Pelagic Fish Committee

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REPORT OF THE PLANNING GROUP FOR HERRING SURVEYS

Lysekil, Sweden

28-31 May 1996

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

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1 TERMS OF REFERENCE

In accordance with C.Res.1995/2:40, the Planning Group for Herring Surveys (Chairman: Mr. E.J. Simmonds, UK) met in Lysekil, Sweden from 28-31 May 1996 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,
b) combine the survey data to provide estimates of abundance for the populations within the area,
c) consider the possibility of improved coverage of 1-ring herring and sprat in the eastern part of Division IVb and in Division IIIa,
d) consider further development in the standardisation of methods between participating countries,
e) consider the use of additional data, such as sonar (school) data, to enhance the acoustic index,
f) define the future data processing needs for combining future proposed acoustic and larval survey data from different countries and where this should be carried out over the next few years.

In addition, the Herring Assessment Working Group for the Area South of 62°N at its 1996 meeting requested the the Planning Group to address:

a) the level of spatial and temporal coverage required to provide a reliable larval production estimate (LPE),
b) the validity of the assumptions made in the multiplicative model,
c) the optimum timing and survey area required to provide adequate coverage for the application of the multiplicative model,
d) the usefulness of a biennial or triennial survey strategy with limited coverage of targeted areas in the intervening years,
e) the possibility of EU funding for North Sea larvae surveys,
f) to review the acoustic survey time series to establish the consistency among the surveys from the 1980s and 1990s.

The terms of reference given above do not follow an obvious organisational structure so for clarity the relationship between terms of reference and the report is as follows:

a) Sections 3.1, 3.2, 4.1, 4.2 and 4.3;
b) Two separate papers by Patterson and Beveridge 1996 and Simmonds *et al.*, 1996;
c) Section 4.4
d) Sections 4.5 and 4.6;
e) Section 5.4;
f) Sections 3.3 and 4.8;
g,h,i,j,k) Section 3.2; l) sections 4.6 and 4.7

2 PARTICIPANTS

Guus Eltink	Netherlands
Paul Fernandes	United Kingdom
Philippe Guiblin	France
Cornelius Hammer	Germany
Nils Håkansson	Sweden
Hans P. Knudsen	Norway
Ian McQuinn	Canada
Johan Modin	Sweden
Jens Pedersen	Denmark
Dave Reid	United Kingdom
Ann-Christin Rudolphi	Sweden
Dietrich Schnack	Germany
John Simmonds (Chairman)	United Kingdom
Karl-Johan Stæhr	Denmark
Else Torstensen	Norway

A full list of participants addresses, telephone numbers and fax information is given in Appendix I.

3 HERRING LARVAE SURVEYS

3.1 Availability of ships in 1996 and 1997

At present, ship time has been allocated for herring larvae surveys from two countries only. Germany will carry out surveys both in 1996 and 1997. The surveys are scheduled firstly in the second half of September in the Shetland/Orkney area and possibly in the Buchan area, and secondly, in the first two weeks of January 1997 in the eastern Channel and southern North Sea.

The Netherlands will carry out one survey in the third week of September 1996 in the Central North Sea and a second in the third week of December 1996 in the Southern North Sea. Due to reductions in funding no herring larvae surveys are yet planned for 1997, although the Herring Assessment Working Group HAWG (Anon 1996a) recommended increasing the effort in these surveys.

Scotland has no definite plans yet for participation in the herring larvae surveys in 1997, but ship time might become available when the four quarterly International Bottom Trawl Surveys (IBTS) are reduced to two quarterly surveys. It is suggested that any possible contribution from Scotland should be utilised for a second coverage of the Shetland/Orkney area in the first half of September. If English participation could be achieved a second coverage of the Central North Sea area in October is suggested.

In total, the ship time so far allocated to the 1996 and 1997 surveys appears to be even further reduced compared to the previous season. An effort has to be made to achieve a coverage both in time and space which can provide the minimum information required for assessment purposes. For decisions on priorities in allocating ship time, the following aspect should be considered: In relation to herring in Divisions IVc and VIId (Downs herring) ICES (in press) has recommended that the fishing mortality on this stock component should be reduced to the lowest possible level and that no directed fishing for herring should be allowed in Divisions IVc and VIId for the remaining part of 1996 and in 1997. The stock component in this area (Downs herring), which is part of the North Sea herring, is managed separately. Herring larvae surveys provide the only information that indicates changes in spawning stock biomass in this area. If the herring larvae surveys were stopped, there would be no basis to consider a reopening of the fishery.

The Herring Survey Planning Group strongly recommends an increase in the coverage in time and space of the herring larvae surveys with first priority given to the southern North Sea and the eastern Channel area during the period mid-December to the end of January.

3.2 Considerations for Future of the Herring Larvae Surveys

The Herring Assessment Working Group recognised that it was perhaps unlikely that effort on the herring larvae surveys could be increased again to the level of the 1980's. In order to maximise the benefits of available ship time the Herring Survey Planning Group was asked to consider the additional terms of reference as listed in Section 1. It was not expected that this Group would provide definitive answers to these questions until its proposed meeting in 1997 (prior to the next HAWG meeting). Therefore descriptions are given on how these questions might be answered.

The 1990 meeting of the Working Group on Herring Larvae Surveys South of 62°N discussed the possibilities for reducing the coverage in time for each survey area based on the introduction of the LPE index which utilises the complete information by inclusion of larvae up to 20 mm in length (Anon., 1990). Analyses of the historical data sets for each survey area have identified seasonal periods during which LPE values from individual surveys compare well with values obtained from complete coverage. It is assumed that the data series from the subsequent years could not contribute additional information to this question due to very restricted coverage.

The survey schedule which was defined as a minimum for valid LPE-estimates includes one single survey in each area at a fairly late stage in the season, except for the Buchan area, where two coverages were required:

Shetland/Orkneys- Mid September
Central North Sea- Second half of October
Southern North Sea- First half of January
Buchan- End of September / Beginning of October

It was pointed out that the effects of using this schedule would have to be tested with the available data set before adopting it as a standard, particularly if reduction in effort cannot be avoided. An analysis to confirm the correct time and coverage for estimating the LPE has still to be carried out and is recommended in order to confirm the comparability of indices from complete and reduced coverage.

The multiplicative model applied at present to fill in the gaps in area and time coverage is based on a Larval Abundance Index (LAI) calculated for individual sampling units separately and on the assumption that the abundance of larvae in each sampling unit represents specific stable proportions of the total stock (Patterson and Beveridge 1996). As this assumption may not hold true over extended periods of time, it is suggested that the database be analysed to determine the period over which the interaction term (years × sampling units) is sufficiently low and the proportions of individual stock components are sufficiently stable. The effect of the seasonal timing of the surveys, and of the reduction and selection of survey areas, is to be studied correspondingly.

The results of these tests may allow an assessment of the usefulness of a biennial or triennial survey strategy with limited coverage of targeted sampling units in the intervening years. For a more complete utilisation of the sampled larvae and possible reduction in spatial variability, the LPE-index for individual sampling units will have to be tested in addition to the LAI-index presently used in the multiplicative model. The IfM Kiel in cooperation with the Federal Board of Fisheries Rostock (IOR) is asked to carry out these analyses and to consider the additional terms of reference as given in Section

1. It is recommended that an evaluation be made available at the next meeting of the Herring Survey Planning Group in February 1997.

The possibilities for EU support in funding the North Sea herring larvae surveys are presently being discussed between Germany, the Netherlands and England. It appears that this type of funding may not solve the problems in other countries and, even if successful, these funds will not be available in 1996 and 1997. Thus, the continuation of this survey programme has to be achieved by other means at present, and should focus on assuring a complete coverage at least in the Southern North Sea for the reasons given above.

3.3 Database, Data Transfer and Data Analyses

The database for the herring larvae surveys is located in Aberdeen (Scotland) and will remain there for the time being. Scotland will maintain the database and carry out the standard analyses for assessment purposes. However, it is recognised that Scotland will not be able to perform further detailed analyses and the testing of survey strategies on the basis of this data series as outlined above. For this purpose it is suggested that a copy of the entire database be transmitted to Kiel (Germany) as soon as possible and that this be updated regularly.

4 HERRING ACOUSTIC SURVEYS

4.1 Co-ordination for 1996 Baltic Surveys

Since 1987 the herring in the Western Baltic including Sub-divisions 22 and 23 have been coverd by hydroacoustic surveys on a regular basis (Neudecker and Stæhr 1988, Stæhr and Neudecker 1990, Neudecker *et al.* 1991, Götze *et al.* 1992, 1993, 1994). Since 1993, parts of the Kattegat have been included in this survey.

In 1994 the Herring Assessment Working Group raised the question of a possible synchronisation of the hydroacoustic survey in the North Sea and the hydroacoustic survey in the Western Baltic (Anon. 1994a). Both the Planning Group for Hydroacoustic Surveys in the Baltic and the Planning Group for Herring Surveys came to the conclusion that this was not possible but instead recommended that the Skagerrak-Kattegat should be covered during both the ICES co-ordinated hydroacoustic survey in the North Sea and in the ICES-coordinated survey for Division IIIa and Sub-divisions 22, 23, and 24 (Anon. 1994b, 1994c Appendix II).

In 1996 a coverage of the total area of Division IIIa and the Western Baltic is planned for September - October.

Ship	Period	Area
Dana	96.09.24-96.10.05	Skagerrak and Northern Kattegat
Havfisken Havkatten	96.09.30-96.10.05	Sub.div 23 (The Sound)
Solea	96.10.02-9610.19	Southern Kattegat, Sub. div 23(The Sound), Sub div 22 (The Belt Sea) and Sub.div 24 (Western Baltic).

This hydroacoustic survey in IIIa and Western Baltic corresponds in timing with the joint hydroacoustic survey in the Baltic proper (Anon. 1996) which means that there will be a total coverage from Skagerrak to Åland Islands in the period 24 September to 29 October.

4.2 Co-ordination for 1996 North Sea, VIaS and VIIb Surveys

The dates and general strategy for the 1996 North Sea surveys were finalised and are shown in Figure 1 and the text table on the following page:

Country	Vessel	Survey dates	Survey strategy
Scotland	Scotia	12 - 30 July	Starting at 58° 45'N and proceeding North, east of the Orkney / Shetlands. Overlapping on eastern edge with G.O.Sars from 1° to 2° E. North to Southwest of the Orkney/ Shetlands.
Netherlands	Tridens	1 - 19 July	Proceeding north from an appropriate start point in order to arrive at 58° 45'N on 13 July, then returning to start point to cover the remainder of the southern area. Overlapping on eastern edge with G.O.Sars from 1° to 2° E as far south as 57° N.
Denmark	Dana	19 - 30 July	Proceeding west from 6° E.
Norway	G.O.Sars	25 June - 14 July	Proceeding from north to south. Overlapping on western edge with Scotia from 2° to 1° E as far south as 58° 45'N. South of 58° 45'N overlapping with Tridens from 2° to 1° E as far south as 57° N.
Germany	Solea	4 - 16 July	Proceeding from south to north, to 2° E and 57° N.
Scotland	Charter	To be arranged	Proceeding from south to north on completion of the Minch
Ireland	Lough Foyle	15 July - 2 August	Proceeding from north to south

4.3 Co-ordination for the 1997 North Sea, VIaS and VIIb Surveys

The timing and strategy for the 1997 North Sea surveys were discussed. It was emphasised that the ideal time for all surveys would be the first three weeks in July. Scotland aims to comply with this time frame; however, it is more likely that availability will be similar to that of 1996. Norway is requested to start one week later than in 1996. Denmark has not, as yet, finalised its plans for 1997. It is recommended that Denmark continues to carry out this survey in July, with effort concentrated in the Skagerrak and Kattegat areas where the younger age groups are prevalent. The Netherlands availability will be similar to that of 1996. Germany will have extended survey time for 1997 (three weeks) and will therefore consider extension to 58° N, overlapping with the Danish, Norwegian and Dutch surveys. It is recommended that the survey of Divisions VIa and VIIb be continued as this is the only source of fishery-independant management information (see Section 6.4 of Anon. 1996a).

4.4 0-group herring and sprat

Improvement in the estimation of 0-group (0-ring) herring was encouraged. In particular the Dutch survey will now include the Moray Firth and the Fife coastal region. The Skagerrak and Kattegat regions are also important areas for younger age groups and it is recommended that either Denmark or Sweden survey this area. Sweden is investigating the possibility of obtaining funds to deploy the research vessel Argos for such an exercise.

The group was reminded that estimates of sprat should be included in their survey reports. To date this has only been carried out in Norway, although data are available for the Kattegat and Skagerrak areas. Norway would be grateful to receive frozen or preserved samples of juvenile (< 3.5 cm) sprat from anywhere in the North Sea. The German Bight also contains large amounts of sprat which will be surveyed by Solea.

4.5 Acoustic Survey Time Series

The 1996 HAWG inspected the time series of acoustic surveys and expressed concerns about the inconsistency between survey results from 1984 to 1988 and subsequent surveys from 1989 to 1995. Improvements in procedures were reported between the surveys in the earlier and later years. The survey reports and data archives have been investigated to examine the consistency of data collection procedures, acoustic calibrations, data analysis methods and analysis programs. An initial collation of this examination is given below in Section 5.6. Examination of the survey time series for total 2+ to 3+ mortality indicates that the most likely source of variability lies between the surveys before 1988 and those subsequent to 1990. However, further analysis (see Section 5.7) is required before any conclusions can be reached.

4.6 Survey Parameters and Settings

The planning group addressed the needs for monitoring the comparability of acoustic surveys and defined an Excel spreadsheet to be completed by participants. The details are included in Table 4.6.1 and the individual country spreadsheets are included as Appendix III.

4.7 Further Analysis of the acoustic survey time series

- The planning group discussed the possible methods for examining the consistency of the acoustic survey time series. The choice was between, firstly, an examination of the survey data used by the HAWG for possible problems:- in this case the surveys most likely to yield information on the problem would be prioritised and selected for reanalysis. Alternatively all early surveys could be examined and where possible reanalysis carried out using current computer software. The Planning Group concluded that the first approach was likely to be the most efficient. The group indicated that individual countries should check the data and present analyses in the following ways.

- Examination of survey reports for procedural or calculation changes.

- Investigation of data sets at the individual acoustic sample level (elementary sampling distance unit ESDU) should be carried out for differences in amplitude PDF between areas and years. This should be by examination of national series of surveys on a comparable basis using both linear and square-route-of-2 scales, where possible data should be expressed in absolute SA format (Ref. to Simrad EK500 output) or if this is not possible on a consistent year to year basis.

- Examination of historical series of spatial distributions of herring abundance at age in July over the full time series. This will be carried out in Aberdeen.

Results of these data examinations will be circulated by 2 December 1996.

It is proposed that the Planning Group should meet from 24 to 28 February 1997 to discuss and report on these analyses of the data series.

4.8 Database and future routine analysis

The Planning Group discussed the implications of a project funded by the European Commission for (ECHOHER) which includes the creation of an international database for the acoustic and biological sampling data from the North Sea and western Scotland herring acoustic surveys. It was agreed that it would be desirable to have the datasets collected by each country involved in this survey (Denmark, Germany, Netherlands, Norway, Scotland, Sweden) archived in a standardized format in order to facilitate data exchange and analysis. Although the details of the structure of the database have not been determined, the major issues to be resolved include:

1) the level of data aggregation;
2) data security;
3) allowing the inclusion of ancillary data and analysis information.

Similar initiatives have recently been undertaken by the Baltic International Fisheries Survey Working Group as well as by Canada. The Baltic database is proposed to be held in spreadsheet form with data aggregation at the SA per ICES rectangle level and is intended as a summary format for validation. The Canadian project, presented at the recent meeting of the Working Group on Fisheries Acoustic Science and Technology (FAST) in Woods Hole, includes the proposal for an international standard data format at the ping sample level and is proposed to allow the addition of analysis information (e.g. selection criteria for species allocation, editing commands, etc.) while preserving the integrity of the original data. It was noted that data aggregation should be at the lowest level possible while considering data storage and rapid access limitations, although given the state of present day storage capacity and disk access speed, this should not be a major concern. The Planning Group recommends that the Baltic and Canadian initiatives be followed closely during the development of the North Sea database.

The routine data analyses and combination at statistical rectangle level will be carried out in 1996 (and provisionally in 1997) in Aberdeen, Scotland. Data should be sent to Aberdeen by 9 September 1996 to ensure that results are available for ACFM.

The data format should be in the form of :-

1) tabulated total numbers and total biomass by ICES Statistical Rectangle,
2) proportions of numbers at age/maturity/ population in an analysis region,
3) mean weights at age/maturity/population in an analysis region
4) a map of region boundaries on a Statistical Rectangle basis.

Categories for proportions (2) and mean weights (3) above should distinguish between North Sea herring and Baltic herring and should be as follows:

N S Her	O	1	2Im	2Mat	3Im	3Mat	4	5	6	7	8	9+
Balt Her	O	1	2Im	2Mat	3Im	3Mat	4	5	6	7	8	9+

5 METHODOLOGY

A number of specific methodological problems were addressed during the meeting and are summarised below.

5.1 Celtic Sea and Division IVaS / VIIb Survey Strategy

A presentation entitled "Herring acoustic surveys in the Republic of Ireland" was given. Acoustic surveys for herring are carried out each year in two areas around the Irish coast: the Celtic Sea (two surveys a year in autumn and winter since 1989/90); and the west coast (each July since 1994). The Celtic Sea survey takes place during the two supposed peaks of the spawning season, close to the southern Irish coast (ICES Divisions VIIaS, VIIg and VIIj). However, due to possible mismatch between the exact spawning time and area, coverage has been extended offshore in order to contain the stock at various levels of transit to, and from, the inshore spawning sites. There is evidence to suggest that a shift may be taking place from a predominantly autumn- spawning component to one that spawns mainly in winter. Over the past three years winter surveys have consistently produced higher biomass estimates, despite covering a significantly smaller area than the equivalent autumn surveys. The results of the winter 1996 survey in particular, suggest that the stock is at it highest level since acoustic surveys began.

The Planning Group discussed the problems associated with surveys on spawning aggregations. The problem of containment is primarily due to the unpredictable nature of the timing of spawning. This could be alleviated by undertaking a stratified design encompassing widely spaced transects further offshore into Division VIIg, in order to contain the stock in transit (either to or from the spawning grounds), and a closer transect spacing inshore to cover the spawning component. In the case of the Celtic Sea, the extended transects could be inserted at the expense of the west coast which appears to be a nursery area and, therefore, contains very little of the spawning stock biomass. A separate, south-west coast young herring survey could be undertaken on a smaller vessel such as the R.V. Lough Beltra. An alternative consideration, to switch to a summer survey, was considered premature in the light of the current time series and the problems associated with summer feeding surveys (such as contagious fish distributions, difficulties in fishing and multi-species identification). Evidence from a German research cruise which included Division VIIg, suggests that herring may be mixed with many more fish species than those encountered in the autumn/winter, when the herring move inshore.

The west coast survey extends to the margin of the continental shelf in ICES Divisions VIIb and VIaS. In 1994 the survey was stratified following advice from fishermen, which proved not to be completely accurate; therefore, in 1995, a regular transect spacing was adopted throughout. The locations of the major fish schools were consistent in both years, i.e. in areas where the depth of water was between 100 and 200m. The two surveys carried out on the west coast have produced wildly different results. The estimate in 1994 (350,000t) was not used by the HAWG because the echo traces were not properly identified (due to the total lack of herring catches). In 1995 fishing success was significantly improved; however, a much lower biomass estimate was obtained (137,000 t). The frequency distributions of herring density were highly skewed in both years, particularly in 1994. Removal of the two extreme values encountered in 1994 reduced the mean density to almost exactly the same value as that in 1995; there is, therefore, a variance problem.

The Irish west coast survey bears a strong resemblance to the history of the survey of the west coast of Scotland. The latter has been significantly improved with experience which has led to the identification of areas with higher probabilities of fish occurrence and subsequent stratification. Areas with higher probabilities of fish occurrence have now been identified from the results of the last two years in the Irish surveys. The Planning Group suggested that stratification should be implemented, for example, in areas of depths of 100 to 200 m, which could be surveyed at twice the intensity of others. The use of model-based estimators for evaluation of the mean should also be considered. Fishing success could also be improved by adopting a quick deployment to the bottom to coincide with the location of the target school. The net should be towed as close to the bottom as possible to minimise avoidance under the gear.

5.2 Weight at Length and Age

Attention has been drawn to the impact of geographic variation in weight at age as a source of variability in acoustic surveys. This is particularly relevant to the Scottish and Netherlands surveys in ICES Division IVa (Anon. 1996a). Studies based on the 1994 Scottish Division VIa acoustic survey (Hammer *et al.* 1995) have shown that the calculation of the weight-length relationship is robust to either random or length-stratified sampling regimes at the level currently carried out in the survey. It also appears to be fairly constant, with negligible biological differences across the whole study area, and independent of substantial length frequency variation.

Preliminary analyses of weight at age data indicate that there are substantial differences across both Divisions IVa and VIa. It is therefore recommended that it is important to use local age keys within each survey area. Comparisons of weight at age calculated directly from sample data or indirectly through length data and age-length keys indicate that these calculations are also robust to technique.

It is concluded that weight-length relationships can be calculated effectively from random sample data and that they are globally applicable for a given survey area. However, age keys should be calculated and applied locally to each sub-area as appropriate.

The Planning Group recommends that the enhanced biological data collection programme in Division VIa should be continued, and that in the Scottish and Norwegian surveys in Division IVa, both random and length stratified weight and age data should if possible be recorded to confirm the findings in Division VIa.

5.3 Spatial Distribution of Length

Trawl data from acoustic surveys for North Sea herring in the Orkney-Shetland area were analysed to investigate the spatial distribution of length and age across years using geostatistical tools (Guiblin *et al.*, 1996). The data from each trawl station consisted of distributions of lengths and ages. The lengths are summarised by mean length. In general, the larger and the older the fish, the further offshore they occur. The spatial distribution of mean length is not stationary. However, it appears to be very stable across years. The spatial variability of mean length was modelled with a variogram. Two types of variogram were computed: firstly a mean variogram for all years with each year treated separately; and secondly, a variogram computed from all years combined. The nugget effect on the second variogram provided a measure of the interannual variability at any location. This was small for mean length whereas it was important for age proportions. Kriged maps for any one year can be improved using the length data of other years. Use of a model with small interannual variability allows the derivation of a map that honours exactly the length values of the current year, and uses but does not honour exactly the length data from other years.

In contrast, proportions at age vary much more than mean length from year to year, because both year class strength and spatial distribution change. However, for each year the proportion at age can be expressed as a function of the mean length, this function varying from year to year. Instead of the proportion at age, a monotonic relationship with length is obtained if the proportion from age+ (at and above age) is considered. Splitting by years, the scatter around the line is so much reduced that the relationship can be fitted by a deterministic function usually with good precision. In practical terms this makes it possible to transform the length map for a given year to a good map of proportion at age+ and by the difference to proportions at age. Although age proportions vary between years, the spatial distribution of the mean length is more stable from year to year. This would suggest that the occupation of space by the herring population is driven by size. Age proportions are only a secondary effect, derived from length, in the spatial distribution of herring for a given year.

5.4 Combination of Sonar Data

The use of sonar data along with the traditional echointegrator data may be used to provide more information during a survey. This may be used in two distinct ways, firstly to investigate or correct for survey bias due to distortion of observations resulting from a relationship between fish behaviour and the survey vessel, or secondly to add additional information by increasing the sampling volume and reducing the variance of the estimate of fish density.

5.4.1 To reduce behaviour-related bias

A number of members of the Planning Group have carried out experiments with sonar during their cruises. There remains at present considerable uncertainty about the nature and the appropriate interpretation of sonar data. It was reported that schools could be observed avoiding the approaching vessel, but may also be attracted by the noise and move into the path of the vessel. In other cases it remained unclear whether the observations were artefacts. In addition it is still almost impossible to attribute a certain signal to a particular fish species unless the exercise is carried out in a mono-species area. In areas where more than one species occur in schools there is no objective criterion to decide the nature of the observed objects. Sonar deployment also has an impact since semi-horizontal forward projections of the sonar (Misund *et al.*, 1996) will yield different information from side-based applications (Soria *et al.*, 1996). Additionally, no software is available to qualify and quantify these signals satisfactorily. It was reported that software for school quantification by sonar is at present being developed in Norway and it is thought that there are developments in France.

The Planning Group acknowledged, however, that the sonar technique could in principle provide very valuable information. This would mainly be in mono-specific situations. In the North Sea such data would not yet be at a level substantially to improve the acoustic estimate. However, there are some areas where sonar screening could increase the resolution of fish distribution. According to Norwegian observations sprat and small herring change in vertical distribution throughout the seasons in the Skagerrak area. Sometimes they are found in the upper layers and cannot be detected with vertical hull-mounted echo-sounders. Such concentrations can be detected with sonar, but not satisfactorily quantified.

In essence, the Planning Group concluded that the issue of incorporating sonar data in hydroacoustic stock assessment should be pursued with more effort as soon as suitable software is available. The Planning Group was of the opinion that considerable uncertainties still remain in sonar screening. In the context of very tight cruise schedules for the hydroacoustic surveys and the current state of knowledge of sonar data treatment, it appears unrealistic, at present, to expect to improve fish density estimates from vertical echo-sounders by involving additional sonar data. It is hoped that further development in this area will continue.

5.4.2 To reduce survey variance

During an acoustic survey the fish density of schooling fish may be estimated both by data from the vertical echosounder-echointegrator combination and the sonar by estimating biomass via the school area or volume. Estimates of instantaneous fish density by sonar are thought to be inherently more variable due to greater variability in fish aspect. Data from these two methods combined, however, should have a lower variance than from one method only. The best method for combining data would be a weighted mean with weights inversely proportional to the variance of each method. For this purpose it is thought that the correct procedure would be to separate the estimates of fish density by both methods into two aspects - the estimate of the number of schools and the estimate of mean school size - which combined will give population estimates. This will allow comparable partition of variance for sonar and vertical sounder. This is particularly important due to the different relationships and methods used to estimate mean school size by the sonar and the vertical echosounder. The methods of variance partition and estimation are discussed in Marchal and Petitgas (1993). In this paper the variance of a vertical sounder survey was partitioned between school number estimation and mean school size for a sardine population. It should be noted that for this study the estimate of overall survey variance was dominated by the estimate of mean school size while the estimate of numbers of schools was found to be rather precise. Thus in this case, for the sonar data to be used significantly to improve the survey estimate, the variance of the estimate of mean school size (number of fish per school) must be of the same order as that for a vertical sounder. Estimates of the precision of measurements of mean school size must be calculated before data from these two sources can be combined.

6 RECOMMENDATIONS

The Herring Survey Planning Group strongly recommends an increase in coverage in time and space of herring larvae surveys with first priority given to the southern North Sea and the eastern Channel area during the period mid-December to the end of January.

It is recommended that the Skagerrak and the Kattegat are surveyed during the ICES-coordinated hydroacoustic survey in July for the North Sea and also during the ICES-coordinated hydroacoustic survey in October-November for Division IIIa and the Baltic Sub-divisions 22, 23 and 24.

It is recommended that the survey of Divisions VIa and VIIb be continued as this is the only source of fishery-independent management information (see Section 6.4 in Anon 1996a).

The Planning Group recommends further analysis of available hydroacoustic time series. Specific tasks include:

1. an examination of survey reports for procedural or calculation differences.

2. an investigation of ESDU data sets for differences in amplitude PDF. The task should be done by examination of national series of surveys on a comparable basis using both linear and square-route-of-2 scales where possible data should be expressed in absolute SA format (ref. to SIMRAD EK500 output or if this is not possible on a consistent year to year basis).

3. examination of historical series of spatial distributions of herring abundance at age in July over the full time series. This task will be carried out in Aberdeen.

Results of these data examinations should be circulated by 2 December 1996. Results and analyses should be reported to and discussed during the next meeting scheduled from 24 to 28 February 1997.

The Planning Group noted an international project to set up a hydroacoustic database for the North Sea. The Group recommends that similar initiatives put forward for the Baltic Sea and Canadian waters should be followed closely during the development of the North Sea database.

It is recommended that local age keys should be sampled within each primary survey areas.

The Planning Group recommends that programmes for enhanced biological data collection in Division VIa should be continued and that in Division IVa both random and length-stratified weight and age data should, if possible, be recorded during the Scottish and Norwegian surveys and analysed in order to confirm similar analyses in Division VIa.

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Table 4.6.1

Acoustic equipment and practices	
Year	Year (YYYY) Gregorian calendar
Ship and dates	Ship name and date according to Gregorian calendar
Area expessed as SW corner and N.E. corner	Maximum and minimum latitude and maximum and minimum longitude containing the whole survey area
Survey direction (principal)	The direction of the sequence of transects, not the movement within the transects. Ex N to S.
Echo sounder	Name (and manufacturer) of echo sounder
Transducer	Name (and manufacturer, type) of transducer
Transducer mounting and depth	Mounted on hull, towed body or centre board and transducer depth and transmitting direction if not downwards
Calibration method	Type and diameter of sphere or description of other method
Date of calibration	Date according to gregorian calender
SL + VR	Sum of Source Level and Voltage response referred to 0 DB total gain
TVG and gain	Used TVG compensation, Output power and echosounder gain
Sv tr. gain or DG	The value of this parameter in the EK500 settings. DG is a correction factor between the actual setting and the calibration
Integrator	Name (and manufacturer) of integrator.
Output unit	Example: SA is expressed as m^2/NM^2
ESDU	Distance, time or number of pings and type of log connection
Time of acoustic sampling	Time of day when integration is performed. Day, night or D and N
Species allocation method	Principal method for allocation of SA values to species. Catches or echo traces or other method
Analysis program	Name and origin of analysis program used for calculation of biomasses and age composition
Data storage	Present storage of data eg. paper forms, flat data files, flat ascii files, database, spreadsheet.

Fishing gear and biological parameters	
Year	Year (YYYY) Gregorian calendar
Ship and dates	Ship name and date according to Gregorian calendar
Fishing gear	Name and type of gear
Trawl doors with floats for surface layer	Indicate with YES or NO if floats on the trawl doors have been used for fishing in the surface layer
Codend mesh size (stretched)	In mm.
Special features	Indicate if other special features or methods have been used
Speed (knots)	Vessel and/or measured trawl speed.
Duration (min)	Duration of fishing in minutes.
Total number of hauls	Total number of hauls in the survey
Fishing time - Day/Night	Time of day when fishing is performed. Day, night or D and N
Subsampling method	Length stratified or random sampling for age and length/weight relationship
TS regression Species group	Name of species group for corresponding TS regression
TS regression	TS regression for a species group.
Regression	
Length/Weight relationship (L in cm)	Not mandatory.
Data storage	Present storage of data eg. paper forms, flat data files, flat ascii files, database

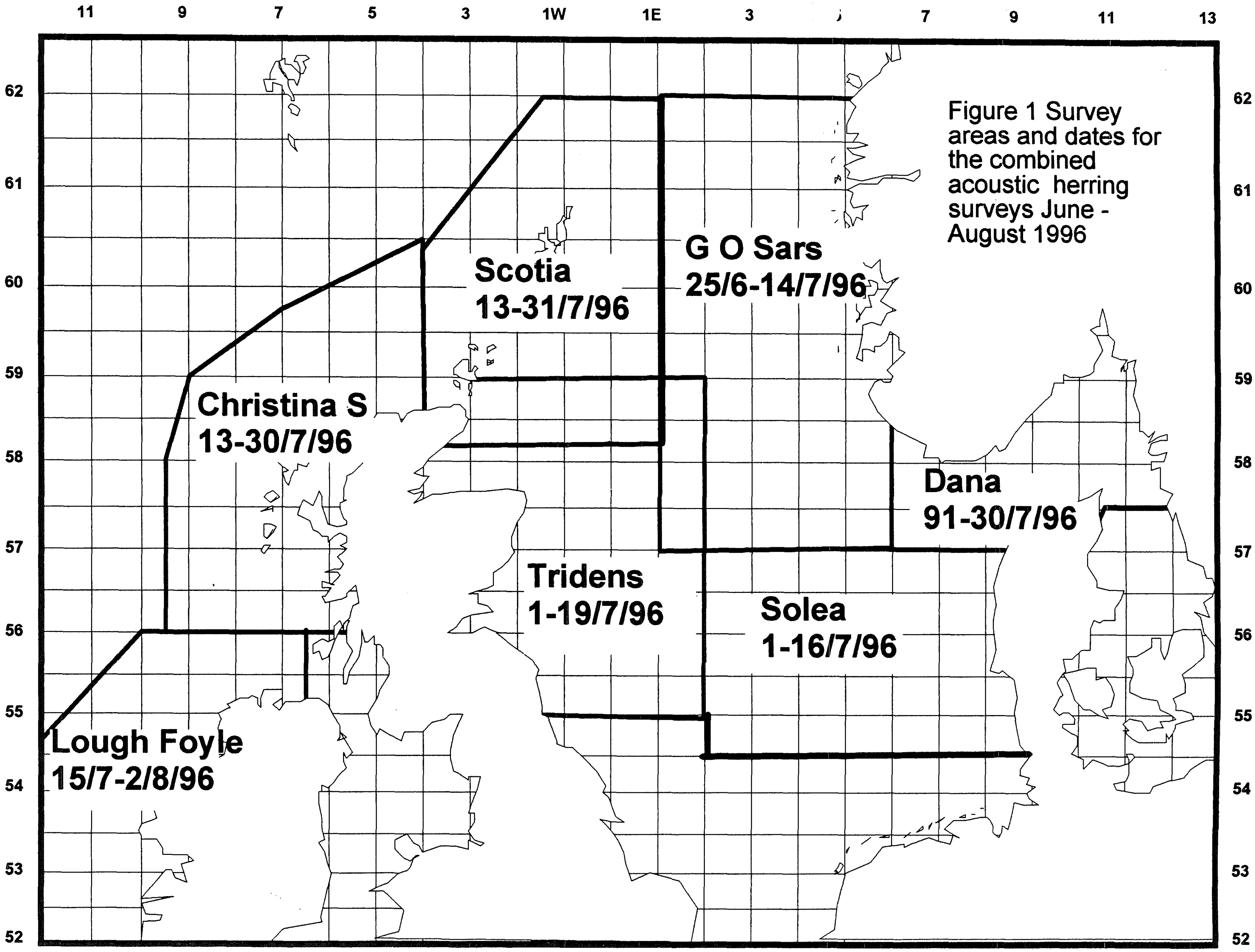


Figure 1 Survey areas and dates for the combined acoustic herring surveys June - August 1996

Appendix I

Planning Group for Herring Survey
Lysekil 28-31 May 1996

John Simmonds **(Chairman)**	SOAEFD Marine Laboratory P.O. Box 101 Victoria Road Aberdeen AB9 8DB United Kingdom	+44 1224 876544	+44 1224 295511	simmondsej@ marlab.ac.uk
Guus Eltink	RIVO-DLO P.O. Box 68 NL-1970 AB IJmuiden Netherlands	+31 255 564 646	+31 255 564 644	guus@rivo.dlo.nl
Paul Fernandes	SOAEFD Marine Laboratory P.O. Box 101 Victoria Road Aberdeen AB9 8DB United Kingdom	+44 1224 295403	+44 1224 295511	fernandespg@ marlab.ac.uk
Philippe Guiblin	Centre de Geostatistique (Ecole des Mines de Paris) 35, rue St Honor'e 77300 Fontainebleau France	+33 1 64 694956	+33 1 64 694705	guiblin@ cg.ensmp.fr
Cornelius Hammer	Institute for Sea Fisheries Federal Research Centre for Fisheries Palmaille 9 22767 Hamburg Germany	+49 40 38905 232	+49 40 38905 264	100565.1223@ compuserve.com
Nils Håkansson	Institute of Marine Research P.O. Box 4 453 21 Lysekil SWEDEN	+46-523-18716	+46-523-13977	n.hakansson@ imr.se
Hans P. Knudsen	Institute of Marine Research P.O.B. 1870 Nordnes N-5024 Bergen Norway	+47 55 238500	+44 55 238532	hansk@imr.no
Ian McQuinn	Institut Maurice LaMontagne Mont-Joli Québec Canada GOK IPO	+418 775 0627	+418 775 0740 +418 775 0542	I_MCQUINN@ qc.dfo.ca

NAME	ADDRESS	TELEPHONE	FAX	E-MAIL
Johan Modin	Institute of Marine Research P.O. Box 4 453 21 Lysekil SWEDEN	+46-523-18700 +46-523-18722	+46-523-13977	j.modin@imr.se
Jens Pedersen	Danish Instistute for Fisheries Research North Sea Centre DK-9850 Hirtshals Denmark	+45 33 9632 00	45 33 9632 60	jp@dfu.min.dk
Dave Reid	SOAEFD Marine Laboratory P.O. Box 101 Victoria Road Aberdeen AB9 8DB United Kingdom	+44 1224 295363	+44 1224 295511	reiddg@ marlab.ac.uk
Ann-Christin Rudolphi	Institute of Marine Research P.O. Box 4 453 21 Lysekil SWEDEN	+46-523-18724	+46-523-13977	a-c.rudolphi@ imr.se
Dietrich Schnack	Institut für Meereskunde Düsternbrookes Weg 20 24105 Kiel Germany			dschnack@ifm.uni-kiel.de
Karl-Johan Staehr	Danish Instistute for Fisheries Research North Sea Centre DK-9850 Hirtshals Denmark	+45 33 9632 00	45 33 9632 60	kjs@dfu.min.dk
Else Torstensen	Institute of Marine Research Flødevigen Research Station N-4817 His Norway	+47 37059 000	+47 37059 001	else.torstensen@ imr.no

Appendix II

Planning Group for Herring Surveys, Lysekil 28-31May 1996
Working Paper

Reprint of Poster from
the 9. Danske Havforskermøde

Do Herring use the Sound as migration route ?

Rasmus Nielsen and Karl-Johan Stæhr
Danish Institute for Fisheries Research
Institute for Fish Biology
P.O. Box 101, DK-9800 Hirtshals
E-mail: kjs@dfu.min.dk

INTRODUCTION

The Sound is a transition area for several migrating fish stocks such as herring, garfish, lumpsucker, mackerel, and to some extent cod. Results on early tagging experiments (Biester 1979; Otterlind 1984) showed that the Sound is a major over-wintering area and a major migration route for the presently important western Baltic (Rügen) herring stock. However, no detailed quantitative investigations of the over-wintering western Baltic herring and the passage of migrating herring in and through the Sound have previously been carried out. Only qualitative and anecdotal information existed before the present studies. The western Baltic herring have feeding grounds in the Skagerak-Kattegat and North Sea area where the 2 year old and older herring are located during summer. In July/August, they migrate southwards through Kattegat. During the period (late)

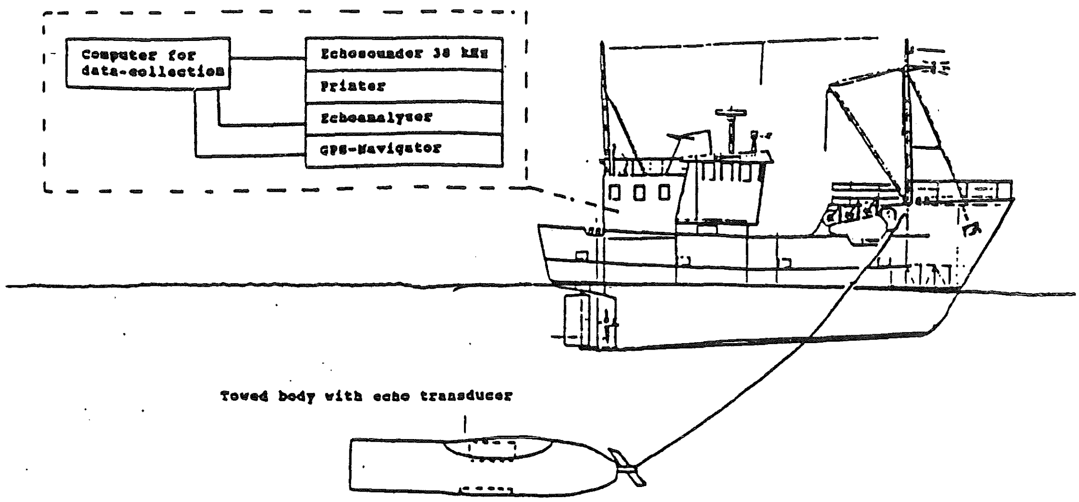
August to March, the herring are found in high concentrations in the Sound, and spawning at Rügen and surrounding areas in the western Baltic takes place during April-May. After spawning the herring migrate back to the Kattegat-Skagerak area partly through the Sound in late spring and early in the summer. Mature herring will be located in the Sound with high abundance from the late summer period and first autumn period probably waiting for the right conditions and moment to leave the area heading towards the spawning grounds during winter and spring. (Biester 1979; Otterlind 1984; Nielsen 1994; present results). The western Baltic herring is an significant fishery resource for the Danish, German, Norwegian and Swedish fishery in the western Baltic area (including the Sound and the Belts), in the Kattegat-Skagerak area and to a less extent in the North Sea (Anon. 1995).

Schematic presentation of survey activities during the period September 1993 to May 1995.

Month	September	October	November	December	January	February	March	April	May
Surveys 1993/1994	S-09-93	S-10-93	S-11-12-93	See Nov.	S-01-94	S-02-94	S-03-94	S-04-94	
Period(s)	17-22/9	25-30/10	29/11-4/12		10-15/1	14-19/2	14-19/3	11-16/4	
Acoustic integration	x	x	x		x	x	x	x	
Biological sampling	x	x	x		x		(x)	x	
Individ. analysis of herr.							x		
Hydrographical sampling									
Surveys 1994/1995		S-10-94	S-11-94	S-12-94	S-01-95	S-02-95	S-(02)-03-95	S-(03)-04-95	S-05-95
Period(s)		17-20/10	21-27/11	12-16/12	9-16/1	6-10/2	27/2-4/3	27/3-2/4	25/5
		24-26/10							30-31/5
Acoustic integration		x	x	x	x	x	x	x	x
Biological sampling		x	x	x	x	x	x	x	
Individ. analysis of herr.		x		x		x		x	
Hydrographical sampling		x	x	x	x	x	x	x	

OBJECTIVES

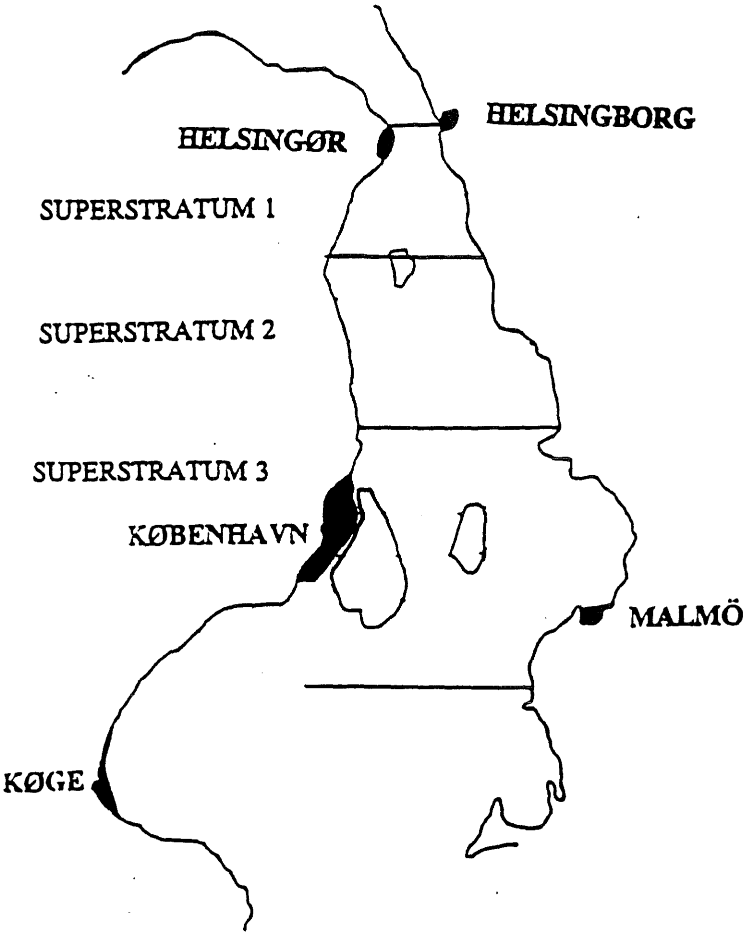
The objectives of these monitoring investigations on herring in the Sound is to obtain detailed information about and describe horizontal and vertical distribution, densities, biomass and stock composition of herring in the Sound with special emphasis on the western Baltic herring stock, and successively describe the spatial and temporal variances in the occurrences of herring based on monthly monitoring activities. Further, the purpose is to establish reference data and knowledge concerning the herring in the Sound related to design of later monitoring programmes for evaluation of the environmental impact from the construction of the fixed link between Denmark and Sweden.



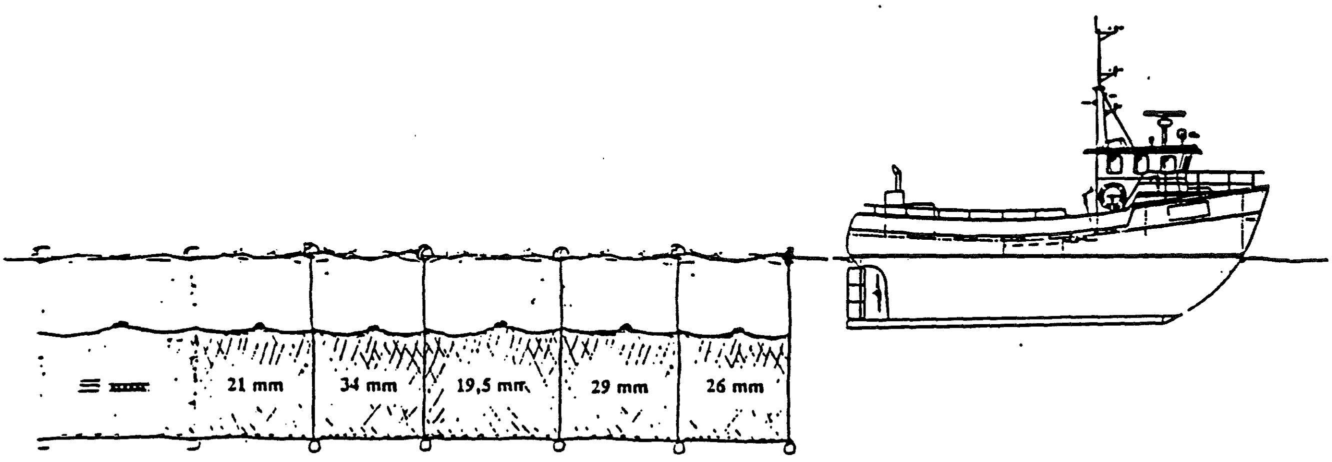
HYDRO ACOUSTIC ECHO INTEGRATION

MATERIALS AND METHODS

In the period September 1993 to April/May 1995, 15 hydro acoustic surveys were carried out in the Sound (ICES Subdiv. 23). Echo integration divided in acoustic transects covering the whole Sound from Helsingør-Helsingborg (north) to Drogden (south) was performed on each survey once a month during the autumn, winter and spring periods. Identical transects on both Danish and Swedish side, respectively, were covered monthly. The investigations included biological sampling performed on each survey with scientific, multi panel gill nets equipped with a broad spectre of mesh sizes. From the biological sampling species distribution and herring stock composition were analysed with respect to length and age distribution, length weight relationship, and sex ratio. Further, racial composition of herring were examined based on meristic characters and mean length in order to distinguish between relative occurrence of juvenile herring from the western Baltic spring spawning stock and the North Sea autumn spawning stock (Bank herring) occurring in the Sound. Abundance indices of herring in age and length groups are calculated from the combined acoustic integration values according to stock composition data from biological sampling, using length dependant target strength values from literature estimates. Data from hydrographical CTD-profiles sampled during the 8 latest surveys were analysed to evaluate variations in relative density of herring related to hydrographical conditions.



STUDY AREA



BIOLOGICAL GILL NET SAMPLING
(SCIENTIFIC MULTI PANEL GILL NETS)

RESULTS

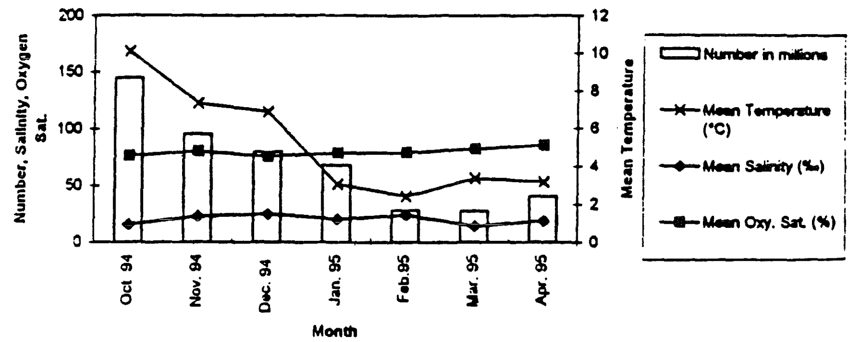
The performed analyses of the hydro acoustic measurements and biological sampling show that the far most abundant fish species in the Sound during the monitoring period was herring. Among herring stocks occurring in the Sound the western Baltic spring spawning herring stock was by size the far most important stock component during the monitoring period with measured biomass up to 130.000 tons in the late summer and autumn period.

The measured total biomass and abundance of herring in the Sound varied between 130.000 to 5.000 tons and 940 mill. to 40 mill. herring in the period September 1993 to May 1995. In general, the occurrence of herring in the Sound was observed to be higher in 1993/94 than in 1994/95. Highest occurrences were observed in September 1993 and lowest in April 1994. In September-October 1993 and in October 1994 around 100.000 tons of herring or more were found in the whole Sound area. In November-January in both 1993/94 and 1994/95 there were around 40-70.000 tons, however, while the biomass in January 1995 was intermediary (approx. 40.000 tons) between the level in November-December (60-70.000 tons) and the stable level in February-May both years (5-20.000 tons) the biomass in February 1994 differed from this pattern as a biomass of around 85.000 tons was observed here. Thus, in both monitoring periods the highest occurrences of herring were in the period (August)/September to February/(March). Within this period, the herring had a tendency to concentrate in the northern and central Sound (Superstratum 1 & 2) especially around the island of Hven. However, there seems to have been a more continuos southwards displacement (emigration) of herring in 1994/95 than in 1993/94, where the emigration occurred abruptly over a relatively short period in February/March. (Figure 1).

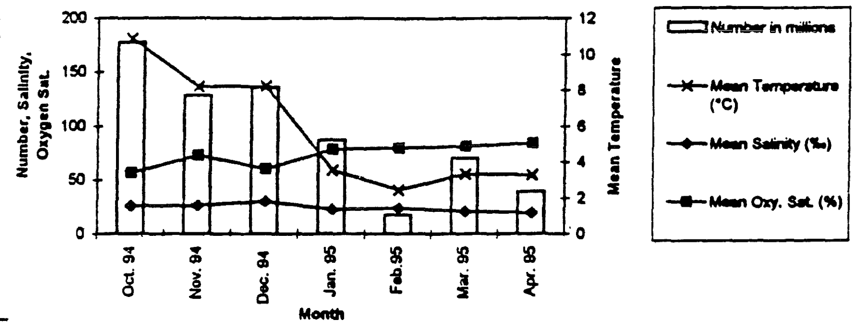
Consequently, the results support quantitatively the former published qualitative indices in Biester (1979) and Otterlind (1984) that the Sound seems to be a dominant over-wintering area and an important spawning migration route for the western Baltic (Rügen) spring spawning herring stock.

The migration from the spawning grounds in the western Baltic Sea to the feeding areas (Skagerak-Kattegat and the North Sea) of post spawned herring is not well documented, however, sexual maturity indices from present investigations (not shown) seems to indicate that there during the monitoring periods have been a continuous migration in the spring from March to May of post spawned herring from the southern spawning grounds northwards through the Sound.

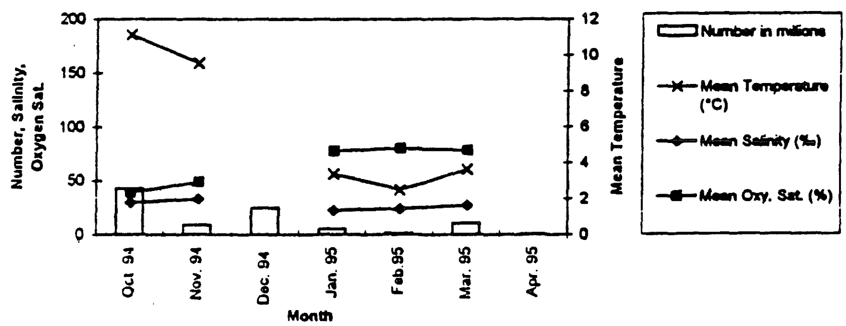
Number of herring and mean temperature, salinity and oxygen saturation in the depth layer 5-10 m from surface.



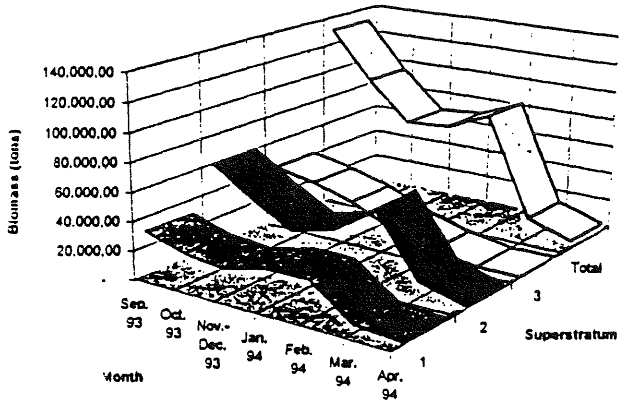
Number of herring and mean temperature, salinity and oxygen saturation in the depth layer 10-20 m from surface.



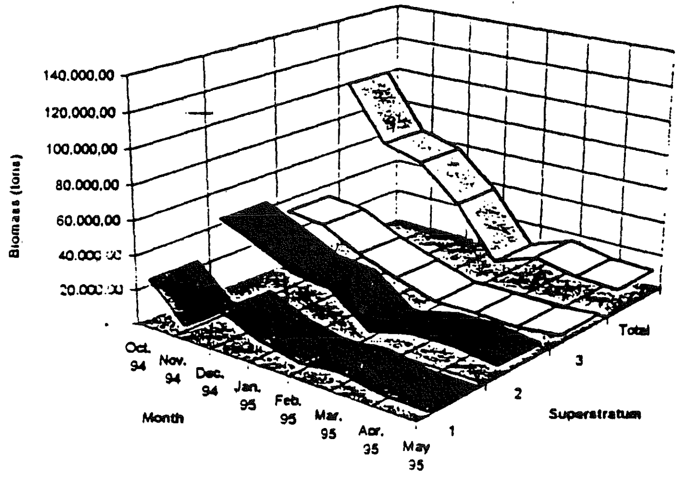
Number of herring and mean temperature, salinity and oxygen saturation in the depth layer > 20 m from surface.



Herring biomass in the Sound during monitoring period 1 (Sep. 93 to Apr. 94)



Herring biomass in the Sound during monitoring period 2 (Oct. 94 to May 95)



In all months during the monitoring periods in 1993/94 and 1994/95 the highest abundances of herring were found in the depth layer from the sea surface to 20 m depth. Within this layer the highest abundances were found in the 10-20 m depth layer compared to the herring occurrences in the surface layer from 5-10 m depth. The occurrences of herring in depths below 20 m were very limited.

The start period (October to December) of the southwards displacement of herring out of the Sound towards the spawning grounds during the 1994/95 monitoring period coincides with decreases in water temperature and slight increases in mean salinity in all depth layers. These factors might trigger this migration. Temperatures will fall and salinity will rise when cold and relatively high saline inflowing North Sea water enters the Sound.

QUESTIONS TO BE ANSWERED THROUGH FUTURE INVESTIGATIONS

Is the Sound the main migration route for herring migrating from spawning grounds in the western Baltic Sea to the feeding grounds in Skagerak-Kattegat and North Sea area ? (The Belt Sea ?)

Which factors triggers the southwards displacement of the overwintering herring in the Sound when migrating to the spawning grounds ? Hydrographical factors ?

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Appendix III

Spreadsheet tables of survey practice and system performance for acoustic surveys 1984 - 1996

Sweden

Acoustic equipment and practices

Year	Ship and dates	Area expessed as SW coroner and NE corner	Survey direction (principal)	Echo sounder	Transducer	Transducer mounting and depth	Calibration method	Date of calibration	SL + VR	TVG and gain	Sv tr. gain or DG	Integrator	Output unit	ESDU	Time of acoustic sampling	Species allocation method	Analysis program	Data storage
1984	Argos 0821-0901	N54°30' E10°	N to S	EK400	38-29/25E	Hull 4.5 m	Cu 60 mm	840821	137.8	20log(R)-2 aR-10		NORD-10/S	m²/NM²	1 NM		Catches	ABC ref.	Flat data files
		N59° E15°										Bergen program		log pulses	D and N		J. Modin	
1985	Argos 0820-0901	N54°30' E10°	N to S	EK400	38-29/25E	Hull 4.5 m	Cu 60 mm	850823	137.6	20log(R)-2 aR-10		NORD-10/S	m²/NM²	2 NM		Catches	ABC ref.	
		N59° E15°										Bergen program		log pulses	D and N		J. Modin	Year
1986	Argos 0901-0919	N56° E06°	Irregular	EK400	38-29/25E	Hull 4.5 m	Cu 60 mm	860910	137.2	20log(R)-2 aR-10		NORD-10/S	m²/NM²	2 NM		Catches	ABC ref.	
		N59° E13°										Bergen program		log pulses	D and N		J. Modin	
1988	Argos 0801-0819	N56° E02°	Irregular	EK400	38-29/25E	Hull 4.5 m	Cu 60 mm	880913	136.9	20log(R)-2 aR-10		NORD-10/S	m²/NM²	2 NM		Catches	ABC ref.	
		N60°30' E13°										Bergen program		log pulses	D and N		J. Modin	

Fishing gear and biological parameters														
Year	Ship and date	Fishing gear	Trawl doors with floats for surface layer	Codend mesh size (stretched)	Special features	Speed (knots)	Duratio n	Total number of hauls	Fishing time Day/Night	Subsampling method	TS regression Species group	Regression (L in cm)	Length/Weight relationship (L in cm)	Data storage
1984	Argos 0821-0901	Fotö one boat	YES	16		4	30	26	D and N	Length	Clupeids	21,7log(L)-75,5		Paper
		pelagic trawl								stratified	Gadoids	21,8log(L)-72,7		forms
											Mackerel	21,7log(L)-81,5		
1985	Argos 0820-0901	Fotö one boat	YES	16		4	30	30	D and N	Length	Clupeids	21,7log(L)-75,5		Paper
		pelagic trawl								stratified	Gadoids	21,8log(L)-72,7		forms
											Mackerel	21,7log(L)-81,5		
1986	Argos 0901-0919	Fotö one boat	YES	16		4	30	42	D and N	Length	Clupeids	21,7log(L)-75,5		Paper
		pelagic trawl								stratified	Gadoids	21,8log(L)-72,7		forms
											Mackerel	21,7log(L)-81,5		
1988	Argos 0801-0819	Fotö one boat	YES	16		4	30	48	D and N	Length	Clupeids	20,0log(L)-71,2		Paper
		pelagic trawl								stratified	Gadoids	20,0log(L)-67,5		forms
											Mackerel	20,0log(L)-77,2		
1989	Argos 0801-0804	Fotö one boat	YES	16		4	30	12	D and N	Length	Clupeids	20,0log(L)-71,2		Paper
		pelagic trawl								stratified	Gadoids	20,0log(L)-67,5		forms
											Mackerel	20,0log(L)-77,2		
1990	Argos 0730-0818	Fotö one boat	YES	16		4	30	30	D and N	Length	Clupeids	20,0log(L)-71,2		Paper
		pelagic trawl								stratified	Gadoids	20,0log(L)-67,5		forms
											Mackerel	20,0log(L)-77,2		

Acoustic equipment and practices

Year	Ship and dates	Area expessed as NW corner and SE corner	Survey direction (principal)	Echo sounder	Transducer	Transducer mounting and depth	Calibration method	Date of calibration	SL + VR	TVG and gain	Sv tr. gain or DG	Integrator	Output unit	ESDU	Time of acoustic sampling	Species allocation method	Analysis program	Data storage
1984	DANA 22.08-06.09	Skagerrak and Kattegat	W to E	Simrad EK 400	hull 38-29/25E	6 m	Cu 60 mm	840803	123			Simrad QD	m^2/NM^2	1 NM	D and N	catches	VAX/VMS	ASCII files
					towed 38-29/25E	2-4 m			116.1									
1985	DANA 14.08-06.09	Skagerrak and Kattegat,	W to E	Simrad EK/ES 400	hull ES38-29	6 m	Cu 60 mm	850826	122.4			Simrad QD	m^2/NM^2	1 NM	D and N	catches	VAX/VMS	ASCII
		and sub div 22-24			towed ES38-29	2-4 m			128.4									
1986	DANA 30.07-26.08	5°E;58°N-8°E;55°N	W to E	Simrad EK/ES 400	hull ES38-29	6 m	Cu 60 mm	860813	131.4			Simrad QD	m^2/NM^2	1 NM	D and N	catches	VAX/VMS	ASCII
		and Skagerrak-Kattegat			towed ES38-29	2-4 m			129.7									
1987	DANA 02.08-07.09	2°E;60°N-8°E;54°N	W to E	Simrad EK/ES 400	hull ES38-29	6 m	Cu 60 mm		129.7			Simrad QD	m^2/NM^2	1 NM	D and N	catches	VAX/VMS	ASCII
		and Skagerrak-Kattegat			towed ES38-29	2-4 m			128.5									
1988	DANA 21.07-04.08	3°E;58.3°N-8°E;55°N	W to E	Simrad EK/ES 400	hull ES38-29	6 m	Cu 60 mm					Simrad QD	m^2/NM^2	1 NM	D and N	catches	VAX/VMS	ASCII
		and Skagerrak-Kattegat			towed ES38-29	2-4 m												
1989	DANA 19.07-09.08	4°E;56°N-8°E;54°N and	W to E	Simrad EK/ES 400	hull ES38-29	6 m	Cu 60 mm					Simrad QD	m^2/NM^2	1 NM	D and N	catches	VAX/VMS	ASCII
		western part of Skagerrak			towed ES38-29	2-4 m												
1990	DANA 24.07-12.08		W to E	Simrad EK/ES 400	hull ES38-29	6 m	Cu 60 mm					Simrad QD	m^2/NM^2	1 NM	D and N	catches	VAX/VMS	ASCII files
					towed ES38-29	2-4 m												
1991	DANA 22.06-12.07	5°E;58.3°N-8°E;57°N	W to E	Simrad EK/ES 400	hull ES38-29	6 m	Cu 60 mm					ECHOANN	m^2/NM^2	1 NM	D and N	catches	INGRES	D.B
		and Skagerrak-Kattegat			towed ES38-29	2-4 m												
1992	DANA 06.07-24.07	5°E;58.3°N-8°E;57°N	W to E	Simrad EK/ES 400	hull ES38-29	6 m	Cu 60 mm					ECHOANN	m^2/NM^2	1 NM	D and N	catches	INGRES	D.B
		and Skagerrak-Kattegat			towed ES38-29	2-4 m												
1993	DANA 10.07-23.07	5°E;58.3°N-8°E;57°N	W to E	Simrad EK/ES 400	hull ES38-29	6 m	Cu 60 mm	930710				ECHOANN	m^2/NM^2	1 NM	D and N	catches	INGRES	D.B
		and Skagerrak-Kattegat			towed ES38-29	2-4 m			130.5									
1994	DANA 10.07-26.07	5°E;58.3°N-8°E;57°N	W to E	Simrad EK/ES 400	hull ES38-29	6 m	Cu 60 mm	940710	132.5			ECHOANN	m^2/NM^2	1 NM	D and N	catches	INGRES	D.B
		and Skagerrak-Kattegat			towed ES38-29	2-4 m												
1995	DANA 28.06-12.07	5°E;58.3°N-8°E;57°N	W to E	Simrad EK/ES 400	hull ES38-29	6 m	Cu 60 mm	950628	131.6			ECHOANN	m^2/NM^2	1 NM	D and N	catches	INGRES	D.B
		and Skagerrak-Kattegat			towed ES38-29	2-4 m			129.6									

Fishing gear and biological parameters

Year	Ship and date	Fishing gear	Trawl doors with floats for surface layer	Codend mesh size (stretched)	Special features	Speed (knots)	Duration	Total number of hauls	Fishing time Day/Night	Subsampling method	TS regression Species Group	Regression	Length/Weight relationship (L in cm)	Data storage
1984	DANA 22.08-06.09	Fotö trawl	yes	16 mm		4-5	60	54	night	length strat.	clupeids	21.0log L-75.5		data base
											gadoids	21.8log L-72.7		
											mackerel	6 dB below herring		
											horse mackerel	21.0log L-75.5		
1985	DANA 14.08-06.09	Fotö trawl	yes	16 mm		4-5	60	59	night	length strat.	clupeids	21.0log L-75.5		data base
											gadoids	21.8log L-72.7		
											mackerel	6 dB below herring		
											horse mackerel	21.0log L-75.5		
1986	DANA 30.07-26.08	Fotö trawl	yes	16 mm		4-5	60	54	night	length strat.	clupeids	21.0log L-75.5		data base
												20.0log L-71.2		
											gadoids	21.8log L-72.7		
												20.0log L-67.5		
											mackerel	21.7log L-81.5		
												20.0log L-77.2		
											horse mackerel	21.0log L-75.5		
												20.0log L-67.5		
1987	DANA 02.08-07.09	Fotö trawl	yes	16 mm		4-5	60	77	night	length strat.	clupeids	20.0log L-71.2		data base
											gadoids	20.0log L-67.5		
											mackerel	20.0log L-77.2		
											horse mackerel	20.0log L-67.5		
1988	DANA 21.07-04.08	Fotö trawl	yes	16 mm		4-5	60	25	night	length strat.	clupeids	20.0log L-71.2		data base
											gadoids	20.0log L-67.5		
											mackerel	20.0log L-77.2		
											horse mackerel	20.0log L-67.5		
1989	DANA 19.07-09.08	Fotö trawl	yes	16 mm		4-5	60	25	night	length strat.	clupeids	20.0log L-71.2		data base
											gadoids	20.0log L-67.5		
											mackerel	20.0log L-77.2		
											horse mackerel	20.0log L-67.5		
1990	DANA 24.07-12.08	Fotö trawl	yes	16 mm		4-5	60		night	length strat.				data base
1991	DANA 22.06-12.07	Fotö trawl	yes	16 mm		4-5	60		night	length strat.				data base

1992	DANA 06.07-24.07	Fotö trawl	yes	16 mm		4-5	60		night	length strat.	clupeids	20.0log L-71.2		data base
											gadoids	20.0log L-67.5		
											mackerel	21.7log L-81.5		
											horse mackerel	20.0log L-67.5		
1993	DANA 10.07-23.07	Fotö trawl	yes	16 mm		4-5	60	37	night	length strat.	clupeids	20.0log L-71.2		data base
											gadoids	20.0log L-67.5		
											mackerel	21.7log L-81.5		
											horse mackerel	20.0log L-67.5		
1994	DANA 10.07-26.07	Fotö trawl	yes	16 mm		4-5	60	44	night	length strat.	clupeids	20.0log L-71.2		data base
											gadoids	20.0log L-67.5		
											mackerel	20.0log L-84.9		
											horse mackerel	20.0log L-67.5		
1995	DANA 28.06-12.07	Fotö trawl	yes	16 mm		4-5	60	35	night	length strat.	clupeids	20.0log L-71.2		data base
											gadoids	20.0log L-67.5		
											mackerel	20.0log L-84.9		
											horse mackerel	20.0log L-67.5		

Scotland

Acoustic equipment and practices																		
Year	Ship and dates	Area expessed as SW corner and NE corner	Survey direction (principal)	Echo sounder	Transducer	Transducer mounting and depth	Calibration method	Date of calibration	SL + VR	TVG and gain	Sv tr. gain or DG	Integrator	Output unit	ESDU	Time of acoustic sampling	Species allocation method	Analysis program	Data storage
1984	Scotia 6-26 July		N-S	EK400	E20-26	TB/5m	38.1mm TC ball		+54.38	20logR -10dB		Abd. Dig E. Int.	count	5Nmi	0200:2200GMT	Trace	BASIC	Paper
1985	Scotia 12-31 July		N-S	EK400	E20-26	TB/5m	38.1mm TC ball		+54.31	20logR -10dB		Abd. Dig E. Int.	count	5Nmi	0200:2200GMT	Trace	BASIC	Paper
1986	Scotia 11-31 July		N-S	EK400	E20-26	TB/5m	38.1mm TC ball		+53.91	20logR -10dB		Abd. Dig E. Int.	count	5Nmi	0200:2200GMT	Trace	BASIC	Paper
1987	Scotia 15 July-3 August		N-S	EK400	E20-26	TB/5m	38.1mm TC ball		+53.80	20logR -10dB		Abd. Dig E. Int.	count	5Nmi	0200:2200GMT	Trace	BASIC	Paper
1988	Scotia 6 -23 July		Irregular	EK400	E20-26	TB/5m	38.1mm TC ball		+53.80	20logR -10dB		Abd. Dig E. Int.	count	5Nmi	0200:2200GMT	Trace	MILAP	D. B. & Sheet
1989	Scotia 5-25 July		S-N/E-W	EK400	E20-26	TB/5m	38.1mm TC ball		+53.51	20logR -10dB		C.A. Comp E. Int.	count	2.5Nmi	0200:2200GMT	Trace	MILAP	D. B. & Sheet
1990	Scotia 4-24 July		S-N/E-W	EK400	E20-26	TB/5m	38.1mm TC ball		+52.69	20logR -10dB		C.A. Comp E. Int.	count	2.5Nmi	0200:2200GMT	Trace	MILAP	D. B. & Sheet
1991	Scotia 12 July-1 August		S-N/E-W	EK500	ES38	TB/5m	38.1mm TC ball					EK500	Sa	2.5Nmi	0200:2200GMT	Trace	MILAP	D. B. & Sheet
1992	Scotia 13-31 July		S-N/E-W	EK500	ES38	TB/5m	38.1mm TC ball					EK500	Sa	2.5Nmi	0200:2200GMT	Trace	MILAP	D. B. & Sheet
1993	Scotia 10-30 July		S-N/E-W	EK500	ES38	TB/5m	38.1mm TC ball					EK500	Sa	2.5Nmi	0200:2200GMT	Trace	MILAP	D. B. & Sheet
1994	Scotia 6-26 July		S-N/E-W	EK500	ES38	TB/5m	38.1mm TC ball					EK500	Sa	2.5Nmi	0200:2200GMT	Trace	MILAP	D. B. & Sheet
1995	Scotia 8-27 July		S-N/E-W	EK500	ES38	TB/5m	38.1mm TC ball					EK500	Sa	2.5Nmi	0200:2200GMT	Trace	MILAP	D. B. & Sheet

Fishing gear and biological parameters

Year	Ship and date	Fishing gear	Trawl doors with floats for surface layer	Codend mesh size (stretched)	Special features	Speed (knots)	Duration	Total number of hauls	Fishingtime Day/Night	Subsampling method	TS regression Species group	Regression	Length/Weight relationship (L in cm)	Data storage
1984	Scotia 6-26 July	Jackson PT 160		20mm		4.5kn	10-60min		Day	Len strat	Herring	20 logL -71.2	7.29*10-7L^3.45	Paper
1985	Scotia 12-31 July	Jackson PT 160		20mm		4.5kn	10-60min		Day	Len strat	Herring	20 logL -71.2	1.51*10-3L^3.52	Paper
1986	Scotia 11-31 July	Jackson PT 160		20mm		4.5kn	10-60min		Day	Len strat	Herring	20 logL -71.2	1.23*10-3L^3.60	Paper
1987	Scotia 15 July-3 August	Jackson PT 160		20mm		4.5kn	10-60min		Day	Len strat	Herring	20 logL -71.2	1.65*10-3L^3.51	Paper
1988	Scotia 6 -23 July	Jackson PT 160		20mm		4.5kn	10-60min		Day	Len strat	Herring	20 logL -71.2	2.23*10-3L^3.41	D. B. & Sheet
1989	Scotia 5-25 July	Jackson PT 160		20mm		4.5kn	10-60min		Day	Len strat	Herring	20 logL -71.2	1.26*10-3L^3.58	D. B. & Sheet
1990	Scotia 4-24 July	Jackson PT 160		20mm		4.5kn	10-60min		Day	Len strat	Herring	20 logL -71.2	1.22*10-3L^3.60	D. B. & Sheet
1991	Scotia 12 July-1 August	Jackson PT 160		20mm		4.5kn	10-60min		Day	Len strat	Herring	20 logL -71.2	3.92*10-3L^3.27	D. B. & Sheet
1992	Scotia 13-31 July	Jackson PT 160		20mm		4.5kn	10-60min		Day	Len strat	Herring	20 logL -71.2	1.63*10-3L^3.51	D. B. & Sheet
1993	Scotia 10-30 July	Jackson PT 160		20mm		4.5kn	10-60min		Day	Len strat	Herring	20 logL -71.2	7.26*10-3L^3.06	D. B. & Sheet
1994	Scotia 6-26 July	Jackson PT 160		20mm		4.5kn	10-60min		Day	Len strat	Herring	20 logL -71.2	1.78*10-3L^3.50	D. B. & Sheet
1995	Scotia 8-27 July	Jackson PT 160		20mm		4.5kn	10-60min		Day	Len strat	Herring	20 logL -71.2	0.66*10-3L^3.79	D. B. & Sheet

NORWAY

Fishing gear and biological parameters																		
Year	Ship and dates	Area expessed as Sw corner and NE corner	Survey direction (principal)	Echo sounder	Transducer	Transducer mounting and depth	Calibration	Date of calibration	SL + VR	TVG and gain	Sv tr. gain or DG	Integrator	Output unit	ESDU	Time of acoustic sampling	Species allocation method	Analysis program	Data storage
1984	G.O.Sars	N6145 to 5930	N to S	EK400/38	Ni 45x48 cm	hull 5 m	Cu 60 mm	840725	134.4	20 log R		NORD 10	m^2/NM^2	5nm	D and N	traces		data-
	10.07 - 17.07	W100 to E500			(5.5x5deg.)					- 10 dB		QX						base
	17.07 - 26.07	N6100 to 5730	N to S															
		W400 to 000																
	26.07 -31.07	N6045 to 5845	S to N															
		W330 to 000																
1984	Eldjarn	N6045 to 5700	N to S	EK400/38	38-29/25E	hull 5 m	Cu 60 mm	840802	140.6	20 log R		NORD 10	m^2/NM^2	5nm	D and N	traces		Data-
	21.07 - 31.07	W200 to E400								-20 dB		QX						base
1984	Bei Dou	N6100 to 5915	N to S	EK400/38	38-29/25E	hull 5 m	Cu 60 mm	840820	141.6	20 log R		QD	mm	5nm	D and N	traces		Data-
	19.07 - 25.07	W200 to E100								-20 dB								base
1985	G.O.Sars	N6030 to 5700	N to S	EK/ES400	38-29/25E	hull 5 m	Cu 60 mm	850716	135.9	20 log R		NORD 10	m^2/NM^2	5nm	D and N	traces		Data-
	15.07 - 28.07	W300 to E700								-10 dB		QX						base
1985	Eldjarn	N6150 to 5800	N to S	EK/ES400	38-29/25E	hull 5 m	Cu 60 mm	850717	136.7	20 log R		NORD 10	m^2/NM^2	5nm	D and N	traces		Data-
	16.07 - 29.07	W100 to E400								-10 dB		QX						base
1986	Eldjarn	N6200 to 5700	N to S	EK/ES400	38-29/25E	hull 5 m	Cu 60 mm	860710	134.1	20 log R		NORD 10	m^2/NM^2	5nm	D and N	traces		Data-
	10.07 - 28.07	W200 to E700								-10 dB		QX						base
1987	G.O.Sars	N6200 to 5700	N to S	EK400/38	Ni 45x48 cm	hull 5 m	Cu 60 mm	870704	138.3*	20 log R		NORD 10	m^2/NM^2	5nm	D and N	traces		Data-
	04.07 - 26.07	W400 to E700			(5.5x5deg.)					-10 dB		QX						base
1987	Eldjarn	N 6130 to 5330	S to N	EK400/38	38-29/25E	hull 5 m	Cu 60 mm	870507	139.1	20 log R		NORD 10	m^2/NM^2	5nm	D and N	traces		Data-
	24.06 - 11.08	W200 to E800								-10 dB		QX						base
1988	Eldjarn	N6200 to 5330	S to N	EK400/38	38-29/25E	hull 5 m	Cu 60 mm	880630	139.1	20 log R		NORD 10	m^2/NM^2	5nm	D and N	traces		Data-
	24.06 - 16.07	W200 to E400								-10/-20 dB		QX						base
1989	Eldjarn	N6200 to 5500	mainly	EK400/38	38-29/25E	hull 5 m	Cu 60 mm	890629	140.1	20 log R		NORD 10	m^2/NM^2	5nm	D and N	traces		Data-
	28.06 - 20.07	W100 to E600	S to N							-20 dB		QX						base
1990	Eldjarn	N6215 to 5730	mainly	EK400/38	38-29/25E	hull 5 m	Cu 60 mm	900703	139.3	20 log R		NORD 10	m^2/NM^2	5nm	D and N	traces		Data-
	02.07 - 20.07	E000 to 800	S to N							-20 dB		QX						base
1991	Johan Hjort	N6315 to5645	mainly	EK500	ES38B	hull 5 m					26.9 dB	EK500	m^2/NM^2	5nm	D and N	traces		Data-
	06.07 - 23.07	W100 to E800	S to N									BEI						base

1992	Johan Hjort	N6200 to5700	S to N	EK500	ES38B	hull 5 m	Cu 60 mm	920201			26.9 dB	EK500	m^2/NM^2	5nm	D and N	traces		Data-
	24.06 - 11.07	E100 to 700										BEI						base
1993	Johan Hjort	N6200 to 5700	S to N	EK500	ES38B	hull 5 m	Cu 60 mm	930214			26.6 dB	EK500	m^2/NM^2	5nm	D and N	traces		Data-
	01.07 - 24.07	E000 to 600										BEI						base
1994	G.O.Sars	N6150 to 5700	S to N	EK500	ES38B	hull 5 m	Cu 60 mm	940713			24.8/25.2	EK500	m^2/NM^2	5nm	D and N	traces		data-
	02.07 - 21.07	W130 to E900										BEI						base
1995	G.O.Sars	N6130 to 5700	S to N	EK500	ES38B	hull 5 m	Cu 60 mm	950626			25.3 dB	EK500	m^2/NM^2	5nm	D and N	traces		Data-
	26.06 - 16.07	W200 to E700										BEI						base

Fishing gear and biological parameters

Year	Ship and date	Fishing gear	Trawl doors with floats for surface layer	Codend mesh size (stretched)	Special features	Speed (knots)	Duration	Total number of hauls	Fishing time Day/Night	Subsampling method	TS regression Species group	Regression	Length/Weight relationship (L in cm	Data storage
1984	G.O.Sars	Fotö one boat	No	11		4	10-100	35	D/N	Random	Clupeids	20,0log(L)-71,2		Data
	10.07 - 31.07	C 1800		6**		3	ca30	15						base
1984	Eldjarn	Capelin pel.tr	No	10		3	10-100	16	D/N	Random	Clupeids	20,0log(L)-71,2		Data
	21.07 - 31.07	C 1800		6**		3	ca30	25						base
1984	Bei Dou	Semipel.tr	No	22		3,5?	10-100	12	D/N	Random	Clupeids	20,0log(L)-71,2		Data
	19.07 - 25.07	Alfredo 4		?		3,5?	ca30	14						base
1985	G.O.Sars	Fotö one boat	No	11		4	10-100	26	D/N	Random	Clupeids	20,0log(L)-71,2		Data
	15.07 - 28.07	C 1800		6**		3	ca30	16						base
1985	Eldjarn	Capelin pel.tr.	No	10		3	10-100	17	D/N	Random	Clupeids	20,0log(L)-71,2		Data
	16.07 - 29.07	C 1800		6**		3	ca30	19						base
1986	Eldjarn	Capelin pel.tr.	No	10		3	10-100	19	D/N	Random	Clupeids	20,0log(L)-71,2		Data
	10.07 - 28.07	C 1800		6**		3	ca30	33						base
1987	G.O.Sars	Capelin pel.?	No	10?		3?	10-100	36	D/N	Random	Clupeids	20,0log(L)-71,2		Data
	04.07 - 26.07	C 1800		6**		3	ca30	23						base
1987	Eldjarn	Fotö one boat	No	11		4	10-100	88	D/N	Random	Clupeids	20,0log(L)-71,2		Data
	24.06 - 11.08	C 1800		6**		3	ca30	36						base
1988	Eldjarn	Fotö one boat	No	11		4	10-100	39	D/N	Random	Clupeids	20,0log(L)-71,2		Data
	24.06 - 16.07	C 1800		6**		3	ca30	20						base
1989	Eldjarn	Fotö one boat	YES*	11		4	10-100	67	D/N	Random	Clupeids	20,0log(L)-71,2		Data
	28.06 - 20.07	C 1800		6**		3	ca30	11						base
1990	Eldjarn	Fotö one boat	YES*	11		4	10-100	54	D/N	Random	Clupeids	20,0log(L)-71,2		Data
	02.07 - 20.07	C 1800		6**		3	ca30	4						base
1991	Johan Hjort	Fotö one boat	YES*	11		4	10-100	58	D/N	Random	Clupeids	20,0log(L)-71,2		Data
	06.07 - 23.07	C 1800		6**		3	ca30	9						base
1992	Johan Hjort	Fotö one boat	YES*	11		4	10-100	47	D/N	Random	Clupeids	20,0log(L)-71,2		Data

	24.06 - 11.07	C 1800		6**		3	ca30	0						base
1993	Johan Hjort	Fotö one boat	YES*	11		4	10-100	67	D/N	Random	Clupeids	20,0log(L)-71,2		Data
	01.07 - 24.07	C 1800		6**		3	ca30	5						base
1994	G.O.Sars	Fotö one boat	YES*	11		4	10-100	87	D/N	Random	Clupeids	20,0log(L)-71,2		Data
	02.07 - 21.07	C 1800		22		3	ca30	3						base
1995	G.O.Sars	Fotö one boat	YES*	11		4	10-100	95	D/N	Random	Clupeids	20,0log(L)-71,2		Data
	26.06 - 16.07	C 1800		22		3	ca30	7						base
*Floates attached to trawl wings														
** Mesh size of inner lining														

Germany

Acoustic equipment and practices						
Year	Ship and dates	Area expessed as SW corner and NE corner	Survey direction (principal)	Echo sounder	Transducer	Transducer mounting and depth
1994	Walther Herwig III	55 N 4 E	N to S	EK 500	ES38B	Hull 5,8m
	12.07.-25.07.	57 N 8 E		Simrad		
1995	Walther Herwig III	54 30'N 1 E	N to S	EK500	ES38B	Hull 5,8m
	17.07.-08.08.	57 N 8 E		Simrad		

Calibration method	Date of calibration	SL + VR	TVG and gain	Sv tr. gain	Integrator	Output unit	ESDU	Time of acoustic sampling	Species allocation method	Analysis program	Data storage
Cu 60 mm	940713	not used	20logR	27,7 dB	BI500	m²/NM²	1 NM	D and N	Trace	Excel	Paper forms
		for EK500	2 kW						Ident.	sheet	Excel files
Cu 60 mm	950725		20logR	27,7 dB	BI500	m²/NM²	1 NM	D	Trace	Excel	Paper forms
			2 kW						Ident.	sheet	Excel files

Fishing gear and biological parameters									
Year	Ship and date	Fishing gear	Trawl doors with floats for surface layer	Codend mesh size (stretched)	Special features	Speed (knots)	Duration	Total number of hauls	Fishing time Day/Night
1994	Walther Herwig III	1600#	NO	20 mm		4	30	41	D and N
	12.07.-25.07.								
1995	Walther Herwig III	GOV	NO	20 mm		4	30	60	D
	17.07.-08.08.	1600#							

Subsampling	TS regression		Length/Weight	Data
method	Species group	Regression	relationship	storage
			(L in cm)	
length strat.	Clupeids	20,0logL-71,2		Paper forms
				DBASE
length strat.	Clupeids	20,0logL-71,2		Paper forms
				DBASE