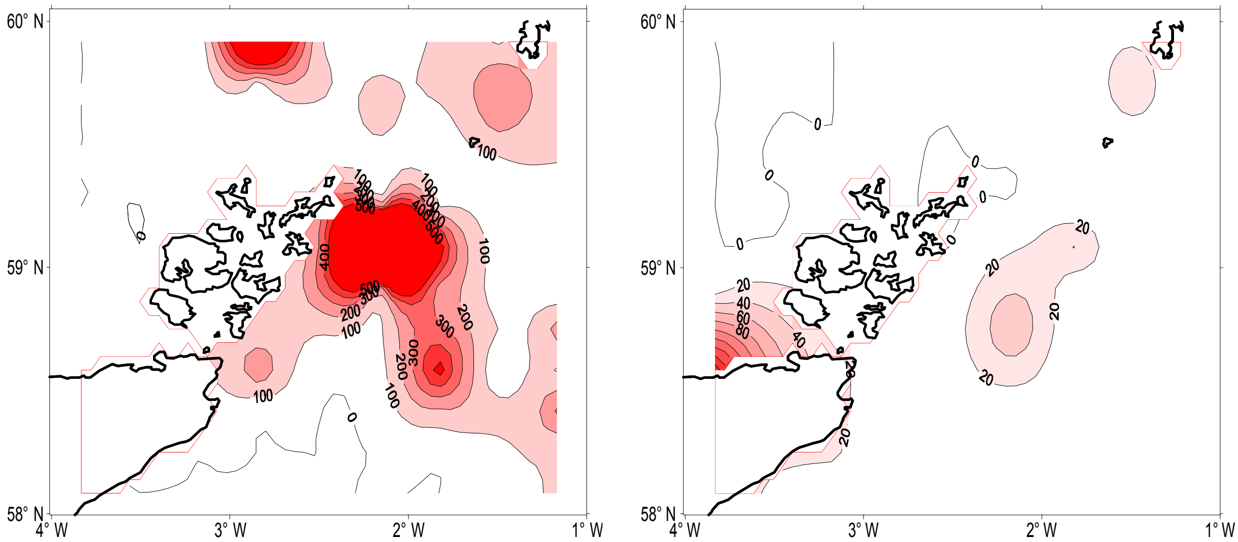

Figure 1 Distribution of larvae < 10 mm (n/m²) obtained from German (left panel) and Norwegian (right panel) larvae survey September 2000.

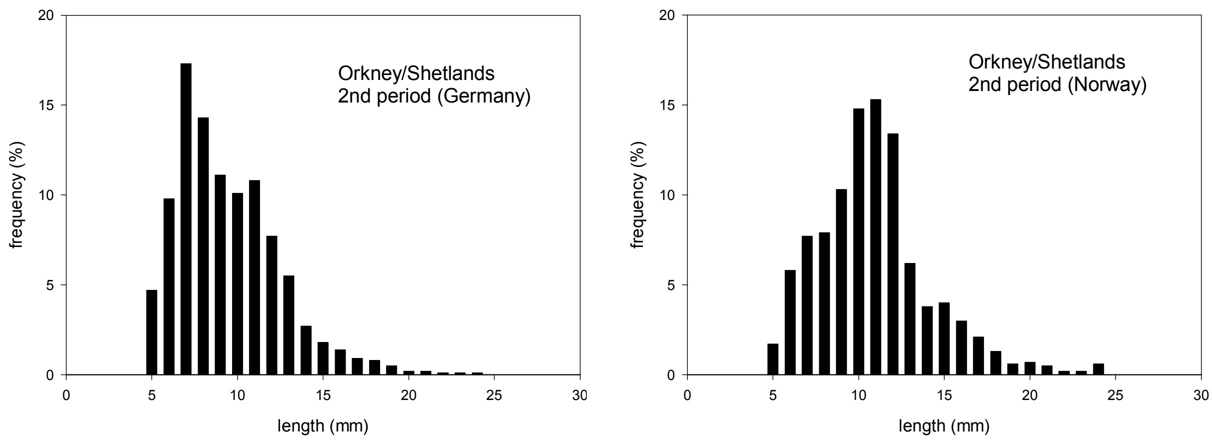

Figure 2 Length-frequency distribution of German (left panel) and Norwegian (right panel) larvae survey September 2000.

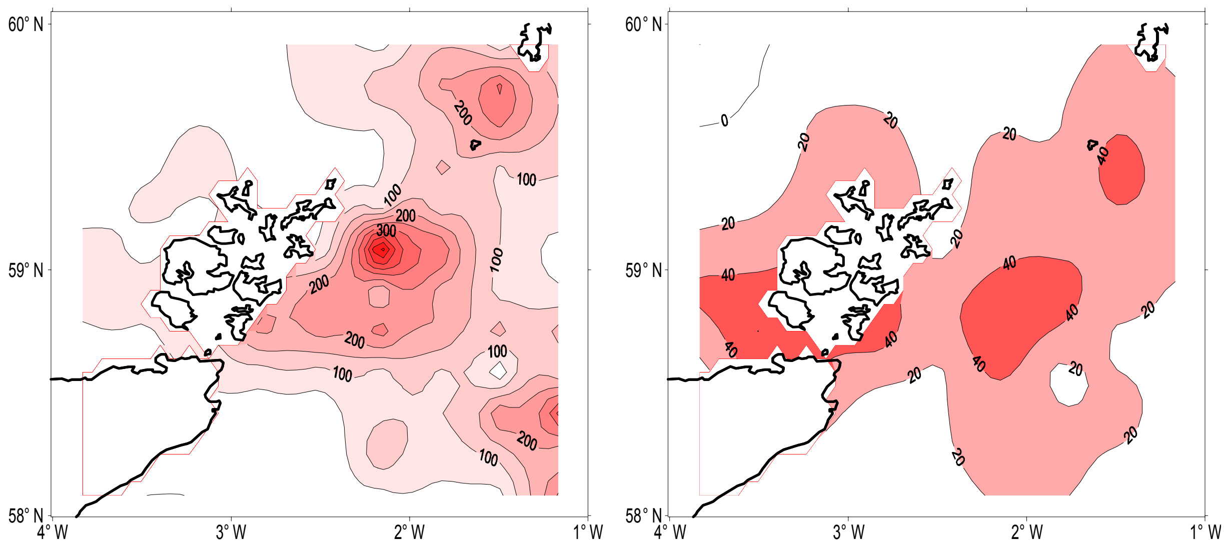

Figure 3 Distribution of larvae > 10 mm (n/m²) obtained from German (left panel) and Norwegian (right panel) larvae survey September 2000.

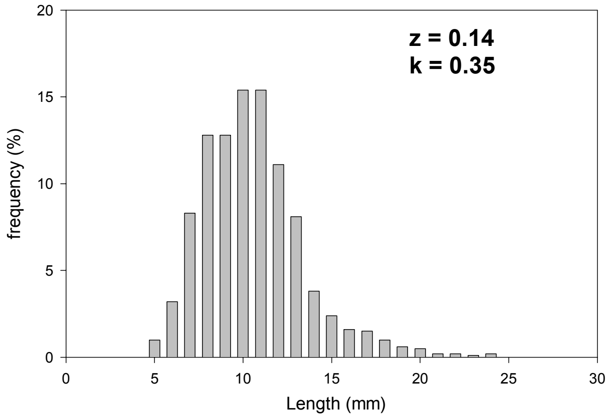

Figure 4 Resulting length-frequency distribution of calculated “grown” larvae, derived from the German larvae survey September 2000.

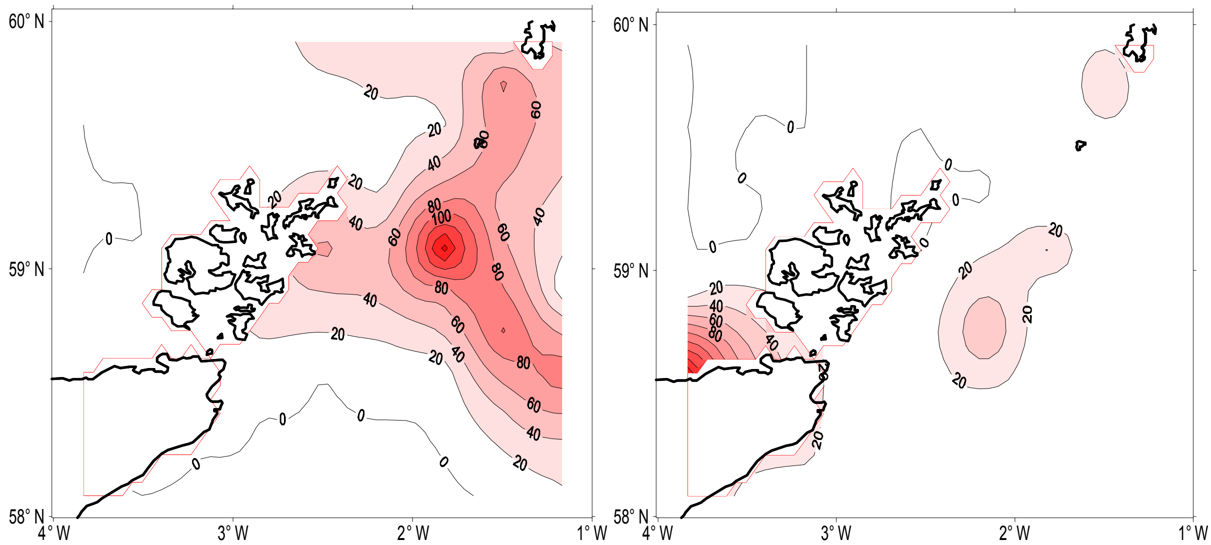

Figure 5 Artificial distribution of larvae < 10 mm (n/m²) reflecting the impact of z and k derived from the German survey (left panel) compared to the original Norwegian one (right panel) from September 2000.

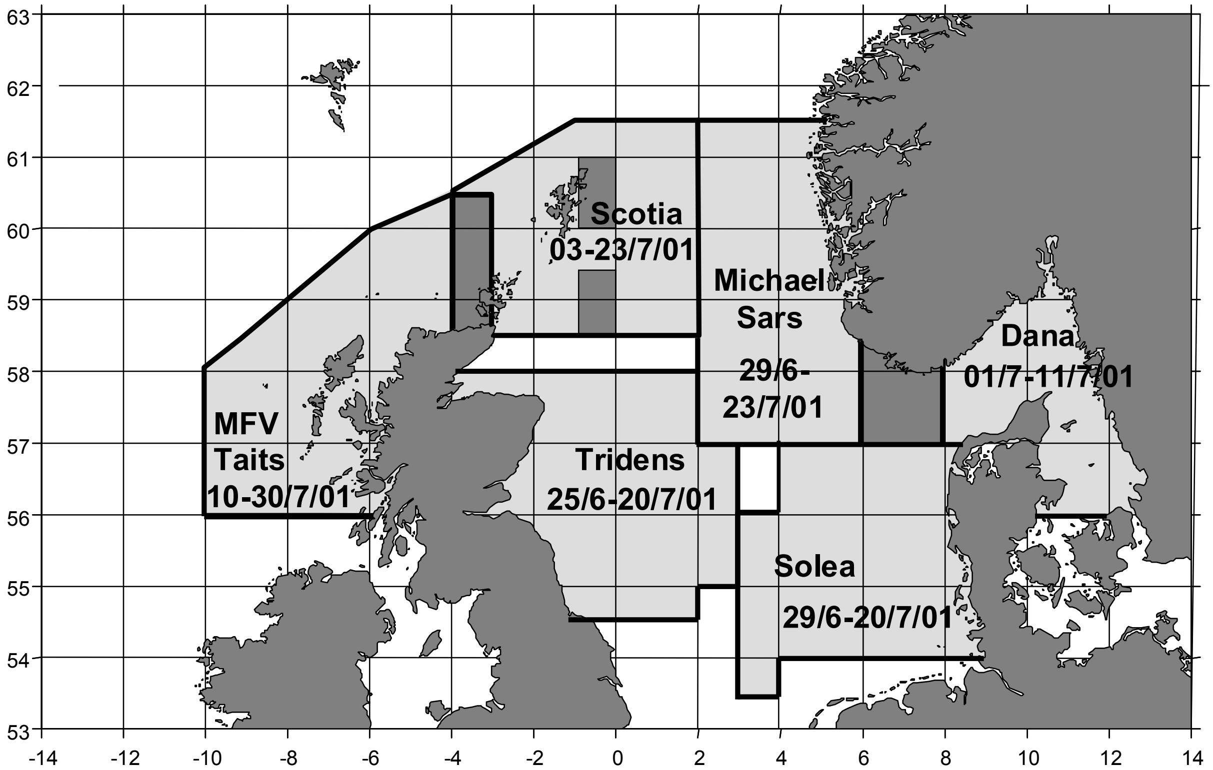

Figure 6 Survey area layouts and dates for all participating vessels in the 2001 acoustic survey of the North Sea and adjacent areas. Shaded areas indicate areas of overlap.

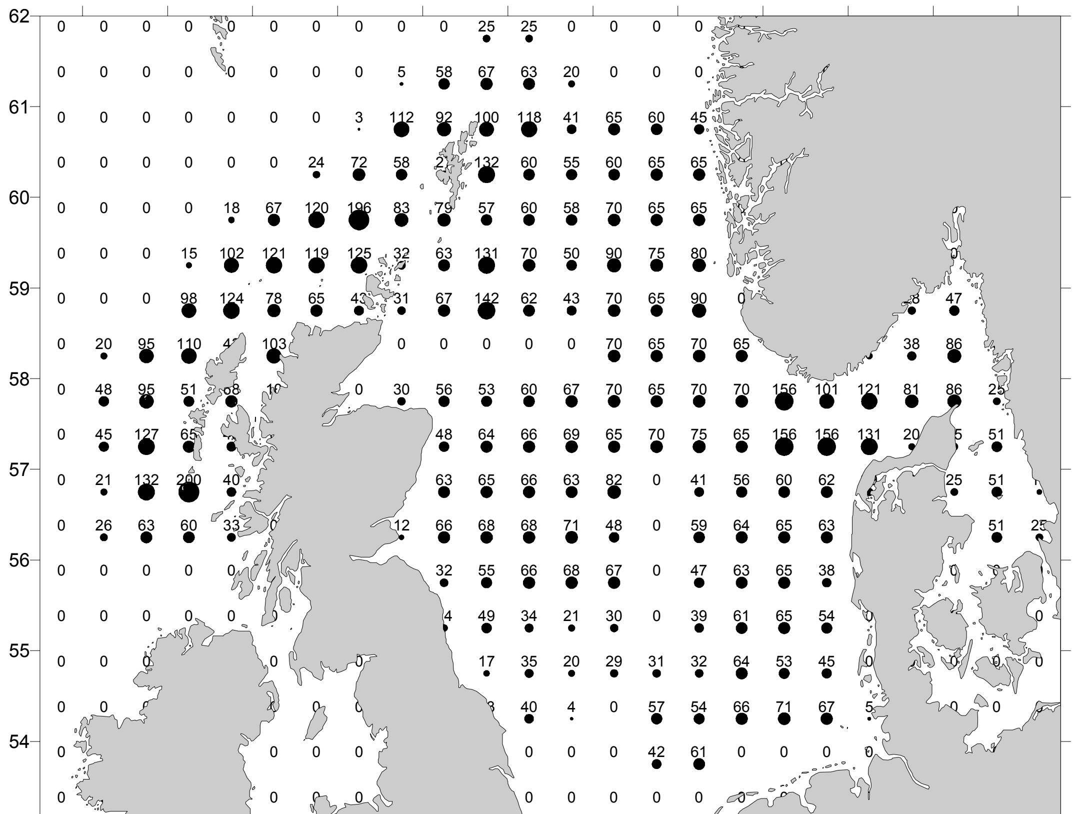

Figure 7 Acoustic survey effort in 2001 expressed as number of nautical miles of acoustic survey track with data per ICES rectangle.

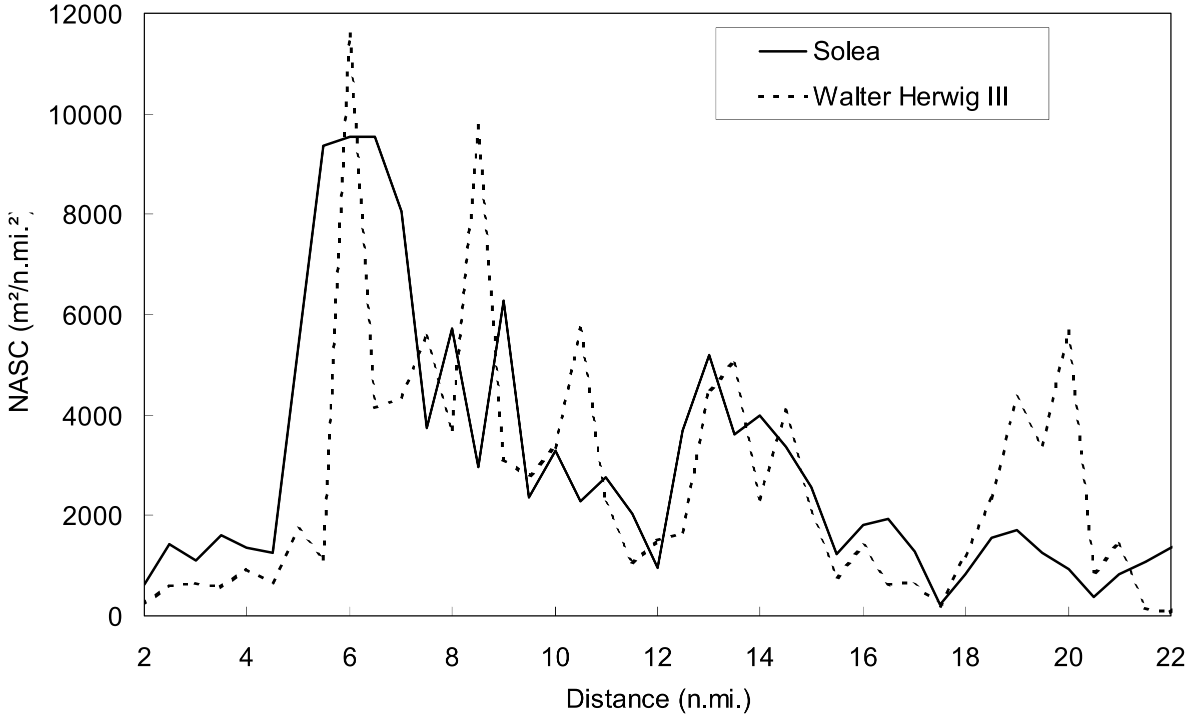

Figure 8 Aligned sequence of NASCs from the intercalibration between FRV *Walther Herwig III* and FRV *Solea* July 2001.

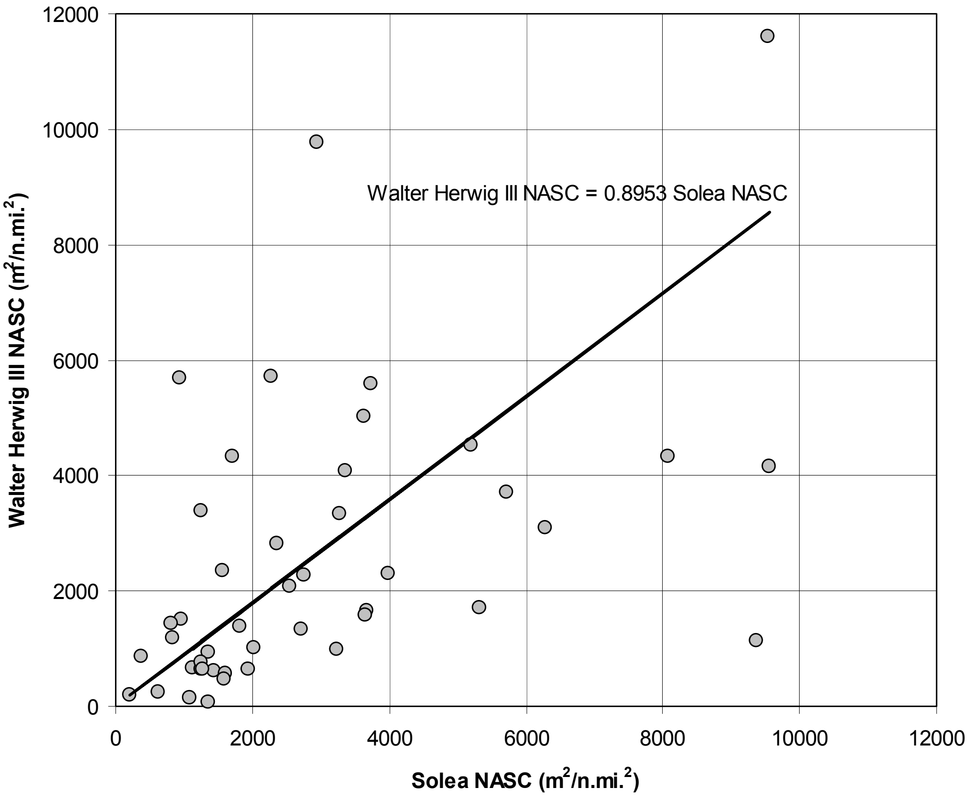

Figure 9 Scatterplot of NASCs from 0.5 n.mi. sampling intervals from the intercalibration between *Walther Herwig III* and *Solea*. Solid line indicates fitted regression with equation posted.

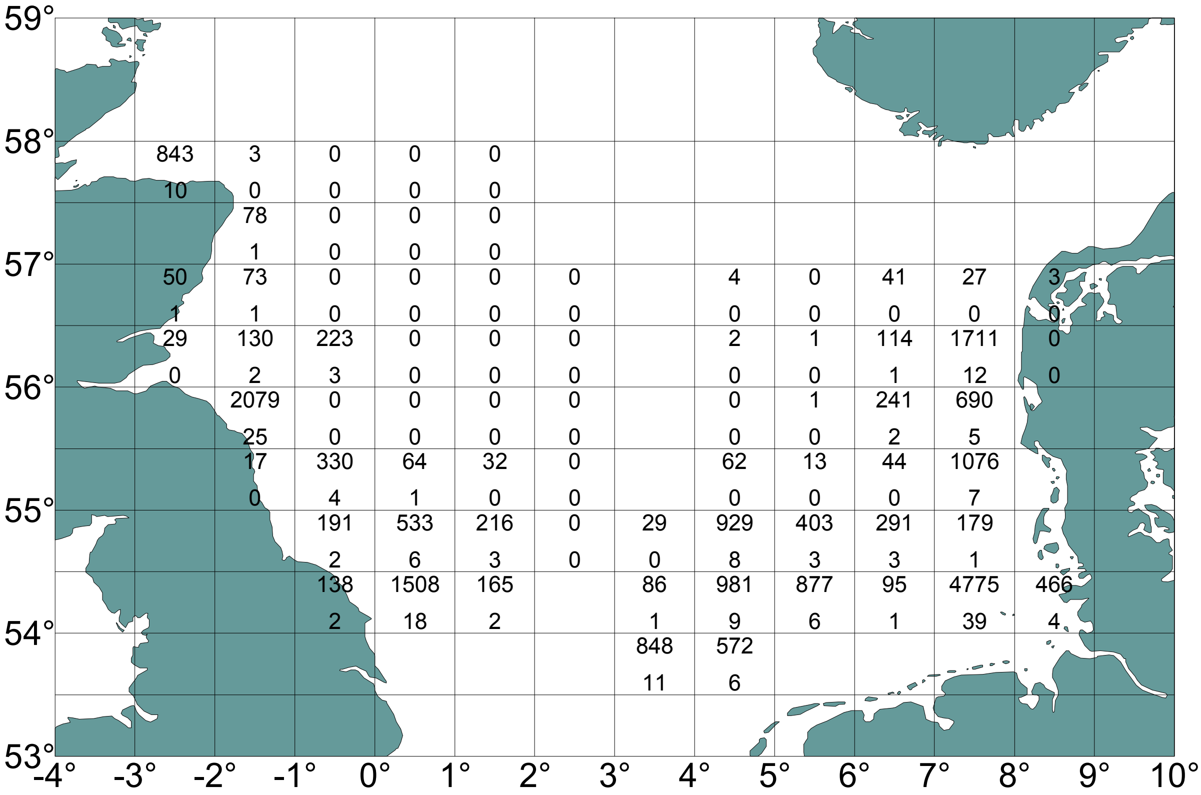

Figure 10 Map showing estimated numbers of sprat in millions (figure in upper half of each rectangle) and biomass in thousands of tonnes (lower half) by ICES rectangle. Combined results from the July 2001 North Sea hydro acoustic survey, using data from FRV *Tridens* and FRV *Solea*.

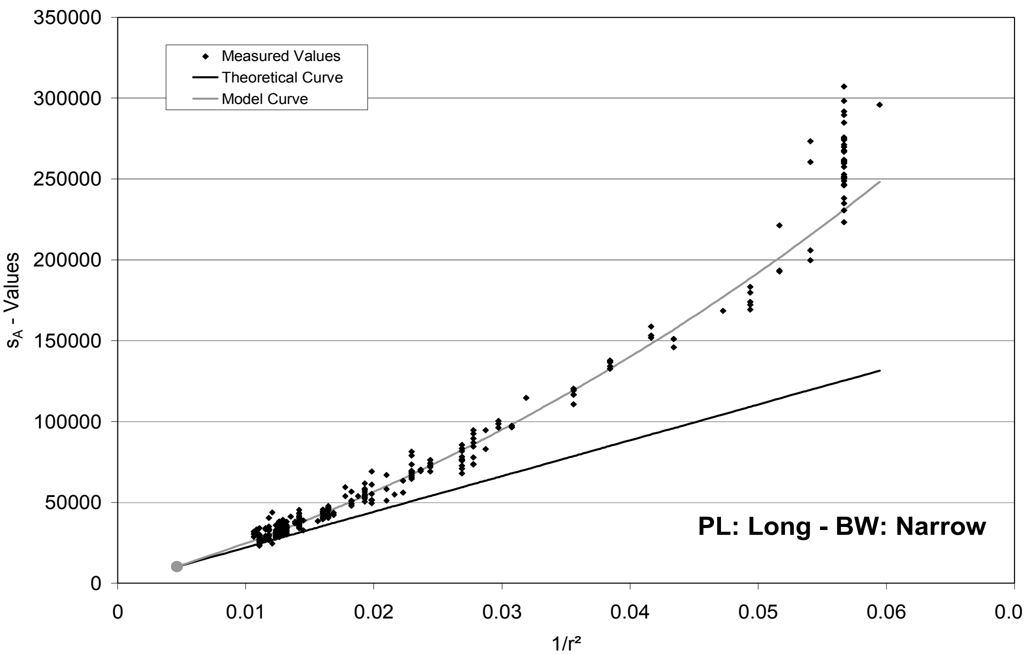

Figure 11 Measured NASCs showing dependence on inverse squared distance for long pulses and narrow bandwidth.

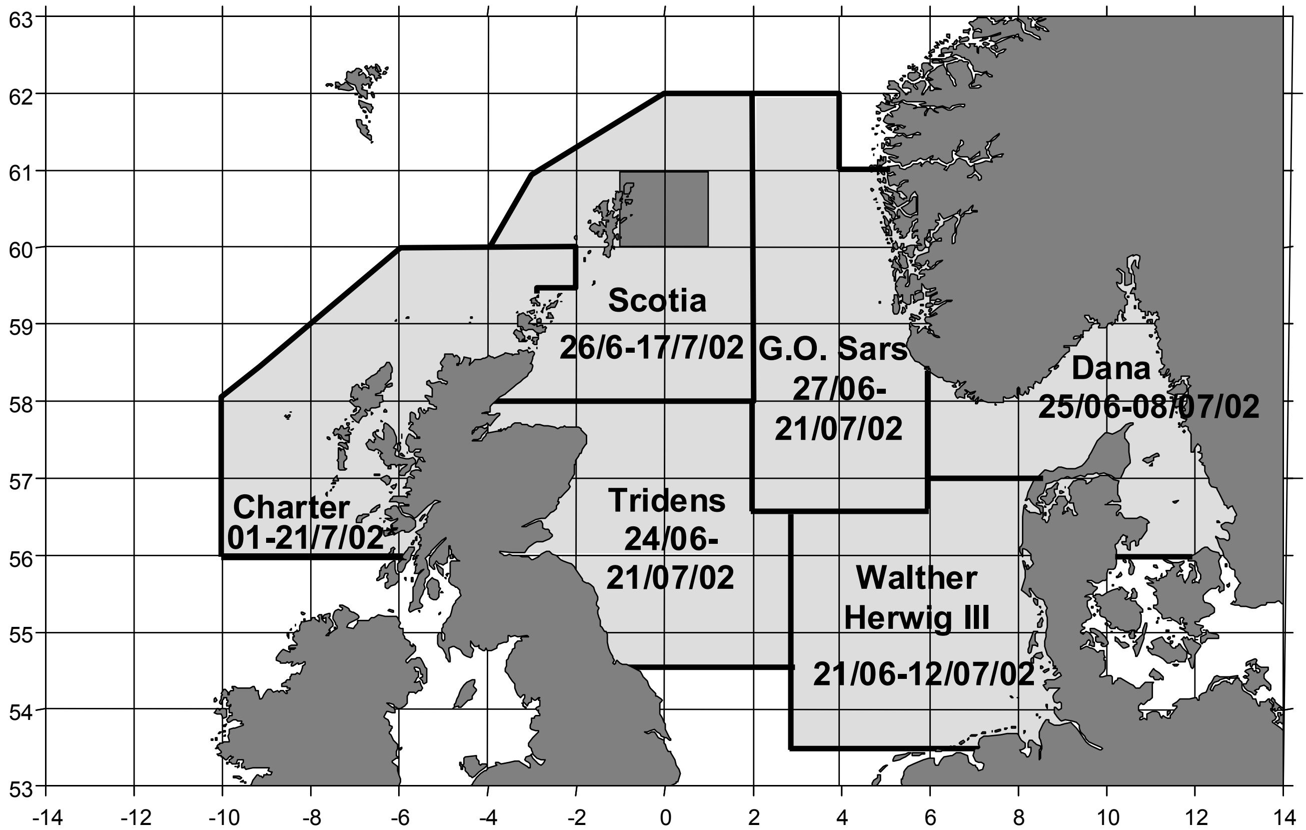

Figure 12 Survey area layouts and dates for all participating vessels in the 2002 acoustic survey of the North Sea and adjacent areas. Shaded areas indicate areas of overlap.

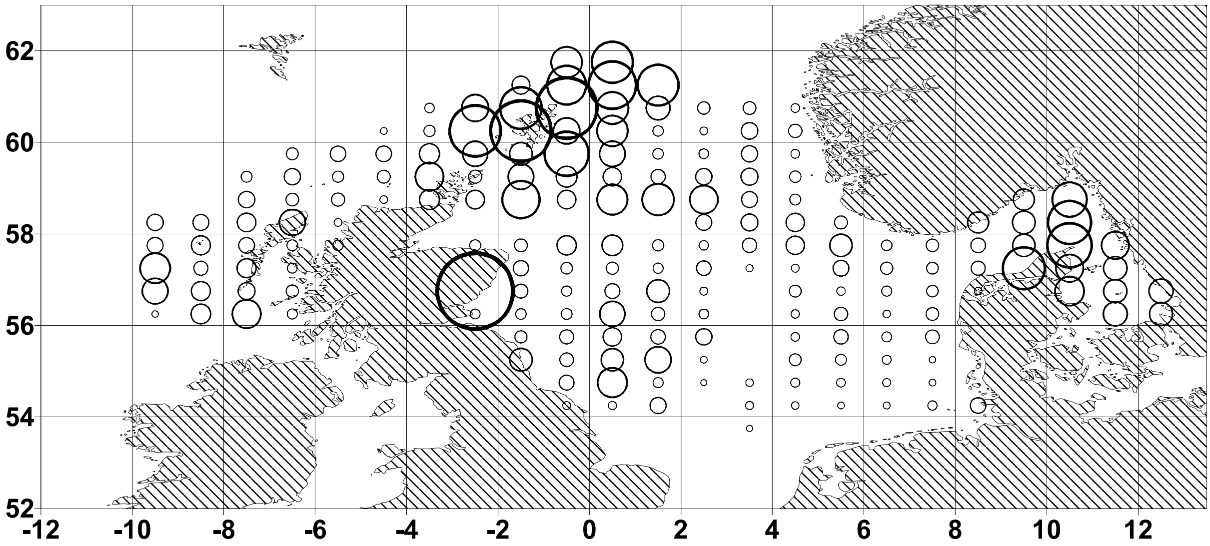

Figure 13 Post plot of the ratio of long term mean biomass (1989 – 2001) to survey effort in 2001 (n.mi. per rectangle). Circles are scaled to a maximum of 520 tonnes per nautical mile.

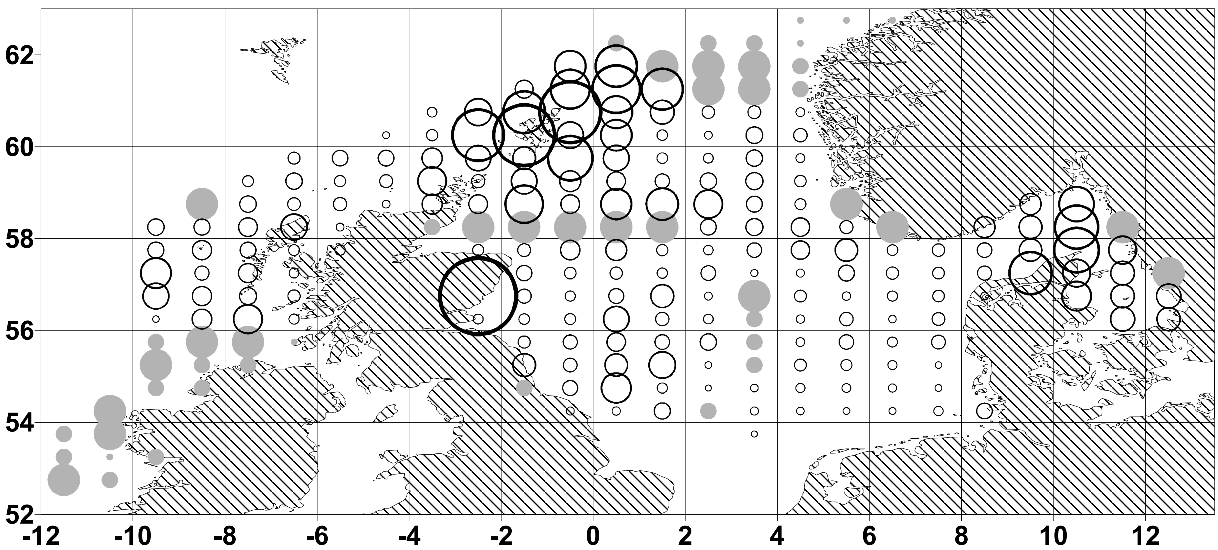

Figure 14 Post plot of the historic survey biomass in rectangles unsampled in 2001 (Grey circles). The data are co-plotted with the survey effort data from Figure 13 for clarity. The circles are shown at three levels; less than 100 tonnes, 100-1000 tonnes, and more than 1000 tonnes. It should be noted that the area between 58^{o} and 58^{o} 30'N was not deliberately unsampled in 2001.

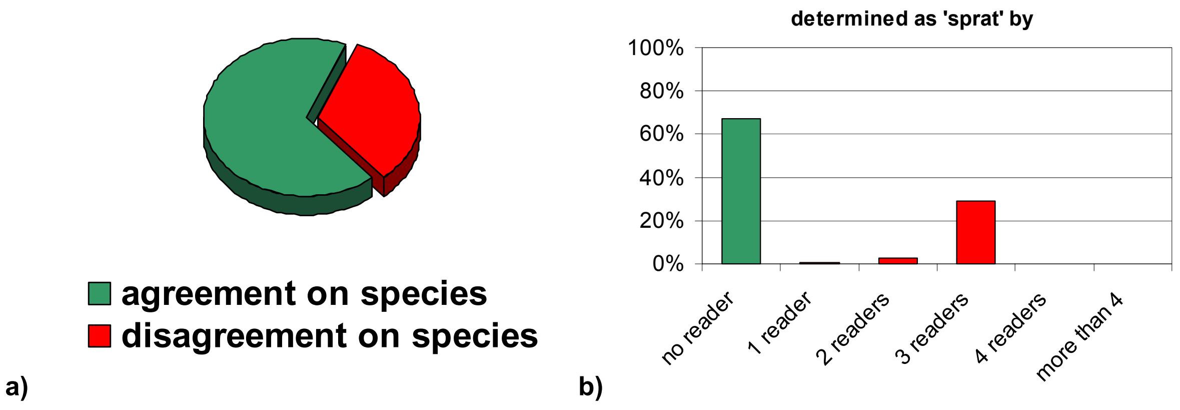

Figure 15 Results of the otolith exchange for species determination.

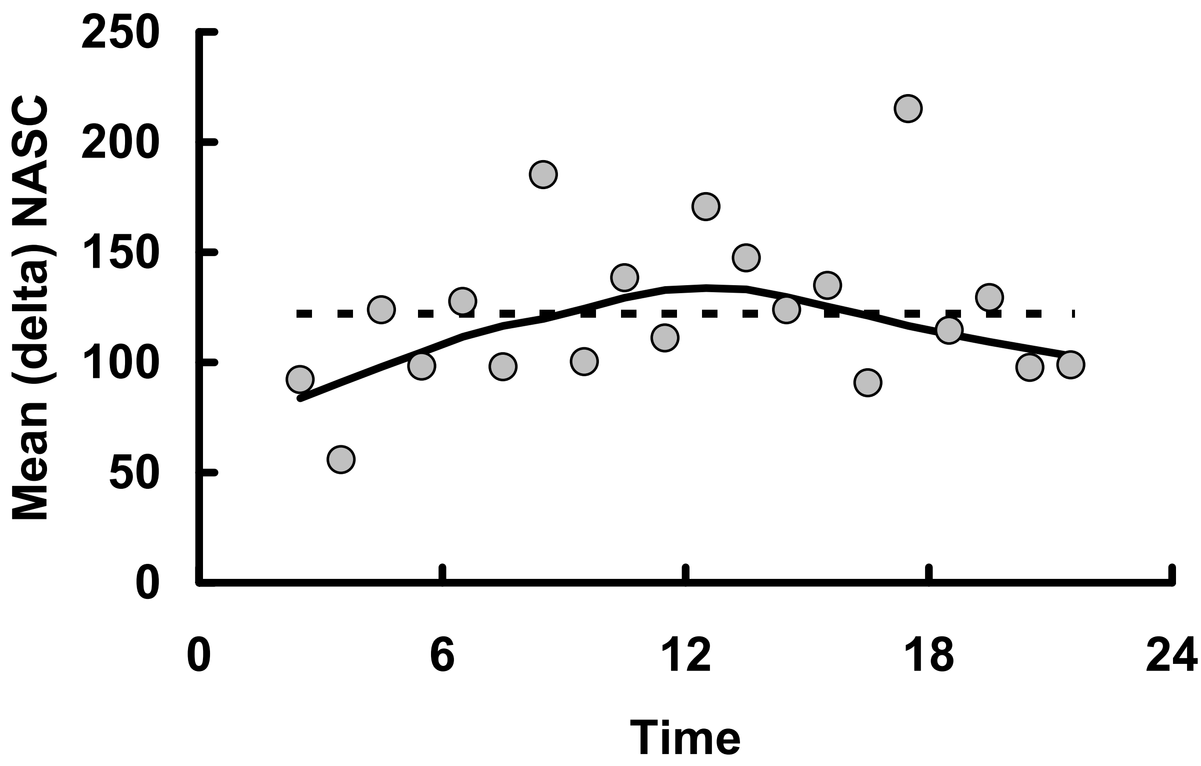

Figure 16 Bin averaged NASCs (mean of the delta distribution) against time from the Orkney Shetland acoustic survey from 1991 and 1993-1997 (all years combined). Solid fitted line is a LOESS smoother which is significantly different (chi sq. p<0.01) from the straight line fit (mean of all values, dotted) to the data.

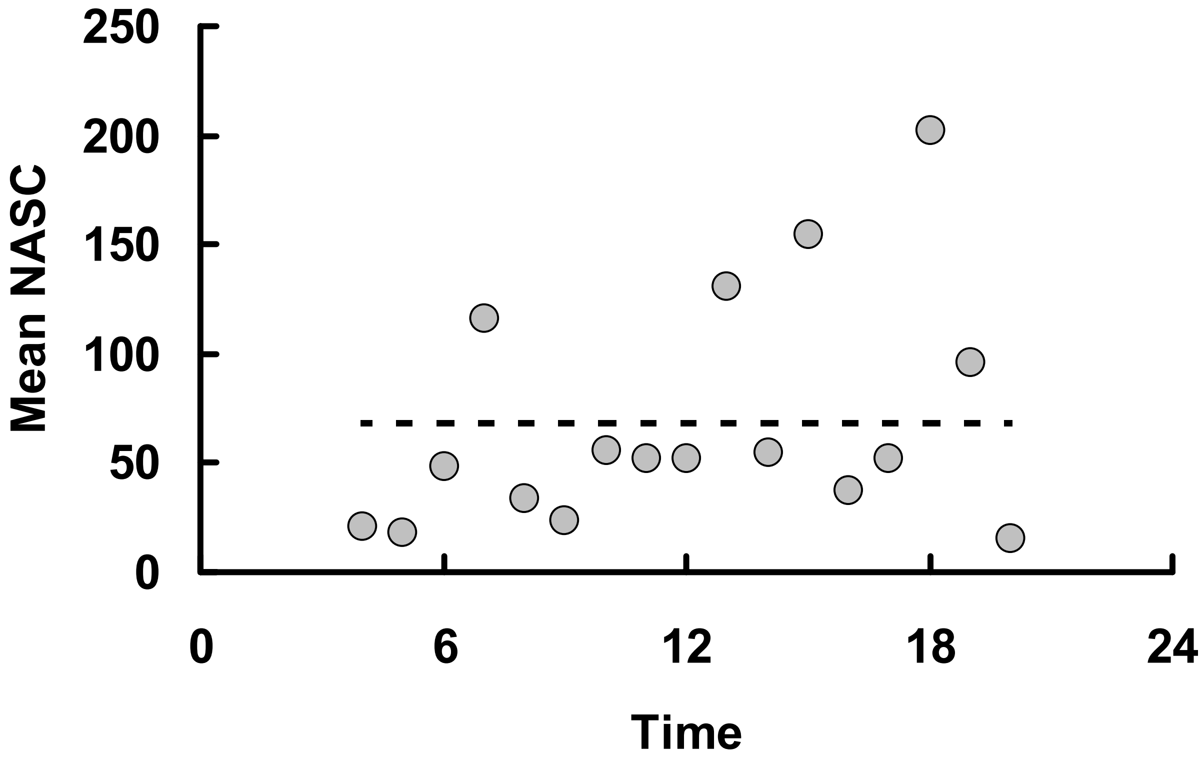

Figure 17 Bin averaged NASCs (aritmetic mean) against time from the 2001 Dutch acoustic survey. Dotted line is the straight line fit (mean of all values) to the data.

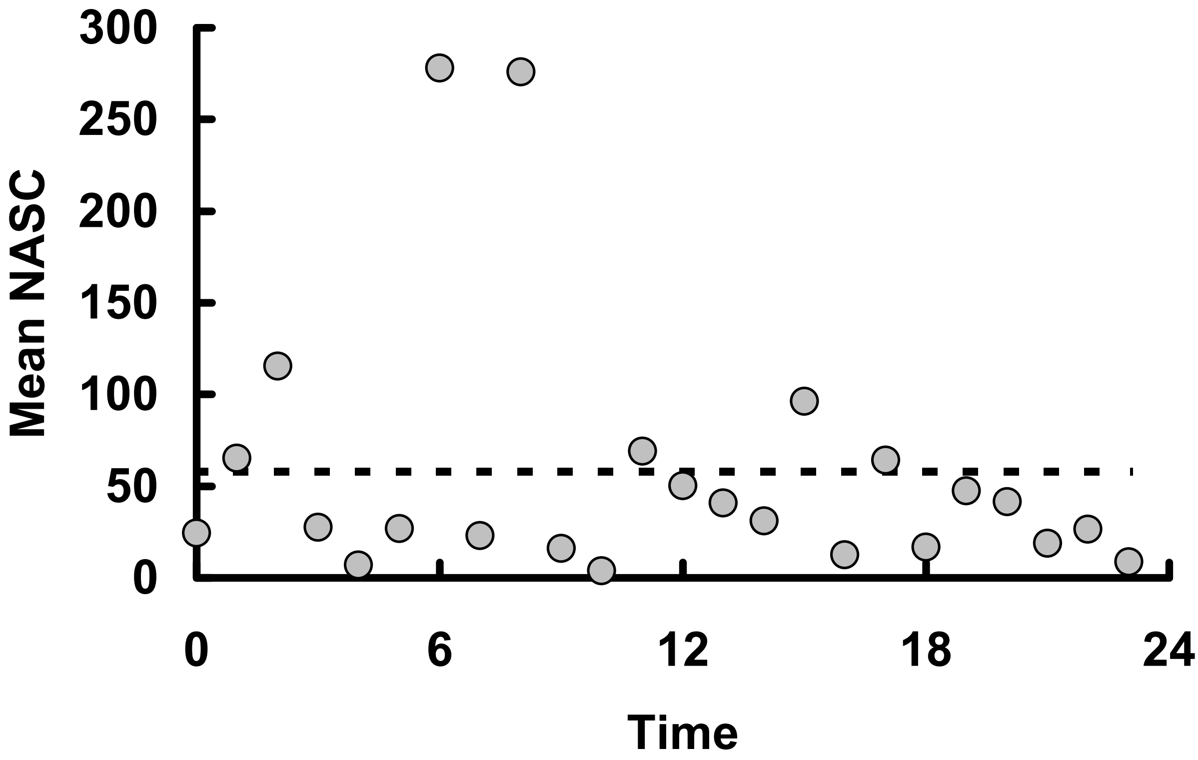

Figure 18 Bin averaged NASCs against time (aritmetic mean) from the 2001 Norwegian acoustic survey. Dotted line is the straight line fit (mean of all values) to the data.

APPENDIX I
PARTICIPANT CONTACT DETAILS

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APPENDIX II

2001 ACOUSTIC SURVEY REPORTS

APPENDIX IIA WEST OF SCOTLAND

Survey report for MFV "Taits"
10 –30 July 2001

Dave Reid, FRS Marine Laboratory, Aberdeen

1. INTRODUCTION

An acoustic survey for herring was carried out by the Marine Laboratory on the west coast of Scotland (ICES Div VIa(N)) from the 10th to the 30th July 2001. The survey was conducted on the chartered fishing vessel MFV *Taits*. The main objective of the survey was to provide an abundance estimate for herring in this area and to map the distribution of this species.

The survey was carried out as a part of the ICES co-ordinated herring acoustic survey of the North Sea and adjacent waters. The data from this survey were combined with other surveys in the North Sea to provide an age disaggregated abundance index for use in the assessment process. The assessment will be carried out by the ICES Herring Assessment Working Group (HAWG) to be held in April 2002.

This survey has been carried out every year, at this time, by the Marine Laboratory since 1992. With the exception of 1997 the survey has always been conducted using chartered commercial fishing vessels.

2. SURVEY DESCRIPTION AND METHODS

2.1 Personnel

Dave Reid (Cruise Leader)
Phil Copland (Acoustics)
Stuart Halewood (Acoustics)
Craig Davis (Fish Lab)
Rob Watret (Fish Lab)

2.2 Narrative

Loading of the vessel and installation of container and equipment was carried out on the 5th and was completed successfully. The vessel left Fraserburgh at 1400 on the 10th July and proceeded to Loch Eriboll for a calibration carried out overnight. Survey work began at Cape Wrath on the morning of the 11th. The survey continued in initially poor weather until 21st July when the vessel steamed to Ullapool for half landing and crew change. A second calibration was carried out in Loch Broom on the 21st. The survey continued from the 21st in good weather, until the 28th when the weather deteriorated to gale force, however, the vessel was able to continue the survey to completion on the 29th. A final calibration was carried out at Scapa Flow on the evening of the 29th, although this was somewhat compromised by high winds and tide. The vessel then steamed to Fraserburgh for offloading on the 30th. No time was lost due to weather or mechanical breakdown. One net was seriously damaged on a wreck.

2.3 Survey design

The survey design (Figure IIA.1) was selected to cover the area in three levels of sampling intensity based on herring densities found in 1991-2000. Areas with highest intensity sampling had a transect spacing of 4.0 nautical miles, areas with medium intensity sampling had a transect spacing of 7.5 nautical miles and lower intensity areas a transect spacing of 15 nautical miles. The track layout was systematic, with a random start point. The ends of the tracks were positioned at ½ the actual track spacing from the area boundary, giving equal track length in any rectangle within each intensity area. Where appropriate the between-track data could then be included in the data analysis. Between track data were abandoned at the westward end of all transects, and on the eastward ends between 56° 45' and 58° 00'N, along the coast of the Outer Hebrides. The survey area was within an area defined by 56 and 60.5°N, and the shelf break in the west and the Scottish coast or the 3°W line in the east.

2.4 Calibration

Three calibrations were carried out, at the beginning, middle and end of the survey. The first two calibrations were carried out in ideal conditions, and the constants agreed to within 0.1dB (Table IIA.1). The calibration showed a slightly lower sensitivity in the system and this is being investigated. The final calibration was carried out in rough weather, and so the data were not used in this analysis. All procedures were according to those defined in the survey manual.

2.5 Acoustic data collection

The survey was carried out using a Simrad EK500 38 kHz sounder echo-integrator, the system settings are given in Table IIA.1. Further data analysis was carried out using Sonar Data Echoview and Marine Laboratory Analysis systems. Data from the echo integrator were summed over quarter hour periods (2.5Nm at 10 knots). The survey was restricted to hours of daylight between 0300h and 2300h UTC. A total of 2810 nautical miles of track were recorded. Echo integrator data was collected from 9 metres below the surface (transducer at 5m depth) to 1m above the seabed. Data were archived as EchoView files and stored on CDR.

2.6 Biological data - fishing trawls

53 trawl hauls (Figure IIA.1 & Tables IIA.2 & IIA.3) were carried out opportunistically during the survey on the denser echo traces. All trawls were carried out using a PT160 pelagic trawl with a 20mm cod end liner. A scanning netsonde was mounted on the headline. 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 for all fish aged. An eight stage maturity scale was used. Immature fish were defined as stages 1 & 2.

2.7 Hydrographic data

No hydrographic data was collected

2.8 Data analysis

EDSUs were collected at 15 minute intervals using a simulated log speed of 10 knots representing 2.5 n.mi. per EDSU. The data were divided into four categories, by visual inspection of the echo-sounder paper record, EchoView data and the integrator cumulative output. The data were categorised as "herring traces", "probably herring traces", "probably not herring traces" which were presumed to be mainly gadoids and a species mixture category. Data were analysed using rectangles of 15 by 15'.

Target strength to length relationships used were those recommended by the acoustic survey planning group (ICES 1994).

For herring	$TS = 20\log_{10}L - 71.2$ dB per individual
For mackerel:	$TS = 20\log_{10}L - 84.9$ dB per individual
For gadoids:	$TS = 20\log_{10}L - 67.5$ dB per individual
For sprat:	$TS = 20\log_{10}L - 71.2$ dB per individual

The herring data from the trawl hauls were used to divide the area into seven strata based on length distributions and geographic criteria. The seven regions (Fig. IIA.1) were:

I. Ullapool
II. North Minch
III. Mid Minch
IV. South Minch
V. West Hebrides
VI. Lewis
VII. North VIa(N)

The first three strata were based on single hauls with small numbers of herring in each. However, they also presented dramatically different length frequencies, and so were included for this reason. It should be borne in mind that trawling in the Minch area is difficult due to the topography and the presence of fixed gear. This made it impossible to obtain further samples.

The length frequencies are presented in Table IIA.4. The overall age length key is presented in Table IIA.5.

3. RESULTS AND DISCUSSION

3.1 Acoustic data

The geographical distribution of the NASC values assigned to herring are presented in Figure IIA.2. The main areas of concentration were; South of Barra head, along the shelf break and NW of Lewis. It should be noted that these values do not include herring in the mixture category. The most important of these were in the are between 3 and 4^{o}W.

3.2 Biological data

A total of 53 trawl hauls were carried out, the results of these are shown in Tables IIA.2 & IIA.3. 38 hauls contained more than 50 herring and these hauls were used to define 7 survey sub areas (Figure IIA.3). Herring was present in 42 hauls. Other hauls were mostly dominated by young gadoids, or were unsuccessful. Although the catches in the Minch (hauls 3 & 4) contained less than 50 fish, they were considered as quite different to the fish in other areas, and so were used to define the "North Minch" and "Mid Minch" areas. The "West Hebrides" sub area covered all of the deeper water. Based on the mean lengths in the trawl hauls, there was no basis for separating this area into two as has been done in previous years.

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:

$W = 0.003633.L^{-3.266}$ g L measured in cm

This was a steeper curve than in 2000 with a higher coefficient. There was a good coverage of herring trawl hauls across the area. All major concentrations were well characterised biologically from these trawls.

3.3 Biomass estimates

The total biomass estimates for the survey were:

Category 1 herring 310,200 tonnes 71%
Category 2 herring 61,200 tonnes 14% Herring in mixture 65,500 tonnes 15%

Total herring 436,900 tonnes

Spawning stock biomass 409,840 tonnes 94%
Immature 27,060 tonnes

The survey included all of ICES sub-division VIa(N) plus the area between 3 and 4^{o}W. The estimates for Via(N) alone were:

Total herring 353,700 tonnes

Spawning stock biomass 327,500 tonnes 94%
Immature 26,200 tonnes

Total abundance (numbers of fish) were:

Total herring 2,802 million
Spawning stock numbers 428 million
Immature numbers 2374 million

The stock estimate for VIa(N) is down substantially by approximately 29% from 2000 (500,580 to 353,760 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 decreased by 26% (443,850 to 327,500 tonnes) from 2000 to 2001. Examination of the abundance and biomass distribution (Figure IIA.4) shows that large amounts of herring were identified just to the east of 4^{o}W. This was much less apparent in the 2000 survey. The comparative figures for total survey area biomass were; 523,580 tonnes in 2000 and 436,900 tonnes in 2001, a reduction of 16%. For SSB the figures were 464,240 and 409,840 tonnes respectively, a reduction of 12%. It therefore seems possible that a least some of the herring seen in the area between 3 and 4^{o}W may be considered as VIa(N) fish. A breakdown of these data by age class is provided in Table IIA.6.

There were also continued indications of changes in the age and maturity structure of the stock (see Table IIA.5). In 1998, 87% of the two ringers were mature, in 1999 64% were mature and in 2000 only 46% were mature. In 2001 the pattern returned to that of 1998 with 93% of the 2 ringers being mature. The proportion of older fish (4+) in the stock increased from 34% in 1998 and 41% in 1999 to 62.5% in 2000, but dropped this year to 41%. This can be compared with 55% in 1995, 43% in 1996 and 16.6% in 1997. The 2 ring group was very strong this year (1,045 million fish) compared to 2000 (361 million fish), approximately a three fold increase. This may indicate the presence of new strong year class. The very strong 5 ring group this year was also seen as a strong 3 ring group in the 1999 survey and as 4 ring in 2000. The mean weight at age in the stock also shows a slight change with the older fish (4+) being heavier than in 2000, and the younger ones being slightly lighter, this is reflected in the larger coefficient in the weight length relationship.

The main concentrations were found at Barra Head, off the coast of Lewis and along the shelf edge North and west of Lewis (Figures 5 & 6). However, as in 2000 the fish appeared to have a wider spread than was seen in previous years. Also in a similar pattern to 2000, there were more, large, fish seen along the shelf break in the southern part of the survey area, and very few herring seen south of 56^{o} 30'N.

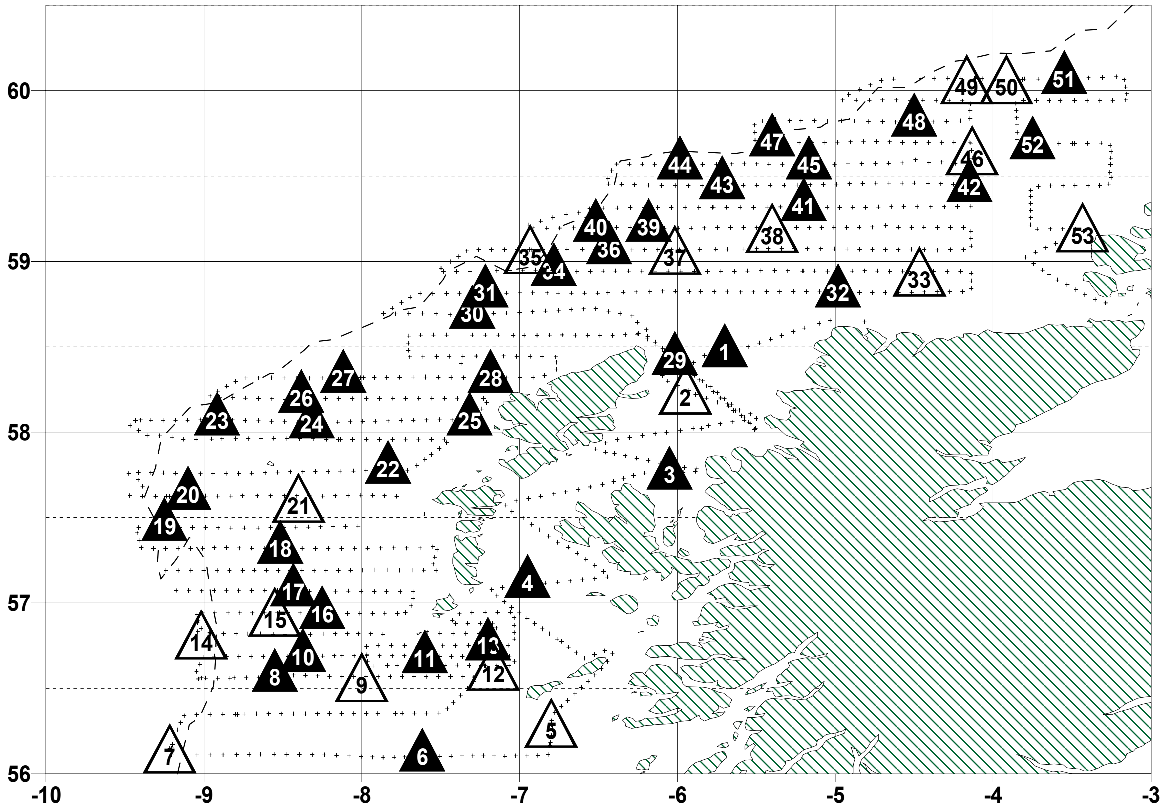

Figure IIA.1 Map of the west of Scotland showing cruise track and positions of fishing trawls undertaken during the July 2001 west coast acoustic survey on MFV Taits. Filled triangles indicate trawls in which significant numbers of herring were caught, whilst open squares indicate trawls with few or no herring.

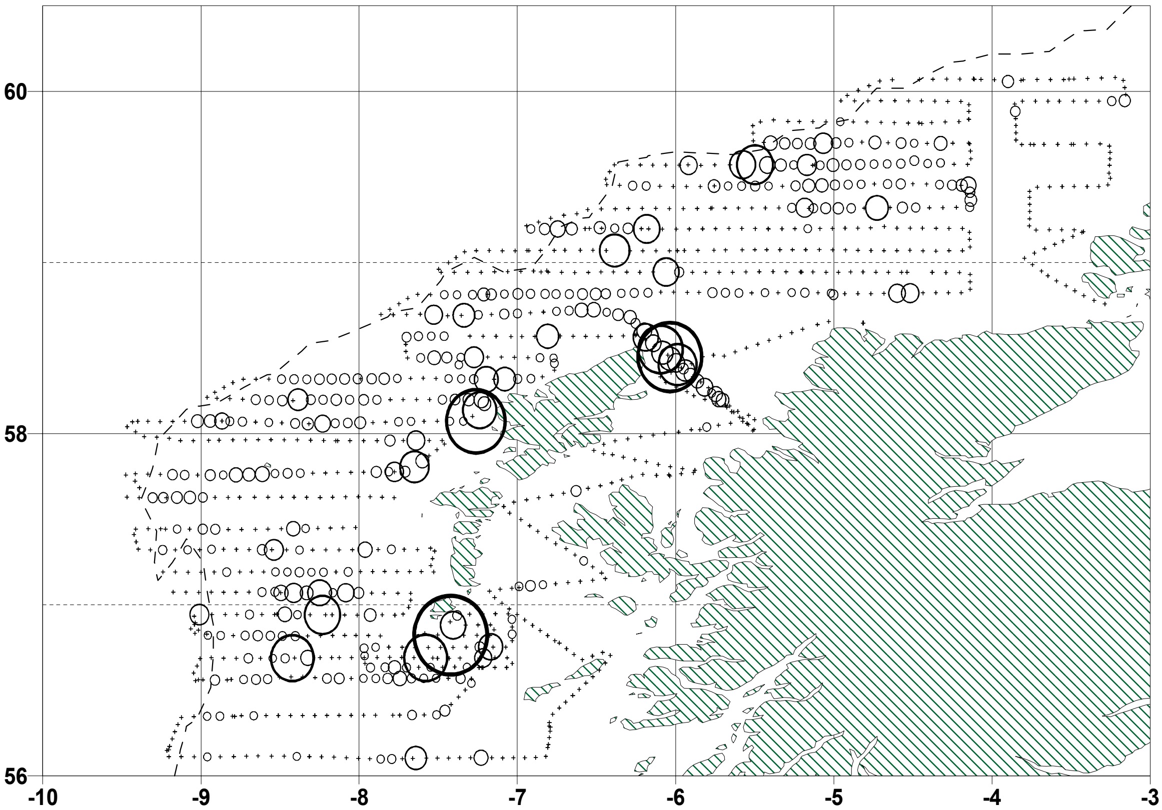

Figure IIA.2 Post plot showing the distribution of total herring NASC values (on a proportional square root scale relative to the largest value of 3,200) obtained during the July 2001 west coast acoustic survey on MFV Taits. Crosses indicate zero values.

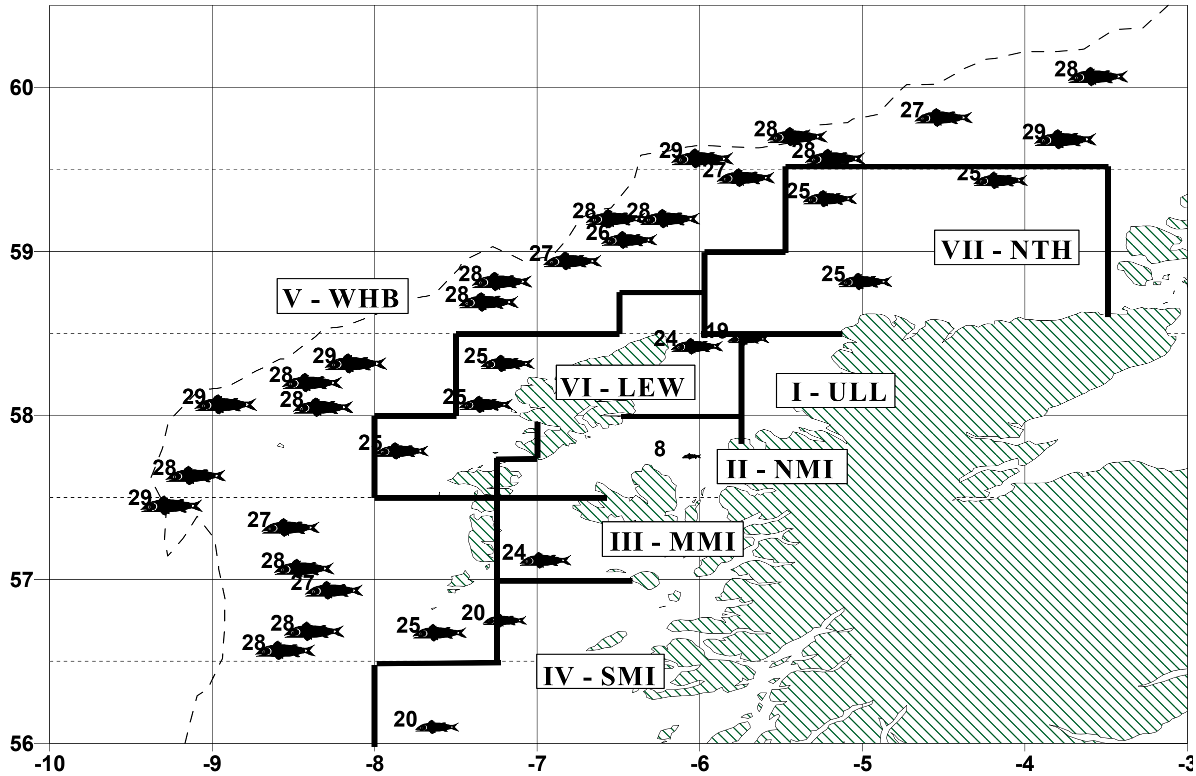

Figure IIA.3 Post plot showing the mean length of herring caught in the trawl hauls carried out during the July 2001 west coast acoustic survey on MFV Taits. The plot also shows the area strata used for combining data from the trawl hauls

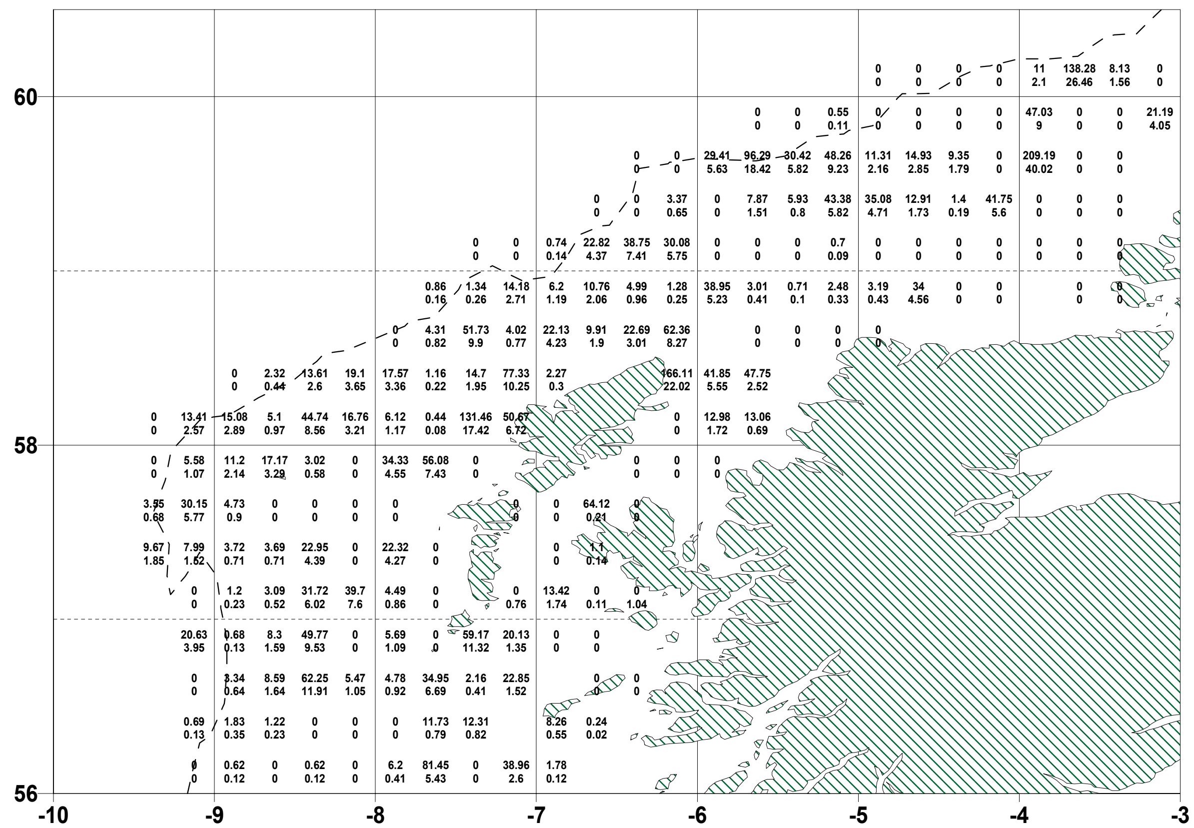

Figure IIA.4 Post plot showing the herring numbers in millions (top) and biomass in thousands of tonnes (bottom) by quarter ICES rectangle obtained during the July 2001 west coast acoustic survey on MFV Taits

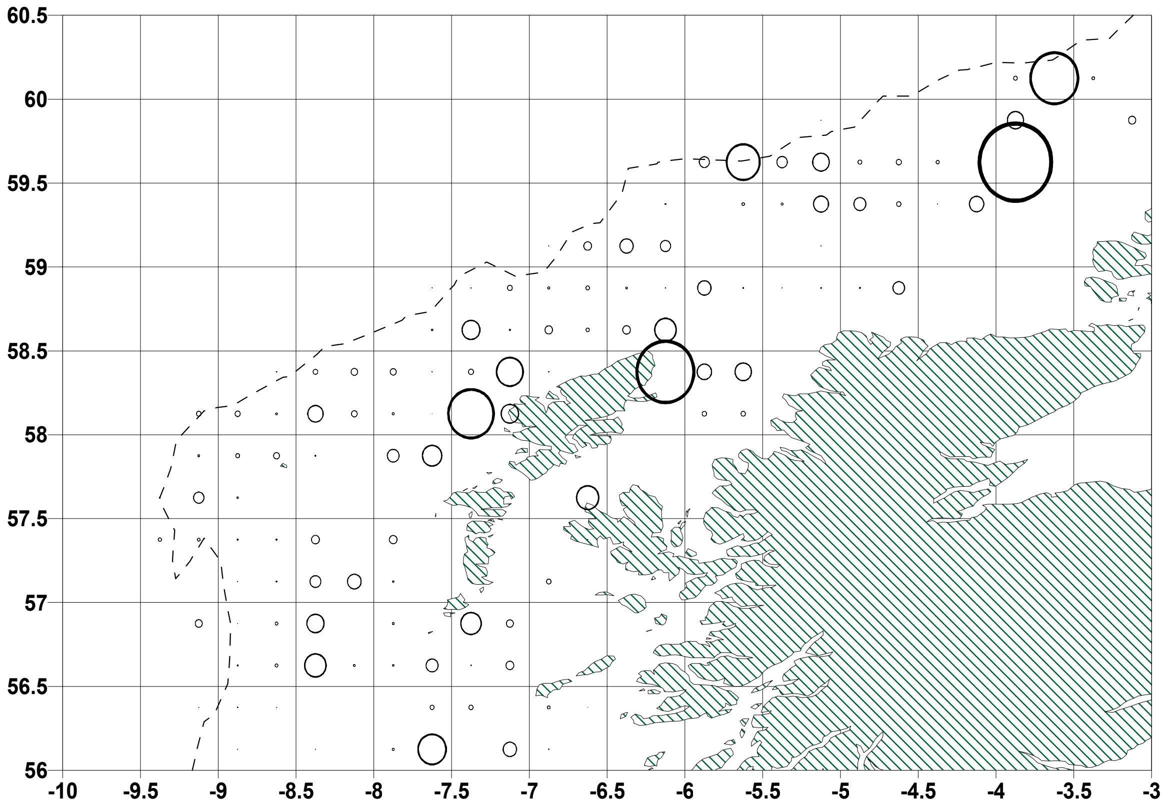

Figure IIA.5 Bubble plot of abundance (numbers) by quarter ICES rectangle for the west coast acoustic survey MFV Taits July 2001.

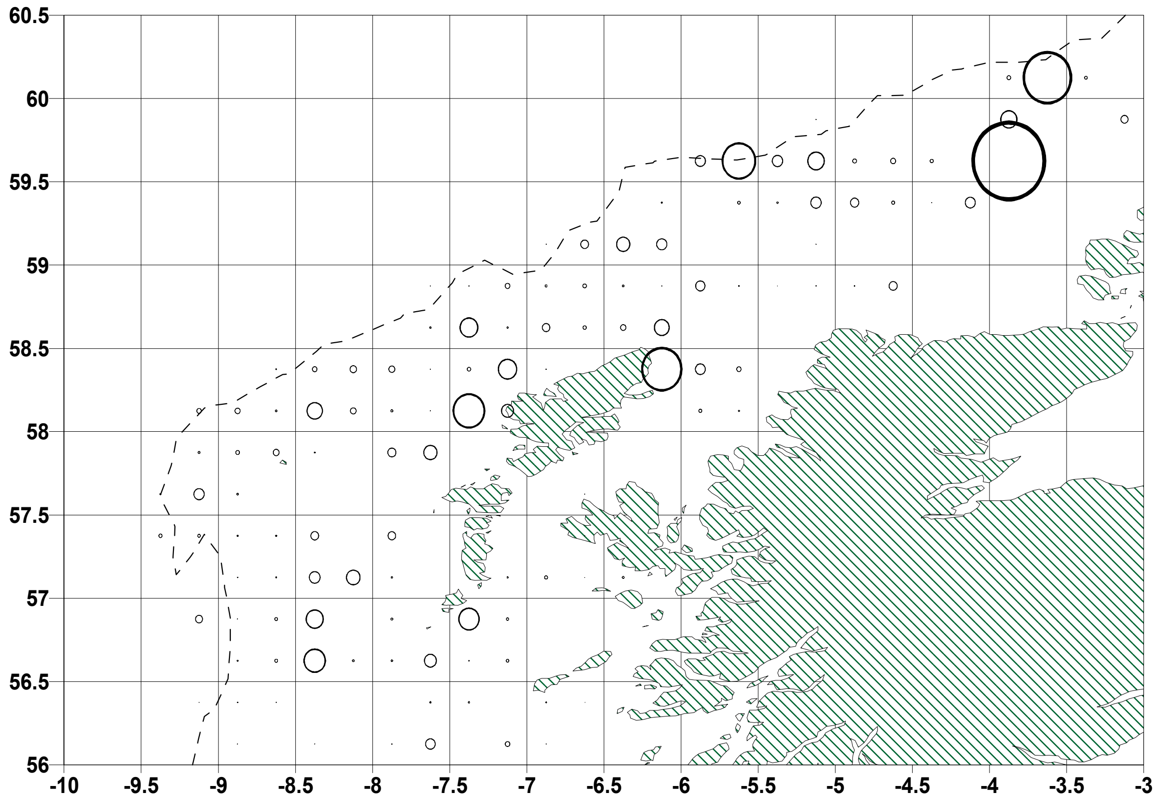

Figure IIA.6 Bubble plot of biomass (tonnes) by quarter ICES rectangle for the west coast acoustic survey MFV Taits July 2001.

Table IIA.1. Simrad EK500 and analysis settings used on the July 2001 west coast of Scotland herring acoustic survey.

Transceiver Menu	
Frequency	38 kHz
Sound speed	1500 m.s^{-1}
Max. Power	2000 W
Equivalent two-way beam angle	-20.6 dB
Default Transducer Sv gain	26.5 dB
3 dB Beamwidth	7.1°
Calibration details	
TS of sphere	-42.36 dB
Range to sphere in calibration	9.80
Measured NASC value for calibration	2920
Calibration factor for NASCs	0.727
Calibration constant for MILAP (optional)	0.80 at -35 dB
Log Menu	
Simulated	2.5 n.mi. at 10 knots
Operation Menu	
Ping interval	1 s at 100 m range
	1.5 s at 250 m range
	2.5 at 500 m range
Analysis settings	
Bottom margin (backstep)	0.5 m
Integration start (absolute) depth	11 m
Range of thresholds used	-70 to -50 dB

Table IIA.2 Details of the fishing trawls taken during the West Coast acoustic survey, July 2001; Trawl depth = depth (m) of headrope *if net is on bottom; Gear type P=pelagic, D=demersal, O=other; Duration of trawl (minutes); Total catch [state in number or weight]; Use h=used to qualify herring acoustic data, s= used to qualify sprat acoustic data (blank if neither).

Haul	Date	Latitude (°N)	Longitude (°W)	Time (UTC)	Water Depth	Trawl Depth	Gear Type	Duration	Use	Catch number
1	11/7/01	58 28.35	5 41.61	1230	125	125	P	24	H	77
2	11/7/01	58 14.57	5 56.97	1700	100	100	P	30		1
3	12/7/01	57 45.24	6 03.10	1030	120	120	P	25	H	34
4	12/7/01	57 06.65	6 57.35	1900	125	125	P	25	H	332
5	13/7/01	56 18.25	6 48.15	0745	60	60	P	25		90
6	13/7/01	56 06.13	7 37.19	1315	130	130	P	15	H	3107
7	13/7/01	56 08.61	9 13.08	2000	260	70	P	30		
8	14/7/01	56 34.18	8 33.05	1515	150	150	P	15	H	3910
9	14/7/01	56 33.88	9 00.10	1730	140	140	P	20		
10	14/7/01	56 41.24	8 23.38	2145	125	125	P	15	H	5445
11	15/7/01	56 40.51	7 36.46	0540	80	80	P	30	H	3068
12	15/7/01	56 38.00	7 09.90	0950	170	170	P	10		54
13	15/7/01	56 45.14	7 11.92	1645	100	100	P	15	H	12620
14	16/7/01	56 49.41	9 00.64	0840	125	125	P	25		
15	16/7/01	56 56.95	8 33.39	1220	130	130	P	35		
16	16/7/01	56 56.43	8 14.65	1440	130	130	P	12	H	2674
17	16/7/01	57 04.17	8 25.54	2130	140	140	P	15	H	1104
18	17/7/01	57 19.29	8 30.95	1300	140	140	P	15	H	2747
19	17/7/01	57 26.70	9 15.31	1845	155	155	P	30	H	403
20	18/7/01	57 37.51	9 05.51	1830	150	150	P	30	H	547
21	18/7/01	57 37.20	9 23.78	1120	200	200	P	20		697
22	18/7/01	57 46.64	7 50.40	1825	130	130	P	20	H	1368
23	19/7/01	58 04.44	8 54.87	1000	170	170	P	15	H	1724
24	19/7/01	58 03.32	8 18.94	1300	135	135	P	15	H	336
25	19/7/01	58 03.79	7 19.40	1740	125	125	P	10	H	1086
26	19/7/01	58 11.92	8 22.61	2315	130	130	P	35	H	78
27	20/7/01	58 19.32	8 07.04	0850	135	135	p	30	H	69
28	20/7/01	58 18.99	7 10.62	1330	120	120	P	30	H	787
29	22/7/01	58 25.31	6 00.56	1530	90	90	P	10	H	761
30	22/7/01	58 41.51	7 18.08	2115	95	95	P	30	H	248
31	23/7/01	58 48.93	7 13.34	0630	110	110	P	15	H	297
32	23/7/01	58 49.50	4 59.95	1425	105	105	P	20		19
33	23/7/01	58 56.55	4 27.27	2025	75	75	P	5		
34	24/7/01	58 56.77	6 47.44	0840	165	165	P	30	H	10702
35	24/7/01	59 04.26	6 55.96	1440	185	185	P	30		319
36	24/7/01	59 04.15	6 25.51	1750	105	105	P	43	H	2082
37	24/7/01	59 04.10	6 00.45	2030	75	75	P	10		3
38	25/7/01	59 11.75	5 23.56	1140	85	85	P	20		
39	25/7/01	59 111.97	6 10.80	1515	110	110	P	25		30
40	25/7/01	59 11.95	6 30.87	1740	115	115	P	15	H	1431
41	26/7/01	59 19.30	5 12.50	0515	110	110	P	20	H	76
42	26/7/01	59 25.93	4 08.60	1045	110	110	P	30	H	803
43	26/7/01	59 26.65	5 43.27	1655	120	120	P	30	H	700
44	26/7/01	59 34.07	5 58.86	2220	130	130	P	20	H	363
45	27/7/01	59 34.13	5 09.72	0530	130	130	P	18	H	55
46	27/7/01	59 39.00	4 08.37	1120	100	100	P	15		
47	27/7/01	59 41.87	5 23.52	1605	140	140	P	25	H	228
48	27/7/01	59 48.82	4 29.94	2120	125	125	P	10	H	113
49	28/7/01	60 04.33	4 09.54	0915	150	150	P	25		
50	28/7/01	60 3.76	3 54.92	1155	125	125	P	20		23
51	28/7/01	60 04.24	3 32.77	1415	135	135	P	20	H	779
52	28/7/01	59 41.42	3 45.23	2125	135	135	P	20	H	194
53	29/7/01	59 12.12	3 26.23	1010	80	80	p	5		2

Table IIA.3 Catch composition by trawl haul on the west coast herring acoustic survey. FRV *Taits* (10 - 30 July 2001)

	Haul	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
	Catch																	
Herring	*Clupea harengus*	59	1	34	27	6	366		3696		5445	3068	5	12620			2674	1104
Sprat	*Spratus spratus*					72	43											
Mackerel	*Scomber scombrus*								187				1					
Horse mackerel	*Trachurus trachurus*																	
Blue whiting	*Micromesistius poutassou*						11		23				36					
Whiting	*Merlangius merlangius*				290	12	2						1					
Norway pout	*Trisopterus esmarrki*	18					2671		4				11					
Haddock	*Melanogrammus aeglifinus*				14		13											
Gurnards	Ingala spp.													1				
Dogfish																		
Spurdog	Squalus acanthius				1													
	Argentinia silus																	
	A. sphyraena												1		13			
Poor cod																		
Saithe	Pollachius virens														1			1
Cod	Gadus morhua																	
Blue mouth																		
Megrim																		
Lemon sole																		
Common dab																		
Ling																		
	Sebastes viviparus																	
Boar fish													1					
Sand Eel				many														
Hake	Merluccius merluccius						1											

Table IIA.3(cont.) Catch composition by trawl haul on the west coast herring acoustic survey. FRV *Taits* (10 - 30 July 2001)

	Haul	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**
	Catch																	
Herring	*Clupea harengus*	2712	145	503	4	1266	1638	239	1034	73	66	745	760	241	296	18		826
Sprat	*Spratus spratus*								6									
Mackerel	*Scomber scombrus*	27	172	22	60		6				1	19	1	5	1	1		12
Horse mackerel	*Trachurus trachurus*		2		6													34
Blue whiting	*Micromesistius poutassou*	8	69		609		76					1						220
Whiting	*Merlangius merlangius*		1	1		2		5	22			5						120
Norway pout	*Trisopterus esmarrki*		12	18	1	9		63	22	1		4					many	9003
Haddock	*Melanogrammus aeglifinus*			2	3	1	4	28	2	1	2	12						412
Gurnards	Ingala spp.			1						2		1						18
Dogfish																		2
Spurdog	Squalus acanthius																	
	Argentinia silus																	10
	A. sphyraena		1		13													28
Poor cod																		1
Saithe	Pollachius virens				1			1										4
Cod	Gadus morhua																	2
Blue mouth																		2
Megrim																		2
Lemon sole																		2
Common dab																		
Ling																		
	Sebastes viviparus									1								
Boar fish			1															
Sand Eel																		
Hake	Merluccius merluccius																	

Table IIA.3(cont.) Catch composition by trawl haul on the west coast herring acoustic survey. FRV *Taits* (10 - 30 July 2001)

	Haul	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**
	Catch																			
Herring	*Clupea harengus*		2076			24	1431	72	792	696	361	55		228	66		4	148	177	
Sprat	*Spratus spratus*								4											
Mackerel	*Scomber scombrus*	7	5	2		6		4		4					1		2	3		2
Horse mackerel	*Trachurus trachurus*	8									2						1			
Blue whiting	*Micromesistius poutassou*	248																627		
Whiting	*Merlangius merlangius*	3		1													4		1	
Norway pout	*Trisopterus esmarrki*	31							4				man		45		10		11	
Haddock	*Melanogrammus aeglifinus*	13							3						1				2	
Gurnards	Ingala spp.	2																1	2	
Dogfish																				
Spurdog	Squalus acanthius																			
	Argentinia silus																			
	A. sphyraena	4																		
Poor cod																				
Saithe	Pollachius virens	1															1			
Cod	Gadus morhua																			
Blue mouth		1																		
Megrim																				
Lemon sole																				
Common dab																			1	
Ling																				
	Sebastes viviparus																			
Boar fish																				
Sand Eel																				
Hake	Merluccius merluccius																			

Table IIA.4 Herring length frequency proportion by trawl haul by sub- area for west coast acoustic survey FRV *Taits* (10 – 26 July 2000).

Length in cm, weight in g, TS=target strength in dB.

Haul No	Area I		Area II		Area III		Area IV			Area V											
	1	Mean	3	Mean	4	Mean	6	13	Mean	8	10	11	16	17	18	19	20	23	24	27	30
6.5			2.9	2.9																	
7.0			17.6	17.6																	
7.5			55.9	55.9																	
8.0			20.6	20.6																	
8.5			2.9	2.9																	
9.0																					
16.0																					
16.5																					
17.0																					
17.5																					
18.0																					
18.5																					
19.0	1.7	1.7																			
19.5	8.5	8.5					0.3	2.2	1.2												
20.0	20.3	20.3			3.7	3.7	1.1	8.3	4.7												
20.5	27.1	27.1					10.1	15.6	12.8												
21.0	13.6	13.6					14.5	22.5	18.5												
21.5	15.3	15.3			7.4	7.4	19.9	20.3	20.1												
22.0	8.5	8.5					12.0	13.4	12.7												
22.5	1.7	1.7					11.2	6.2	8.7												
23.0	3.4	3.4					4.1	4.0	4.0												
23.5							2.5	1.8	2.1												
24.0							1.9	0.7	1.3												
24.5					3.7	3.7	3.6	0.4	2.0												
25.0					3.7	3.7	5.5	0.7	3.1			0.4									
25.5					3.7	3.7	6.0	1.5	3.7			5.1	0.8		0.3						
26.0					18.5	18.5	3.8	1.1	2.5	0.6		13.6	2.9								
26.5					18.5	18.5	1.9	0.4	1.1	0.9		20.8	5.5		1.5				0.4		
27.0					11.1	11.1	1.1	1.1	1.1	0.9	0.8	19.9	6.8		2.1		0.4		0.4		
27.5					3.7	3.7	0.3		0.1	1.2	0.8	15.3	13.1	1.5	4.4		0.4		1.3		1.7
28.0										2.1	1.9	9.3	11.0	6.0	5.6		0.4		2.5		2.9
28.5										5.1	7.2	3.0	12.0	9.3	16.2		2.4		5.4		6.6
29.0										10.1	12.7	3.8	15.7	11.2	14.2	0.7	12.5	2.2	10.0	3.0	9.5
29.5					3.7	3.7				16.4	23.7	1.3	17.8	17.7	24.5	0.7	25.6	6.7	27.2	7.6	24.1
30.0							0.3		0.1	25.0	19.3	2.5	7.9	24.4	15.0	6.9	19.3	14.6	22.6	24.2	19.1
30.5					3.7	3.7				16.7	17.9	2.5	5.0	15.8	12.7	13.1	20.3	23.0	20.5	22.7	24.9
31.0					3.7	3.7				14.9	6.9	1.7	1.3	10.1	2.7	30.3	10.3	26.6	5.0	25.8	5.0
31.5										4.5	6.1	0.8	0.3	3.0	0.6	23.4	6.0	14.6	3.3	6.1	2.5
32.0					3.7	3.7				1.5	2.8			0.7	0.3	15.9	2.4	9.3	1.3	9.1	0.8
32.5										0.3						5.5		2.7			2.1
33.0														0.3		2.1		0.4			0.4
33.5																1.4					
34.0																				1.5	
34.5																					
																					0.4
Number	59		34		27		366	12620		3696	5445	3068	2674	1104	2712	145	503	1638	239	66	241
Mean lgt	18.8	18.8	8.0	8.0	24.5	24.5	20.5	19.5	20.0	27.9	27.9	25.3	26.5	27.7	27.2	29.3	28.0	28.8	27.8	28.6	27.9
Mean wt	53	53	3	3	130	130	73	61	67	193	191	140	163	189	178	224	195	213	190	209	192
TS/ind	-45.7	-45.7	-53.1	-53.1	-43.4	-43.4	-44.9	-45.4	-45.1	-42.3	-42.3	-43.1	-42.7	-42.3	-42.5	-41.9	-42.2	-42.0	-42.3	-42.1	-42.3
TS/kg	-32.9	-32.9	-28.3	-28.3	-34.5	-34.5	-33.5	-33.2	-33.4	-35.1	-35.1	-34.6	-34.8	-35.1	-35.0	-35.4	-35.1	-35.3	-35.1	-35.3	-35.1

Table IIA.4(cont.) Herring length frequency by trawl haul by sub area. MFV *Taits* (10 to 30 July 2001) mean length - cm, mean weight - g, target strength - dB)

	Area V (cont.)												Area VI					Area VII		
Haul No	31	34	36	40	43	44	45	47	48	51	52	Mean	22	25	28	29	Mean	41	42	Mean
15.5																				
16.0																				
16.5																				
17.0																				
17.5																0.3	0.1			
18.0																2.5	0.6			
18.5																2.8	0.7			
19.0																4.7	1.2			
19.5																4.2	1.1			
20.0																4.2	1.1		1.4	0.2
20.5																2.2	0.6		0.8	0.4
21.0														0.8	0.3	1.2	0.6			
21.5													0.2			1.4	0.4		1.8	0.4
22.0		0.2										0.0	0.2	0.3	0.3	0.5	0.3		0.4	0.2
22.5		0.2	0.2	0.3							0.6	0.1	2.1	2.0		5.1	2.3		3.8	1.9
23.0			6.9		0.1							0.6	13.3	6.7	1.7	12.1	8.4	5.6	10.2	7.9
23.5		1.0	8.1	0.5	0.4					0.7	1.1	1.3	16.4	11.6	8.2	16.3	13.1	4.2	15.9	10.0
24.0		4.1	16.8	0.5	4.5		1.8		3.0		0.6	2.6	19.9	19.6	19.1	13.8	18.1	27.8	21.2	24.5
24.5	0.3	3.9	10.1	0.5	10.2		3.6	0.9	4.5	1.4	1.7	3.0	12.6	16.0	21.2	9.1	14.7	18.1	24.6	21.3
25.0	0.7	7.5	7.5	2.5	18.5			0.4	13.6	4.7	6.8	4.4	10.0	13.9	19.5	8.2	12.9	25.0	12.1	18.6
25.5	2.7	4.8	4.0	2.8	12.8	0.6	7.3	1.3	9.1	4.1	3.4	4.1	3.8	10.0	8.9	7.1	7.4	8.3	6.1	7.2
26.0	3.4	8.5	4.6	3.6	11.6	0.6	5.5	3.5	9.1	4.1	4.5	5.5	5.9	5.6	7.1	2.5	5.3	4.2	0.8	2.5
26.5	9.8	13.8	6.9	3.8	9.1	0.6	3.6	9.2	4.5	7.4	3.4	7.7	4.3	3.3	3.4	0.3	2.8	1.4	1.1	1.3
27.0	18.9	22.0	7.5	12.4	14.5	8.6	16.4	14.9	21.2	14.9	5.1	15.2	7.1	6.3	5.5	1.2	5.0			
27.5	22.6	13.3	10.3	19.4	8.5	12.2	18.2	18.4	12.1	16.9	5.6	15.6	2.4	1.6	2.7		1.7	1.4		0.7
28.0	19.3	11.6	9.3	16.8	6.2	16.3	29.1	16.7	12.1	16.9	9.6	15.6	1.4	1.4	2.0	0.3	1.3			
28.5	10.8	4.4	4.2	14.5	1.9	11.9	7.3	15.4	9.1	10.8	10.2	10.5	0.5	0.7			0.3	1.4	0.4	0.9
29.0	7.1	2.2	1.0	6.8	1.3	11.9	3.6	7.5	1.5	6.8	14.1	5.9		0.3			0.1	2.8		1.4
29.5	2.0	1.0	0.6	2.8	0.1	10.0		1.8		2.7	9.0	3.2			0.3		0.1		1.1	0.6
30.0	2.0	1.0	0.8	4.3	0.1	6.9		3.5		2.7	7.9	1.7							0.4	0.2
30.5	0.3	0.2	0.4	2.5	0.1	10.0		3.1			8.5	1.2								
31.0			0.4	1.7		6.6	1.8	1.3		3.4	2.8	0.8								
31.5		0.2	0.2	1.5		2.5		0.4		1.4	1.1	0.4								
32.0				1.0		0.8		0.4		0.3	2.8	0.2								
32.5				0.5		0.6		0.9			1.1	0.1								
33.0			0.2	0.3			1.8			0.7		0.1								
33.5				0.3								0.0								
34.0				0.3				0.4		0.7		0.1								
34.5																				
35.0				0.3								0.0								
35.5																				
36.0																				
36.5																				
37.0								0.1												
Number	296	826	2076	1431	696	361	55	228	66	148	177		1266	1034	745	760		72	792	
Mean lgt	28.1	27.2	26.2	28.5	26.5	29.4	27.9	28.4	27.1	28.2	28.8	27.8	25.1	25.2	25.4	23.5	24.8	25.3	24.7	25.0
Mean wt	196	178	159	207	164	228	194	205	176	200	216	191	136	139	143	112	133	139	129	134
TS/ind	-42.2	-42.5	-42.8	-42.1	-42.7	-41.8	-42.3	-42.1	-42.5	-42.2	-42.0	-42.3	-43.2	-43.2	-43.1	-43.7	-43.3	-43.1	-43.3	-43.2
TS/kg	-35.2	-35.0	-34.8	-35.3	-34.9	-35.4	-35.1	-35.2	-35.0	-35.2	-35.3	-35.1	-34.6	-34.6	-34.6	-34.3	-34.5	-34.6	-34.5	-34.5

Table IIA.5 Age/maturity-length key for herring (numbers of fish sampled). MFV Taits July 2001

L (cm)	0 Total	1 Total	2		3		4 Total	5 Total	6 Total	7 Total	8 Total	9+ Total	Total
			imm	mat	imm	mat							
6.5	1												1
7.0	6												6
7.5	19												19
8.0	7												7
8.5	1												1
15.5		2											2
16.5		2											2
17.0		12											12
17.5		20											20
18.0		23	1										24
18.5		19	1										20
19.0		22	1										23
19.5		18	2										20
20.0		30	2										32
20.5		28	4										32
21.0		17	5										22
21.5		7	7	3									17
22.0		2	10	8									20
22.5		2	16	34		2							54
23.0			11	78		2							91
23.5		1	15	95									111
24.0		1	9	116	1	6							133
24.5		1	7	133		6		1		1			149
25.0			15	152		20	1		1				189
25.5			6	137	1	45	11	3					203
26.0			3	87	4	86	23	16	1				220
26.5				35	1	89	45	56	6	1			233
27.0				9		55	61	118	12	8			263
27.5				6		27	46	135	32	16	1		263
28.0						16	34	120	54	30	10		264
28.5				1		6	21	77	45	40	24	13	227
29.0						3	13	50	36	39	20	19	180
29.5						1	2	28	13	21	22	20	107
30.0							2	20	18	17	9	6	72
30.5						1	3	9	7	11	4	9	44
31.0								2	5	7	10	10	34
31.5								1	2	7	7	6	23
32.0									2	2	4	5	13
32.5										2	3	3	8
33.0											2	2	4
33.5												1	1
34.0												4	4
35.0												1	1
Total	34	207	115	894	7	366	263	637	234	203	116	99	3175

Table IIA.6 Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age and maturity obtained during the MFV Taits July 2001 herring acoustic survey.

Total area						
Age (ring)	Mean Length (cm)	Mean Weight (g)	Number×10^6	%	Biomass×10^3 T	%
0A	7.5	3.3	64.12	2.3	0.21	0.05
1A	19.2	62.5	285.36	10.2	17.82	4.08
2I	23.2	114.1	74.89	2.7	8.55	1.96
2M	24.5	133.8	970.17	34.6	129.82	29.71
3I	25.7	155.9	3.42	0.1	0.53	0.12
3M	26.4	171.8	257.21	9.2	44.19	10.11
4A	27.3	190.4	213.65	7.6	40.67	9.31
5A	27.7	198.7	532.05	19.0	105.72	24.19
6A	28.2	211.7	165.20	5.9	34.98	8.01
7A	28.6	220.3	126.99	4.5	27.97	6.40
8A	29.2	235.7	65.73	2.3	15.49	3.55
9+	29.9	254.6	43.22	1.5	11.00	2.52
Mean	25.1	155.9				
Total			2802	100.0	436.9	100.0
Immature			2374	15.3	27.1	6.2
Mature			428	84.7	409.8	93.8

APPENDIX IIB DENMARK

Survey report for RV "DANA"
28th June2001 – 11th July 2001

Karl-Johan Stæhr
Danish Institute for Fisheries Research, Dept for sea fishery, Hirtshals, Denmark

1. INTRODUCTION

Since 1991 the Danish institute for Fisheries research has participated in the ICES co-ordinated international hydro acoustic survey on herring in the North Sea, Skagerrak and Kattegat with the responsibility for the survey area in Skagerrak and Kattegat. In 2001 the survey with R/V DANA covered the Skagerrak and Kattegat.

2. SURVEY

2.1 Personnel

During calibration 28/6-1/7

Karl-Johan Stæhr (cruise leader), DIFRES
Bo Lundgren (ass. cruise leader), DIFRES
Torben Filt Jensen, DIFRES
Mogens R. Sørensen, DIFRES
Bo Tegen Nielsen, DIFRES
Claus Halle, DIFRES

During acoustic monitoring 1-11/7

Karl-Johan Stæhr (cruise leader), DIFRES
Torben Filt Jensen (ass. cruise leader), DIFRES
Annegrete D. Hansen (acoustic), DIFRES
Lise Sindahl (fish lab.), DIFRES
Uffe Nielsen (acoustic), DIFRES
Hans Jørgen Christensen (fish lab.), DIFRES
Lotte A. Worsøe (fish lab.), DIFRES
Valeriu Popescu (fish lab.), DIFRES
Inge Holmberg (fish lab.), DIFRES
Ulrik Cold (fish lab.), DIFRES
Bo Tegen Nielsen (electronics), DIFRES

2.2 Narrative

Departure: Hirtshals 28 June 2001 at 2200 hour for calibration.

The departure was delayed from 1200 to 2200 hour due to engine problems on the vessel. Furthermore the departure from the calibration place was delayed by 18 hours due to technical problems with the echosounder and anchor problems.

Visit to harbour 1 July 2001 for exchange of scientific personnel before start of acoustic monitoring.

Arrival: Hirtshals 11 July 2001 at 0600 hour.

2.3 Survey design

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 northwest corner of the survey area. In principal the survey design were planned with north-south survey tracks with a spacing of 10-15 n.mi. in the area west of 10°E. Due to the fixed time periods for fishing this design could not be implemented fully, resulting in a non-standard survey track in the western part of Skagerrak. Along the Swedish coast the transects were orientated east to west with a spacing of 10 n.mi. In Kattegat the survey tracks were zigzags due to depth curves and ship traffic.

2.4 Calibration

The echosounder was calibrated with a standard copper sphere at Bornö, Sweden 29-30 June 2001 (Table IIB.1).

2.5 Acoustic data collection

Acoustic data were collected using a Simrad EY500 38 kHz echo sounder with the transducer in a towed body (Type ES 38-29). The towed body was operated at approx. 3 m depth. The speed of the vessel during acoustic sampling was 8 – 12 knots. Acoustic data were collected for all 24 hours of the day. The sampling unit was 1 n.mi. and data were stored in 1 m intervals for each 1 n.mi on tape. Integration was conducted from 3 – 300 m below the transducer.

2.6 Biological data - fishing trawls

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 in the time intervals 1000 to 1600h and 2000 to 0400h UTC (Table IIB.1). The trawling strategy was made in a way that all depth areas were covered within each geographical strata (see Fig. IIB.2). In the deeper areas midwater hauls were made to establish how deep herring could be found. 1 hour hauls were used as standard during the survey.

The fish caught were sorted into species, and measured for length and weight. Fish were measured to the nearest 0.5 cm total length below and weighed to the 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. Otolith micro-structures formed during the larval period were used for the discrimination of herring race.

2.7 Hydrographic data

In conjunction with trawling, CTD profiles were made with a SeaBird CTD probe. During the survey salinity and temperature were measured at 5 m depth intervals. The distribution of CTD stations is shown in Figure IIB.5.

2.8 Data analysis

Scrutiny of the acoustic data was done for each nautical mile. For each sub-area the mean back scattering cross section was estimated for herring, sprat, gadoids and mackerel. The TS relationships given in the Manual for Herring Acoustic Surveys in ICES Division III, IV, and IVa (ICES 2000) were used.

$$\text{Herring TS} = 20 \log L - 71.2 \text{ dB}$$
$$\text{Sprat TS} = 20 \log L - 71.2 \text{ dB}$$
$$\text{Gadoids TS} = 20 \log L - 67.5 \text{ dB}$$
$$\text{Mackerel TS} = 20 \log L - 84.9 \text{ dB}$$

Where L is the total length in cm. 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 sub-area using the species composition in the trawl hauls. The nearest trawl hauls were allocated to sub-areas 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.

Length-weight relationships by race for the herring were determined from the single fish sampled in each haul for otolith micro-structure analysis.

3. RESULTS AND DISCUSSION

3.1 Acoustic data

The total number of acoustic sample units at 1 n.mi. used in the stock size calculation was 1155. Herring and sprat were not observed in midwater trawl hauls at depths below 150 meters. Therefore, layers below 150 meters were excluded during the estimation.

3.2 Biological data

33 hauls were conducted (16 surface hauls, 6 mid water hauls and 11 bottom hauls (Figs. IIB.3 and IIB.4 and Tables IIB.2 and IIB.3). The total catch was 19,182 kg with a mean catch at 581 kg. Herring was present in 27 of the hauls and was the dominant catch in the fishery with a total catch at 7,932 kg No herring was present in hauls below 150 m depths. Haddock dominated the remaining species with a total catch at 3043 kg mainly taken in the bottom hauls. Krill and jellyfish were also present in high quantities in the catches, totalling 2,353 kg and 2,052 kg respectively.

Keys for length-race, length-age per race and length-weight per race were made for each strata based on the single fish sampled in each haul for micro-structure analysis of the otolith.

Based on the single fish sampled in each haul for otolith micro-structure analysis a maturity-age key was made for both North Sea herring and Western Baltic herring as given in the text table below. For the North Sea autumn spawners all herring at maturity state 3 and up worth were taken as mature.

North Sea autumn spawners:

W-ring	0im	1im	2im	2ma	3im	3ma	4im	4ma	5	6
%	100	100	93	7	90	10	50	50	100	100

For the Western Baltic spring spawners all herring of maturity state 2 and up worth were taken as mature.

Western Baltic spring spawners:

W-ring	1im	1ma	2im	2ma	3im	3ma	4im	4ma	5im	5ma	6	7	8	9	10	11
%	90	10	64	36	31	69	15	85	8	92	100	100	100	100	100	100

The total catch during the survey was 19,182 kg with a mean catch of 581 kg. This is 60% of the catches seen during the survey in 2000, but the mean catch is of the same level as in 1998. For herring the mean catch in all hauls was 240 kg which is 55 % of the mean catch in 2000. For the surface hauls the mean catch was 635 kg witch is 53% of what was seen in 2000. These catches in 2001 were dominated by herring (Table IIB.2). For the bottom hauls the mean catch was 753 kg witch is 56 % of what was seen in 2000. These catches in 2001 were dominated by haddock.

3.3 Biomass estimates

The total biomass estimates for the survey:

North Sea autumn spawning herring 81,162 tonnes 49%
Western Baltic spring spawning herring 85,198 tonnes 51%

Total herring 166,360 tonnes

The age composition and mean weight per age and mean length per age for the two herring stock components in the survey area are given in Table IIB.5.

The biomass of North Sea autumn spawning herring in the survey area was estimated to 81,162 tonnes. This is 17 % of the biomass estimated in 2000 and 50% of the biomass estimated in 1998. Compared to 2000 and 1998 especially the 0 and 1 WR the biomass are much less in 2001 (see text table below).

Biomass estimate per age for North Sea autumn spawning herring 1998 to 2001 in tonnes

	WR									
Year	0	1	2	3	4	5	6	7	8	Total
2001	1427.6	53022.2	20373.9	5118.0	844.3	275.0	101.1			81162.2
2000	5240.6	446190.5	19457.2	1082.7	982.9					472953.8
1998	4450.5	129264.4	19804.0	4484.0	265.8	85.1	73.4		498.1	161163.0

The biomass of the Western Baltic spring spawning herring in the survey area was estimated to be 85,198 t. This is 35 % of the biomass estimated in 2000 and 36 % of the biomass estimated in 1998. Compared to 2000 all the year classes are less in 2001, but especially the 1, 2, 4 and 5 WR. Compared to 1998 especially the 2 and 4 WR are less in 2001 (see text table below).

Biomass estimate per age for Western Baltic spring spawning herring 1998 to 2001 in tonnes

	WR										
Year	1	2	3	4	5	6	7	8	9	10	11	Total
2001	3606.6	34159.2	31981.0	7796.0	5297.8	1838.7	278.7	159.9		45.5	34.3	85197.7
2000	64747.5	133347.6	69313.5	42998.9	25043.5	5839.7	1472.0					342762.7
1998	5587.6	115485.5	59395.7	20021.2	8579.8	3801.6	3119.6	3957.8	863.8	401.2		234800.9

The geographic distribution by number for both stocks are shown in Figure IIB.6. The geographical distribution of the biomass given as % of the total estimated biomass per sub area is given for each stock component in the text tables below.

% of total biomass estimate per sub area for North Sea autumn spawning herring 1998 to 2001

	sub area					
Year	4	5	6	7	8	9
2001	14.2	7.6	16.6	3.7	44.4	13.4
2000	28.7	1.1	32.1	1.1	9.2	27.7
1998	9.5	6.5	15.5	13.2	31.5	23.7

% of total biomass estimate per sub area for Western Baltic spring spawning herring 1998 to 2001

	sub area					
Year	4	5	6	7	8	9
2001	16.8	12.8	12.6	6.0	24.4	27.5
2000	22.9	3.1	36.4	1.5	16.1	20.0
1998	6.5	17.3	6.8	24.3	24.2	20.9

It can be seen that the geographical distribution for both stock components is very variable in this survey area, Skagerrak and Kattegat.

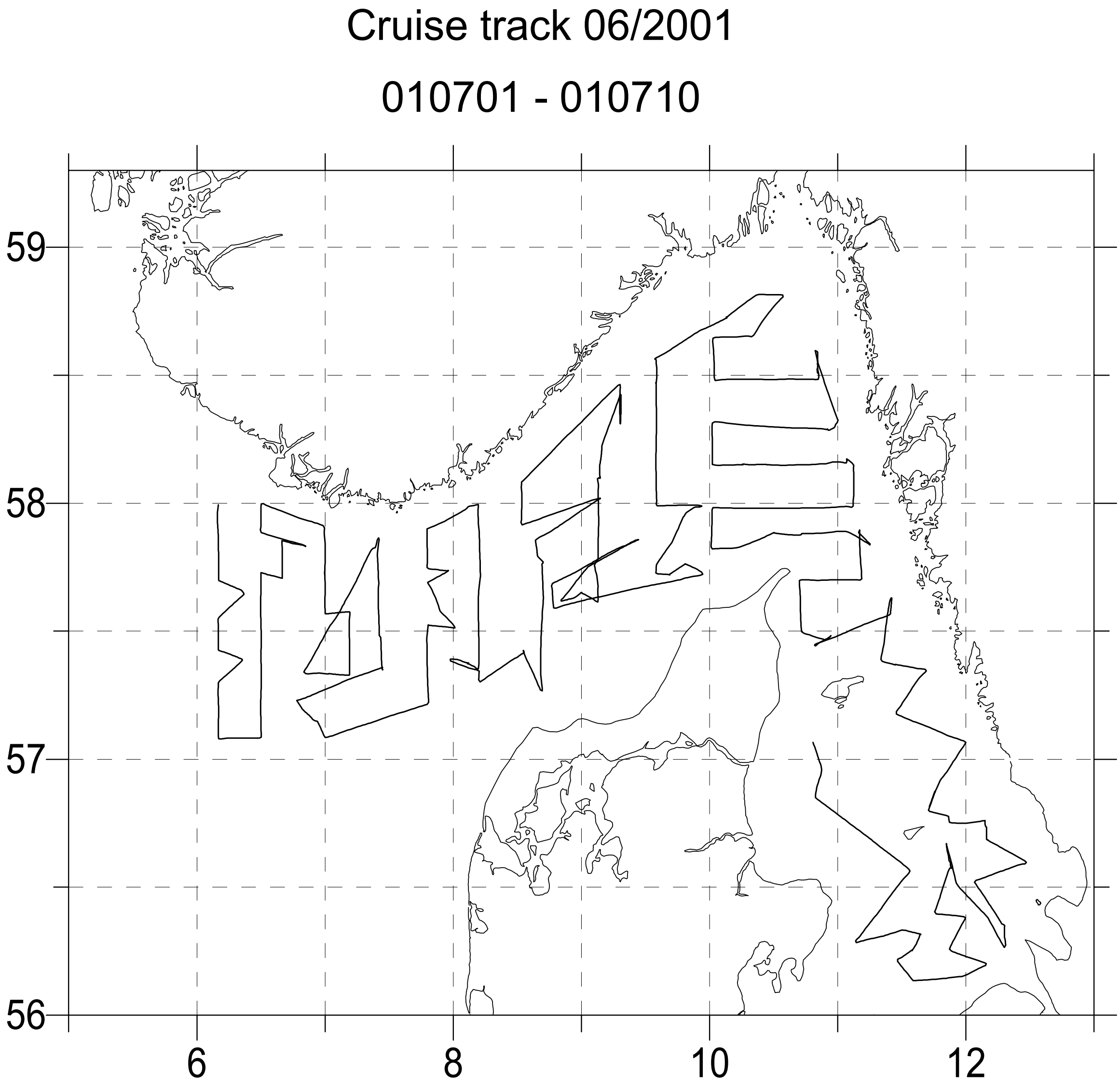

Figure IIB.1 Map of the eastern North Sea., Skagerrak and Kattegat showing cruise track of the FRV Dana during the July 2001 Danish acoustic survey.

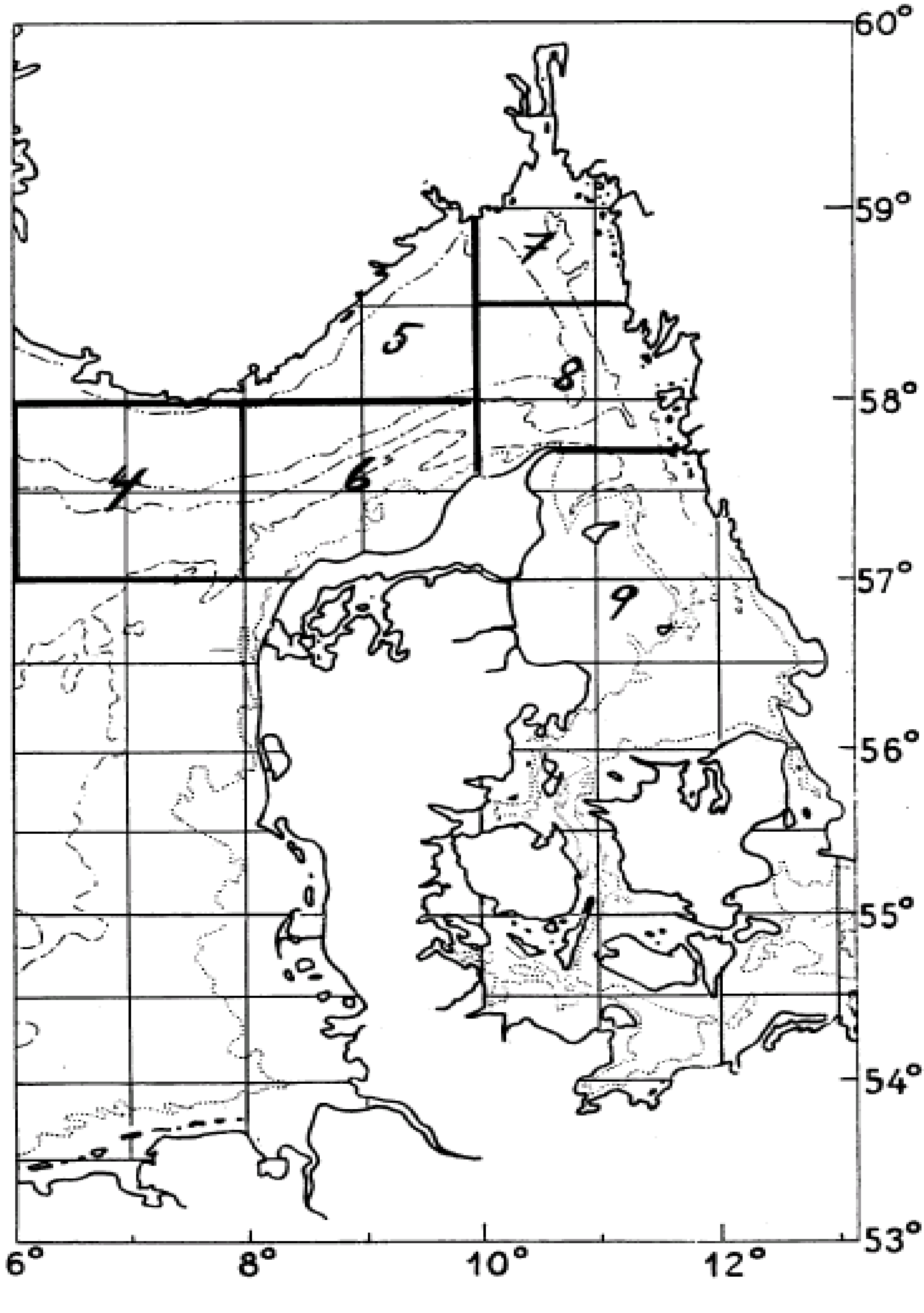

Figure IIB.2 Map of the eastern North Sea., Skagerrak and Kattegat showing sub-areas used in the estimation for the FRV Dana during the July 2001 Danish acoustic survey.

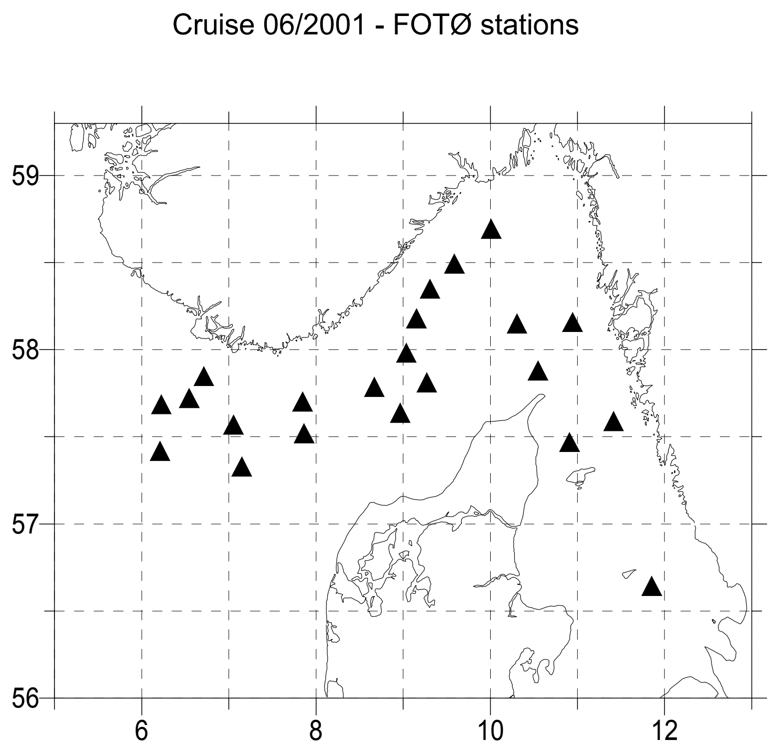

Figure IIB.3 Map of the eastern North Sea, Skagerrak and Kattegat showing locations of pelagic hauls undertaken during the July 2001 Danish acoustic survey.

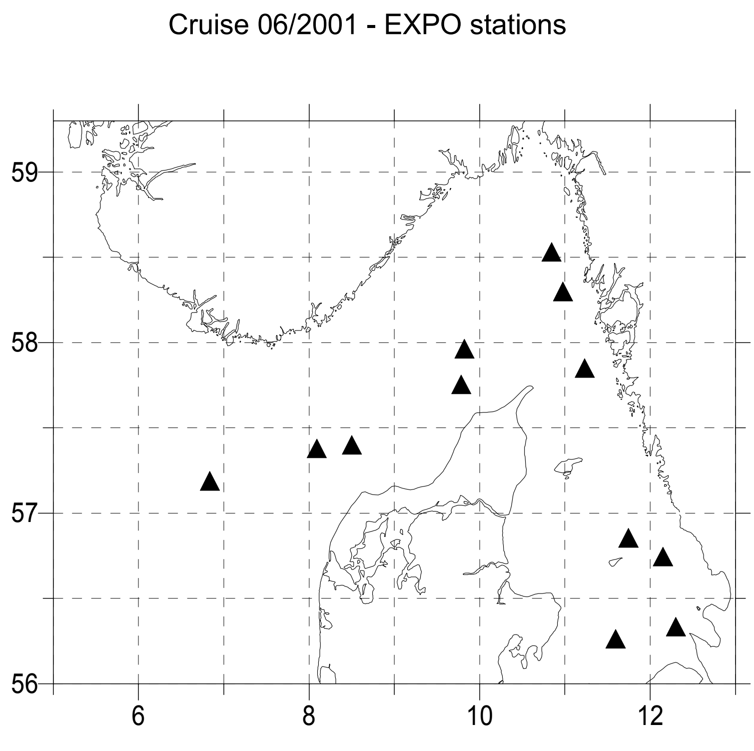

Figure IIB.4 Map of the eastern North Sea, Skagerrak and Kattegat showing locations of demersal hauls undertaken during the July 2001 Danish acoustic survey.

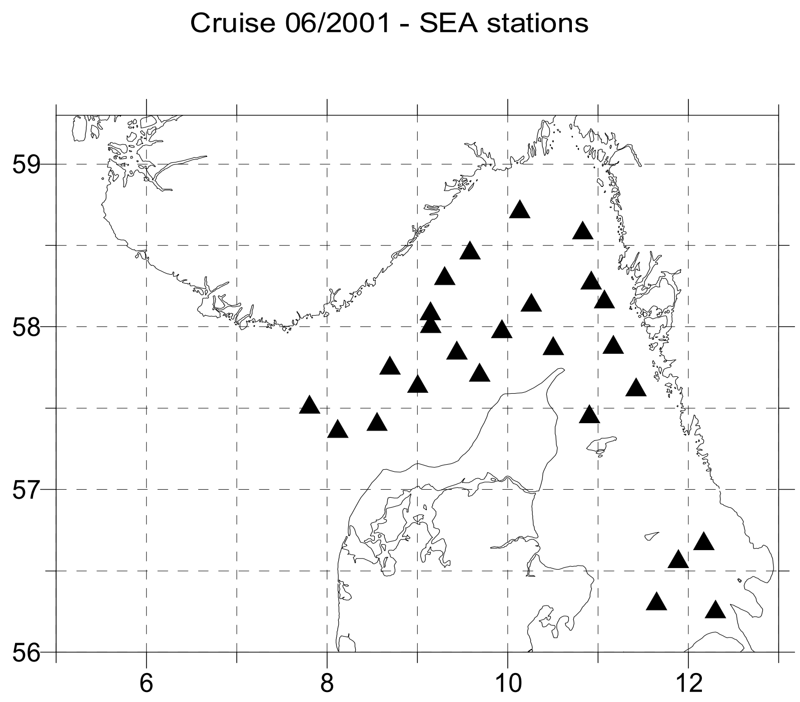

Figure IIB.5 Map of the eastern North Sea, Skagerrak and Kattegat showing locations of CTD stations undertaken during the July 2001 Danish acoustic survey.

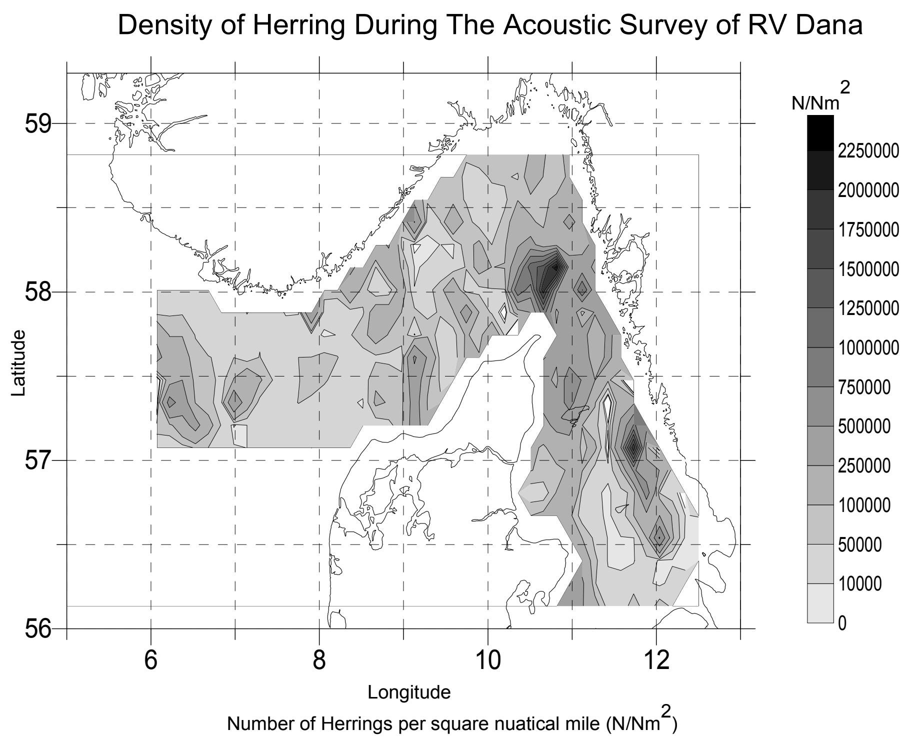

Figure IIB.6 Map of the eastern North Sea, Skagerrak and Kattegat showing contoured density of herring from the July 2001 Danish acoustic survey.

Table IIB.1. Simrad EY500 and analysis settings used on the July 1998 herring acoustic survey.

Transceiver Menu	
Frequency	38 kHz
Sound speed	1498 $m.s^{-1}$
Max. Power	2000 W
Equivalent two-way beam angle	-20.5 dB
Default Transducer Sv gain	25.13 dB
3 dB Beamwidth	6.6°
Calibration details	
TS of sphere	-33.6 dB
Range to sphere in calibration	8.20
Measured NASC value for calibration	26500
Calibration factor for NASCs	0.844
Log Menu	
Simulated	1.0 n.mi. at 10 knots
Operation Menu	
Ping interval	1 s external trigger
Analysis settings	
Bottom margin (backstep)	1.0 m
Integration start (absolute) depth	9 m
Range of thresholds used	-70 dB

Table IIB.2. Trawl haul information from R/V Dana 28 June to 11 July 2001

Haul no.	Date yy/mm/dd	Position N	E	Time local	Mean depth m	Trawl depth m	Trawl	Use in calculation	Total catch kg
83	010701	57 41.24	006 13.24	22.22	170	74-100	Fotö	+	137
106	010702	57 25.11	006 12.59	02.18	78	Surface	Fotö	+	222
182	010702	57 43 33	006 32.69	13.11	302	118-150	Fotö	+	42
196	010702	57 50.88	006 42.74	16.01	372	230	Fotö		15
256	010702	57 34.21	007 03.23	23.05	240	Surface	Fotö	+	570
277	010703	57 19.73	007 08 92	02.25	87	Surface	Fotö	+	457
378	010703	57 11.30	006 50.28	15.36	65	Bottom	Expo	+	749
435	010703	57 31.24	007 51.79	23.07	178	Surface	Fotö	+	481
452	010704	57 42.15	007 50.73	02.22	420	Surface	Fotö	+	310
528	010704	57 22.76	008 05.48	12.45	68	Bottom	Expo		-
553	010704	57 23.98	008 30.12	14.39	39	Bottom	Expo	+	691
598	010704	57 47.22	008 40.16	23.05	490	Surface	Fotö	+	1606
615	010705	57 58.95	009 02.23	02.23	520	Surface	Fotö	+	1170
692	010705	58 20.92	009 18.44	13.14	425	140-160	Fotö	+	21.3
711	010705	58 10.75	009 09.16	16.38	649	260	Fotö		56
753	010705	57 38.23	008 57.89	23.04	70	Surface	Fotö	+	54
773	010706	57 48.76	009 16.27	02.21	103	Surface	Fotö	+	265
854	010706	57 45.26	009 47.07	12.31	36	Bottom	Expo	+	2064
877	010706	57 57.82	009 49.30	16.24	104	Bottom	Expo	+	489
924	010706	58. 29.60	009 35.20	23.07	545	Surface	Fotö	+	513
941	010707	58 41.59	010 00.65	02.24	370	Surface	Fotö	+	443
1022	010707	58 31.90	010 60.56	12.32	85	Bottom	Expo	+	1002
1045	010707	58 17.99	010 58.63	16.27	116	Bottom	Expo	+	472
1094	010707	58 09.03	010 18.36	23.03	190	Surface	Fotö	+	2291
1112	010708	58 09.52	010 56.66	02.19	142	Surface	Fotö	+	841
1191	010708	57 52.83	010 32.83	12.38	116	58-105	Fotö	+	465
1216	010708	57 51.01	011 13.88	16.13	60	Bottom	Expo	+	1409
1265	010708	57 28.16	010 54.61	23,14	45	Surface	Fotö	+	393
1291	010709	57 34.42	011 24.90	02.38	50	Surface	Fotö	+	183
1376	010709	56 51.30	011 44.70	12.46	40	Bottom	Expo	+	616
1354	010709	56 44.70	012 08.90	16.09	42	Bottom	Expo	+	205
1441	010709	56 20.04	012 18.00	22.17	29	Bottom	Expo		351
1474	010710	56 38.62	011 51.23	02.41	27	Surface	Fotö	+	365
1550	010710	56 15,77	011 35.65	12.29	20	Bottom	Expo	+	235

Table IIB.3. Trawl haul species composition for R/V Dana 28 June to 11 July 2001

Haul		83	106	182	196	256	277	378	435	452	553	598	615	692
Trawl catch, kg		136	222	42	15	570	457	749	481	310	691	1606	1170	21
	Lycodes vahli													
Anchovy	*Engraulis encrasicolus*													
Squid	*Loligo spp.*						0.1							
Blue whiting	*Micromesistius poutassou*				2.2	1.8			27.8	90.7		4.6		
Sprat	*Sprattus sprattus*										0.1			
	Trachinus draco													
	Lampetr fluviatilis	0.3												
Dragonet	*Calllionymus spp.*													
Gurnard	*Trigala spp.*		1.2								0.1			
	Trisopterus minutus							0.2						
Monkfish	*Lophius piscatorius*							1.6			0.6			
Horse mackerel	*Trachurus trachurus*													
Long rough dab	*Hippoglosides plattessoides*							4.2						
Garfish	*Belone belone*		0.4							0.4				
Whiting	*Merlangius merlangus*		0.1		0.1	0.9	0.6	38.3	0.2	0.2	258.8			0.1
Invertebrates		5.1	38.0			231.0								
Dab	*Limanda limanda*							8.4						
Norway lobster	*Nephrops norvegicus*													
	Notoscopelus kroeyeri				0.2									
Haddock	*Melanogrammus aeglefinus*						0.1	659.2			389.7			
Hake	*Merluccius merluccius*	2.1			6.5						3.0			
Pearlsides	*Maurolicus muelleri*	22.2		14.0	1.3									3.2
	Lumpenus lampretaeformis													
krill		5.8		10.9	3.8		118.0		305.5					18.0
Mackerel	*Scomber scombrus*		39.2			3.6	137.5		79.5			5.2	8.9	
Whelk	*Buccinum undantum*							4.5						
Spurdog	*Squalus acanthias*													
	Psetta maxima													
Plaice	*Pleuronectes platessa*							2.6			0.9			
Saithe	*Pollachius virens*	73.9		17.1						14.4	1.5		10.1	
Herring	*Clupea harengus*		2.1			331.0	198.7		65.5	199.7		1578.2	1143.5	
Roundnose grenadier	*Coryphaenoides rupestris*													
Norway pout	*Trisopterus esmarki*		128.7		0.5	1.6	2.2	6.8						
Lumpsucker	*Cyclopterus lumpus*	18.5	12.3				2.5		2.4	4.6		18.0	7.6	
	Argentina sphyraena				0.7									
Starry ray	*Raja radiata*							0.9						
Sandeels	*Ammodytes spp.*													
Greater sandell	*Hyperoplus lanceolatus*										1.4			
Cod	*Gadus Morhua*							47.4			34.3			
Sole	*Solea vulgaris*							4.7			0.7			

Table IIB.3. Continued

Haul		711	753	773	854	877	924	941	1022	1045	1094	1112	1191	1216
Trawl catch, kg		56	54	265	2064	489	513	443	1002	472	2291	841	465	1409
	Lycodes vahli									0.2				
Anchovy	*Engraulis encrasicolus*													
Squid	*Loligo spp.*											0.1		
Blue whiting	*Micromesistius poutassou*	49.3				18.2				290.0				
Sprat	*Sprattus sprattus*													
	Trachinus draco													
	Lampetr fluviatilis													
Dragonet	*Calllionymus spp.*													
Gurnard	*Trigala spp.*		0.5											
	Trisopterus minutus													
Monkfish	*Lophius piscatorius*													
Horse mackerel	*Trachurus trachurus*		0.4									0.7		
Long rough dab	*Hippoglosides plattessoides*													1.1
Garfish	*Belone belone*		0.1	0.6				4.5						
Whiting	*Merlangius merlangus*		1.0	1.6	95.2			3.1		3.9				63.8
Invertebrates			49.2		1.8		46.1	184.0	23.9			178.8		64.0
Dab	*Limanda limanda*				8.8	0.6								
Norway lobster	*Nephrops norvegicus*					0.1			0.3	0.3				
	Notoscopelus kroeyeri													
Haddock	*Melanogrammus aeglefinus*		0.1	0.2	1926.6	50.9		0.1		11.5				2.7
Hake	*Merluccius merluccius*				7.7					0.2				18.7
Pearlsides	*Maurolicus muelleri*								18.1				8.2	
	Lumpenus lampretaeformis													
krill		1.2		258.7					823.5		400.3		407.0	
Mackerel	*Scomber scombrus*		2.4	1.3			220.9	13.9			212.8	6.3		4.4
Whelk	*Buccinum undantum*													
Spurdog	*Squalus acanthias*								1.5					
	Psetta maxima						0.4	0.6						
Plaice	*Pleuronectes platessa*				3.2									0.1
Saithe	*Pollachius virens*	3.0			2.9	118.1			24.1	99.5	4.1		31.5	1.1
Herring	*Clupea harengus*	0.1	0.4	2.4	12.2	93.5	235.5	226.4	116.6	1.4	1621.5	654.5	12.4	1219.3
Roundnose grenadier	*Coryphaenoides rupestris*					0.3								
Norway pout	*Trisopterus esmarki*					203.7				59.6				33.9
Lumpsucker	*Cyclopterus lumpus*	1.8		0.1			8.6	10.4			52.3	0.6	6.0	
	Argentina sphyraena	0.5												
Starry ray	*Raja radiata*													
Sandeels	*Ammodytes spp.*													
Greater sandell	*Hyperoplus lanceolatus*													
Cod	*Gadus Morhua*				6.3	2.5				3.4				3.5
Sole	*Solea vulgaris*				0.7	0.8								0.3

Table IIB.3. Continued

Haul		1265	1291	1376	1354	1441	1474	1550	catch	catch	catch	catch
Trawl catch, kg		393	183	616	205	351	365	235	19182	581.27	2291	15
	Lycodes vahli					0.1			0.3	0.01	0.2	0.1
Anchovy	*Engraulis encrasicolus*	0.1							0.1	0.00	0.1	0.1
Squid	*Loligo spp.*								0.2	0.01	0.1	0.1
Blue whiting	*Micromesistius poutassou*								484.6	14.68	290	1.8
Sprat	*Sprattus sprattus*	1.0	0.4		0.8	0.1	1.2	41.0	44.6	1.35	41	0.1
	Trachinus draco	0.5		0.1			3.7	0.9	5.2	0.16	3.7	0.1
	Lampetr fluviatilis								0.3	0.01	0.3	0.3
Dragonet	*Calllionymus spp.*					0.1			0.1	0.00	0.1	0.1
Gurnard	*Trigala spp.*	0.1		0.7			0.7		3.3	0.10	1.2	0.1
	Trisopterus minutus								0.2	0.01	0.2	0.2
Monkfish	*Lophius piscatorius*								2.2	0.07	1.6	0.6
Horse mackerel	*Trachurus trachurus*	0.2	1.7						3	0.09	1.7	0.2
Long rough dab	*Hippoglosides plattessoides*				0.1	0.5			5.9	0.18	4.2	0.1
Garfish	*Belone belone*								6	0.18	4.5	0.1
Whiting	*Merlangius merlangus*	214.7	3.0	72.0	11.6	147.1		170.0	1086.3	32.92	258.8	0.1
Invertebrates		113.6	49.8	479.4	151.7	184.8	250.5		2051.7	62.17	479.4	1.8
Dab	*Limanda limanda*			5.9	0.1	8.5		16.5	48.8	1.48	16.5	0.1
Norway lobster	*Nephrops norvegicus*			0.2		2.9		0.1	3.9	0.12	2.9	0.1
	Notoscopelus kroeyeri								0.2	0.01	0.2	0.2
Haddock	*Melanogrammus aeglefinus*			1.0				1.1	3043.2	92.22	1926.6	0.1
Hake	*Merluccius merluccius*					0.2			38.4	1.16	18.7	0.2
Pearlsides	*Maurolicus muelleri*								67	2.03	22.2	1.3
	Lumpenus lampretaeformis							0.3	0.3	0.01	0.3	0.3
krill									2352.7	71.29	823.5	1.2
Mackerel	*Scomber scombrus*	0.3	16.9		2.2		86.0		841.3	25.49	220.9	0.3
Whelk	*Buccinum undantum*								4.5	0.14	4.5	4.5
Spurdog	*Squalus acanthias*								1.5	0.05	1.5	1.5
	Psetta maxima								1	0.03	0.6	0.4
Plaice	*Pleuronectes platessa*			6.4	1.2	1.9		1.4	17.7	0.54	6.4	0.1
Saithe	*Pollachius virens*			0.1					401.4	12.16	118.1	0.1
Herring	*Clupea harengus*	62.3	110.7	6.2	15.3	0.5	20.6	1.1	7931.6	240.35	1621.5	0.1
Roundnose grenadier	*Coryphaenoides rupestris*								0.3	0.01	0.3	0.3
Norway pout	*Trisopterus esmarki*			6.3	1.5			0.8	445.6	13.50	203.7	0.5
Lumpsucker	*Cyclopterus lumpus*		0.5	0.9		1.8	2.6		151.5	4.59	52.3	0.1
	Argentina sphyraena								1.2	0.04	0.7	0.5
Starry ray	*Raja radiata*							0.8	1.7	0.05	0.9	0.8
Sandeels	*Ammodytes spp.*							0.4	0.4	0.01	0.4	0.4
Greater sandell	*Hyperoplus lanceolatus*	0.1					0.1	0.6	2.2	0.07	1.4	0.1
Cod	*Gadus Morhua*			3.7	31.2	0.6			132.9	4.03	47.4	0.6
Sole	*Solea vulgaris*				0.4				7.6	0.23	4.7	0.3

Table IIB.4. Trawl length frequency composition (by trawl number and strata) for R/V Dana 2001

Sub area	4	4	4	4	4	6	5/6	6	6	6	6	5	7	7	8	8	8	8	8	9	9	9	9	9	9
cm\haul	106	256	277	435	452	598	615	753	773	854	877	924	941	1022	1045	1094	1112	1191	1216	1265	1291	1376	1354	1474	1550
8.0																					8				
8.5																					58				
9.0																					125				
9.5																					242				
10.0																				1	134				
10.5																				3	250				
11.0																				6	217				
11.5																				7	75				
12.0																				1					
12.5																									
13.0																				1					
13.5																									
14.0																				1					
14.5																				1					
15.0																				*4*					
15.5																									
16.0														2						*22*	1				2
16.5																			1	*88*	5				
17.0			12																3	*206*	7	2			
17.5			21						1									5	2	*250*	5	3	1	2	
18.0		1	56	2													1	10	12	*311*	7		1	3	
18.5		1	76	4					3				1	3			8	15	23	*189*	41	4	2	11	1
19.0			58	2		5	7			3	1	3		8		2	39	22	52	*123*	69	5	4	15	4
19.5	1	3	56	10	4	8	8		4	24	1	5	9	22		7	85	25	77	*48*	70	3	3	29	
20.0		9	33	19	2	21	15		1	38	2	21	6	41		15	60	23	50	*22*	77	6	2	53	4
20.5	1	12	29	22	8	35	35		7	32	6	41	16	74	3	38	57	28	41	*44*	69	3	6	78	2
21.0	1	14	12	19	23	53	50		5	37	14	49	28	79		46	78	28	39	*31*	63	1	11	70	5
21.5		14	5	22	12	69	44		7	20	22	48	52	46	2	49	34	18	24	*13*	32	2	19	30	2
22.0	1	27	6	24	22	31	30	1	4	4	30	32	40	29	2	30	14	9	18	*9*	16	2	24	12	1
22.5		16	2	14	16	31	19	1	2	7	42	10	43	18		22	14	7	8	*18*	12		25	6	
23.0	2	24	1	11	21	16	21	1			33	11	29	17		9	2	3	5		9		28	11	
23.5	1	14	1	13	14	18	14			1	21	8	18	6	2	9		1	4	*4*	3		11	6	
24.0	3	21		17	19	7	14				17	9	10	2	2	9			1		2		6	3	
24.5	2	16		12	14	6	6		1		7	8	15	3		6					1		12	3	
25.0	3	8		9	15	9	6				2	2	6	3		3					1		4		
25.5	2	14	1	3	2	5	10				3	2	9	2	1	5								2	
26.0	1	10		1	8	7	8	1				1	4		2	3			1		1		2	3	
26.5		4		1	8	1	2					1	2			3							2		
27.0		2		4	4	4	5				1	2	4	1		4							3		
27.5		3		1	7	2	3					1	1										1		
28.0		3		1	5	1	2								1	3									
28.5		4		1	1	1	1									2							2		
29.0				1	1		1									1									
29.5		1			1							1	1												
30.0																									

Table IIB.5a. Biomass of herring by age, stock and sub area for R/V Dana 28 June to 11 July 2001

Subarea	WR										Total biomass tonnes
	0	1	2 im	2ma	3im	3ma	4im	4ma	5	6	
	North Sea Autumn spawners										
4		7126.5	4110.4	299.9	0.0	0.0	0.0	0.0		17.4	11554.2
5		4262.8	1757.3	128.2	41.0	4.6	0.0	0.0			6193.8
6		7417.9	5009.7	365.5	565.0	62.8	0.0	0.0		83.7	13504.7
7		2239.3	686.8	50.1	0.0	0.0	0.0	0.0			2976.2
8		24892.7	5402.2	394.2	3878.8	431.0	391.0	391.0	275.0		36055.8
9	1427.6	7082.9	2022.1	147.5	121.4	13.5	31.2	31.2			10877.5
Total	1427.6	53022.2	18988.5	1385.4	4606.2	511.8	422.2	422.2	275.0	101.1	81162.2
%	1.8	65.3	23.4	1.7	5.7	0.6	0.5	0.5	0.3	0.1	100.0

Subarea	WR																Total biomass tonnes
	1im	1ma	2im	2ma	3im	3ma	4 im	4ma	5im	5ma	6	7	8	9	10	11	
	Western Baltic spring spawners																
4	67.5	7.5	2244.1	1262.3	2166.6	4822.5	171.0	968.8	117.1	1346.6	747.0	240.5	117.8				14279.3
5	170.8	19.0	3641.3	2048.2	1202.9	2677.4	88.3	500.2	34.0	390.7	55.4				34.3	34.3	10896.9
6	262.0	29.1	2503.5	1408.2	1600.3	3562.0	93.8	531.4	33.3	382.9	320.8						10727.4
7	10.9	1.2	1107.9	623.2	719.9	1602.4	98.5	558.1	11.5	131.8	204.8		42.1		11.2		5123.6
8	321.3	35.7	4732.7	2662.1	2433.7	5416.8	424.3	2404.2	176.8	2033.5	142.1						20783.2
9	2413.4	268.2	7632.4	4293.2	1790.7	3985.7	293.6	1663.8	51.2	588.4	368.7	38.2					23387.3
Total	3245.9	360.7	21861.9	12297.3	9914.1	22066.9	1169.4	6626.6	423.8	4874.0	1838.7	278.7	159.9		45.5	34.3	85197.7
%	3.8	0.4	25.7	14.4	11.6	25.9	1.4	7.8	0.5	5.7	2.2	0.3	0.2		0.1	0.0	100.0

Table IIB.5b. Number of herring by age, stock and sub area for R/V Dana 28 June to 11 July 2001

Subarea	WR										Total number
	0	1	2im	2ma	3im	3ma	4im	4ma	5	6	
	North Sea autumn spawners										*1000,000
4		104.9	36.3	2.6	0.0	0.0	0.0	0.0		0.1	143.9
5		56.3	18.3	1.3	0.2	0.0	0.0	0.0			76.2
6		99.8	48.3	3.5	6.1	0.7	0.0	0.0		0.6	159.1
7		30.2	6.1	0.4	0.0	0.0	0.0	0.0			36.7
8		350.4	61.7	4.5	35.5	3.9	4.2	4.2	2.1		466.4
9	169.7	252.6	23.6	1.7	0.9	0.1	0.2	0.2			449.1
Total	169.7	894.2	194.3	14.2	42.7	4.7	4.4	4.4	2.1	0.7	1331.5
%	12.7	67.2	14.6	1.1	3.2	0.4	0.3	0.3	0.2	0.1	100.0

Subarea	**WR**																Total number
	1im	1ma	2im	2ma	3im	3ma	4 im	4ma	5im	5ma	6	7	8	9	10	11	
	Western Baltic spring spawners																*1000,000
4	1.6	0.2	26.3	14.8	18.0	40.0	1.2	6.6	0.7	8.2	4.5	1.2	0.6				123.8
5	2.3	0.3	39.9	22.5	10.8	23.9	0.7	4.2	0.2	2.4	0.3				0.2	0.2	107.8
6	3.3	0.4	28.1	15.8	13.4	29.9	0.6	3.6	0.2	2.2	2.2						99.7
7	0.2	0.0	14.6	8.2	6.9	15.4	0.6	3.6	0.1	1.6	1.8		0.2		0.1		53.5
8	6.3	0.7	63.1	35.5	24.0	53.4	4.6	26.2	1.1	12.5	0.7						228.0
9	46.6	5.2	118.6	66.7	21.5	47.8	3.0	17.0	0.3	3.7	2.1	0.3					332.8
Total	60.3	6.7	290.6	163.5	94.5	210.4	10.8	61.2	2.7	30.7	11.6	1.5	0.8		0.2	0.2	945.7
%	6.4	0.7	30.7	17.3	10.0	22.3	1.1	6.5	0.3	3.2	1.2	0.2	0.1		0.0	0.0	100.0

Table IIB.5c. Mean weight (g) by age, stock and sub area of herring for R/V Dana 28 June to 11 July 2001

Subarea	WR									
	0	1	2im	2ma	3im	3ma	4im	4ma	5	6
	North Sea autumn spawners									
4		67.9	113.4	113.4						185.0
5		75.7	95.9	95.9	182.0					
6		74.3	103.7	103.7	92.8					129.1
7		74.3	111.9	111.9						
8		71.0	87.6	87.6	109.4		93.6	93.6	128.9	
9	8.4	28.0	85.6	85.6	129.0		137.1	137.1		

Subarea	WR															
	1im	1ma	2im	2ma	3im	3ma	4 im	4ma	5im	5ma	6	7	8	9	10	11
	Western Baltic spring spawners															
4	42.1	42.1	85.5	85.5	120.5	120.5	146.7	146.7	164.0	164.0	164.9	200.4	203.3			
5	75.3	75.3	91.2	91.2	111.8	111.8	118.3	118.3	161.2	161.2	177.2				203.6	203.6
6	80.0	80.0	89.2	89.2	119.1	119.1	146.1	146.1	173.6	173.6	147.0					
7	52.9	52.9	75.7	75.7	104.1	104.1	156.9	156.9	80.0	80.0	110.9		177.2		203.6	
8	50.8	50.8	75.0	75.0	101.5	101.5	91.8	91.8	163.3	163.3	213.1					
9	51.8	51.8	64.3	64.3	83.4	83.4	98.1	98.1	157.2	157.2	176.2	140.6				

Table IIB.5d. Mean length (cm) by age, stock and sub area of herring for R/V Dana 28 June to 11 July 2001

Subarea	WR									
	0	1	2im	2ma	3im	3ma	4im	4ma	5	6
	North Sea autumn spawners									
4		67.9	113.4	113.4						185.0
5		75.7	95.9	95.9	182.0					
6		74.3	103.7	103.7	92.8					129.1
7		74.3	111.9	111.9						
8		71.0	87.6	87.6	109.4		93.6	93.6	128.9	
9	8.4	28.0	85.6	85.6	129.0		137.1	137.1		

Subarea	WR															
	1im	1ma	2im	2ma	3im	3ma	4 im	4ma	5im	5ma	6	7	8	9	10	11
	Western Baltic spring spawners															
4	42.1	42.1	85.5	85.5	120.5	120.5	146.7	146.7	164.0	164.0	164.9	200.4	203.3			
5	75.3	75.3	91.2	91.2	111.8	111.8	118.3	118.3	161.2	161.2	177.2				203.6	203.6
6	80.0	80.0	89.2	89.2	119.1	119.1	146.1	146.1	173.6	173.6	147.0					
7	52.9	52.9	75.7	75.7	104.1	104.1	156.9	156.9	80.0	80.0	110.9		177.2		203.6	
8	50.8	50.8	75.0	75.0	101.5	101.5	91.8	91.8	163.3	163.3	213.1					
9	51.8	51.8	64.3	64.3	83.4	83.4	98.1	98.1	157.2	157.2	176.2	140.6				

APPENDIX IIC NORWAY

RV "MICHAEL SARS" 29 June - 23 July 2001

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1. INTRODUCTION

This report presents the results from the Norwegian coverage of the International Herring Acoustic Survey for 2001. 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 2001), a sub group under the ICES Herring Assessment Working Group for the Area South of 62^{o}N.

Objectives: Abundance estimation of herring and sprat in the area between latitudes 57º00'N and 62º00'N and 02º00'-08°00'E. Map the general hydrographical regime and monitor the standard profiles Oksøy-Hanstholm, Hanstholm-Aberdeen, Utsira - Start Point and Feie - Shetland.

2. SURVEY DESCRIPTION AND METHODS

Personnel

E. Torstensen (cruise leader)
I. Fjeldstad (acoustic)
K. Hansen (fish.lab)
J. de Lange (fish.lab)
S. Myklevoll (fish.lab)
B.V. Svendsen (fish.lab)
Ø. Torgersen (acoustic)
R. Skeide (29.6-4.7)

2.1 Narrative

RV "Michael Sars" departed from Bergen 29 June 2001. A call was made in Aberdeen on 3 July, Egersund on 12 July and in Lerwick, Shetland on 17 July. A denser coverage (the horizontal transects abt 7 n.mi. apart) of the ICES rectangles 46E9, 47E9, 49E9 and 50E9 were made as part of an intercalibration exercise between the RV "Michael Sars" and the RV "Scotia". The vessel stayed 3 days in Lerwick harbour due to bad weather. The survey was finished in Bergen on 23 July.

The survey started on the hydrographic transect off Kristiansand and continued with transects from south to north. From Aberdeen we went north to 58° 30'N and 01°W to survey the ICES statistical rectangles 46E9 and 47E9. The hydrographic transect Start Point-Utsira was carried out after the overlapping exercise in the ICES statistical rectangles 46E9 and 47E9, and the vessel vent south - east to continue the acoustic survey.

2.2 Survey design

The survey was carried out in systematic parallel transects in the east-west direction from south to north with a distance of about 15 n.mi. between the transects. The area to be covered by RV "Michael Sars" was between 57°00 - 61°30 N, 2°-8° E. The cruise tracks with fishing stations and the hydrographic profiles are shown in Figures IIC.1 and IIC.2, respectively. Nearly 4 000 n. mi. were covered by the survey.

2.3 Calibration

The echo sounder was newly calibrated and calibration of the acoustic instruments was thus not made as part of this survey.

2.4 Acoustic data collection

Acoustic data were sampled by a SIMRAD EK500 echo sounder and ES38B (38 kHz) transducer. The echo sounder settings are given in Table IIC.1. Acoustic data were sampled over the full 24 h day. The speed of the vessel during acoustic sampling was 10-12 knots. The sampling unit was 1 n.mi. The acoustic data were archived to tape.

2.5 Biological data - fishing trawls

Trawling was carried out during the survey for species identifications by weight and numbers and biological sampling of the target species. 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 North Sea autumn spawning herring and Baltic spring spawners. All samples were worked up on board. Sampling procedures are described in Fotland *et al*.2000.

Fishing was carried out using a "Firkløver" pelagic trawl (16 x 20 m). The characteristics of the trawl gear are given in Appendix IV. For bottom trawl hauls a Campelen 1800 was used.

2.6 Hydrographic data

The number of CTD stations for temperature, salinity and density measures were 144. Four standard hydrographical profiles, Oksøy-Hanstholm, Hanstholm-Aberdeen, Utsira - Start Point and Feie – Shetland, were made.

2.7 Data analysis

Echogram scrutiny was done for each 5 n.mi, with a Bergen Echo Integrator System (BEI). The NASC was allocated to the following categories on the basis of trawl catches and characteristics on the echo recording paper: herring, sprat, other pelagic, demersal fish and plankton. The TS/length relationships used to convert NASC of herring and sprat to number of fish: were those recommended by the acoustic survey planning group (ICES 1994). The calculation is made by ICES rectangles and summed up for the whole area. Toresen *et al* (1998) describes the acoustic method used for the abundance estimation in this survey.

In Skagerrak and off the south west coast of Norway, North Sea autumn spawners and Western Baltic spring spawners (WBSS) 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, WBSS= ((56,5-VS(sample))/(56.5-55.8)) (ICES 1999). The length-at age and weight-at age were assumed to be the same in the two stocks. The measured proportions of mature fish were applied equally to calculate the maturing part of each age group in both Western Baltic spring spawners and North Sea autumn spawners.

3. RESULTS AND DISCUSSION

3.1 Acoustic data

Figure IIC.3 gives the horizontal distribution of herring. Herring in the North Sea was mostly found in the south-western part of the area. The herring were scattered distributed in the surveyed area east of lat. 2°E and were mainly found close to the surface. Few "real" herring schools were observed, in 46F2 and 44F5. Most of the trawling positions were regularly chosen, by trawling every 20-30 nautical miles 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, are 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.

Sprat

Small values of sprat were measured in the shallow areas near Hanstholm, Denmark, in ICES square 43F8. A trawl sample consisted of 2-group fish with a length between 9.0 and 13.0 cm. No abundance estimates were made.

3.2 Biological data

The total number of trawl hauls was 92, 71 pelagic and 21 bottom trawl hauls (Fig. IIC.1, Table IIC.2). Of the pelagic hauls, 13 were midwater hauls equipped with netsondes and 58 were equipped with large buoys for fishing in the surface area. In the two overlapping areas, squares 46E9/47E9 and 49E9/50E9, 10 (5 BT and 5 PT) and 11 (3 BT and 8 PT) hauls, respectively, were made. In general 30 min hauls were made. In the Norwegian area herring was present in 27 trawl hauls of which 15 had sample size >30 herring. Length frequencies of herring by trawl haul in the area east of 2ºE are given in Table IIC.3. Age-length key with total number of otoliths by age and length class is given in Table IIC.4. This key was made for both stocks combined; the North Sea autumn spawners and the Western Baltic Spring Spawners.

3.3 Biomass estimates

The mean length, mean weight, numbers in millions and biomass in thousand of tonnes, are presented in Table IIC.5. The estimates of the spawning stock biomass of North Sea herring and Western Baltic spring spawners are shown in the text table below for 1997-2001. The total herring biomass estimate in the area covered by RV ”Michael Sars” was about 270 000 t. The estimated spawning stock biomass of North Sea herring was about 51 000 t which is significantly higher than last year, but low compared to the 1999-estimate. The survey faced difficulties in separating the maturity stages 2 (immature) and 3 (maturing)/8 recovered, which might have underestimated the component of the North Sea spawning stock. The estimated biomass of Baltic spring spawners in the North Sea, 90 000 tonnes, was higher than last year but in the same range as the estimates from 1999 and 1998 (75-90 000 tonnes).

Year	Herring Biomass	(10^3 tonnes)
	North Sea herring SSB	Western Baltic Spring Spawners
1997	50	160
1998	73	88
1999	259	74
2000	13	51
2001	51	90

3.4 Hydrological data

The number of CTD stations for temperature, salinity and density measures were 144, see Figure IIC.2.

3.5 References

Fotland, AA., Borge, A., Gjøsæter, H. And Mjanger, H. 2000. Manual for sampling of fish and shellfish. (In Norwegian). Ver. 3.14. Institute of Marine Research.

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.

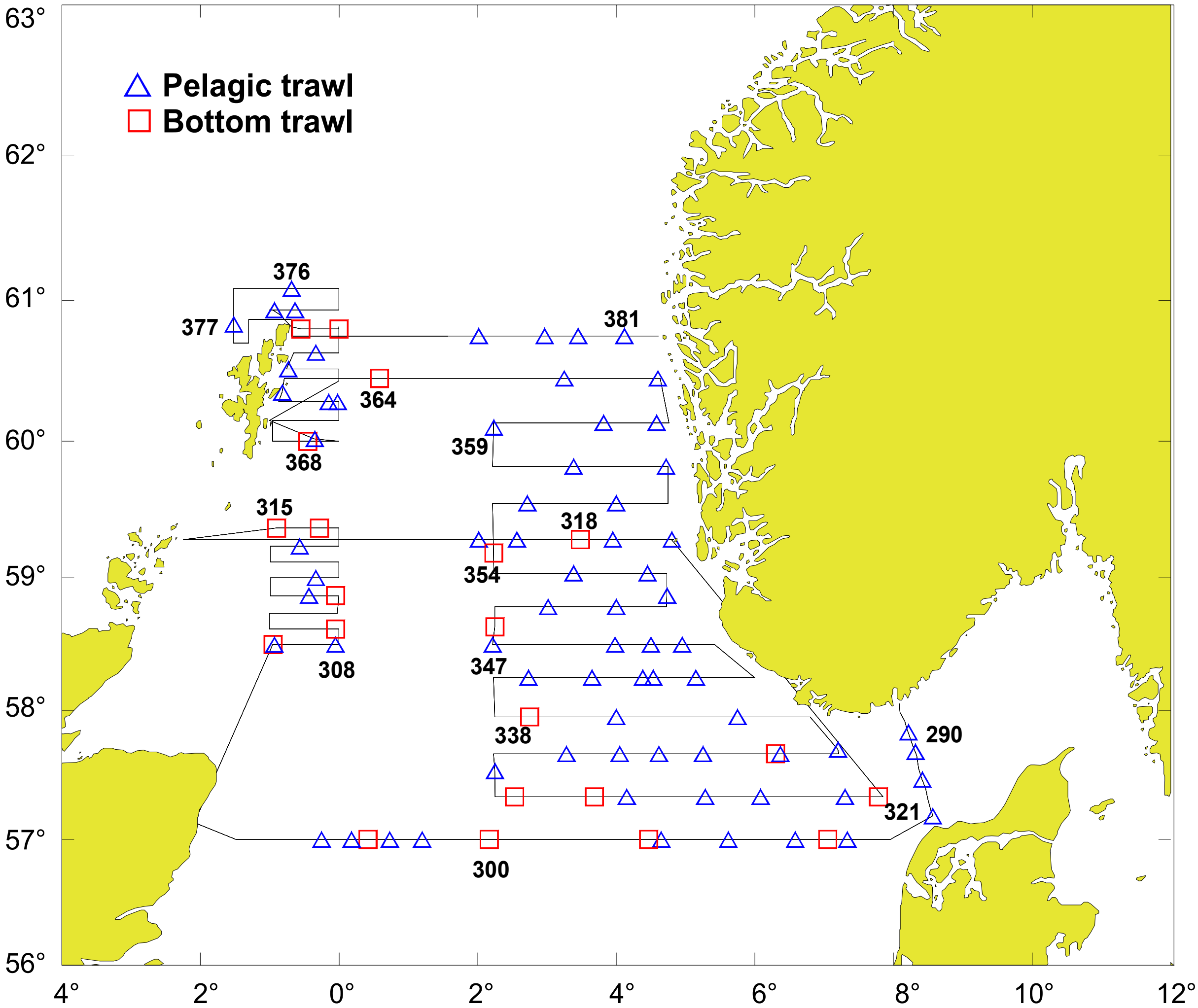

Figure IIC.1 Cruise track and positions of fishing trawls undertaken during the acoustic survey on RV "Michael Sars", 29 June-23 July 2001.

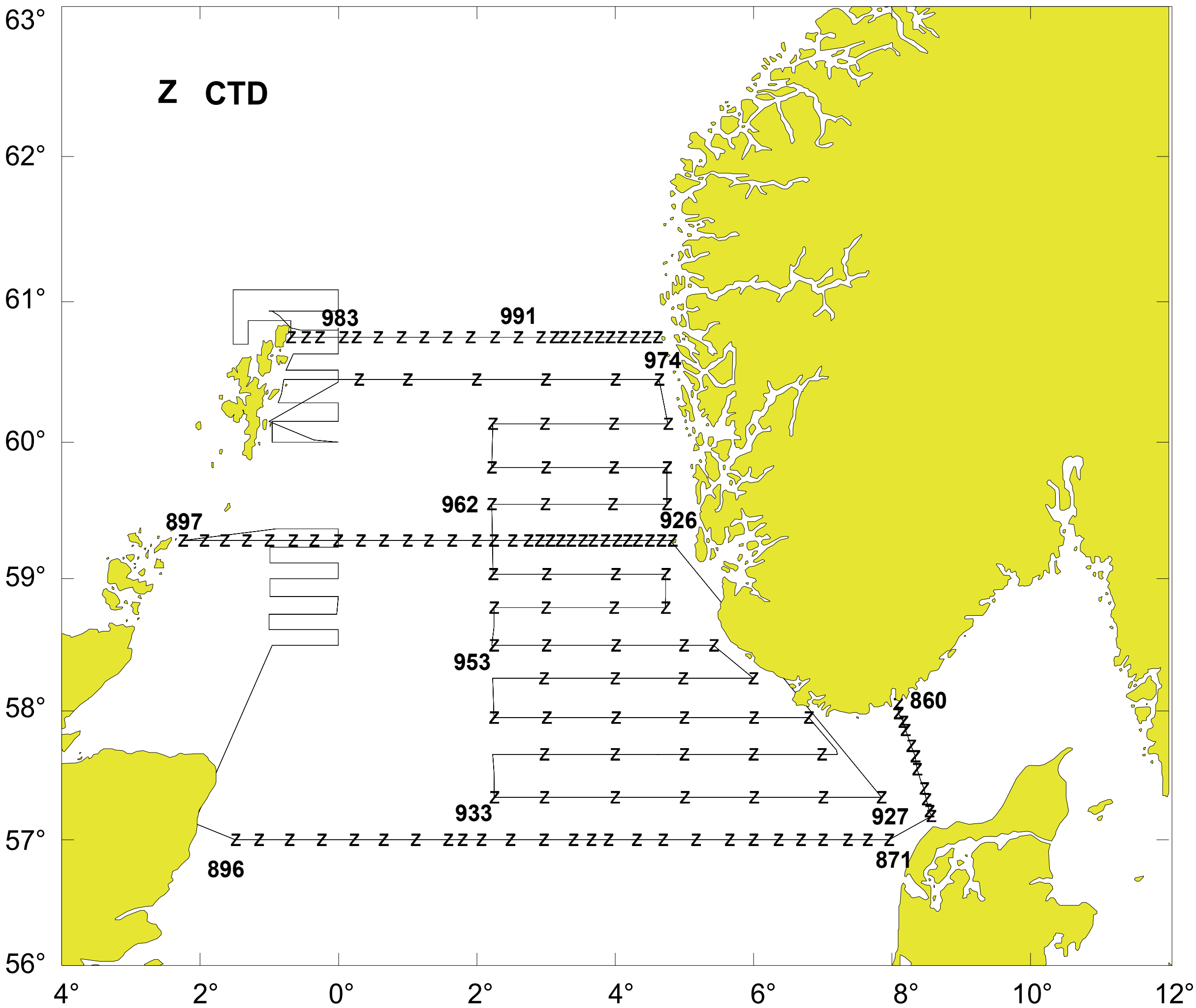

Figure IIC.2 Cruise track and positions of CTD-stations undertaken during the acoustic survey on RV "Michael Sars", 29 June-23 July 2001.

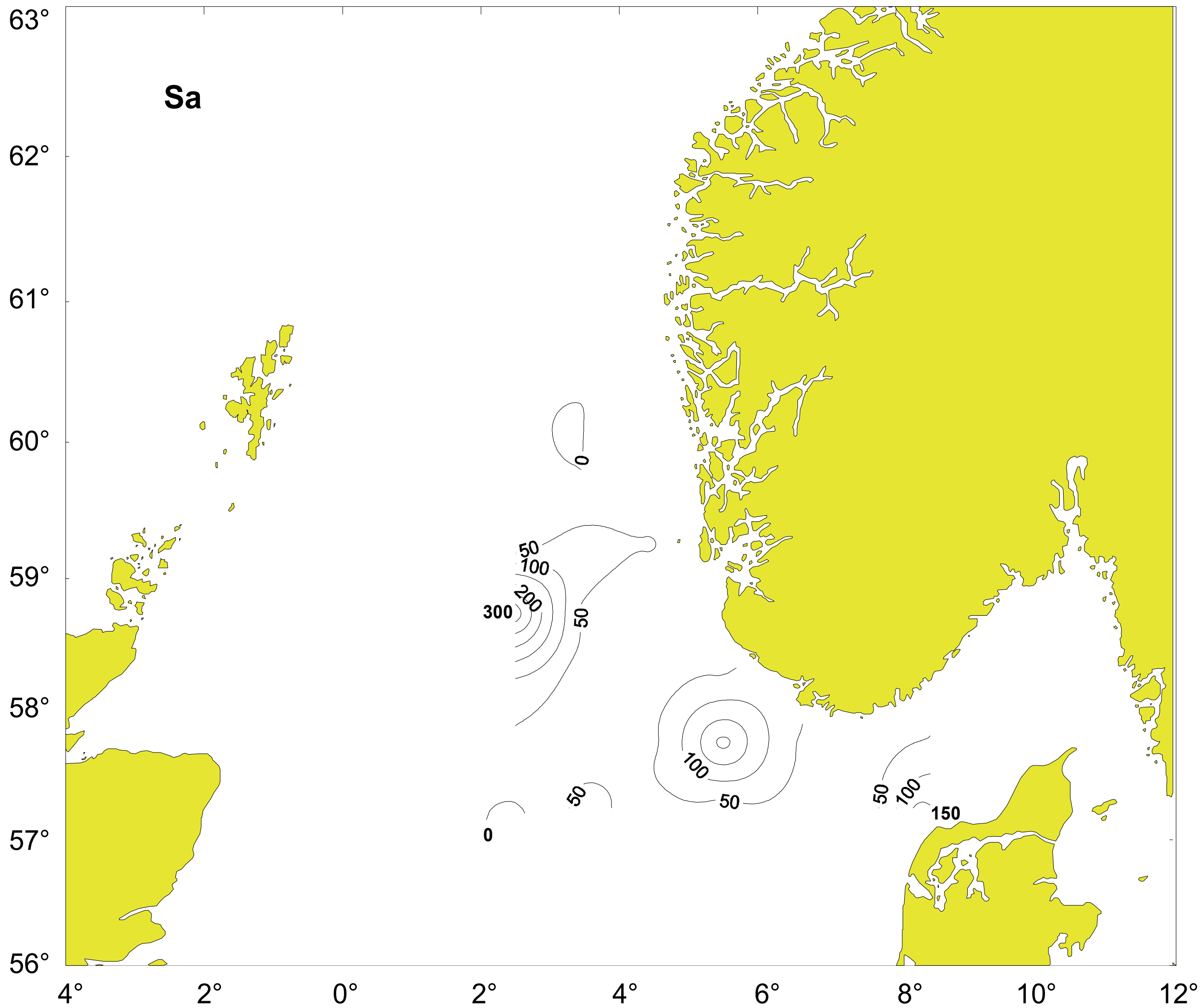

Figure IIC.3 Horizontal distribution of NASC attributed to herring, during the acoustic survey on RV "Michael Sars", 29 June-23 July 2001.

Table IIC.1. Simrad EK500 and analysis settings used on the July 2001 herring acoustic survey.

Transceiver Menu	
Frequency	38 kHz
Sound speed	1500 m.s^{-1}
Max. Power	2000 W
Equivalent two-way beam angle	-21,0 dB
Default Transducer Sv gain	27.05 dB
3 dB Beam width	6.8°/6.8 °deg
Alongship offset	-0.17 deg
Athw. Ship Offset	-0. 21 deg
Analysis setting	
Bottom margin	0.5 m
Integration start	8.5 m

Table IIC.2 RV " Details of fishing trawl stations during the Norwegian aoustic survey, on Michael Sars", 29 June-23 July 2001

PT= pelagic trawl
BT= bottom trawl.

Trawl haul no	Date	Lat	Lon	Time UTC	Water depth (m)	Trawl depth (m)	Duration min
PT290	30.jun	57°50'	8°14' E	16:55	540	0	60
PT291	30.jun	57°41'	8°20' E	19:54	320	0	31
PT292	30.jun	57°30'	8°25' E	22:42	76	0	30
PT293	01.jul	57°12'	8°35' E	02:09	29	0	14
PT294	01.jul	57°00'	7°21' E	07:51	40	0	34
BT295	01.jul	57°00'	7°04' E	10:06	31	31	30
PT296	01.jul	57°00'	6°35' E	14:18	59	35	30
PT297	01.jul	57°00'	5°38' E	20:31	53	0	29
PT298	02.jul	57°00'	4°40' E	02:21		0	30
BT299	02.jul	57°00'	4°28' E	04:18	64	64	24
BT300	02.jul	57°00'	2°11' E	13:10	86	86	41
PT301	02.jul	57°00'	1°12' E	18:23	84	60	33
PT302	02.jul	57°00'	0°47' E	21:30	92	0	30
BT303	02.jul	57°00'	0°26' E	23:47	88	91	35
PT304	03.jul	57°00'	0°12' E	02:05	86	0	33
PT305	03.jul	57°00'	0°15' W	04:50	81	0	30
BT306	04.jul	58°30'	0°58' W	19:36	112	112	29
PT307	04.jul	58°30'	5°59' W	20:51	117	0	31
PT308	05.jul	58°30'	0°03' W	00:11	139	0	35
BT309	05.jul	58°37'	0°03' W	02:07	145	145	32
BT310	05.jul	58°53'	0°05' W	10:32	117	117	33
PT311	05.jul	58°53'	0°27' W	12:58	135	0	40
PT312	05.jul	59°00'	0°21' W	18:26	138	0	30
PT313	06.jul	59°14'	0°34' W	01:18	137	0	42
BT314	06.jul	59°22'	0°18' W	05:41	140	140	29
BT315	06.jul	59°23'	0°54' W	08:40	124	124	30
PT316	07.jul	59°17'	2°02' E	04:06	121	0	30
PT317	07.jul	59°17'	2°35' E	06:56	121	10	34
BT318	07.jul	59°16'	3°30' E	11:18	216	216	50
PT319	07.jul	59°17'	3°57' E	15:26	284	0	23
PT320	07.jul	59°16'	4°49' E	20:26	220	0	29
BT321	08.jul	57°20'	7°47' E	12:47	67	70	40
PT322	08.jul	57°21'	7°18' E	15:17	60	0	30
PT323	08.jul	57°20'	6°05' E	20:00	75	0	28
PT324	08.jul	57°20'	5°17' E	23:47	71	0	31
PT325	09.jul	57°20'	4°09' E	04:30	66	0	30
BT326	09.jul	57°20'	3°41' E	07:17	63	63	32
BT327	09.jul	57°21'	0°26' E	12:50	84	84	36
PT328	09.jul	57°32'	2°15' E	16:40	81	0	30
PT329	09.jul	57°40'	3°17' E	21:34	72	0	30
PT330	10.jul	57°40'	4°03' E	00:52	69	0	30
PT331	10.jul	57°40'	4°37' E	03:33	82	40	39
PT332	10.jul	57°40'	5°16' E	07:04	104	0	30
BT333	10.jul	57°40'	6°18' E	11:20	171	186	40
PT334	10.jul	57°40'	6°23' E	13:14	175	30	47
PT335	10.jul	57°43'	7°12' E	17:49	347	0	30
PT336	11.jul	57°59'	5°45' E	00:30	263	0	46
PT337	11.jul	57°57'	4°00' E	08:00	96	0	30
BT338	11.jul	57°57'	2°46' E	12:52	62	62	21
PT339	11.jul	58°14'	2°44' E	19:08	73	0	30

Table IIC.2. Contd.

Trawl haul no	Date	Lat	Lon	Time UTC	Water depth (m)	Trawl depth (m)	Duration min
PT340	11.jul	58°15'	3°39' E	22:46	118	0	30
PT341	12.jul	58°16'	4°23' E	02:07	226	0	37
PT342	12.jul	58°16'	4°33' E	03:58	282	200	16
PT343	12.jul	58°15'	5°10' E	07:09	308	0	31
PT344	12.jul	58°30'	4°58' E	20:47	286	0	29
PT345	12.jul	58°31'	4°31' E	23:05	275	0	30
PT346	13.jul	58°31'	3°59' E	01:51	250	50	42
PT347	13.jul	58°30'	2°14' E	08:33	94	0	31
BT348	13.jul	58°38'	2°15' E	11:41	100	100	19
PT349	13.jul	58°47'	3°02' E	16:28	111	0	32
PT350	13.jul	58°47'	4°00' E	20:21	278	0	30
PT351	14.jul	58°53'	4°44' E	00:14	248	0	34
PT352	14.jul	59°02'	4°27' E	03:07	256	0	35
PT353	14.jul	59°02'	3°24' E	07:16	185	0	30
BT354	14.jul	59°11'	2°15' E	12:43	122	122	30
PT355	14.jul	59°32'	2°43' E	17:34	117	0	31
PT356	14.jul	59°33'	4°01' E	22:08	277	0	30
PT357	15.jul	59°49'	4°44' E	03:06	223	0	30
PT358	15.jul	59°49'	3°23' E	07:56	250	0	30
PT359	15.jul	60°06'	2°14' E	14:21	105	108	29
PT360	15.jul	60°08'	3°49' E	20:30	291	0	30
PT361	15.jul	60°08'	4°35' E	23:36	323	0	35
PT362	16.jul	60°27'	4°37' E	03:26	336	0	30
PT363	16.jul	60°27'	3°15' E	08:12	218	0	30
BT364	16.jul	60°28'	0°36' E	17:03	135	135	27
PT365	16.jul	60°22'	0°45' W	21:58	89	0	30
PT366	17.jul	60°17'	0°10' W	01:21	122	0	30
PT367	17.jul	60°17'	0°01' W	02:40	130	120	25
BT368	17.jul	60°00'	0°28' W	09:24	131	131	26
PT369	17.jul	60°02'	0°22' W	13:01	135	115	23
PT370	20.jul	60°32'	0°45' W	22:39	85	0	31
PT371	21.jul	60°39'	0°21' W	02:15	97	20	15
BT372	21.jul	60°49'	0°00' W	06:03	162	161	23
BT373	21.jul	60°49'	0°33' W	09:28	107	111	17
PT374	21.jul	60°56'	0°57' W	12:41	112	95	23
PT375	21.jul	60°57'	0°39' W	15:13	119	95	13
PT376	21.jul	61°05'	0°43' W	21:28	135	0	32
PT377	22.jul	60°50'	1°32' W	02:14	124	0	30
PT378	22.jul	60°45'	2°02' E	18:37	123	0	30
PT379	22.jul	60°45'	2°59' E	23:18	190	0	30
PT380	23.jul	60°45'	3°28' E	02:38	327	0	36
PT381	23.jul	60°45'	4°08' E	07:05	319	0	30

Table IIC.3. Herring length frequency distribution in trawl hauls where sample size>10 herring

Trawl st	299	306	307	308	309	310	313	315	323	324	326	328	336	340	343	345
ICES rect	43F4	46E9	46E9	46E9	46E9	46E9	47E9	47E9	43F6	43F5	43F3	44F2	44F5	45F3	45F5	46F4
15,0										1,0						
15,5										4,0						
16,0									8,1	10,0	1,6					
16,5				1,6					8,1	11,0	12,5					
17,0	2,0								8,1	11,0	20,3			1,0		
17,5	7,0					1,0			13,5	24,0	23,4	1,0		1,0		
18,0	12,0								8,1	12,0	17,2	2,0		3,0		
18,5	50,0								13,5	24,0	17,2	20,0		6,0		
19,0	18,0			1,6					16,2	2,0	3,1	14,0		5,0	1,1	
19,5	9,0								16,2	1,0	1,6	39,0	2,0	11,0	2,2	
20,0	1,0								5,4			8,0	2,0	2,0	1,1	
20,5	1,0										3,1	8,0	1,0	1,0		
21,0				4,8								1,0	2,0			1,0
21,5		1,0	2,6	4,8								3,0	10,0	2,0	3,3	7,0
22,0		5,0	10,3	7,9			3,0	3,4				2,0	12,0	1,0	4,4	18,0
22,5		2,0	15,4	9,5	2,1		2,0	6,9				2,0	12,0	2,0	2,2	13,0
23,0		12,0	25,6	4,8	2,1	3,0	9,0	13,8					11,0	2,0	8,8	16,0
23,5		11,0	28,2	20,6		3,0	21,0	13,8					9,0	4,0	4,4	11,0
24,0		11,0	12,8	6,3	16,7	6,0	13,0	10,3					3,0	6,0	4,4	5,0
24,5		26,0	5,1	19,0	14,6	20,0	28,0	24,1					12,0	12,0	5,5	12,0
25,0		12,0		3,2	14,6	9,0	10,0	6,9					4,0	8,0	2,2	3,0
25,5		12,0		4,8	6,3	12,0	8,0	6,9	2,7				6,0	6,0	4,4	1,0
26,0		5,0		3,2	10,4	8,0		6,9					3,0	6,0	1,1	3,0
26,5		2,0		3,2	6,3	9,0	1,0						2,0	5,0	7,7	4,0
27,0					10,4	8,0	1,0						4,0	3,0	11,0	2,0
27,5		1,0		3,2	6,3	6,0							1,0	3,0	4,4	
28,0				1,6	4,2	5,0	3,0	3,4					1,0	5,0	9,9	2,0
28,5						1,0							1,0	2,0	5,5	2,0
29,0					4,2	5,0	1,0	3,4					2,0	2,0	8,8	
29,5						1,0									3,3	
30,0						2,0									4,4	
30,5					2,1									1,0		
31,0						1,0										
31,5																
32,0																
32,5																
33,0																
Total N	100	100	39	63	48	100	100	29	37	100	64	100	100	100	91	100
mean W(g)	46,5	121,6	101,1	108,1	144,4	155,6	118,4	115,1	50,2	40,3	42,0	62,5	119,4	127,6	157,8	119,1
mean L(cm)	18,6	24,3	23,2	23,6	25,7	25,9	24,3	24,4	18,4	17,5	17,7	19,5	23,6	23,5	25,9	23,55

Table IIC.3. contd

Trawl st	348	351	352	353	354	356	361	363	364	366	367	369	370	371	375
ICES rect	46F2	46F4	47F4	47F3	47F2	48F4	49F4	49F3	49F0	49E9	49E9	49E9	50E9	50E9	50E9
15,0															
15,5															
16,0															
16,5															
17,0	1,0						2,9								
17,5	1,0														
18,0	9,0														
18,5	18,0				1,0										
19,0	10,0														
19,5	23,0														
20,0	14,0														
20,5	10,0				1,0										
21,0	4,0		5,3		1,0										
21,5	1,0	9,0	5,3		1,0										
22,0	4,0	13,0	10,5		7,0	3,0						2,0			
22,5		15,0	21,1		9,0	5,0	2,9					1,0			
23,0	1,0	19,0	26,3	1,5	15,0	11,0	14,7					1,0	2,0	1,8	1,0
23,5	1,0	12,0	15,8		12,0	9,0	2,9		2,0		2,0	6,0	1,0	1,8	
24,0		9,0	10,5	3,0	11,0	6,0	5,9		5,0	14,3	8,0	3,0	4,0	8,8	4,0
24,5	1,0	4,0	5,3		13,0	12,0	14,7		11,0	42,9	21,0	30,0	18,0	29,8	22,0
25,0		2,0		3,0	7,0	8,0	11,8		18,0	35,7	15,0	17,0	24,0	24,6	31,0
25,5	1,0	4,0		3,0	9,0	8,0	2,9		19,0		12,0	15,0	15,0	22,8	19,0
26,0	1,0	4,0		7,6	2,0	3,0	8,8	3,4	11,0	7,1	5,0	8,0	6,0	5,3	10,0
26,5		2,0		3,0	4,0	3,0	5,9		14,0		11,0	4,0	7,0	5,3	5,0
27,0		1,0		4,5	5,0	11,0	2,9		7,0		6,0	1,0	4,0		2,0
27,5				6,1	1,0	8,0	2,9		3,0		6,0	3,0	1,0		2,0
28,0		5,0		6,1		5,0	11,8	3,4	7,0		8,0	3,0	3,0		
28,5				18,2		3,0	2,9	3,4			2,0	4,0	2,0		1,0
29,0				13,6	1,0	2,0	2,9	31,0	3,0		2,0	1,0	6,0		
29,5				10,6		1,0		13,8			1,0		2,0		
30,0				9,1			2,9	13,8				1,0	1,0		
30,5				6,1				10,3							1,0
31,0				3,0		1,0		10,3					3,0		
31,5				1,5							1,0		1,0		2,0
32,0		1,0				1,0		6,9							
32,5								3,4							
33,0															
Total	100	100	19	66	100	100	34	29	100	14	100	100	100	57	100
mean W(g)	64,0	120,2	111,3	188,9	118,3	153,8	155,8	207,9	145,9	126,3	154,1	141,1	159,1	134,6	142,6
mean L(cm)	19,7	23,6	22,9	28,3	24,0	25,4	25,3	29,8	25,9	24,7	25,9	25,3	26,0	25,0	25,4

Table IIC.4. Age/maturity-length key for herring (numbers of fish sampled) in the Norwegian area east of 2º E.

Length	1	2		3		4	5	6	7	8	9+	Grand
(cm)	Imm	Imm	Mat	Imm	Mat	Total	Total	Total	Total	Total	Total	Total
15,0	1											1
15,5	4											4
16,0	10											10
16,5	18											18
17,0	23											23
17,5	43											43
18,0	46											46
18,5	117											117
19,0	40	1										41
19,5	61	2										63
20,0	20	2										22
20,5	16	3										19
21,0	5	3										8
21,5	8	24	1	3								36
22,0	5	46	3	5		1						60
22,5	6	36	4	10		4						60
23,0		41	9	27		5	1	1				84
23,5		26	10	20	2	5						63
24,0		9	16	13	7	3		1				49
24,5		9	23	28	8	7						75
25,0		4	11	11	9	2	2		1			40
25,5		3	6	11	10	6	5					41
26,0			5	1	9	6	6	2	2			31
26,5			1	2	7	10	9	1	1			31
27,0			1		9	15	8	6	3			42
27,5			1	1	3	3	2	8	4			22
28,0				1	2	14	12	4	1	1		35
28,5					2	8	10	4		2		26
29,0						4	15	11	3	1		34
29,5						2	7	2	3		1	15
30,0						1	5	6	2	1	1	16
30,5							3	2	2	1		8
31,0						1		1	2	1	1	6
31,5								1				1
32,0									1	3		4
32,5												0
33,0											1	1
Grand Total	423	209	91	133	68	97	85	50	25	10	4	1195

Table IIC.5 Mean length, mean weight, numbers (millions) and biomass (thousands of tonnes) by age and maturity obtained during the acoustic survey on RV "Michael Sars", 29 June-23 July 2001.

			North Sea Autumn Spawners				Western Baltic Spring Spawners			
Age	L_{mean}	W_{mean}	No (mill)	%	Biom.(10^3 t)	%	No (mill)	%	Biom(10^3 t)	%
1	19,0	52,6	2130	77,5	101,690	56,1	0	0,0	0,000	0,0
2I	22,8	98,8	215	7,8	21,144	11,7	169	26,3	16,981	18,8
2M	24,8	131,0	147	5,3	18,484	10,2	59	9,1	7,964	8,8
3I	24,2	121,4	61	2,2	7,465	4,1	149	23,3	17,912	19,8
3M	26,0	150,7	65	2,4	9,613	5,3	49	7,6	7,363	8,1
4	26,6	167,7	38	1,4	6,190	3,4	87	13,6	14,618	16,2
5	28,2	189,4	54	2,0	8,950	4,9	67	10,5	13,221	14,6
6	28,5	192,4	27	1,0	5,065	2,8	27	4,2	5,115	5,7
7	28,8	202,3	8	0,3	1,676	0,9	22	3,5	4,613	5,1
8	30,4	241,6	3	0,1	0,779	0,4	9	1,4	1,905	2,1
9+	31,3	254,5	1	0,0	0,236	0,1	3	0,4	0,667	0,7
Total	23,8	117,6	2750	100,0	181	100	641	100	90	100
Immature			2406	87,5	130	71,9	318	49,6	35	38,6
Mature			344	12,5	51	28,1	323	50,4	55	61,4

APPENDIX IID SCOTIA

Survey report for RV Scotia

3-23 July 2001

E J Simmonds
FRS Marine Laboratory Aberdeen

1. INTRODUCTION

This survey was developed from 1979 to 1983 and has been carried out annually since 1984 to provide estimates of adult herring in the Orkney Shetland area. The survey is designed to provide indices of abundance to be combined with other surveys in the international herring acoustic survey in the North Sea and adjacent waters.

The specific objectives of the survey were:

1. To participate in an ICES – co-ordinated acoustic and mid-water trawling survey in the north western North Sea and North of Scotland between 58^o to 62^{o}N 4^o 30’ W to 2^{o}E excluding Norwegian and Faroes waters.

2. To obtain samples of herring for biological analysis, including age, length, weight, sex, maturity and ichthyophonus infection.

3. To obtain thermosalinograph recordings of surface temperature and salinity throughout the survey area. CTD (and XBT) profiles of temperature and salinity at depth for analysis with herring distributions.

4. To obtain simultaneous coverage with FRV Micheal Sars of ICES rectangles 46E9,47E9,49E9 and 50E9

2. Survey Description and Methods

2.1 Personnel

E J Simmonds,	MLA	(Cruise leader)
P Fernandes,	MLA	(Acoustic Expert)
A P Robb,	MLA	(Fish Lab)
F Armstrong,	MLA	(Acoustic Technician)
M Mathewson,	MLA	(Fish Lab)
M Harding	MLA	(Database developer)
A Lebourg.	IRD	(Acoustic Expert)

2.2 Narrative

Scotia sailed at 1300 on 3 July 2001 and made passage to Scapa Flow anchoring at 2300Hrs to calibrate the acoustic instruments on all scientific sounders. At 0900 FRV Scotia left Scapa Flow and commenced survey at 1100 GMT at 58^o 39’ N 2^o 45’ W. Communication with FRV Micheal Sars was established and the period for the joint survey selected as 5-7 July 2001. The survey was carried out on east west transects on a 15n.mi. spacing progressing northwards between 2E, the Scottish mainland, and the Orkney and Shetland Islands from 0200 to 2200 GMT (Figure IID.1). Additional short transects were added into the survey in areas of expected higher herring abundance and in the area of joint survey with FRV Micheal Sars.. FRV Scotia ceased the survey at 2200GMT (60^o 34’N 1^{o}45’E) and docked in Lerwick at 0730 GMT on 13 July for a mid cruise break. Scotia sailed again at 0800 GMT on 14 July and recommenced the survey at 60^{o}39’N 0^o 45’W at 1045 GMT. FRV Scotia continued the survey north to 61^o 32’N and then progressed southwards to the west of Shetland and Orkney and finished the survey at 0745 GMT on 22 July (58^o 42’N 3^o 27’W). FRV Scotia then proceeded to Scapa flow to carry out a second calibration of the acoustic instruments. FRV Scotia departed Scappa Flow following successful calibration of acoustic instruments at 1700GMT and sailed to Aberdeen and docked at 0530 GMT on 23 July 2001.

2.3 Survey design

The survey track (Fig. IID.1) was selected to cover the area in one levels of sampling intensity based on the limits of herring densities found in previous years, a transect spacing of 15 nautical miles was used in most parts of the area with the exception of a section over the 80 miles holes east of Orkney and areas both east and west of Shetland where short additional transects were carried out at 7.5 nm spacing. On the administrative boundaries of 2°E and 4°W the ends of the tracks were positioned at twice the actual track spacing from the area boundary, giving equal track length in any rectangle within the area. The between-track data could then be included in the data analysis. Transects at shelf break were continued to the limits of the stock and the transect ends omitted from the analysis. Transects at the coast were continued ax close inshore as practical, those on average less than half a transect spacing from the coast were included in the analysis, those less were excluded. The origin of the survey grid was selected randomly with a 15 n.mi. interval the track was then laid out with systematic spacing from the random origin. Where 7.5 n.mi. transect spacing was used the same random origin was used.

2.4 Calibration

Two calibrations were carried out the transducer systems used during the survey one at the beginning on 4 July and one at the end on 22 July both in Scapa Flow. A standard sphere calibration was carried using 38.1mm diameter tungsten carbide sphere. Agreement between mean of the calibrations this year and value from last year on the same systems was better than 0.1 dB. Agreement between the calibrations was better than 0.2 dB. The Calibration settings and results given in Table IID.1.

2.5 Acoustic data collection

The acoustic survey on FRV *Scotia* was carried out using a Simrad EK500 38 kHz sounder echo-integrator with transducer mounted on the drop keel. Additional data was collected at 18, 120 and 200 kHz. Data were archived for further data analysis was carried out using Echoview software and Marine Lab Analysis systems. Only data from 38, 120 and 200 kHz systems were used in the analysis. Data were collected from 0200 to 2200 GMT. Paper records were kept for acoustic data at 38, 120 and 200kHz. A total of 2,600 n.mi. were surveyed.

2.6 Biological data - fishing trawls

Trawl hauls (positions shown in Fig. IID.1) were carried out during the survey on the denser echo traces. The fishing gear used throughout the survey was PT160. The haul was monitored using Simrad FS903 scanning netsonde. Each haul was sampled for length, age, maturity and weight of individual herring. In addition weights of gonads and livers were also collected. Between 250 and 500 fish were measured at 0.5 cm intervals from each haul. Otoliths were collected with five per 0.5 cm class below 24 cm, and ten per 0.5 cm class for 24.5 cm and above. The same fish were sampled for whole weight, gonad weight, liver weight, sex, maturity, stomach contents and macroscopic evidence of Ichthyophonus infection. The maturity scale used in data collection was the Scottish 8 point scale.

In this survey some problems catching fish traces were experienced east of Shetland. Initially fishing at 4.5 knots on haul 225 (Fig. IID.3) substantial numbers of schools were observed on the echosounder but no fish traces were observed either going into the net or avoiding the net laterally or vertically. Fishing speed was increased to 5.1 knots and fish schools and then fish schools were seen entering the net on the netsonde, the catch was 100% herring. Subsequently fishing speed was increased for most occasions.

2.7 Hydrographic data

Surface temperature and salinity was collected throughout the survey. CTD stations were taken at each night location (2200hrs) and XBTs were taken at each haul location.

2.8 Data analysis

Data from the echo integrator were summed over quarter hour periods (2.5 n.mi. at 10 knots). Echo integrator data was collected from 11 m below the surface (transducer at 8 m depth) to 1 m above the seabed. The data were divided into eight categories, by visual inspection of the echo-sounder paper record and the integrator cumulative output;

1)"herring traces",
2)"probably herring traces" and
3)"probably not herring traces" all below 50 m

4) shallow herring schools above 50 m,
5) shallow schools not herring above 50m,
6) mixture including herring whiting haddock and Norway pout
7) Norway pout and
8) probably haddock traces.

To calculate integrator conversion factors the target strength of herring and for gadoid species in the mixture were estimated using the TS/length relationship recommended by the acoustic survey planning group (Anon, 1992):

$$TS = 20\log_{10}L - 71.2 \text{ dB per individual for herring}$$
$$TS = 20\log_{10}L - 67.5 \text{ dB per individual for gadoids}$$

The weight of herring at length was determined by weighing fish from each trawl haul which contained more than 200 herring. Lengths were recorded by 0.5 cm intervals to the nearest 0.5 cm below.

To process the data for extraction of schools the variable computation method available in Echo View was used. Previously when processing by hand a small 'background' value for scattered fish was removed from integrator layers with many fish schools. It was noted that fish schools appear consistently on 38,120 and 200kHz echograms while other features such as plankton may be strong on some frequencies and week on others. The processing was

Sv_{used} = $Sv38*[Sv_{38}+ Sv_{120}+Sv_{200}$ ** Blur>-170dB]

Where Blur is a convolution matrix

[1 2 1
2 1 2
1 2 1]

The Blur convolution filter is chosen as a suitable smoothing function as previous experiences suggests it is wee suited to the types of amplitude distributions expected from echos from fish aggregations. It provides a smoother spatial filter for filling in values in a school than either a centered weighted or uniform averaging filters.

An example of the process can be seen in Figures IID.4a to c which show the echograms at 38,120 and 200kHz respectively. It is easy to sea that the major schools are consistent on all the echograms but the plankton occurs mostly on 38kHz The masked results can be seen in Figure IID.4d.

Table IID.5 shows a comparison of the masked and unmasked Sv_{38} integrator values for the 15 minute periods prior to a number of trawl hauls including haul 212 illustrated in Figure IID.4.

Data were allocated to quarter statistical rectangles by their mid point location, the estimate of density was obtained as the arithmetic mean of all values weighted by duration of the run to accommodate the small number of short ESDUs.

Biological information in post stratified method based on Kolmogorov-Smirnov test (see MacLennan and Simmonds 1992). The length frequency data is given in Table IID.4.

3. RESULTS

3.1 Acoustic data

The distribution of NASC along the cruise track is shown in Figure IID.2. One exceptionally large value from a single school was observed to the North west of Shetland (NASC over 2.5n.mi. if 39,000). The school that gave this value can be seen in Figure IID.5. This run, despite being the largest ever observed contributes only 11% of the population estimate from FRV Scotia.

3.2 Biological data

A total of 48 trawl hauls were carried out (Figure IID.1), the results of these are shown in Table IID.2. 40 hauls with significant numbers of herring were used to define seven survey sub areas (Figure IID.2). Table IID.3 shows the total catch by species. The mean length keys, mean lengths, weights and target strengths for each haul and for each sub area are shown in Table IID.4. The spatial distribution of mean length is shown in Figure IID.2. A total of 4,513 otoliths were taken to establish 7 age length keys, one per area, the total number of otoliths taken by length and age is given in Table IID.6. There is again evidence of only very small icthyophonus infection in the population. This was lower than last year. Only 6 herring from 4,513 herring sampled were found to be infected. From these numbers its not possible to infer age or size of the infected fish. The stratified weight at length data was used to define the weight-length relationship for herring was:

$$W = 2.05\ 10^{-3}\ L^{3.445}\ g \quad \text{(L measured in cm)}$$

The proportions of mature 2 ring and 3 ring herring were estimated at 91% and 92% respectively. This is a higher proportion for 2 ring mature than those found in 2000 Proportion of 3 ring mature was similar to the long term mean.

3.3 Biomass and Abundance estimates

The numbers and biomass of fish by quarter ICES statistical rectangle are shown in Figure IID.6. A total estimate of 11,796 million herring or 1,992 thousand tonnes was calculated for the survey area. 1,862 thousand tonnes of these were mature. Herring were found mostly in water with the seabed deeper than 100 m, with traces being found in waters with depths of up to 200 m. The survey was continued to 250 m depth for most of the western and northern edge between 0°and 4°W. Herring were generally found in similar water depths and location to 2000 however, the distributions were more westerly with more herring found west of Shetland. The proportion of 2 ring herring was much higher than last year, rising from 0.13% of the total 2+ biomass in 2000 to 49% in 2001. The fish traces were continuous in character similar to 1998 more mixed in size but in most case quite separate from other species. Table IID.7 shows the estimated herring numbers mean lengths weights and biomass and proportion mature at age 2 & 3 ring by sub area and by age class.

In addition to the 1,992 thousand tonnes of herring, approximately 200 thousand tonnes of other fish species were observed in mid water in similar depths and conditions. Examination of the catch by species (Table IID.1) shows the difficulty of allocating this between species so this has not been attempted. The dominant part must be considered to be Norway pout with some haddock, mackerel and whiting. The survey indicates that the overall biomass has increased substantially due mostly to the influx of 2 ring herring. The abundance of 2 ring herring in the Scotia survey is approximately six times that observed last year.

Table IID.1. Simrad EK500 settings used on the July 1998 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	-20.6 dB
3 dB Beamwidth	7.1°
Calibration details (1)	
TS of sphere	-42.36 dB (tungsten carbide 38.1mm diameter)
Range to sphere in calibration	10.098
Selected NASC value for calibration	3099
Calibration factor for NASCs	1.00
Calibration constant for MILAP	1.01 at -35 dB
Calibration details (2)	
TS of sphere	-42.36 dB (tungsten carbide 38.1mm diameter)
Range to sphere in calibration	9.75
Selected NASC value for calibration	3158
Calibration factor for NASCs	1.038
Calibration constant for MILAP	1.05 at -35 dB
Log Menu	
Simulated	2.5 n.mi. at 10 knots
Operation Menu	
Ping interval	1.2 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. Summary of trawls hauls FRV Scotia 3-23 July 2001

Haul No	Date	Position	Time (utc)	water depth	trawl depth	gear	Duration	Use	Total catch
206	07/04/01	58 39N 002 06W	14:40	80	80	PT160	70	h	11585
207	07/04/01	58 39N 001 13W	19:30	102	102	PT160	45	h	1464
208	07/05/01	58 32N 000 11W	6:45	130	130	PT160	45	h	2088
209	07/05/01	58 32N 000 56W	10:25			PT160	60	h	379
210	07/05/01	58 46N 000 50W	13:20	128	128	PT160	20	h	4292
211	07/06/01	58 38N 001 01W	3:15	121	121	PT160	65	h	288
212	07/06/01	58 54N 001 39W	16:55	100	100	PT160	40	h	1145
213	07/07/01	59 09N 001 43W	4:20	95	95	PT160	50	h	6613
214	07/07/01	59 01N 000 03W	12:00	128	128	PT160	40	h	996
215	07/08/01	59 24N 001 10W	17:00	105	105	PT160	55	h	3940
216	07/09/01	59 28N 002 20W	2:45	95	95	PT160	40		11
217	07/09/01	59 39N 001 10W	8:35	112	112	PT160	35	h	4378
218	07/09/01	59 39N 001 18W	17:30	112	112	PT160	30		0
219	07/10/01	59 54N 000 44W	11:30	112	112	PT160	40	h	941
220	07/10/01	60 01N 000 47W	16:15	110	110	PT160	35	h	4040
221	07/10/01	60 05N 000 00W	20:00	112	112	PT160	25	h	674
222	07/11/01	60 17N 000 12W	3:25	130	130	PT160	40	h	20
223	07/11/01	60 09N 000 54W	8:48			PT160	42	h	805
224	07/12/01	60 24N 000 7W	4:36	130	130	PT160	53	h	7455
225	07/12/01	60 25N 000 34W	8:40	125	125	PT160	40	h	1305
226	07/12/01	60 29N 000 47W	11:10	85	85	PT160	30		0
227	07/12/01	60 31N 000 00W	12:45	112	112	PT160		h	3208
228	07/12/01	60 32N 000 27W	18:02	143	143	PT160	25	h	1096
229	07/14/01	60 38N 000 28W	12:10	140	140	PT160	15	h	975
230	07/14/01	60 38N 000 06W	16:09	70	70	PT160	30		85
231	07/14/01	60 38N 000 12W	17:40	145	145	PT160	30	h	6451
232	07/15/01	60 53N 000 53W	4:43	125	125	PT160	9	h	1944
233	07/15/01	60 46N 000 27W	8:40	145	145	PT160	25		0
234	07/15/01	60 47N 000 01W	10:12	147	147	PT160	30	h	4418
235	07/15/01	60 46N 001 14W	19:30	147	147	PT160	25	h	6444
236	07/16/01	61 02N 001 10W	5:00	157	157	PT160	29	h	2742
237	07/16/01	61 02N 000 5W	9:20	146	146	PT160	22	h	980
238	07/16/01	61 17N 000 44W	14:06	173	173	PT160	37	h	109
239	07/16/01	61 16N 000 43W	16:18	174	174	PT160	51		5
240	07/17/01	61 02N 001 29W	13:50	166	166	PT160	60		206
241	07/17/01	60 53N 002 00W	19:52	132	132	PT160	48		0
242	07/18/01	60 54N 001 07W	3:43	105	105	PT160	57	h	558
243	07/18/01	60 47N 001 07W	7:05	95	95	PT160	13	h	5000
244	07/18/01	60 39N 002 17W	15:48	145	145	PT160	40	h	3120
245	07/18/01	60 39N 000 00W	19:15	105	105	PT160			75
246	07/19/01	60 32N 002 19W	4:10	145	145	PT160	31	h	115
247	07/19/01	60 23N 002 32W	10:40			PT160	50	h	1486
248	07/19/01	60 10N 001 54W	17:05	58	58	PT160	30		1
249	07/20/01	60 08N 003 27W	4:00	136	136	PT160	55	h	247
250	07/20/01	59 53N 002 58W	10:12	85	85	PT160	46	h	2970
251	07/20/01	59 54N 002 01W	14:42	120	120	PT160	33	h	2600
252	07/21/01	59 47N 003 50W	6:42	139	139	PT160	26	h	570
253	07/21/01	59 35N 002 59W	10:55	85	85	PT160	42		17
254	07/21/01	59 31N 003 45W	15:00	163	163	PT160	28	h	10080

Table IID.3. Numbers of fish caught by species FRV Scotia Survey 3-23 July 2001

Haul No/ Species	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228
Herring	11060	1432	2048	373	4280	288	1075	6373	994	284		200		617	4040	674	20	805	7455	1305		3208	1096
Mackerel							21	40			3			19									
Sprat	280						7	107															
NPout		14	4						2	3100	8**	4060		206									
Bl whiting												1											
Haddock	140	18	20	3			21	26		468		59		60									
Whiting			16	2	10			67		70		42		16									
Argentine	70									5		12		4									
L sole	35									1				1									
G gurnard				1			21			7		2		1									
T minutus														1									
Saithe					2					3		1		14									
Cod										1		1											
pearlsides														1									
Hake														1									
Dabs										1													
Lumpsucker																							
Scad																							

Table IID.3 (continued) Numbers of fish caught by species FRV Scotia Survey 3-23 July 2001

Haul No/ Species	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254
Herring	975	45	6213	1944		4305	6420	2742	974	108	3	2		534	5000	3114	9	110	1102		243	2970	2600	568		10060
Mackerel		40	238			38			6		1	201		24				3		1	2			2		20
Sprat																										
NPout						60					1 **						63		45						17**	
Bl whiting																			333							
Haddock																6		2								
Whiting						15											2		6							
Argentine																										
L sole																										
G gurnard												2									1					
T minutus																										
Saithe							24																			
Cod																										
pearlsides																										
Hake										1																
Dabs																										
Lumpsucker														1								1				
Scad																		1								

Table IID.4 Length frequency distribution by haul and means by analysis area (I, II, III) FRV Scotia 3-23 July 2001 see Figure IID.1

	236	237	238	mean	219	220	222	223	224	225	227	228	229	230	231	232	234	242	243	Mean	211	214	221	235	mean
20.5																									
21.0																									
21.5								0.2												0.0	0.3				0.1
22.0																									
22.5						0.2		0.2								0.2				0.0	0.3				0.1
23.0					0.2	2.0	5.0	1.5	0.7	0.9	0.7	0.4				0.4			0.8	0.8	0.7		0.3		0.2
23.5					3.0	5.9	10.0	5.5	5.4	3.7	6.5	1.8	4.4		0.8	1.2	0.2	0.6	0.8	3.3	0.3	0.8			0.3
24.0					12.5	11.4	25.0	11.1	16.0	9.9	18.5	5.1	10.8	2.2	4.6	5.1	0.9	2.2	5.3	9.4	2.1	1.2	0.9	0.2	1.1
24.5		0.2		0.1	13.6	13.9	10.0	15.2	16.2	12.4	19.2	8.2	13.1	11.1	11.4	8.0	1.6	8.7	12.0	11.6	3.8	2.6	3.0	3.4	3.2
25.0		0.2		0.1	13.4	18.1	10.0	17.4	19.0	17.5	23.2	11.3	20.0	17.8	15.7	14.2	5.7	13.8	16.5	15.6	4.2	4.6	5.6	7.3	5.4
25.5	0.2	1.8	0.9	1.0	11.7	10.9	10.0	13.6	13.4	16.6	14.2	9.9	13.6	20.0	13.3	14.8	7.7	14.0	13.0	13.1	8.0	6.6	7.7	9.7	8.0
26.0	0.4	0.6	1.9	1.0	11.4	10.6	10.0	12.4	12.0	14.7	10.2	9.1	13.6	6.7	13.3	13.6	8.7	15.2	12.8	11.6	8.3	9.5	10.4	11.0	9.8
26.5	0.4	1.2	1.9	1.2	7.6	8.4	5.0	7.1	6.1	8.0	2.2	7.8	6.4	4.4	8.4	10.3	9.2	9.8	7.0	7.2	11.8	10.9	11.9	12.0	11.6
27.0	1.5	0.8	0.9	1.1	7.3	5.7	10.0	5.5	5.2	7.4	2.0	8.4	4.6	8.9	6.0	6.4	9.6	6.7	5.5	6.6	16.7	10.9	14.8	11.2	13.4
27.5	2.0	4.5	0.9	2.5	6.3	5.7	5.0	3.3	1.6	3.0	1.2	7.3	4.4	6.7	4.6	5.8	9.6	4.5	5.0	4.9	15.6	11.1	12.5	9.7	12.2
28.0	4.2	8.2	2.8	5.0	6.0	3.2		2.3	0.7	2.1	0.7	7.5	2.8	6.7	4.9	5.8	10.5	4.5	5.0	4.2	14.2	12.9	12.8	9.7	12.4
28.5	7.9	9.9	10.2	9.3	3.9	2.2		1.7	1.2	2.3	0.7	7.3	2.8	6.7	4.3	4.3	9.6	4.2	3.8	3.7	7.3	12.1	8.6	8.0	9.0
29.0	13.3	14.0	16.7	14.7	1.3	0.7		0.5	1.2	0.9	0.2	5.8	2.1		4.6	4.1	8.7	5.9	3.0	2.6	4.9	8.9	5.6	7.7	6.8
29.5	17.7	14.4	13.9	15.3	1.3	0.2		1.0	0.9	0.2	0.2	3.5	0.5	4.4	3.0	2.3	7.3	3.1	3.3	2.1	1.0	4.0	2.7	4.5	3.1
30.0	17.9	15.6	13.9	15.8	0.2	0.7		0.8	0.2	0.5		2.6	0.5	2.2	1.6	1.6	5.6	2.8	1.8	1.4	0.3	1.0	2.1	3.2	1.7
30.5	13.3	11.7	15.7	13.6				0.3	0.2			2.0	0.5	2.2	1.6	1.0	2.8	1.7	1.8	0.9		1.4	0.3	1.5	0.8
31.0	7.9	8.2	6.5	7.5				0.3				0.4			1.1	0.4	1.0	0.3	0.8	0.3		0.8	0.3	0.7	0.5
31.5	5.3	4.9	5.6	5.2	0.2							0.7					0.9	0.3	0.3	0.2		0.2			0.1
32.0	2.4	2.1	1.9	2.1				0.2				0.5				0.2	0.3	1.4	1.0	0.2		0.4			0.1
32.5	2.2	1.0	3.7	2.3				0.2				0.2			0.5		0.2	0.3	0.3	0.1		0.2	0.3		0.1
33.0	1.1	0.2	1.9	1.1								0.2			0.3	0.2			0.5	0.1			0.3	0.2	0.1
33.5	1.3		0.9	0.7															0.3	0.0					
34.0	0.4			0.1																					
34.5	0.2	0.4		0.2																					
35.0	0.2			0.1																					
Num	457	487	108		463	404	20	605	426	435	401	548	390	45	369	486	574	356	400		288	497	337	535	
L(cm)	30.4	30.0	30.3	30.2	26.3	26.0	25.5	26.0	25.8	26.1	25.5	27.2	26.1	26.9	26.9	26.8	28.1	27.1	26.8	26.5	27.4	27.8	27.6	27.7	27.6
W (g)	265	253	262	260	162	155	145	155	150	156	144	184	158	175	175	173	203	180	175	166	185	196	191	193	191
TS/in	-41.5	-41.7	-41.6	-41.6	-42.8	-42.9	-43.1	-42.9	-43.0	-42.9	-43.1	-42.5	-42.9	-42.6	-42.6	-42.6	-42.2	-42.5	-42.6	-42.7	-42.4	-42.3	-42.4	-42.3	-42.4
TS/kg	-35.8	-35.7	-35.7	-35.7	-34.9	-34.8	-34.7	-34.8	-34.7	-34.8	-34.6	-35.1	-34.8	-35.0	-35.0	-35.0	-35.3	-35.1	-35.0	-34.9	-35.1	-35.2	-35.2	-35.2	-35.2

Table IID.4(continued) Length frequency distribution by haul and means by analysis area (IV, V, VI, VII) FRV Scotia 3-23 July 2001 see Figure IID.1

	215	217	251	mean	207	208	209	210	212	213	mean	244	246	247	249	250	252	254	mean	206	mean
20.5																		0.2	0.0		
21.0																		0.2	0.0	2.5	2.5
21.5					1.4			0.2		0.2	0.3					0.7		0.2	0.1	7.0	7.0
22.0	1.4	0.5	0.2	0.7	1.9		4.6	0.9	3.4	4.0	2.5					2.0		0.2	0.3	15.8	15.8
22.5	3.5	1.5	1.5	2.2	6.4	0.4	10.2	6.8	7.1	9.0	6.6			0.2	2.9	5.4	0.2	1.0	1.4	17.4	17.4
23.0	10.9	6.5	6.3	7.9	16.1	0.2	17.7	14.3	14.2	18.0	13.4		3.6	0.9	5.8	11.1	0.7	0.8	3.3	21.5	21.5
23.5	11.6	11.0	10.6	11.1	18.7	3.3	19.3	15.2	17.8	18.0	15.4	0.4	7.3	1.1	7.8	15.8	1.9	3.2	5.4	14.6	14.6
24.0	16.2	16.0	16.9	16.4	19.4	5.7	22.0	20.8	22.2	22.2	18.7	1.5	7.3	3.3	17.3	20.2	1.6	6.0	8.2	10.8	10.8
24.5	15.5	14.0	18.5	16.0	13.7	7.4	13.1	16.4	13.5	11.1	12.5	5.4	11.8	6.4	14.0	15.5	3.3	10.1	9.5	4.7	4.7
25.0	15.5	19.5	17.9	17.6	10.0	9.8	4.8	10.0	10.5	8.8	9.0	5.8	14.5	9.6	13.2	14.1	6.2	16.3	11.4	3.2	3.2
25.5	9.2	8.0	9.4	8.9	5.7	9.0	3.8	6.3	4.9	4.6	5.7	6.7	10.0	7.1	7.8	8.4	4.0	13.5	8.2	1.9	1.9
26.0	8.1	7.5	8.5	8.0	2.6	11.3	1.6	3.3	2.8	1.5	3.8	6.2	9.1	8.2	4.5	4.4	4.9	13.3	7.2	0.6	0.6
26.5	2.1	3.0	2.9	2.7	1.9	11.3	1.1	2.3	2.5	1.7	3.5	6.2	7.3	6.7	2.5	0.7	4.8	7.2	5.0		
27.0	2.5	4.5	2.5	3.2	0.9	12.7	0.8	1.6	0.9	0.4	2.9	6.6	4.5	8.2	4.5	0.3	4.2	7.2	5.1		
27.5	2.1	3.0	1.9	2.3	0.9	8.4	0.5	0.7	0.3	0.4	1.9	5.8	1.8	5.6	5.3	0.3	6.2	4.0	4.1		
28.0	1.4	3.5	0.2	1.7	0.2	8.2	0.3	0.7		0.2	1.6	9.2	3.6	6.7	4.9	0.7	10.4	6.4	6.0		
28.5		1.0	1.0	0.7		5.7		0.5			1.0	9.2	5.5	7.8	2.9	0.3	10.4	3.2	5.6		
29.0			1.2	0.4		4.1					0.7	9.6	1.8	9.4	1.2		12.9	2.0	5.3		
29.5		0.5	0.4	0.3		1.2	0.3				0.2	7.3	4.5	5.1	1.6		8.1	2.0	4.1		
30.0						0.6					0.1	8.5	3.6	5.4	0.4		7.7	1.0	3.8		
30.5			0.2	0.1		0.2					0.0	5.4		3.1	0.8		5.3	1.0	2.2		
31.0						0.4					0.1	2.7	1.8	1.8	0.4		3.0	0.4	1.4		
31.5						0.2					0.0	1.9	1.8	1.3	0.4		1.8	0.4	1.1		
32.0												0.8		0.9	0.4		1.8		0.6		
32.5												0.4		0.4	0.8			0.2	0.3		
33.0												0.2		0.5	0.4		0.2	0.2	0.2		
33.5												0.2					0.2		0.1		
34.0														0.4					0.1		
34.5																	0.4		0.1		
35.0																					
Num	284	200	520		422	512	373	428	325	478		519	110	551	243	297	568	503		316	
L(cm)	25.0	25.4	25.3	25.2	24.5	26.9	24.3	24.7	24.5	24.3	24.9	28.4	26.6	27.8	25.9	24.7	28.5	26.5	26.9	23.5	23.5
W (g)	136	144	141	140	126	174	122	129	126	123	134	211	170	198	156	129	216	166	178	109	109
TS/in	-43.2	-43.1	-43.1	-43.1	-43.4	-42.6	-43.5	-43.3	-43.4	-43.5	-43.3	-42.1	-42.7	-42.3	-42.9	-43.3	-42.1	-42.7	-42.6	-43.8	-43.8
TS/kg	-34.6	-34.7	-34.6	-34.6	-34.4	-35.0	-34.4	-34.5	-34.4	-34.4	-34.5	-35.4	-35.0	-35.3	-34.8	-34.5	-35.4	-34.9	-35.1	-34.1	-34.1

Table IID.5 Comparison of example MVBS before and after masking and the amount removed for scattered fish and plankton and the proportion of herring in the catch.

Haul Number	Unmasked Sv_{38}	Masked Sv_{38}	Amount removed	% herring caught
207	850	816	34	97.8
210	155	103	48	99.7
212	2077	2014	63	93.9
214	1273	1230	43	99.7
232	7394	7279	115	100
234	3820	3798	22	97.4
Total	15569	97.89%		98.08

Table IID.6 Number of otoliths collected by age and length and maturity stage for 2 ring and three ring. (ages expressed as winter rings) FRV Scotia 3-23 July 2001.

Len	1	2i	2m	3i	3m	4	5	6	7	8	9+	Total
205	1											1
210	1	3	2									6
215	4	13										17
220	2	33	7									42
225	4	40	21									65
230		53	50	2								105
235		38	101	4	4							147
240		45	239	8	15	2						309
245		30	278	8	24	2						342
250	1	7	282	3	59	5						357
255		2	262	5	72	13	3					357
260		4	237	1	70	17	9	2				340
265		4	173		79	33	21	1				311
270			88		88	57	49	12	1			295
275			46		90	56	67	20	2	1		282
280			14		70	93	70	13	3			263
285			4		53	81	92	21	6	1		258
290			2		31	62	98	22	4			219
295					18	55	98	23	6	2	1	203
300			1		7	21	86	26	12	7	1	161
305					2	15	75	19	15	8	1	135
310					1	12	33	21	10	10	4	91
315					1	1	17	19	16	12	5	71
320					1		6	13	13	17	10	60
325					1	1	6	3	5	11	7	34
330							2	2	3	4	11	22
335							1	4			5	10
340								1	1	1	1	4
345											5	5
350											1	1
Total	13	272	1806	31	686	526	734	222	97	74	52	4513

Table IID.6 Number (millions), mean length (cm), mean weight(g) and total biomass (thousands of tonnes of herring by sub area (figure1) from FRV Scotia 3-23 July 2001

Area / Age	Numbers	Mean Length	Mean Weight	Biomass
Area I	(millions)	(cm)	(g)	(thousands t)
1A	0.0			0.00
2I	1.2	26.0	163.8	0.20
2M	17.9	26.3	172.3	3.09
3I	1.6	25.5	153.4	0.25
3M	130.4	28.7	231.6	30.19
4A	207.6	29.2	244.0	50.65
5A	361.7	29.9	263.8	95.43
6A	91.4	30.6	287.9	26.33
7A	43.4	30.8	293.7	12.75
8A	28.5	31.3	308.8	8.81
9+	19.2	32.5	352.3	6.75
Total	903.0	29.7	259.6	234.46
Area II				
1A	7.8	24.7	138.3	1.07
2I	364.6	24.1	127.0	46.30
2M	3,649.7	25.3	149.3	545.00
3I	91.4	24.4	132.2	12.08
3M	1,056.6	26.4	173.7	183.54
4A	525.7	27.7	205.4	107.98
5A	548.7	28.5	225.9	123.93
6A	122.7	28.7	231.0	28.35
7A	36.7	29.5	254.1	9.32
8A	20.4	31.2	305.8	6.23
9+	11.6	32.2	339.1	3.92
Total	6,435.8	26.0	165.9	1,067.72
Area III				
1A	0.0			0.00
2I	19.1	24.9	144.3	2.76
2M	164.5	25.6	157.1	25.85
3I	4.8	25.2	147.1	0.70
3M	177.3	26.7	180.2	31.94
4A	179.0	27.9	208.8	37.37
5A	160.1	27.9	208.0	33.30
6A	60.5	28.1	215.3	13.03
7A	14.9	29.3	245.6	3.65
8A	6.8	29.8	264.7	1.80
9+	1.3	30.8	295.3	0.37
Total	788.2	27.1	191.3	150.77
Area IV				
1A	0.0			0.00
2I	65.3	23.4	114.7	7.50
2M	370.1	24.7	137.8	51.01
3I	1.5	25.5	153.4	0.24
3M	59.1	25.6	156.9	9.27
4A	13.4	26.7	179.9	2.42
5A	12.8	28.0	212.3	2.72
6A	1.6	28.0	211.7	0.35
7A	0.0			0.00
8A	0.0			0.00
9+	0.0			0.00

Area / Age	Numbers	Mean Length	Mean Weight	Biomass
Area I	(millions)	(cm)	(g)	(thousands t)
Total	523.9	24.7	140.3	73.50
Area V				
1A	7.9	22.4	99.3	0.79
2I	255.4	23.0	108.1	27.62
2M	819.7	24.2	129.7	106.28
3I	4.2	24.0	125.0	0.52
3M	143.7	25.5	154.5	22.20
4A	54.8	27.1	190.8	10.46
5A	39.0	27.7	204.5	7.98
6A	7.7	28.3	218.2	1.68
7A	3.5	28.3	220.8	0.78
8A	0.4	31.0	297.2	0.13
9+	0.0			0.00
Total	1,336.5	24.4	133.5	178.44
Area VI				
1A	3.1	21.8	90.5	0.28
2I	53.5	23.5	117.3	6.27
2M	695.3	24.9	143.7	99.88
3I	5.3	24.2	128.3	0.67
3M	147.6	27.0	189.3	27.94
4A	91.5	28.1	214.9	19.66
5A	219.6	28.9	235.9	51.81
6A	57.1	29.5	252.2	14.39
7A	17.7	30.9	296.2	5.24
8A	17.6	31.0	299.1	5.27
9+	9.4	32.1	336.5	3.15
Total	1,317.5	26.4	178.0	234.55
Area VII				
1A	33.3	22.0	93.1	3.10
2I	204.7	22.4	100.1	20.49
2M	226.6	23.5	117.0	26.52
3I	0.0			0.00
3M	24.1	24.0	125.4	3.02
4A	2.6	24.5	134.0	0.35
5A	0.0			0.00
6A	0.0			0.00
7A	0.0			0.00
8A	0.0			0.00
9+	0.0			0.00
Total	491.3	23.0	108.8	53.48
Total Area				
1A	52.0	22.4	100.7	5.24
2I	963.9	23.4	115.3	111.14
2M	5,943.9	25.0	144.3	857.63
3I	108.8	24.4	133.0	14.46
3M	1,738.8	26.5	177.2	308.10
4A	1,074.7	28.0	213.0	228.89
5A	1,341.9	28.8	234.9	315.17
6A	341.1	29.2	246.6	84.11
7A	116.2	30.2	273.2	31.75
8A	73.8	31.1	301.5	22.24
9+	41.3	32.3	343.3	14.19
Total	11,796.3	26.0	168.9	1,992.91

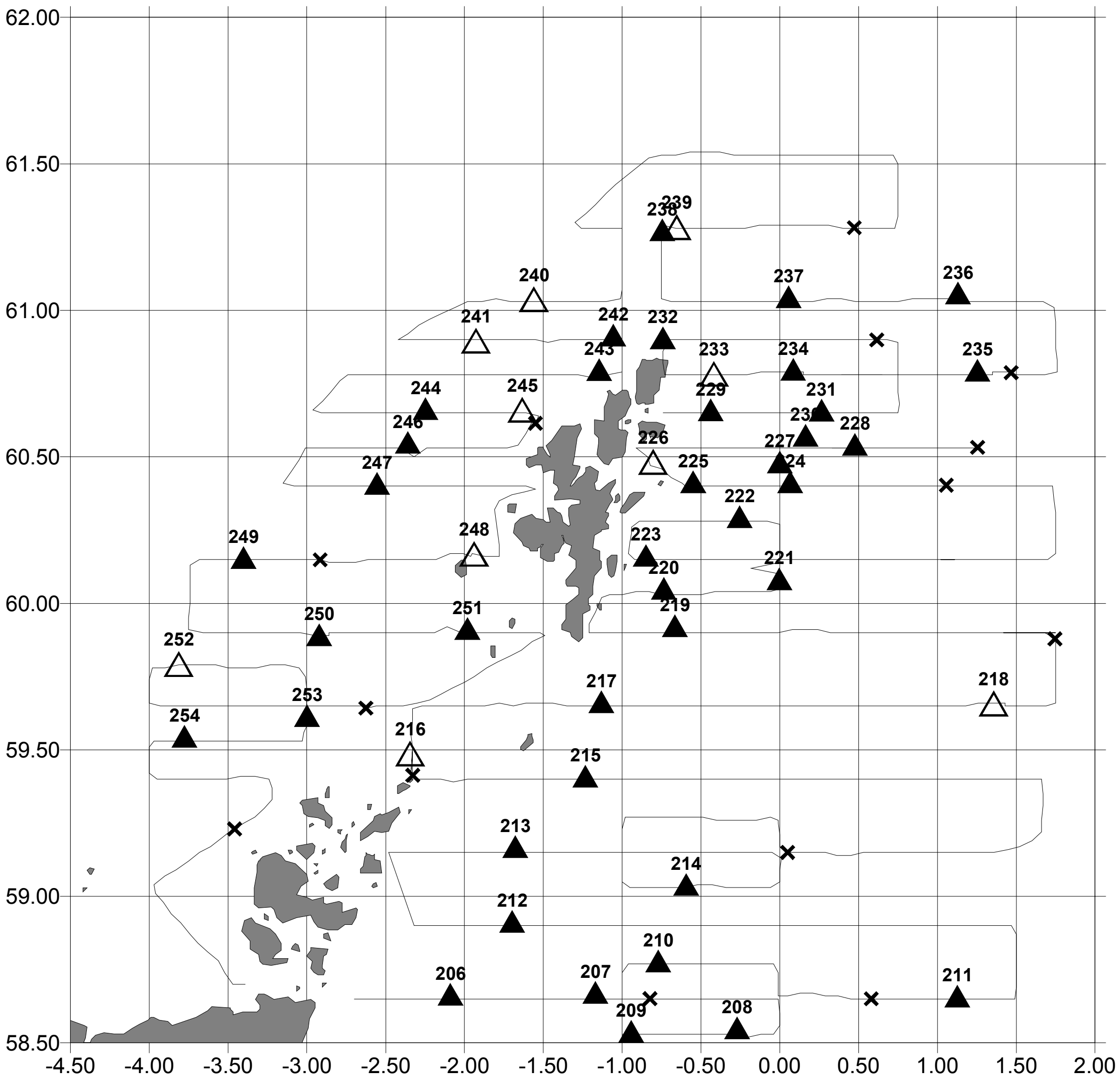

Figure IID.1 Cruise track, trawl haul locations, CTD locations and analysis areas FRV Scotia 3-23 July 2001. Open triangles indicate trawls without herring, closed triangles indicate hauls with herring.

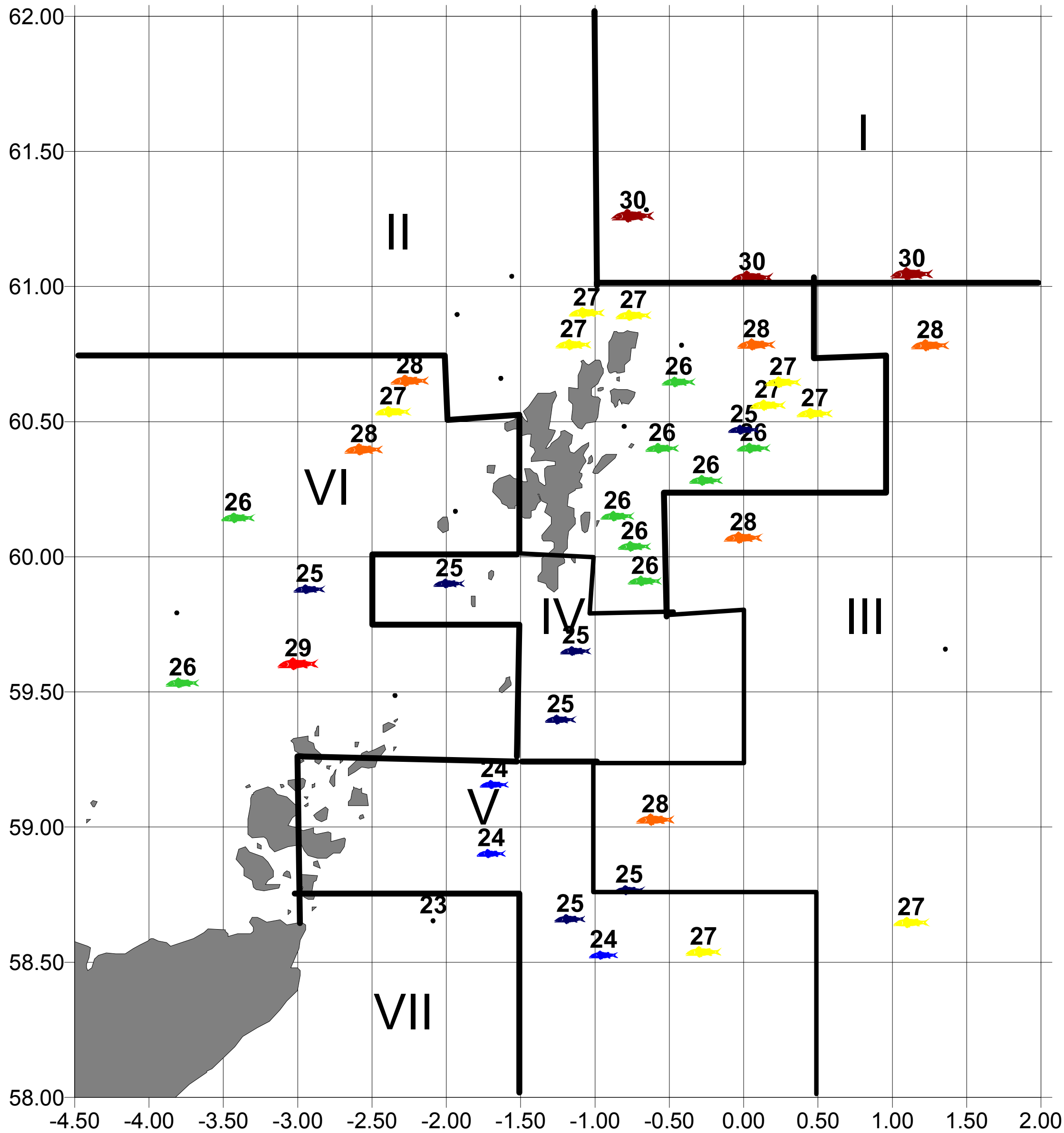

Figure IID.2 Length of herring at trawl haul locations, FRV Scotia 3-23 July 2001. Open triangles indicate trawls without herring, closed triangles indicate hauls with herring.

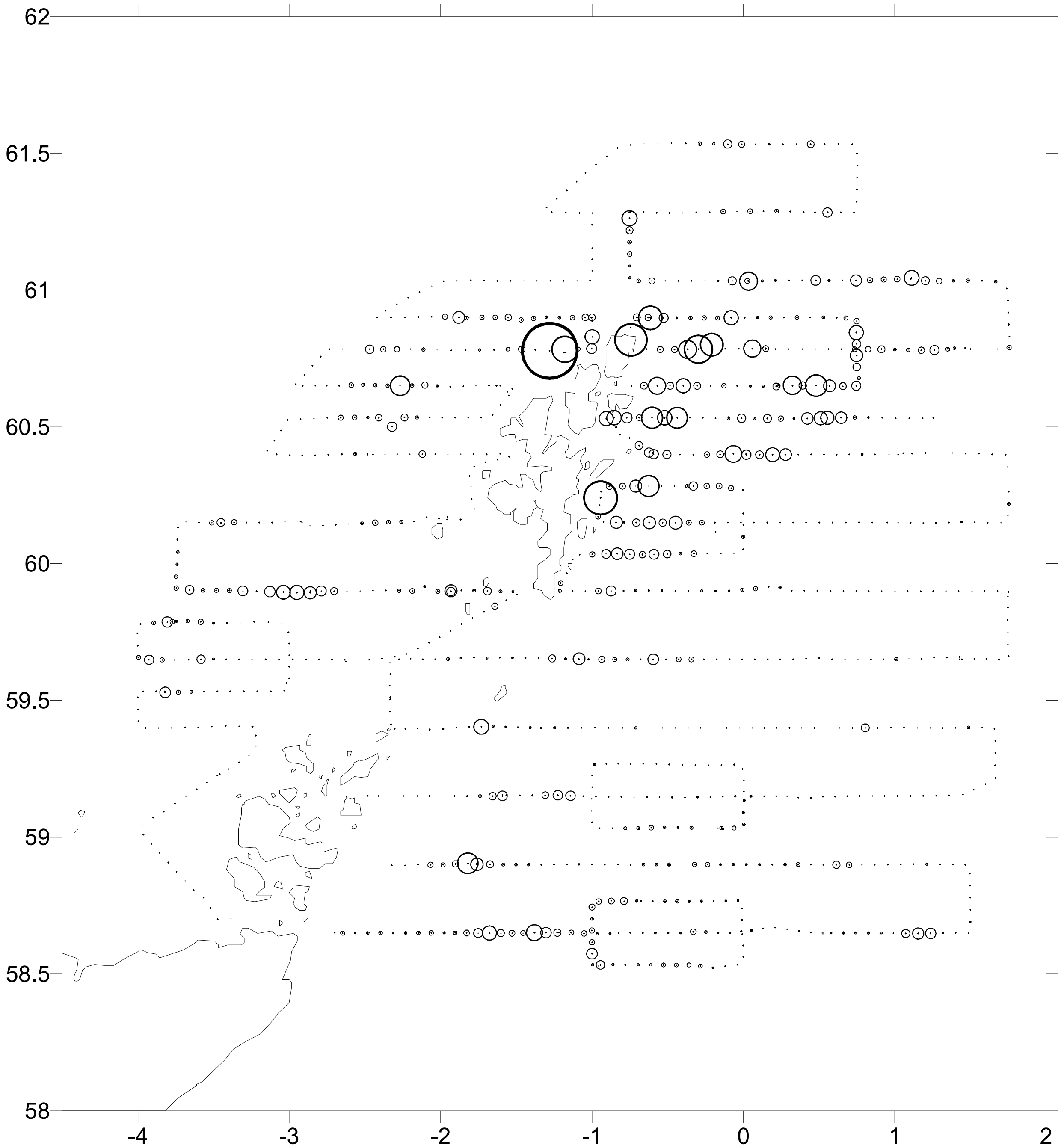

Figure IID.3 Post plot of NASC all categories allocated to herring using area related scaling scaled to maximum (40,000). This exclude the small (negligible) amount of herring found in a mixture south of Shetland.

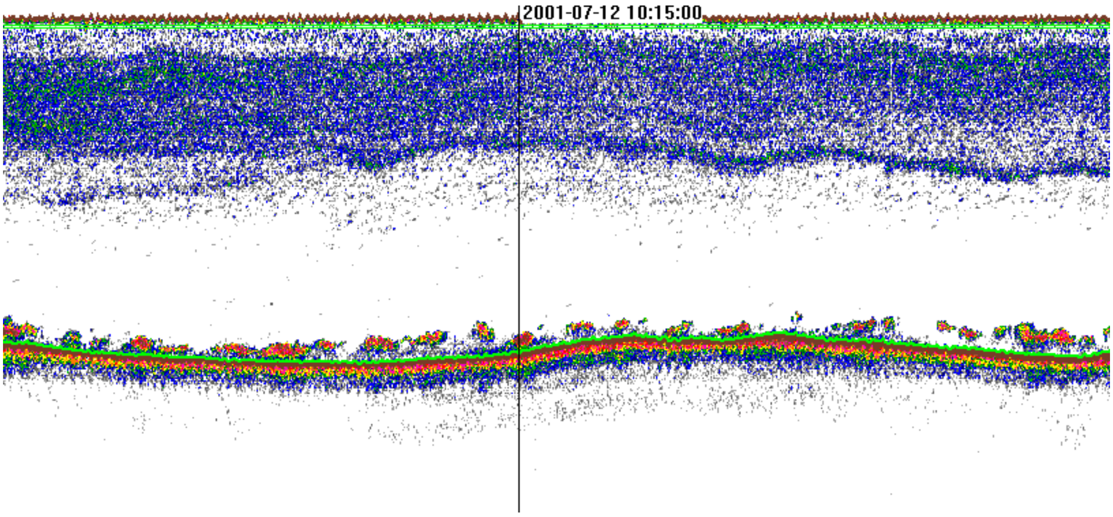

Figure IID.4. Echogram from during Haul 225. During the first part of the haul at a towing speed of 4.5knots no fish were observed entering or vertically or laterally avoiding the net. During the second half of the trawl speed was increased to 5.1Knots, fish were observed entering the net. Catch was 100% herring.

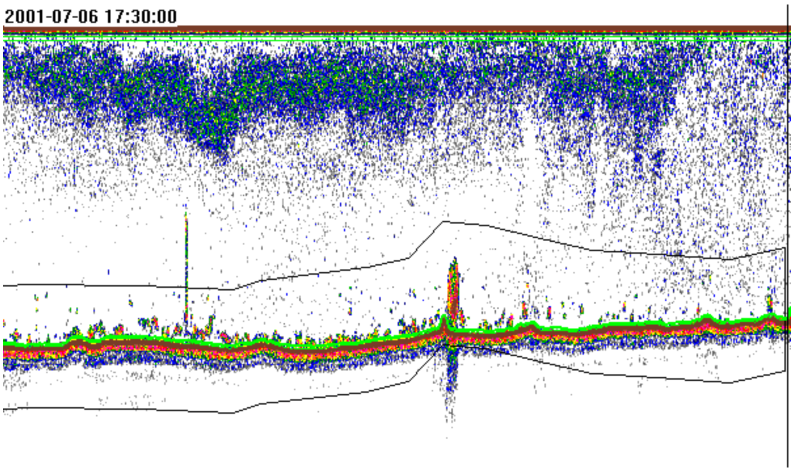

Figure IID.5 a Echogram from 38kHz channel from hail 212 which had 94% herring catch giving NASC of 2077

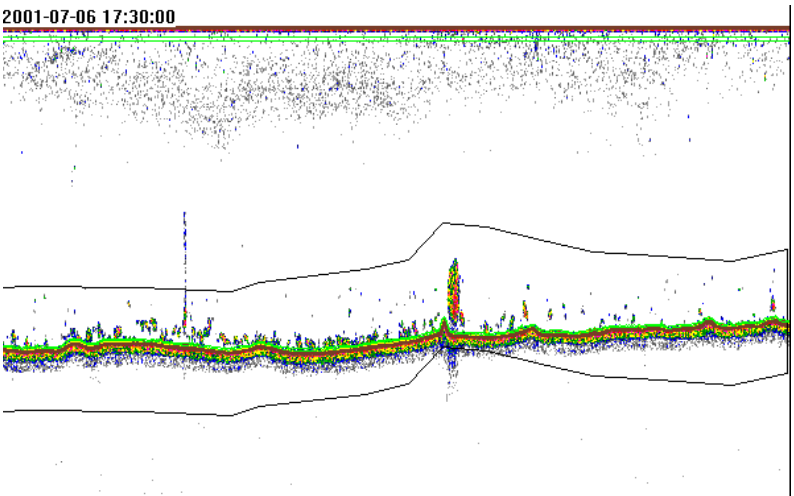

Figure IID.5b, Echogram from 120 kHz channel Haul 212

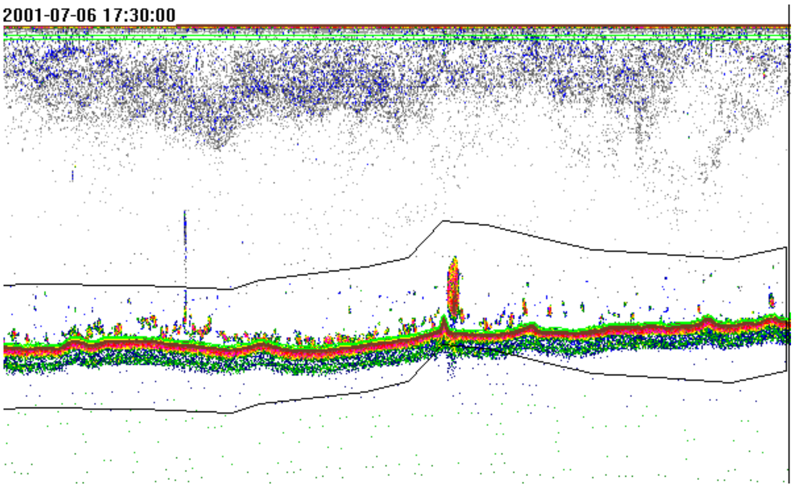

Figure IID.5c Echogram from 200 kHz channel Haul 212

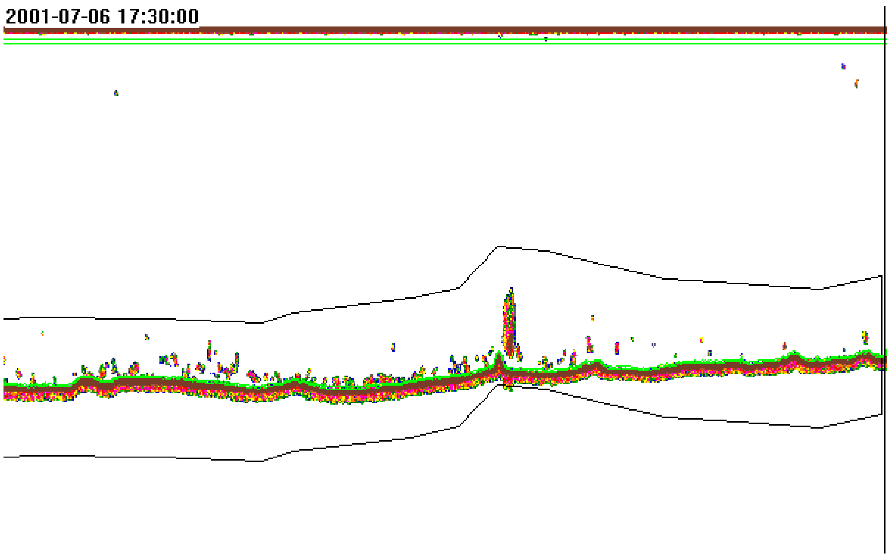

Figure IID.5d, Masked echogram used for echo integration from haul 212 with NASC of 2014

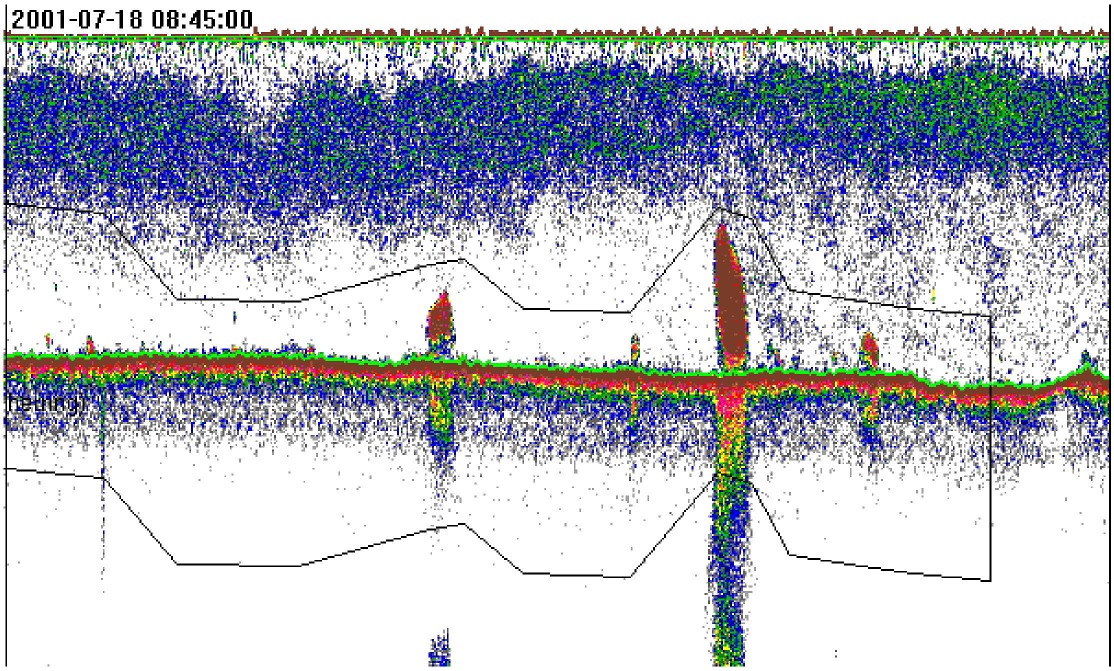

Figure IID.6. Large school found to the west of Shetland

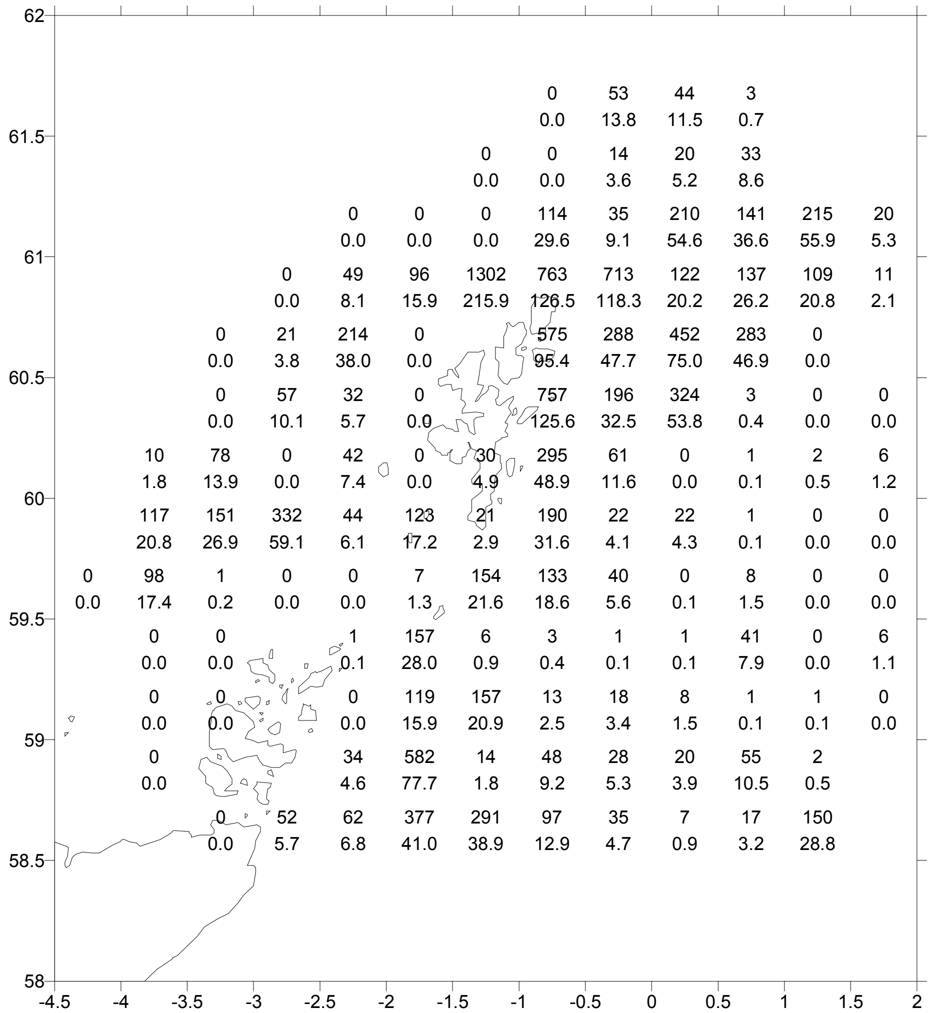

Figure IID.7. Millions (upper) and thousands of Tonnes (lower) of herring FRV Scotia 3-23 July 2001.

APPENDIX IIE NETHERLANDS

Survey report for FRV "Tridens"

25 June – 20 July 2001

Bram Couperus, RIVO

1. Introduction

The Netherlands Institute for Fisheries Research (RIVO) participates in the international North Sea hydro acoustic survey since 1991. The aim of this survey is to provide an abundance estimate of the whole North Sea herring population. This estimate is used as a tuning index by the Herring Assessment Working Group (HAWG) to determine the population size. In this report the results are presented of the survey in the central North Sea, carried out by FRV "Tridens".

2. Methods

2.1 Scientific Staff

Bram Couperus	(Cruiseleader)
Ronald Bol	
Kees Bakker	(1st two weeks)
Dirk den Uyl	(1st two weeks)
Mario Stoker	(2nd two weeks)
Arie Kraayenoord	(2nd two weeks)
Kees Camphuysen	(Birdwatcher)
Jaap van der Meer	(Birdwatcher; 1st two weeks)
Tanja Weichler	(Birdwatcher; 2nd two weeks)
Isabel Aidos	(Guest; 1st two weeks)

2.2 Narrative

"Tridens" left the port of IJmuiden on Monday 25 June heading for the scheduled calibration site at Scapa Flow, Orkneys. Under way on 26 June, the weather conditions were so good (0-1 bft) that it was tried to calibrate the hull mounted transducer at sea. However, even the little wind present, was enough to move the vessel so that it was impossible to manoeuvre the calibration sphere across three-quarter of the beam section.

On the evening of 26 June "Tridens" anchored in Scapa Flow (exact position: 58°55.71 N - 003°01.97 W). Next morning the calibration procedure started. The performance of the transducer in the towed body was so bad that it was decided to run the whole survey with the hull mounted transducer. The new calibration program "Calibrate" did take measurements, but it was not possible to compute the new calibration settings. Therefore it was decided to run the survey on default settings and correct the NASCs after the survey.

The survey started in the Moray Firth at 57°55 N. In the first week, two transects were covered. The weekend of 30 June/1 July was spent in Aberdeen. In the second week three transects were covered. The eastern most rectangles south of 56°30 N were covered by running on transect in southern direction on the way to IJmuiden, where the weekend of 7/8 July was spent.

The survey was resumed on 9 July at the 56°40 N transect in western direction. Large concentrations of herring in the whole area and in particular around Devils Hole were encountered. On 12 July surveying was not possible during almost the whole day due to the weather conditions. The weekend of 14/15 July was spent in Edinburgh. Due to lack of time, during the last week, large parts of the scheduled transects south of 55°30 N were cancelled. On 19 July "Tridens" was homeward bound.

2.3 Survey design

The survey was carried out from 25 June to 20 July 2001, covering an area east of Scotland from latitude 54° to 58° North and from longitude 3° West (or the Scottish/English coast) to 3° East. A stratified survey design was applied, based on the herring distribution from previous years. Parallel transects along the lines of latitude were used with spacing between the lines set at 15 n.mi. From 55°40 southwards ICES rectangles were covered less extensively (Figure IIE.1). Acoustic data from transects running north-south close to the shore (that is parallel to the depth isolines) were excluded from the dataset.

2.4 Calibration

For the calibration of the 38 kHz splitbeam hull mounted and the towed body transducer, the program "Calibrate" was used. During the calibration of the transducer in the towed body the transducer did not observe the calibration sphere in large parts of the beam's cross section. Since there were serious doubts whether the cable configuration between the transceiver and the transducer was correct and there was no way to find the correct configuration at the time, it was decided not to use this transducer for the survey.

The measurements on the hull mounted transducer were collected by "Calibrate", but it was not possible to compute the new calibration settings due to lack of experience of the scientific crew with this program. It was therefore decided to use the default Sv gain and the transducer offset of the last calibration (June 2000). After the survey a correction factor has been calculated (see Table IIE.1). The calculated correction factor to apply on the NASC's is 1.45, which is relatively high compared to correction factors found previous year (less than 10% deviation of the previous year). This may have been caused by the renewal of the EK500 transceiver board since the last calibration in June 2000.

2.5 Acoustic data collection

A Simrad 38 kHz splitbeam transducer was operated from the hull, 4.2 m under the water surface. Acoustic data were collected with a Simrad EK500 scientific echosounder. The data were logged with the Simrad BI500 integrator software on a UNIX based platform. The EK500 received the vessel speed (approximately 12 knots) from the ship's GPS. A ping rate of 0.6 s was used. This ping rate has proved the most suitable with depths (50 - 150 m) in most of the area. The data were logged in 1 n.mi. intervals. In total NASC from 1824 intervals have been collected.

2.6 Biological data

The acoustic recordings were verified by fishing with a 2000 mesh pelagic trawl with 20 mm meshes in the cod-end. Fishing was carried out when there was doubt about the species composition of recordings observed on the echosounder and to obtain biological samples of herring and sprat. In general, after it was decided to fish, the vessel turned and fished back on its trackline. If the recordings showed schools, a 60 kHz sonar was used to be able to hunt schools away from the trackline. In haul 3, 5, 15 and 25 four large floating buoys were attached to the upper rope in order to keep the net as high as possible at the surface and to enlarge the vertical opening (25-30 m). In most other hauls the bottom rope was very close to the bottom with vertical netopenings varying from 10 to 20 m.

Fish samples were divided into species by weight and by number and calculated to number per hour fishing. Measurements were taken to the 0.5 cm below for sprat and herring and to the cm below for other species. For herring and sprat length stratified samples were taken for maturity, age (otolith extraction) and weight, five specimens per 0.5 cm class as a maximum.

2.7 Hydrographical data

Hydrographical data have been collected in 60 CTD stations spread over the survey area (Figure IIE.2). At the transects of 57°40, 57°10, 56°40 and 56°10 a number of CTD profiles have been taken close to each other in order to find the front between mixed and stratified water. The CTD-data are used for other studies.

2.8 Data analysis

The NASCs from each log interval were assigned to the following categories: "definitely herring", "probably herring", "possibly herring", "definitely sprat", "probably sprat", "possibly sprat", "Norway pout", "mackerel", "other gadoids" and "sandeel". The breakdown of sprat and herring in "definitely", "probably" and "possibly" serves merely as a relative indication of certainty within the subjective process of integral partitioning ("scrutinizing"). For the analysis "definitely –" and "possibly herring/sprat" integrator counts were summed to obtain a "best herring/sprat" estimate. The

TS/length relationships used were those recommended by the ICES Planning Group for Herring Surveys (ICES 2000). The numbers of herring and sprat per ICES rectangle were calculated.

The biological samples were grouped in 7 strata for herring and 1 stratum for sprat, based on similar length distribution and geographical position (see Figure IIE.3). The numbers per year/maturity class were calculated, based on the age/length key for each stratum. For each separate stratum the mean weight per year/maturity class was then calculated.

2.9 Results

2.9.1 Acoustic data

Figure IIE.4 shows the acoustic values per five nm interval along the tracklines for herring and sprat.

2.9.2 Biological data

In all 33 trawl hauls have been conducted (Figure IIE.1). Herring was found in 24 hauls of which 23 samples were taken. Sprat was found in 6 hauls of which 5 samples were taken (no sample from haul 11). In 17 hauls herring was the most abundant species in weight. Sprat was most abundant in 3 hauls. Whiting, haddock, mackerel and Norway pout dominated other trawls. In three surface hauls the codend was empty, but the meshes were stuck with small sandeel (2) or small Norway pout (1). The catch weights per haul and species are presented in Table IIE.2.

Table IIE.3a-h shows the age/maturity length keys for herring (strata A-G) and sprat.

2.9.3 Biomass estimates

Table IIE.4a and IIE.4b summarize numbers and biomass for stratum A-G for herring. Table IIE.5a and IIE.5b summarize numbers and biomass for the whole area for herring and sprat. The spawning stock biomass estimate of herring is 382.000 tonnes and for sprat 70.000 tonnes. Figure 5 shows the estimated numbers and biomass of herring by ICES rectangle.

2.10 Discussion

The numbers of mature herring in the area south of 58° N are higher than in the previous five years. The recruits from the 98 yearclass account for 63% of the estimated biomass of the spawning stock. This observation is in line with the high MIK- and IBTS indices for the 1998 yearclass and the high abundance of immatures observed in the 2000 North Sea hydro acoustic survey. The area covered by FRV “Tridens” is mainly important for immatures and for recruits (three ringers) in the herring spawning stock. The 2001 situation is comparable with the years 87-89 when recruits from the strong 84, 85 and 86 yearclasses showed up in the area south of 58° N.

Compared to previous years the adult herring was less often mixed with Norway pout. Especially in the 1999 survey, when the abundance of herring was extremely low in the area south of 58° N, mixed aggregations of herring and Norway pout caused severe problems in the scrutinizing process. Like in 2000, most herring were found in the area of the Devil’s Holes. Compared to 2000 the herring concentrations were slightly more distributed in easterly direction. Especially the concentration in ICES rectangle 40F2 (haul 28: 55°55 N - 2°19 E) is worth mentioning.

Table IIE.1. Simrad EK500 settings used on the July 2001 North Sea hydro acoustic survey for herring, FRV "Tridens".

Transceiver menu	
Absorption coefficient	10 dB/km
Pulse length	Medium
Bandwith	wide
Max Power	2000 W
Two-way beam angle	-20.7 dB
3 dB Beamwidth	7.1 dg
Calibration details	
TS of sphere	-33.6 dB
Range to sphere in calibration	19.88 m
Selected NASC value for calibration	5766
Calibration factor for NASC's	1,45
Log/Navigation Menu	
speed	serial from ship's GPS
Operation Menu	
Ping interval	0.6 s
Display/Printer Menu	
TVG	20 log R
Integration line	1000
TS clour min.	-50 dB
Sv colour min.	-70 dB

Table IIE.2a. Details of the fishing trawls taken during the July 2001 North Sea hydro acoustic survey, FRV “Tridens”.

haul no	date	latitude(N)	longitude	E/W	time UTC	Geartype	depth meters	trawl depth	duration min.	Used (biol. Samples)
1	27-June	57.55	2.42	W	21.00	pel. trawl	109	bottom	30	her & sprat
2	28-June	57.55	0.43	W	11.00	pel. trawl	102	bottom	45	her
3	28-June	57.55	0.05	E	15.30	pel. trawl	123	surface	50	no samples
4	29-June	57.4	0.46	E	9.00	pel. trawl	127	bottom	2	her
5	29-June	57.24	1.32	W	21.00	pel. trawl	90	surface	40	no samples
6	2-July	57.25	0.01	W	10.00	pel. trawl	76	bottom	40	her
7	2-July	57.25	0.59	E	14.25	pel. trawl	93	bottom	55	her
8	2-July	57.25	1.38	E	17.55	pel. trawl	92	bottom	40	her
9	2-July	57.2	1.49	E	20.30	pel. trawl	92	bottom	25	no samples
10	3-July	57.1	0.03	E	9.35	pel. trawl	80	bottom	60	her
11	3-July	56.55	1.47	W	19.47	pel. trawl	77	midwater	33	her
12	4-July	56.56	0.08	E	11.55	pel. trawl	110	bottom	75	her
13	4-July	56.55	2.05	E	17.30	pel. trawl	85	bottom	65	no samples
14	5-July	56.25	2.51	E	10.00	pel. trawl	82	bottom	32	no samples
15	5-July	56.26	2.48	E	11.30	pel. trawl	85	surface	20	no samples
16	5-July	55.16	2.51	E	15.50	pel. trawl	83	bottom	25	no samples
17	10-July	56.4	1.24	E	8.50	pel. trawl	98	bottom	25	her
18	10-July	56.4	0.59	E	11.20	pel. trawl	84	bottom	20	her
19	11-July	56.25	0.05	W	12.00	pel. trawl	85	bottom	90	her
20	11-July	56.25	0.31	E	16.30	pel. trawl	85	bottom	25	her
21	11-July	56.25	1.14	E	20.00	pel. trawl	88	bottom	15	her
22	12-July	56.1	1.11	E	11.17	pel. trawl	80	bottom	133	her
23	13-July	56.1	0.29	W	10.50	pel. trawl	80	bottom	55	her
24	13-July	56.1	1.01	W	14.05	pel. trawl	67	bottom	35	her & sprat
25	13-July	56.1	1.54	W	18.52	pel. trawl	54	surface	38	no samples
26	16-July	55.55	0.43	W	8.45	pel. trawl	68	midw./bottom	45	her
27	16-July	55.55	0.26	E	13.42	pel. trawl	77	midw./bottom	48	no samples
28	16-July	55.55	2.19	E	20.53	pel. trawl	80	bottom	9	her
29	17-July	55.35	0.09	E	12.04	pel. trawl	69	bottom	91	her
30	17-July	55.28	0.5	W	17.07	pel. trawl	90	bottom	30	her & sprat
31	18-July	54.54	1.1	E	15.05	pel. trawl	49	bottom	33	no samples
32	18-July	54.4	0.05	W	21.00	pel. trawl	62	bottom	50	sprat
33	19-July	54.21	0.22	E	8.47	pel. trawl	65	bottom	33	her & sprat

Table IIE.2b. Trawl catches during the July 2001 North Sea hydro acoustic survey, FRV "Tridens".

haul	herring	N. pout	other gadoids	mackerel	sprat	others	comments
1	48	1	2	0	177	1	
2	63	12	0.7	0	0	0.2	
3	2880	0	0	120	0	0	
4	59	3.6	4.8	0	0	0.1	
5	0	0	0	3.3	0	0	small sandeel in the meshes
6	477	0	2.8	176	0	2.9	
7	368.5	301.5	9.1	81.9	0	0	
8	7.4	0	0.7	7.2	0	0	
9	0	6.2	1.8	2.3	0	0	
10	145	0	117	135	0	1.1	
11	3.7	0	0.2	0	1.4	0.4	
12	4326	135	1.9	37	0	0.2	
13	0	15	1.7	900	0	0	small Norway pout in the meshes
14	0	80	2.7	0	0	0	small Norway pout in the meshes
15	0.1	18	0.3	0	0	1.6	small Norway pout in the meshes
16	0	0	517.6	0	0	7	
17	1275	225	0	0	0	0	
18	2300	0	0	0	0	0	
19	162	0	210.9	0	0	5.6	
20	2300	0	43.8	14.6	0	0.2	
21	4000	0	0	0	0	0	
22	699	0	1108	262	0	7	
23	216	0	147	16	0	32	
24	5	0	11.8	1.5	54.9	12.6	
25	0	0	0	0	0	0	small sandeel in the meshes
26	33.7	0	4.5	11	0	1.8	
27	3.2	0	632	2.1	0	2.5	
28	4400	0	33.1	0	0	12.5	
29	14.9	0	11.1	10	0	0.9	
30	1932	5.5	49.8	2	368	0	
31	0.3	0	1323	5.7	0	29.1	
32	0	0	0	0	9.8	50.4	
33	416	0	0	0	1604	0	

Table IIE.3a. Age/maturity-length key for herring - Stratum A.

Tridens, North Sea acoustic survey 2001

Length	0		1		2		3		4	5	6	7	8	9+	Grand
(cm)	imm	mat	imm	mat	imm	mat	imm	mat	Total	Total	Total	Total	Total	Total	Total
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13,5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
14	0	0	8	0	0	0	0	0	0	0	0	0	0	0	8
14,5	0	0	7	0	0	0	0	0	0	0	0	0	0	0	7
15	0	0	12	0	0	0	0	0	0	0	0	0	0	0	12
15,5	0	0	15	0	0	0	0	0	0	0	0	0	0	0	15
16	0	0	15	0	0	0	0	0	0	0	0	0	0	0	15
16,5	0	0	15	0	0	0	0	0	0	0	0	0	0	0	15
17	0	0	15	0	0	0	0	0	0	0	0	0	0	0	15
17,5	0	0	14	0	0	0	0	0	0	0	0	0	0	0	14
18	0	0	15	0	0	0	0	0	0	0	0	0	0	0	15
18,5	0	0	12	0	0	0	0	0	0	0	0	0	0	0	12
19	0	0	6	0	0	0	0	0	0	0	0	0	0	0	6
19,5	0	0	4	0	0	0	0	0	0	0	0	0	0	0	4
20	0	0	5	0	1	0	0	0	0	0	0	0	0	0	6
20,5	0	0	5	0	1	0	0	0	0	0	0	0	0	0	6
21	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
21,5	0	0	2	0	1	0	0	0	0	0	0	0	0	0	3
22	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
22,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	1	0	1	0	0	0	0	0	0	0	0	0	2
23,5	0	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	1	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	0	1	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	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	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	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	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	152	0	7	2	0	0	0	0	0	0	0	0	161

Table IIE.3b. Age/maturity-length key for herring - Stratum B.

Tridens, North Sea acoustic survey 2001

Length	0		1		2		3		4	5	6	7	8	9+	Grand
(cm)	imm	mat	imm	mat	imm	mat	imm	mat	Total	Total	Total	Total	Total	Total	Total
13	0	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	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	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	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	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	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18,5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
19	0	0	2	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	0
20	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
20,5	0	0	9	1	4	0	0	0	0	0	0	0	0	0	14
21	0	0	17	0	12	2	0	0	0	0	0	0	0	0	31
21,5	0	0	11	0	17	5	0	0	0	0	0	0	0	0	33
22	0	0	5	0	18	9	0	0	0	0	0	0	0	0	32
22,5	0	0	4	0	16	11	0	0	0	0	0	0	0	0	31
23	0	0	0	0	7	25	1	0	0	0	0	0	0	0	32
23,5	0	0	0	0	4	26	0	1	0	0	0	0	0	0	31
24	0	0	0	0	2	24	0	9	0	0	0	0	0	0	35
24,5	0	0	0	0	0	25	0	10	0	0	0	0	0	0	35
25	0	0	0	0	0	21	0	14	0	0	0	0	0	0	35
25,5	0	0	0	0	0	12	0	22	1	0	0	0	0	0	35
26	0	0	0	0	0	11	0	16	5	0	0	0	0	0	32
26,5	0	0	0	0	0	8	0	8	4	3	0	0	0	0	23
27	0	0	0	0	0	2	0	7	8	3	0	0	0	0	20
27,5	0	0	0	0	0	1	0	2	5	2	0	0	0	0	10
28	0	0	0	0	0	0	0	2	3	0	1	0	0	0	6
28,5	0	0	0	0	0	0	0	0	2	2	1	0	0	0	5
29	0	0	0	0	0	0	0	0	2	2	1	1	0	0	6
29,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
30,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	49	1	81	182	1	91	30	12	4	1	0	0	452

Table IIE.3c. Age/maturity-length key for herring - Stratum C.

Tridens, North Sea acoustic survey 2001

Length	0		1		2		3		4	5	6	7	8	9+	Grand
(cm)	imm	mat	imm	mat	imm	mat	imm	mat	Total	Total	Total	Total	Total	Total	Total
13	0	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	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	0
15	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
15,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	6	0	0	0	0	0	0	0	0	0	0	0	6
16,5	0	0	9	0	0	0	0	0	0	0	0	0	0	0	9
17	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
17,5	0	0	12	0	0	0	0	0	0	0	0	0	0	0	12
18	0	0	15	0	0	0	0	0	0	0	0	0	0	0	15
18,5	0	0	13	0	2	0	0	0	0	0	0	0	0	0	15
19	0	0	12	0	3	0	0	0	0	0	0	0	0	0	15
19,5	0	0	12	0	3	0	0	0	0	0	0	0	0	0	15
20	0	0	13	0	2	0	0	0	0	0	0	0	0	0	15
20,5	0	0	15	0	0	0	0	0	0	0	0	0	0	0	15
21	0	0	10	0	3	1	0	0	0	0	0	0	0	0	14
21,5	0	0	8	2	4	1	0	0	0	0	0	0	0	0	15
22	0	0	6	2	5	3	0	0	0	0	0	0	0	0	16
22,5	0	0	2	2	7	4	0	0	0	0	0	0	0	0	15
23	0	0	1	0	4	9	0	0	0	0	0	0	0	0	14
23,5	0	0	0	0	4	9	0	0	0	0	0	0	0	0	13
24	0	0	0	0	3	4	1	1	0	0	0	0	0	0	9
24,5	0	0	0	0	0	9	0	1	0	0	0	0	0	0	10
25	0	0	0	0	0	2	0	1	0	0	0	0	0	0	3
25,5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
26	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
26,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
27,5	0	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	1	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	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Grand Total	0	0	145	6	40	43	1	5	1	0	0	0	0	1	242

Table IIE.3d. Age/maturity-length key for herring - Stratum D.

Tridens, North Sea acoustic survey 2001

Length	0		1		2		3		4	5	6	7	8	9+	Grand
(cm)	imm	mat	imm	mat	imm	mat	imm	mat	Total	Total	Total	Total	Total	Total	Total
13	0	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	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	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	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	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	0
18	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
18,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3
19,5	0	0	6	0	1	0	0	0	0	0	0	0	0	0	7
20	0	0	18	0	2	0	0	0	0	0	0	0	0	0	20
20,5	0	0	10	0	10	0	0	0	0	0	0	0	0	0	20
21	0	0	21	0	9	5	0	0	0	0	0	0	0	0	35
21,5	0	0	19	2	9	5	0	0	0	0	0	0	0	0	35
22	0	0	11	1	12	11	0	0	0	0	0	0	0	0	35
22,5	0	0	3	1	17	14	0	0	0	0	0	0	0	0	35
23	0	0	1	0	13	21	0	0	0	0	0	0	0	0	35
23,5	0	0	0	0	7	26	0	2	0	0	0	0	0	0	35
24	0	0	0	0	2	27	1	5	0	0	0	0	0	0	35
24,5	0	0	0	0	0	27	1	7	0	0	0	0	0	0	35
25	0	0	0	0	0	21	0	13	1	0	0	0	0	0	35
25,5	0	0	0	0	0	12	0	19	2	1	0	0	0	0	34
26	0	0	0	0	0	6	0	21	5	1	0	0	0	0	33
26,5	0	0	0	0	0	9	0	13	5	2	0	0	0	0	29
27	0	0	0	0	0	2	0	5	11	2	0	0	0	0	20
27,5	0	0	0	0	0	0	0	2	4	8	0	0	0	0	14
28	0	0	0	0	0	0	0	0	4	0	2	0	0	0	6
28,5	0	0	0	0	0	0	0	0	4	2	2	0	0	0	8
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	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	94	4	82	186	2	87	36	16	4	0	0	0	511

Table IIE.3e. Age/maturity-length key for herring - Stratum E.

Tridens, North Sea acoustic survey 2001

Length	0		1		2		3		4	5	6	7	8	9+	Grand
(cm)	imm	mat	imm	mat	imm	mat	imm	mat	Total	Total	Total	Total	Total	Total	Total
13	0	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	0	0
14	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
14,5	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3
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	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	0
17	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
17,5	0	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	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19,5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
20	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
20,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	2	1	0	0	0	0	0	0	0	0	0	0	3
21,5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
22	0	0	0	1	0	2	0	0	0	0	0	0	0	0	3
22,5	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
23	0	0	0	1	0	0	0	2	0	0	0	0	0	0	3
23,5	0	0	0	0	0	3	0	2	0	0	0	0	0	0	5
24	0	0	0	0	0	2	0	3	0	0	0	0	0	0	5
24,5	0	0	0	0	0	2	0	3	0	0	0	0	0	0	5
25	0	0	0	0	0	1	0	1	3	0	0	0	0	0	5
25,5	0	0	0	0	0	1	0	1	3	0	0	0	0	0	5
26	0	0	0	0	0	0	0	3	0	2	0	0	0	0	5
26,5	0	0	0	0	0	0	0	0	2	2	1	0	0	0	5
27	0	0	0	0	0	0	0	0	0	2	0	3	0	0	5
27,5	0	0	0	0	0	0	0	0	0	2	1	0	2	0	5
28	0	0	0	0	0	0	0	0	0	0	1	2	1	1	5
28,5	0	0	0	0	0	0	0	0	0	1	1	2	0	1	5
29	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5
29,5	0	0	0	0	0	0	0	0	0	0	1	0	0	2	3
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31,5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	10	3	0	14	0	15	8	9	5	7	3	10	84

Table IIE.3f. Age/maturity-length key for herring - Stratum F.

Tridens, North Sea acoustic survey 2001

Length	0		1		2		3		4	5	6	7	8	9+	Grand
(cm)	imm	mat	imm	mat	imm	mat	imm	mat	Total	Total	Total	Total	Total	Total	Total
13	0	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	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	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	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	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	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	0
19	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
19,5	0	0	5	0	0	0	0	0	0	0	0	0	0	0	5
20	0	0	5	0	0	0	0	0	0	0	0	0	0	0	5
20,5	0	0	2	0	2	1	0	0	0	0	0	0	0	0	5
21	0	0	5	0	0	0	0	0	0	0	0	0	0	0	5
21,5	0	0	5	0	0	0	0	0	0	0	0	0	0	0	5
22	0	0	2	1	0	1	0	1	0	0	0	0	0	0	5
22,5	0	0	0	0	0	5	0	0	0	0	0	0	0	0	5
23	0	0	0	0	0	5	0	0	0	0	0	0	0	0	5
23,5	0	0	0	0	0	4	0	1	0	0	0	0	0	0	5
24	0	0	0	0	0	5	0	0	0	0	0	0	0	0	5
24,5	0	0	0	0	0	3	0	1	1	0	0	0	0	0	5
25	0	0	0	0	0	1	0	4	0	0	0	0	0	0	5
25,5	0	0	0	0	0	3	0	2	0	0	0	0	0	0	5
26	0	0	0	0	0	1	0	0	1	0	0	0	0	0	2
26,5	0	0	0	0	0	0	0	2	2	0	0	0	0	0	4
27	0	0	0	0	0	0	0	2	1	0	0	0	0	0	3
27,5	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2
28	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
28,5	0	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	1	0	0	1
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	26	1	2	29	0	14	6	1	0	1	0	0	80

Table IIE.3g. Age/maturity-length key for herring - Stratum G.

Tridens, North Sea acoustic survey 2001

Length	0		1		2		3		4	5	6	7	8	9+	Grand
(cm)	imm	mat	imm	mat	imm	mat	imm	mat	Total	Total	Total	Total	Total	Total	Total
13	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
13,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	4	0	0	0	0	0	0	0	0	0	0	0	4
14,5	0	0	5	0	0	0	0	0	0	0	0	0	0	0	5
15	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
15,5	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
16	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
16,5	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
17	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
17,5	0	0	9	0	0	0	0	0	0	0	0	0	0	0	9
18	0	0	9	0	0	0	0	0	0	0	0	0	0	0	9
18,5	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
19	0	0	5	1	0	0	0	0	0	0	0	0	0	0	6
19,5	0	0	4	1	0	0	0	0	0	0	0	0	0	0	5
20	0	0	4	1	0	0	0	0	0	0	0	0	0	0	5
20,5	0	0	3	2	0	0	0	0	0	0	0	0	0	0	5
21	0	0	2	2	0	1	0	0	0	0	0	0	0	0	5
21,5	0	0	0	1	0	3	0	0	0	0	0	0	0	0	4
22	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2
22,5	0	0	0	0	0	4	0	1	0	0	0	0	0	0	5
23	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
23,5	0	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	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	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	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	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	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	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	107	9	0	9	0	2	0	0	0	0	0	0	127

Table IIE.3h. Age/maturity-length key for sprat - Total area.

Tridens, North Sea acoustic survey 2001

Length	1		2		3		4		5	Grand
(cm)	imm	mat	imm	mat	imm	mat	imm	mat	Total	Total
8,5	1	0	0	0	0	0	0	0	0	1
9	0	9	0	1	0	0	0	0	0	10
9,5	0	15	0	0	0	1	0	0	0	16
10	0	14	0	4	0	0	0	1	0	19
10,5	0	13	0	7	0	1	0	0	0	21
11	0	10	0	15	0	0	0	0	0	25
11,5	0	0	0	17	0	3	0	0	0	20
12	0	0	0	20	0	0	0	0	0	20
12,5	0	0	0	19	0	0	0	0	1	20
13	0	0	0	16	0	2	0	0	0	18
13,5	0	0	0	8	0	7	0	1	0	16
14	0	0	0	4	0	5	0	2	0	11
14,5	0	0	0	2	0	4	0	1	0	7
15	0	0	0	0	0	4	0	0	0	4
Grand	1	61	0	113	0	27	0	5	1	208

Table IIE.4. Herring. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age and maturity per stratum obtained during the July 2001 North Sea hydro acoustic survey for herring, FRV "Tridens".

Stratum C							
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2000im			0	0.0	0.000	0.0
0M	2000ad			0	0.0	0.000	0.0
1I	1999im	19.4	55.0	425	74.1	23.413	65.7
1M	1999ad	21.9	82.5	10	1.7	0.828	2.3
2I	1998im	20.7	70.1	87	15.2	6.112	17.1
2M	1998ad	23.2	102.2	45	7.9	4.646	13.0
3I	1997im	24.0	103.0	1	0.1	0.086	0.2
3M	1997ad	25.5	122.0	4	0.7	0.471	1.3
4A	1996	27.0	136.0	1	0.1	0.101	0.3
5A	1995			0	0.0	0.000	0.0
6A	1994			0	0.0	0.000	0.0
7A	1993			0	0.0	0.000	0.0
8A	1992			0	0.0	0.000	0.0
9+	<1992	32.0	0.0	1	0.1	0.000	0.0
Mean		24.2	83.9				
Total				574	100.0	35.657	100.0
Immature				514	89.4	29.612	83.0
Mature				61	10.6	6.045	17.0

Stratum D							
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2000im			0	0.0	0.000	0.0
0M	2000ad			0	0.0	0.000	0.0
1I	1999im	21.3	78.3	598	18.2	46.861	13.1
1M	1999ad	21.9	89.4	41	1.3	3.680	1.0
2I	1998im	22.2	89.3	675	20.6	60.309	16.9
2M	1998ad	23.7	115.6	1370	41.8	158.353	44.3
3I	1997im	24.2	123.6	15	0.4	1.802	0.5
3M	1997ad	25.3	142.4	438	13.4	62.346	17.5
4A	1996	26.6	167.3	97	3.0	16.225	4.5
5A	1995	26.9	162.7	37	1.1	6.102	1.7
6A	1994	28.2	196.4	7	0.2	1.428	0.4
7A	1993			0	0.0	0.000	0.0
8A	1992			0	0.0	0.000	0.0
9+	<1992			0	0.0	0.000	0.0
Mean		24.5	129.5				
Total				3279	100.0	357.106	100.0
Immature				1288	39.3	108.972	30.5
Mature				1990	60.7	248.134	69.5

Table IIE.4. (continued)

Stratum E							
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2000im			0	0.0	0.000	0.0
0M	2000ad			0	0.0	0.000	0.0
1I	1999im	18.3	48.2	4	4.0	0.179	1.4
1M	1999ad	22.0	81.7	1	1.3	0.101	0.8
2I	1998im			0	0.0	0.000	0.0
2M	1998ad	24.0	114.2	11	11.5	1.219	9.5
3I	1997im			0	0.0	0.000	0.0
3M	1997ad	24.8	126.8	13	14.5	1.698	13.2
4A	1996	25.6	136.8	14	14.8	1.878	14.6
5A	1995	27.0	167.9	16	17.0	2.639	20.5
6A	1994	27.7	171.5	7	8.0	1.277	9.9
7A	1993	27.6	172.2	12	13.1	2.093	16.2
8A	1992	27.6	177.4	7	7.1	1.174	9.1
9+	<1992	28.9	78.7	8	8.6	0.625	4.8
Mean		25.3	127.5				
Total				93	100.0	12.883	100.0
Immature				4	4.0	0.179	1.4
Mature				89	96.0	12.703	98.6

Stratum F							
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2000im			0	0.0	0.000	0.0
0M	2000ad			0	0.0	0.000	0.0
1I	1999im	20.5	69.1	155	46.1	10.742	34.4
1M	1999ad	22.0	87.0	6	1.7	0.503	1.6
2I	1998im	20.5	71.0	28	8.4	2.007	6.4
2M	1998ad	23.0	107.4	96	28.5	10.313	33.0
3I	1997im			0	0.0	0.000	0.0
3M	1997ad	25.0	135.5	33	9.7	4.411	14.1
4A	1996	26.2	153.1	13	3.8	1.951	6.2
5A	1995	28.0	190.0	3	1.0	0.610	2.0
6A	1994			0	0.0	0.000	0.0
7A	1993	29.5	214.0	3	1.0	0.687	2.2
8A	1992			0	0.0	0.000	0.0
9+	<1992			0	0.0	0.000	0.0
Mean		24.3	128.4				
Total				337	100.0	31.225	100.0
Immature				184	54.5	12.749	40.8
Mature				154	45.5	18.476	59.2

Stratum G							
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2000im			0	0.0	0.000	0.0
0M	2000ad			0	0.0	0.000	0.0
1I	1999im	15.6	29.7	234	99.5	6.950	98.7
1M	1999ad	19.8	64.0	1	0.4	0.053	0.8
2I	1998im			0	0.0	0.000	0.0
2M	1998ad	22.0	86.9	0	0.1	0.029	0.4
3I	1997im			0	0.0	0.000	0.0
3M	1997ad	22.7	95.3	0	0.0	0.007	0.1
4A	1996			0	0.0	0.000	0.0
5A	1995			0	0.0	0.000	0.0
6A	1994			0	0.0	0.000	0.0
7A	1993			0	0.0	0.000	0.0
8A	1992			0	0.0	0.000	0.0
9+	<1992			0	0.0	0.000	0.0
Mean		20.0	69.0				
Total				236	100.0	7.039	100.0
Immature				234	99.5	6.950	98.7
Mature				1	0.5	0.089	1.3

Table IIE.5a. Herring. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age and maturity obtained during the July 2001 North Sea hydro acoustic survey for herring, FRV "Tridens".

Total area (all strata summarized)					
Age (winter ring)	Year	Number (millions)	%	Biomass (1000 tons)	%
1I	99im	1945	31,5	109,662	18,7
1M	99ad	60	1,0	5,220	0,9
2I	98im	1081	17,5	92,737	15,8
2M	98ad	2113	34,3	238,875	40,7
3I	97im	19	0,3	2,242	0,4
3M	97ad	676	11,0	93,198	15,9
4A	96	154	2,5	25,200	4,3
5A	95	69	1,1	11,630	2,0
6A	94	19	0,3	3,455	0,6
7A	93	17	0,3	3,024	0,5
8A	92	7	0,1	1,174	0,2
9+	<92	9	0,1	0,625	0,1
Total		6168	100,0	587,041	100,0
Immature		3046	49,4	204,641	34,9
Mature		3123	50,6	382,400	65,1

Table IIE.5b. Sprat. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age and maturity obtained during the July 2001 North Sea hydro acoustic survey for herring, FRV "Tridens".

Total area (all strata summarized)					
Age	Year	Number (millions)	%	Biomass (1000 tons)	%
1I	00im	5	0,1	0,025	0,0
1M	00ad	1801	26,9	13,761	17,2
2I	99im	0	0,0	0,000	0,0
2M	99ad	4106	61,3	53,402	66,6
3I	98im	0	0,0	0,000	0,0
3M	98ad	622	9,3	10,548	13,2
4I	97im	0	0,0	0,000	0,0
4M	97ad	118	1,8	1,776	2,2
5A	96	49	0,7	0,643	0,8
Total		6701	100,0	80,156	100,0
Immature		5	0,1	0,025	0,0
Mature		6696	99,9	80,131	100,0

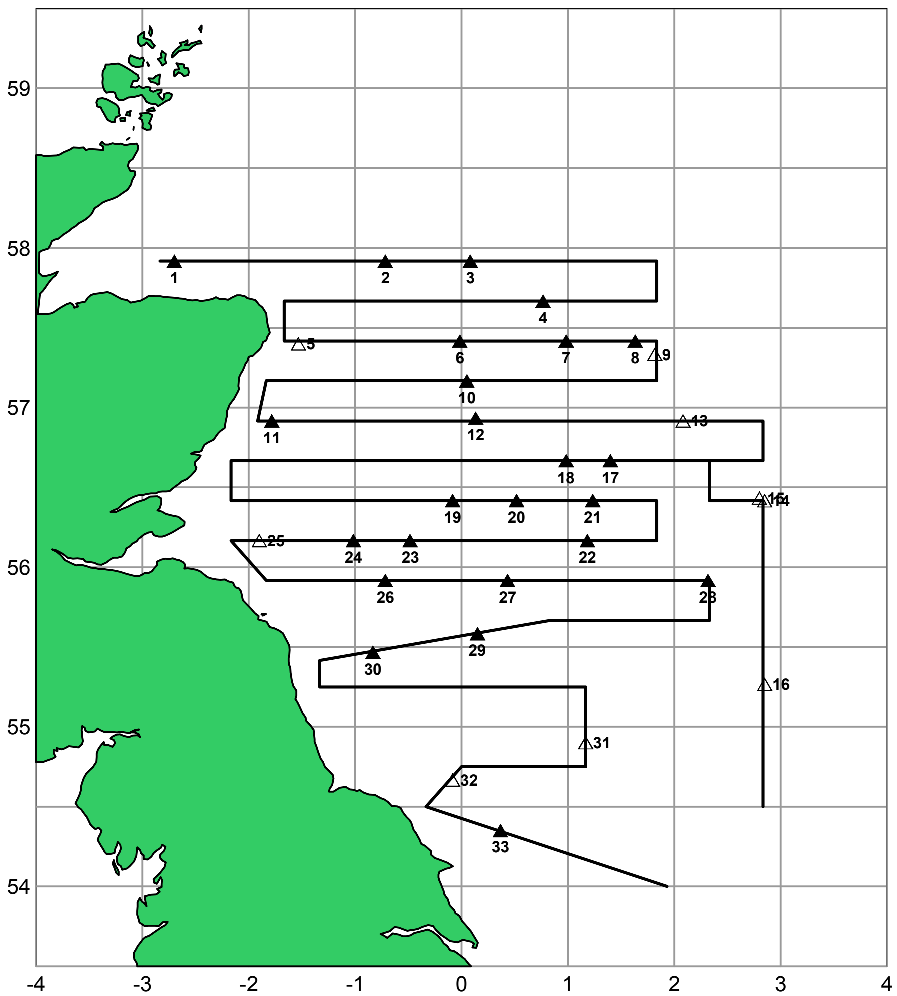

Figure IIE.1 Map of east of Scotland showing cruise track and positions of fishing trawls undertaken during the July 2001 North Sea hydro acoustic survey for herring by RV Tridens. Filled triangles indicate pelagic trawls in which herring were caught. Open triangles indicate trawls with no herring. Sprat was caught in haul 1, 11, 24, 30, 32 and 33.

Figure IIE.2 Positions of CTD stations undertaken during the July 2001 North Sea hydro acoustic survey for herring by FRV "Tridens".

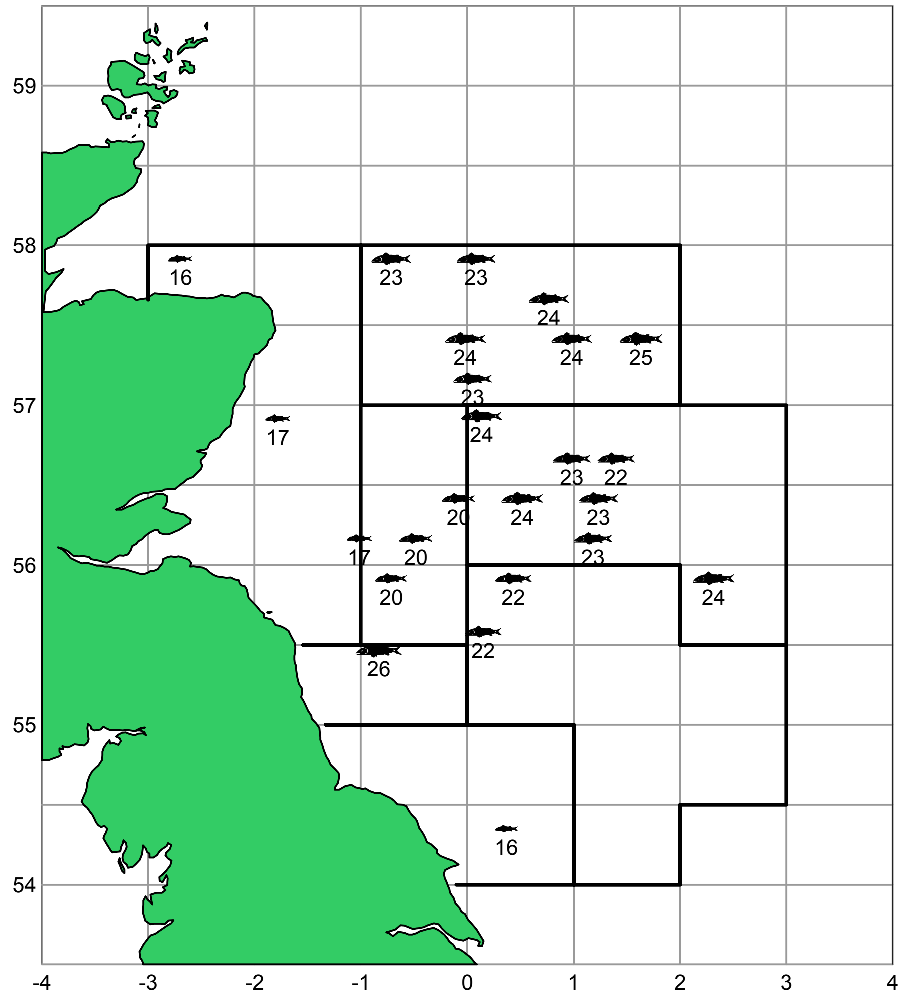

Figure IIE.3 Post plot of herring mean length from FRV "Tridens", observed during the July 2001 North Sea hydro acoustic survey for herring. Symbol size is proportional to the mean length from trawl hauls used to qualify the acoustic data. The number below the symbols indicates the mean length in cm. Strata-areas A to G are indicated.

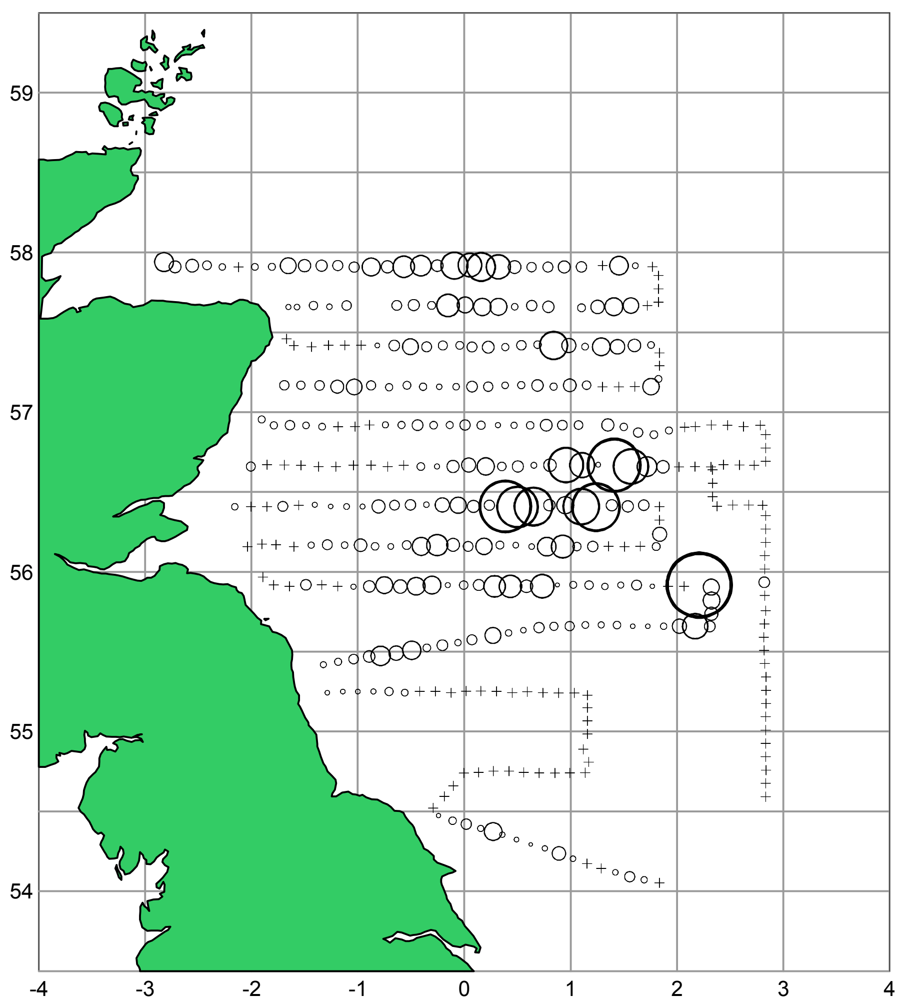

Figure IIE.4 Post plot showing the distribution of total herring NASCs (on a proportional square root scale relative to the largest value of 4318,1) obtained during the July 2001 North Sea herring hydro acoustic survey on FRV "Tridens". Crosses indicate zero values.

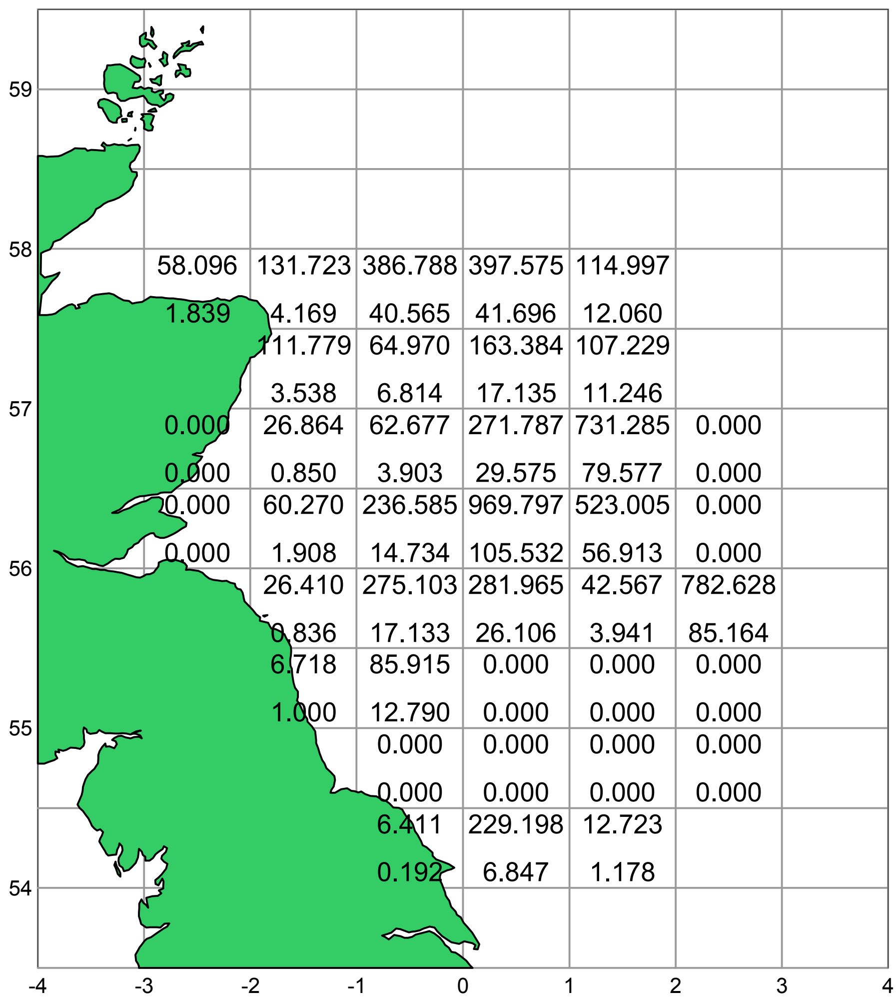

Figure IIE.5 Map showing estimated numbers of herring in millions (upper half square) and biomass in thousands of tonnes (lower half of square) by ICES rectangle. Results from the July 2001 North Sea hydro acoustic survey, FRV "Tridens".

APPENDIX IIF GERMANY

Survey report for FRV "Solea" cruise 478 International Herring Acoustic Survey in the North Sea 29 Jun 2001 – 19 Jul 2001

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1. INTRODUCTION

Context: Solea cruise So 478 was conducted in the framework of the international hydroacoustic survey on pelagic fish in the North Sea, which is co-ordinated by the ICES Planning Group for Herring Surveys (PGHERS). 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. Since 1984 they represent the most important fishery independent data (i.e. biomass estimate) for the assessment of herring stocks in the area.

The working area for "Solea" was confined to the South-Eastern North Sea. This area is regarded to be one of the main distribution areas for juvenile herring. After 7 years of additional coverage of this area, PGHERS now intends to calculate a separate juvenile biomass index for the North Sea herring assessment. This year, it was possible to extend the survey area southwards to 53.5° latitude in an attempt to reach the southern distribution limit for sprat in the North Sea.

Objectives: Hydroacoustic recording of pelagic fish stocks for abundance and biomass estimation, 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 and other fish within the EU-project LIFECO.

2. SURVEY DESCRIPTION AND METHODS

Personnel

Mrs G Gentschow	fishery biology	ISH
E Götze	hydroacoustics	IFF
M Sasse	hydroacoustics	IFF
J Schmidt	fishery biology	ISH
Dr C Zimmermann	scientist in charge, fishery biology	ISH

Narrative

FRV "Solea" left the port of Büsum early on June 29th and calibrated the hydroacoustic equipment in Helgoland port. The survey commenced June 30th north-west of Horns Rev. On July 9th the vessel was re-supplied with water at the port of Esbjerg, and the survey continued as planned until July 18th, interrupted only by an intercalibration with FRV "Walther Herwig III" (July 11th) and one day of heavy weather (July 12th), which had to be spent at Helgoland. "Solea" reached Büsum at 19th July 2001 at noon.

2.9 Survey design

As in previous years, the working area for the German vessel contributing to the survey was confined to the south-eastern North Sea between 56.5°N and 54°N, and 3°E to the 20 m depth line off the Danish and German coasts. This year, the survey area was extended southwards to a latitude of 53.5° N for two statistical rectangles (Figure IIF.1).

Hydroacoustic measurements were conducted on east-west transects with 15 n.mi. intertransect distance (as done by other research vessels participating in the survey) on fixed longitudes (7.5 n.mi. distance to upper and lower limits of statistical rectangle). In general, each ICES statistical rectangle was surveyed with two transects. However, the survey intensity was halved in some rectangles at the western edge of the area, where no significant amounts of clupeids have been detected during the last years' surveys. Due to logistic reasons and time constraints, some transect fractions have been conducted in directions different from east to west.

Calibration

The towed body mounted transducer 38-26 was calibrated at the start of the survey (June 29th) in the outer basin of Helgoland port. The calibration procedure was carried out as described in the 'Manual for Herring Acoustic Surveys in ICES Divisions III, IV and VI' (ICES CM 2000/G:02, Appendix 6). Important parameters and settings are listed in Tab. IIF.1. The difference to the last calibration on "Solea" (conducted prior to the Western Baltic hydroacoustic survey on 01 Oct 2000) was found to be minimal (-0.14 dB).

An intercalibration between the two German vessels regularly conducting the survey was carried out on 11 Jul 2002 to the south-east of Helgoland. A detailed description and the results can be found in the PGHERS 2001 report.

Acoustic data collection

The acoustic investigations were performed during daylight (0400 to 2000 hrs UTC), using a Simrad EK500 echosounder with a standard frequency of 38 kHz. The echo telegrams were continuously recorded with the Bergen integrator BI500. The specific settings of the hydroacoustic equipment were used as described in the 'Manual for Herring Acoustic Surveys in ICES Divisions III, IV and VI' (ICES CM 2000/G:02, Appendix 6). Basic settings are documented in Table IIF.1. The transducer 38-26 was installed in a towed body to reduce escape reactions of fish. The towed body was running at a speed of 8 knots in a lateral distance to the vessel of about 30 m at 4 m water depth. During cruise 478, "Solea" sailed 2652 n.mi. Of these, 1840 n.mi. could be used for acoustic data sampling.

Biological data - fishing trawls

For the identification of echo traces and further biological sampling, trawl hauls were conducted either on specific large schools (after turning the ship) or, if small schools occurred frequently, continuing the survey track. On "Solea", a small pelagic trawl (PSN388, ca 8 m vertical opening, mesh size in the codend 10 mm) was used both in the midwater and close to the bottom. The net was equipped with a Scanmar net sonde. Standard tow periods were 30 mins; however, they varied between 18 and 62 mins depending on the indications of net filling.

From each trawl, the mass of the total catch and species compositions (on subsamples, if needed) were determined. Length frequency distributions were produced for each species. Length-stratified samples (10 samples per half cm class per ICES stat rectangle) of herring and sprat were taken for the determination of maturity (using a 4 point scale), sex and individual body mass, and otoliths were removed for age reading. If conditions did not allow conducting this work immediately after the haul, fish was frozen for further processing at the institute.

Rarely, nets were shot without having detected fish concentrations to exclude the possibility that fish could be present but not detected on the echographs. Fish was never found in these hauls.

Hydrographic data

After each haul and on some additional hydrographic stations, vertical profiles of temperature, salinity and depth were recorded using a "Meerestechnik" (ME) memory CTD probe (Fig. IIF.1). Water samples for calibration have been taken close to the bottom by means of a Nansen bottle and an electronic reversing thermometer.

Data analysis

The echo integration, i.e. the allocation of the nautical area backscattering cross section (NASC) to the species herring and sprat was done using a Bergen integrator BI500. The identification of the echo records was made by means of aimed trawling. Herring and sprat were exclusively found in characteristic "pillars". The NASC attributed to clupeoids was estimated for each ESDU of 1 nautical mile. Contributions from air bubbles, bottom structures and scattering layers were manually removed from the echogram using the BI500.

As it was not possible to distinguish between herring and sprat within clupeid schools and to allocate the integrator readings to a single species. ,species composition was based on the trawl catch results (see above).

For each rectangle the species composition and length distribution of herring and sprat were determined as the weighted mean of all trawl results in this rectangle. For rectangles without valid hauls a mean of the catch results of the neighbouring rectangles was used. From these distributions the mean cross section s was calculated according to the following target strength-length (TS) relationship:

TS = 20 log L (cm) - 71.2 (ICES 1983/H:12)

The total number of fish (total N) in one rectangle was estimated to be the product of the mean area scattering cross section NASC and the rectangle area, divided by the corresponding mean cross section. This total number was divided into species and age/maturity classes according to the trawl catch results.

3. RESULTS AND DISCUSSION

3.1 Acoustic data

As in previous years, clupeids were exclusively found in characteristic schools which appeared in single clusters of some n.mi. extension. Echoes attributed to plankton were found to be disturbing this year, especially close to the Danish coast. They might even have masked echoes of clupeid schools in this area.

The highest nautical area scattering coefficients (NASCs) have been found close to the Danish coast. A maximum was detected close to the island Helgoland (24’600 $m^2 n.mi.^{-2}$), which is among the maximum values ever detected during the survey. Fig. IIF.2 gives the NASC distribution on 1 n.mi. EDSUs.

3.2 Biological data

31 hauls with the pelagic trawl PSN388 have been deployed. Due to time constraints, 9 statistical rectangles out of 30 covered during the survey could not be sampled with trawl hauls (Fig. IIF.1 and Tab. IIF.2).

The distribution of fish species differed significantly from those of previous years: the largest abundances of herring have previously been found in the center of the survey area and those of sprat on the southern fringe. This year, clupeids were concentrated in rectangles close to the Danish coast and off the Island of Helgoland. Sprat and herring were found in almost the same numerical proportions in catches, even in the southern rectangles where sprat usually is dominating; this expected dominance of sprat was only found in the two southernmost rectangles covered for the first time this year (Fig. IIF. 3).

The enormous abundance of 0-group whiting close to the Danish coast was notable (up to 20’000 fish per hour trawled). Only 13 species have been caught during this year’s survey (2000: 27), the mean number of species per haul was 3.9. The highest presence was found for herring (in 23 out of 31 hauls), whiting (22), sprat (21) and gray gurnard (20). Herring and sprat had the highest share of the total biomass caught with 57% and 40% respectively (Tab. IIF.3).

Figure IIF.6 gives the total length frequency distribution for herring and sprat in comparison to the 2000 survey resultsHerring has clearly grown better this year. Furthermore, most of the bigger clupeids gutted during the survey had a high fat content. Their maturity, however, was not further developed.

3.3 Biomass and abundance estimates

The total biomass estimates for the survey:

Total herring	**216’600 tonnes**	
Spawning stock biomass	130 tonnes	(0.06 %)
Total sprat	**121’800 tonnes**	
Spawning stock biomass	77’100 tonnes	(63 %)

The total abundance estimates for the survey:

Total herring	**15’900 mill.**	
Spawning stock abundance	2 mill.	(0.01 %)

Total sprat	**14'600 mill.**	
Spawning stock abundance	8'200 tonnes	(56 %)

The age composition is very similar to previous years' results: the vast majority of herring in this area consists of 0- and 1-wr (Age 1 and 2). The fraction of mature herring was further reduced due to changes in the maturity reading protocol. The herring biomass was calculated to be 140% of last year's value and the second highest in the time series (following the 1995 survey), while the abundance was the overall highest of the series.

In contrast to herring, the majority of sprat in the area was found to be mature. Abundance and biomass have been reduced significantly (to 80 % and 62 %) as compared to last year, in spite of the fact that a larger part of the distribution area of sprat was covered in 2001.

Detailed information on abundance and biomass by statistical rectangle can be found in Fig. IIF.4 and IIF.5, they are further split to age group and maturity in Tab. IIF.6 and IIF.7.

3.4 Hydrographic data

39 CTD vertical profiles have been recorded at stations spread over the whole area. Temperatures at the bottom were found to be between 5.7°C (at 60 m water depth) and 16.7°C (at 18 and 21 m), with the usual increase in the coastal area. A clear stratification could only be detected until the gale-force winds of the 12th of July. After this event, the water column was completely mixed down to a depth of 40 m.

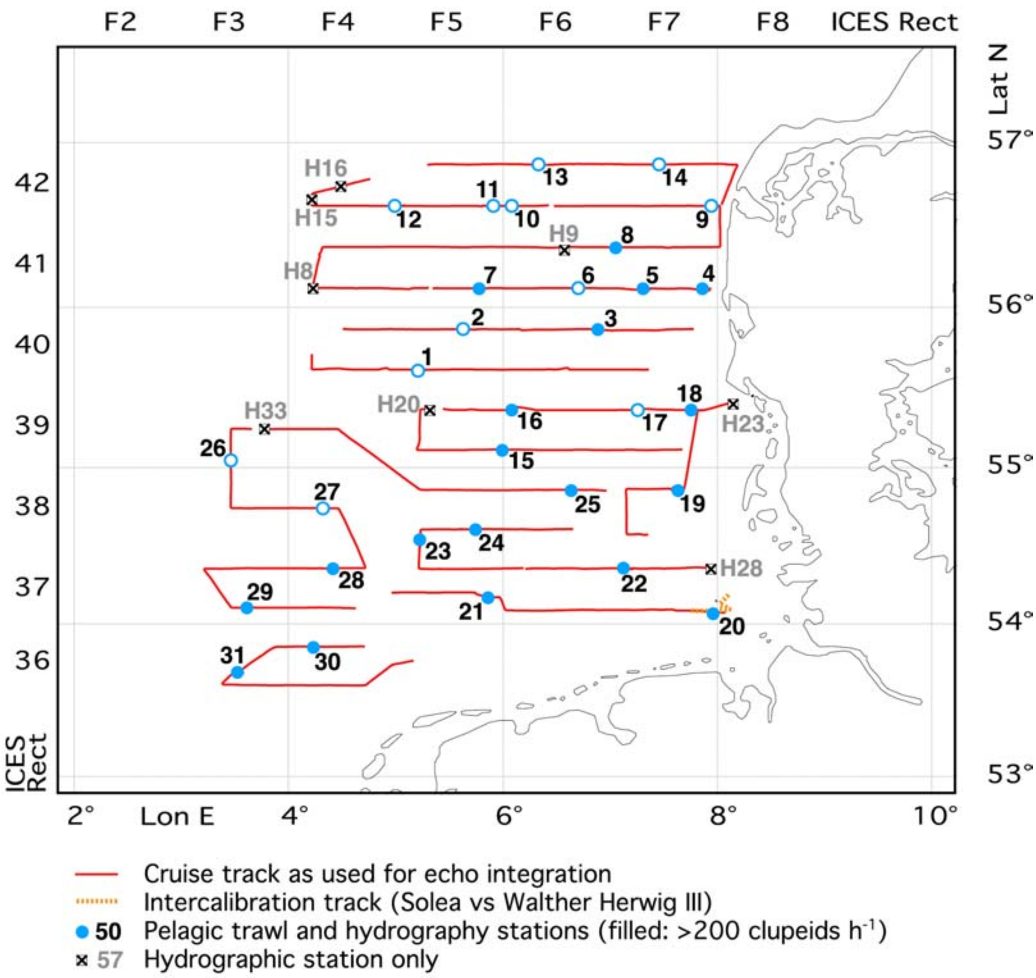


Figure IIF.1. FRV "Solea", cruise 478: International hydroacoustic survey on herring in the North Sea, 29 June – 19 July 2001: cruise track, fishing stations and hydrographic stations.

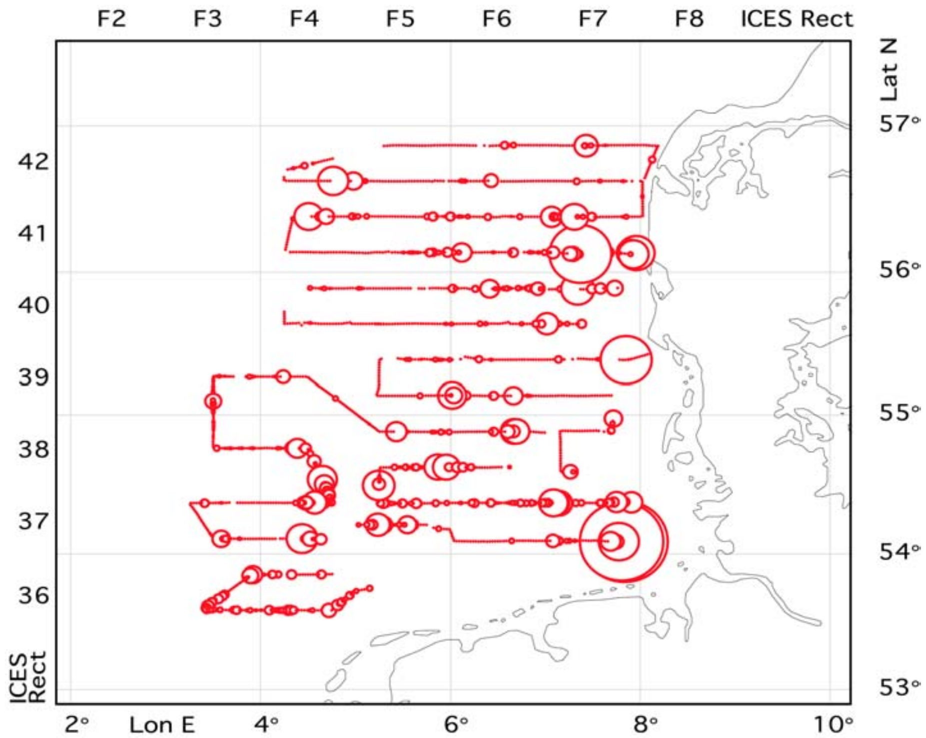


Figure IIF.2. FRV "Solea", cruise 478: International hydroacoustic survey on herring in the North Sea, 29 June – 19 July 2001: Post plot showing the distribution of total NASC values attributed to clupeids (on a proportional sq. root scale relative to the largest value of 24'600 m^2nm^{-2})). Smallest dots indicate zero values.

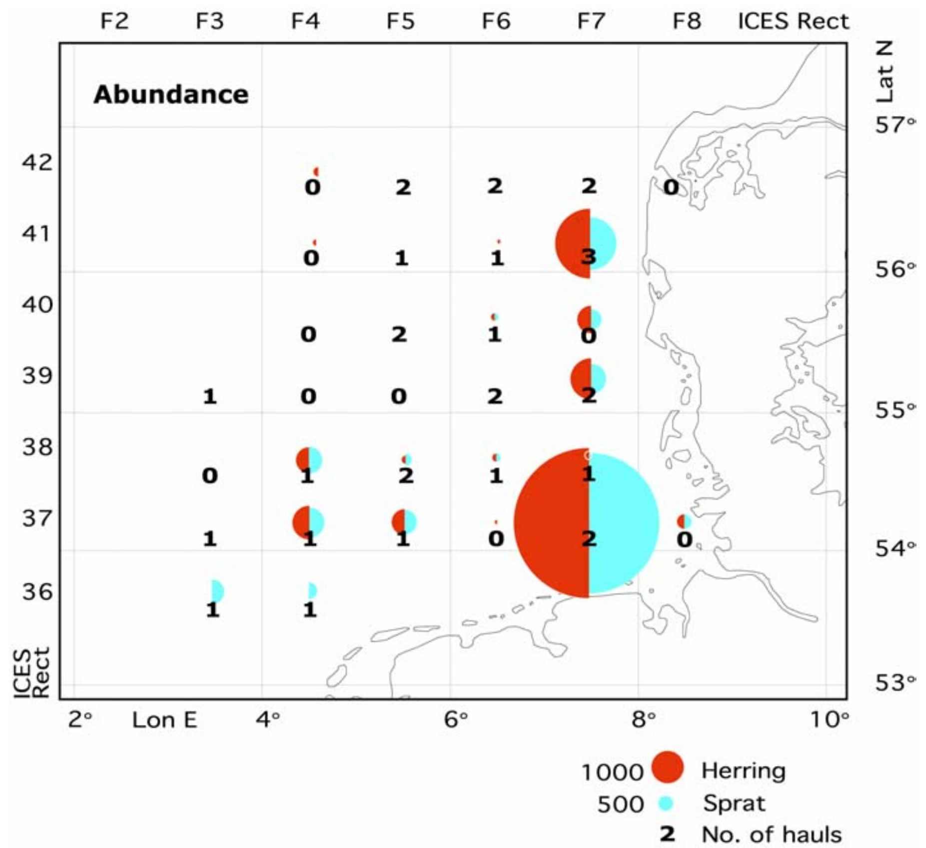


Figure IIF.3. FRV "Solea", cruise 478: International hydroacoustic survey on herring in the North Sea, 29 June – 19 July 2001: abundance of herring and sprat (circle diameter is proportional to abundance), relative proportion of herring and sprat, and number of hauls per statistical rectangle.

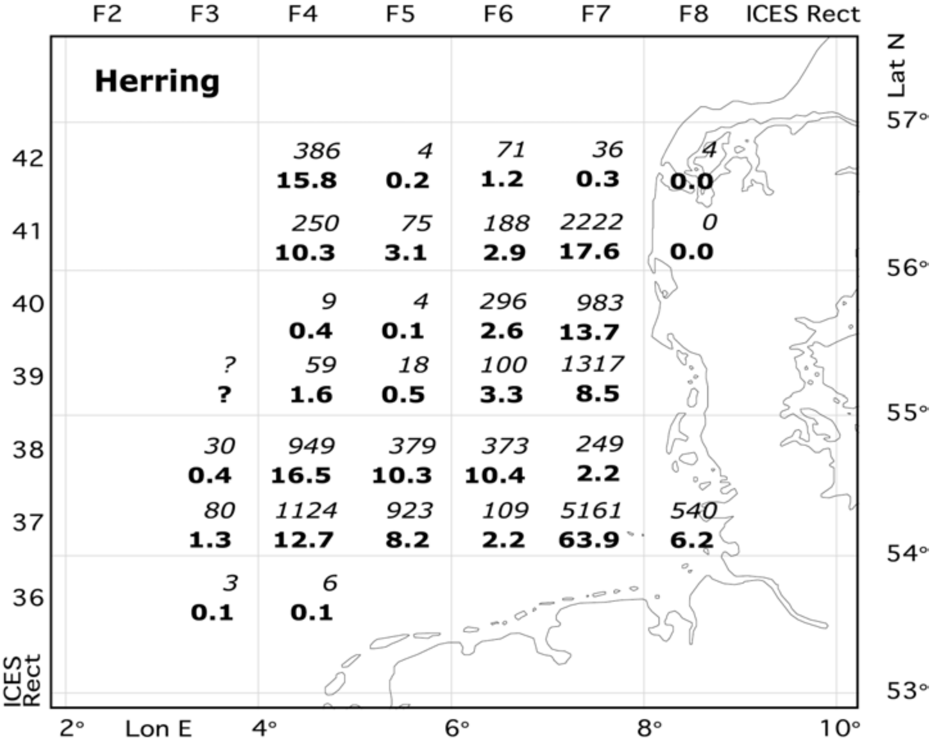


Figure IIF.4. FRV "Solea", cruise 478: International hydroacoustic survey on herring in the North Sea, 29 June – 19 July 2001: Abundance (Mill. Individuals, upper value in italics) and biomass (thousand t, lower value in bold) of herring per statistical rectangle. ? indicates the area where trawl information neither from this nor from neighboring rectangles was available to verify acoustic data.

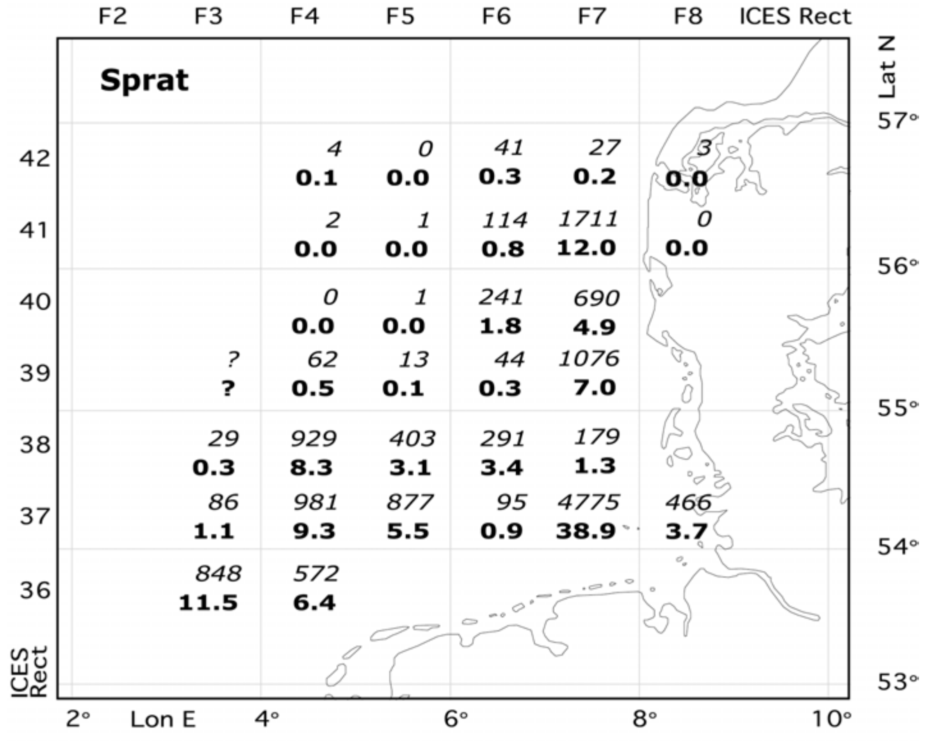
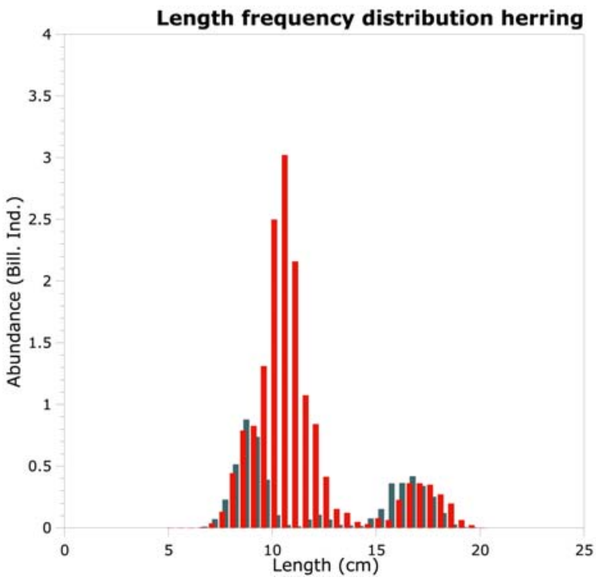


Figure IIF.5. FRV "Solea", cruise 478: International hydroacoustic survey on herring in the North Sea, 29 June – 19 July 2001: Abundance (Mill. Individuals, upper value in italics) and biomass (thousand t, lower value in bold) of sprat per statistical rectangle. ? indicates the area where trawl information neither from this nor from neighboring rectangles was available to verify acoustic data.



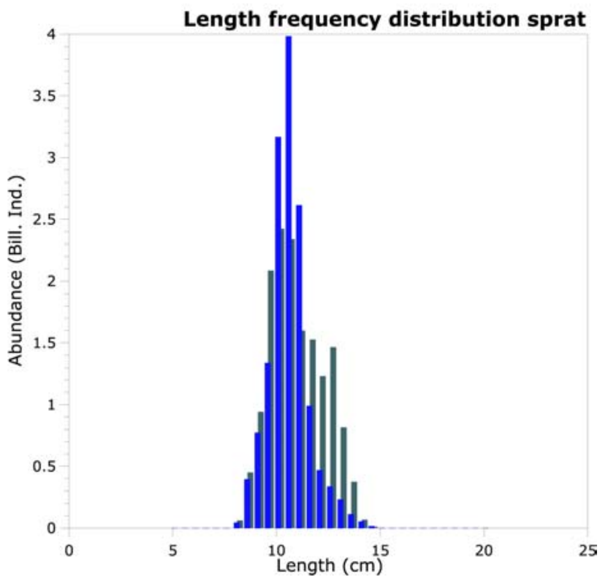


Figure IIF.6. FRV "Solea", cruise 478: International hydroacoustic survey on herring in the North Sea, 29 June – 19 July 2001: Length frequency distribution of herring (left panel) and sprat (right) raised to the total abundance in the area covered. Grey bars in the background represent last year's LF's (cruise WH218, 2000).

Transceiver Menu		
Frequency	38 kHz	
Transducer	23101	
Sound speed	1495 m.s^{-1}	
Max. Power	**7.1**	**1000 W**
Equivalent two-way beam angle	-16.7 dB	
Default Transducer Sv gain	21.06 dB	
Calibration details		
TS of sphere	-33.6 dB	
Range to sphere in calibration	4.50 m	
Measured NASC value for calibration	43519	
Log Menu		
Speed	1 n.mi.	
Operation Menu		
Ping interval	1 s at 100 m range	
Analysis settings		
Bottom margin (backstep)	0.5 m	
Integration start (absolute) depth	7 m	
Range of thresholds used	-50 dB	

Table IIF.1. FRV "Solea", cruise 478: International hydroacoustic survey on herring in the North Sea, 29 June – 19 July 2001: Simrad EK500 and analysis settings used.

Table IIF.2. FRV "Solea", cruise 478: International hydroacoustic survey on herring in the North Sea, 29 June – 19 July 2001: Trawl station data

Stat	Haul	Rect	Dat	Time of day (h:min UTC)	Trawl	ShotPosLat (°°MM.MM)	Shot PosLon (°°MM.MM)	Water Depth (m)	Catch Depth (m)	catch time (min)
2	1	40F5	30.06.2001	13:46	PSN388	553697N	0051433E	49	40	31
5	2	40F5	01.07.2001	8:58	PSN388	555195N	0053896E	51	41	62
7	3	40F6	01.07.2001	15:15	PSN388	555188N	0065350E	36	27	62
10	4	41F7	02.07.2001	4:48	PSN388	560682N	0075226E	23	17	26
12	5	41F7	02.07.2001	8:31	PSN388	560681N	0071870E	28	22	30
14	6	41F6	02.07.2001	12:20	PSN388	560705N	0064311E	37	31	30
16	7	41F5	02.07.2001	16:58	PSN388	560698N	0054766E	48	39	31
23	8	41F7	04.07.2001	6:30	PSN388	562199N	0070601E	33	24	20
25	9	42F7	04.07.2001	13:32	PSN388	563699N	0075667E	22	15	30
28	10	42F6	05.07.2001	5:46	PSN388	563700N	0060569E	50	30	31
30	11	42F5	05.07.2001	7:36	PSN388	563703N	0055618E	53	39	45
32	12	42F5	05.07.2001	12:12	PSN388	563702N	0050137E	65	33	45
39	13	42F6	06.07.2001	8:20	PSN388	565196N	0062074E	49	32	31
41	14	42F7	06.07.2001	13:42	PSN388	565195N	0072828E	29	20	32
44	15	39F6	07.07.2001	12:52	PSN388	550710N	0060110E	44	37	30
48	16	39F6	08.07.2001	6:55	PSN388	552214N	0060569E	50	44	30
50	17	39F7	08.07.2001	12:32	PSN388	552209N	0071624E	28	19	30
54	18	39F7	09.07.2001	9:58	PSN388	552192N	0074594E	22	18	30
56	19	38F7	09.07.2001	14:17	PSN388	545203N	0073805E	22	15	30
59	20	37F7	10.07.2001	4:47	PSN388	540535N	0075765E	38	21	30
61	21	37F5	10.07.2001	15:07	PSN388	541120N	0055288E	37	29	50
66	22	37F7	13.07.2001	13:25	PSN388	542202N	0070839E	43	36	30
69	23	38F5	14.07.2001	10:35	PSN388	543270N	0051521E	41	37	39
72	24	38F5	14.07.2001	15:24	PSN388	543702N	0054570E	43	36	29
75	25	38F6	15.07.2001	5:50	PSN388	545212N	0063897E	43	36	18
79	26	39F3	16.07.2001	6:55	PSN388	550321N	0032992E	36	26	30
81	27	38F4	16.07.2001	14:06	PSN388	544510N	0042135E	51	43	30
84	28	37F4	17.07.2001	4:27	PSN388	542216N	0042657E	50	44	29
86	29	37F3	17.07.2001	13:37	PSN388	540707N	0033877E	45	40	31
90	30	36F4	18.07.2001	6:26	PSN388	535202N	0041553E	43	38	21
92	31	36F3	18.07.2001	10:33	PSN388	534195N	0033375E	40	34	19

Table IIF.3. FRV "Solea", cruise 478: International hydroacoustic survey on herring in the North Sea, 29 June – 19 July 2001: Species distribution per haul (catch in kg), relative composition of the clupeid catch, and total raised number of clupeids. Stations marked yellow were used for verification of echo traces.

Station	*Ammodytes marinus*	*Ammodytes tobianus*	*Callionymus lyra*	***Clupea harengus***	*Eutrigla gurnardus*	*Gadus morhua*	*Hyperoplus lanceolatus*	*Limanda limanda*	*Merlangius merlangus*	*Scomber scombrus*	***Sprattus sprattus***	*Trachurus trachurus*	**total catch (kg)**	**Number of Species**	Herring (n in haul)	Herring (% of clupeid catch)	Sprat (n in haul)	Sprat (% of clupeid catch)	**Number of clupeids/30 min**
2	0.39				0.23	0.00			0.02				**0.6**	4	0		0		0
5	0.16				2.76				6.25				**9.2**	3	0		0		0
7	7.31			79.33	0.60				16.91		31.75		**135.9**	5	9526	**75%**	3155	**25%**	6136
10				298.40							145.60		**444.0**	2	68248	**75%**	22459	**25%**	104662
12				1518.25					22.03		84.72		**1625.0**	3	211074	**96%**	9489	**4%**	220563
14	0.02			0.68	1.05				5.03				**6.8**	4	76	**100%**	0	**0%**	76
16				23.09	0.97	0.01			28.58		0.06		**54.7**	6	566	**99%**	3	**1%**	551
23			0.01	1079.90	2.28						620.10		**1702.3**	4	152633	**73%**	56952	**27%**	314378
25				0.08	3.10				0.24			0.07	**3.5**	4	1	**100%**	0	**0%**	1
28					1.59	0.01			2.69				**4.3**	3	0		0		0
30	0.02				1.24	0.00			2.58				**3.8**	4	0		0		0
32	4.76				0.36				0.44				**5.6**	3	0		0		0
39					0.25				0.17				**1.6**	3	0		0		0
41	1.86			0.23	3.46		0.04		0.09		0.10		**5.8**	6	24	**77%**	7	**23%**	29
44				594.38	3.80				0.68		1.14		**600.0**	4	13153	**100%**	59	**0%**	13212
48				13.50	0.12				45.46		10.61		**69.7**	4	811	**41%**	1187	**59%**	1998
50					12.84								**6.1**	1	0		0		0
54				169.58	0.33		0.08		0.14		145.92		**315.7**	4	27943	**62%**	17064	**38%**	45007
56		0.20		89.27		0.05	2.96	0.04			96.48	0.16	**189.5**	8	10547	**51%**	9933	**49%**	20480
59				427.41							472.59	5.08	**905.1**	3	54683	**51%**	51918	**49%**	106601
61				13.41	0.27				3.33		20.64	1.41	**39.1**	5	1616	**36%**	2823	**64%**	2663
66				125.78					0.09	0.27	294.22	0.69	**421.0**	5	8239	**23%**	26954	**77%**	35193
69				17.15	0.34						6.52	0.12	**24.1**	4	497	**41%**	701	**59%**	922
72				61.09						9.74	249.91	10.78	**331.5**	4	6805	**21%**	25366	**79%**	33280
75				318.52						1.64	281.48		**601.6**	3	12420	**37%**	20777	**63%**	55328
79	0.15				66.00			0.04				0.48	**66.7**	4	0		0		0
81				0.02	0.14				0.02		0.66		**0.8**	4	5	**11%**	40	**89%**	45
84				122.28					0.00		249.72		**372.2**	4	12070	**34%**	23555	**66%**	36853
86				33.68					0.20		43.86		**77.7**	3	2225	**41%**	3238	**59%**	5287
90				1.63					0.56		187.81		**190.0**	3	158	**1%**	15046	**99%**	21720
92				2.52					0.85	0.09	306.64		**310.0**	4	64	**0%**	21603	**100%**	34211

Table IIF.4a. FRV "Solea", cruise 478: International hydroacoustic survey on herring in the North Sea, 29 June – 19 July 2001: **Herring** length frequency proportion (%) by trawl haul. Length in cm.

rectangle	**41F5**	**41F7**	**41F7**	**41F7**	**40F6**	**39F6**	**39F6**	**39F7**	**38F5**	**38F5**	**38F6**	**38F7**	**37F3**	**37F4**	**37F5**	**37F7**	**37F7**	**36F3**	**36F4**
station	**16**	**10**	**12**	**23**	**7**	**44**	**48**	**54**	**69**	**72**	**75**	**56**	**86**	**84**	**61**	**59**	**66**	**92**	**90**
5.25																			
5.75																			
6.25																			
6.75																			
7.25		2						1		1									
7.75		11			1		1	2		1				1					
8.25		19					1	13		1				6					
8.75	1	27					2	21		2			1	13		1			
9.25		22	5		2		2	17	1	3	1		2	15	2	2			
9.75		14	20		9		2	14	1	2	1	6	1	13	10	14			33
10.25		5	54	2	28		1	13	1	7		43	1	4	38	33			
10.75			20	49	44		3	8	5	36		37	1	1	33	35	9		
11.25			2	45	14		10	8	10	39		9	1	7	10	13	24		
11.75				4	1		27	3	4	6	4	3	6	11	3	2	23		33
12.25					1		23		2	2	9	1	21	10	2		20		
12.75							6		1	1	15		25	5	2		7		33
13.25							1				12		20	3			1		
13.75											7		14	2	1				
14.25							1				3		6	1					
14.75									1		1		2	1					
15.25	4						1		2		2			1					
15.75							2		1		3			1			1		
16.25	15					1	1		3		8			1			2		
16.75	29					3	2		5		5			1			3		
17.25	21					10	2		14		10			1			2	100	
17.75	19					16	2		16		9			1			2		
18.25	6					25	3		17	1	6						3		
18.75	6					31	3		10		2						1		
19.25						12	3		4		1								
19.75						2	1		1										
2.25						1													
total n	326	231	285	253	296	318	384	393	384	171	418	267	297	457	282	272	225	1	3

Table IIF.4b. FRV “Solea”, cruise 478: International hydroacoustic survey on herring in the North Sea, 29 June – 19 July 2001: **Sprat** length frequency proportion (%) by trawl haul. Length in cm.

rectangle	**41F5**	**41F7**	**41F7**	**41F7**	**40F6**	**39F6**	**39F6**	**39F7**	**38F5**	**38F5**	**38F6**	**38F7**	**37F3**	**37F4**	**37F5**	**37F7**	**37F7**	**36F3**	**36F4**
station	**16**	**10**	**12**	**23**	**7**	**44**	**48**	**54**	**69**	**72**	**75**	**56**	**86**	**84**	**61**	**59**	**66**	**92**	**90**
5,25																			
5,75																			
6,25																			
6,75																			
7,25																			
7,75																			
8,25		4					1												
8,75		35			1		1	7		1									
9,25		40			6		5	13	2	3		1			22				
9,75		11	16	1	19		10	22	8	13	1	7		5	39	11			1
10,25		6	43	19	34		32	32	45	28	1	49	2	15	23	45	6	1	7
10,75		3	27	43	27		32	20	33	33	4	36	7	27	9	36	41	5	19
11,25			9	27	8		15	3	9	19	27	5	23	26	3	6	41	15	33
11,75			5	8	2		3	1	2	2	27	1	16	14	3	1	10	15	14
12,25				2	1		2		1	1	22		21	7			1	19	5
12,75						43					11	1	17	4				20	5
13,25	67					14					5		11	2				14	7
13,75					1	29					2		2	1				7	6
14,25	33					14							1	1				4	2
14,75													1					1	1
15,25																			
15,75																			
16,25																			
16,75																			
total n	3	236	56	259	241	7	301	321	244	304	327	192	320	399	268	234	223	335	286

Table IIF.5. FRV "Solea", cruise 478: International hydroacoustic survey on herring in the North Sea, 29 June – 19 July 2001: Age/maturity-length key for herring (numbers of fish sampled).

Length	0wr	1wr		2wr		3wr	4wr	Total
[cm]	imm	imm	mat	imm	mat	mat	mat	
5.25								
5.75	1							**1**
6.25	1							**1**
6.75	3							**3**
7.25	19							**19**
7.75	29							**29**
8.25	43							**43**
8.75	54							**54**
9.25	81							**81**
9.75	93							**93**
10.25	100							**100**
10.75	107							**107**
11.25	107							**107**
11.75	101							**101**
12.25	71							**71**
12.75	59	1						**60**
13.25	34	2						**36**
13.75	32	1						**33**
14.25	23	6						**29**
14.75	5	19						**24**
15.25		31						**31**
15.75		47						**47**
16.25		52						**52**
16.75		56						**56**
17.25		54						**54**
17.75		53						**53**
18.25		56						**56**
18.75		50						**50**
19.25		27	1	1				**29**
19.75		17		1				**18**
20.25		4						**4**
20.75								
21.25								
21.75								
22.25								
22.75								
23.25								
23.75						1		**1**
24.25								
24.75								
25.25								
25.75								
26.25								
26.75							1	**1**
27.25								
Total	**963**	**476**	**1**	**2**	**0**	**1**	**1**	**1444**

Table IIF.6. FRV "Solea", cruise 478: International hydroacoustic survey on herring in the North Sea, 29 June – 19 July 2001:Mean weight, biomass (thousands of tonnes) and numbers (millions) for **herring** by age and maturity per statistical rectangle.

Summary by rectangle = interpolated square

Herring

		F3		F4		F5		F6		F7		F8	
		W [t]	N [10^6]	W [t]	N [10^6]	W [t]	N [10^6]	W [t]	N [10^6]	W [t]	N [10^6]	W [t]	N [10^6]
42	total			**15'838**	**385.8**	**171**	**4.2**	**1'163**	**71.3**	**281**	**35.5**	**29**	**3.7**
	1i			23.1	3.8	0.2	0.0	423.2	53.5	281.3	35.5	28.9	3.7
	2i			15'805.7	381.8	170.4	4.1	739.8	17.9	0.1	0.0	0.0	0.0
	2m	no stations and		2.4	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
	3i	no echo-information		6.7	0.1	0.1	0.0	0.3	0.0	0.0	0.0	0.0	0.0
	3m			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4m			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5m			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5+			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	total			**10'278**	**250.3**	**3'074**	**74.9**	**2'905**	**188.1**	**17'604**	**2221.8**	**0**	**0.0**
	1i			15.0	2.5	3.3	0.7	1'175.2	146.3	17'539.1	2218.2	0.0	0.0
	2i			10'256.6	247.8	3'055.9	74.0	1'728.6	41.8	64.5	3.6	0.0	0.0
	2m	no stations and		1.6	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
	3i	no echo-information		4.4	0.1	15.0	0.2	0.7	0.0	0.0	0.0	0.0	0.0
	3m			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4m			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5m			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5+			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	total			**380**	**9.2**	**126**	**3.8**	**2'597**	**296.3**	**13'650**	**982.7**		
	1i			0.6	0.1	15.3	1.4	2'568.4	295.3	6'931.8	849.9		
	2i			379.0	9.2	109.6	2.4	28.3	1.0	6'637.1	131.5		
	2m	no stations and		0.1	0.0	0.3	0.0	0.0	0.0	34.4	0.6	no stations and	
	3i	no echo-information		0.2	0.0	0.4	0.0	0.0	0.0	46.7	0.8	no echo-information	
	3m			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	4m			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	5m			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	5+			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
39	total			**1'594**	**58.8**	**524**	**18.2**	**3'349**	**99.9**	**8'524**	**1317.1**		
	1i			312.5	31.4	115.9	9.5	516.8	43.4	8'524.5	1317.1		
	2i			1'273.5	27.2	404.3	8.6	2'831.7	56.5	0.0	0.0		
	2m	echo-information available		3.4	0.1	1.4	0.0	0.0	0.0	0.0	0.0	no stations and	
	3i	no valid stations and		4.4	0.1	1.9	0.0	0.0	0.0	0.0	0.0	no echo-information	
	3m	no neighbous w/ valid stat		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	4m			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	5m			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	5+			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
38	total	**415**	**30.3**	**16'511**	**948.9**	**10'279**	**379.1**	**10'435**	**372.5**	**2'192**	**248.8**		
	1i	357.4	28.5	8'079.5	758.7	1'992.4	201.7	3'233.0	200.5	2'173.2	247.9		
	2i	58.0	1.9	8'387.2	189.5	8'160.4	175.3	7'201.9	172.0	18.9	0.9		
	2m	0.0	0.0	19.0	0.3	62.9	1.0	0.0	0.0	0.0	0.0	no stations and	
	3i	0.0	0.0	24.9	0.4	62.9	1.0	0.0	0.0	0.0	0.0	no echo-information	
	3m	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	4m	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	5m	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	5+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
37	total	**1'304**	**80**	**12'672**	**1123.7**	**8'212**	**922.5**	**2'224**	**108.6**	**63'945**	**5161.3**	**6'152**	**540.3**
	1i	1'283.9	79.1	9'567.0	1039.5	8'211.7	922.5	884.7	77.3	48'246.6	4795.6	4'994.9	513.4
	2i	20.5	0.8	3'104.5	84.2	0.0	0.0	1'334.1	31.2	15'698.0	365.7	1'151.0	26.8
	2m	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	1.6	0.0
	3i	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.1	0.0	0.0	4.4	0.1
	3m	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4m	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5m	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	total	**107**	**3**	**70**	**6.0**								
	1i	0.0	0.0	69.7	6.0								
	2i	106.6	2.5	0.0	0.0								
	2m	0.0	0.0	0.0	0.0	no stations and		no stations and		no stations and		no stations and	
	3i	0.0	0.0	0.0	0.0	too little echo-information		no echo-information		no echo-information		no echo-information	
	3m	0.0	0.0	0.0	0.0								
	4m	0.0	0.0	0.0	0.0								
	5m	0.0	0.0	0.0	0.0								
	5+	0.0	0.0	0.0	0.0								

Weight at age & maturity [g]	
1i	8.04
2i	38.76
2m	49.00
3i	53.24
3m	---
4m	---
5m	---
5+	---

Totals [t]:		Totals [mio]:	
Weight	**216'601**	**Numbers**	**15'946**
1i	127'569	1i	13'883
2i	88'726	2i	2'058
2m	130	2m	2
3i	176	3i	3
3m	0	3m	0
4m	0	4m	0
5m	0	5m	0
5+	0	5+	0

Table IIF.7. FRV "Solea", cruise 478: International hydroacoustic survey on herring in the North Sea, 29 June – 19 July 2001:Mean weight, biomass (thousands of tonnes) and numbers (millions) for **sprat** by age and maturity per statistical rectangle.

Acoustic Survey on Herring 2001 (SA-478)
Summary by rectangle
= interpolated square

Sprat

		F3		F4		F5		F6		F7		F8	
		W [t]	N [10^6]	W [t]	N [10^6]	W [t]	N [10^6]	W [t]	N [10^6]	W [t]	N [10^6]	W [t]	N [10^6]
42	total			**65**	**3.5**	**1**	**0.0**	**292**	**41.2**	**192**	**27.3**	**20**	**2.8**
	1i			0	0.0	0	0.0	121	21.1	81	14.1	8	1.4
	1m	no stations and		0	0.0	0	0.0	143	17.3	95	11.6	10	1.2
	2i			0	0.0	0	0.0	4	0.5	3	0.3	0	0.0
	2m	no echo-information		54	3.0	1	0.0	22	2.2	13	1.4	1	0.1
	3m			11	0.5	0	0.0	1	0.0	0	0.0	0	0.0
	4			0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
41	total			**42**	**2.3**	**13**	**0.7**	**811**	**113.8**	**12'033**	**1'710.6**	**0**	**0.0**
	1i			0	0.0	0	0.0	336	57.5	2'704	595.7	0	0.0
	1m	no stations and		0	0.0	0	0.0	397	48.7	8'487	1'026.3	0	0.0
	2i			0	0.0	0	0.0	12	1.4	0	0.0	0	0.0
	2m	no echo-information		35	2.0	8	0.5	63	6.0	842	88.5	0	0.0
	3m			7	0.3	5	0.2	2	0.1	0	0.0	0	0.0
	4			0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
40	total			**2**	**0.1**	**10**	**1.3**	**1'778**	**241.2**	**4'870**	**690.0**		
	1i			0	0.0	4	0.6	60	12.2	2'098	350.7		
	1m	no stations and		0	0.0	5	0.6	1'548	212.8	2'359	297.8	no stations and	
	2i			0	0.0	0	0.0	0	0.0	68	8.3		
	2m	no echo-information		1	0.1	1	0.1	170	16.3	334	32.5	no echo-information	
	3m			0	0.0	0	0.0	0	0.0	10	0.6		
	4			0	0.0	0	0.0	0	0.0	0	0.0		
39	total			**476**	**62.5**	**119**	**13.4**	**343**	**43.8**	**7'018**	**1'075.8**		
	1i			178	25.5	29	4.2	38	6.7	2'357	442.7		
	1m	no valid stations		264	33.3	57	6.6	274	34.9	4'661	633.1	no stations and	
	2i			8	0.9	2	0.2	31	2.2	0	0.0		
	2m	no neighbous w/ valid sta		25	2.7	30	2.3	0	0.0	0	0.0	no echo-information	
	3m	echo-information availabl		0	0.0	1	0.1	0	0.0	0	0.0		
	4			0	0.0	0	0.0	0	0.0	0	0.0		
38	total	**324**	**29.5**	**8'343**	**929.5**	**3'067**	**403.1**	**3'419**	**291.4**	**1'331**	**178.9**		
	1i	35	4.4	2'008	284.8	2'741	367.9	60	8.1	867	123.3		
	1m	125	13.2	3'899	456.4	87	8.7	1'829	174.5	450	54.6	no stations and	
	2i	4	0.5	125	14.1	167	19.6	0	0.0	0	0.0		
	2m	150	10.9	2'195	167.3	61	5.1	1'530	108.7	14	0.9	no echo-information	
	3m	9	0.5	116	6.9	11	0.9	0	0.0	0	0.0		
	4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0		
37	total	**1'063**	**86.1**	**9'274**	**981.1**	**5'540**	**876.7**	**861**	**94.9**	**38'913**	**4'774.7**	**3'716**	**465.7**
	1i	2	0.3	2'884	372.5	4'476	735.2	196	27.5	17'552	2'328.8	1'233	166.9
	1m	322	33.3	2'978	316.9	749	113.2	410	47.2	19'942	2'320.5	2'178	266.0
	2i	0	0.0	139	21.0	174	15.5	13	1.4	1'131	99.3	65	7.7
	2m	705	50.6	3'273	270.7	99	9.4	232	18.2	0	0.0	238	24.8
	3m	34	2.0	0	0.0	42	3.3	10	0.6	288	26.1	3	0.2
	4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
36	total	**11'478**	**848.0**	**6'421**	**572.0**								
	1i	329	38.5	295	41.6								
	1m	1'862	186.5	2'695	291.0	no stations and		no stations and		no stations and		no stations and	
	2i	155	17.0	0	0.0								
	2m	7'926	542.2	3'340	235.4	too little echo-information		no echo-information		no echo-information		no echo-information	
	3m	1'206	63.8	92	4.0								
	4	0	0.0	0	0.0								

Weight at age &	maturity [g]
1i	8.18
1m	10.07
2i	9.85
2m	13.98
3	16.70
4	---

Totals [t]:			Totals [mio]:		
Weight		**121'833**	**Number:**		**14'562**
1i		40'691	1i		6'032
1m		55'825	1m		6'607
2i		2'102	2i		210
2m		21'366	2m		1'602
3		1'849	3		110
4		0	4		0

APPENDIX III WESTERN BALTIC ACOUSTIC SURVEY

Survey Report for RV "SOLEA"

28.09-18.10.2001

Federal Research Centre for Fisheries, Germany
Tomas Gröhsler[1] & Eberhard Götze[2]

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1 INTRODUCTION

The main objective is to assess clupeoid resources in the Baltic Sea. The joint German/Danish survey in September/October is traditionally co-ordinated within the frame of the **International Acoustic Survey for Pelagic Fish Stocks in the Baltic Sea.** 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 (WGBFAS)' with an index value for the stock size of sprat in the Western Baltic area (Sub-division 21, 22, 23 and 24).

2 METHODS

2.1 Personnel

J. Dröse	Institute for Baltic Sea Fishery Rostock
M. Drenkow	Inst. for Fishery Technology and Fish Quality, Hamburg
Dr. T. Gröhsler	Institute for Baltic Sea Fishery Rostock, Cr. Leader
U. Nielsen	DIFRES, Charlottenlund, Denmark
R. Oeberst	Institute for Baltic Sea Fishery Rostock

2.3 Narrative

The 482nd cruise of RV 'Solea' represents the 14th subsequent survey and took place from 28th to 15th October in 2001. RV "SOLEA" left the port of Rostock/Warnemünde on 28th September 2001. The joint German-Danish acoustic survey was intended to cover the whole sub-divisions 21, 22, 23 and 24. The applied permission to enter the Swedish 12-miles-zone was not given. In consequence the whole sub-division 23 and parts of sub-division 21 and 24 could not be covered. The survey ended on 15th October 2001 in Rostock/Warnemünde.

2.4 Survey design

For all Sub-divisions the statistical rectangles were used as strata (ICES 2001/H:02 Ref.:D: Annex 2). The area is limited by the 10 m depth line. The survey area in the Western Baltic Sea is characterised by a number of islands and sounds. Parallel transects would lead in consequence to an unsuitable coverage of the survey area. Therefore a zig-zag track was used to cover all depth strata regularly. The survey covered an area of 12,200 NM^2. The cruise track (Figure III.1) reached in total a length of 882 nautical miles.

2.5 Calibration

The transducer 38-26 was calibrated before the survey in Rostock/Warnemünde. The calibration procedure was carried out as described in the 'Manual for the Baltic International Acoustic Surveys (BIAS)' (Appendix 2 of Annex 2 in the 'Report of the Baltic International Fish Survey Working Group', ICES CM 2001/H:02).

2.6 Acoustic data collection

The acoustic investigations were performed during night time. The main pelagic species of interest were herring and sprat. The acoustic equipment was an echosounder EK500. The standard frequency for the survey was 38 kHz. The echo integration, i.e. the allocation of the area backscattering strength S_a to the species was done by a Bergen integrator BI500. The specific settings of the hydroacoustic equipment were used as described in the 'Manual for the Baltic International Acoustic Surveys (BIAS)' (Annex 2 in the 'Report of the Baltic International Fish Survey Working Group', ICES CM 2001/H:02). The transducer 38-26 was installed in a towed body, which had a lateral distance of about 30 m to reduce escape reactions of fish. The mean volume back scattering values (Sv) were integrated over 1 n.mi. intervals from 8 m below the surface to the bottom. Contributions from air bubbles, bottom structures and scattering layers were removed from the echogram by using the BI500.

2.7 Biological data – fishing stations

Trawling was done with the pelagic gear PSN388 in midwater as well as near the bottom. The mesh size in the codend was 10 mm. The intention was to carry out at least two hauls per ICES statistical rectangle. The trawling depth and the net opening were controlled by a netsonde. The trawl depth was chosen in accordance to the 'characteristic indications' by the echogram. Normally a net opening of about 8-10 m was achieved. The trawling time lasted usually 30 minutes, but in dense concentrations the duration was reduced. From each haul sub-samples were taken to determine length and weight of fish. Sub-samples of herring and sprat were frosted for further investigations in the lab (i.e. sex, maturity, age). After each trawl haul the hydrographic condition was investigated by a SST-SDA-probe.

2.8 Data analysis

The pelagic target species sprat and herring are usually distributed in mixed layers in combination with other species so that it is impossible to allocate the integrator readings to a single species. Therefore the species composition was based on the trawl catch results. For each rectangle the species composition and length distribution were determined as the unweighted mean of all trawl results in this rectangle. From these distributions the mean cross section σ was calculated according to the following target strength-length (TS) relationships:

Clupeoids	TS = 20 log L (cm) - 71.2	(ICES 1983/H:12)
Gadoids	TS = 20 log L (cm) - 67.5	(Foote *et al.* 1986)

The total number of fish (total N) in one rectangle was estimated as the product of the mean area scattering cross section (Sa) and the rectangle area, divided by the corresponding mean cross section. The total number were separated into herring and sprat according to the mean catch composition.

3 RESULTS

3.1 Biological data

In total 47 trawl hauls were carried out (11 hauls in sub-division 21, 19 hauls in sub-division 22 and 17 hauls in sub-division 24). 1205 herring and 770 sprat were frosted for further investigations in the lab (i.e sex, maturity, age).

The results of the catch composition by Sub-division are presented in Tables III.1-3. In general the catch composition was dominated by herring and to a lower extend by sprat.

The length distributions of herring and sprat of the years 2000 and 2001 are presented by Sub-division in Figures III.2 and III.3.

3.2 Acoustic data

The survey statistics concerning the survey area, the mean Sa, the mean scattering cross section σ, the estimated total number of fish, the percentages of herring and sprat per Sub-division/rectangle are shown in Table III.4.

The horizontal distribution of NASCs (Figure III.4 and Table III.4) was similar to the years before. High fish concentrations were found in the Arkona Basin (Sub-division 24) and in the southern part of Sub-division 22. In the Belt Sea (northern part of Sub-division 22) and the southern Kattegat (Sub-division 21) the fish density was as low as in the years before. The northern Kattegat was covered for the first time and high NASCs of more than 1000 $m^2/n.mi.^2$ were recorded in this area. Such high fish densities were in former years usually characteristic for the area in the Sound (Sub-division 23), which could not be investigated this year due to the missing Swedish permission.

3.3 Abundance estimates

The total abundance of herring and sprat are presented in Table III.4. The estimated number of herring and sprat by age group and Sub-division/rectangle are given in Table III.5 and Table III.8. The corresponding mean weight by age group and Sub-division/rectangle are shown in Table III.6 and Table III.9. The estimates of herring and sprat biomass by Sub-division/rectangle are summarised in Table III.7 and Table III.10. It should be noted that the results in the northern Kattegat cannot be compared to last years results since this area was covered for the first time.

The herring stock was estimated to be 9.8 x 10^9 fish or about 299.2 x 10^3 tonnes in Sub-divisions 21-24. For the included area of Sub-divisions 22-24 the number of herring was calculated to be 4.8 x 10^9 individuals or 230.5 x 10^3 tonnes.

Last years total abundance and biomass estimates of herring (excluding the northern Kattegat) was extremely low. This years result reached again the level of the years before 2000. As in the years before 2000, the present level is mainly caused by the high fraction of 0-group herring (Figure III.2 and Table III.5), which was almost missing last year.

The estimated sprat stock was 8.7 x 10^9 fish or 90.9 x 10^3 tonnes in Sub-divisions 21-24. For the included area of Sub-divisions 22-24 the number of sprat was calculated to be 7.5 x 10^9 fish or 74.0 x 10^3 tonnes.

The present sprat abundance and biomass estimate (excluding the northern Kattegat) increased compared to last years result. The whole time series is characterised by strong fluctuations from year to year. Nevertheless, the high estimate of sprat in the Kattegat is unusual. As in former years the abundance estimates are dominated by the fraction of young sprat (Figure III.3 and Table III.8).

4 DISCUSSION

Caused by the missing Swedish permission some parts of the planned survey area could not be covered as in the years before. Specially the Sound (Sub-division 23), which is at that time of the year the main distribution area for adult herring in the Western Baltic, could not be investigated by RV “SOLEA” in 2001.

The herring abundance estimates in the southern Sub-division 21, Sub-divisions 22 and 24 reached about the same high level as in years before 2000. Both for herring and sprat the contribution of the new incoming year class was much higher than compared to last year’s low results.

The high abundance estimate of herring in the northern Sub-division 21 are characterised by a high fraction of young fishes. This result emphasizes the claim to cover the total Kattegat (and possibly the Skagerrak) each year in order to get a total stock index value for the herring in the western Baltic area.

5 REFERENCES

ICES 1983. Report of the Planning Group on ICES co-ordinated herring and sprat acoustic surveys. ICES CM 1983/H:12.

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

Species/Haul No./ICES Rectangle	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**Total**
	41G2	**41G1**	**41G1**	**42G1**	**42G1**	**43G1**	**44G1**	**44G0**	**44G0**	**43G1**	**42G2**	
ANGUILLA ANGUILLA										0.08		**0.08**
APHIA MINUTA				+				+	0.01	+	+	**0.01**
CALLIONYMUS LYRA											+	+
CLUPEA HARENGUS	57.69	4.55	2.48	12.95	14.44	68.78	38.12	14.13	32.19	0.67	5.25	**251.25**
CTENOLABRUS RUPESTRIS		+										+
CYCLOPTERUS LUMPUS					1.97							**1.97**
ENGRAULIS ENCRASICOLUS	0.25	0.01	0.03	0.08	0.02			0.15				**0.54**
EUTRIGLA GURNARDUS				0.04	+					0.28	+	**0.32**
GADUS MORHUA								0.01				**0.01**
GASTEROSTEUS ACULEATUS		+	0.01	+						+	+	**0.01**
LIMANDA LIMANDA		0.14										**0.14**
LOLIGO		0.01	+	0.14	0.06	0.94	0.02	0.24	0.12	0.04	0.02	**1.59**
MERLANGIUS MERLANGUS	0.22	0.38	0.65	8.27	6.54	13.25	9.69	19.68	7.83	3.60	3.48	**73.59**
PLEURONECTES PLATESSA						0.16						**0.16**
POMATOSCHISTUS MINUTUS		+		+	+				0.01	+	0.01	**0.02**
SCOMBER SCOMBRUS				0.16		0.07						**0.23**
SPRATTUS SPRATTUS	2.75	0.32	0.99	0.15	6.29	0.04	2.97	46.36	136.10	0.02	0.68	**196.67**
TRACHINUS DRACO	0.03	1.37	0.22	1.11	1.63	0.82				0.55	0.10	**5.83**
TRACHURUS TRACHURUS	1.03	0.09	0.47	0.06	0.02	+	0.05	0.01		0.01	+	**1.74**
TRISOPTERUS ESMARKI				+							+	**+**
Total	**61.97**	**6.87**	**4.85**	**22.96**	**30.97**	**84.06**	**50.85**	**80.58**	**176.26**	**5.25**	**9.54**	**534.16**
Medusae	1.90	0.90	1.60	0.60			2.00			1.70		8.70

+ = < 0,01 Kg

Table 2a Catch composition (kg/0.5 h) per trawl No. in Sub-division 22

Species/Haul No./ICES Rectangle	1	2	3	4	5	6	7	8	9	10	11	12
	37G1	37G1	37G1	38G1	38G1	38G1	38G0	37G0	38G0	38G0	39F9	39F9
AGONUS CATAPHRACTUS												
AMMODYTES TOBIANUS						0.02						
APHIA MINUTA												
CLUPEA HARENGUS	4.81	15.72	2.55	48.84	323.43	6.25	6.47	20.66	5.65	6.73	0.01	0.69
CRANGON												
ENGRAULIS ENCRASICOLUS			0.01			+			0.11	0.03		
GADUS MORHUA	11.52	5.17	18.20			+	+	5.22		6.32	0.03	+
GASTEROSTEUS ACULEATUS	+	0.09	+	0.03		+	0.01	0.01		0.01	0.64	
GOBIUS NIGER						+	+					
LIMANDA LIMANDA			0.03	0.33		0.39	0.03	0.17			0.08	
LIPARIS LIPARIS												
LOLIGO												
MERLANGIUS MERLANGUS	17.32	0.20	3.77	1.02	0.08	0.05	0.08	0.38	0.04	5.99	0.01	0.57
MULLUS SURMULETUS												
PHOLIS GUNELLUS												
POMATOSCHISTUS MINUTUS	+		+	0.01		0.06	+					
SCOMBER SCOMBRUS				0.04				0.09	0.03			0.06
SPRATTUS SPRATTUS	1.40	37.55	9.58	2.24	76.18	0.91	0.87	14.46	14.80	29.10	2.99	3.08
SYNGNATHUS ROSTELLATUS												
SYNGNATHUS TYPHLE												
TRACHURUS TRACHURUS	4.45	0.13	0.03	0.01	0.08	0.31		0.51	4.23	10.75	0.33	53.55
Total	**39.50**	**58.86**	**34.17**	**52.52**	**399.77**	**7.99**	**7.46**	**41.50**	**24.86**	**58.93**	**4.09**	**57.95**
Medusae	2.20	4.90		3.00			16.30	2.20	1.90	9.57	1.90	

Table 2b: Catch composition (kg/0.5 h) per trawl No. in Sub-division 22

Species/Haul No./ICES Rectangle	13	14	15	16	17	18	19	Total
	39F9	40G0	40G0	39G0	39G1	39G1	38G0	
AGONUS CATAPHRACTUS		+						+
AMMODYTES TOBIANUS			0.02					0.04
APHIA MINUTA						+		+
CLUPEA HARENGUS	0.34	0.12			0.01	0.03	0.04	442.35
CRANGON						0.04	+	0.04
ENGRAULIS ENCRASICOLUS		0.01	0.02		0.03	0.01	0.01	0.23
GADUS MORHUA	0.01			+	11.44	0.02	0.07	58.00
GASTEROSTEUS ACULEATUS	0.34	0.05		+		0.04	+	1.22
GOBIUS NIGER		+						+
LIMANDA LIMANDA		0.10	0.06			0.01	0.09	1.29
LIPARIS LIPARIS						+		+
LOLIGO			0.01				+	0.01
MERLANGIUS MERLANGUS	0.16	0.10	0.02	0.01		+	0.03	29.83
MULLUS SURMULETUS		0.01		0.01				0.02
PHOLIS GUNELLUS		0.01						0.01
POMATOSCHISTUS MINUTUS		0.01	0.01	+		0.01	0.01	0.11
SCOMBER SCOMBRUS								0.22
SPRATTUS SPRATTUS	14.88	6.26	+	0.01	0.08	0.01	0.01	214.41
SYNGNATHUS ROSTELLATUS		+	+			+	+	+
SYNGNATHUS TYPHLE		+						+
TRACHURUS TRACHURUS	0.92	0.15	0.79	0.05	0.1	0.03	0.04	76.46
Total	**16.65**	**6.82**	**0.93**	**0.08**	**11.66**	**0.20**	**0.30**	**824.24**
Medusae	0.30	0.56	4.77	6.50	2.97	6.16	6.75	69.98

Table 3a Catch composition (kg/0.5 h) per trawl No. in Sub-division 24

Species/Haul No./ICES Rectangle	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
	37G2	**38G2**	**38G2**	**38G3**	**38G4**	**38G4**	**38G4**	**38G3**	**38G3**	**38G2**	**39G2**	**39G3**
ANGUILLA ANGUILLA												0.36
CLUPEA HARENGUS	104.32	10.81	58.00	27.94	37.68	14.24	22.42	102.55	57.57	21.58	9.80	70.72
ENGRAULIS ENCRASICOLUS	0.20											
GADUS MORHUA	1.20	1.50		1.30		+	0.68	+	3.50	0.93		2.00
GASTEROSTEUS ACULEATUS	0.13	+										
MERLANGIUS MERLANGUS		+		1.87			0.17		1.63	0.73	0.37	3.96
OSMERUS EPERLANUS		0.02		0.02	0.01	0.01	0.01					
POMATOSCHISTUS MINUTUS		+			+	+		0.04		0.05		0.01
SALMO SALAR					5.00							
SCOMBER SCOMBRUS												0.05
SPRATTUS SPRATTUS	26.15	4.06		94.00	28.63	1.75	4.68	2.90	63.23	7.61	0.12	7.77
TRACHURUS TRACHURUS		0.03	0.01	0.06	0.04		0.01			+		0.02
Total	**132.00**	**16.39**	**58.00**	**125.13**	**71.32**	**16.00**	**27.96**	**105.49**	**125.93**	**30.90**	**10.29**	**84.87**
Medusae		4.0		5.6	2.5	5.7	3.5			2.1	7.5	2.0

Table 3b Catch composition (kg/0.5 h) per trawl No. in Sub-division 24

Species/Haul No./ICES Rectangle	**32**	**33**	**34**	**35**	**36**	**Total**
	39G3	**39G4**	**39G4**	**39G3**	**39G3**	
ANGUILLA ANGUILLA	0.19			0.77		1.32
CLUPEA HARENGUS	21.81	17.34	4.60	84.06	19.45	684.89
ENGRAULIS ENCRASICOLUS						0.20
GADUS MORHUA	5.63	2.96	0.44	0.70	2.14	22.98
GASTEROSTEUS ACULEATUS						0.13
MERLANGIUS MERLANGUS	2.17			0.27	0.40	11.57
OSMERUS EPERLANUS						0.07
POMATOSCHISTUS MINUTUS	+		+			0.10
SALMO SALAR						5.00
SCOMBER SCOMBRUS						0.05
SPRATTUS SPRATTUS	10.26	21.42	2.29	48.06	27.69	350.62
TRACHURUS TRACHURUS		0.02				0.19
Total	**40.06**	**41.72**	**7.33**	**133.86**	**49.68**	**1077.12**
Medusae	2.1	0.5	2.3		2.0	39.8

Table 4 Survey statistics RV "Solea" September/October 2001

Sub-division	ICES Rectangle	Area (nm²)	Sa (m²/NM²)	Sigma (cm²)	N total (million)	Herring (%)	Sprat (%)	NHerring (million)	NSprat (million)
21	**41G1**	946.8	53.38	1.81	280.0	66.5	14.9	186.2	41.8
21	**41G2**	432.3	43.72	2.05	92.2	86.9	7.7	80.1	7.1
21	**42G1**	884.2	126.67	2.47	453.1	67.7	13.3	306.6	60.1
21	**42G2**	606.8	100.56	2.8	218.3	59.7	11.6	130.4	25.3
21	**43G1**	699.0	314.71	3.2	686.5	52.7	0.3	361.4	2.1
21	**44G0**	239.9	820.34	1.64	1198.6	23.2	66.5	278.1	796.4
21	**44G1**	580.5	1458.84	1.83	4624.4	78.6	5.5	3635.9	253.4
	Total	4389.5			7553.0			4978.6	1186.1
22	**37G0**	209.9	272.22	1.17	486.5	29.9	66.4	145.6	323.2
22	**37G1**	723.3	280.37	2.55	796.3	36.5	40.7	290.9	323.8
22	**38G0**	735.3	148.04	2.54	429.1	25.0	40.6	107.0	174.0
22	**38G1**	173.2	153.75	1.18	225.7	70.8	20.7	159.7	46.8
22	**39F9**	159.3	245.72	0.56	698.0	0.6	66.7	4.0	465.8
22	**39G0**	201.7	28.15	0.82	69.6	0.0	5.9	0.0	4.1
22	**39G1**	250.0	307.03	5.7	134.7	2.8	21.5	3.8	28.9
22	**40F9**	51.3	175.49	0.57	158.3	0.6	95.1	1.0	150.5
22	**40G0**	538.1	33.56	0.7	258.5	0.3	48.4	0.8	125.2
22	**41G0**	173.1	24.95	1.12	38.7	28.9	34.6	11.2	13.4
	Total	3215.2			3295.3			724.0	1655.7
24	**37G2**	192.4	121.65	1.1	213.2	68.7	30.8	146.5	65.6
24	**38G2**	832.9	352.44	2.38	1235.2	61.4	35.7	758.0	441.3
24	**38G3**	865.7	752.49	2.37	2743.8	35.2	63.5	964.3	1742.9
24	**38G4**	1034.8	562.35	2.36	2467.2	41.2	58.1	1016.0	1433.6
24	**39G2**	406.1	409.72	4.47	372.2	94.1	5.2	350.1	19.3
24	**39G3**	765.0	344.24	2.8	939.5	41.0	57.7	384.9	542.2
24	**39G4**	524.8	729.72	1.84	2082.0	22.8	76.7	475.6	1596.4
	Total	4621.7			10053.1			4095.5	5841.3
22-24	**Total**	7836.9			13348.4			4819.5	7497.0
21-24	**Total**	12226.4			20901.3			9798.1	8683.1

Table 5 Estimated numbers (millions) of herring RV "Solea" September/October 2001

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	**41G1**	182.33	3.85								186.18
21	**41G2**	74.74	4.64	0.76							80.14
21	**42G1**	301.76	3.77	0.51	0.51						306.55
21	**42G2**	123.96	5.99	0.42							130.37
21	**43G1**	327.86	23.13	10.40							361.39
21	**44G0**	276.71	1.35								278.06
21	**44G1**	3634.90	1.04								3635.94
	Total	4922.26	43.77	12.09	0.51						4978.63
22	**37G0**	113.59	29.03	1.26		0.84	0.84				145.56
22	**37G1**	212.72	38.58	19.38	6.32	6.44	3.21	4.28			290.93
22	**38G0**	96.51	8.15	1.45	0.44	0.25	0.25				107.05
22	**38G1**	156.99	2.52	0.08		0.06	0.06				159.71
22	**39F9**	3.95									3.95
22	**39G0**	0.00									0.00
22	**39G1**	3.78									3.78
22	**40F9**	0.99									0.99
22	**40G0**	0.81									0.81
22	**41G0**	10.97	0.18	0.03	0.01						11.19
	Total	600.31	78.46	22.20	6.77	7.59	4.36	4.28			723.97
24	**37G2**	143.31	1.84	0.99	0.15	0.20	0.03				146.52
24	**38G2**	315.49	153.10	158.08	84.96	33.17	8.09	4.94	0.21		758.04
24	**38G3**	191.83	154.80	219.90	236.28	93.88	35.13	29.06	3.45		964.33
24	**38G4**	155.31	279.07	327.98	168.03	64.39	14.14	6.61	0.46		1015.99
24	**39G2**	27.41	72.58	114.43	94.14	28.68	7.94	4.66	0.29		350.13
24	**39G3**	83.63	86.39	104.21	71.83	26.28	7.86	4.17	0.57		384.94
24	**39G4**	85.80	153.44	138.56	61.81	27.05	7.20	1.73			475.59
	Total	1002.78	901.22	1064.15	717.20	273.65	80.39	51.17	4.98		4095.54
22-24	**Total**	1603.09	979.68	1086.35	723.97	281.24	84.75	55.45	4.98		4819.51
21-24	**Total**	6525.35	1023.45	1098.44	724.48	281.24	84.75	55.45	4.98		9798.14

Table 6 Herring mean weight (g) per age group RV "Solea" September/October 2001

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	**41G1**	16.3	41.8								16.9
21	**41G2**	21.4	42.2	55.9							23.0
21	**42G1**	16.3	39.3	51.0	74.0						16.7
21	**42G2**	19.3	40.7	49.1							20.4
21	**43G1**	16.7	44.2	55.1							19.5
21	**44G0**	10.9	41.4								11.1
21	**44G1**	12.6	23.0								12.6
	Total	13.4	42.3	54.8	74.0						13.8
22	**37G0**	11.3	41.9	46.4		39.9	39.9				18.1
22	**37G1**	10.5	43.2	58.4	59.5	73.5	67.8	83.5			22.2
22	**38G0**	11.3	42.6	55.5	60.5	45.6	46.8				14.7
22	**38G1**	10.4	39.4	49.1		39.9	39.9				10.9
22	**39F9**	10.5									10.5
22	**39G0**	0.0									0.0
22	**39G1**	12.6									12.6
22	**40F9**	9.5									9.5
22	**40G0**	9.5									9.5
22	**41G0**	12.7	40.1	49.6	54.5						13.3
	Total	10.8	42.5	57.5	59.6	68.6	60.8	83.5			17.5
24	**37G2**	8.8	41.1	42.6	34.2	39.7	37.3				9.5
24	**38G2**	9.4	43.5	58.5	83.1	78.3	128.4	122.4	136.5		39.9
24	**38G3**	9.3	42.9	62.4	98.3	113.8	147.9	158.9	180.0		68.9
24	**38G4**	12.2	42.3	57.0	78.4	72.3	88.8	110.2	188.2		51.5
24	**39G2**	12.4	45.3	63.3	94.2	92.1	127.3	116.2	136.5		68.5
24	**39G3**	13.4	42.1	59.3	86.9	88.9	121.6	132.0	173.6		54.9
24	**39G4**	14.3	41.7	55.2	73.4	63.0	87.3	114.2			47.0
	Total	10.6	42.7	59.0	88.0	90.0	125.5	141.5	175.7		53.2

Table 7 Herring Total biomass (t) per age group RV "Solea" September/October 2001

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	**41G1**	2971.98	160.93								3132.91
21	**41G2**	1599.44	195.81	42.48							1837.73
21	**42G1**	4918.69	148.16	26.01	37.74						5130.60
21	**42G2**	2392.43	243.79	20.62							2656.84
21	**43G1**	5475.26	1022.35	573.04							7070.65
21	**44G0**	3016.14	55.89								3072.03
21	**44G1**	45799.74	23.92								45823.66
	Total	66173.67	1850.85	662.16	37.74						68724.42
22	**37G0**	1283.57	1216.36	58.46		33.52	33.52				2625.42
22	**37G1**	2233.56	1666.66	1131.79	376.04	473.34	217.64	357.38			6456.41
22	**38G0**	1090.56	347.19	80.48	26.62	11.40	11.70				1567.95
22	**38G1**	1632.70	99.29	3.93		2.39	2.39				1740.70
22	**39F9**	41.48									41.48
22	**39G0**	0.00									0.00
22	**39G1**	47.63									47.63
22	**40F9**	9.41									9.41
22	**40G0**	7.70									7.70
22	**41G0**	139.32	7.22	1.49	0.55						148.57
	Total	6485.91	3336.71	1276.15	403.21	520.65	265.25	357.38			12645.25
24	**37G2**	1261.13	75.62	42.17	5.13	7.94	1.12				1393.12
24	**38G2**	2965.61	6659.85	9247.68	7060.18	2597.21	1038.76	604.66	28.67		30202.60
24	**38G3**	1784.02	6640.92	13721.76	23226.32	10683.54	5195.73	4617.63	621.00		66490.93
24	**38G4**	1894.78	11804.66	18694.86	13173.55	4655.40	1255.63	728.42	86.57		52293.88
24	**39G2**	339.88	3287.87	7243.42	8867.99	2641.43	1010.76	541.49	39.59		23972.43
24	**39G3**	1120.64	3637.02	6179.65	6242.03	2336.29	955.78	550.44	98.95		21120.80
24	**39G4**	1226.94	6398.45	7648.51	4536.85	1704.15	628.56	197.57			22341.03
	Total	10593.00	38504.40	62778.06	63112.05	24625.96	10086.33	7240.21	874.77		217814.8
22-24	**Total**	17078.91	41841.11	64054.21	63515.26	25146.61	10351.58	7597.59	874.77		230460.0
21-24	**Total**	83252.58	43691.95	64716.36	63553.00	25146.61	10351.58	7597.59	874.77		299184.4

Table 8 Estimated numbers (millions) of sprat RV "Solea" September/October 2001

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	**41G1**	0.42	36.90	3.32	0.90	0.28					41.82
21	**41G2**	1.73	4.54	0.56	0.14	0.10					7.07
21	**42G1**	0.00	50.72	7.75	1.14	0.45					60.06
21	**42G2**	1.01	23.46	0.80							25.27
21	**43G1**		1.25	0.85							2.10
21	**44G0**	3.11	766.16	27.16							796.43
21	**44G1**	2.26	240.74	10.39							253.39
	Total	8.53	1123.77	50.83	2.18	0.83					1186.14
22	**37G0**	313.05	6.34	1.92	1.35	0.19	0.29	0.10			323.24
22	**37G1**	161.23	32.20	55.76	43.40	20.16	7.56	3.46			323.77
22	**38G0**	136.48	13.70	11.41	7.95	2.84	1.18	0.44			174.00
22	**38G1**	43.08	2.45	0.80	0.35	0.08	0.03	0.02			46.81
22	**39F9**	465.83									465.83
22	**39G0**	2.97	1.12								4.09
22	**39G1**	28.91									28.91
22	**40F9**	150.45									150.45
22	**40G0**	125.19									125.19
22	**41G0**	10.49	2.30	0.36	0.21	0.03					13.39
	Total	1437.68	58.11	70.25	53.26	23.30	9.06	4.02			1655.68
24	**37G2**	63.22	1.81	0.21	0.19	0.16	0.02	0.02			65.63
24	**38G2**	289.47	15.49	54.54	44.03	26.49	7.00	3.72	0.54		441.28
24	**38G3**	821.92	123.32	352.88	254.37	135.01	34.50	18.42	2.46		1742.88
24	**38G4**	794.79	82.93	244.11	175.64	100.75	20.82	14.58			1433.62
24	**39G2**	0.69	2.26	6.63	5.21	3.48	0.70	0.33			19.30
24	**39G3**	12.28	67.39	211.07	147.25	74.75	19.16	9.37	0.96		542.23
24	**39G4**	826.81	142.47	301.18	200.68	95.89	16.52	12.86			1596.41
	Total	2809.18	435.67	1170.62	827.37	436.53	98.72	59.30	3.96		5841.35
22-24	**Total**	4246.86	493.78	1240.87	880.63	459.83	107.78	63.32	3.96		7497.03
21-24	**Total**	4255.39	1617.55	1291.70	882.81	460.66	107.78	63.32	3.96		8683.17

Table 9 Sprat mean weight (g) per age group RV "Solea" September/October 2001

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	**41G1**	7.4	14.3	17.4	20.7	27.0					14.7
21	**41G2**	1.8	15.5	19.6	20.4	24.4					12.7
21	**42G1**	0.0	16.2	19.2	20.1	19.2					16.7
21	**42G2**	3.1	14.8	15.5							14.4
21	**43G1**		17.6	21.4							19.1
21	**44G0**	8.2	14.2	13.4							14.1
21	**44G1**	8.2	14.0	13.3							13.9
	Total	6.3	14.3	14.8	20.4	22.5					14.3
22	**37G0**	5.2	14.3	22.8	23.0	22.9	22.6	23.8			5.6
22	**37G1**	5.4	18.3	22.2	23.1	26.2	24.7	26.6			13.9
22	**38G0**	3.9	17.0	21.5	22.5	25.6	23.9	25.0			7.5
22	**38G1**	6.0	15.8	17.4	21.7	23.9	23.6	24.6			6.8
22	**39F9**	1.7									1.7
22	**39G0**	12.6	12.6								12.6
22	**39G1**	3.8									3.8
22	**40F9**	2.9									2.9
22	**40G0**	2.7									2.7
22	**41G0**	4.3	15.1	18.6	20.3	20.5					6.8
	Total	3.5	17.2	22.0	23.0	26.1	24.5	26.3			5.9
24	**37G2**	4.7	8.0	16.3	17.4	18.9	20.1	20.1			4.9
24	**38G2**	4.8	15.1	17.4	17.8	18.2	19.0	18.9	22.0		9.2
24	**38G3**	4.7	15.2	17.0	17.4	17.4	18.6	17.4	22.0		11.2
24	**38G4**	5.1	15.2	16.9	17.0	17.5	18.2	17.6			10.3
24	**39G2**	10.8	14.9	17.5	16.8	16.7	18.3	18.2			16.7
24	**39G3**	5.4	15.5	16.8	17.1	17.3	18.2	17.3	22.0		16.6
24	**39G4**	4.8	14.8	16.1	16.1	16.5	17.6	16.3			10.2
	Total	4.9	15.1	16.7	17.0	17.3	18.3	17.3	22.0		11.0

Table 10 Sprat Total biomass (t) per age group RV "Solea" September/October 2001

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	**41G1**	3.11	527.67	57.77	18.63	7.56					614.74
21	**41G2**	3.11	70.37	10.98	2.86	2.44					89.76
21	**42G1**	0.00	821.66	148.80	22.91	8.64					1002.02
21	**42G2**	3.13	347.21	12.40							362.74
21	**43G1**		22.00	18.19							40.19
21	**44G0**	25.50	10879.47	363.94							11268.92
21	**44G1**	18.53	3370.36	138.19							3527.08
	Total	53.39	16038.74	750.27	44.40	18.64					16905.44
22	**37G0**	1627.86	90.66	43.78	31.05	4.35	6.55	2.38			1810.14
22	**37G1**	870.64	589.26	1237.87	1002.54	528.19	186.73	92.04			4500.40
22	**38G0**	532.27	232.90	245.32	178.88	72.70	28.20	11.00			1305.00
22	**38G1**	258.48	38.71	13.92	7.60	1.91	0.71	0.49			318.31
22	**39F9**	791.91									791.91
22	**39G0**	37.42	14.11								51.53
22	**39G1**	109.86									109.86
22	**40F9**	436.31									436.31
22	**40G0**	338.01									338.01
22	**41G0**	45.11	34.73	6.70	4.26	0.62					91.05
	Total	5047.87	1000.37	1547.58	1224.32	607.77	222.20	105.91			9752.53
24	**37G2**	297.13	14.48	3.42	3.31	3.02	0.40	0.40			322.17
24	**38G2**	1389.46	233.90	949.00	783.73	482.12	133.00	70.31	11.88		4053.39
24	**38G3**	3863.02	1874.46	5998.96	4426.04	2349.17	641.70	320.51	54.12		19527.99
24	**38G4**	4053.43	1260.54	4125.46	2985.88	1763.13	378.92	256.61			14823.96
24	**39G2**	7.45	33.67	116.03	87.53	58.12	12.81	6.01			321.61
24	**39G3**	66.31	1044.55	3545.98	2517.98	1293.18	348.71	162.10	21.12		8999.92
24	**39G4**	3968.69	2108.56	4849.00	3230.95	1582.19	290.75	209.62			16239.75
	Total	13645.50	6570.15	19587.84	14035.41	7530.92	1806.30	1025.55	87.12		64288.78
22-24	**Total**	18693.37	7570.53	21135.42	15259.73	8138.69	2028.50	1131.46	87.12		74041.31
21-24	**Total**	18746.75	23609.27	21885.68	15304.13	8157.33	2028.50	1131.46	87.12		90946.75

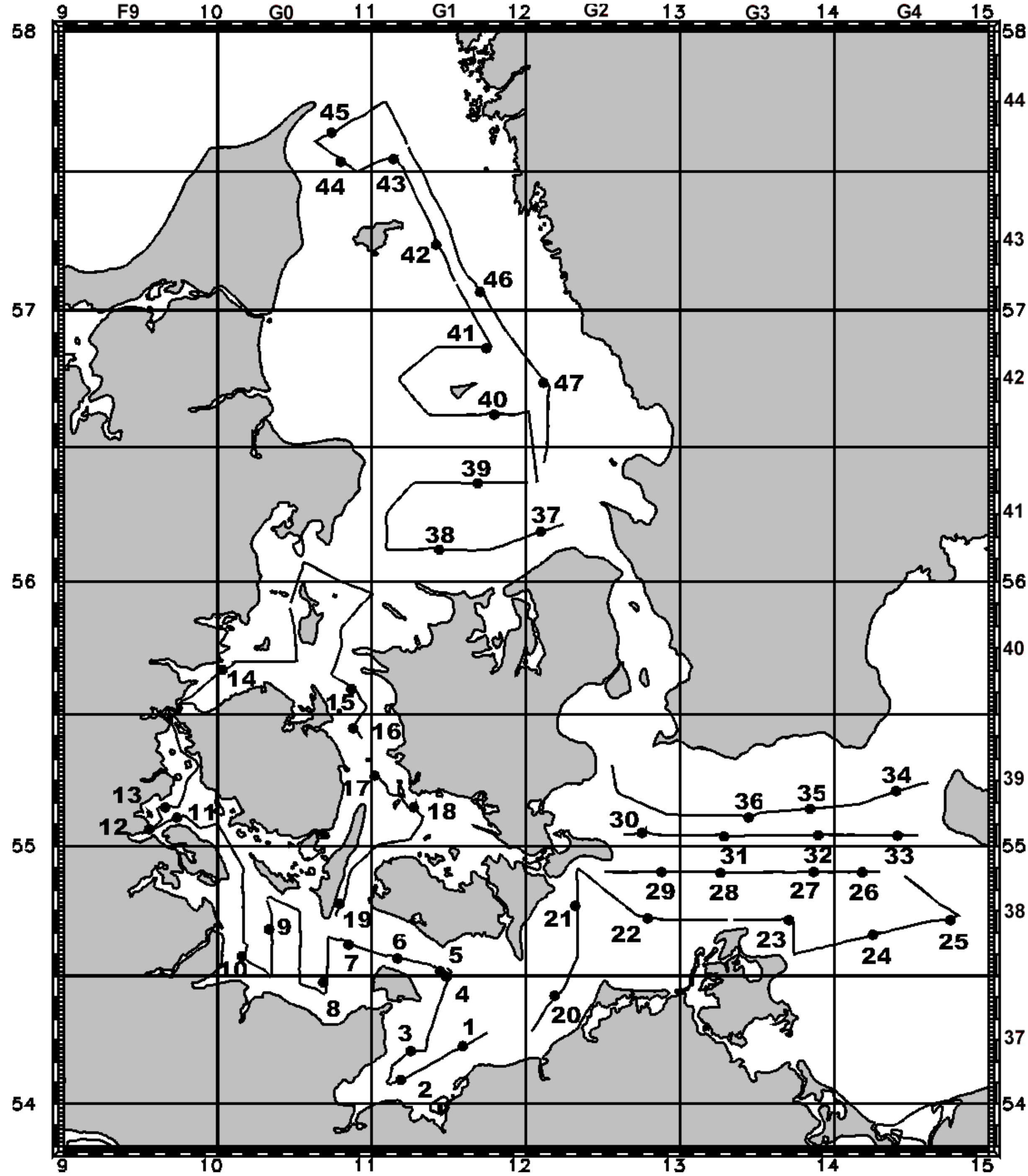

Figure III.1 Cruise track and trawl positions for RV „SOLEA“ in September/October 2001.

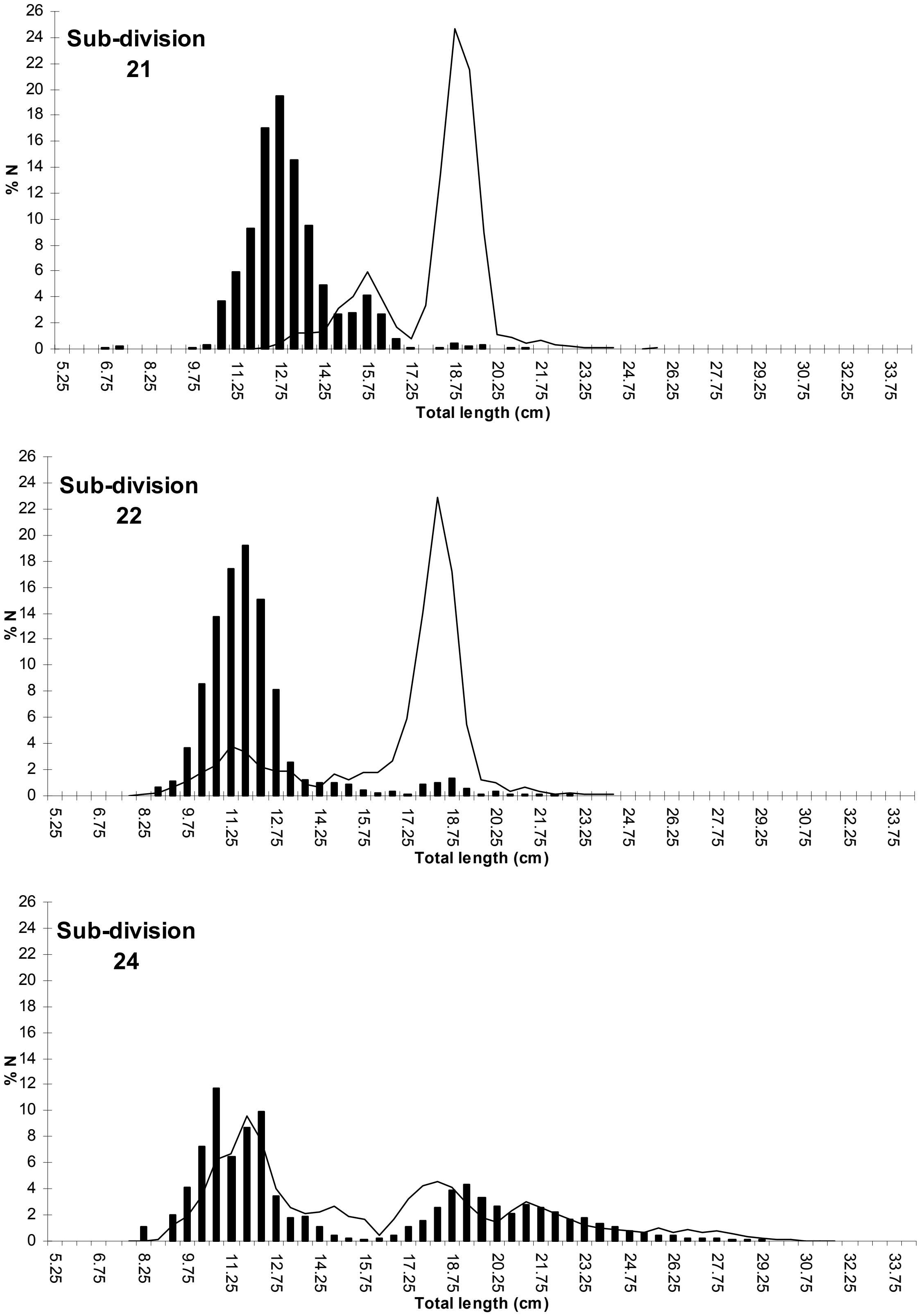

Figure III.2. Length distribution of herring in Sub-divisions 21, 22 and 24 in 2000 (=line) and in 2001 (=bar).

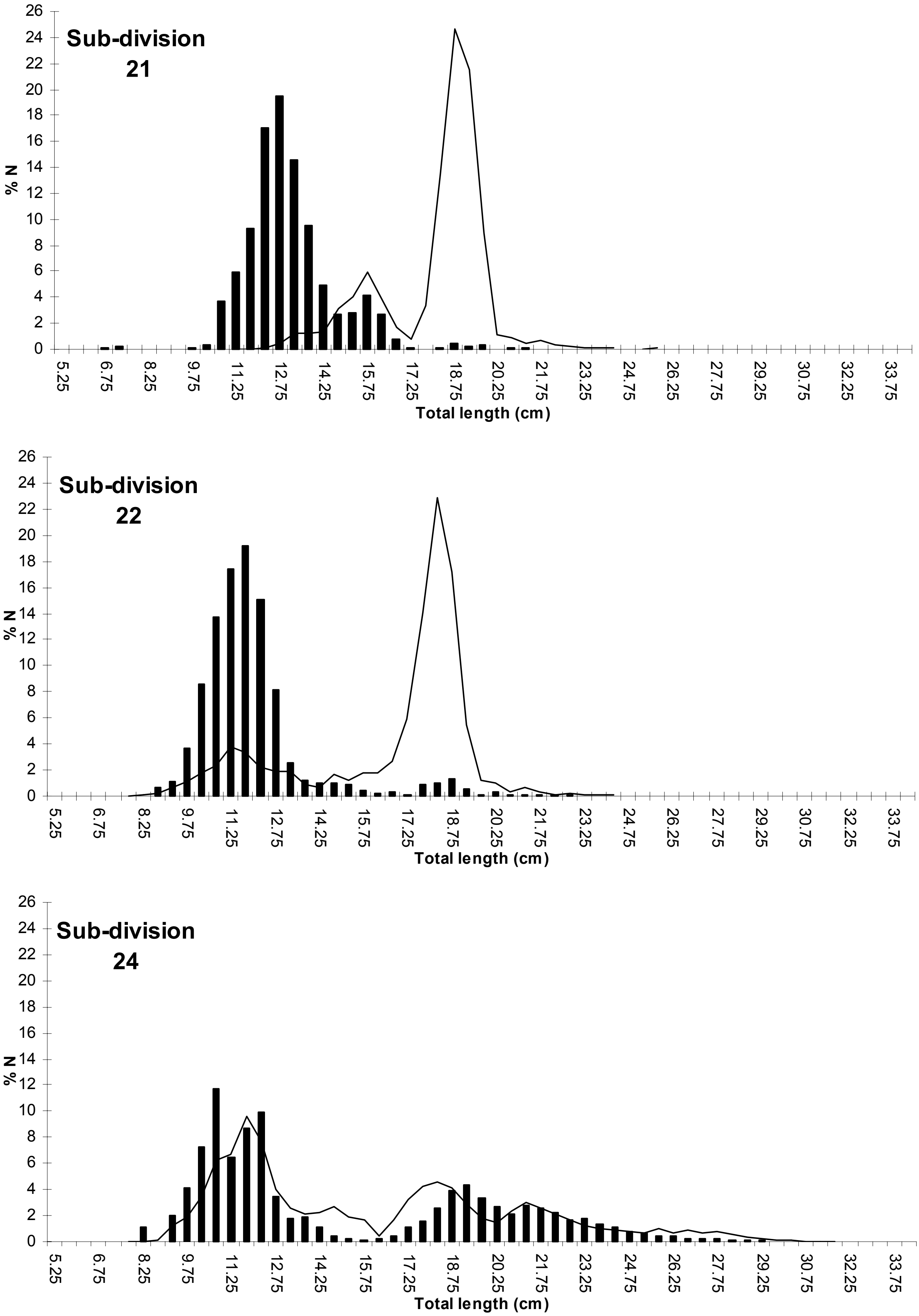

Figure III.3 Length distribution of sprat in Sub-divisions 21, 22 and 24 in 2000 (=line) and in 2001 (=bar).

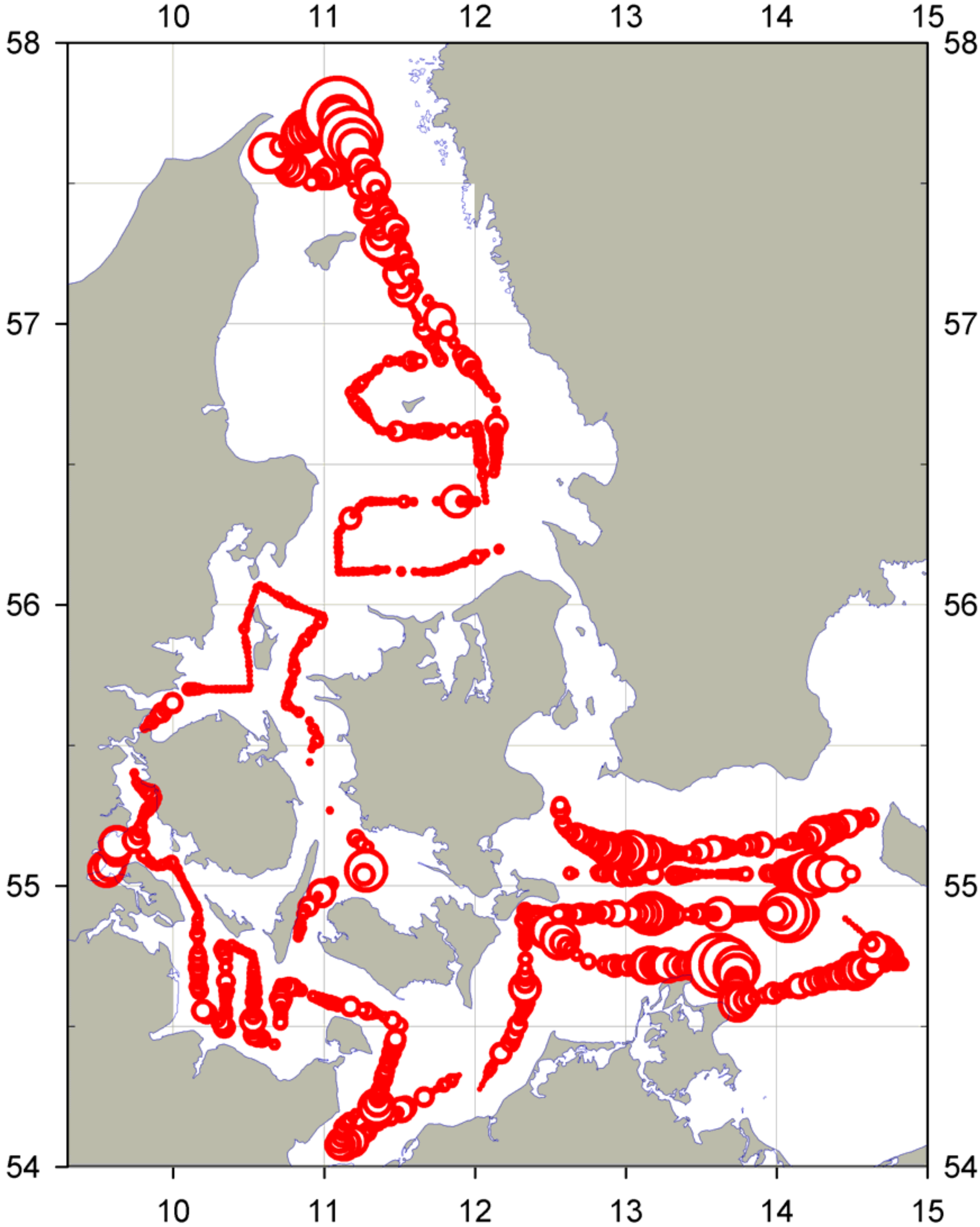

Figure III.4 Distribution of NASCs for RV "SOLEA" in September/October 2001.

APPENDIX IV

MANUAL FOR HERRING ACOUSTIC SURVEYS IN ICES DIVISIONS III, IV AND VIa

Version 3

December 2001

1 Transducer and calibration

The standard frequency used for the survey is 38 kHz. In order of preference, it is advisable to mount the transducer in a dropped keel, a towed body or on the hull of the vessel. Steps should be taken to ensure that the flight of the towed body is stable and level, this should ideally be achieved with the aid of a motion sensor.

Calibration of the transducer should be conducted at least once during the survey. Calibration procedures are described in the Simrad EK500 manual and Foote *et al.* (1987). Ideally, the procedure as described in the Simrad manual should be followed with certain exceptions (see below). Minimum target range for the calibration of a split beam 38 kHz echosounder is 10 metres, although greater distances are recommended (about 20 m), particularly with hull mounted transducers, where centering of the target below the transducer is facilitated if the target is suspended at a greater depth. An average integrated value for the sphere, taken when it is centrally located, should be taken as the measured s_A. The calculations should be then performed a number of times (two or three) in an iterative procedure such that the values of measured NASC and theoretical NASC should converge, as described in the Simrad manual. A choice is then made as to whether the S_v Transducer gain should be changed, rendering absolute **NASC's**, or alternatively, the S_v Transducer gain can be unaltered and a correction factor applied to the **NASC's**. Only one strategy should be applied during a cruise, such that for example, the latter option is to be employed when calibration is only possible after the cruise has started. If possible, the transducer should be calibrated both at the beginning and the end of the survey; with a mean correction factor applied to the data. If a new calibration differs by more than 0.4 dB, the system should be thoroughly inspected.

There are a number of parameters which require knowledge of the speed of sound in water. It is therefore recommended that appropriate apparatus be used to determine the temperature and salinity of the water so that sound speed can be calculated (see MacLennan & Simmonds 1992 for equations) and entered into the EK500.

It is evident that all versions of the EK500 up to and including version 5.* do not take account of the receiver delay in the calculation of target range (see Fernandes & Simmonds 1996). This is particularly important when calibrating at short range (10 m) as it can lead to a systematic underestimate of biomass of 3%. The correct range to the target should therefore be applied in calibration (see below). The equivalent two way beam angle (ψ) should also be corrected for sound speed according to Bodholt (1999).

A number of calibration parameters and results should be included as a minimum in the survey report. These are tabulated in Table 1. Some of these parameters are not included in the Simrad operator manual and are defined as follows.

Table 1. Calibration report sheet

Calibration report	
Frequency (kHz)	
Transducer serial no.	
Vessel	
Date	
Place	
Latitude	
Longitude	
Bottom depth (m)	
Temperature (°C)	
Salinity (ppt)	
Speed of sound (m.s-1)	
TS of sphere (dB)	
Pulse duration (s)	
Equivalent 2-way beam angle (dB)	
Receiver delay (s)	
Default S_v transducer gain	

Iteration no.	1	2	3
Time			
Range to half peak amplitude (m)			
Range to sphere (m)			
Theoretical NASC (m2.nmile-2)			
Measured NASC (m2.nmile-2)			

Calibated S_v transducer gain			
DeltaG = New gain - Old gain			
Correction factor for pre-calibration NASC's on EK			
Correction factor for pre-calibration S_v's			

Default TS transducer gain			
Iteration no.	1	2	3
Time			
Measured TS			
Calibrated TS gain			

Receiver delay = $\mathbf{t_{del}}$ This is very specific to the echosounder bandwidth (due to the band pass filters), to the transducer bandwidth, and to a lesser extent to the standard target and the pulse duration which may affect the peak value. Target, bandwidth and pulse duration specific values for the Simrad EK400 are given in Foote *et al.* (1987, their Table 1). Values for the EK500 are not available, but Simrad recommend using

3 sample distances (10 cm) in wide bandwidth (3 kHz). This equates to a value of $\mathbf{t_{del}}$ of 0.00039 s at 38 kHz.

Range to half peak amplitude = $\mathbf{r_m}$ This is the measured range between the start of the transmit pulse and the point on the leading edge of the echo at which the amplitude has risen to half the peak value (m). This is usually determined from experience with the readings from an oscilloscope display. For example, for a 38.1 mm tungsten carbide standard target insonified at 38 kHz at a colour threshold setting of -70 dB (S_v colour min.), it is measured as from the top of the transmit pulse to the leading edge of the pink colour on the target sphere echo.

Range to sphere = $\mathbf{r_{sph}}$ may then be calculated from:

$$\mathbf{r_{sph} = r_m - ((c \times t_{del})/2)}$$

Correction factor for pre-calibration NASC's on EK500 = K = 1/(10^(DeltaG/5))

Where:

DeltaG = Calibrated S_v Transducer Gain – Default S_v Transducer gain

Correction factor for pre-calibration S_v's on EK = $10(\log_{10}(s_A$ correction factor))

2 Instrument settings during the survey (for the Simrad EK500)

For most settings the default values from the manufacturer may be used, or alternatively the operator can choose his own settings depending on the circumstances. It is recommended that each year the same settings be used for the printer in order to facilitate comparison of echograms.

There are a number of settings that are set during calibration that have a direct influence on the fundamental operation for echo-integration and target strength measurement and therefore affect logged data. Once set according to the particular transducer, these should **NOT** be changed during the survey. These important settings are listed in Table 2.

The minimum detection level on the bottom detection menu depends on the water depth and bottom type. At depths less than 100 m and hard bottoms, the threshold level may be set at –30 dB: this will enable the instrument to detect dense schools close to the bottom. At depths greater than 100 m or soft bottoms, the threshold has to be lowered (-60 dB), otherwise the upper layer of the bottom will be counted as fish as well.

In the operation menu it is recommended to use as short a regular ping interval as possible. It is not advisable to use a ping rate of 0.0 seconds (variable interval according to depth) as this brings about irregular sample (ping) numbers per equivalent distance sampling unit which may bias the analysis.

A bottom margin of the order of 0.5 m is recommended for the layer menus. In shallow areas (<100 m) this can be somewhat reduced.

The S_v minimum for echo integration and presentation of the echogram should be set at –70 dB. Increasing the S_v minimum will reduce the integration values if the herring occur in scattering layers or in loose aggregations. This setting is less important when the data is collected by a post processing package such as Simrad's BI500 or Sonardata's echoview software as the threshold can be determined in post processing.

Table 3 lists those settings which are important for target strength measurements. It should be noted however, that the transducer depth setting may affect the calibration if the range to target is read form the echo sounder.

3 Survey design

Transects are spaced at a maximum distance of 15 nautical miles. Two aspects should be considered in choosing the direction of the transects. Transects should preferably run perpendicular to the greatest gradients in fish density, which are often related to gradients in bottom topography and hydrography. This means that transects will normally run perpendicular to the coast. The second aspect considers the direction in which the fish are migrating. If there is evidence of rapid displacement of the fish throughout the area, it is advisable to run the transects parallel to the direction of the migration. This survey design will minimise the bias caused by migration. A detailed simulation study of the effects of motion on the survey design of North Sea herring is available in Rivoirard *et al*. (2000).

Ship's speed during the survey is typically 10-12 knots. At higher speeds, problems are encountered with engine noise or propellor cavitation. These problems, however, depend on the vessel. In rough weather, the ship's speed may be reduced in order to avoid problems with air bubbles under the ship, although this problem is alleviated by the use of a dropped keel.

If species identification depends on recognition of schools on the echogram (see section 4.3), the survey will have to be interrupted during periods in the 24 hour cycle when the schools disperse. This occurs during the hours of darkness, depending on the area. When schools disperse during darkness, some of the herring may rise to the surface and get above the transducer. During this time (23:00 – 03:00 around Shetland / Orkney for example) it is advisable to cease surveying. It is recommended – if time permits during the survey – to study the diurnal behaviour of fish schools, in order to determine at what time during the 24hr period the fish may not be available to the echosounder.

Table 2 Important calibration and survey settings, which should not be changed during the survey. Those marked * indicate settings that are specific to the transducer / transceiver.

/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/BANDWIDTH
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/PULSE LENGTH
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/MAX. POWER*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/2-WAY BEAM ANGLE*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/SV TRANSD. GAIN*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/TS TRANSD. GAIN*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/ABSORPTION COEF.*
/OPERATION MENU/TRANSMIT POWER
/BOTTOM DETECTION MENU/BOTTOM DETECTION-1 MENU/MINIMUM DEPTH
/BOTTOM DETECTION MENU/BOTTOM DETECTION-1 MENU/MAXIMUM DEPTH
/BOTTOM DETECTION MENU/BOTTOM DETECTION-1 MENU/MINIMUM LEVEL
/SOUND-VELOCITY MENU/PROFILE TYPE
/SOUND-VELOCITY MENU/VELOCITY MIN
/SOUND-VELOCITY MENU/ VELOCITY MAX

Table 3 Settings affecting tracking or locating objects within the beam. Those marked * indicate settings that are specific to the transducer / transceiver.

/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/TRANSDUCER DEPTH
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/ANGLE SENS.ALONG*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/ANGLE SENS.ATHW.*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/ALONGSHIP OFFSET*
/TRANSCEIVER MENU/TRANSCEIVER-1 MENU/ATHW.SHIP OFFSET*
/TS DETECTION MENU/TS DETECTION-1 MENU/MIN. VALUE
/TS DETECTION MENU/TS DETECTION-1 MENU/MIN. ECHO LENGTH
/TS DETECTION MENU/TS DETECTION-1 MENU/MAX. ECHO LENGTH
/TS DETECTION MENU/TS DETECTION-1 MENU/MAX. GAIN COMP.
/TS DETECTION MENU/TS DETECTION-1 MENU/MAX. PHASE DEV.
/MOTION SENSOR MENU/HEAVE
/MOTION SENSOR MENU/ROLL
/MOTION SENSOR MENU/PITCH
/MOTION SENSOR MENU/TD-1 ATH. OFFSET
/MOTION SENSOR MENU/TD-1 ALO. OFFSET
/MOTION SENSOR MENU/TD-2 ATH. OFFSET
/MOTION SENSOR MENU/TD-2 ALO. OFFSET
/MOTION SENSOR MENU/TD-3 ATH. OFFSET
/MOTION SENSOR MENU/TD-3 ALO. OFFSET

4 Species allocation of acoustic records

Different methods of species allocation are being used in the various areas. The method used depends largely upon the schooling behaviour of the herring and sprat, and the mixing with other species. In the North Sea and Division VIa the species allocation is based mainly on the identification of individual schools on the echogram. In the Skagerrak-Kattegat and Baltic the identification is based on composition of trawl catches. Both methods are described in more detail below.

Only persons who are familiar with the area and the way fish aggregations of different species occur in the area should scrutinise the echo records. The way species aggregate either in schools or in layers, mixed or not mixed with other species is very different per (sub) area. Allocation of **NASC's** to species always needs support of trawl-information. However, one has to be aware that the catch composition is influenced by the fish behaviour in response to the net. It is therefore necessary to judge whether the catch-composition is a reflection of the real species composition and whether the allocated percentage of sprat/herring needs correction.

It is obvious that during the scrutinising process subjective decisions have to be made. However, joint sessions of scientists from participating countries who scrutinised each others data has shown that the deviation between the estimated quantities of herring are within the range of 10%, provided that trawl information of the recordings is available (Reid *et al.* 1998).

4.1 Using the EK500 printer output and/or post processing systems

Scrutiny of the echo recordings may be done by measuring the increment of the integrator line on the printed paper output of the echogram. This is a simple and efficient way of scrutinising if one deals with single species schools and if there are no problems with bottom integration. Post processing systems may then be used as backup. More generally, computer based post-processing systems such as the Simrad BI500 or Sonardata Echoview systems are currently being used for scrutinising. The printer output is mostly used as a visual backup.

It is recommended that one depth-range is used for the whole area in the printer output and on post-processing systems. This will ensure that similar echo traces from all parts of the survey area will have the same appearance and hence are visually more comparable.

4.2 Allocation to classified schools

In the western and northern part of the area covered by the survey, most of the herring occur in well-defined schools, often of a characteristic shape as pillar-shaped large dense schools or as layers of very small and dense school at the surface. In the northern and central part, schools of Norway pout and herring are difficult to distinguish from each other. In low density area's of the western area mixed layers and aggregation of small schools consisting of gadoids and herring may occur.

Sprat marks in the North Sea and VIa appear mostly as quite large, typical, pillar-shaped marks, usually slightly more diffuse than herring and usually in shallow water.

4.3 Use of trawl Information

The allocation of echo-traces to species is governed by the results of trawl hauls. In many cases these are considered together with observations from the netsonde and the echogram during the haul. In some cases it is not possible to assign schools (echo traces) to species directly e.g. where the haul contains a mixture of species and no clear differentiation can be made between the observed schools. In such situations the integral is assigned to a species mixture category according to the trawl results. This is defined as percentage by number or weight taking into account the correct conversion to scattering length (see section 6.2); post processing software is then used to apply weights and lengths. There are two main problems with using trawl data to define "acoustic" mixtures:

- Different species are known to have different catchabilities, so the exact proportions in the trawl are unlikely to be an exact sample of the true mixture. For instance herring are likely to be faster swimmers than Norway pout.

- Herring are often found in a mixture with "0" group pout, which are mostly lost through the meshes. This may also occur with other small gadoids. In this case the exact proportions are unavailable and the operator must make an informed guess.

4.4 Thresholding to filter out plankton

An advantage of using a post-processing system like the BI500 and EchoView, is the ability to change the threshold-value of the received echo's. By changing the threshold the non-target-species (plankton in particular) can be filtered out. The threshold used may differ, depending on a variety of conditions, including the water depth (more care should be taken at greater depth) and the particular size of fish. Examples of conditions where certain thresholds have been applied are described below; they should not be used without verification. At the beginning of the survey it is advisable to find the right thresholds by isolating schools and changing the threshold.

In stratified waters (mainly in the northern - and northeastern part of the survey area) there is often a layer of plankton in the upper 50 m. In this layer, very small, dense schools of herring may be found. Normally all the plankton is filtered out at –42 dB. The remaining **NASC's** may be assigned to herring if clear schools are still visible and, of course, trawl information indicates that herring are present. In the range of 30-60 m the same procedure may be used. Here **NASC's** are normally assigned to schools of fish after filtering out plankton by putting the threshold in the range of –48 to –51 dB. In the layer below 60 m a threshold of –54 to –60 dB may be applied. In the deeper parts of the area (>150m) a lower threshold than –60 dB may be applied. At these depths, often close to the bottom, herring schools are normally, larger and easier to recognise.

4.5 Use of other frequencies

The echosounder frequency routinely used in the North Sea echo survey is 38 kHz. However, data may be collected at 120 and 200 kHz. In some cases these can be used as an aid to identify marks to species. For instance, herring and mackerel may have different target strengths at different frequencies. Mackerel is believed to backscatter more strongly at 200 kHz than at 38 kHz, whilst for herring the reverse is the case. In the absence of good observations of such relationships, this approach should be used with caution.

4.6 Use of single target TS distribution data

The SIMRAD EK500 used with a split-beam transducer allows the collection of TS values for all single targets detected in the beam. A TS distribution can then be produced for each EDSU. In some situations there may be two species present in an area with substantially different TS values, and this could be used to determine the species allocation. Again, this data must be used with caution. There are doubts about the precision of the TS detection algorithm, particularly in older firmware releases. By definition, single targets are unlikely to be detected from fish in schools. As schools are often the main subject for herring acoustic surveys, such data may be unrepresentative. However, where the survey encounters diffuse mixtures, there may be value in such data.

4.7 Use of image analysis techniques

The Marine Laboratory Aberdeen has developed an image processing system for post processing of echograms. This can extract a range school descriptors; energetic, morphometric and positional, which can be used to define the characteristics of schools of a particular species. Such systems have also been developed elsewhere and one example is available with Sonardata's Echoview post processing software. In general such systems can differentiate most observed schools to species, however, these are usually the schools which an experienced survey operator can also discriminate by more traditional methods. These systems are likely to become more invaluable in the future when they can be combined with multi-frequency data.

4.8 Allocation to mixed layers or mixed schools

Sometimes herring occur mixed with other species in aggregations of smaller schools. In this case, species allocation is based on the composition of trawl catches.

In the southern North Sea, Skagerrak, Kattegat and the Baltic, herring and sprat may occur in mixed schools. Those schools are separated from other fish using the standard scrutinising procedures (see above) and the allocation of the proportion of herring (spring and/or autumn spawners) and sprat is done afterwards on the basis of catch composition. Trawl catches within each stratum (or statistical rectangle) are combined to give an average species, stock, age and length composition of the clupeid fraction of the catch.

5 Biological sampling

5.1 Trawling

Species allocation of the acoustic records is impossible if no trawl information is available. The general rule is to make as many trawl hauls as possible, especially if echo traces are visible on the echosounder after a blank period. If surface schools are known to occur in the area it is often advisable to take occasional surface trawls even in the absence of any significant marks.

The principal objective is to obtain a sample from the school or the layer that appears as an echo trace on the sounder. The trawling gear used is of no importance as long as it is suitable to catch a sample of the target-school or layer. Some dimensions of the trawls used by the participants are given in Table 4.

Table 4 Characteristics of trawl gear used in the North Sea herring survey. “Mesh sizes in all panels” are listed for panels from the mouth of the net to the cod end; the number of entries is not an indication of the number of panels as adjacent panels may have the same mesh size.* Cod end has an inner net with mesh size of 10 mm.

Country	Vessel	Power	Code	Name	Type	Panels	Headl	Groundr	Sweeps	Length	Circum	Mesh sizes in all panels						Codend	Height	Spread
		kW			B/P	2/4	m	m	m	m	m	mm	mm	mm	mm	mm	mm	**mm**	m	m
DEN	DAN2																	**16**		
GFR	WAH3	2900	GOV	GOV	B	2	36.0	52.8	110.0	51.7	76.0	200	160	120	80	50			4	23
GFR	WAH3	2900	PS205	PSN205	P	4	50.4	55.4	99.5	84.3	205.0	400	200	160	80	50		**10**	15	28
GFR	SOL	588	AAL	Aalhopser	B	2	31.0	29.7	63.5	57.5	119.0	160	120	80	40				6	19
GFR	SOL	588	PS388	Krake	P	4	42.0	42.0	63.5	59.8	142.4	400	200	80				**10**	10	21
NED	TRI2	2940		2000 M Pel. Trawl	P	4	64.0	72.0	100.0	140.0	400	800	400	200	120	80		**20**	16	45
NOR	GOS	1700	3532	Akratral	P	4	72.0	72.0	160.0	130.0	486.4	3200	1620	400	200	100	38	**10**	33	
NOR	**GOS**	**1700**		Firkløver	**B**		74.0	74.0	120.0	108.2	320.0	400	400	300	200	120	80	60/10*		
SCO	SCO2	3000	PT160	Pel. Sampl. Trawl	P	4	36.0	36.0	70.0	87.0	256.0	800	600	400	200	100	38	**20**	14	20

During trawling it is important to take note of the traces on the echosounder and the netsonde in order to judge if the target-school entered the net or if some other traces "spoil" the sample. It is recommended that notes be made on the appearance and behaviour of fish in the net during every haul. If a target is missed during a haul, the catch composition should not be used for species allocation.

Biological sampling procedure

The fish sample obtained from the trawl catch are to be divided into species by weight and by number. Length measurements are taken to the 0.5 cm below for and herring (and to the whole cm below for other species). For herring and sprat either representative or length stratified samples are taken for maturity, age (otolith extraction) and weight.

6 Data analysis

This section describes the calculation of numbers and biomass by species from the echo-integrator data and trawl data. Most of this section is taken from Simmonds *et al.* 1992.

The symbols used in this section are defined in the text but for completeness they have been collated and are given below:

F_i	estimated area density of species i
K	equipment physical calibration factor
$<\sigma_i>$	mean acoustic cross-section of species i
E_i	partitioned echo-integral for species i
E_m	echo-integral of a species mixture
c_i	echo-integrator conversion factor for species i
TS	target strength
TS_n	target strength of one fish
TS_w	target strength of unit weight of fish
a_i, b_i	constants in the target strength to fish length formula
a_n, b_n	constants in formula relating TS_n to fish length
a_w, b_w	constants in formula relating TS_w to fish length
a_f, b_f	constants in the fish weight-length formula
L	fish length
W	weight
L_j	fish length at midpoint of size class j
f_{ij}	relative length frequency for size class j of species i
w_i	proportion of species i in trawl catches
A_k	area of the elementary statistical sampling rectangle k
Q	total biomass
Q_i	total biomass for species i

The objective is to estimate the density of targets from the observed echo-integrals. This may be done using the following equation from Foote *et al.* (1987):

$$F_i = \left(\frac{K}{<\sigma_i>}\right)E_i \qquad \textbf{(1)}$$

The subscript i refers to one species or category or target. K is a calibration factor, $<\sigma_i>$ is the mean acoustic cross-section of species i, E_i is the mean echo-integral after partitioning and F_i is the estimated area density of species i. The quantity is the number or weight of species i, depending on whether σ_i is the mean cross-section per fish or unit weight. $c_i = (K/<\sigma_i>)$ is the integrator conversion factor, which may be different for each species. Furthermore, c_i depends upon the size-distribution of the insonified target, and if this differs over the whole surveyed area, the calculated conversion factors must take the regional variation into account.

K is determined from the physical calibration of the equipment, which is described in section 1 above. K does not depend upon the species or biological parameters. Several calibrations may be performed during a survey. The measured values of K or the settings of the EK500 may be different but they should be within 10% of one another. If two successive measurements are very different the cause should be investigated since the equipment may be malfunctioning. Otherwise, K should be taken as the average of two measurements before and after the relevant part of the survey.

Conversion factors for a single species

The mean cross-section $<\sigma_i>$ should be derived from a function which describes the length-dependence of the target-strength, normally expressed in the form:

$$TS = a_i + b_i Log_{10}(L) \qquad \textbf{(2)}$$

Where a_i and b_i are constants for the i'th species, which by agreement with the other participants in the survey are given in Table 5.

Table 5 The recommended target strength relationships for herring surveys in the North Sea and adjacent waters.

	Target Strength Equation Coefficients	
Species	$\mathbf{b_i}$	$\mathbf{a_i}$
Herring	20	-71.2
Sprat	20	-71.2
Gadoids	20	-67.5
Mackerel	20	-84.9
horse mackerel	20	-71.2

The equivalent formula for the cross-section is:

$$\sigma_i = 4\pi 10^{\left(\left(a_i + b_i Log(L)\right)/10\right)} \qquad \textbf{(3)}$$

The mean cross-section is calculated as the σ average over the size distribution of the insonified fish. Thus L_j is the mid-point of the j'th size class and f_{ij} is the corresponding frequency as deduced from the fishing samples by the method described earlier. The echo-integrator conversion factor is $c_i = K/<\sigma_i>$. The calculation may be repeated for any species with a target strength function.

$$< \sigma_i >= 4\pi \sum_j f_{ij} 10^{\left(\left(a_i + b_i Log(L_j)\right)/10\right)} \qquad \textbf{(4)}$$

Note that it is the cross-section that is averaged, not the target-strength. The arithmetic average of the target-strengths gives a geometric mean, which is incorrect. The term "mean target-strength" may be encountered in the literature, but this is normally the target-strength equivalent to $<\sigma_i>$, calculated as $10\log_{10}(<\sigma_i>/4\pi)$. Some authors refer to TS as 10 $\log(\sigma_{bs})$ the definition of σ is different from σ_{bs} and should not be confused.

Conversion factors for mixed species layers or categories

Sometimes several species are found in mixed concentrations such that the marks on the echogram due to each species cannot be distinguished. From inspection of the echogram, the echo-integrals can be partitioned to provide data for the mixture as one category, but not for the individual species. However, further partitioning to species level is possible by reference to the composition of the trawl catches (Nakken and Dommasnes, 1975).

Suppose E_m is the echo-integral of the mixture, and w_i is the proportion of the i'th species, calculated from fishing data. It is necessary to know the target-strength or the acoustic cross-section, which may be determined in the same manner as for single species above. The fish density contributed by each species is proportional to w_i. Thus the partitioned fish densities are:

$$F_i = \frac{w_i K}{(\sum_i w_i <\sigma_i>)} E_m \qquad \textbf{(5)}$$

The w_i may be expressed as the proportional number or weight of each species, according to the units used for $<\sigma_i>$ and c_i. Consistent units must be used throughout the analysis, but the principles are the same whether it is the number of individuals or the total weight that is to be estimated.

Using weight-length relationships

The abundance is expressed either as the total weight or the number of fish in the stock. When considering the structure of the stock, it is convenient to work with the numbers at each age. However, an assessment of the commercial fishing opportunities would normally be expressed as the weight of stock yield. Consistent units must be used throughout the analysis. Thus if the abundance is required as a weight while the target-strength function is given for individual fish, the latter must be converted to compatible units. This may be done by reference to the weight-length relationship for the species in question.

For a fish of length L, the weight W is variable but the mean relationship is given by an equation of the form:

$$W = a_f L^{b_f} \quad \textbf{(6)}$$

Where a_f and b_f are taken as constants for one species. However, a_f and b_f could be considered as variables varying differently with stock and time of year as well as species. Suppose the target-strength of one fish is given as:

$$TS_n = a_n + b_n \log_{10}(L) \quad \textbf{(7)}$$

The corresponding function TS_w, the target-strength of unit weight of fish has the same form with different constants:

$$TS_w = a_w + b_w \log_{10}(L) \quad \textbf{(8)}$$

The number of individuals in a unit weight of fish is (1/W), so the constant coefficients are related to the formulae:

$$b_w = b_n - 10b_f \quad \textbf{(9)}$$

$$a_w = a_n - 10\log_{10}(a_f) \quad \textbf{(10)}$$

Abundance estimation

So far the analysis has produced an estimate of the mean density of the insonified fish, for each part of the area surveyed, and for each species considered. The next step is to determine the total abundance in the surveyed area. The abundance is calculated independently for each species or category of target for which data have been obtained by partitioning the echo-integrals. The calculations are the same for each category:

$$Q_i = \sum_{k=1}^{n} A_k F_i \quad \textbf{(11)}$$

The total biomass for all species is:

$$Q = \sum_i Q_i \quad \textbf{(12)}$$

The F_i are the mean densities and A_k are the elements of the area that have been selected for spatial averaging. The may be calculated from the shape of an area or measured, depending upon the complexity of the area. The presence of land should be taken into account, possibly by measuring the proportions of land and sea.

7 Data exchange

Each individual country is responsible for working up its own survey data. However, the results need to be submitted to the chairman of the PGHS in a standard format for the coordinated survey results. In addition, the **NASC's** per sampling unit allocated to target species together with all trawl information should be entered in the international database for acoustic herring surveys in the North Sea (HERSUR-database).

Exchange of data for the combined survey result.

The standard spreadsheet template should be used to enter the results of the survey by ICES statistical rectangles on two data sheets: the cruise sheet by ICES statistical rectangle; and the proportions by age class sheet.

The cruise sheet consists of six columns of data with as many rows as there are statistical rectangles sampled in the survey. The six columns are: the central (decimalised) latitude of the ICES rectangle; central (decimalised) longitude of the ICES rectangle; the biological sub-area to which the ICES rectangle belongs; the ICES statistical rectangle code (calculated according to the first two columns); herring abundance in millions of fish; and the survey weight (in nautical miles of survey track per rectangle). Part of an example data sheet is given in Table 6.

The proportions data contains the proportion of North Sea autumn spawners and Baltic spring spawners broken down according to biological sub-areas (in rows) and age/maturity (in columns). These proportions can be submitted as actual proportions or as total abundances. It also contains the mean weights at age/maturity by biological sub-area for North Sea autumn spawners and Baltic spring spawners. **Ages of autumn spawning herring should be submitted as winter ring (where winter ring = age class – 1). Sprat and spring spawning herring ages are expressed as age class.** An example of this data sheet is given in Table 7.

Currently different maturity scales are in use. Table 8 provides the scales and their relationship.

A cruise report is produced following a standardised format. A description and an example of this format is given in the current report in Appendix IIA (all text, figures and tables with the exception of Figure IIA.5 and IIA.6 are required).

In order for the co-ordinator to prepare this report, the following data should be supplied by each participant:

- a chart giving the total number of herring per rectangle (excluding 0-ringers)
- a chart showing the stratification for age keys and mean weights per age
- for each stratum an age/length key and the mean weight by age. The age groups (in winter rings) to be used are:

1 immature (maturity stage 1 or 2), 1 mature (maturity stage 3+), 2 immature, 2 mature, 3 immature, 3 mature, 4, 5, 6, 7, 8, 9+ (ref. 1-8 scale in Table 8).

Data exchange for the international acoustic database (HERSUR)

All acoustic data from the national surveys is to be entered in the international database for acoustic surveys in the North Sea (HERSUR) together with the biological data from trawling.

Acoustic data, consisting of the s_A value per sampling unit allocated to species, together with additional information on time, position and instrumentation shall be exchanged according to the format described in the HERSUR Exchange Format Specification (to be submitted March 2000). This specification also described how trawl information is to be submitted.

Data exchange will be performed through the Internet (www.dfu.min.dk/hersur) through XLM files described in the HERSUR Exchange Format Specification. A users guide to the Internet site and upload procedure will be submitted in March 2000.

8 References

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Table 6 An example of the excel worksheet used to submit survey data by ICES statistical rectangle - the 'cruise sheet' with data from four ICES statistical rectangles.

1999 Cruise sheet on ICES stat square scale.
Ship name and country (in here): Scotia

Origin:	**00A0**
lat	**35.5**
long	**-50**

Latitude	Longitude	Sub-area	Stat Rect	Abundance (millions)	Survey weight (n.mi.)
59.75	2.5	**A**	**48F2**	15.00	40
59.75	3.5	**A**	**48F3**	9.35	45
59.25	2.5	**B**	**47F2**	2.65	27
59.25	3.5	**B**	**47F3**	12.33	60
			-71F0		
			-71F0		
			-71F0		
			-71F0		
			-71F0		
			-71F0		
			-71F0		
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			-71F0		
			-71F0		
			-71F0		
			-71F0		
			-71F0		

Table 7 An example of the excel worksheet used to submit survey data broken down by age/sub area - the 'proportions sheet'

	North Sea Autumn spawners.									Mean weights and lengths in over here >>>>>>				
		Abundance (Millions)......								Weights - column AC, lengths in column BC				
Sum	**Stratum**	**0**	**1i**	**1m**	**2i**	**2m**	**3i**	**3m**	**4**	**5**	**6**	**7**	**8**	**9+**
77.000	**A**	0.000	0.000	24.987	0.555	51.281	0.000	0.177	0.000	0.000	0.000	0.000	0.000	0.000
48.300	**B**	0.000	0.000	0.000	0.000	47.620	0.000	0.680	0.000	0.000	0.000	0.000	0.000	0.000
109.600	**C**	0.000	0.000	8.921	0.000	100.679	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
217.500	**D**	0.000	0.000	0.000	0.000	214.048	0.000	3.452	0.000	0.000	0.000	0.000	0.000	0.000
0.801	**E**	0.000	0.000	0.303	0.004	0.490	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000
494.200	**F**	0.000	0.000	191.716	4.260	298.224	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

North Sea Autumn spawners.... Mean weight (grams).....												
0	**1i**	**1m**	**2i**	**2m**	**3i**	**3m**	**4**	**5**	**6**	**7**	**8**	**9+**
0.000	6.375	6.375	27.750	35.826		70.429	120.667	181.000	0.000	0.000	0.000	0.000
0.000	6.375	6.375	27.750	35.826		70.429	120.667	181.000	0.000	0.000	0.000	0.000
0.000	6.375	6.375	27.750	35.826		70.429	120.667	181.000	0.000	0.000	0.000	0.000
0.000	6.375	6.375	27.750	35.826		70.429	120.667	181.000	0.000	0.000	0.000	0.000
0.000	6.375	6.375	27.750	35.826		70.429	120.667	181.000	0.000	0.000	0.000	0.000
0.000	6.375	6.375	27.750	35.826		70.429	120.667	181.000	0.000	0.000	0.000	0.000

North Sea Autumn spawners.... Mean length (cm).....												
0	**1i**	**1m**	**2i**	**2m**	**3i**	**3m**	**4**	**5**	**6**	**7**	**8**	**9+**

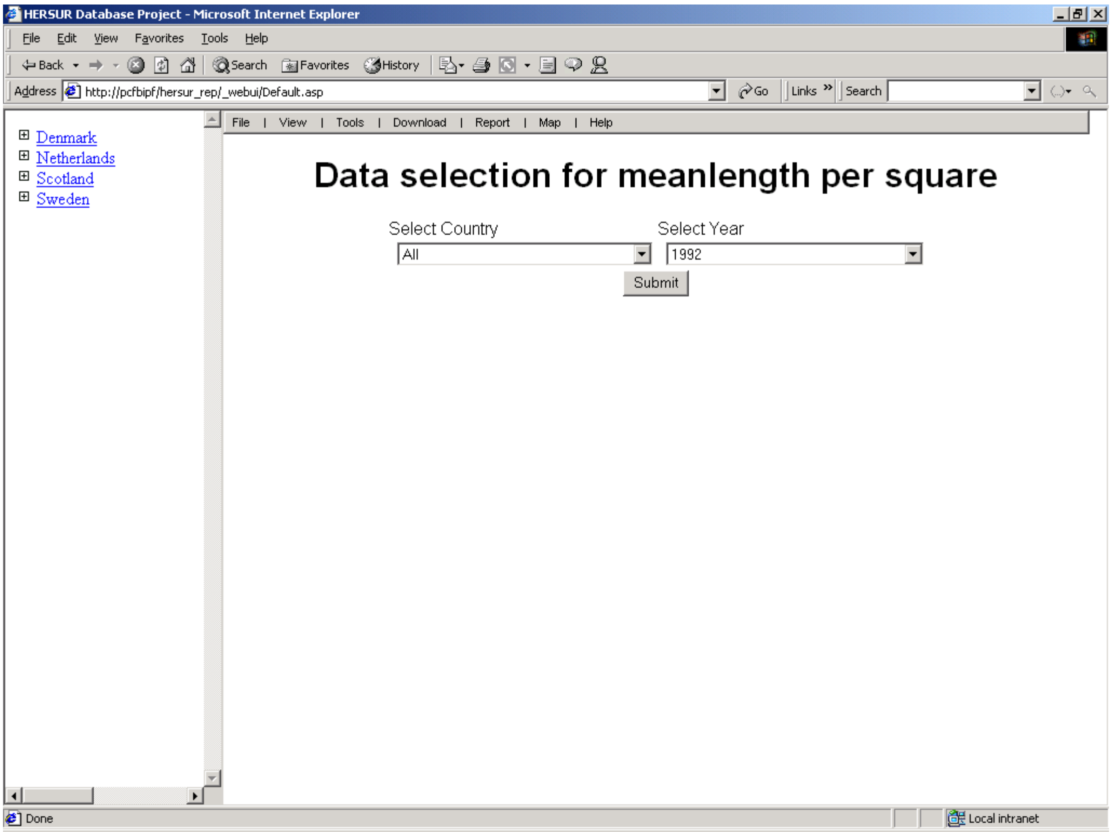
Table 8 Maturity scales currently used by the participants in ICES coordinated acoustic surveys in ICES divisions III, IV and Va.

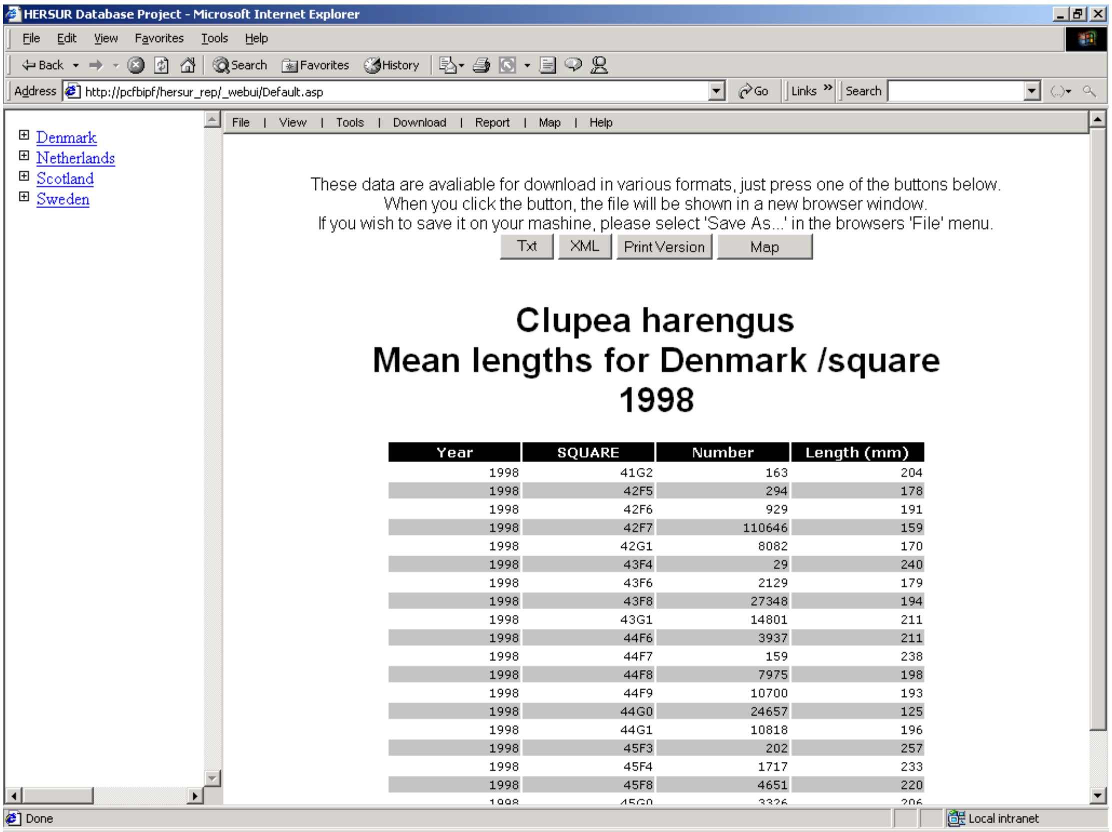
Reporting state	8 point scale (Scotland, Norway, Denmark)	5 point scale (HERSUR)	4 point scale Netherlands	4 point scale (Germany)
Immature	9. Virgin	1. Virgin	I. Virgin	1. Virgin
	10. Small gonads			
Mature	11. Gonads half cavity	2. Maturing	M. Maturing	2. Maturing
	12. Gonads long cavity			
	13. Gonads fill cavity			
	14. Ripe & running	3. Spawning	R. Spawning	3. Spawning
	15. Spent	4. Spent	S. Spent & recovering	4. Spent
	16. Recovering spents	5. Resting		

APPENDIX V

HERSUR REPORT EXAMPLES

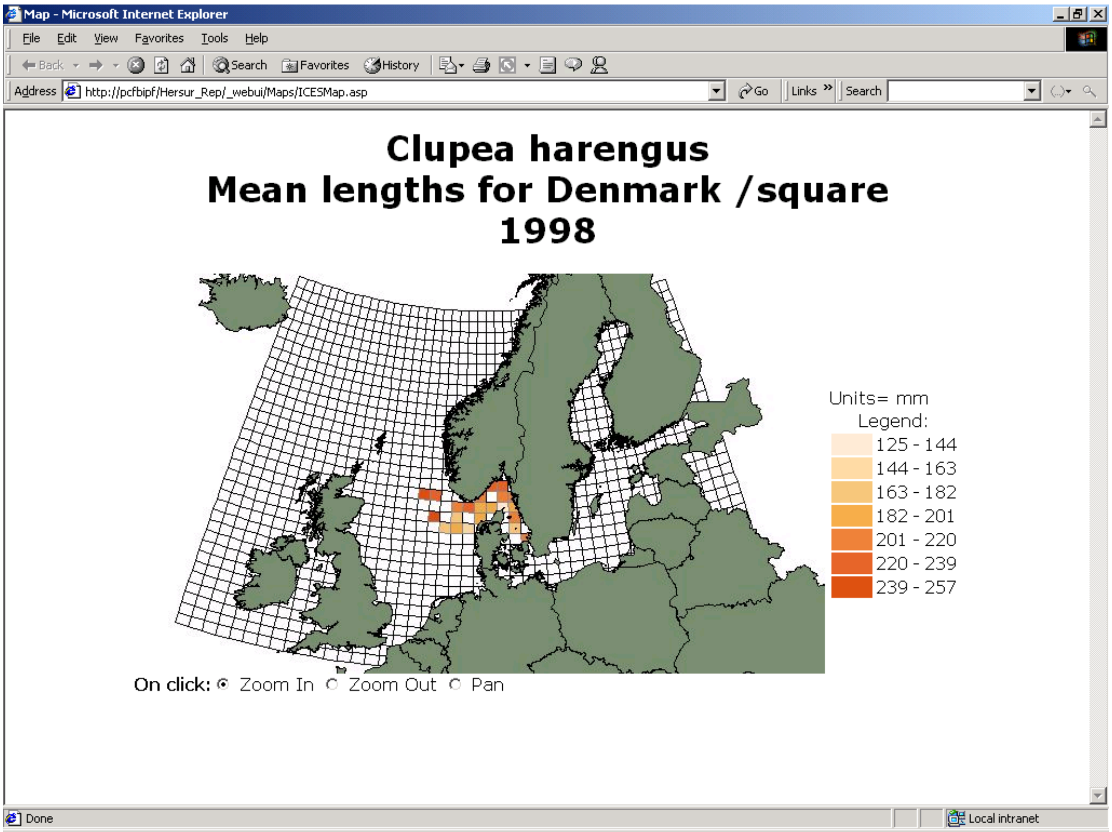
Report: Mean herring length per square



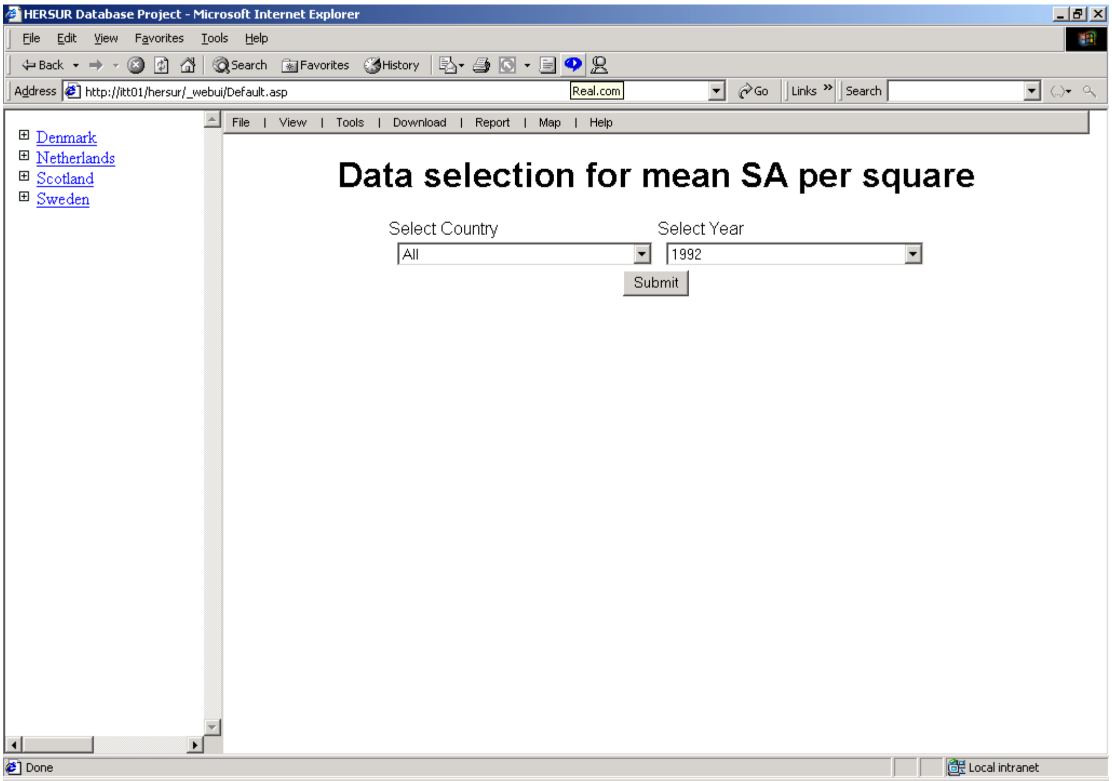


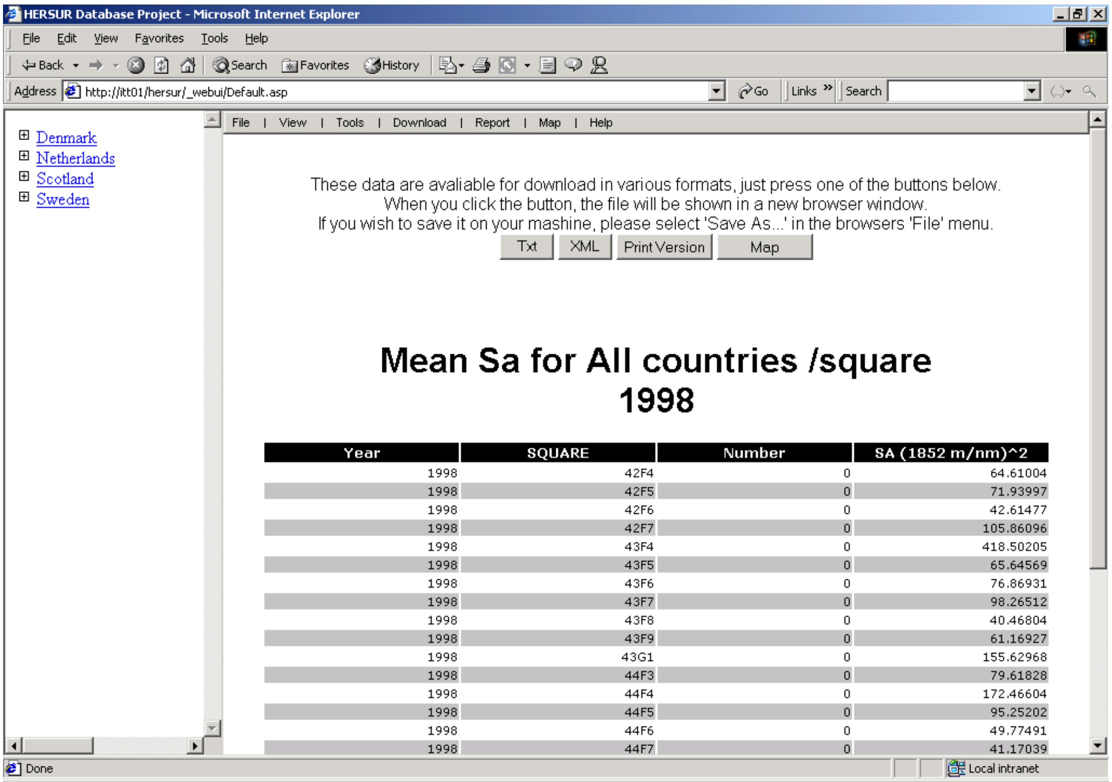
Clupea harengus
Mean lengths for Denmark /square
1998

Year	SQUARE	Number	Length (mm)
1998	41G2	163	204
1998	42F5	294	178
1998	42F6	929	191
1998	42F7	110646	159
1998	42G1	8082	170
1998	43F4	29	240
1998	43F6	2129	179
1998	43F8	27348	194
1998	43G1	14801	211
1998	44F6	3937	211
1998	44F7	159	238
1998	44F8	7975	198
1998	44F9	10700	193
1998	44G0	24657	125
1998	44G1	10818	196
1998	45F3	202	257
1998	45F4	1717	233
1998	45F8	4651	220
1998	45G0	3326	206

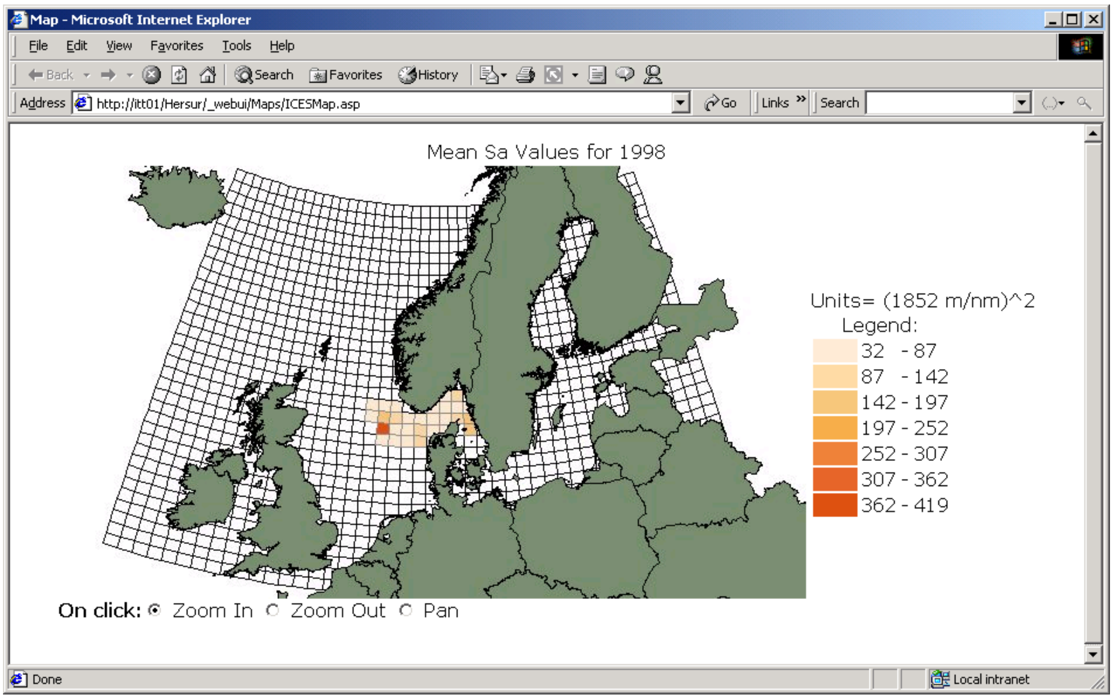

Map - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://pcfbipf/Hersur_Rep/_webui/Maps/ICESMap.asp
Go Links Search
Clupea harengus
Mean lengths for Denmark /square
1998
Units= mm
Legend:
125 - 144
144 - 163
163 - 182
182 - 201
201 - 220
220 - 239
239 - 257
On click: Zoom In Zoom Out Pan
Done
Local intranet

Report: NASC per square

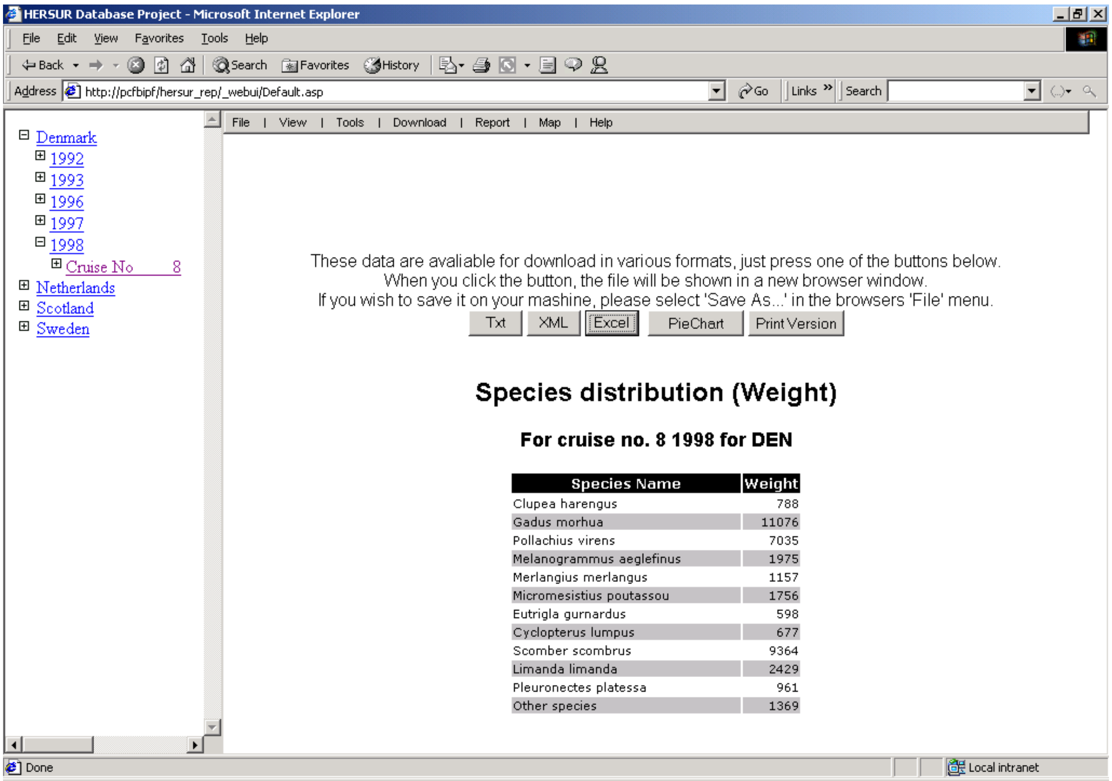




Year	SQUARE	Number	SA (1852 m/nm)^2
1998	42F4	0	64.61004
1998	42F5	0	71.93997
1998	42F6	0	42.61477
1998	42F7	0	105.86096
1998	43F4	0	418.50205
1998	43F5	0	65.64569
1998	43F6	0	76.86931
1998	43F7	0	98.26512
1998	43F8	0	40.46804
1998	43F9	0	61.16927
1998	43G1	0	155.62968
1998	44F3	0	79.61828
1998	44F4	0	172.46604
1998	44F5	0	95.25202
1998	44F6	0	49.77491
1998	44F7	0	41.17039


Map - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://itt01/Hersur/_webui/Maps/ICESMap.asp
Go Links Search
Mean Sa Values for 1998
Units= (1852 m/nm)^2
Legend:
32 - 87
87 - 142
142 - 197
197 - 252
252 - 307
307 - 362
362 - 419
On click: Zoom In Zoom Out Pan
Done
Local intranet

Report: Species distribution (Weight) per cruise



Species Name	Weight
Clupea harengus	788
Gadus morhua	11076
Pollachius virens	7035
Melanogrammus aeglefinus	1975
Merlangius merlangus	1157
Micromesistius poutassou	1756
Eutrigla gurnardus	598
Cyclopterus lumpus	677
Scomber scombrus	9364
Limanda limanda	2429
Pleuronectes platessa	961
Other species	1369