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REPORT OF THE PLANNING GROUP ON HERRING SURVEYS (PGHERS)

24-27 JANUARY 2006

ROSTOCK, GERMANY

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Conseil International pour l'Exploration de la Mer

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Executive summary

Review of larvae surveys in 2005/2006: At the time of writing two of the seven surveys in the North Sea remained to be carried out in January 2006. Results will be ready for the Herring Assessment Working Group (HAWG) meeting in March 2005.

Coordination of larvae surveys for 2006/2007: In the 2006/2007 period, the Netherlands and Germany will undertake seven larvae surveys in the North Sea from 1 September 2005 to 31 January 2006. Germany will contribute a second vessel to the IHLS to ensure coverage in the Orkney and Buchan area, which has not been covered in recent years; this will also take place in the first half of September. Thus, with the combined effort of Germany and Netherlands an almost complete coverage of the main spawning grounds is achievable. The Baltic Sea Fisheries Institute will continue with the larvae survey in the Greifswalder Bodden area in 2006.

North Sea acoustic surveys in 2005: Six acoustic surveys were carried out during late June and July 2005 covering the North Sea and west of Scotland. The provisional total combined estimate of North Sea spawning stock biomass (SSB) is 1.9 million t, a decrease from 2.6 million t in 2004. The stock is dominated by the 2000 year class. Growth of the 2000 year class seems again to be slower than average: 96% is mature. The west of Scotland SSB estimate is 190,000 t (400,000 t in 2004); this is a substantial reduction from last years estimate. The surveys are reported individually in Annex 2.

Western Baltic acoustic survey in 2005: A joint German-Danish acoustic survey was carried out with RV “Solea” from 4 to 21 October in the Western Baltic. The estimate of Western Baltic spring spawning herring SSB is 197,700 t (192,100 t in 2004). A full survey report is given in Annex 3.

Manuals for acoustic and herring larvae surveys: The *manual for herring acoustic surveys in ICES Divisions III, IV, and VI*A will be reviewed and updated in 2006 by correspondence. Development of the equipment used, has been extensive in recent years: an extensive review is, therefore, required: there was not enough time to carry out this activity at the meeting. The *manual for the International Herring Larvae Surveys south of 62° north* has been reviewed and updated. Version 2 of the manual is attached in Annex 5.

Status and future of the FISHFRAME and HERSUR database: The status of the HERSUR database has not changed since 2005. Only Denmark has uploaded new data. Three countries have uploaded aggregated (“stage 3”) data in the Fishframe database. The international data set was completed by extracting national input data from the excel sheet used so far. The calculation, aggregation and reporting procedures on uploaded data of 2003, 2004 and 2005 was tested against the old procedure. The minor differences found were caused by differences in precision. It was decided that the Fishframe stage 3 module will be used to aggregate data from the 2006 surveys at the next meeting in 2007. To ensure that all countries confirm to same methods in stage 2, a group to design the user requirement specifications should be formed and meet during 13–14 June 2006 at DIFRES in Copenhagen.

Sprat: Data on sprat were available from RV “Walther Herwig” III, RV “Tridens” and RV “Dana”. The total sprat biomass was estimated as 562,000 t in the North Sea (up from 360,000 t in 2004) and 59,800 t in the Kattegat (up from 15,000 t in 2004). The present data suggest that sprat abundance is decreasing in the south and the distribution limit might therefore have been reached.

Coordination of acoustic surveys in 2006: Six acoustic surveys will be carried out in the North Sea and west of Scotland in 2006 between 25 June and 30 July. Participants are referred to Figure 4.4.1 for indications of survey boundaries. “Tridens” and “Walther Herwig” will

cover the area between 52º and 57º together with interlaced transects. A survey of the western Baltic and southern part of Kattegat will be carried out by a German research vessel in October.

Larvae survey sampler: In the sampling period 2004-2005 the Netherlands changed from a Gulf III to a Gulf VII plankton torpedo. The Gulf VII seems to perform better in that the oblique hauls show a sharp ‘V’-shape. Possible differences between these two sampling devices will be investigated by sampling simultaneously with the Gulf III and Gulf VII during the September 2006 survey. A special set-up will be tested and improved during a survey in May targeting spawning horse mackerel in the southern North Sea. If the tests during the May survey prove successful, the apparatus will be used during the herring larvae survey in September 2006 to obtain a set of intercalibration hauls.

Review of the Age Reading Workshop at the Archipelago Research Institute on the island of Seili, Finland on 6–June 2005: Thirty-five participants from 25 countries attended the Age Reading Workshop to identify present problems in herring age determination, improve the accuracy and precision of age determinations and spread information of the methods and procedures used in different ageing laboratories working with herring. The main conclusion was that it is recommended that regular otolith exchanges take place between institutes in order to detect precision drift in the age estimations.

Evaluating the potential of the Torry Fish Fat Meter for measuring lipid content of herring at sea: Deborah Davidson from the University of Aberdeen gave a presentation of her ongoing PhD study examining the fat content in herring (see working document in Annex 7). The overall aim of the field study in 2006 is to determine whether lipids impose a threshold on the onset of maturation in North Sea herring. PGHERS recommends that in the 2006 North Sea acoustic surveys, all participants take a student from Aberdeen University to make measurements of the fat content of herring.

1 Terms of reference

The **Planning Group for Herring Surveys** [PGHERS] (Chair: B. Couperus, The Netherlands) will meet at the Institute for Baltic Sea Fisheries in Rostock, Germany, from 24–27 January 2006 to:

a) combine the 2005 survey data to provide indices of abundance for the population within the area;

b) coordinate the timing, area and effort allocation and methodologies for acoustic and larvae surveys for herring and sprat in the North Sea, around Ireland, Division VIa and IIIa and Western Baltic in 2006;

c) review and update the PGHERS manual for acoustic surveys to address standardization of all sampling tools and survey gears;

d) assess the status and future of the HERSUR database and an intermediate database, containing aggregated data;

e) review the conclusions of the herring age reading exchange and workshop (Turku, Finland) and report on implications and use;

f) investigate and report on the possible bias introduced by a change in gear for sampling herring larvae during the Dutch herring larvae survey.

PGHERS will report by 6 February 2006 for the attention of the Living Resources, and the Resource Management Committees as well as to HAWG.

2 Participants

Bram Couperus (Chair)	The Netherlands
Eric Armstrong	UK
Eckhard Bethke	Germany
Thomas Größler	Germany
Paul Fernandes	UK
Eberhard Götze	Germany
Birgitt Klenz	Germany
Bo Lundgren	Denmark
John Boyd	Ireland
Norbert Rohlf	Germany
Deborah Davidson	UK
Teunis Jansen	Denmark
Cindy van Damme	The Netherlands
Christopher Zimmermann (Host)	Germany

3 Herring larvae surveys

3.1 Review of Herring Larvae Surveys in 2005/2006

3.1.1 Review of the western Baltic larvae survey

The German Institute for Baltic Sea Fisheries Rostock continued with the weekly repeated larvae surveys in the main spawning ground and hatching area of spring spawning herring during the 2005 spawning season. The estimated numbers of larvae for the period 1991 to 2005 are summarised in Table 3.1.1.1. Compared to previous years the 2005 larvae index estimate (number of larvae which will grow to the juvenile stage with a total length of 30 mm) is at a similar level to the weak 2000 and 1995 year-classes.

The importance of a fishery-independent recruitment-index has increased since western Baltic spring-spawning herring has been subjected to an analytical assessment (ICES 2005). After the evaluation by the “ICES Planning Group for Herring Surveys” (ICES 2004) it was proposed that the western Baltic larvae survey could provide this recruitment index. PGHERS (ICES 2004) requested that data from the surveys between 1977 and 1991 be made available; however, the raw data from 1977 to 1987 are no longer available (see Brielmann 1989); and data in 1988 and 1989 are not reliable; data from 1990 onwards can be taken as reliable.

A correlation coefficient was estimated for the period 1992 to 2001 (Oeberst and Klenz 2003) between the recruitment index N30 and the numbers of fish in AG 0 (obtained from the final ICA run by the HAWG). The value was $R=0.69$ ($p<0.05$). When excluding an outlier in the 1998 year-class from the N30-calculation, the corresponding R increased to 0.80 ($p<0.01$).

However, when including the N30 as a recruitment index in the assessment of the Baltic western spring spawning herring, the ICA runs result in an overestimation of the SSB by orders of magnitude. The reason for this overestimation is unclear. Therefore, the N30 as it stands (recruitment index with absolute numbers) can not be used in the assessment. PGHERS recommends that further attempts are made to develop a recruitment index based on N30; this may include consideration of relevant environmental parameters. Any modified index should be tested to establish if it results in a better fit in the assessment.

Table 3.1.1.1: Results of the German herring larvae surveys in the Greifswalder Bodden and adjacent waters, 1991 to 2005.

N30 = year-class index, estimated number of herring larvae which will grow up to the juvenile stage with total length >= 30mm; S = total survival rate; S1 = survival rate of the youngest larvae.

YEAR	NUMBER OF LARVAE = YEAR-CLASS INDEX N30 [MILLIONS]	MEAN SURVIVAL RATE PER DAY S / S1[%]	MEAN GROWTH RATE PER DAY [MM D^{-1}]
1991	236	91 / 93	0.48
1992	18	80 / 71	0.48
1993	199	79 / 75	0.53
1994	788	92 / 92	0.47
1995	171	90 / 64	0.53
1996	31	81 / 77	0.44
1997	54	76 / 73	0.43
1998	2,553	92 / 96	0.63
1999	1,945	91 / 95	0.59
2000	151	87 / 91	0.68
2001	421	92 / 98	0.53
2002	2,051	94 / 94	0.48
2003	2,005	97 /100	0.51
2004	860	91 / 95	0.60
2005	162	89 / 96	0.51

3.1.2 North Sea

In the reporting period the Netherlands and Germany participated in the larvae surveys. In total six units and time periods out of ten were covered in the North Sea. They are listed below.

Table 3.1.2.1: Areas and time periods covered during the 2005/06 herring larvae surveys:

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

The final herring larvae sampling period was finished just prior to the PGHERS meeting.

For most of the larvae surveys in the North Sea, sample examination and larvae measurements have not yet been completed; therefore, it is not yet possible to give an overview on the larvae survey results. Distribution maps of larval abundance from individual surveys analysed so far are shown in Figures 3.1.2.1 – 3.1.2.3.

However, as in previous years, the information necessary for the larvae abundance index calculation will be ready for and presented at the Herring Assessment Working Group (HAWG) meeting in March 2006.

3.2 Coordination of Larvae Surveys for 2006/2007

At present only the participation of the Netherlands and Germany is confirmed in the 2006/07 period. Germany will contribute a second vessel to the IHLS to ensure coverage in the Orkney and Buchan area, also in the first half of September, which wasn’t done in recent years. Together with the effort undertaken by the Netherlands an almost complete coverage of the main spawning grounds is achievable. Only two periods in the Central North Sea will remain uncovered. If there is any possibility of additionally covering these areas, the first half of October in the CNS would be preferred.

A preliminary survey schedule is presented in the following table:

Table 3.2.1: Areas and time periods for the 2006/07 herring larvae surveys.

Area / Period	1–15 September	16–30 September	1–15 October
Orkney / Shetland	Germany	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 should be sent to Norbert Rohlf (Bundesforschungsanstalt für Fischerei, Hamburg), for inclusion into the IHLS database. BFA Fi reports the summarised results and the updated series of MLAI-values to the HAWG.

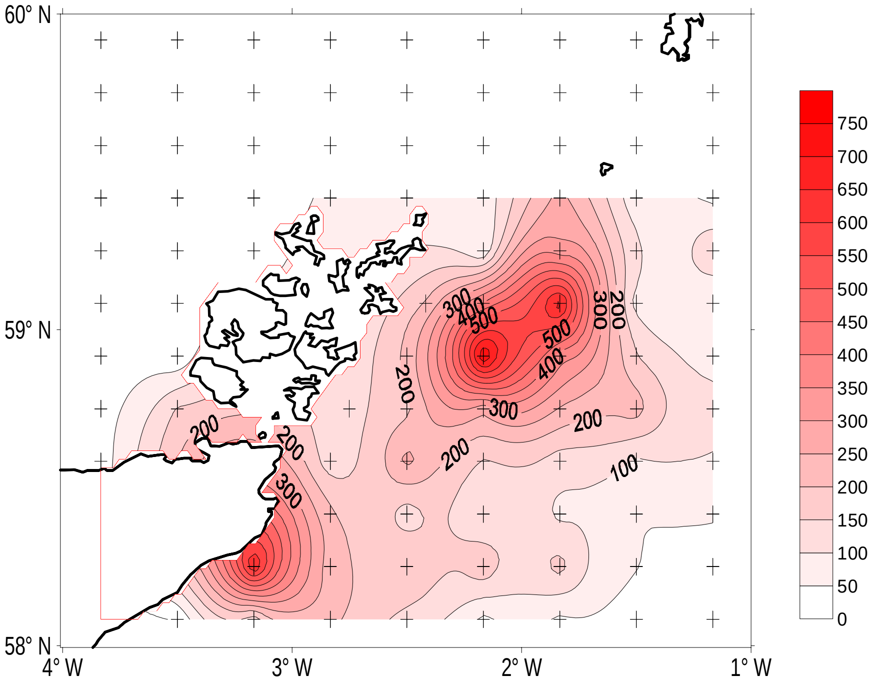

Figure 3.1.2.1: Orkney/Shetlands 16– 30 September 2005 (FRG), Larvae Abundance, all length classes (n/m²)

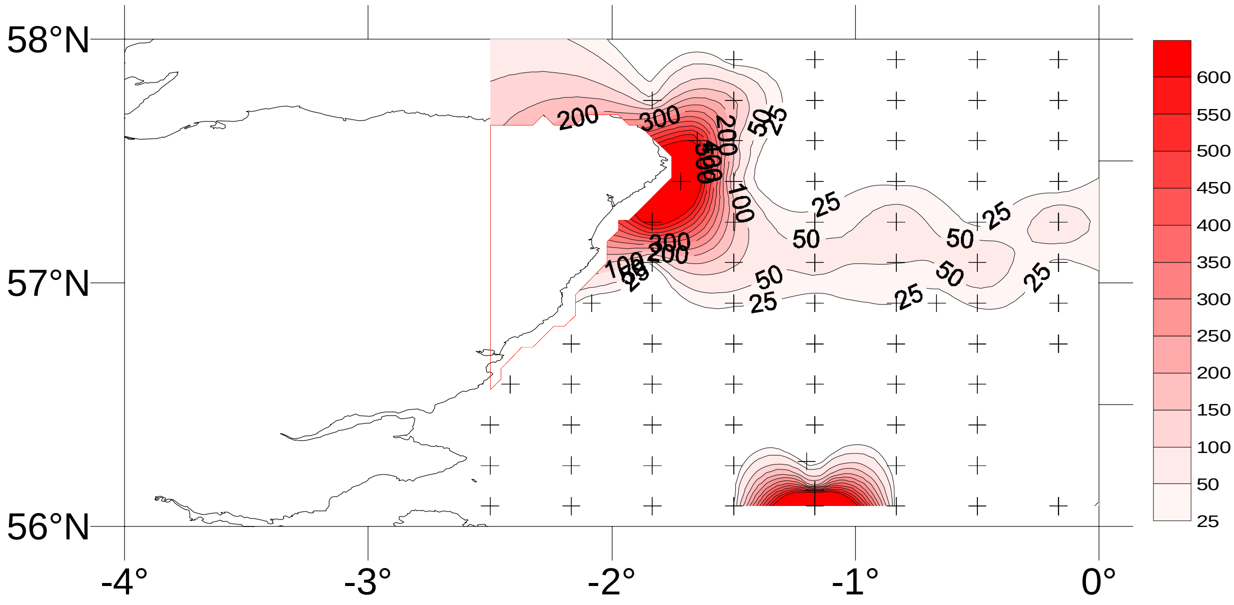

Figure 3.1.2.2: Buchan 16–30 September 2005 (NL), Abundance of herring larvae < 10 mm (n/m²).

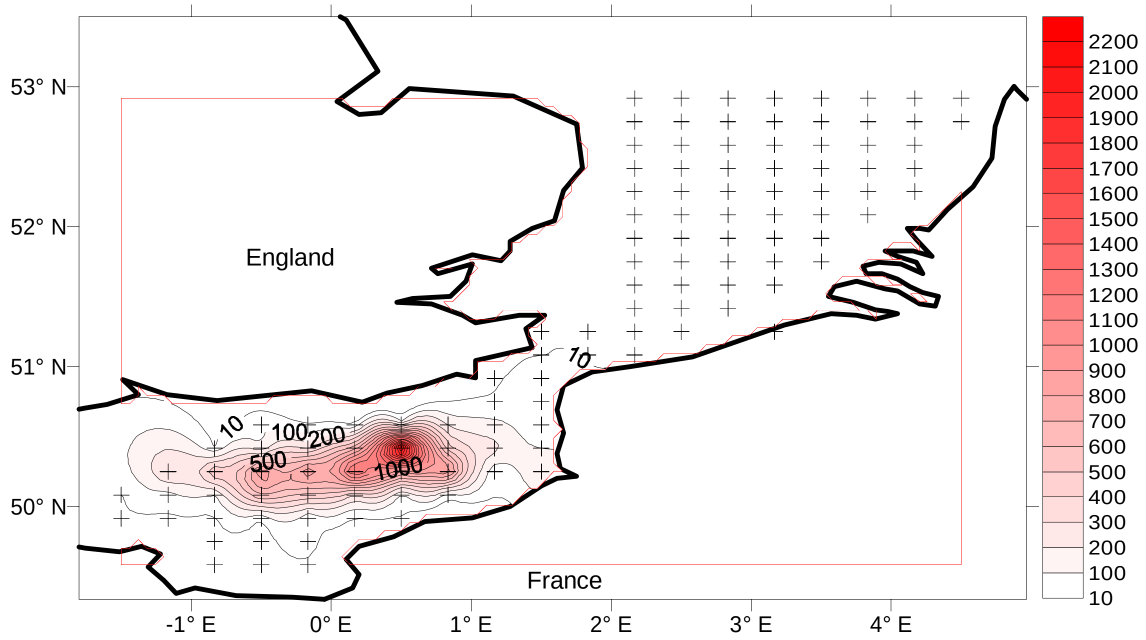

Figure 3.1.2.3: Southern North Sea 1–15 January 2006 (FRG), Larvae Abundance, all length classes (n/m²).

3.3 Investigation of bias introduced by change of gear (ToR f)

In the sampling period 2004-2005 the Netherlands changed from a Gulf III to a Gulf VII plankton torpedo. The Gulf VII seems to perform better in that the oblique hauls show a sharp 'V'-shape, even during bad weather. This is probably due to the fact that the Gulf VII has an open frame instead of enclosed. The open frame also decreases the torpedo weight and, therefore, the Gulf VII is easier to handle on board a vessel. An additional difference between the Gulf III and Gulf VII is that the Gulf III has a blunt nosecone while that of the Gulf VII is sharper.

Possible differences between these two sampling devices will be investigated by sampling simultaneously with the Gulf III and Gulf VII during the September 2006 survey. A frame will be developed to enable deployment of both torpedoes at the same time. On this frame, a pitch-and-roll sensor, altimeter, 3 flow meters (internal on the Gulf III, both internal and external on the Gulf VII) and a depressor will be mounted. This set-up will be tested and improved during a survey in May targeting spawning horse mackerel in the southern North Sea. If the tests during the May survey prove successful, the apparatus will be used during the herring larvae survey in September 2006 to obtain a set of intercalibration hauls. The results will be investigated to determine the difference in performance between the gears.

4 Acoustic surveys

4.1 Combined estimates of the acoustic survey

4.1.1 North Sea and west of Scotland acoustic survey

The surveys are reported individually in the Appendices of this report. A combined report has been prepared as a working document attached as Annex 4. The combined survey results provide spatial distributions of herring abundance by number and biomass at age by statistical rectangle; and distributions of mean weight and fraction mature at age.

The estimates of North Sea autumn spawning herring SSB are reasonably consistent with previous years, at 1.9 million tonnes and 9,600 millions herring individuals (Table 4.1.1.1). The distribution of the adults was located more to the middle of the survey area than in previous years, with large amounts of herring detected between the surveys carried out by the "Tridens" and the "Scotia" (Figure 4.1.1.1 and 4.1.1.2). The survey again shows two well-above average year classes of herring (1998 and 2000). Growth of the 2000 year class seems still to be slower than average. Individuals of this year class are smaller and lighter than the 1998 year class at the same age. Now 96% are mature at age 4 compared to 65% at age 3 and 100% for previous year classes at this age. This compares with fairly typical values in 2005 for 2 and 3 wr herring of 76% and 97% respectively.

Four ICES statistical rectangles were not surveyed. Abundance estimates for these have been obtained by inverse-distance interpolation (taking the eight surrounding rectangles into account). After some discussion, this method was deemed to be the best compromise between accuracy and simplicity, for the purposes of any retrospective analyses in future.

It is apparent from examination of mean lengths and weights by statistical rectangle, that where analysis procedures differ, newly introduced interlaced components of the survey generate somewhat unusual results. Whilst this is unlikely to affect the global estimates, it has some presentational difficulties and highlights the need for better integration. In the medium term (2007 survey), when the analysis system being developed in Fishframe is expected to be ready, this problem will become obsolete. In the short term (2006 survey), participants with interlaced data should conduct their analyses in close co-operation with each other.

The estimates of Western Baltic spring spawning herring SSB are 81,000 tonnes and 530 million herring (Table 4.1.1.2) which is a decrease following last years increase. The Western Baltic survey produces a rather noisy signal and the indications are that the stock has declined to a level comparable to that between 1996 and 2000.

The West of Scotland estimates of SSB are 190,000 tonnes and 1.1 billion herring (Table 4.1.1.3). This is a substantial reduction from last years estimate. Total adult mortality estimated from the survey is rather variable but high in the last two years. The mean mortality over the last 6 years has been approximately 0.4, this is a higher than the assessment indicates. The survey puts the stock at a low level relative to recent history. The abundant 1998 year class is now depleted; the 2000 year class is the strongest remaining and there is no sign of incoming year classes.

Table 4.1.1.1: Total numbers (millions of fish) and biomass (thousands of tonnes) of North Sea autumn spawning herring in the area surveyed in the acoustic surveys July 2005, with mean weights, mean lengths and fraction mature by age ring.

AGE (RING)	NUMBERS	BIOMASS	MATURITY	WEIGHT(G)	LENGTH (CM)
0	5015.9	16.0	0.00	3.2	7.9
1	3112.5	134.7	0.01	43.3	17.5
2	1890.2	255.4	0.76	135.1	24.5
3	3436.4	587.8	0.97	171.0	26.2
4	5609.3	1014.4	0.96	180.8	26.6
5	1211.3	276.8	1.00	228.5	28.5
6	1172.3	290.3	1.00	247.6	29.2
7	139.9	35.3	1.00	252.6	29.5
8	126.5	34.7	1.00	274.4	30.2
9+	106.7	31.5	1.00	295.1	30.7
Immature	8920.4	234.8			
Mature	9577.8	1867.9			
Total	21821.0	2676.9			

Table 4.1.1.2: Total numbers (millions of fish) and biomass (thousands of tonnes) of Western Baltic spring spawning herring in the area surveyed in the acoustic surveys July 2005, with mean weights, mean length and fraction mature by age ring.

AGE (RING)	NUMBERS	BIOMASS	MATURITY	WEIGHT(G)	LENGTH (CM)
0	0.0	0.0	0.00		
1	2687.0	105.9	0.01	39.42	17.1
2	1342.1	100.1	0.11	74.59	21.0
3	463.5	46.6	0.30	100.5	23.0
4	201.3	28.9	0.63	143.7	24.3
5	102.5	16.5	1.00	160.9	26.2
6	83.6	14.9	1.00	177.7	26.9
7	37.2	7.5	1.00	202.3	28.0
8	12.4	2.9	1.00	230.3	29.3
9+	9.0	2.1	1.00	227.7	28.8
Immature	4265.4	227.5			
Mature	534.8	80.9			
Total	4938.6	325.3			

Table 4.1.1.3: Total numbers (millions of fish) and biomass (thousands of tonnes) of autumn spawning of West of Scotland herring in the area surveyed in the acoustic surveys July 2005, with mean weights, mean lengths and fraction mature by age ring.

AGE (RING)	NUMBERS	BIOMASS	MATURITY	WEIGHT(G)	LENGTH (CM)
0	0.0	0.0	0.00		
1	50.2	3.8	0.00	75.1	20.6
2	243.4	31.6	0.84	129.6	24.7
3	230.3	35.4	1.00	153.8	26.1
4	423.1	70.4	1.00	166.5	26.8
5	245.1	44.2	1.00	180.2	27.5
6	152.8	29.2	1.00	191.1	28.0
7	12.6	2.7	1.00	212.5	29.0
8.00	39.0	7.9	1.00	203.0	28.6
9+	26.8	6.1	1.00	228.4	29.7
Immature	89.2	8.3			
Mature	1103.8	187.5			
Total	1423.3	231.3			

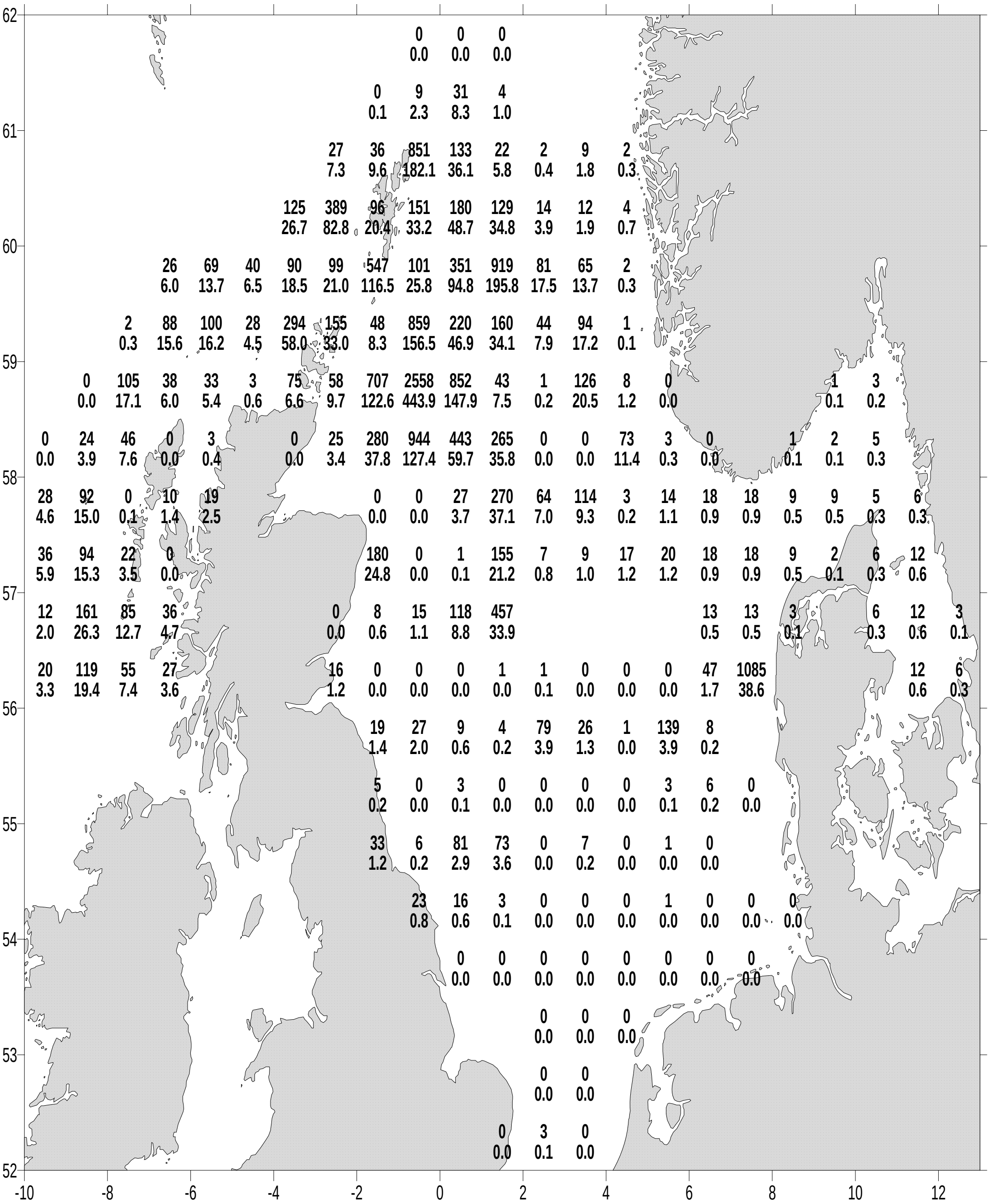

Figure 4.1.1.1: Abundance of Autumn spawning herring 1-9+ from combined acoustic survey July 2005. Numbers (millions) (upper figure) and biomass (thousands of tonnes) (lower figure).

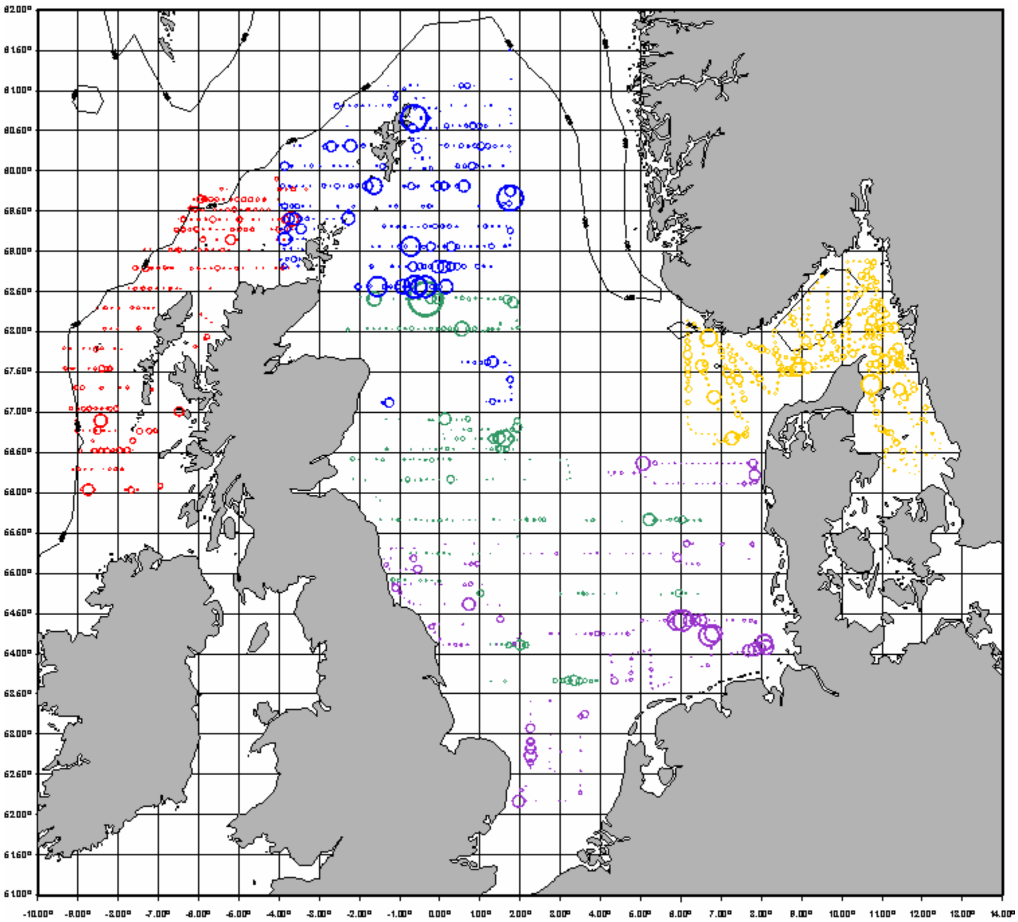

Figure 4.1.1.2: Post plot of 5 nm NASC values for clupeids (herring and sprat) for all the countries except Norway. The plot shows the distribution of clupeid NASC values (on a proportional square root scale relative to a value of 5000).

4.1.2 Western Baltic

A joint German-Danish acoustic survey was carried out with RV '"Solea"' from 4–21 October 2005 in the Western Baltic. This survey is traditionally coordinated within the framework of the Baltic International Acoustic Survey. As in previous years, the survey was carried out during the night. An EK60 echosounder with a hull mounted ES38B transducer and EchoView3 integrator software were used to collect and process acoustic data. The cruise track was 1,356 nautical miles in an area of 13,895 n.mi.^{2} and covered the ICES Subdivisions 21, 22, 23 and 24. To identify the target species and determine length and weight of fish, 51 trawl hauls were carried out. Samples of herring and sprat were frozen for subsequent analysis in the lab. After each haul hydrographic measurements were taken with a CTP-O_2 probe. The Western Baltic spring spawning herring stock was estimated to be 5.4 billion fish or about 197,700 t in Subdivisions 22–24. This is comparable to last year's result. The estimated total sprat stock was 7,61 billion fish or 72,600 t. A survey report is provided in Annex 3.

4.2 Targeting additional species in the acoustic survey

In the light of recent recruitment failures of small pelagic fish species and following breeding failures in Scottish bird colonies, the possibility of adding sandeel to the main target species - herring and sprat – in the North Sea hydro acoustic survey was discussed. Bram Couperus showed distribution of 0 group sandeel during the Dutch surveys east of Scotland to illustrate the possibility. It was noted that it is generally difficult to scrutinize sandeel using a single frequency echosounder. In order to detect (0 group) sandeel in an acoustic survey, one should employ at least one additional high frequency (e.g. 120 or 200 kHz in addition to 38 kHz). Algorithms to isolate sandeel echotraces using multifrequency data have been developed in the Simfami project (e.g. Mosteiro *et al*., 2004).

It was pointed out that targeting other species, especially non-swim bladdered species like sandeel, requires more trawl sampling: this reduces the time available for other activities during the survey. Furthermore, with the exception of Scotland (and possibly Norway), nobody has fully implemented the use of multi frequency data yet, although this would act as an incentive to develop this extremely useful tool; Germany and the Netherlands are presently working on it.

The group recommends that multifrequency data be collected during the 2006 surveys and if possible additional trawl hauls be taken from traces thought to contain sandeel. This will determine how feasible it may be to provide data on this species during these surveys.

4.3 Sprat

Sprat data were available from RV "Walther Herwig III", RV "Tridens" and RV "Dana". No sprat was reported in the northern areas by RV "Scotia" and RV "Johan Hjort". The distribution of sprat by numbers in millions and biomass in the North Sea is shown in Figure 4.3.1. The southern border of the survey area 2005 was limited to 52°N. There was no clear indication that the southern distribution has been reached; however, by far the highest concentration of sprat was observed in the inner German Bight and therefore covered by the survey.

In contrast to 2004, when 0-group sprat contributed to 34% of the total abundance, no 0-group sprat was detected during the 2005 survey. In Division IIIa, in the south-eastern Kattegat, the abundance and total biomass was estimated to have increased to about 4570 million individuals, equivalent to 54 kt, and in the south western part of the Skagerrak about 490 million individuals, equivalent to 5.8 kt. In the North Sea, abundance was calculated to be 76814 million ind., and biomass 562 kt, which is a significant increase compared to last year (Table 4.3.1).

Table 4.3.2 gives numbers, mean weights and mean length at age and maturity separately for the area east and west of 3°E.

In 2005 for the first time, large overlapping areas were surveyed by two vessels (“Tridens” and “Solea”) where sprat occurred in quantity. Significant differences in the estimation of abundance and biomass between the two teams became obvious. The reasons for this will have to be investigated intersessionally.

Table 4.3.1: Comparison of biomass and abundance of sprat as obtained by the summer North Sea acoustic survey. Note that the survey area was increased over the year (by factor 3 for the sprat distribution area). Therefore, only figures for the last three years are roughly comparable.

BIOMASS							NUMBERS				
	0	**1**	**2**	**3+**	**sum**		**0**	**1**	**2**	**3+**	**sum**
2005	**0.0**	**479.6**	**67.4**	**16.8**	563.8		**0**	**70175**	**5533**	**1106**	76814
2004	19.4	266.6	71.5	2.1	359.6		17400	28940	5180	99	51620
2003	0.0	198.8	61.3	6.0	266.1		0	25292	3984	339	29616
2002	0.0	166.8	55.1	3.7	225.6		0	15769	3687	207	19664
2001	0.0	96.5	23.5	1.8	121.8		0	12639	1812	110	14561
2000	0.0	100.4	92.4	2.8	195.6		0	11569	6407	180	18156
1999	0.0	3.3	0.0	0.0	3.3		0	353	5	0	358
1998	0.1	48.2	14.1	0.8	63.2		17	5365	960	37	6379

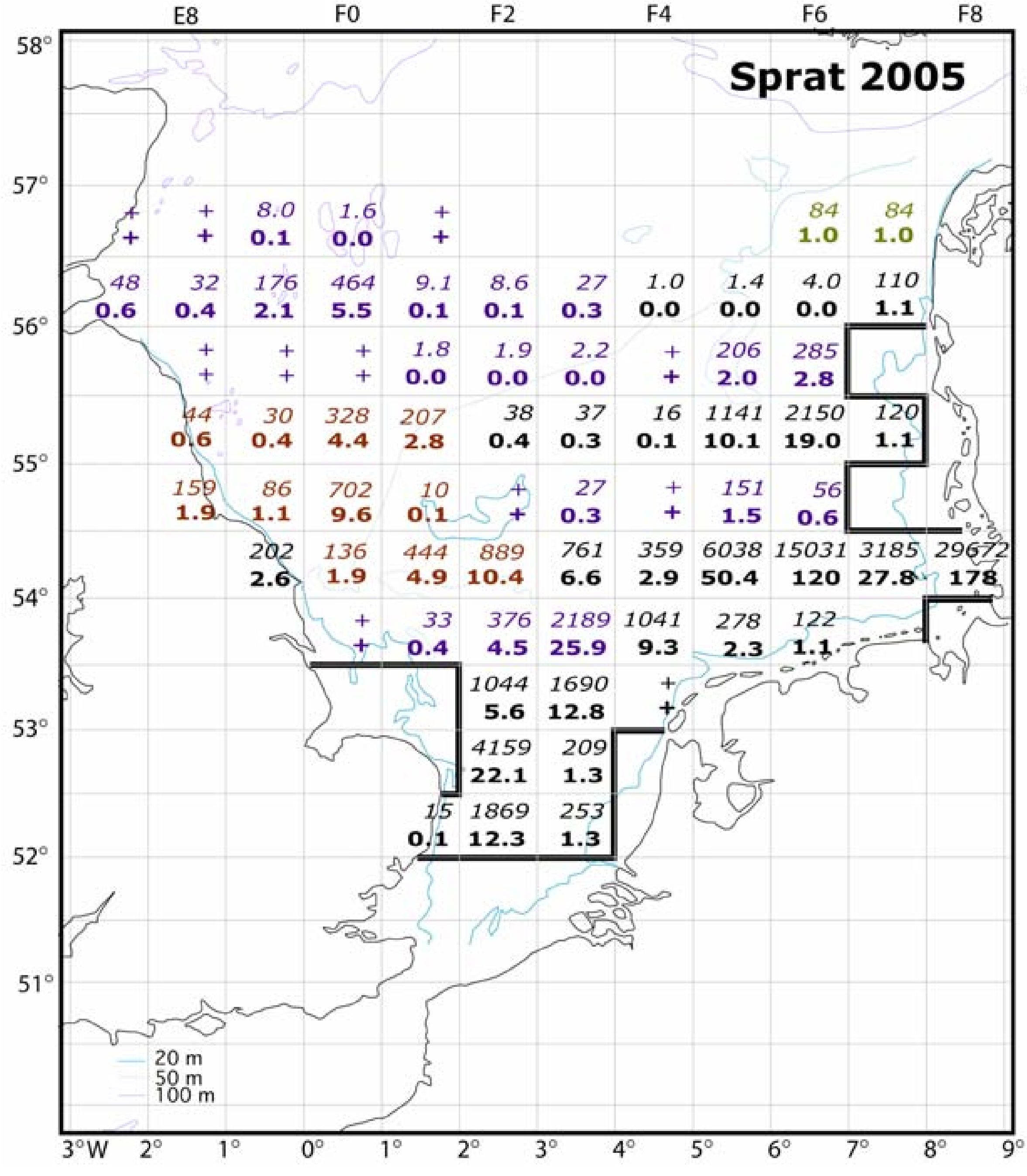

Figure 4.3.1: Sprat abundance (upper figure in italics, in million ind.) and biomass (lower figure in bold, in kt) per statistical rectangle in the southern North Sea as obtained by the herring acoustic survey 2005. Colours indicate different vessels: black: "Solea", green: "Dana", violet: "Tridens" and red: mean for "Tridens" and "Solea" (weighted by survey intensity in a specific rectangle).

Table 4.3.2: Sprat in the North Sea: Abundance, Biomass, mean mass and mean length by age and maturity, for the area east and west of 3°E and fort he total North Sea.

	1I	1M	2I	2M	3I	3M	4M	5M	TOTAL
	Abundance (mill.)								
w of 3°E	6658.8	4345.1	536.2	4054.8	0.0	1065.5	17.9		**16678.2**
e of 3°E	23406.0	35765.3	282.3	659.3	5.3	16.6	0.9	0.2	**60135.9**
total North Sea	30064.8	40110.4	818.5	4714.1	5.3	1082.1	18.8	0.2	**76814.1**
immature total									**30888.6**
mature total									**45925.5**
	Biomass (kt)								
w of 3°E	30.8	42.0	4.6	52.4	0.0	16.2	0.3	0.0	**146.3**
e of 3°E	103.9	302.9	2.6	7.8	0.1	0.2	0.0	0.0	**417.6**
total North Sea	134.7	344.9	7.2	60.2	0.1	16.5	0.3	0.0	**563.8**
immature total									**141.9**
mature total									**421.9**
	mean mass (g)								
w of 3°E	7.9	11.5	8.4	12.9		15.4	16.9		
e of 3°E	5.1	8.7	10.6	13.7	14.7	16.0	22.6	23.7	
total North Sea	7.1	10.8	8.7	13.2	14.7	15.6	17.2	23.7	
	mean length (cm)								
w of 3°E	10.3	11.5	10.5	11.8		12.4	13.0		
e of 3°E	8.9	10.5	10.9	12.2	12.3	12.9	14.2	14.5	
total North Sea	9.9	11.2	10.5	11.9	12.3	12.6	13.1	14.5	

4.4 Coordination of acoustic surveys in 2006

4.4.1 North Sea and West of Scotland

In 2004 the group re-allocated the survey effort (see Sec 5 of 2003 PGHERS report). In 2005, survey transects were interlaced for those vessels for which a good agreement of scrutiny procedures was demonstrated, and where fishing and interpretation of trawl haul information were comparable. The present layout is considered to be intermediate; it should facilitate further harmonisation of the methods without increasing the risk of losing continuity in the time series. In addition, the North Sea sprat stock should continue to be surveyed for reasons given in section 4 of last year's report (ICES 2005b). This requires that the southern boundary of the survey area be kept at 52°N.

Last year the group considered that interlacing survey transects would benefit the overall quality of the survey, but a higher level of coordination would be needed than in the past. To facilitate this, it was decided that tentative cruise tracks should be exchanged prior to the survey for further harmonisation. **Plans should be sent to Bram Couperus, IJmuiden, not later than 30 May 2006**; he will then contact individual cruise leaders if amendments are required.

Additionally, vessels should be in daily radio contact during the cruise at 1900 hrs UTC to exchange position and cruise track information as well as survey results (catch depth, species composition, mean length). Deviations from the original submitted cruise track should be communicated immediately, to enable the coordinator to adapt other nations cruise tracks and to avoid gaps. **Paul Fernandes has agreed to act as coordinator during the 2006 survey. He can be reached by email or phone between 25 June and 1 July and will initiate the radio communication from 1 July onwards**.

Acoustic surveys in the North Sea and west of Scotland in 2006 will be carried out in the periods and areas given in Table 4.4.1.1 and Figure 4.4.1.1 a and b.

Table 4.4.1.1

VESSEL	PERIOD	AREA	RECTANGLES
Charter west Sco (SCO)	01 July – 21 July	56°- 60°30'N, 3° - 10° W	41E0-E3, 42E0-E3, 43E0-E3, 44E0-E3, 45E0-E4, 46E1-E5, 47E2-E7, 48E3-E7, 49E4-E8, 50E5-E6
"Johan Hjort" (NOR) XXXX	28 June – 30 July	56°30'- 62° N, 2° - 6° E	42F2-F7, 43F2-F5, 44F2-F5, 45F2-F5, 46F2-F4, 47F2-F4, 48F2-F4, 49F2-F4, 50F2-F4, 51F2-F4, 52F2-F4, plus overlap area A
"Scotia" (SCO) XXXX	01 July – 21 July	57° - 62° N, 2/4° W - 2° E	43E8-F1, 44E6-F1, 46E6-F1, 47E6-F1, 48E6-F1, 49E6-F1, 50E6-F1, 51E7-F1, 52E8-F1, 52E9-F1
"Tridens" (NED) PBVO	26 June – 21 July	53°30' – 58°30' N, Eng/ Sco to Den/Ger coasts	36F0-F3, 38F2-F7, 40E8-F7, 41E7-F3, 42E7-F1, 45E6-F1
"Solea" (GER) DBFH	29 June – 18 July	52° - 56°30' N, Eng to Den/Ger coasts	33F1-F3, 34F2-F3, 35F2-F4, 36F4-F7, 37E9-F8, 38E9-F1, 39E8-F7, 41F4-F7
"Dana" (DEN) OXBH	25 June – 6 July	Kattegat and North of 56° N, east of 6° E	41G1-G3, 42F6-F7, 42G0-G3, 43F6-G2, 44F6-G1, 45F8-G1, 46F9-G0

Borders of survey areas between the west of Scotland charter vessel and RV "Scotia" can be moved if required. Overlapping areas will be surveyed by (A) RV "Scotia" and RV "Johan Hjort" (mid July, Rectangles 49E9-F0, 50E9-F0), (B) the charter vessel and RV "Scotia" (dates to be defined, in Rectangles 47E6-E7, 48E6-E7. 49E6-E8), (C) RV "Johan Hjort" and RV "Dana" (around 10 July, Rectangles 42F6-7).

No **Intercalibration** is planned for 2006.

The results from the national acoustic surveys in June-July 2006 will be collated and the result of the entire survey will be combined during the next PGHERS. It may be necessary to coordinate analyses for those vessels interlacing during the cruise (NED, GER, SCO), preferably intersessionally. Individual or combined survey results for sprat and herring should be uploaded to FishFrameAcoustics (FFA) no later than **30 November 2006**. The group agreed that if one or more parties deliver their *validated* data later than 15 December 2006, the latest institute will be given the responsibility for producing the combined survey data and report in 2007. In the light of the database development expected for 2006 (step 2, see paragraph 7), participants should be prepared to additionally deliver their raw data to the new database (Hersur or follow-up).

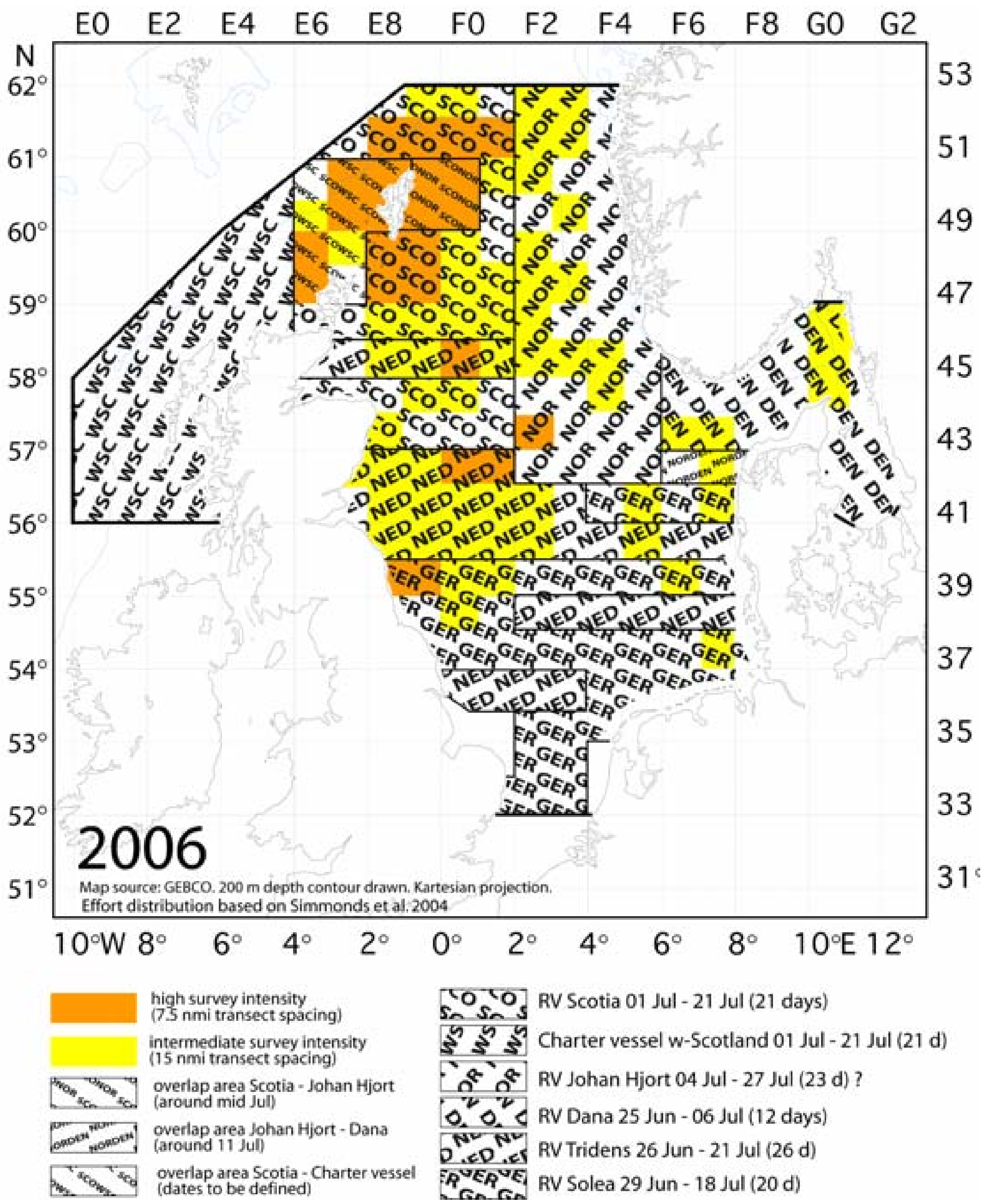

Figure 4.4.1.1a: Survey area layouts and dates for all participating vessel in the 2006 acoustic survey of the North Sea and adjacent area's with survey intensity indicated.

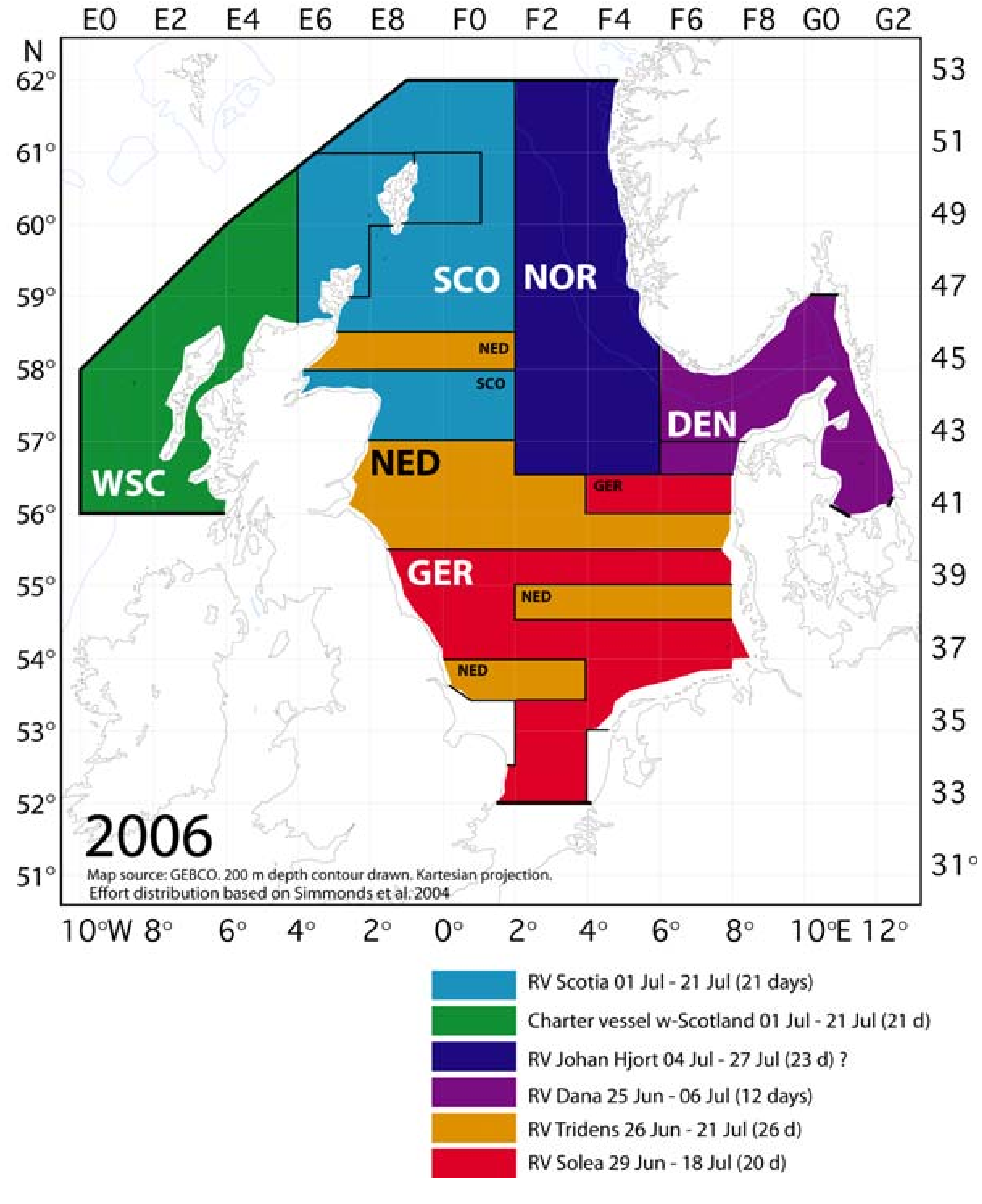

Figure 4.4.1.1b: Survey area layouts and dates for all participating vessel in the 2006 acoustic survey of the North Sea and adjacent area's, for indication of survey intensity see fig 4.1.1.1a.

4.5 Hydrographic data

Following a recommendation of the last PGHERS meeting, hydrographic data from the acoustic survey in June/July from the years 2000 to 2005 were collated and stored in the Ocean Data View format. The result is the following data set of 1540 hydrographic stations:

Table 4.5.1: Data set consisting of hydrographic stations from the ICES coordinated North Sea hydro acoustic survey for herring and sprat since 2000.

YEAR	DK	GER	NL	NOR	TOTAL
2005	41	73	46	120	280
2004	34	93	36	157	320
2003	33	47	20	136	236
2002	32	37	51	165	285
2001	24	35	20	143	222
2000	32	52	25	98	207

It is of special advantage that the hydrographic data are synchronous with the acoustic measurements. A set of standard outputs from the existing data using the software package Ocean Data View were presented. After final evaluation and correction, this dataset will be uploaded into the Fishframe database as an additional table to allow fast and easy access for all users. The analysis of this data will be continued and results will be presented during the next PGHERS meeting. The goal of this analysis is to search for possible relationships between the hydrography and the distribution of fish. Consequently, the data are not necessarily as high a quality as normally required of oceanographic data. It is recommended for future surveys that data continue to be collected and stored.

5 Review and update of PGHERS manuals

5.1 Acoustic Manual

Most participants in the North Sea hydro acoustic survey now employ the Simrad EK60 echosounder, having replaced the Simrad EK500 echosounder which was the instrument the manual was based on. Due to changes in equipment used on some surveys the acoustic survey manual needs to be updated to bring it in line with new equipment and methodologies. **This is to be undertaken by Eckhard Bethke in correspondence with others as appropriate**.

PGHERS considers that the specific problem of differences in the calibration results between the Simrad EK500 and the EK60 echosounders should be addressed by specialists within the FAST Working Group. From a theoretical viewpoint both procedures should show the same results. The advantage of the EK 60 procedure is its more convenient application but PGHERS believes that the on-axis calibration of the EK60 procedure may be poorer due to particular single-target detection problems and larger variances of detected compensated TS values observed during calibration.

5.2 IHLS manual

In period 2004/05 the Netherlands changed from a GULF VII to a GULF III sampler for the IHLS. Modifications to the IHLS manual and any impact on sampling methodology are described in the latest version (2.0) attached as Annex 5 of this report.

6 Review of the Age Reading Workshop at the Archipelago Research Institute on the island of Seili, Finland on 6-9 June 2005

The EU data collection programme provided support and funding for the participation of two members per EU member country to attend a herring age reading workshop in Finland. This was attended by 35 participants from Denmark, Estonia, Finland, France, Germany, Ireland, Latvia, Lithuania, Netherlands, Northern Ireland, Norway, Poland, Russia, Sweden and the UK.

The report from the workshop gives the following introduction:

As part of the process of herring stock assessment, age determinations of herring are conducted in several laboratories in Atlantic and Baltic coastal areas. Age determination errors have been identified as one possible factor reducing the accuracy of stock assessment.

The aim of the workshop was to:

- identify present problems in herring age determination;
- improve the accuracy and precision of age determinations; and
- spread information of the methods and procedures used in different ageing laboratories working with herring.

The workshop brought together two groups of age determination laboratories: those from the Atlantic coastal areas and those from Baltic Sea coastal areas. The meeting benefited both groups by exchanging experience of different practices and spreading knowledge of herring growth and otoliths in different conditions from populations and areas that each group was familiar with.

Before the workshop, four different samples of otoliths were circulated among different laboratories to assess the precision of age readers. Preliminary results from the circulation were presented in the workshop and discussed together. Based on the experience of the workshop members a description of the ageing methods, including the practical preparation procedure, was presented for the Atlantic water and Baltic Sea areas. The following points from the Conclusions and Recommendation section of the report are relevant to the Planning group for the Herring Surveys:

Few disagreements on the interpretation of annual translucent zones exist between experienced readers, including the position of the first translucent zone, split translucent zones and the resolution of the otolith edge. However, otolith readers were much more confident when reading their own stocks. Differing interpretations of the relationship between assigned age and year class caused significant variation in the assigned age for some otoliths. Knowledge of the area, race (time of spawning) and time of capture are critical in this regard.

For Quality Control it is recommended that a proportion of all herring ages used for stock assessment purposes should be estimated by more than one reader at each institute. **It is recommended that regular otolith exchanges take place between institutes in order to detect precision drift in the age estimations.**

7 Status and future of FishFrameAcoustics

7.1 History and objectives

At PGHERS 2004 and 2005 it was decided to initiate the development of a full system to store and process the data from the acoustic survey. The input data level should be scrutinized

NASC values and complete information from trawl hauls. The output level should be global stock estimates. The system was regarded as consisting of three stages (Figure 7.1.1):

Stage I: Basic, disaggregated fisheries and acoustics data (the current HERSUR database).

Stage II: Data manipulation and aggregation tools.

Stage III: Aggregated database and tools to derive global estimates from national, aggregated data.

A stepwise development and implementation approach was chosen. The first step was to:

- Evaluate current HerSur software and complete the dataset on that level.
- Develop and test stage III.
- Second step was to:
- Upgrade stage I (HerSur) to FishFrame technology.
- Develop and test stage II.

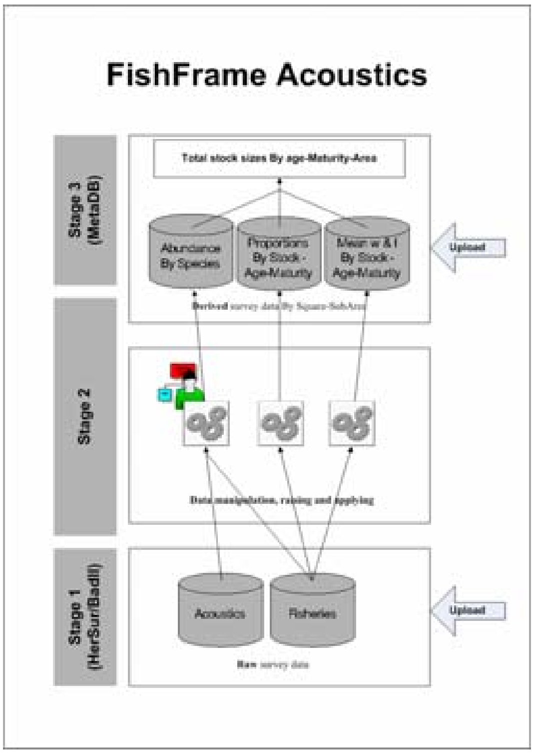

Figure 7.1: FishFrame Acoustics.

7.2 Status

Stage 1 (HerSur)

The status of HerSur has not changed since 2005. Only Denmark has uploaded new data.

Stage 3

Stage 3 was based on FishFrame version 3.1 and released in the autumn 2005. The first users to log in from Germany and Netherlands found some bugs in version 1.0, and the system was immediately updated with version 1.1.

Users from all countries except Norway have logged into the system and Germany, Netherlands and Denmark have uploaded survey data from 2005 for herring and sprat. Teunis Jansen completed the dataset for 2003, 2004 and 2005 by extracting the national input data from John Simmond's combined excel sheets.

7.3 Test

An acceptance test plan was written together with version 1.1 and the testing was performed by the developer. Independent acceptance tests will **be conducted by an independent tester (Eric Armstrong)** as soon as possible.

Testing of the calculation, aggregation and reporting procedures in stage 3 was done on 2003, 2004 and 2005 data during the meeting by Paul Fernandes and Teunis Jansen. The results (Table 7.3.1) showed that the global estimate of herring was similar. The small difference (0.00–0.10%) was due to differences in precision of the fraction field. A difference in splitting between NS and BS herring was detected but not explained. The complete testing in age-maturity-rectangle details and on the mean weight and length was not conducted due to time restraints.

	BALTIC SEA SPRING SPAWNERS	NORTH SEA AUTUMN SPAWNERS	TOTAL
2005	2,23%	-0,59%	-0,08%
2004	6,04%	-0,55%	0,10%
2003	6,13%	-0,55%	0,00%

Table 7.3.1: Results from comparison between John Simmond's combined excel sheet and FishFrameAcoustics stage 3 after removing the interpolations.

7.4 Future

Development has continued on FishFrame to version 4.0 involving major technological upgrades. This has not been inherited into FishFrameAcoustics yet, because the two systems are distinct. Instead of spending development resources on copying code from one project to the other and testing it twice, the two projects could be merged. This would also make the results from the acoustic surveys readily visible in dynamic reports to the assessment biologists using FishFrame.

Merging FishFrame and FishFrameAcoustics also makes the software available for the BIAS survey data in the FishFrame Baltic Sea (FishFrame is one piece of software copied into two clones - one for the North Sea and one for the Baltic Sea, each having separate sets of data in their own copy of the database). This could in time turn out to be a benefit for integrating results on Baltic Sea Spring spawning herring and exchanging ideas and software modules between the two survey groups.

Stage 3

The tasks to finish are:

- Interpolation (estimating values in rectangles not covered by the survey). This should be done using the principle of inverse distance weighting of the average between the eight nearest neighbours.
- Fraction precision change from 4 decimals to 9 decimals.
- Mileage precision should change from integer to 1 decimal.

- Upload of old data. Data should be extracted from John Simmond's combined sheets from as far back in history as possible.
- The complete testing of the calculation of abundance and biomass in age-maturity-rectangle details and on the mean weight and length should be described and performed.

Stage 2

The tasks to finish are:

- Review and detailed description of methodology. Ensure that all countries confirm to same methods.
- Development
- Documentation
- Test

Stage 1

The tasks to finish are:

- Upgrade and improve HerSur to be included in FishFrameAcoustics as stage 1.

7.4.1 Hydrographic data from the survey

The hydrographic data has been compiled in an ASCII database by Eberhard Götze. The correct place for storing these data is the DOME database in ICES. The current version of DOME does not accept lower quality data. Until this is possible a copy of the data will be stored in FishFrameAcoustics. Basic reports, data download and browsing functionality will be developed. Data will be manually copied and updated in the system via an agreed excel format designed by Eberhard Götze and Teunis Jansen.

An interface for automated data exchange should be developed, so that the data can flow easily from the DOME database to FishFrameAcoustics and be displayed in the mentioned reports. This interface could potentially serve as a model for increasing the integration of distributed databases in the ICES community.

8 Evaluating the potential of the Torry Fish Fat Meter for measuring lipid content of herring at sea

Deborah Davidson from Aberdeen University gave a presentation of her ongoing PhD study (See working document in Annex 7).

The overall aim of our proposed field study in 2006 is to determine whether lipids impose a threshold on the onset of maturation in North Sea herring. It is also aims to construct a "fat map" of the North Sea herring stocks: a spatial representation of the average fat values for a given size class of herring within the sample area. Therefore, any spatial, and perhaps temporal, variations in fat content should become evident. This could then be related to environmental factors — such as prey abundance.

The intention is to integrate the Torry Fish Fat Meter (TFFM) into the onboard sampling routine of as many participating vessels in the 2006 acoustic survey of the North Sea herring, as possible. A two week trial run onboard the "Scotia" in July 2005 showed that using the TFFM on a vessel is feasible, and does not interrupt a protocol such as the one utilised by the "Scotia" crew. The TFFM accurately measures lipid content of both whole and gutted herring, making it possible to choose a point in the sampling process that causes as little disruption of the routine as possible, without adversely affecting the accuracy and validity of the readings.

For any vessel agreeing to have one of our samplers onboard, a sampling protocol could be provided beforehand for inclusion in the cruise plan. It is important that the TFFM readings correspond with the biological data of each fish. Therefore a copy of the information collected by the scientists would be needed to properly compare data and to complete our analyses.

9 Recommendations for future work and election of new Chair

The Planning Group for Herring Surveys unanimously recommends that Dr Norbert Rolf, Germany should be invited to Chair GHERS from 1 January 2007.

9.1 Terms of reference

The **Planning Group for Herring Surveys** [PGHERS] (proposed Chair: Norbert Rohlf, Germany) will meet at the Danish Institute for Fisheries Research, Charlottenlund, from 22–26 January 2007 to:

a) combine the 2006 survey data to provide indices of abundance for the population within the area, by means of the FishFrameAcoustics database;

b) coordinate the timing, area and effort allocation and methodologies for acoustic and larvae surveys for herring and sprat in the North Sea, around Ireland, Division VIa and IIIa and the Western Baltic in 2007;

c) intensively test the in-year developments of the FishFrameAcoustics database, specifically verify the ability of the new system to calculate global survey estimates from raw acoustic and trawl data using 2005 and – if possible – 2006 survey data;

d) further harmonise the maturity readings of North Sea and Western Baltic herring conducted by different labs, specifically the definition of mature and immature fish;

e) report on the possible bias introduced by a change in gear in the Dutch herring larvae survey.

PGHERS will report by 5 February 2007 for the attention of the Living Resources, and the Resource Management Committees as well as to HAWG.

Supporting Information

Priority	The International Acoustic and Larvae surveys provide essential data for the assessment of pelagic stocks in and around the North Sea (Divisions IV, VIa, IIIa, and Western Baltic).
Scientific Justification and relation to Action Plan:	The work of this Expert Group refers to Action Items 1.2.1, 1.2.2 and 1.13. Term of reference a) and b) 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 c) The HERSUR database was developed in Hirtshals within the framework of the EU-funded projects “Herrings Surveys in the North Sea and West of Scotland” I and II, and has been online since 2001. It is intended to hold all primary acoustic and trawl data from the North Sea Herring Acoustic Survey (including West of Scotland and Kattegat/Skagerrak) and to provide primary outputs (tables and figures). Use of the HERSUR database, as it currently stands, requires an implementation of a flexible combination of biological and acoustic data that matches current national procedures. In 2005 PGHERS decided therefore agreed to follow a two-track approach: The HERSUR database (“step 1”) should be maintained and completed. In parallel, a higher-level database holding national aggregated data with survey results was developed and successfully tested in 2006. This database is used to provide an automated system for delivering the outputs needed for the combined survey report from 2007 onwards (“step 3”). To finalise the database developments for the group’s data, a system to derive global estimates of target species’ abundance and biomass from acoustic and trawl haul raw data will be developed during 2006 (“step 2”). These routines and the updates of step 1 and step 3 databases have to be intensively tested by the group. Term of reference d) There are apparently still different definitions applied by the different laboratories to the maturity of herring both in the North Sea and in the Western Baltic. As this has significant implementations for the definition of the spawning stock biomass, these definitions urgently have to be harmonized. Term of reference e) The Dutch larvae survey has changed the sampling gear and the impact of this will be addressed in a special study.
Relation to Strategic Plan:	Directly relevant – it allows ICES to respond to requested advice on herring and sprat fisheries.
Resource Requirements:	No specific resource requirements beyond the need for members to prepare for and participate in the meeting
Participants	At least one scientist (preferably the cruise leader) from each survey; hence a minimum of 6 members.
Secretariat Facilities	None
Financial:	None
Linkages to Advisory Committees:	The survey data are prime inputs to the assessments which provide ACFM with information required for responding to requests for advice/information from NEAFC and EC DGXIV.
Linkages to other Committees or Groups:	Survey results are conveyed directly to the Herring Assessment Working Group for the Area South of 62°N (HAWG). HAWG to see this report
Linkages to other Organisations:	None
Cost Share:	ICES 100%

9.2 Further Recommendations

Note that the recommendations below are sorted so that Recommendations 1 to 8 is addressed to parties outside the PGHERS group and recommendations 6 to 17 are addressed to the expert group members. Bold text refers to specific action required by PGHERS members.

RECOMMENDATION	ACTION
1. PGHERS recommends that the FishFrame acoustic database module continue to be developed at DIFRES. This will ensure continuity for the next phase of development – the analysis system for the raw data - which will now start. In the meantime, the acoustic module should be merged with the main FishFrame North Sea module.	DIFRES to approve.
2. PGHERS has recognised differences in the calibration results between Simrad EK500 and EK60 echosounders. PGHERS recommends ICES WGFAST to advise PGHERS and other acoustic survey planning groups (e.g. PGNAPES) on the implications of following the procedure in the EK60 manual for calibrations of this new echosounder.	ICES WGFAST to consider reviewing EK60 calibration procedures.
3. PGHERS recommends that the North Sea herring larvae survey should be considered for priority 1 EC funding, as it is international, it is used in the assessment of herring and could be used for additional species if required (e.g. plaice and cod eggs, sandeel larvae).	Appropriate expert group members to make a case to national DCR representatives.
4. PGHERS recommends to deliver age-disaggregated data from the survey with a moving plus-group in the future (currently: 9+, 2006: 9+, 2007: 10+, 2008:11+) to avoid that the strong 1998 and 2000 year classes enter the plus group. HAWG is asked to advise PGHERS whether this would require a complete recalculation for the historic data set.	HAWG to advise
5. PGHERS recommends that the ICES hydrographic database is amended in such a way that data of different quality (preferably quality flagged) can be kept there. This would allow uploading hydrography data from the North Sea acoustic survey and using them instantly for the evaluation of PGHERS data. In addition, the ICES DC should, in cooperation with the FishFrameAcoustic developers at DIFRES, explore possibilities to develop a common interface between the two databases. The aim is to avoid duplication of the same data in two different databases.	ICES data center to take action
6. PGHERS recommends that in the 2006 North Sea acoustic surveys, all participants take a student from Aberdeen University to make measurements of the fat content of herring.	Expert group members to note and Aberdeen university members to consult.
7. PGHERS recommends that the herring larvae survey in the central North Sea should also cover the first half of October. Participants should try and find funding to do the sampling in October.	Expert group members to solicit ship time
8. PGHERS recommends that the development of FishframeAcoustics is continued so that a system completing the integration of stage I-III can be released in 2006 (see details see paragraph 7) **A group to design the user requirement specifications should be formed and meet during 13 - 14 June 2006 at DIFRES in Copenhagen to be chaired Teunis Jansen, DIFRES**. The evaluation of the stage 2 prototype will preferably be coordinated via e-mail and by the tester.	To DIFRES and the expert members of this group
9. PGHERS recommends **that multifrequency data be collected during the 2006 surveys and if possible additional trawl hauls be taken from traces thought to contain sandeel**. This will help to determine how feasible it may be to provide data on this species during these surveys.	Expert group members
10. The North Sea herring acoustic survey manual needs to be thoroughly updated to bring it in to line with new equipment and methods. **This is to be undertaken by correspondence (Eckhard Bethke to lead) and reported to PGHERS 2007.**	Expert group members to note.

RECOMMENDATION	ACTION
11. **All participants in the 2006 North Sea herring acoustic survey should upload their survey estimates to the Fishframe database by 30 November 2006.** Participants should be prepared to upload the raw (HERSUR) data from 2006, if the stage 1 database development is released.	Expert group members to note.
12. **Participants in the 2005 North Sea herring acoustic survey should upload their 2005 raw data to the Fishframe (HERSUR) database by 1 May 2006.** This will ensure that a full dataset (all surveys) will be available for testing the FishFrame stage II analysis system.	Expert group members to note.
13. **Participants in the 2006 North Sea herring acoustic survey should send their hydrographic data to Eberhard Goetze by 30 September 2006.**	Expert group members to note.
14. PGHERS recommends **that cruise leaders participating in the International North Sea Herring Acoustic Survey should radio contact each other every day at 1900 UTC. Communication should be through medium frequency radio at 3333 kHz**, allowing all participants to listen to each other's conversation. Participants should observe radio operating protocols.	Expert group members to note.
15. PGHERS recommends that survey cruise leaders should take all necessary steps to ensure that all ICES rectangles are surveyed as planned in the coordinated survey. Individual participants who, for whatever reason, are unable to survey any rectangle allocated to them, should make this known to other participants as soon as possible, this may allow for ad hoc adjustments to other surveys to fill any gaps (see recommendation 14 above).	Expert group members to note.
16. PGHERS recommends that **all participants in the International North Sea Herring Acoustic Survey should exchange trawl data soon after the surveys have been completed (preferably via the HERSUR database; see recommendation 12)**. In cases were trawl data are lacking in one particular area, trawl information from an adjacent area collected by a different participant, may be used.	Expert group members to note.
17. PGHERS recommends that the four vessels covering the North Sea start their survey in the center of the combined survey area (NOR and SCO in the south, NED and GER in the north), to keep the quasi-synoptic character of the survey. This is considered specifically important for a survey targeting highly mobile fish like herring and sprat.	Expert group members to note.

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Annex 1: List of participants

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Annex 2: 2005 Acoustic Survey Reports

Annex 2A: West of Scotland

Survey report for MFV *Enterprise*

28 June–15 July 2005

Eric Armstrong, 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 28 June to the 15 July 2005. The survey was conducted on the chartered fishing vessel MFV “Enterprise”. 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 coordinated 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 March 2006.

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

Eric Armstrong	Cruise Leader
Philip Copland	
Craig Davis	
Finlay Burns	
Morag Campbell	
Claire Embling	Visitor (U. of St Andrews)
Isabel Rombouts	Visitor (U. of St Andrews)

2.2 Narrative

Loading of the vessel and installation of a wet lab container and equipment was carried out on the 27 June. The vessel left Fraserburgh at 0500hrs on the 28 June and proceeded to Loch Eriboll for a calibration. Survey work began at Cape Wrath at 0300hrs on the morning of the 29th. The survey continued in generally good weather until 3 July when the survey was suspended due to poor weather, recommencing on the 4 July. On the morning of the 8 July the vessel steamed to Loch Broom where a second calibration was performed prior to landing in Ullapool for a rest day and crew change. The survey continued from the 9th in good weather covering the full survey area up to 60^{o}N 3^{o}W. This was successfully completed by late afternoon of the 14 July. The vessel then steamed to Fraserburgh for off loading of equipment, gear and personnel on the morning of the 15 July. No time was lost to mechanical breakdown and no damage occurred to net gear or acoustic equipment, but one day was lost due to weather.

2.1 Survey design

The survey design (Figure 2A.1) was selected to cover the area in two levels of sampling intensity based on herring densities found in 1991-2004 with adjustments made to fit within the time constraints of the cruise. Areas with highest 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. Between track data, were discarded at the end of all transects. The survey area was within an area defined by 56° and 60° N, and the shelf break in the west to approx. 250m depth and the Scottish coast or the 3° W line in the east.

2.2 Calibration

Two good calibrations were carried out, at the beginning (28 June) in Loch Erribol and in the middle (8 July) in Loch Broom. All calibrations were carried out in ideal conditions, and the constants for the 38 kHz integrating frequency agreed well (Table 2A.1). All procedures were according to those defined in the survey manual.

2.3 Acoustic data collection

The survey was carried out using a Simrad EK500 38 kHz sounder echo-integrator, the system settings are given in Table 2A.1. Further data analysis was carried out using SonarData Echoview and Marine Laboratory Analysis systems. Data from the echo integrator were summed over fifteen minute periods (2.5 n.mi. at 10 knots). The survey was generally restricted to hours of daylight between 0300h and 2300h UTC. A total of 1845 nautical miles of integrator track were recorded. Echo integrator data were collected from 10 metres below the surface (transducer at 5.5 m depth) to 0.5 m above the seabed. Data were processed on a daily basis, then archived as Echoview files (*.ek5,*.evi) and stored on DVD.

2.4 Biological data - fishing trawls

34 trawl hauls (Figure 2A.1 and Tables 2A.2 and 2A.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 20 mm 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 561 fish were measured at 0.5 cm intervals from each haul. Otoliths were collected with 1 per 0.5 cm class below 23 cm, 3 per 0.5 cm class from 23 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 and 2.

2.5 Hydrographic data

A Minilogger unit was attached to the headline during trawling to record temperature.

2.6 Data analysis

EDSUs were defined by 15 minute intervals which represented 2.5 n.mi. per EDSU, assuming a survey speed of 10 knots. The data were divided into three categories: "herring traces"; "probably herring traces" and "possibly herring traces" (which were identified with enough uncertainty as to not be included in the estimate). Data were analysed using rectangles of 15' by 30'.

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 three strata based on length distributions and geographic criteria. The three regions (Figure 2A.4) were:

- Minch and inshore
- Shelf break north and west
- North small herring
- North large herring

Trawling in the Minch area was again very difficult except in the most northerly and southerly parts. The length frequencies are presented in Table 2A.4. The overall age length key is presented in Table 2A.5.

3. RESULTS

3.1 Acoustic data

The geographical distribution of the NASC values assigned to herring are presented in Figure 2A.2. Large quantities of herring were detected to the south and north of the area in the middle of the shelf. The main areas of concentration were North of 59^o 00’N, and around 57^o 00’N. There were also some good marks recorded at the Butt of Lewis. There were no major concentrations NW of Lewis at Gallan Head; little herring in the main part of the Minch; and no evidence of large quantities sometimes found at Barra Head.

3.2 Biological data

A total of 34 trawl hauls were carried out. Table 2A.2 gives the positions and characteristics of these trawl hauls and Table 2A.3 gives their species composition. 29 hauls contained sufficient herring to define the 4 survey sub areas (Figure 2A.4). Herring were present in all but one of the hauls and there was a good coverage of herring trawl hauls across the area. All major concentrations were adequately characterised from these trawls. Other hauls were dominated by whiting/horse mackerel (haul 11) and mackerel (14, 28 and 34). Mackerel were ubiquitous throughout the area although rarely in great numbers.

The weight of herring at length was determined from length stratified samples of each trawl haul. Lengths were measured from a random sample in 0.5 cm intervals to the nearest 0.5 cm below. The resulting weight-length relationship for herring was:

$$W = 0.005299.L^{3.13} \qquad \text{L measured in cm}$$

Samples of fish were aged in the laboratory by counting winter rings. These were then used to compile an age length key (Table 2A.5) to determine the proportion at age for each length class.

3.3 Biomass estimates

The total biomass estimates for the survey were:

Definitely herring	100,468 tonnes	39%
Probably herring	154,438 tonnes	61%
Total herring	**254,906 tonnes**	
Spawning stock biomass	243,588 tonnes	96%
Immature	11,316 tonnes	4%

Total abundance (numbers of fish) were:

Total herring	1,593 million	
Spawning stock numbers	1,472 million	93%
Immature numbers	121 million	7%

A breakdown of the estimates by age class is given in Table 2A.6. The survey included all of ICES Subdivision VIa(N) plus some of the area between 3° and 4°W in Subdivision IV. The estimates given here are for the whole survey.

The results for ICES Subdivision VIa(N) alone were:

Total herring biomass	**231,272 tonnes**
Total herring numbers	1,357 million

4. DISCUSSION

For the second year running the stock estimate for VIa(N) is down substantially, by approximately 50% from 2004 (from 438,100 tonnes to 231,272 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 is also down significantly, by approximately 40% (400,000 to 243,590 tonnes) from 2004 to 2005. This rather large fluctuation may have something to do with the distribution of fish, and by the less intense survey track that was driven by the available time. The distributions were similar to 2004, with a large proportion of fish being detected towards the north and south of the area, and less in the middle reaches west of the Hebrides. The high densities of smaller fish detected at Barra Head in previous years were absent for the second year running. Last year there were large quantities of fish close to 4 degrees, this was not the case this year, their being a clear gap on the 4 degree line. As this line has been shown, on average, to be the best separator of the west of Scotland herring stock from that of the North Sea (Anon 1998), its definition may have implications for estimates of both stocks in any one year.

The abundance by year class is consistent with previous years. The 1998 year class was still very strong (19% of numbers) and there were also a very large number of 4 and 5 ring fish detected on the survey (18 and 20% respectively by number).

References

Anon. 1998. Report of the herring assessment working group for the area south of 62°N. ICES CM 1998/ACFM:14.

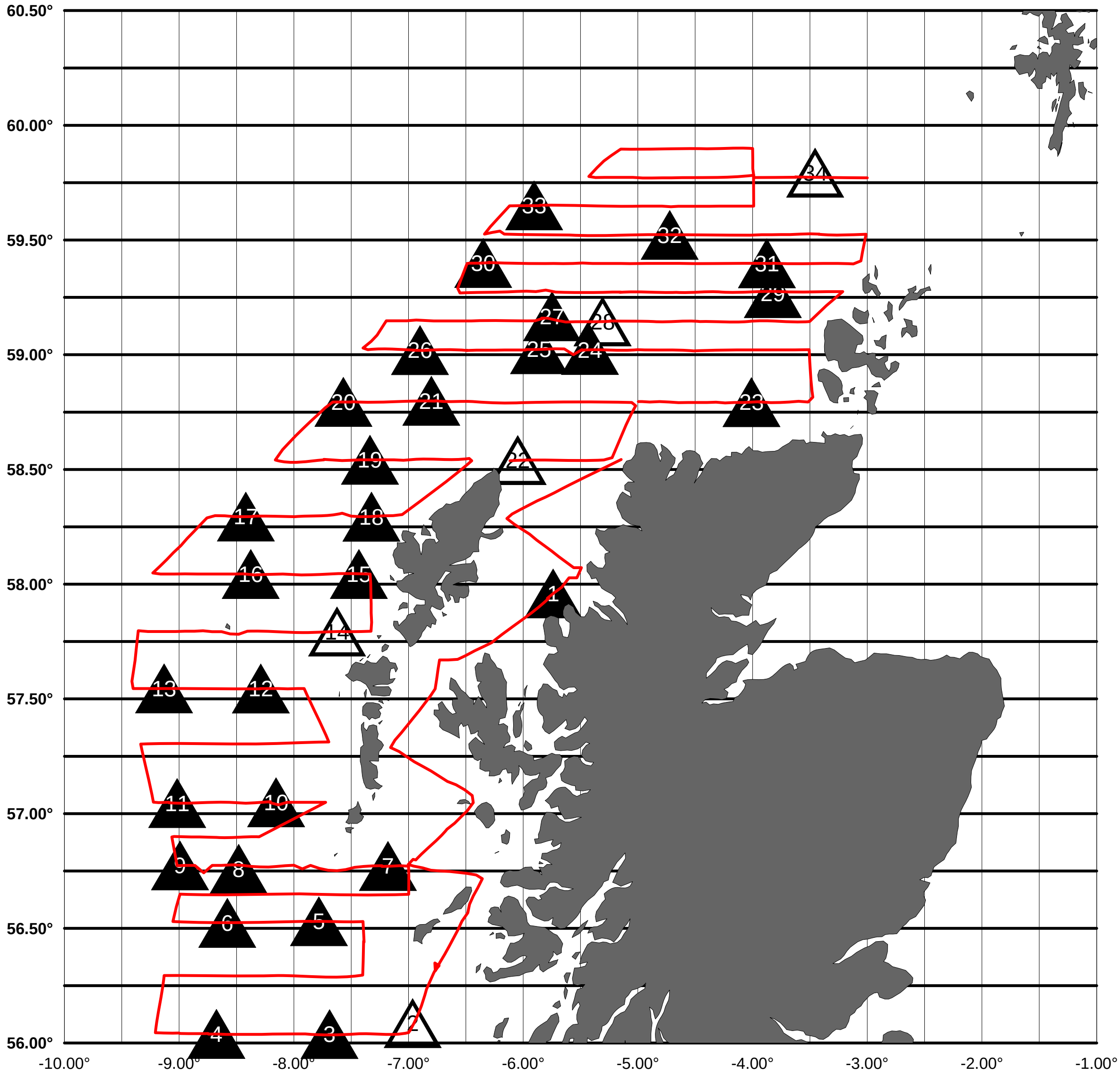

Figure 2A.1: Map of the west of Scotland showing cruise track (red) and positions of fishing trawls undertaken during the June/July 2005 west coast acoustic survey on MFV "Enterprise". Filled triangles indicate trawls in which significant numbers of herring were caught, whilst open triangles indicate trawls with few or no herring.

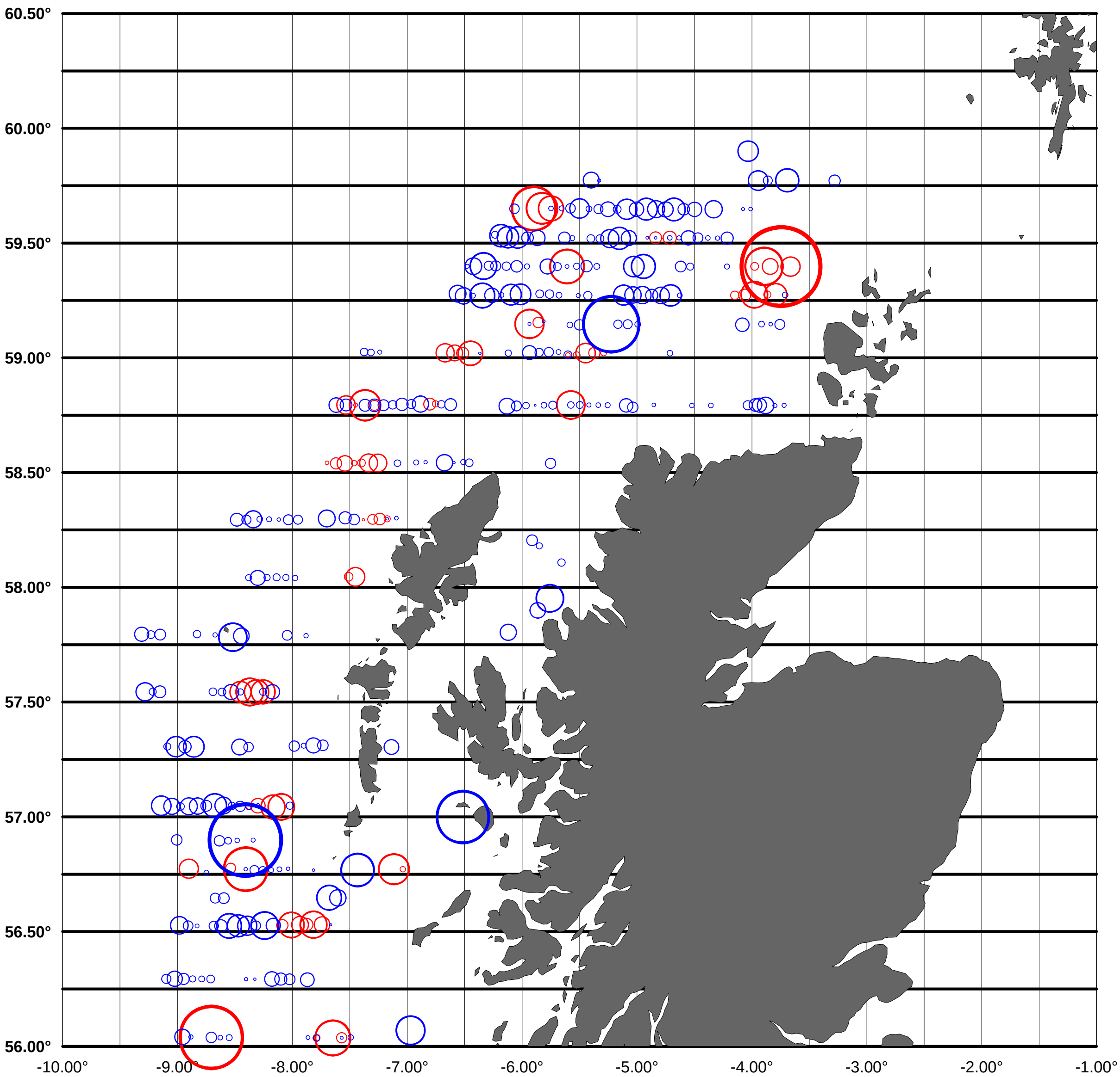

Figure 2A.2: Map of the west of Scotland with a post plot showing the distribution of herring NASC values (on a proportional square root scale relative to a value of 5000) obtained during the July 2005 west coast acoustic survey on MFV "Enterprise". Red indicate definitely herring and blue probably herring.

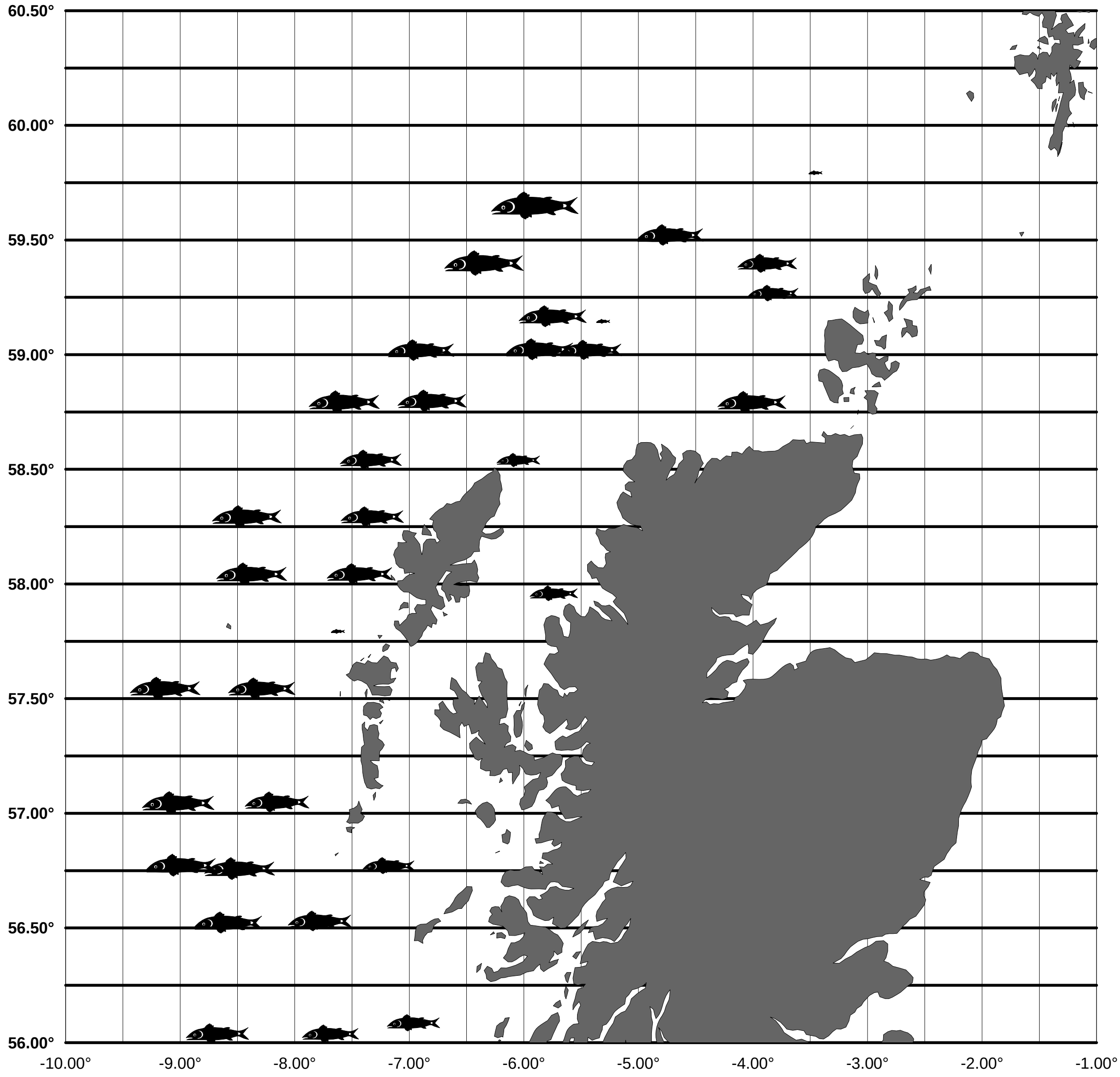

Figure 2A.3: Map of the west of Scotland with a post plot showing the mean length of herring caught in the trawl hauls carried out during the June/July 2005 west coast acoustic survey on MFV "Enterprise".

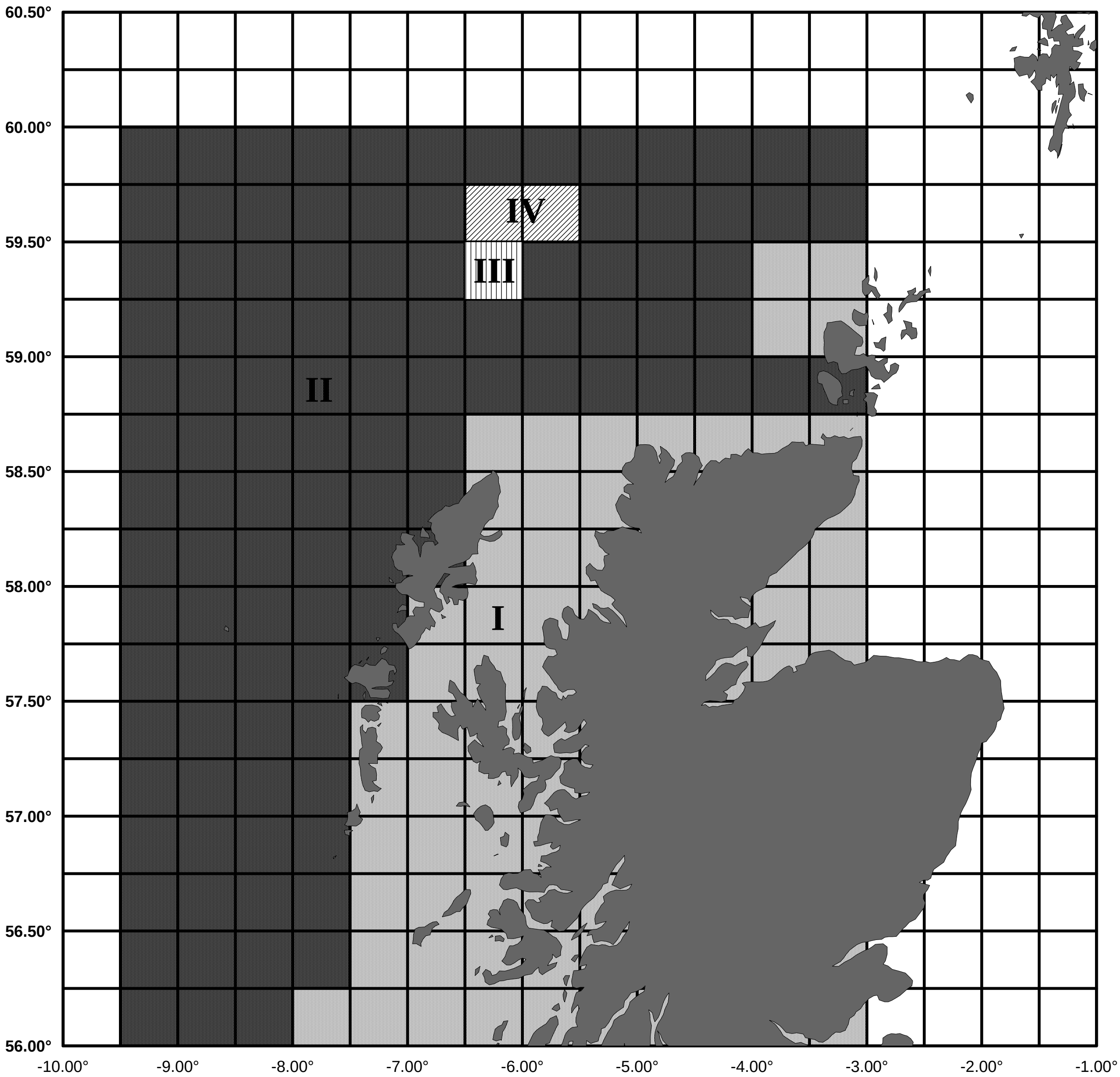

Figure 2A.4: Map of the west of Scotland showing the area strata (indicated by shaded areas with roman numerals I-IV used for combining data from the trawl hauls.

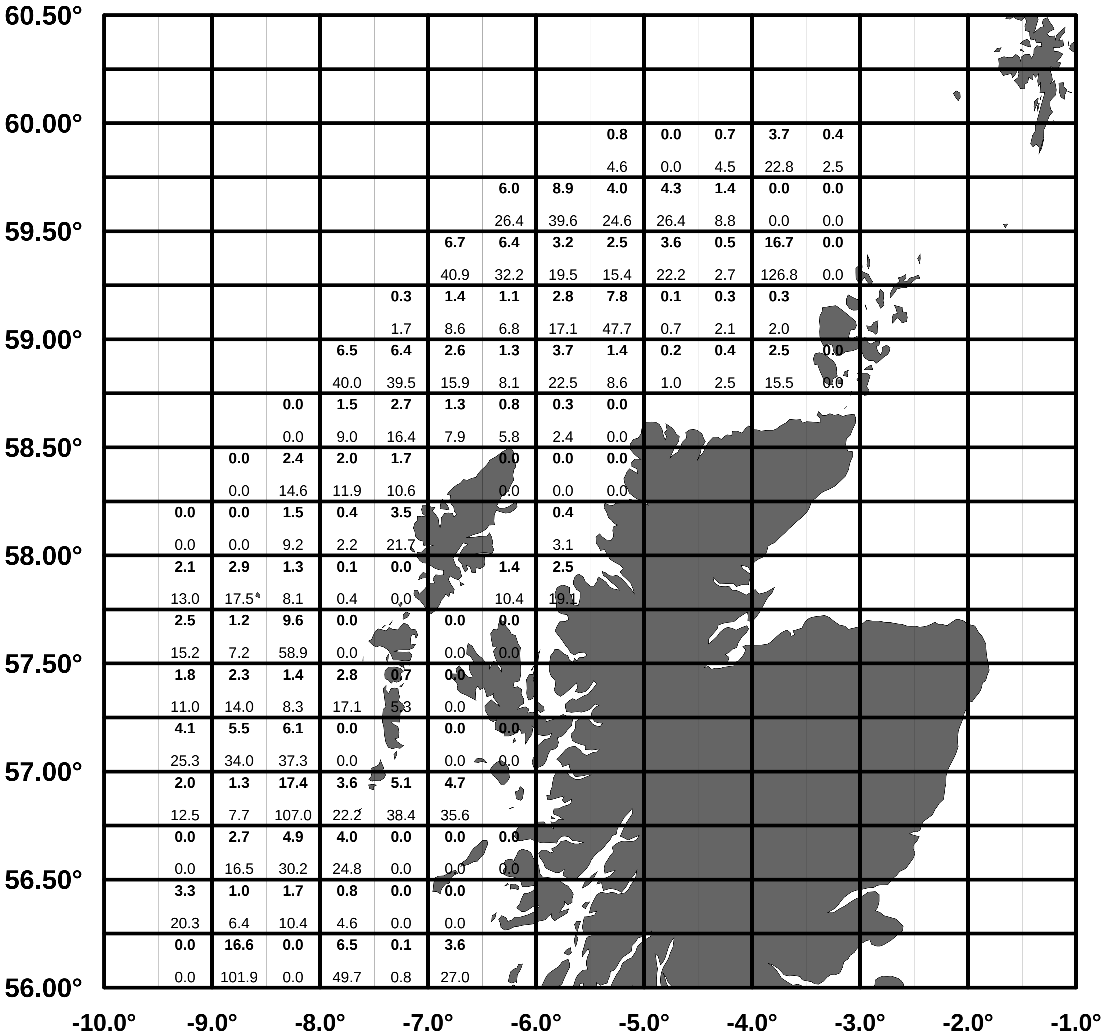

Figure 2A.5: Map of the west of Scotland with a post plot showing the herring numbers in millions (bottom) and biomass in thousands of tonnes (top) by quarter ICES rectangle obtained during the June/July 2005 west coast acoustic survey on MFV "Enterprise".

Table 2A.1: Simrad EK500 and analysis settings used on the June/July 2005 west coast of Scotland herring acoustic survey on MFV "Enterprise". Calibrations a) Loch Erribol 28 June; and b) Loch Broom 8 July. *Milap factor based on a Simrad factor of 1 because calibration settings were incorporated into the Echoview post processing package.

Transceiver Menu	
Frequency	38 kHz
Sound speed	1501[a],1501[b] 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	-42.4 dB
Range to sphere in calibration	9.5[a], 9.6[b]
Measured NASC value for calibration	3118[a], 3111[b]
Calibration factor for NASCs	0.76[a], 0.85[b]
Calibration constant for MILAP (optional)*	1.1005 at -35 dB
Log Menu	
Integration performed in Echoview post processing based on 15 minute EDSUs	
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
Sv gain threshold	-70 dB

Table 2A.2: Details of the fishing trawls taken during the West Coast acoustic survey, June/July 2005; Trawl depth = depth (m) of headrope; Gear type P=pelagic; Duration of trawl (minutes); Total catch (number); Use H=used to qualify herring acoustic data, s= used to qualify sprat acoustic data (blank if neither).

HAUL	DATE	LATITUDE	LONGITUDE	TIME	WATER DEPTH	TRAWL DEPTH	GEAR TYPE	DURATION	USE	BASKETS
1	29/6	57° 56.98 N	5° 45.84 W	09:32	80	72	P	30	H	1.5
2	30/6	56° 4.2 N	6° 58.43 W	10:8	80	80	P	30		0.5
3	30/6	56° 2.35 N	7° 39.74 W	15:12	165	155	P	25	H	5
4	30/6	56° 2.4 N	8° 42.27 W	19:48	135	129	P	32	H	20
5	1/7	56° 31.87 N	7° 48.04 W	13:14	154	130	P	17	H	10
6	1/7	56° 31.47 N	8° 36.12 W	17:22	140	128	P	22	H	30
7	2/7	56° 46.32 N	7° 12.7 W	08:48	84	75	P	32	H	21
8	2/7	56° 44.6 N	8° 29.82 W	14:43	123	110	P	8	H	40
9	2/7	56° 46.41 N	9° 1.05 W	17:48	136	122	P	24	H	14
10	4/7	57° 2.98 N	8° 10.22 W	03:53	135	117	P	15	H	6
11	4/7	57° 2.83 N	9° 2.95 W	08:21	141	123	P	32	H	5.75
12	4/7	57° 32.73 N	8° 17.97 W	20:0	135	124	P	10	H	16
13	5/7	57° 32.7 N	9° 9.61 W	03:57	143	134	P	27	H	6
14	5/7	57° 47.63 N	7° 35.87 W	13:10	82	62	P	23		1.5
15	5/7	58° 2.8 N	7° 27.67 W	17:2	91	81	P	28	H	0.5
16	5/7	58° 2.65 N	8° 24.32 W	21:25	130	120	P	30	H	2.25
17	6/7	58° 17.61 N	8° 23.71 W	08:6	150	140	P	24	H	3
18	6/7	58° 17.8 N	7° 17.51 W	12:47	102	90	P	30	H	5
19	6/7	58° 32.54 N	7° 21.15 W	20:5	95	99	P	16	H	14
20	7/7	58° 47.64 N	7° 32.4 W	06:23	126	124	P	26	H	1.75
21	7/7	58° 47.93 N	6° 47.01 W	58:9	145	130	P	17	H	4.5
22	7/7	58° 32.39 N	6° 4.5 W	21:3	95	84	P	25		0.75
23	9/7	58° 47.09 N	3° 58.33 W	17:40	90	64	P	37	H	0.5
24	10/7	59° 1.26 N	5° 27.09 W	08:3	95	86	P	31	H	5
25	10/7	59° 1.4 N	5° 52.61 W	11:1	76	66	P	39	H	1.5
26	10/7	59° 1.2 N	6° 53.99 W	14:24	112	90	P	23	H	30
27	11/7	59° 10.06 N	5° 44.9 W	03:47	81	80	P	38	H	10
28	11/7	59° 8.75 N	5° 17.1 W	07:13	140	110	P	21		1
29	11/7	59° 16.56 N	3° 51.08 W	17:1	134	123	P	27	H	20
30	12/7	59° 23.99 N	6° 19.24 W	08:10	160	141	P	26	H	1
31	12/7	59° 23.92 N	3° 51.74 W	16:53	139	123	P	10	H	40
32	13/7	59° 31.34 N	4° 44.74 W	06:33	128	112	P	21	H	4
33	13/7	59° 39.06 N	5° 52.88 W	14:41	145	132	P	21	H	30
34	14/7	59° 47.62 N	3° 25.9 W	13:9	115	97	P	22		0.5

Table 2A.3: Catch composition by trawl haul on the west coast herring acoustic survey. MFV “Enterprise” (28 June - 15 July 2005).

	HAUL	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Herring	*Clupea harengus*	290	5	495	3940	2025	5685	5280	7480	2184	1152	129
Sprat	*Sprattus sprattus*	14										
Mackerel	*Scomber scombrus*	121	19	91	202	28	297	360	294	70		2079
Corbin's Sandeel	*Hyperoplus immaculatus*	1										
Haddock	*Melanogrammus aeglefinus*	1	3						7			
Whiting	*Merlangius merlangus*	5	30	4		10					6	
Saithe	*Pollachius virens*									2		
Norway Pout	*Trisopterus esmarki*											
Poor Cod	*Trisopterus minutus*				3							
Blue Whiting	*Micromesistius poutassou*			44		8			7		3	
Lesser Argentine	*Argentina sphyraena*											
Grey Gurnard	*Eutrigla gurnardus*		2	8	3				7		3	2
Hake	*Merluccius merluccius*			3								
Boar Fish	*Capros aper*									660		
Horse Mackerel (Scad)	*Trachurus trachurus*		11		9	2				28		2
Pearlsides	*Maurolicus muelleri*	98										
Norway Haddock	*Sebastes viviparus*									52		
Blue-mouth	*Helicolenus dactylopterus*									27		
Snake Pipefish	*Entelurus aequoreus*			1						60		
Skate	*Raja batis*											

Table 2A.3(cont.) Catch composition by trawl haul on the west coast herring acoustic survey. MFV "Enterprise" (28 June - 15 July 2005)

	HAUL	12	13	14	15	16	17	18	19	20	21	22
Herring	*Clupea harengus*	3336	238	1	31	390	551	923	3496	276	548	25
Sprat	*Sprattus sprattus*											14
Mackerel	*Scomber scombrus*	12	504	423	2	64	46	33	15	6	205	80
Corbin's Sandeel	*Hyperoplus immaculatus*											
Haddock	*Melanogrammus aeglefinus*		12		3			5		1		
Whiting	*Merlangius merlangus*		3			3		9				90
Saithe	*Pollachius virens*							1		1		
Norway Pout	*Trisopterus esmarki*											
Poor Cod	*Trisopterus minutus*											
Blue Whiting	*Micromesistius poutassou*		12			9	2					
Lesser Argentine	*Argentina sphyraena*		2									
Grey Gurnard	*Eutrigla gurnardus*		3			2	3	18		5	8	1
Hake	*Merluccius merluccius*											1
Boar Fish	*Capros aper*											
Horse Mackerel (Scad)	*Trachurus trachurus*		45							1		
Pearlsides	*Maurolicus muelleri*											
Norway Haddock	*Sebastes viviparus*											
Blue-mouth	*Helicolenus dactylopterus*											
Snake Pipefish	*Entelurus aequoreus*						17	7		25		7
Skate	*Raja batis*											

Table 2A.3(cont.) Catch composition by trawl haul on the west coast herring acoustic survey. MFV "Enterprise" (28 June - 15 July 2005)

	HAUL	23	24	25	26	27	28	29	30	31	32	33	34
Herring	*Clupea harengus*	47	873	182	5580	1890	3	4580	164	8287	710	3855	
Sprat	*Sprattus sprattus*												
Mackerel	*Scomber scombrus*	1	2	45		52	131	65			8		144
Corbin's Sandeel	*Hyperoplus immaculatus*												
Haddock	*Melanogrammus aeglefinus*		11	2			1				1		
Whiting	*Merlangius merlangus*										1		
Saithe	*Pollachius virens*												
Norway Pout	*Trisopterus esmarki*							115					
Poor Cod	*Trisopterus minutus*												
Blue Whiting	*Micromesistius poutassou*							5					
Lesser Argentine	*Argentina sphyraena*			2					1				
Grey Gurnard	*Eutrigla gurnardus*	1	23	23			1	15					
Hake	*Merluccius merluccius*												
Boar Fish	*Capros aper*												
Horse Mackerel (Scad)	*Trachurus trachurus*												
Pearlsides	*Maurolicus muelleri*												
Norway Haddock	*Sebastes viviparus*												
Blue-mouth	*Helicolenus dactylopterus*												
Snake Pipefish	*Entelurus aequoreus*			8		6	2		20		12		
Skate	*Raja batis*		1										

Table 2A.4: Herring length frequency proportion by trawl haul by sub- area for west coast acoustic survey MFV "Enterprise" (28 June - 15 July 2005). Length in cm, weight in g, TS=target strength in dB.

L(CM)	I							II			
	1	2	3	7	22	29	mean	5	4	6	8
16.5	1.7						0.0				
17.0	2.4						0.1				
17.5	3.4				4.0		0.1				
18.0	3.1				4.0		0.1				
18.5	1.0		0.2		8.0	0.1	0.1				
19.0	1.4			0.2	4.0	1.1	0.6				
19.5	1.0		0.4			1.2	0.6				
20.0	1.7		0.8	0.4	8.0	3.5	1.7				
20.5	0.7		1.4	1.1	4.0	3.5	2.1				
21.0	0.7		0.8	1.9		4.6	2.9				
21.5	0.7		1.4	1.7	4.0	2.1	1.8	0.2			
22.0	0.7		3.6	2.1		1.9	2.1				
22.5	1.7		3.2	3.0		0.2	1.9	0.2			
23.0	3.8	40.0	6.1	10.4		0.9	5.9	1.0			
23.5	6.6		7.3	11.7		2.4	7.4	3.5	0.5		
24.0	10.0		11.1	16.5	8.0	10.0	13.2	6.7	3.6	0.5	0.3
24.5	5.2		8.1	8.3	12.0	12.7	10.0	6.7	6.1	1.1	0.5
25.0	12.4	20.0	6.3	7.4		14.6	10.4	8.6	12.7	3.7	0.8
25.5	6.6		2.6	4.7	8.0	12.9	7.9	5.4	12.7	7.4	2.9
26.0	9.3	20.0	8.1	7.4	16.0	10.0	8.6	12.1	17.3	13.5	9.9
26.5	8.3		6.5	4.7	4.0	7.0	5.9	12.1	12.9	15.3	11.0
27.0	8.6	20.0	7.3	8.0		6.1	7.1	17.3	18.0	23.5	26.2
27.5	3.4		6.9	4.4	4.0	2.4	3.8	7.9	8.4	14.2	21.1
28.0	4.1		9.9	4.0	4.0	1.5	3.5	11.4	5.3	12.4	16.3
28.5	1.0		3.6	0.9	4.0	0.9	1.2	3.5	1.5	4.7	7.5
29.0	0.3		4.0	1.1	4.0	0.4	1.1	3.0	1.0	2.9	2.7
29.5			0.2				0.0	0.5		0.5	0.8
30.0			0.2				0.0			0.3	
30.5											
31.0											
31.5											
32.0											
32.5											
33.0											
33.5											
34.0											
34.5											
Number	290	5	990	5280	25	4580		2025	3940	5685	7480
mean length	24.6	25.3	25.8	25.2	24.1	25.0	25.2	26.8	26.7	27.4	27.7
mean weight	126.4	132.8	143.1	131.6	120.1	129.9	131.8	158.3	155.6	169.1	175.0
TS/individual	-43.3	-43.1	-42.9	-43.2	-43.5	-43.2	-43.2	-42.6	-42.7	-42.4	-42.3
TS/kilogramme	-34.3	-34.4	-34.5	-34.3	-34.3	-34.3	-34.4	-34.6	-34.6	-34.7	-34.8

Table 2A.4. (cont.) length frequency proportion by trawl haul by sub- area for west coast acoustic survey MFV "Enterprise" (28 June - 15 July 2005). Length in cm, weight in g, TS=target strength in dB.

L(CM)	I							II			
	1	2	3	7	22	29	mean	5	4	6	8
16.5	1.7						0.0				
17.0	2.4						0.1				
17.5	3.4				4.0		0.1				
18.0	3.1				4.0		0.1				
18.5	1.0		0.2		8.0	0.1	0.1				
19.0	1.4			0.2	4.0	1.1	0.6				
19.5	1.0		0.4			1.2	0.6				
20.0	1.7		0.8	0.4	8.0	3.5	1.7				
20.5	0.7		1.4	1.1	4.0	3.5	2.1				
21.0	0.7		0.8	1.9		4.6	2.9				
21.5	0.7		1.4	1.7	4.0	2.1	1.8	0.2			
22.0	0.7		3.6	2.1		1.9	2.1				
22.5	1.7		3.2	3.0		0.2	1.9	0.2			
23.0	3.8	40.0	6.1	10.4		0.9	5.9	1.0			
23.5	6.6		7.3	11.7		2.4	7.4	3.5	0.5		
24.0	10.0		11.1	16.5	8.0	10.0	13.2	6.7	3.6	0.5	0.3
24.5	5.2		8.1	8.3	12.0	12.7	10.0	6.7	6.1	1.1	0.5
25.0	12.4	20.0	6.3	7.4		14.6	10.4	8.6	12.7	3.7	0.8
25.5	6.6		2.6	4.7	8.0	12.9	7.9	5.4	12.7	7.4	2.9
26.0	9.3	20.0	8.1	7.4	16.0	10.0	8.6	12.1	17.3	13.5	9.9
26.5	8.3		6.5	4.7	4.0	7.0	5.9	12.1	12.9	15.3	11.0
27.0	8.6	20.0	7.3	8.0		6.1	7.1	17.3	18.0	23.5	26.2
27.5	3.4		6.9	4.4	4.0	2.4	3.8	7.9	8.4	14.2	21.1
28.0	4.1		9.9	4.0	4.0	1.5	3.5	11.4	5.3	12.4	16.3
28.5	1.0		3.6	0.9	4.0	0.9	1.2	3.5	1.5	4.7	7.5
29.0	0.3		4.0	1.1	4.0	0.4	1.1	3.0	1.0	2.9	2.7
29.5			0.2				0.0	0.5		0.5	0.8
30.0			0.2				0.0			0.3	
30.5											
31.0											
31.5											
32.0											
32.5											
33.0											
33.5											
34.0											
34.5											
Number	290	5	990	5280	25	4580		2025	3940	5685	7480
mean length	24.6	25.3	25.8	25.2	24.1	25.0	25.2	26.8	26.7	27.4	27.7
mean weight	126.4	132.8	143.1	131.6	120.1	129.9	131.8	158.3	155.6	169.1	175.0
TS/individual	-43.3	-43.1	-42.9	-43.2	-43.5	-43.2	-43.2	-42.6	-42.7	-42.4	-42.3
TS/kilogramme	-34.3	-34.4	-34.5	-34.3	-34.3	-34.3	-34.4	-34.6	-34.6	-34.7	-34.8

Table 2A.4. (cont.). Length frequency proportion by trawl haul by sub- area for west coast acoustic survey MFV "Enterprise" (28 June - 15 July 2005). Length in cm, weight in g, TS=target strength in dB.

	II(CONT.)								III		IV	
L(cm)	23	24	25	26	27	31	32	mean	30	mean	33	mean
16.5												
17.0												
17.5												
18.0												
18.5												
19.0						0.6		0.1				
19.5	2.1					1.5	0.1	0.3				
20.0	2.1					3.4	0.1	0.6				
20.5						3.7		0.6				
21.0						4.1		0.7				
21.5						1.7		0.3				
22.0						0.3		0.1				
22.5						0.1		0.0				
23.0								0.1				
23.5		3.8				0.2		0.4				
24.0		6.3	0.5	0.3		0.7	0.3	1.6				
24.5		8.9	1.1	0.3	0.5	1.9	1.4	2.4				
25.0		12.0	0.5	3.2	2.4	3.6	5.4	5.1				
25.5	4.3	7.4	5.5	7.3	2.6	8.7	7.9	7.1	0.6	0.6		
26.0	10.6	17.1	18.1	20.2	18.0	16.2	19.7	15.3	0.6	0.6		
26.5	12.8	13.7	20.3	22.3	21.2	16.7	15.5	14.8	1.8	1.8	0.8	0.8
27.0	25.5	13.7	22.5	21.2	28.0	16.7	25.4	21.4	14.6	14.6	2.2	2.2
27.5	8.5	6.6	13.7	11.8	16.9	8.2	13.0	12.9	15.9	15.9	4.7	4.7
28.0	19.1	4.6	11.0	9.4	7.1	6.3	6.5	10.1	20.7	20.7	8.4	8.4
28.5	8.5	1.7	6.0	2.4	1.9	3.1	2.8	3.8	11.0	11.0	9.3	9.3
29.0	4.3	0.6	0.5	1.6	0.8	1.4	0.6	1.7	11.0	11.0	18.7	18.7
29.5		0.6			0.5	0.5	0.6	0.4	7.9	7.9	14.0	14.0
30.0	2.1	1.7				0.3	0.1	0.1	7.3	7.3	14.8	14.8
30.5						0.2	0.3	0.0	3.0	3.0	9.9	9.9
31.0		0.3					0.1	0.0	3.7	3.7	8.8	8.8
31.5		0.6						0.0	1.2	1.2	3.3	3.3
32.0		0.3					0.1	0.0			2.9	2.9
32.5							0.1	0.0			0.9	0.9
33.0									0.6	0.6	0.7	0.7
33.5											0.5	0.5
34.0											0.1	0.1
34.5											0.2	0.2
Number	47	875	182	5580	1890	8288	710		164		3859	
mean length	27.5	26.6	27.4	27.2	27.3	26.2	27.2	27.1	28.9	28.9	30.0	30.0
mean weight	171.8	155.0	168.0	165.3	167.2	149.8	164.6	163.1	200.2	200.2	225.9	225.9
TS/individual	-42.4	-42.7	-42.5	-42.5	-42.5	-42.8	-42.5	-42.5	-42.0	-42.0	-41.6	-41.6
TS/kilogramme	-34.8	-34.6	-34.7	-34.7	-34.7	-34.6	-34.7	-34.7	-35.0	-35.0	-35.2	-35.2

Table 2A.5: Age/maturity-length key for herring (numbers of fish sampled MFV "Enterprise", 28 June - 15 July 2005).

	Number at age / maturity												
Length(cm)	0	1	2I	2M	3I	3M	4	5	6	7	8	9+	Grand Total
16.5		1											1
17		1											1
17.5		2											2
18		2											2
18.5		4											4
19		5											5
19.5		6											6
20		8											8
20.5		6											6
21		5	1										6
21.5		6	2										8
22		3	1	1									5
22.5		2	2	3									7
23		2	7	10									19
23.5			7	21									28
24			9	39		1							49
24.5			8	43		2	2						55
25			6	38		18	2						64
25.5			1	30		39	17	1					88
26				11		37	33	4	1				86
26.5				5		20	48	12	3				88
27						7	46	26	9		1		89
27.5				1		22	74	109	74	1	7	4	292
28						5	44	95	100	7	25	6	282
28.5						4	30	61	69	15	33	12	224
29						2	20	32	50	14	22	20	160
29.5				1			3	17	18	3	12	6	60
30							5	11	9	2	4	7	38
30.5				1			1	5	5	2	4	3	21
31						1	1	3	4		4	7	20
31.5								1	4	3	1	5	14
32									3	3	1	5	12
32.5								2	2	1	1	5	11
33						1		1	1	1	1	3	8
33.5								1			3	1	5
34									1				1
34.5										2			2
Grand Total		53	44	204		159	326	381	353	54	119	84	1777

Table 2A.6: Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age and maturity obtained during the MFV "Enterprise" 2005 herring acoustic survey.

TOTAL AREA						
Age (ring)	Mean Length (cm)	Mean Weight (g)	Numberx10^6	%	Biomassx10^3 T	%
1	20.75	76.61	66	3	4.96	2
2I	23.57	112.89	55	3	6.35	2
2M	24.55	127.93	258	13	33.64	13
3M	26.35	158.96	255	10	39.02	15
4	27.13	173.52	452	18	75.15	29
5	28.25	196.68	260	20	46.85	18
6	28.64	204.95	165	19	31.45	12
7	29.80	232.46	13	2	2.79	1
8	29.42	222.89	41	5	8.34	3
9+	30.41	246.19	28	7	6.36	2
Mean	25.62	157.76				
Total			1593	100	254.90	100
Immature			121	7	11.32	4
Mature			1472	93	243.59	96

Annex 2B: Denmark

Acoustic Herring Survey report for RV "DANA"

29 June2005 – 11 July 2005

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1. INTRODUCTION

Since 1991 the Danish institute for Fisheries Research (DIFRES) has participated in the ICES coordinated herring acoustic survey of the North Sea and adjacent waters with the responsibility for the surveying the Skagerrak and Kattegat area.

The actual 2005-survey with RV "Dana", covering the Skagerrak and Kattegat, was conducted in the period 30 June to 11 July 2005, while calibration was done during 29 June to 30 June.

2. SURVEY

2.1 Personnel

During calibration 28/6–30/6-2005

Bo Lundgren (cruise leader)	HFI
Torben Filt Jensen(assisting cruise leader)	ITT
Mogens R Sørensen	ITT
Thyge Dyrnesli	ITT
Bo Tegen Nielsen	ITT
Claus Halle	ADM

During acoustic monitoring 30/6-11/7-2005

Bo Lundgren (cruise leader)	HFI
Torben Filt Jensen (assisting cruise leader)	ITT
Lotte Worsøe Clausen	HFI
Lise Sindahl	HFI
Helle Rasmussen	HFI
Tommy Kristensen	HFI
Michael van Deurs	HFI
Mogens R Sørensen	ITT

HFI = Dept for Marine Fisheries, DIFRES, Denmark

ITT = Dept. of IT and Technical Support, DIFRES, Denmark

ADM = Administration Dept, DIFRES, Denmark

2.2 Narrative

RV “Dana” left Hirtshals on 28 June 2005 at 12.00 for the calibration site in the Gullmar Fjord in Sweden. Some tests of the echosounder equipment and some preparations for the calibration next day were carried out underway.

RV “Dana” stopped outside Hirtshals harbour on July 30 2005 at 11.00 for exchange of scientific personnel and left again at 12.00 (Danish local time, 16.00 UTC) with a north-easterly course, starting the survey in the eastern Skagerrak. The survey work (acoustic integration) had already started on the way from the calibration site to Hirtshals.at 06.38 UTC on the position 58º 11.80´ N 11º 07.12´ E in the south-eastern part of the Skagerrak. The eastern Skagerrak area was covered June 30 – July 3, western Skagerrak during July 4 – 7 and Kattegat during July 8 – 11. A short stop just outside Hirtshals on July 4 was done to change a crew member. Totally the survey covered about 1900 nautical miles mainly using data from the 38 kHz paravane transducer running at depths of 4 – 6 m depending on the sea state and sailing direction relative to the waves. Simultaneously data from the 120 kHz and 18 kHz echosounders using the hull-mounted transducers were also recorded. The quality of these data are strongly dependent on the weather conditions, but this year the weather was unusually calm so only about a days time of data were unusable. During trawling hull-mounted transducers were used for all three frequencies. The acoustic integration ended near the Danish coast in Skagerrak at July 11 09.40 UTC on the position 57º 43.18´ N 10º 14.00´ E. “Dana” went to harbour in Hirtshals on July 11 2005 at 10.30 hour.

2.3 Survey design

The survey was carried out in the Kattegat and in the Skagerrak, east of 6° E and north of 56° N (Figure 2B.1). The area is split into 7 sub-areas surveyed by “Dana” and one overlap area to be surveyed also by the Norwegian and German survey partners. This year the survey was started in the eastern Kattegat and ended in the western Skagerrak in order to reach the overlap area on June 10th at the same time as the other partners. In principal the survey is designed with parallel survey tracks at right angles to the depth lines with a spacing of 10-15 nm in the area west of 10°E. Due to limited time periods and places for fishing (late morning, early afternoon and immediately before and after midnight; limited amount of fishable positions for bottom trawl hauls) this structure cannot not be kept strictly. Along the Swedish coast the transects are planned as east-west transects with a spacing of 10 nm approximately at right angles to the coastline. In Kattegat the survey track was made in a zigzag way adapted to the depth curves and the relatively heavy ship traffic.

2.4 Calibration

The echo sounders were calibrated at the Bornö Island site in the Gullmar Fjord, Sweden during 29 June 2005. The calibration was performed according to the procedures established the previous year when the echosounder equipment had been upgraded to EK60 with three frequencies (18, 38 and 120 kHz). This was the second calibration of the year, the previous one during a cruise to the Norwegian Sea in May. Calibration of the paravane split-beam transducer at 38 kHz was done against a 60 mm copper sphere. Calibration of the three hull-mounted split-beam transducers at 18, 38 and 120 kHz were carried out against 63mm, 60 mm and 23 mm copper spheres, respectively. The results were similar to the previous calibration earlier in the year, and for 38 kHz close to results from previous years. The calibration and setup data of the EK60 38 kHz used during the survey are shown in Table 2B.1.

As a backup in case of failures in the EK60 system tests of the functionality were also carried on the previously used EY500 echo sounder.

2.5 Acoustic data collection

Acoustic data were collected using mainly the Simrad EK60 38kHz echosounder with the transducer (Type ES 38 7x7 degrees main lobe) in a towed body. The towed body runs at approx. 3 m depth in good weather and down to about 6 -7 m as needed depending on the weather conditions, this year mostly at 4 – 5 m. The speed of the vessel during acoustic sampling was 9 – 11 knots. Also EK60 18 kHz and 120 kHz data were collected, but has not been directly used for the survey estimate but as an aid when distinguishing between fish and plankton. Acoustic data were recorded as raw data on harddisk all 24 hours also during fishing operations, but data taken during fishing periods (usually two daytime hauls and two night time hauls (the latter immediately before and after local midnight)) are not used for the biomass estimate. The sampling unit (ESDU) was one nautical mile (nm). For the purpose of the later judging process raw data is also pre-integrated into 1 m meter samples for each ping. These samples stored in separate files one for each ESDU. Integration is conducted from 3 m below the transducer to 1 m above the bottom or to max 300 m depth. During trawl hauls the towed body is taken aboard and the EK60 38 kHz echosounder run on the hull transducer.

2.6 Biological data - fishing trawls

Trawl hauls were carried out during the survey for species identification. Pelagic hauls were carried out using a FOTÖ trawl (16 mm in the codend) while demersal hauls (Figure 2B.2) were carried out using an EXPO trawl (16 mm in the codend). Trawling was carried out in the time intervals 1000 to 1800h and 2200 to 0300h UTC (Table 2B.2), usually two day hauls (mostly demersal and two night hauls (mostly surface or midwater). The strategy was to cover most depth zones within each geographical stratum (see Figure 2B.2). In the deeper areas midwater hauls were made to help identify the largest depth at which herring would be expected. 1 hour hauls were used as a standard during the survey, but sometimes shortened if the catch indicators indicated very large catches.

The fish caught were sorted into species groups and length groups within each species. Number of individuals and weight for each length group for each species was recorded with emphasis on pelagic species. The clupeid fish were measured to the nearest 0.5 cm total length below, other fish to 1 cm, and the weight to the nearest 0.1g wet weight. In each trawl haul 10 (if available) herring per 0.5 cm length class were sampled for determination of age, race (North Sea autumn spawners or Baltic Sea spring spawners) and maturity. Micro-structure formed during the larval period was used for the discrimination of herring race. Maturity was determined according to an 8-stage scale as also used by Scotland (see Survey Manual App IV).

2.7 Hydrographic data

CTD profiles with a Seabird 911 were made immediately before or after each trawl haul. Salinity and temperature were measured continuously during the cruise at an intake at about 5 m depth. Data is stored together with position and weather data in the vessel’s general information system. The distribution of CTD stations is shown in Figure 2B.2.

2.8 Data analysis

The raw data is pre-integrated into 1m samples for each ping and divided into 1 mile datasets and stored on harddisk as files. Scrutiny of the acoustic data is done for a fixed set of layers (3-6 m, 6- 10, 10 – 20 and so on) for each mile, using special judging software. It allows deleting layers and/or intervals with interference from wave- or ship wake-bubbles or rarely with bottom-integration. In areas with heavy abundance of jellyfish or zooplankton, usually krill, manually adjustable thresholds is applied separately to each layer to suppress background echoes

For each sub area the mean back scattering cross section was estimated for herring, sprat, gadoids and mackerel based on the TS-relationships given in the Manual for Herring Acoustic Surveys in ICES Divisions III, IV, and IVa (ICES 2000):

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

where L is the total length in cm. The number of fish per species is assumed to be in proportion to the contribution of the given species in the trawl hauls. Therefore, the relative density of a given species is estimated by subarea using the species composition in the trawl hauls. The nearest trawl hauls are allocated to subareas with uniform depth strata. The length-race and length-age distributions for herring are 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 made based on the single fish sampled in each haul and frozen for later for micro-structure analysis of the otolith after the cruise.

3. RESULTS and DISCUSSION

3.1 Acoustic data

The total number of acoustic sample units of 1 nm (ESDU's) used in the stock size calculation is about 1300. Herring and sprat was not observed in mid-water trawl hauls at depths below 150 meters. Therefore, layers below 150 meter were excluded from the estimation.

3.2 Biological data

40 hauls were conducted (20 surface hauls, 2 mid water hauls and 16 bottom hauls, one of which was unsuccessful (Figure IIB.2 and Tables IIB2 and IIB.3.). The total catch was 18 tons of which about 2.2 tons were jellyfish. Herring was present in 30 of the hauls and a total catch of about 2800 kg was taken during the survey. In only one haul herring was present below 150 m depths. Noticeable amounts of sprat were caught in two hauls in the southwestern Skagerrak and relatively large amounts in 8 hauls in Kattegat a total of 4100 kg for the whole survey. Mackerel was also present in many (24) of the hauls distributed over the survey area. Otherwise jellyfish and other invertebrates (krill, shrimp, and Norway lobster) were the most common among the remaining species.

Based on maturity analysis of frozen single fish samples from each haul, where micro-structure analysis of the otoliths was used to differentiate between North Sea herring and Western Baltic herring, the maturity by age key was made for both races is given in the text table below. North Sea autumn spawners at maturity stage 3 and up and spring-spawners at maturity state 2 and up have been considered as mature. The following constants have been used to split the catch.

North Sea autumn spawners:

WR	0	1I	1M	2I	2M	3I	3M	4I	4M	5	6	7	8
%	100	100	0	100	0	80	20	50	50	100	100	100	100

Spring spawners:

WR	0	1I	1M	2I	2M	3I	3M	4I	4M	5	6I	7	8	9+
%	100	89	11	40	60	11	89	4	96	100	100	100	100	100

Figure 2B.4.a shows the length-weight relations for various age groups an the average for the two races based on the single fish data. The trendline estimates are based on the points of the average relations. Figure 2B.4.b shows the length-weight relations for sprat.

Table 2B.4.a shows the size distribution and total number of herring in each trawl haul based on the total catch for small catches or on subsamples raised to total catch for large samples. Table 2B.4.b shows the corresponding total catches.

3.3 Biomass estimates

The total herring biomass estimate for the survey is 242,000 tonnes of which 4.4% or 11,00 tonnes is North Sea autumn spawning herring and 95.6% or 231,000 tonnes is spring spawning herring.

The estimated total number of herring, mean weight and mean length per age and maturity group in each of the surveyed strata for the two herring stock components in the are given in Table 2B.5.a, b, and c. Stratum 560E06 is the overlap area and the others together is the standard Danish survey area.

Figures 2B.5.a and b shows plots of the estimated number of either autumn spawning or spring spawning herring per stratum and the total.

STRATUM OVERVIEW ACOUSTIC HERRING SURVEY RV "DANA" CRUISE 042005 JULY 2005								
Stratum	Stratum	Area	Number	Hauls in	Hauls from	Total hauls	Mean	Mean
Nr	ID	Nm^2	of logs	stratum	neighbour strata	used	Sa	TS
3	580E06	209	27	0	4	4	31.29948	-47.3408
4	570E06	3600	288	7	3	10	192.0751	-47.40157
5	580E08	1822	147	4	1	5	62.3704	-43.64462
6	570E08	3406	296	3	5	8	115.337	-44.97896
7	C	988	109	4	2	6	132.4637	-41.16075
8	D	1837	291	4	6	10	186.8298	-41.36337
9	E	5228	439	8	0	8	229.1694	-48.22463
10	560E06	1990	92	3	3	6	103.1449	-47.65321

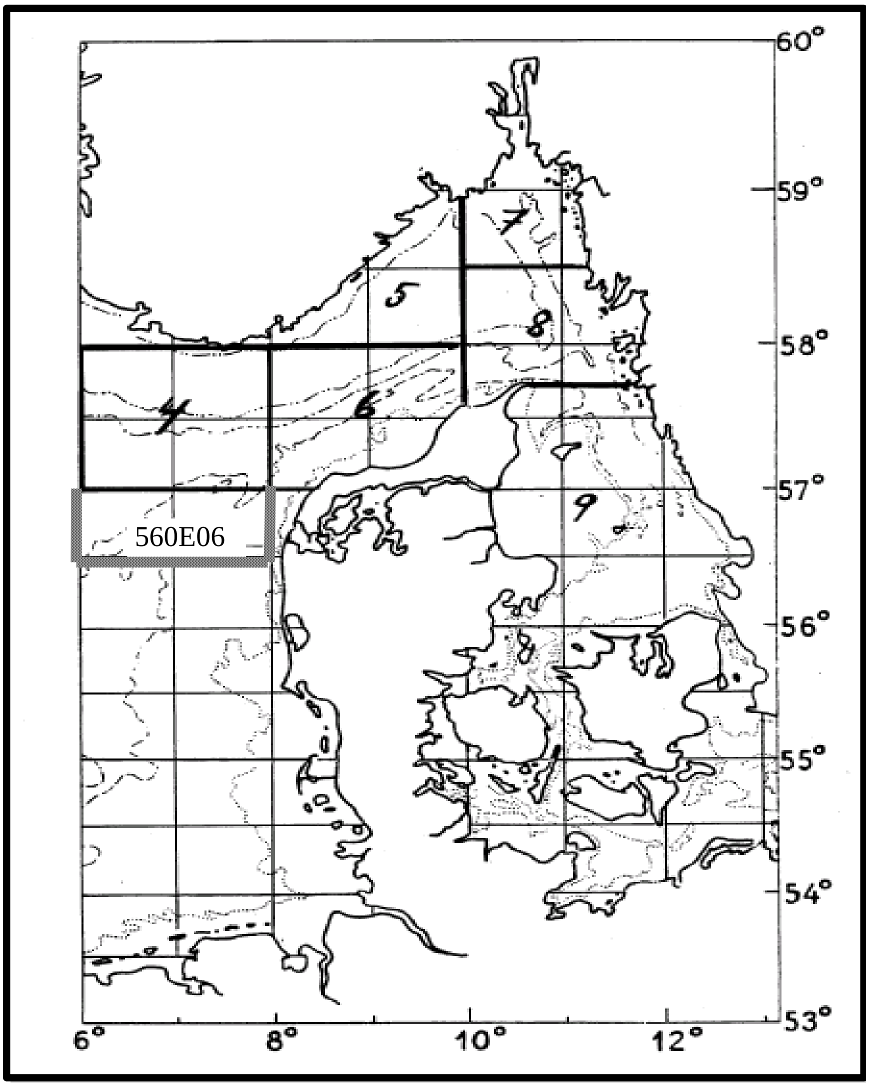


Figure 2B.1: Map of the eastern North Sea, Skagerrak and Kattegat showing the sub areas used in the estimation during the July Danish acoustic survey of RV "Dana" 2005.

Cruise track and stations during the Acoustic Herring Survey RV "Dana" Cruise 042005 July 2005

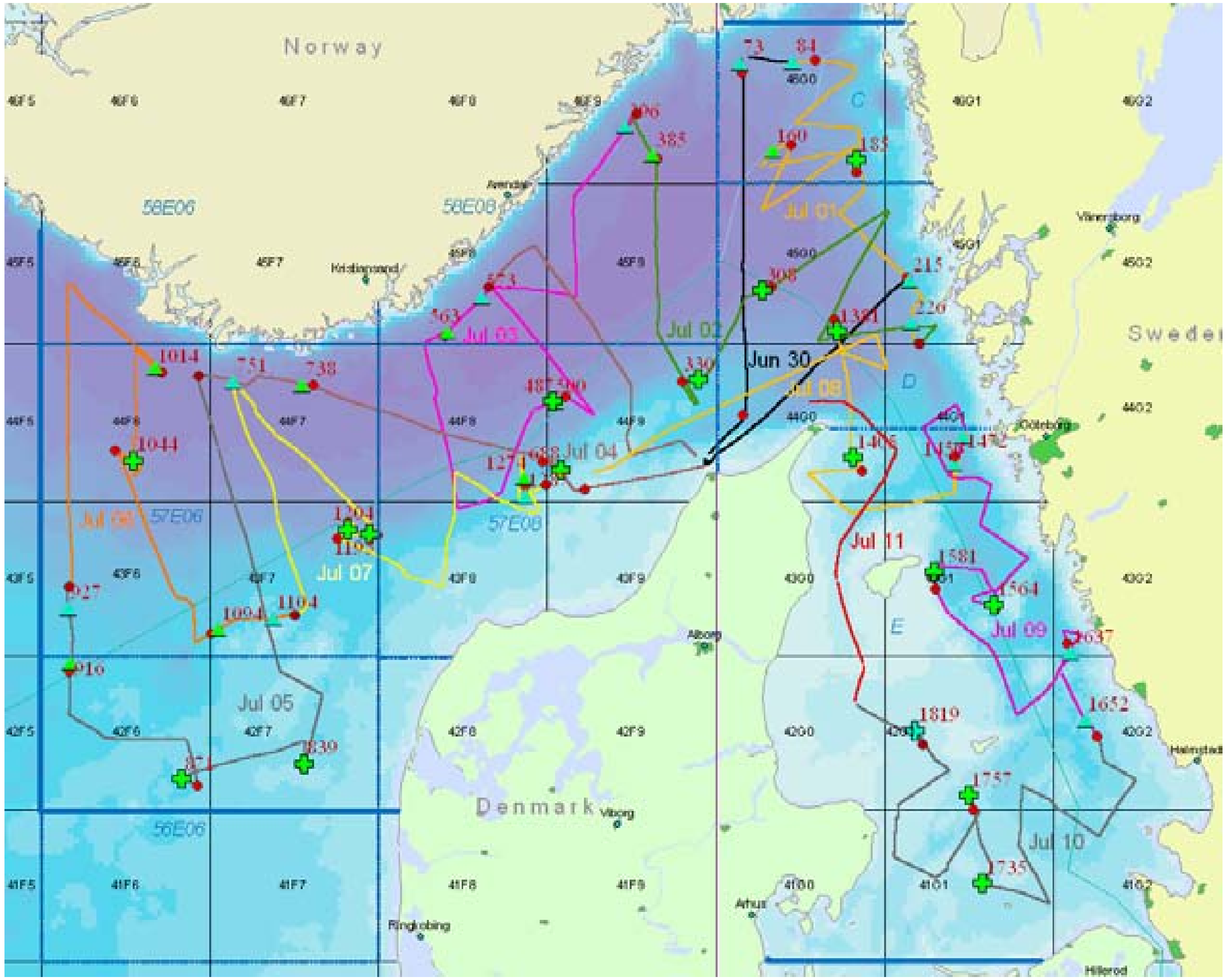


Figure 2B.2: Map of the eastern North Sea, Skagerrak and Kattegat showing cruise track, the location of stations (trawl hauls and CTD stations) during the July Danish acoustic survey (Fotö hauls ▲ are pelagic and Expo hauls ╬ are generally demersal, Red numbers are haul IDs cumulative sailed distance along the track in nm).

Bathymetry from: The MAST project DYNOCS MAST II contract No MAS2-CT94-0088.

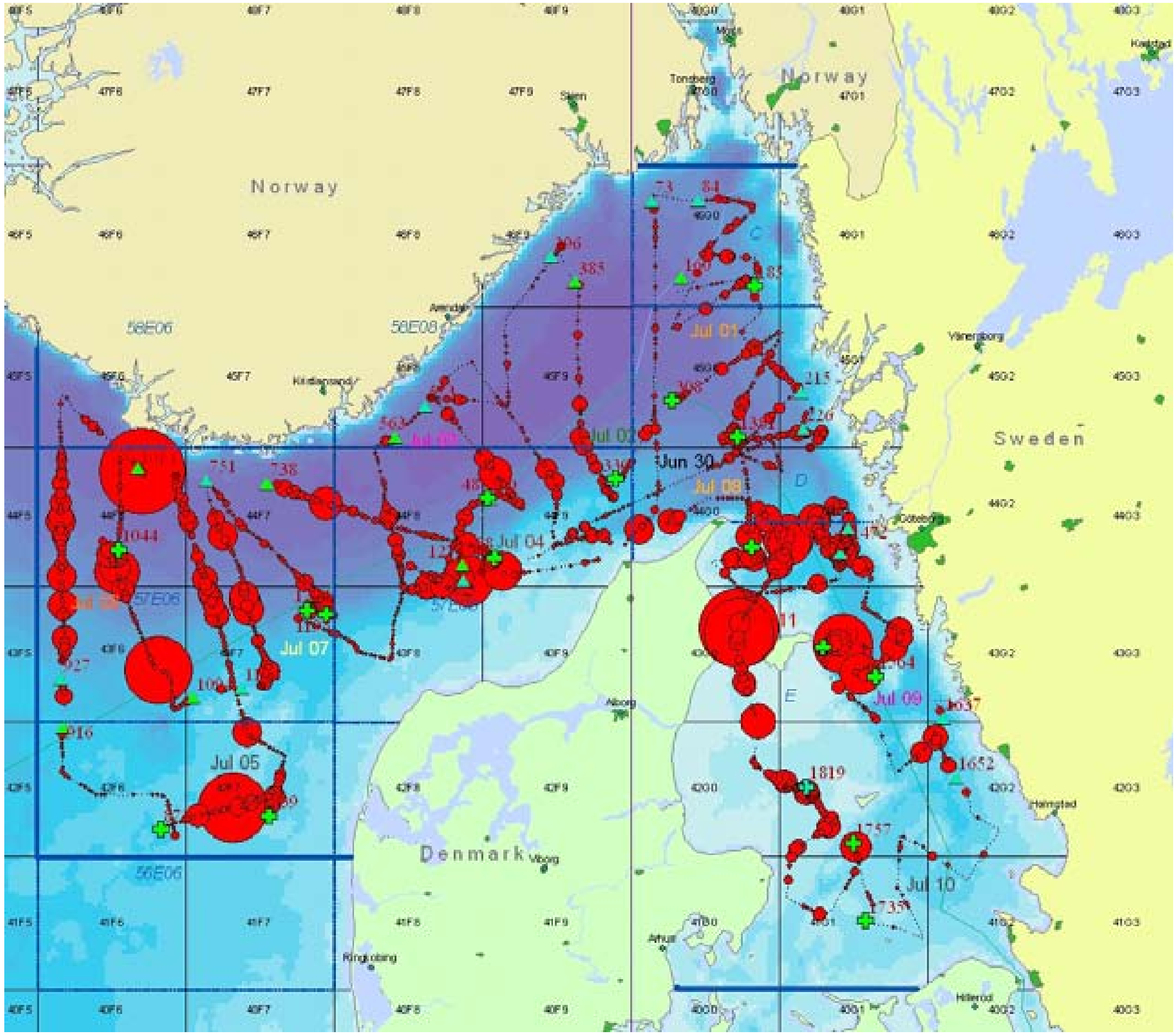
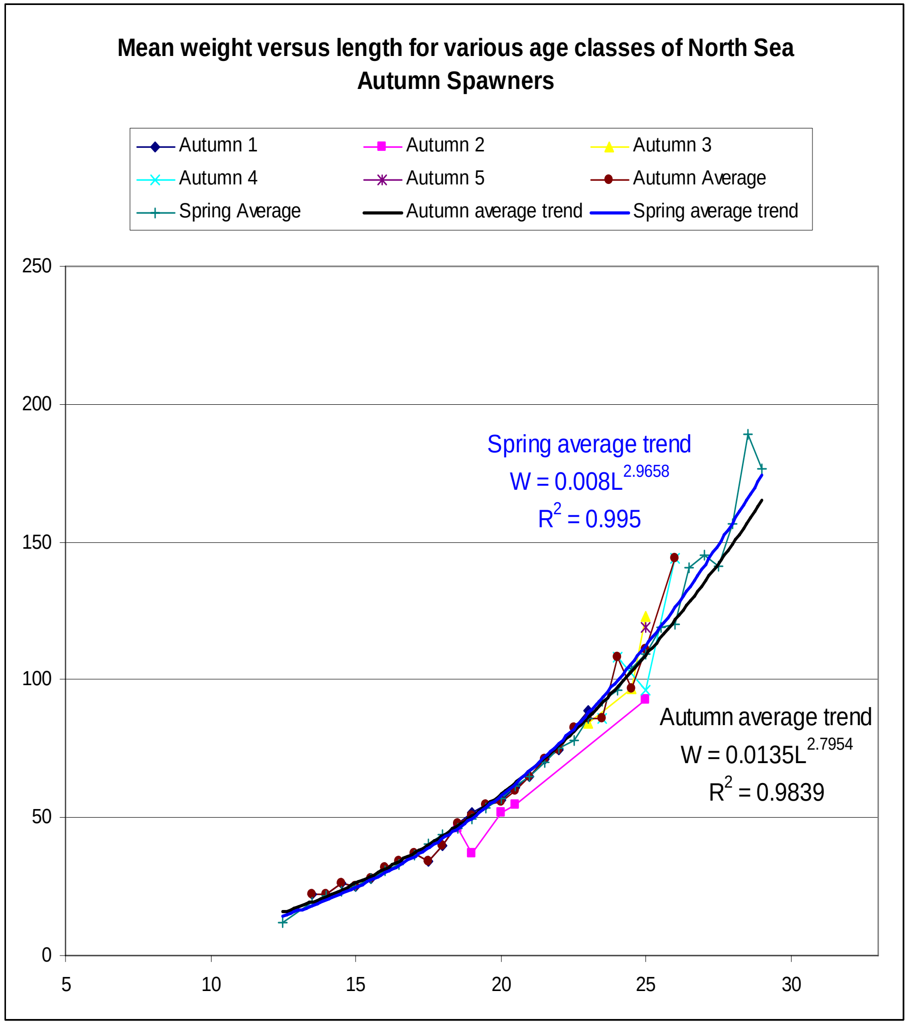


Figure 2B.3.b: Relative herring density (in numbers per nm²) along the track of the July 2005 Danish acoustic survey in the eastern North Sea, Skagerrak and Kattegat. Brown circles indicate relative density of herring per ESDU (1 nm).



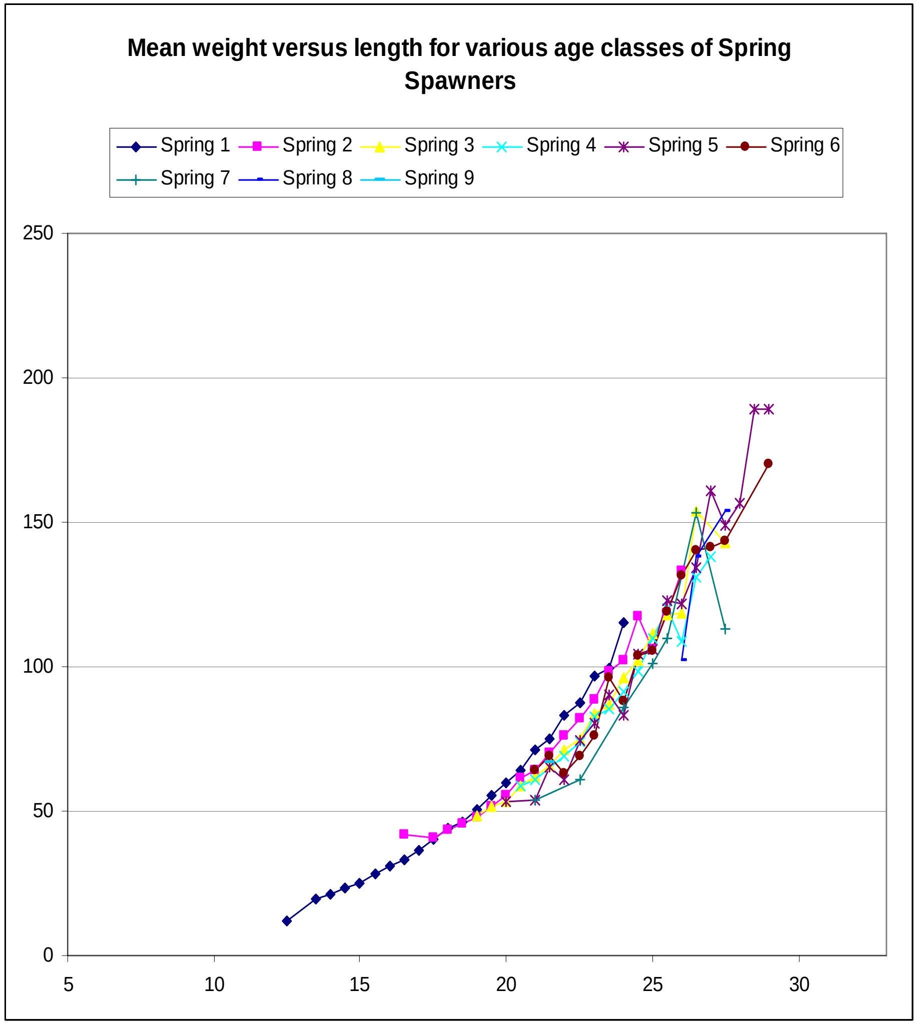


Figure 2B.4.a: Length weight relationship by winter ring numbers for herring from the July 2005 Danish acoustic survey.

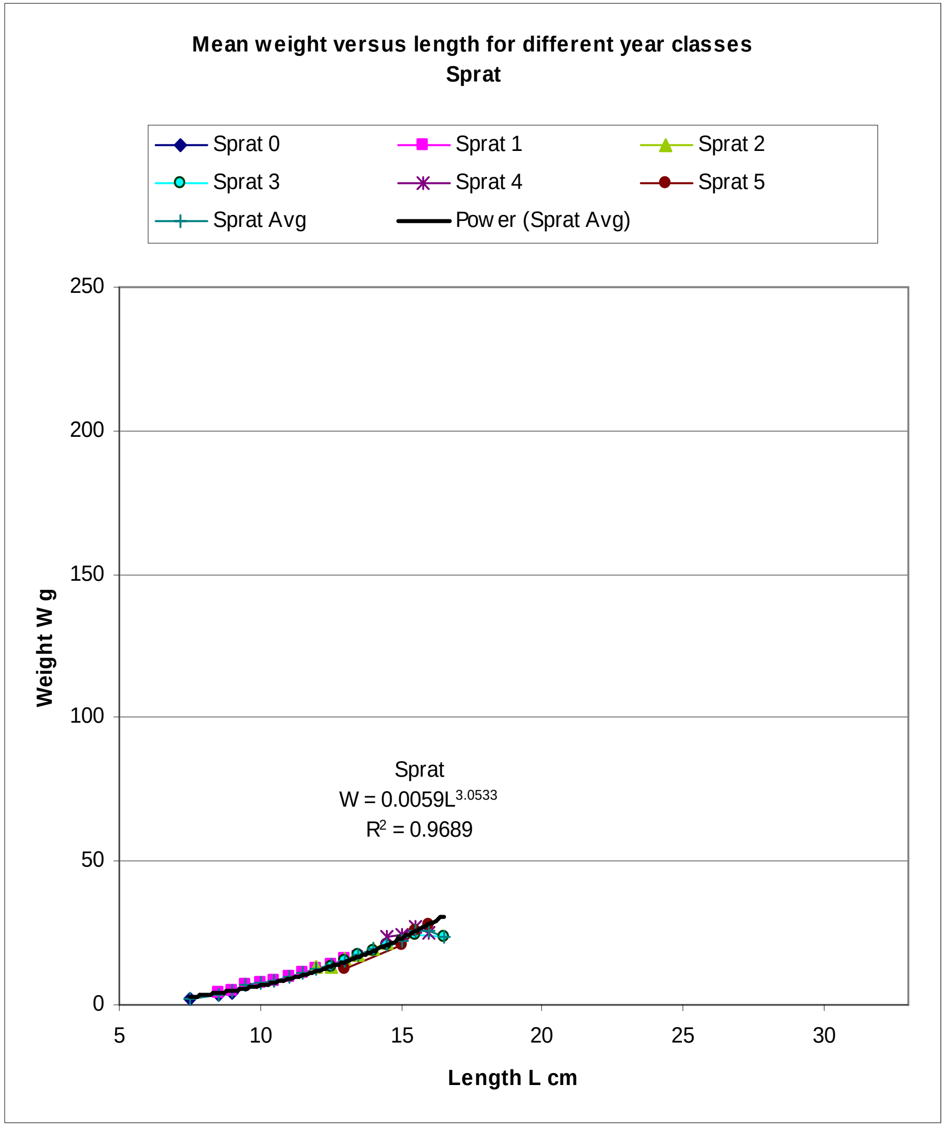


Figure 2B.4.b: Length weight relationship by winter ring numbers for sprat from the July 2005 Danish acoustic survey.

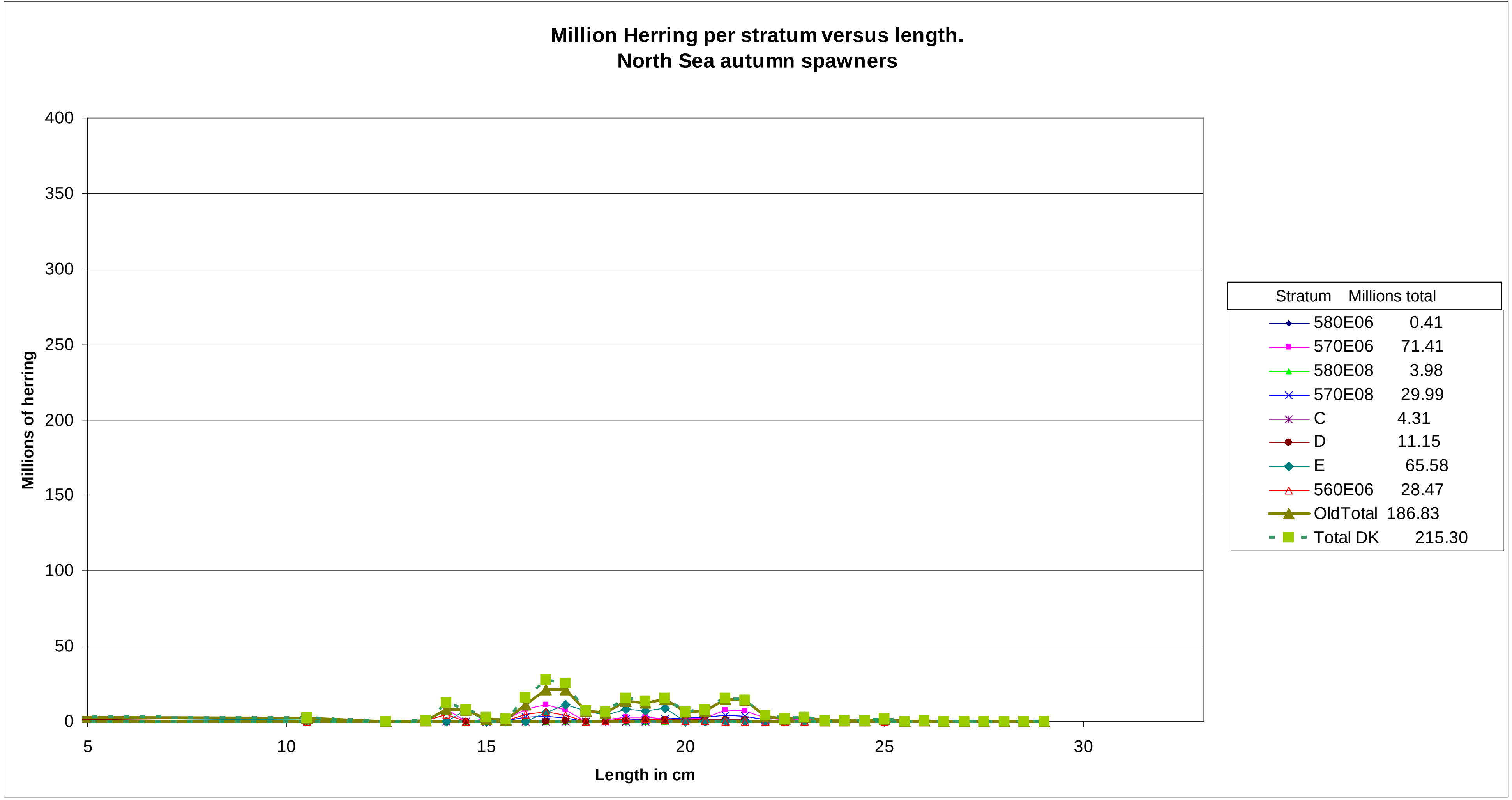


Figure 2B.5.a: Estimated number of herring per length group in various strata from the July 2005 Danish acoustic survey.

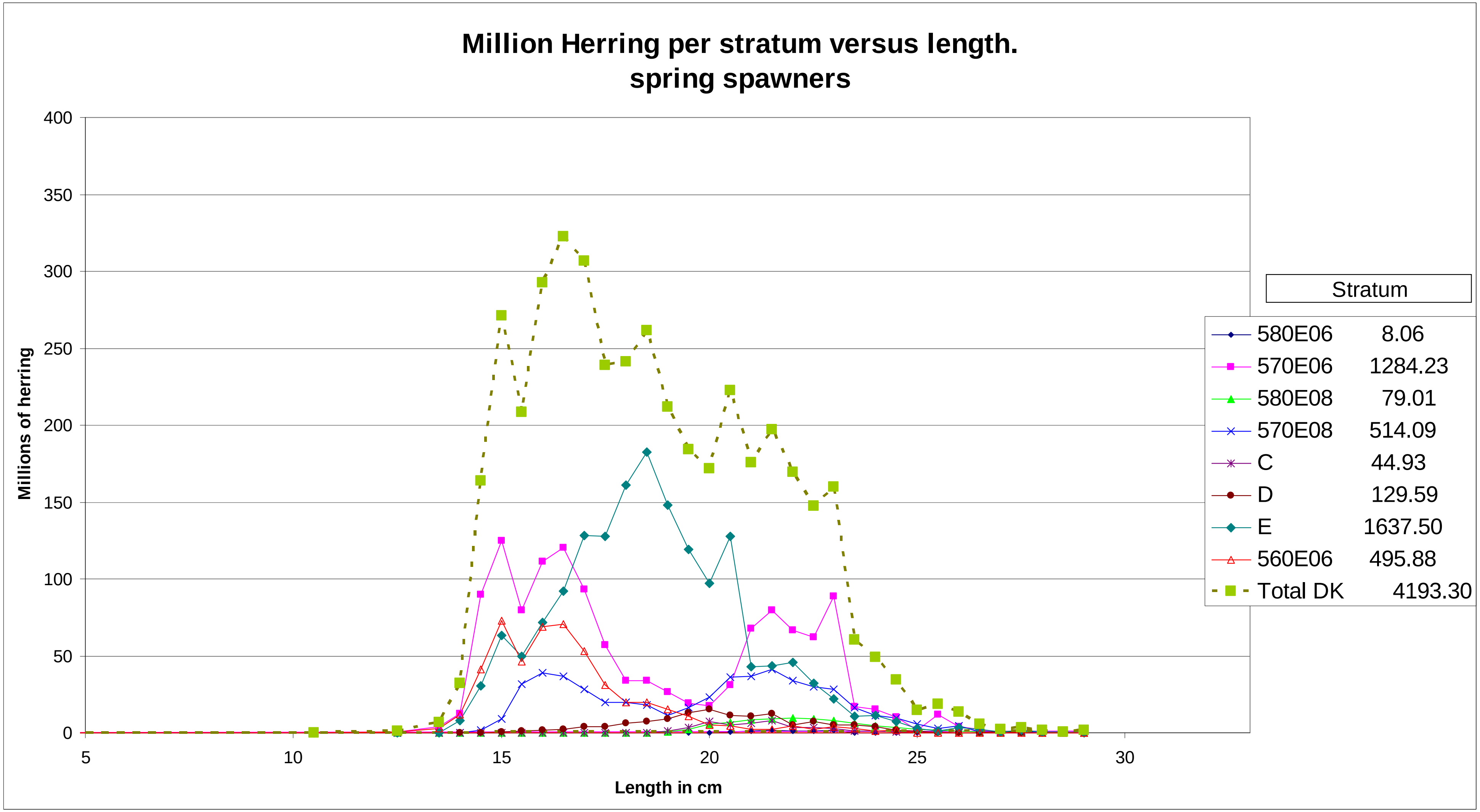


Figure 2B.5.b: Estimated number of herring per length group in various strata from the July 2005 Danish acoustic survey.

Table 2B.1: Simrad EK60 and analysis settings used during the the Acoustic Herring Survey RV "Dana" Cruise July 2005.

Transceiver Menu	
Frequency	38 kHz
Sound speed	1491 m.s^{-1}
Max. Power	2000 W
Equivalent two-way beam angle	-20.5 dB
Default Transducer Sv gain	24.59 dB
3 dB Beamwidth	6.9°
Calibration details	
TS of sphere	-33.6 dB
Range to sphere in calibration	9.08 m
Measured NASC value for calibration	23100 m^2/nmi^2
Calibration factor for NASCs	1.00
Log Menu	
Distance	1,0 n.mi. using GPS-speed
Operation Menu	
Ping interval	1 s external trig
Analysis settings	
Bottom margin (backstep)	1.0 m
Integration start (absolute) depth	7 - 9 m
Range of thresholds used	-70 dB

Table 2B.2: Trawl hauls during the Acoustic Herring Survey RV "Dana" Cruise July 2005.

Haul Nr	Haul ID	Date Time UTC	Sun Time	ICES Square	Lat N	Long E	Trawl Type	Bottom depth m	Wire Length m	Door distan-ce m	Haul dura-tion m	Catch weight kg	Herring weight kg	Raising ratio	Raised herring kg	Main species	Trawl speed kn	Trawl Dir deg	Wind Speed m/s	Wind Dir deg	Sea State Bf
1	73	30-06 21:45	22:25	46G0	58.52.344	010.08.864	Fotø	173.1	340	53	60	182	29.7	1.00	29.7	Jellyfish, Mackerel, Herring, Garfish	3.2	73	2	83	1
2	84	30-06 23:58	00:40	46G0	58.52.599	010.27.641	Fotø	162.6	370	53	61	350	35.0	2.77	97.1	Mackerel, Krill, Herring	3.9	89	5	118	2
3	160	01-07 10:56	11:38	46G0	58.36.192	010.20.741	Fotø	270.8	800	103	60	200				Krill, Saithe	3.3	323	4	46	2
4	185	01-07 15:22	16:05	46G0	58.34.453	010.50.227	Expo	85.4	400	65	60	3500	0.6	132.74	75.4	Mainly Krill, Dogfish, Saithe, Cod	2.7	176	3	322	1
5	215	01-07 21:19	22:04	45G1	58.11.855	011.08.990	Fotø	69.6	320	68	61	438	27.2	8.23	223.9	Herring, Mackerel, Jellyfish, Garfish	3.5	144	2	113	1
6	226	01-07 23:31	00:15	45G1	58.03.924	011.09.950	Fotø	89.5	330	58	60	774	32.7	15.25	498.2	Herring, Krill, Mackerel, Garfish	3.8	172	1	272	0
7	308	02-07 10:35	11:16	45G0	58.10.094	010.17.027	Expo	202.7	1000	95	60	80				Blue whiting, Lumpsucker, Saithe	2.9	294	3	191	1
8	330	02-07 14:08	14:48	44F9	57.53.218	009.54.010	Expo	60.1	360	66	60	56	13.4	1.00	13.4	Jellyfish, Herring, Haddock, Whiting, Hake	2.8	281	3	251	1
9	385	02-07 21:19	21:57	46F9	58.35.340	009.37.850	Fotø	486.1	340		60	310	22.1	2.20	48.5	Mackerel, Herring, Jellyfish, Garfish	4.0	210	5	202	2
10	396	02-07 23:35	00:13	46F9	58.40.624	009.28.108	Fotø	292.8	330		60	157	21.6	1.00	21.6	Jellyfish, Krill, Herring, Mackerel, Garfish	3.5	43	5	190	2
11	487	03-07 10:38	11:14	44F9	57.48.992	009.03.163	Fotø	172.5	1100		60	70				Saithe, Mackerel, Lumpsucker	3.4	292	5	91	2
12	500	03-07 13:05	13:42	44F8	57.49.046	009.02.173	Expo	176.2	630	83	60	35				Jellyfish, Lumpsucker	3.0	297	7	95	3
13	563	03-07 21:21	21:54	45F8	58.02.148	008.24.995	Fotø	461	320	68	60	261	24.7	2.71	67.0	Jellyfish, Krill, Herring, Mackerel, Garfish	3.5	43	5	105	3
14	573	03-07 23:30	00:04	45F8	58.08.827	008.37.063	Fotø	340.4	320		60	456	25.1	1.00	25.1	Jellyfish, Krill, Mackerel, Herring, Garfish	2.7	41	8	147	3
15	688	04-07 14:16	14:52	44F9	57.36.050	009.04.993	Expo	42.9	410	75	60	30	0.1	1.00	0.1	Jellyfish, Herring, Gurnard	3.3	247	11	96	5
16	738	04-07 21:19	21:49	44F7	57.52.191	007.33.267	Fotø	481	330	68	60	191	9.8	1.00	9.8	Mackerel, Jellyfish, Krill, Herring, Garfish, Blue whiting	5.2	258	16	108	6
17	751	04-07 23:40	00:09	44F7	57.52.889	007.08.613	Fotø	374	320		60	439	18.0	4.14	74.5	Jellyfish, Krill, Mackerel, Herring, Garfish, Blue whiting	5.2	259	17	105	6
18	839	05-07 10:24	10:54	42F7	56.39.159	007.33.719	Expo	33.9	220	73	60	120	9.9	5.95	59.0	Herring, Jellyfish, Sprat, Gurnard, Flatfish	3.7	2	8	235	4
19	871	05-07 14:55	15:23	42F6	56.36.136	006.50.132	Expo	42.6	275	80	60	59	5.2	1.91	10.0	Sprat, Herring, Jellyfish, Krill, Gurnard, Whiting, Cod, Flatfish	3.3	116	3	211	2
20	916	05-07 21:25	21:49	43F6	56.58.665	006.10.814	Fotø	58.8	325	72	60	127	11.3	1.93	21.9	Mackerel, Herring, Jellyfish, Garfish	3.8	3	4	193	2
21	927	05-07 23:34	23:59	43F6	57.09.403	006.09.863	Fotø	66	325		60	160	20.0	4.40	87.9	Herring, Mackerel, Jellyfish, Garfish	4.0	181	3	147	2
22	1014	06-07 10:30	10:56	44F6	57.55.406	006.40.724	Fotø	375.2	325	68	60	76	1.3	1.00	1.3	Jellyfish, Herring, Garfish	4.5	225	5	126	2
23	1044	06-07 14:55	15:21	44F6	57.37.884	006.33.266	Expo	183.7	720		60	50				Pearlside, Lumpsucker, Krill, Haddock	3.3	245	2	170	1
24	1094	06-07 21:22	21:50	43F7	57.05.391	007.03.426	Fotø	55.5	330	68	60	511	15.0	10.78	161.9	Mackerel, Herring, Jellyfish	3.8	60	5	31	2
25	1104	06-07 23:41	00:10	43F7	57.07.410	007.22.811	Fotø	44	325		61	212	16.8	9.08	152.5	Herring, Mackerel, Jellyfish, Gurnard, Whiting	3.7	76	3	79	2
26	1195	07-07 10:28	11:00	43F7	57.23.860	007.57.107	Expo	82.3	436		60	49	6.1	1.00	6.1	Cod, Haddock, Herring, Ling, Jellyfish Saithe	3.0	275	6	46	3
27	1204	07-07 12:38	13:09	43F7	57.24.710	007.49.170	Expo	119.4	400	74	60	20				Jellyfish	2.4	312	7	68	3
28	1274	07-07 21:21	21:56	44F8	57.34.437	008.52.114	Fotø	67.3	325	68	60	115	16.4	2.19	35.9	Jellyfish, Herring, Mackerel	3.8	189	5	31	3
29	1287	07-07 23:45	00:21	44F8	57.31.111	008.52.371	Fotø	40.5	325	67	60	510	10.3	27.55	285.0	Herring, Mackerel, Horse mackerel, Haddock, Hake	3.9	63	4	65	2
30	1381	08-07 10:43	11:26	45G0	58.02.328	010.43.400	Expo	200.1	850	100	60	469	1.6	2.14	3.5	Shrimp, Blue whiting, Saithe, Lumpsucker, Jellyfish	3.0	169	2	11	1
31	1405	08-07 14:37	15:20	44G0	57.38.368	010.49.194	Expo	25.5	205	65	60	1492	5.2	9.65	49.7	Sprat, Whiting, Herring, Jellyfish, Dogfish, Flatfish, Hake	3.2	146	4	340	2
32	1456	08-07 21:19	22:05	44G1	57.37.047	011.24.769	Fotø	57.7	330	63	60	241	19.3	4.51	87.1	Jellyfish, Herring, Sprat, Mackerel, Dogfish	3.8	175	7	7	3
33	1472	08-07 23:58	00:44	44G1	57.42.430	011.28.371	Fotø	64.4	320		60	420	21.1	16.37	344.7	Herring, Jellyfish, Mackerel, Sprat	3.8	343	2	74	1
34	1564	09-07 10:39	11:25	43G1	57.10.112	011.39.316	Expo	63.9	400	60	47	895	17.7	3.38	59.9	Jellyfish, Whiting, Herring, Cod, Saithe, Flatfish, Haddock	2.9	6	3	289	1
35	1581	09-07 13:37	14:23	43G1	57.16.449	011.17.931	Expo	33.4	260	77	60	1317	1.4	7.07	10.1	Sprat, Dogfish, Whiting, Haddock, Flatfish, Jellyfish, Herring, Hake, Common Weaver	3.2	175	6	344	3
36	1637	09-07 21:23	22:11	42G2	57.00.878	012.06.485	Fotø	45.6	325	62	60	225	12.3	3.77	46.3	Jellyfish, Sprat, Herring, Mackerel	3.7	326	4	276	2
37	1652	10-07 00:04	00:53	42G2	56.47.729	012.11.747	Fotø	38.3	325	69	60	456	3.2	1.00	3.2	Jellyfish, Herring, Mackerel, Common weaver, Sprat	3.7	149	4	41	2
38	1735	10-07 10:23	11:10	41G1	56.15.536	011.35.239	Expo	26.6	200		60	575	0.4	3.49	1.3	Sprat, Jellyfish, Herring, Flatfish	3.3	30	3	288	1
39	1757	10-07 14:10	14:56	42G1	56.32.946	011.30.115	Expo	26	230		51	1270	0.4	8.51	3.3	Sprat, Jellyfish, Whiting, Flatfish, Bullrout, Herring,	3.0	164	6	307	2
40	1819	10-07 21:39	22:23	42G1	56.45.687	011.11.158	Expo	16.5	180		60	1200	16.3	9.74	158.4	Jellyfish, Herring, Sprat, Mackerel	3.2	157	6	285	3

Table 2B.3: Trawl haul species composition in kg during the Acoustic Herring Survey RV "Dana" Cruise July 2005.

	Stratum	**560E06**			**570E06**										**570E08**						**580E08**			
	Station Nr	839	871	916	738	751	927	1014	1044	1094	1104	1195	1204	1274	330	487	500	688	1287	1381	385	396	563	573
	Fishing depth	30.5 m	44 m	Surf	Surf	Surf	Surf	Surf	166 m	Surf	Surf	54 m	90 m	Surf	50 m	120 m	175 m	35 - 60 m	Surf	200 m	Surf	Surf	Surf	Surf
	ICES square	42F7	42F6	42F6	44F7	44F7	43F6	44F6	44F6	43F7	43F7	43F7	43F7	44F8	44F9	44F9	44F9	44F9	44F8	45G0	46F9	46F9	45F8	45F8
SpeciesName	GearName	Expo	Expo	Fotø	Fotø	Fotø	Fotø	Fotø	Expo	Fotø	Fotø	Expo	Expo	Fotø	Expo	Fotø	Expo	Expo	Fotø	Expo	Fotø	Fotø	Fotø	Fotø
Sprattus sprattus		11.6	23.5			0.0													0.3				0.0	
Clupea harengus		59.0	10.0	21.9	9.8	74.5	87.9	1.3		161.9	152.5	6.1		35.9	13.4			0.1	285.0	3.8	48.5	21.6	67.0	25.1
Medusa, spp		22.4		13.0			10.8	71.9	0.6	12.9	17.3	3.3	20.0	65.7	24.8		30.6	30.0		7.6	21.0			
Invertebrata			9.4		70.4	207.0										8.6						108.0	129.0	350.2
Scomber scombrus		1.4		89.5	97.7	130.8	60.0			335.0	31.4			12.1		0.6			129.8		224.8	19.7	30.7	70.9
Pollachius virens									6.0			2.1				56.7				56.0				
Squalus acanthias					0.8																			
Gadus Morhua			2.5							0.3	0.0	16.8		0.3	0.5				0.4	36.6				
Merlangius merlangus			3.1	0.0	0.0	0.5	0.0	0.0		0.1	2.1	0.0		0.2	3.7		0.0		1.0				0.1	
Euphausidae spp.									10.9															
Pollachius pollachius												1.2												
Micromesistius poutassou					2.0	9.7														144.1			0.5	1.0
Pandalus spp., Crangon spp.																				166.6				
Merluccius merluccius															2.8				3.0	0.2				
Trisopterus esmarki												0.0		0.1						2.9				
Belone belone				2.5	9.1	14.4	1.0	1.3		0.7											15.6	7.5	33.3	8.6
Cyclopterus lumpus					1.0			0.1	14.8						0.7	4.1	3.9			44.3			0.3	0.2
Trachurus trachurus		4.7				0.4													86.4					
Maurolicus muelleri					0.0	0.0			16.7											1.2				
Melanogrammus aeglefinus		0.3	0.0		0.0		0.0	0.0	1.0		0.0	14.4		0.0	9.7		0.0			0.1				
Limanda limanda		7.9	2.7																					
Trigala spp.		9.4	4.2	0.1			0.3				8.6							0.1	3.2					
Pleuronectes platessa		0.4	2.3												0.4					0.3				
Trachinus draco																								
Myoxocephalus scorpius																								
Molva molva												4.7												
Hippoglosides plattessoides															0.1									
Salmo salar						1.7		1.4																
Microstomus kitt		2.5																						
Scophthalmus rhombus																								
Loligo spp.					0.1					0.1		0.2		0.6					0.9					
Enchelyopus cimbrius																				1.8				
Hyperoplus lanceolatus		0.6	0.4																					
Nephrops norvegicus																				1.0				
Lycodes vahli																				1.0				
Oncorhynchus mykiss, Salmo gairdneri																								
Ammodytes xx			0.5																					
Argentina sphyraena *																				0.3				
Glyptocephalus cynoglossus																				0.3				
Lumpenus lampretaeformis																								
Myxine glutinosa																				0.2				
Platichthys flesus																								
Hovedtotal		120.0	58.5	127.0	191.0	439.0	160.0	76.0	50.0	511.0	212.0	48.8	20.0	115.0	56.0	70.0	34.6	30.2	510.0	468.5	310.0	156.8	261.0	456.0

Table 2B.3: Trawl haul species composition in kg during the Acoustic Herring Survey RV "Dana" Cruise July 2005 (continued).

STRATUM	C				D					E								TOTAL	MAX
Station Nr	73	84	160	185	215	226	308	1405	1456	1472	1564	1581	1637	1652	1735	1757	1819	In survey	In survey
Fishing depth	Surf	Surf	120-160 m	86 m	Surf	Surf	180 m	17 m	Surf	Surf	48 m	23 m	Surf	Surf	20 m	18 m	10 m		
ICES square	46G0	46G0	46G0	46G0	45G1	45G1	45G0	44G0	44G1	44G1	43G1	43G1	42G2	42G2	41G1	42G1	42G1		
SpeciesName	Fotø	Fotø	Fotø	Expo	Fotø	Fotø	Expo	Expo	Fotø	Fotø	Expo	Expo	Fotø	Fotø	Expo	Expo	Expo		
Sprattus sprattus					0.2	0.1		1231.6	34.9	1.5	0.1	1033.6	86.7	1.2	553.2	1123.7	21.2	4123.4	1231.6
Clupea harengus	29.7	97.1		75.4	223.9	498.2		49.7	87.1	344.7	59.9	10.1	46.3	3.2	1.3	6.7	158.4	2776.9	498.2
Medusa, spp	101.6				28.6				129.0	64.4			88.2	447.9	17.6		1007.1	2236.3	1007.1
Invertebrata						184.0		34.5			728.4	11.2				106.5		1947.1	728.4
Scomber scombrus	43.2	136.8			179.0	78.6			4.2	8.4			2.2	2.4		0.9	2.1	1692.2	335.0
Pollachius virens			23.9	1261.0			1.5				4.4							1411.6	1261.0
Squalus acanthias	1.2			995.6				19.2	1.3		1.5	177.2						1196.8	995.6
Gadus Morhua				491.1				2.3			20.0							570.9	491.1
Merlangius merlangus	0.0	0.0		121.3	0.0			125.0	0.1	0.1	74.3	16.3	0.7		0.2	17.4	0.1	366.5	125.0
Euphausidae spp.		116.0	157.8															284.7	157.8
Pollachius pollachius				257.0														258.1	257.0
Micromesistius poutassou							24.7											181.9	144.1
Pandalus spp., Crangon spp.																		166.6	166.6
Merluccius merluccius				151.2				4.3				2.1						163.7	151.2
Trisopterus esmarki				141.2							0.1							144.4	141.2
Belone belone	5.8	0.2			3.5	12.1			0.3	0.2							8.1	124.1	33.3
Cyclopterus lumpus			13.6		1.7	0.3	23.1				0.4		0.1				0.2	108.7	44.3
Trachurus trachurus					0.7				1.4	0.4			0.2				0.4	94.6	86.4
Maurolicus muelleri		0.0	4.6				30.7				0.1							53.4	30.7
Melanogrammus aeglefinus	0.0	0.0	0.1	6.1	0.0						2.2	16.0				0.1		50.1	16.0
Limanda limanda					0.5			8.8				12.3			2.6	10.6	0.2	45.5	12.3
Trigala spp.								1.2									0.1	27.2	9.4
Pleuronectes platessa								4.4			0.2	1.4				1.8		11.1	4.4
Trachinus draco	0.1								0.1	0.1		5.9	0.7	1.3	0.1		2.2	10.5	5.9
Myoxocephalus scorpius								1.6								5.2		6.8	5.2
Molva molva																		4.7	4.7
Hippoglosides plattessoides											3.3	0.7						4.1	3.3
Salmo salar										0.3		0.2						3.5	1.7
Microstomus kitt												0.2						2.7	2.5
Scophthalmus rhombus								1.7				0.7						2.4	1.7
Loligo spp.																		2.0	0.9

STRATUM	C				D					E								TOTAL	MAX
Station Nr	73	84	160	185	215	226	308	1405	1456	1472	1564	1581	1637	1652	1735	1757	1819	In survey	In survey
Fishing depth	Surf	Surf	120-160 m	86 m	Surf	Surf	180 m	17 m	Surf	Surf	48 m	23 m	Surf	Surf	20 m	18 m	10 m		
ICES square	46G0	46G0	46G0	46G0	45G1	45G1	45G0	44G0	44G1	44G1	43G1	43G1	42G2	42G2	41G1	42G1	42G1		
SpeciesName	Fotø	Fotø	Fotø	Expo	Fotø	Fotø	Expo	Expo	Fotø	Fotø	Expo	Expo	Fotø	Fotø	Expo	Expo	Expo		
Enchelyopus cimbrius																		1.8	1.8
Hyperoplus lanceolatus																0.6		1.6	0.6
Nephrops norvegicus																		1.0	1.0
Lycodes vahli																		1.0	1.0
Oncorhynchus mykiss, Salmo gairdneri						0.9												0.9	0.9
Ammodytes xx																		0.5	0.5
Argentina sphyraena *																		0.3	0.3
Glyptocephalus cynoglossus																		0.3	0.3
Lumpenus lampretaeformis											0.3							0.3	0.3
Myxine glutinosa																		0.2	0.2
Platichthys flesus												0.2						0.2	0.2
Hovedtotal	181.6	350.0	200.0	3500.0	438.1	774.0	80.0	1484.4	258.5	420.0	895.1	1288.0	225.0	456.0	575.0	1273.4	1200.1	18080.6	3500.0

Table 2B.4.a: Raised length frequency composition by stratum and trawl station for the Acoustic Herring Survey RV "Dana" Cruise July 2005.

Stratum	560E06			570E06								570E08				580E08				C			D				E								
Station	839	871	916	738	751	927	1014	1094	1104	1195	1274	330	688	1287	1381	385	396	563	573	73	84	185	215	226	1405	1456	1472	1564	1581	1637	1652	1735	1757	1819	
ICES Sq	42F7	42F6	43F6	44F7	44F7	43F6	44F6	43F7	43F7	43F7	44F8	44F9	44F9	44F8	45G0	46F9	46F9	45F8	45F8	46G0	46G0	46G0	45G1	45G1	44G0	44G1	44G1	43G1	43G1	42G2	42G2	41G1	42G1	42G1	
Length / Gear	Expo	Expo	Fotø	Fotø	Fotø	Fotø	Fotø	Fotø	Fotø	Expo	Fotø	Expo	Expo	Fotø	Expo	Fotø	Fotø	Fotø	Fotø	Fotø	Fotø	Expo	Fotø	Fotø	Expo	Fotø	Fotø	Expo	Expo	Fotø	Fotø	Expo	Expo	Expo	Total
3.5																						133													133
10.5																									10										10
12.5		2																																	2
13.5	60	2																																	61
14	214	15	2																						10				7						248
14.5	786	90	8			4			18					165											10				42						1124
15	709	159	33			54		22	109	8	7			496											39				35	4		3		10	1686
15.5	322	57	42			152		86	272	24	28			1901											58		16		14			3		29	3006
16	107	31	168			362		269	454	43	68	1		1543											97		16		21	4		3		166	3352
16.5	54	17	208	1		331		280	772	34	88	5		1405						1					125		65			4		3	9	409	3811
17	36	4	98	1		259		431	826	21	79	7		992										15	183	9	164			8	1	3	9	857	4003
17.5	12		15			161		269	736	12	46	10		606											125		246	10		41	1		9	1227	3526
18	6		4			94		226	427	8	64	18		413							8		123	61	164	18	458	17	21	30			34	711	2906
18.5	6		6		4	80		323	336	9	64	21		138			1			6	17		272	183	106	131	393	41	35	49	2		77	351	2649
19	12		10	1		67		334	100	4	44	9		193		2	6	3	2	9	80		543	519	87	167	475	30	42	87	1	3		166	2995
19.5			2	1		27		323	45	2	55	15		165		4	23	24	6	26	191	133	765	1084	19	266	458	81	7	109	5	3		88	3929
20			2	5	25	27		119	27	1	66	19		55		26	49	43	12	71	345	265	708	1740	10	194	393	105	7	64	2		9	39	4427
20.5				14	58	27		119	9	2	57	32		28		33	44	41	32	78	273		469	1221		180	606	71	7	79	4	14		10	3507
21				19	133	27	9	32			55	32			9	55	60	43	34	63	246	133	181	916	10	90	360	68		45					2619
21.5				35	145	18	4	54	9		9	29		28		73	55	41	35	57	144	398	181	870		90	409	91		49	6				2829
22				17	195	54	1	75			9	10		28	2	59	33	87	45	39	97		99	550		36	393	101	7	68	4				2008
22.5				16	137	36	4	22			4	7			34	70	25	98	33	37	50		140	214		32	376	68		45	4				1451
23				13	75	40	36	75		1	4	3			2	64	8	90	40	14	25	133	66	92		27	262	64		30	3				1167
23.5				2	58	40		43				1	1		34	46	5	76	29	15	14		49	61		18	115	34		15	2				659
24				2	12	9	1	22							19	46	1	62	15	8	8		25	46		32	82	27		15					432
24.5				3	25	22		22							2	33	3	46	13	3			8	76		9	49	10		15	1				341
25					8	4						1			2	18	2	46	5	3	6		16	31		18		24		4	2				190
25.5				1	4	4	1									20	1	14	4		3		16	31		5	16	7							126
26				2	8	4										9		19	6	2			8			5	33			8					104
26.5					12											2		3	2	1						5	16			4					45
27															2		1	3									16	3							26
27.5																4	1	8								5		3		4	3				28

Stratum	560E06			570E06								570E08				580E08				C			D				E								
Station	839	871	916	738	751	927	1014	1094	1104	1195	1274	330	688	1287	1381	385	396	563	573	73	84	185	215	226	1405	1456	1472	1564	1581	1637	1652	1735	1757	1819	
ICES Sq	42F7	42F6	43F6	44F7	44F7	43F6	44F6	43F7	43F7	43F7	44F8	44F9	44F9	44F8	45G0	46F9	46F9	45F8	45F8	46G0	46G0	46G0	45G1	45G1	44G0	44G1	44G1	43G1	43G1	42G2	42G2	41G1	42G1	42G1	
Length / Gear	Expo	Expo	Fotø	Fotø	Fotø	Fotø	Fotø	Fotø	Fotø	Expo	Fotø	Expo	Expo	Fotø	Expo	Fotø	Fotø	Fotø	Fotø	Fotø	Fotø	Expo	Fotø	Fotø	Expo	Fotø	Fotø	Expo	Expo	Fotø	Fotø	Expo	Expo	Expo	Total
28					4											2										5									11
28.5																										5		3							8
29					8															1															9
Total	2322	377	598	133	913	1903	56	3148	4141	169	745	220	1	8154	107	568	318	747	313	434	1505	1195	3670	7708	1052	1345	5418	858	247	780	41	38	145	4061	53429

Table 2B.4.b: Raised catch weights of herring by trawl station for the Acoustic Herring Survey RV "Dana" Cruise July 2005.

	560E06			570E06								570E08				580E08				C			D				E								
	839	871	916	738	751	927	1014	1094	1104	1195	1274	330	688	1287	1381	385	396	563	573	73	84	185	215	226	1405	1456	1472	1564	1581	1637	1652	1735	1757	1819	
	42F7	42F6	43F6	44F7	44F7	43F6	44F6	43F7	43F7	43F7	44F8	44F9	44F9	44F8	45G0	46F9	46F9	45F8	45F8	46G0	46G0	46G0	45G1	45G1	44G0	44G1	44G1	43G1	43G1	42G2	42G2	41G1	42G1	42G1	
	Expo	Expo	Fotø	Fotø	Fotø	Fotø	Fotø	Fotø	Fotø	Expo	Fotø	Expo	Expo	Fotø	Expo	Fotø	Fotø	Fotø	Fotø	Fotø	Fotø	Expo	Fotø	Fotø	Expo	Fotø	Fotø	Expo	Expo	Fotø	Fotø	Expo	Expo	Expo	Total
Total kg	59.0	10.0	21.9	9.8	74.5	87.9	1.3	161.9	152.5	6.1	35.9	13.4	0.1	285.0	3.5	48.5	21.6	67.0	25.1	29.7	97.1	75.4	223.9	498.2	49.7	87.1	344.7	59.9	10.1	46.3	3.2	1.3	3.3	158.4	2773.2

Table 2B.5a: Numbers of herring by age, maturity, stock and sub area for the Acoustic Herring Survey RV "Dana" Cruise July 2005.

	North Sea Autumn spawners. Abundance (Millions)													
Stratum	0	1i	1m	2i	2m	3i	3m	4i	4m	5	6	7	8	9+
580E06	0.0000	0.3851	0.0000	0.0091	0.0000	0.0112	0.0056	0.0003	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000
570E06	0.0000	69.6662	0.0000	0.6873	0.0000	0.6750	0.3375	0.0215	0.0215	0.0000	0.0000	0.0000	0.0000	0.0000
580E08	0.0000	3.5147	0.0000	0.2155	0.0000	0.1284	0.0642	0.0298	0.0298	0.0000	0.0000	0.0000	0.0000	0.0000
570E08	0.0000	28.3151	0.0000	0.9269	0.0000	0.3903	0.1952	0.0800	0.0800	0.0000	0.0000	0.0000	0.0000	0.0000
C	1.0944	3.0023	0.0000	0.1542	0.0000	0.0336	0.0168	0.0059	0.0059	0.0000	0.0000	0.0000	0.0000	0.0000
D	1.9871	8.6846	0.0000	0.3401	0.0000	0.0699	0.0350	0.0180	0.0180	0.0000	0.0000	0.0000	0.0000	0.0000
E	0.3906	57.5723	0.0000	4.1469	0.0000	0.5860	0.2930	1.0518	1.0518	0.4858	0.0000	0.0000	0.0000	0.0000
560E06	0.0000	28.2782	0.0000	0.1150	0.0000	0.0452	0.0226	0.0025	0.0025	0.0000	0.0000	0.0000	0.0000	0.0000

	Spring Spawners Abundance (Millions)													
Stratum	0	1i	1m	2i	2m	3i	3m	4i	4m	5	6	7	8	9+
580E06	0.0000	0.8485	0.1098	1.8295	2.6843	0.2251	1.7381	0.0390	0.3081	0.1819	0.0724	0.0183	0.0048	0.0000
570E06	0.0000	749.3839	96.9700	115.4572	169.4059	13.2829	102.5731	2.3849	18.8146	10.4452	4.2243	1.0281	0.2567	0.0000
580E08	0.0000	10.0615	1.3020	16.6373	24.4112	2.0967	16.1914	0.5701	4.4974	1.7494	1.1433	0.2266	0.1265	0.0000
570E08	0.0000	231.7951	29.9942	68.3147	100.2356	6.8937	53.2349	1.6595	13.0914	4.9372	3.1045	0.5629	0.2670	0.0000
C	0.0000	9.5996	1.2422	10.2887	15.0963	0.7523	5.8095	0.1410	1.1125	0.5225	0.2881	0.0527	0.0291	0.0000
D	0.0000	50.4916	6.5336	21.6217	31.7247	1.5589	12.0381	0.3804	3.0009	1.0449	1.0527	0.1218	0.0258	0.0000
E	0.0000	770.9889	99.7656	233.8818	343.1658	13.6462	105.3790	3.2205	25.4063	19.4624	16.3734	4.1163	0.8115	1.2864
560E06	0.0000	430.9351	55.7628	1.3058	1.9159	0.5854	4.5205	0.0626	0.4936	0.2021	0.0709	0.0234	0.0000	0.0000

Table 2B.5b: Mean weight of herring by age, maturity, stock and subarea for the Acoustic Herring Survey RV "Dana" Cruise July 2005.

	North Sea Autumn spawners. Mean weight (g)													
Stratum	**0**	**1i**	**1m**	**2i**	**2m**	**3i**	**3m**	**4i**	**4m**	**5**	**6**	**7**	**8**	**9+**
580E06	0.00	75.50	75.50	70.34	70.34	100.19	100.19	124.44	124.44	0.00	0.00	0.00	0.00	0.00
570E06	0.00	47.63	47.63	69.62	69.62	100.98	100.98	124.44	124.44	0.00	0.00	0.00	0.00	0.00
580E08	0.00	72.26	72.26	81.89	81.89	111.66	111.66	124.44	124.44	0.00	0.00	0.00	0.00	0.00
570E08	0.00	56.61	56.61	75.96	75.96	109.98	109.98	124.44	124.44	0.00	0.00	0.00	0.00	0.00
C	0.27	69.39	69.39	69.50	69.50	108.06	108.06	124.44	124.44	0.00	0.00	0.00	0.00	0.00
D	0.40	60.49	60.49	71.30	71.30	110.97	110.97	124.44	124.44	0.00	0.00	0.00	0.00	0.00
E	8.34	41.52	41.52	48.71	48.71	111.70	111.70	119.82	119.82	124.44	0.00	0.00	0.00	0.00
560E06	0.00	35.97	35.97	67.87	67.87	106.96	106.96	124.44	124.44	0.00	0.00	0.00	0.00	0.00

	Spring Spawners Mean weight (g)													
Stratum	**0**	**1i**	**1m**	**2i**	**2m**	**3i**	**3m**	**4i**	**4m**	**5**	**6**	**7**	**8**	**9+**
580E06	0.00	73.11	73.11	83.16	83.16	93.54	93.54	106.80	106.80	120.47	129.36	131.42	149.20	0.00
570E06	0.00	35.56	35.56	81.34	81.34	93.75	93.75	106.88	106.88	119.37	127.76	130.79	149.20	0.00
580E08	0.00	69.37	69.37	82.51	82.51	98.07	98.07	112.82	112.82	119.84	125.76	125.79	162.25	0.00
570E08	0.00	42.46	42.46	79.24	79.24	95.33	95.33	111.73	111.73	113.93	122.08	125.70	160.79	0.00
C	0.00	65.23	65.23	75.51	75.51	92.05	92.05	109.26	109.26	116.15	126.25	125.69	162.67	0.00
D	0.00	52.08	52.08	74.09	74.09	93.58	93.58	115.76	115.76	113.95	134.23	120.57	157.54	0.00
E	0.00	39.23	39.23	60.54	60.54	78.64	78.64	82.88	82.88	105.31	101.97	111.80	140.61	77.79
560E06	0.00	35.19	35.19	87.89	87.89	106.20	106.20	112.29	112.29	112.30	115.56	117.84	0.00	0.00

Table 2B.5c: Mean length of herring by age, maturity, stock and subarea for the Acoustic Herring Survey RV "Dana" Cruise July 2005

North Sea Autumn spawners. Mean length (cm)														
Stratum	**0**	**1i**	**1m**	**2i**	**2m**	**3i**	**3m**	**4i**	**4m**	**5**	**6**	**7**	**8**	**9+**
580E06	0.0	21.3	21.3	20.7	20.7	23.3	23.3	25.0	25.0	0.0	0.0	0.0	0.0	0.0
570E06	0.0	18.0	18.0	20.7	20.7	23.4	23.4	25.0	25.0	0.0	0.0	0.0	0.0	0.0
580E08	0.0	21.0	21.0	21.6	21.6	24.1	24.1	25.0	25.0	0.0	0.0	0.0	0.0	0.0
570E08	0.0	19.2	19.2	21.2	21.2	24.0	24.0	25.0	25.0	0.0	0.0	0.0	0.0	0.0
C	3.5	20.7	20.7	20.6	20.6	23.9	23.9	25.0	25.0	0.0	0.0	0.0	0.0	0.0
D	3.6	19.7	19.7	20.8	20.8	24.1	24.1	25.0	25.0	0.0	0.0	0.0	0.0	0.0
E	10.5	17.4	17.4	18.5	18.5	24.1	24.1	24.6	24.6	25.0	0.0	0.0	0.0	0.0
560E06	0.0	16.6	16.6	20.5	20.5	23.8	23.8	25.0	25.0	0.0	0.0	0.0	0.0	0.0

Spring Spawners Mean length (cm)														
Stratum	**0**	**1i**	**1m**	**2i**	**2m**	**3i**	**3m**	**4i**	**4m**	**5**	**6**	**7**	**8**	**9+**
580E06	0.0	21.0	21.0	21.9	21.9	22.8	22.8	23.7	23.7	24.6	25.0	25.4	26.5	0.0
570E06	0.0	16.5	16.5	21.7	21.7	22.8	22.8	23.7	23.7	24.5	25.0	25.4	26.5	0.0
580E08	0.0	20.7	20.7	21.8	21.8	23.1	23.1	24.2	24.2	24.6	25.0	25.1	27.2	0.0
570E08	0.0	17.5	17.5	21.5	21.5	22.9	22.9	24.1	24.1	24.2	24.7	25.0	27.1	0.0
C	0.0	20.3	20.3	21.2	21.2	22.6	22.6	23.9	23.9	24.3	25.0	25.0	27.2	0.0
D	0.0	18.8	18.8	21.1	21.1	22.7	22.7	24.3	24.3	24.1	25.5	24.7	27.0	0.0
E	0.0	17.1	17.1	19.7	19.7	21.5	21.5	21.9	21.9	23.5	23.3	23.8	26.0	21.5
560E06	0.0	16.5	16.5	22.2	22.2	23.7	23.7	24.2	24.2	24.1	24.4	24.5	0.0	0.0

Annex 2C: Norway

ICES coordinated acoustic Survey for Herring and Sprat in the North Sea

RV "Johan Hjort", 4 – 27 July 2005

Else Torstensen

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1. INTRODUCTION

The Institute of Marine Research carried out an acoustic survey for herring and sprat in the North Sea from the 4–27 July 2005. The survey was part of the ICES coordinated herring acoustic survey for the North Sea and adjacent areas planned and coordinated by the Planning Group for Herring Surveys (ICES 2005). Five countries cooperate in surveying the North Sea and the Skagerrak for an acoustic abundance estimation of herring and sprat. Data from this survey will be combined with the other surveys to provide a combined age disaggregated abundance index for use in the assessment carried out by the ICES Herring Assessment Working Group (HAWG) to be held in March 2006.

Objectives for the survey with RV "Johan Hjort" were:

a) To conduct an acoustic survey to estimate the abundance and distribution of herring and sprat in the eastern part of the North Sea, between 56°- 62° N, 2°- 6° E.

b) To obtain samples of herring for biological analysis: including length, weight, age, sex, maturity and Ichthyophonus infection.

c) To map the general hydrographical regime and monitor the standard profiles: Oksøy – Hanstholm, Hanstholm – Aberdeen, Utsira - Start Point.

2. SURVEY DESCRIPTION AND METHODS

2.1 Personnel

Else Torstensen (Cruise leader)
Øyvind Torgersen (Acoustic expert)
Hege Øverbø Hansen (Technician)
Anne-Liv Johnsen (Technician)
Jan de Lange (18 – 27 July) (Technician)
Bente Lundin (18 – 27 July) (Technician)
Sigmund Myklevoll (Technician)
Bjørn Vidar Svendsen (4-17 July) (Technician)
Arild Sæther (Acoustic operator)

No exchange of staff with other vessels was made.

2.2 Narrative

The RV "Johan Hjort" left Bergen at 1300 UTC on 4 July 2005 and set the course southwards. A call was made in Egersund in the morning 5 July to take onboard samples of herring from commercial landings. "Johan Hjort" proceeded to the Rossfjord, 58°03'96"N 7°00'4"E, for calibration of the acoustic instruments. Like last year the conditions were unfavourable for calibration. Last calibration was made in April. The survey continued eastwards to Kristiansand and commenced with the Oksøy-Hanstholm transect (58^{o} 3'N and 8^{o}5' E) at

2310h. In the morning of 6th July we started the Hanstholm-Aberdeen transect and had a call in Aberdeen on the 8th. The survey continued with east-west transects from south to north between 2°and 6°E. The planned overlap between RV "Johan Hjort" and RV "Dana" around 11 July in the area 42F6-F7, was not realised. The vessel broke off the survey at N59° 47,5' and E2°48,9' and called Stavanger on the 17th at 1600 UTC for change of maritime crew. "Johan Hjort" sailed again on 18 July at 1400 UTC and passed Husøy/Karmøy to get onboard a trawl being repaired. The survey recommenced at 2045 UTC by the eastern station of the Utsira-Start Point hydrographical transect (59° 17' N 4° 50'E). The transect was finalized on the 20 July (0840 UTC) and "Johan Hjort" was back in the position from the 17th, on the 21 July at 1440 UTC (log 9157). The weather conditions were good during the first half of the survey, but the survey suffered by strong wind and rough sea in the period 21-25 July.

A call was made in Lerwick, Shetland on 25 July for a short break. We left in the same afternoon and sailed tracks abt 15 nmi apart, in 49E9 and 50E9. The weather conditions had calmed down and the last two days the weather was good. Finishing the two rectangles on the east coast of Shetland, "Johan Hjort" sailed south to 60°15'N and 02°05E and sailed eastwards and finished the survey area at 60°15'N and 04°35'E. We proceeded to Bergen where "Johan Hjort" docked at 1500 UTC. A total of 3,450 n.mi were sailed, and 72 trawl hauls and 121 CTD-stations were taken. Figure 1 gives the cruise track and locations of trawl hauls and Figure 2 the locations of CTD-stations.

2.3 Survey design

The survey was carried out in systematically parallel east-west transects with about 15 n.mi spacing between 2º and 4º E and a spacing of about 30n.mi between 4º and 6ºE progressing northwards (ICES 2005).

2.4 Calibration

Calibration was not performed as no calibration conditions were found. The sounders were calibrated in April 2005, with only minor changes. The main settings for the 38 kHz transceiver are given in Table 1.

2.5 Acoustic data collection

The acoustic survey on RV "Johan Hjort" in 2005 was carried out using a Simrad ER60 38 kHz sounder and transducer ES38B SK mounted on the drop keel. Acoustic data were collected 24 hours per day. Additional data were collected at 18, 120 and 200 kHz (ES120–7 transducer) but was not used in the present analysis. The mean volume back scattering values (Sv) were integrated over 1 nm intervals from 9-13m (depending on weather conditions and the use of keel) below the surface to 0,5m above the seabed. The speed of the vessel during the acoustic sampling was 10–11 knots. The acoustic data were archived on tape. The acoustic recordings were scrutinized twice per day using the IMR BEI/SIMRAD BI500 Scientific Post Processing System (The Bergen Echo Integrator) (Foote *et al*. 1991). No paper records were available.

2.6 Biological data - fishing trawls

Trawling was carried out for supporting the species identifications of acoustic scatters and for biological sampling. For pelagic trawling a "salmon" trawl was used. A Campelen 1800 equipped with a Rock hopper gear, was used for bottom trawling. The pelagic trawl had an 11 mm cod end liner. The bottom trawl hauls were monitored using Scanmar TE40 (wide beam) and distance/depth sensor (A 4693) and Scanmar TE40-2 (PL) (narrow beam) and depth sensor D1200 were used to monitor pelagic trawl hauls. Halfway through the survey we lost the bottom trawl, including gear, one of the doors and the sensors. As we had no spare door for bottom trawling only pelagic trawling was undertaken in the second part of the survey.

The catches were sampled for species composition by weights, and biological samples (length, weight) of the most important species were taken according to the IMR fish-sampling manual (Fotland *et.al*. 2002). Herring were examined for age, sex, maturity (8 point scale), fat, stomach contents, vertebrae counts (east of 2°00’E) and macroscopic evidence of *Ichthyophonus* infection.

If the catch of a target species contained less than 100 specimens, the total catch was sampled. If the catch contained more than 100 specimens, representative samples of about 100 specimens were randomly chosen.

2.7 Hydrographic data

CTD-stations were taken regularly in addition to the four standard hydrographical profiles: Oksøy-Hanstholm, Hanstholm-Aberdeen and Utsira - Start Point

2.8 Data analysis

Data from the echo integrator were averaged per 5 n.mi. The acoustic data were allocated to the following categories: herring, sprat, pelagic fish, demersal fish and plankton. To calculate integrator conversion factors the target strength of clupeids in the mixture were estimated using the following TS/length relationship:

$$TS = 20\log10L - 71.2 \text{ dB}$$

Herring were separated from other recordings by using catch information and characteristics of the recordings. The abundance estimation (Toresen *et al* 1998) was made by ICES rectangles and summed up for the whole area.

North Sea autumn spawners and Western Baltic spring spawners (WBSS) are mixed during summer in the area covered by RV “Johan Hjort”. No system for workable stock discrimination on individual herring during the survey is available. The proportion of Baltic spring spawners and North Sea autumn spawners by age was calculated by applying the formula

WBSS= ((56,5-VS (sample))/(56.5–55.8)) (ICES 1999). All samples were worked up on board. 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 stocks.

3 RESULTS and DISCUSSION

3.1 Acoustic data

3.1. 1 Herring

The distribution of sA-values (NASC) assigned to herring along the cruise track, are presented as mean values per 5 n.mi intervals in Figure 3. Herring were distributed along the surveyed area. Unfortunately we were not able to cover the area north to 62°due to loss of time in bad weather. More herring schools were observed than in the last years. Most of them were small and occurred scattered throughout the area, either close to the surface or near bottom. Highest mean densities were measured in the ICES rectangles 44F3, 46F3 and 47F3. Trawling was mainly based on random trawling positions regularly chosen for trawling at the surface, i.e. not based on echo registration. In the “Norwegian” area herring tend to keep close to the surface and may thus be underestimated.

3.2.2 Sprat

No sprat was observed in the target area of the Norwegian survey. This is the same situation as last years. A trawl haul on small, strong registration off Aberdeen contained a few numbers of small sprat which where in, and just after metamorphoses.

3.3 Biological data

A total of 71 valid trawl hauls were carried out, 65 pelagic and 6 bottom hauls (Figure 1, Table 2). Of the pelagic hauls, 62 were carried out with large buoys for fishing at the surface and 3 were mid water hauls. In general 30 min hauls were made. Catch composition per haul is given in Table 3. Herring were present in 46 hauls of which 30 had sample size >20 herring. The length distributions of herring are presented in Table 4. A total of 2,324 fish were length measured and 2,197 fish were aged (winter rings in otoliths). Of the otoliths aged, 54 pairs were unreadable. A low number of herring infected by Ichthyophonus was observed (ten herring) which was similar to last years. For the present analysis, 56 hauls taken between 2° and 6°E, are considered. The proportions of mature 2- and 3-ringers were estimated at 43% and 84%, respectively, lower than the proportions estimated in 2004 (78% and 94%). Of the estimated numbers of 1-ringers 9% was classified as maturing. The strong 2000-year class of the North Sea autumn spawner has shown a reduced growth and maturity the last years. As a 4-wr group this year the numbers were thus presented by immature and mature, by 14% and 83% respectively. Where immature herring was classified in older age groups, these were assumed to be mis-interpretation of maturity stages 2 and 3, and were considered as mature in the present analysis.

3.4 Abundance and Biomass estimates

3.4.1 Herring

The geographical distribution of the sA-values assigned to herring, are presented in Figure 3. The bulk of the herring were in general found in the north and central region of the area. Highest concentration was found in the ICES rectangle 44F3 (mean sA = 241). Few good acoustic marks of herring schools were observed and the majority of the trawling positions were, however, regularly chosen for trawling at surface, i.e. not based on echo registration. Due to the tendency of staying near the surface during daytime, herring may have been underestimated.

Total number of herring was 1,510 million of which 52% was North Sea Autumn Spawners (NSAS). Total biomass of NSAS was estimated to 121,000 tonnes and the spawning stock biomass as 107,000 tonnes. These estimates are lower than the respective biomasses from the Norwegian area last year, 162,000t and 154,000t. Herring of the 2000-year-class was still dominating (4-winter ringers) making 25% of total number and 27% of the spawning stock biomass. The 1 –and 2-ringers (2003 and 2002 year class) made about 30% of the number and 17% of the biomass. The total biomass of WBSS was 99,000 tonnes, a small decline since last year.

Table 6 gives the mean length, mean weight, total numbers (millions) and biomass (thousands of tonnes) by age and maturity stage for the North Sea autumn spawners and the Western Baltic spring spawners in the Norwegian target area in July 2005. The mean weight of 1-ringers was more than 40% higher than last year. Also in the elder age groups (5-9+) the mean weights were higher.

3.4.2 Overlap area-Shetland

Three pelagic trawl hauls were taken randomly at surface, PT428-PT430. Herring were caught in the two hauls PT428-429. The estimated abundance (mill) by rectangle was as follows:

ICES RECT.	NUMBER (MILL)
49E9	75.05
50E9	3.51

3.5 Hydrography

A total of 121 CTD-stations were sampled (Figure 2). The horizontal distributions of temperature and salinity at 5m, 50m and at seabed, are shown in Figures 4a-c and 5a-c, respectively. The temperature at surface (5m depth) ranged from 12–14°C in the west to 11–16°C along the Norwegian west coast. Strong northerly winds from the 20 July and onwards, might explain the low temperatures in the northern area during the last week of the survey. A tongue of warmer water was seen at 50 m depth in north. The bottom temperature ranged from <5°C in the north to about 7°C at the level of the Aberdeen-Hanstholm transect, with higher values in the coastal areas. The salinity at 5 m depth was lower than 30‰ along the southern part of the Norwegian west coast and with Atlantic water >35‰ in the central-western part of the area.

The hydrographical data are part of a monitoring program of the IMR and will be analysed and published separately.

4. References

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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.

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Table 1: RV "Johan Hjort", survey 2005208. International acoustic survey on herring in the North Sea, 4–27 July 2005. Simrad ER60 and analysis settings used.

Tranceiver Menu	**38 kHz**
Absorption coefficient	9.8 dB/km
Pulse length	1.024 ms
Bandwidth	2.43 kHz
Max power	2000 W
Two-way beam angle	-21.0 dB
3 dB Beam width	7.04/7.02
Calibration details	
TS of sphere	-33.6
Range to sphere in calibration	18.00-23.00 m
Transducer gain	26.94
Log/Navigation Menu	
Speed	Serial from ship's GPS
Operation Menu	
Ping interval	0.0
Display/Printer Menu	
Integration line	n/a
TS colour min.	-60 dB
Sv colour min.	-70 dB

Table 2: RV "Johan Hjort" 4–27 July 2005. Details of trawl stations during the acoustic survey on herring and sprat in the North Sea. PT = Pelagic Trawl, BT = Bottom Trawl.

Trawl haul no	Date	Lat	Lon	Time UTC	Water depth (m)	Trawl depth (m)	Duration (min)	Total catch (kg)
PT364	06.jul	57°45'	8°16' E	0313	439	150	36	13,45
PT365	06.jul	57°22'	8°29' E	0805	32	0	40	36,39
PT366	06.jul	57°00'	7°46' E	1337	44	0	35	72,45
PT367	06.jul	57°00'	6°39' E	1914	57	0	30	350,12
PT368	06.jul	57°00'	5°58' E	2240	54	0	43	36,14
PT369	07.jul	57°00'	5°41' E	0103	52	0	30	38,62
PT370	07.jul	57°01'	4°50' E	0521	62	0	30	16,56
BT371	07.jul	56°59'	2°42' E	1445	73	73	30	136,02
PT372	08.jul	57°00'	0°37' E	0012	91	0	30	191,07
PT373	08.jul	57°00'	0°16' W	0431	80	0	30	31,70
PT374	09.jul	57°09'	1°20' W	1501	76	0	30	28,15
PT375	09.jul	57°11'	0°23' W	2004	82	0	30	14,63
PT376	09.jul	57°12'	0°41' E	2301	85	0	29	138,23
PT377	10.jul	57°14'	2°02' E	0440	86	0	30	1,34
BT378	10.jul	57°14'	3°12' E	0924	63	63	30	49,42
BT379	10.jul	57°14'	5°30' E	1744	52	52	30	23,20
PT380	10.jul	57°19'	5°55' E	2052	77	0	30	52,64
PT381	11.jul	57°29'	5°23' E	0107	83	0	31	45,99
PT382	11.jul	57°31'	4°44' E	0427	78	0	30	11,69
BT383	11.jul	57°45'	2°05' E	1553	86	86	30	283,05
PT384	11.jul	57°46'	3°14' E	2106	61	0	31	24,80
PT385	12.jul	57°47'	4°00' E	0029	80	0	28	96,76
BT386	12.jul	58°01'	3°08' E	0608	86	86	31	90,22
PT387	12.jul	58°16'	4°12' E	1918	139	0	30	94,98
PT388	12.jul	58°16'	5°01' E	2332	303	0	55	135,31
PT389	13.jul	58°16'	5°41' E	0233	332	0	28	28,54
PT390	13.jul	58°45'	5°15' E	0833	211	0	30	13,49
PT391	13.jul	58°45'	4°29' E	1143	239	0	31	263,36
PT392	13.jul	58°45'	4°03' E	1408	279	0	30	209,00
PT393	13.jul	58°31'	2°42' E	2148	101	0	29	297,78
PT394	14.jul	58°39'	2°06' E	0124	95	0	30	63,51
PT395	14.jul	58°47'	3°02' E	0614	112	0	32	36,62
BT396	14.jul	58°47'	3°22' E	0837	100	100	30	45,60
BT397	14.jul	58°46'	3°23' E	1018	103	103	32	-
PT398	15.jul	58°59,6'	3°56.5' E	1409	280	130	31	23,02
PT399	15.jul	59°01'	3°32' E	1711	219	0	25	1500,00
PT400	15.jul	59°02'	2°27' E	2208	120	0	30	1,47
PT401	16.jul	59°15'	2°06' E	0151	120	0	35	161,69
PT402	16.jul	59°31'	2°52' E	0707	121	0	37	26,46
PT403	16.jul	59°31'	3°06' E	1011	223	0	31	38,26
PT404	16.jul	59°32'	4°08' E	1416	273	0	31	195,88
PT405	16.jul	59°44'	4°46' E	1912	248	0	30	411,22
PT406	16.jul	59°47'	4°05' E	2244	274	0	31	62,82
PT407	17.jul	59°47'	3°28' E	0155	253	0	31	58,79
PT408	17.jul	59°46'	2°54' E	0416	111	0	30	5,11
PT409	18.jul	59°17'	4°37' E	2203	277	0	31	101,80
PT410	19.jul	59°17'	3°49' E	0316	268	0	30	21,01
PT411	19.jul	59°16'	3°20' E	0619	159	0	30	221,44
PT412	19.jul	59°17'	1°57' E	1244	121	0	30	3,39
PT413	19.jul	59°17'	1°26' E	1524	104	0	30	3,85
PT414	19.jul	59°16'	0°03' W	2135	136	0	30	3,31

Table 2. Cont.

Trawl haul no	Date	Lat	Lon	Time UTC	Water depth (m)	Trawl depth (m)	Duration (min)	Total catch (kg)
PT415	20.jul	59°16'	0°41' W	50	121	0	31	37,94
PT416	20.jul	59°17'	1°31'W	0448	98	50	30	10,26
PT417	20.jul	59°25'	0°47' W	1327	125	0	38	17,23
PT418	20.jul	59°36'	0°55' E	1938	117	0	30	33,49
PT419	22.jul	60°03'	4°10' E	0719	292	0	30	103,50
PT420	22.jul	60°16'	4°33' E	1157	277	0	32	25,56
PT421	22.jul	60°44'	4°16' E	1704	315	0	34	20,15
PT422	22.jul	60°31'	3°58' E	2113	301	0	30	58,67
PT423	23.jul	60°31'	2°40' E	0355	105	0	31	32,47
PT424	24.jul	61°06'	3°03' E	0357	368	0	30	26,75
PT425	24.jul	61°04'	2°50' E	0918	291	0	31	69,28
PT426	24.jul	61°24'	2°52' E	1522	378	0	30	127,97
PT427	24.jul	61°09'	2°07' E	1955	137	0	30	8,09
PT428	25.jul	60°22'	0°28'W	2049	87	0	30	82,28
PT429	26.jul	60°35'	0°10'W	0116	99	0	30	27,12
PT430	26.jul	60°50'	0°37' W	0449	104	0	30	4,41
PT431	26.jul	60°32'	1°05' E	1126	140	0	31	1,39
PT432	26.jul	60°15'	2°05' E	1629	104	0	30	1,83
PT433	26.jul	60°15'	2°47' E	2111	106	0	29	256,97
PT434	26.jul	60°14'	3°10' E	2350	153	0	30	198,47
PT435	26.jul	60°15'	3°46' E	0320	296	0	30	23,57
PT436	27.jul	60°15'	4°10' E	0533	298	0	29	27,06

Table 3: RV "Johan Hjort" 4–27 July 2005. Catch compositions in the trawl hauls (kg).

Trawl station		364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384
ICES rect		44F9	43F8	43F7	43F6	43F5	43F5	43F4	43F2	43F0	43E9	43E8	43E9	43F0	43F2	43F3	43F5	43F5	43F5	44F4	44F2	44F3
Total catch (kg)		13,45	36,39	72,45	350,12	36,14	38,62	16,56	136,02	191,07	31,70	28,15	14,63	138,23	1,34	49,42	23,20	52,64	45,99	11,69	283,05	21,92
Herring	Clupea harengus				0,68	1,32	7,77			108,00	17,50			8,33	0,05			15,60	6,24		215,00	0,35
Sprat	Sprattus sprattus											0,39										
Pilchard	Sardina pilchardus																					
Anchovy	Engraulis encrasicolus																					
Mackerel	Scombrus scombrus		0,49	9,96	330,40	19,77	29,20	15,20		78,00	14,12	0,12	1,64	127,86	1,03	8,64			39,00	10,27	1,92	19,65
Horse mackerel	Tracurus tracurus																					
Norway pout	Trisopterus esmarkii																					
Haddock	Melanogrammus aeglefinus	0,00	0,01					0,00	4,00	0,02	0,01	0,17	0,11	1,00		1,42	3,06	36,03			29,05	0,00
Whiting	Merlangius merlangus		0,13	0,12		0,04		0,01	4,76	0,05	0,01	0,01	0,12	1,00		0,60	0,12		0,00		2,61	0,00
Blue-whiting	Micromesistius poutassou	5,15																				
Saithe	Pollachius virens	2,40																				
Hake	Merluccius merluccius																					
Pollack	Pollachius pollachius																					
Torsk	Brosme brosme																					
Cod	Gadus morhua								3,88								0,72				1,26	
Poor cod	Trisopterus minutus																					
Ling	Molva molva																					
Argentine	Argentina sphyraena																					
Sandeels	Ammodytidae spp																					
Gurnard	Trigla spp		2,55	7,40	0,59				1,08							2,02	0,10				3,86	
Dab	Limanda limanda								106,00							30,32	3,50				13,68	
Plaice	Pleuronectes platessa								2,68							0,27	0,24				10,25	
Witch	Glyptocephalus cynoglossus																					
Lemon sole	Microstomus kitt								1,50							0,14	0,11					
Long rough dab	Hippoglossoides platessoides								12,12							6,02	0,42				5,42	
Atlantic halibut	Hippoglossus hippoglossus																					
Wolffish	Anarhichas lupus																					
Lumpsucker	Cyclopterus lumpus	0,54																	0,07			
Monkfish	Lophius piscatorius																					
Salmon	Salmon salar												1,70									
Thorny skate	Amblyraja radiata																0,93					
Garpike	Belona belona			0,62		0,74		0,31												0,42		0,61
Norway haddock	Sebastes marinus																					
Jellyfish		5,13	33,20	54,00	18,40	14,26	1,63	0,95		5,00		27,00	11,00		0,17		14,00	0,94	0,60	0,95		1,27
Other		0,22	0,00	0,35	0,05	0,01	0,02	0,09			0,07	0,47	0,06	0,03	0,09			0,07	0,08	0,05		0,04

Table 3. Cont.

Trawl station		**385**	**386**	**387**	**388**	**389**	**390**	**391**	**392**	**393**	**394**	**395**	**396**	***397***	**398**	**399**	**400**	**401**	**402**	**403**	**404**	**405**
ICES rect		**44F4**	**45F3**	**45F4**	**45F5**	**45F5**	**46F5**	**46F4**	**46F4**	**46F2**	**46F2**	**46F3**	**46F3**	***46F3***	**46F3**	**47F3**	**47F2**	**47F2**	**48F2**	**48F3**	**48F4**	**48F4**
Total catch (kg)		**57,12**	**90,22**	**94,98**	**135,31**	**88,54**	**13,49**	**263,36**	**209,00**	**297,78**	**63,47**	**36,62**	**45,59**	***0,00***	**23,02**	**1500,16**	**1,47**	**161,69**	**26,46**	**38,26**	**195,88**	**242,83**
Herring	Clupea harengus	1,56		16,62	15,36	14,98	8,09		153,00	12,70	0,10	17,03				1460,00		150,20		5,60	18,60	6,06
Sprat	Sprattus sprattus																					
Pilchard	Sardina pilchardus																					
Anchovy	Engraulis encrasicolus																					
Mackerel	Scombrus scombrus	55,50	5,31	38,27	31,15	13,26	4,40	62,50	25,50	280,00	42,50	17,30				40,06		9,94	25,05	31,57	77,00	108,30
Horse mackerel	Tracurus tracurus																					
Norway pout	Trisopterus esmarkii		4,44																			
Haddock	Melanogrammus aeglefinus		14,70	0,03		0,02	0,06	0,01	0,03	0,05	0,41		1,22								0,00	0,04
Whiting	Merlangius merlangus		7,20	0,06	0,27	0,07	0,15	0,06	0,11	0,00	0,35				0,01		0,00				0,06	0,30
Blue-whiting	Micromesistius poutassou				12,90																	
Saithe	Pollachius virens		3,00										32,62		3,38							
Hake	Merluccius merluccius												2,50									
Pollack	Pollachius pollachius												5,53									
Torsk	Brosme brosme																					
Cod	Gadus morhua		0,15										0,75									
Poor cod	Trisopterus minutus																					
Ling	Molva molva																					
Argentine	Argentina sphyraena												0,64				0,03					
Sandeels	Ammodytidae spp																					
Gurnard	Trigla spp		3,24										0,01				0,37	0,29	0,21			
Dab	Limanda limanda		43,26										0,58									
Plaice	Pleuronectes platessa		0,93										0,77									
Witch	Glyptocephalus cynoglossus																					
Lemon sole	Microstomus kitt		0,48										0,89									
Long rough dab	Hippoglossoides platessoides		6,17										0,08									
Atlantic halibut	Hippoglossus hippoglossus		1,35																			
Wolffish	Anarhichas lupus																					
Lumpsucker	Cyclopterus lumpus					0,20		0,01							0,99							
Monkfish	Lophius piscatorius																					
Salmon	Salmon salar							0,78														
Thorny skate	Amblyraja radiata																					
Garpike	belona belona				0,53				0,31													
Norway haddock	Sebastes marinus																					
Jellyfish				40,00	75,00	60,00	0,79	200,00	30,00	5,00	20,00	1,84			12,00		1,00	1,00	0,16	0,50	100,00	128,10
Other		0,06		0,00	0,10	0,01		0,01	0,05	0,03	0,10	0,45	0,00		6,65	0,10	0,06	0,26	1,04	0,59	0,21	0,02

Table 3. Cont.

Trawl station		406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426
ICES rect		**48F4**	**48F3**	**48F2**	**47F4**	**47F4**	**47F3**	**47F1**	**47F1**	**47F0**	**47E9**	**47E9**	**47E9**	**48F0**	**49F4**	**49F4**	**49F4**	**49F3**	**49F2**	**51F3**	**51F2**	**51F2**
Total catch (kg)		**62,82**	**58,80**	**5,11**	**101,80**	**21,01**	**221,44**	**3,39**	**3,851**	**3,31**	**37,94**	**10,26**	**17,23**	**33,49**	**103,50**	**25,56**	**20,15**	**58,67**	**32,47**	**26,75**	**69,28**	**127,97**
Herring	Clupea harengus	3,53	18,04		21,43	0,11	0,22	0,14				3,73			5,09	0,46		28,86	8,60	0,42	0,17	1,58
Sprat	Sprattus sprattus																					
Pilchard	Sardina pilchardus																					
Anchovy	Engraulis encrasicolus																					
Mackerel	Scombrus scombrus	14,63	35,33	1,70	32,00	0,12	215,00	1,46	1,974	2,45	33,86		6,21	29,27	65,00		6,03	7,05	20,60	11,01	28,00	115,00
Horse mackerel	Tracurus tracurus		0,14															0,43	0,45		8,94	
Norway pout	Trisopterus esmarkii																					
Haddock	Melanogrammus aeglefinus	0,00	0,01			0,01			0,00	0,12	0,00				0,00		0,01			0,01	0,01	0,00
Whiting	Merlangius merlangus	0,00			0,18	0,02			0,00	0,01	0,01	0,37	0,00	0,00	0,09	0,08	0,02	0,10		0,03	0,04	0,02
Blue-whiting	Micromesistius poutassou	24,82			5,66																	
Saithe	Pollachius virens	4,30	2,31																			
Hake	Merluccius merluccius											0,70										
Pollack	Pollachius pollachius																					
Torsk	Brosme brosme																					
Cod	Gadus morhua																					
Poor cod	Trisopterus minutus																					
Ling	Molva molva																					
Argentine	Argentina sphyraena									0,01		0,53										
Sandeels	Ammodytidae spp																					
Gurnard	Trigla spp			0,44									0,00									
Dab	Limanda limanda																					
Plaice	Pleuronectes platessa																					
Witch	Glyptocephalus cynoglossus																					
Lemon sole	Microstomus kitt																					
Long rough dab	Hippoglossoides platessoides																					
Atlantic halibut	Hippoglossus hippoglossus																					
Wolffish	Anarhichas lupus																					
Lumpsucker	Cyclopterus lumpus			2,22		0,23		1,753	0,01				2,11		0,16	0,29	1,59			0,83		0,09
Monkfish	Lophius piscatorius																					
Salmon	Salmon salar																					
Thorny skate	Amblyraja radiata																					
Garpike	Belona belona						0,98		1,59					0,89	0,76					1,22		
Norway haddock	Sebastes marinus																					
Jellyfish		15,00	2,50		42,52	20,00	5,00		0,25	0,61	3,74	4,85	8,61	2,50	32,00	24,42	12,00	21,50	2,79	13,00	32,00	11,00
Other		0,54	0,47	0,75	0,02	0,52	0,24	0,04	0,02	0,11	0,33	0,09	0,30	0,83	0,40	0,31	0,49	0,73	0,04	0,24	0,12	0,27

Table 3. Cont.

Trawl station		**427**	**428**	**429**	**430**	**431**	**432**	**433**	**434**	**435**	**436**
		51F2	**49E9**	**49F0**	**50E9**	**50F1**	**49F2**	**49F2**	**49F3**	**49F3**	**49F4**
Total catch (kg)		**8,04**	**82,28**	**27,12**	**4,41**	**1,39**	**1,83**	**256,97**	**198,47**	**23,57**	**27,06**
Herring	Clupea harengus	2,69	21,11	4,45				3,33	0,72	3,94	2,47
Sprat	Sprattus sprattus										
Pilchard	Sardina pilchardus										
Anchovy	Engraulis encrasicolus										
Mackerel	Scombrus scombrus	4,79	55,00	12,90	0,13	0,23		237,78	179,70	4,15	3,10
Horse mackerel	Tracurus tracurus							1,24	9,28		
Norway pout	Trisopterus esmarkii										
Haddock	Melanogrammus aeglefinus										0,01
Whiting	Merlangius merlangus		0,01	0,02					0,01	0,05	0,04
Blue-whiting	Micromesistius poutassou								7,41		
Saithe	Pollachius virens										2,13
Hake	Merluccius merluccius										
Pollack	Pollachius pollachius										
Torsk	Brosme brosme										
Cod	Gadus morhua										
Poor cod	Trisopterus minutus										
Ling	Molva molva										
Argentine	Argentina sphyraena										
Sandeels	Ammodytidae spp										
Gurnard	Trigla spp										
Dab	Limanda limanda										
Plaice	Pleuronectes platessa										
Witch	Glyptocephalus cynoglossus										
Lemon sole	Microstomus kitt										
Long rough dab	Hippoglossoides platessoides										
Atlantic halibut	Hippoglossus hippoglossus										
Wolffish	Anarhichas lupus										
Lumpsucker	Cyclopterus lumpus		0,01		0,78	0,14	0,39	0,67		3,14	
Monkfish	Lophius piscatorius			0,04	0,00	0,28					
Salmon	Salmon salar										
Thorny skate	Amblyraja radiata										
Garpike	belona belona			0,40				0,80			
Norway haddock	Sebastes marinus										
Jellyfish		0,40	2,20	4,07	0,90	0,07	0,04	11,17	1,23	11,50	18,00
Other		0,16	3,95	5,25	2,60	0,67	1,40	1,98	0,11	0,79	1,31

Table 4: RV "Johan Hjort" 4–27 July 2005. Herring length (cm) distribution in trawl hauls where sample size>20 herring.

Trawl st	368	369	372	373	376	380	381	383	385	387	388	389	390	392	393	395	399	401
ICES rect	43F5	43F5	43F0	43E9	43F0	43F5	43F5	44F2	44F4	45F4	45F5	45F5	46F5	46F4	46F2	46F3	47F3	47F2
13,0																		
13,5																		
14,0																		
14,5																		
15,0	2	1																
15,5	4						1											
16,0	18	11				1	4					1						
16,5	9	13					5											
17,0	5	26				1	5											
17,5	1	15				1	6		3									
18,0		19		1	1	4	6		2									
18,5		7	3	1			3		6									
19,0		1	2	4	2	8			4									
19,5		1	1	3		6	5		1									
20,0		3	5	14	2	10	6	2	2			1						
20,5			4	13	2	1	9					1						
21,0			11	11	1	7	10	8	1	1	2	8	5					
21,5			5	7		8	1	2	1	1	6	10	5	3				
22,0		3	5	18	7	10	14	11	1		11	12	5	3	1			1
22,5			8	2	2	12	3	7			8	20	12	9	5			
23,0			1	1	6	10	2	4			7	11	11	12	3		2	1
23,5			6	1	7	7	3	10	1	3	16	11	10	22	7	3		4
24,0			7	6	8	8	2	22		4	3	3	5	4	3	6	1	
24,5			11	2	4		1	7		7	10	8	10	12	11	14	6	6
25,0	1		16	6	15	2	3	20		5	6	6	5	13	13	14	10	17
25,5			2	4	3	2		2		4	3	3	3	4	6	4	2	7
26,0			7	2	5	1			1	8	8	3	2	7	3	13	8	15
26,5			1	2	4			2		11	3	1	2	3	3	12	14	7
27,0			1			1		1		12	7	1	3	3	5	3	13	5
27,5					1					15	3				9	9	14	17
28,0			1	1				1		9	3			3	4	7	11	8
28,5			2		1			1		7	1			1	4	11	8	7
29,0										3	2				2	2	4	
29,5										1	1				4	3	5	4
30,0				1													1	1
30,5														1			1	
31,0																		
31,5													1					
32,0																		
32,5																		
33,0																		
33,5																		
34,0																		
34,5																		
35,0																		
35,5																		
36,0																		
36,5																		
37,0			1															
Total N	40	100	100	100	71	100	89	100	23	91	100	100	79	100	83	101	100	100
mean W(g)	32,9	40,4	106,6	87,2	117,4	127,6	70,1	110,4	68,0	111,7	123,1	96,8	102,4	123,0	153,0	168,6	184,6	178,9
mean L(cm)	16,6	17,7	23,4	22,2	24,1	21,9	20,3	23,9	19,8	26,8	24,6	23,2	23,9	24,5	25,9	26,5	27,2	26,6
mean verteb	-	-	-	-	-	56,02	56,28	56,45	-	56,36	55,89	55,87	55,57	55,59	56,35	56,47	56,20	56,43

Table 4. Cont.

Trawl st	403	404	405	406	407	409	416	419	422	423	428	435
ICES rect	48F3	48F4	48F4	48F5	48F3	47F4	49F3	49F4	49F3	49F2	49E9	49F3
13,0												
13,5												
14,0												
14,5												
15,0												
15,5												
16,0												
16,5												
17,0												
17,5												
18,0												
18,5												
19,0												
19,5												
20,0												
20,5												
21,0												
21,5		4						1				
22,0		2	1			1						
22,5		3		1		6			1			
23,0		8	3	1		15	1	3				
23,5	1	19	5	2		27	5	1	5			
24,0	1	6		1		10	1		2			1
24,5	1	16	3			17	6	4	8			2
25,0	5	13	3	2		11	4	3	11		1	1
25,5	1	7	3		2	1	5	2	8		1	3
26,0	1	6			1	2	2		9		3	2
26,5	2	5	3	2	3	2	1	2	10	1	5	1
27,0	5	3	4		6	5	1		7		9	
27,5	5	4	7	3	8			5	12		5	3
28,0	1	1	2	3	7			6	6	2	9	2
28,5	3	1	2	1	9	2		2	6	1	13	1
29,0	2	1		2	9				3	3	9	1
29,5	3			1	11			2	6	4	11	2
30,0	1		1	1	6	1		1	1	9	12	
30,5				1	5				1	2	3	
31,0					2				1	3	7	2
31,5		1			1				1	2	2	
32,0					1				1		2	
32,5									1	3		
33,0										1		1
33,5											1	
34,0					1						1	
34,5					1							
35,0												
35,5												
36,0												
36,5					1							
37,0												
Total	32	100	37	21	74	100	26	32	100	31	94	22
mean W(g)	174,9	136,2	163,8	168,0	243,8	116,9	143,5	157,4	160,3	277,3	224,6	179,2
mean L(cm)	27,2	24,9	26,1	27,0	29,2	24,5	25,0	26,5	27,0	30,4	29,1	27,7
mean verteb	-	55,63	55,83	56,14	56,29	55,86	-	55,84	56,10	56,19	-	55,82

Table 5: RV "Johan Hjort" 5–27 July 2005. Number of otolith pairs read by age-group, length and maturity.

Length	1		2		3		4	5	6	7	8	9+	Totalt
cm	im	mat	im	mat	im	mat	mat	mat	mat	mat	mat	mat	
15	1		1										2
15,5	4		1										5
16	20		13										33
16,5	20		7										27
17	26		11										37
17,5	20		6										26
18	29		4										33
18,5	15		5										20
19	21		1										22
19,5	14	1	2										17
20	35		10										45
20,5	17	1	12	1									31
21	18		35	7		1							61
21,5	6	4	24	10	1	1	1						47
22	21	3	51	13	5	2	4						99
22,5	5	2	37	20	8	8	4						84
23	4	4	27	18	12	18	10	1	1				95
23,5	1	1	38	37	24	33	32	4	1				171
24			14	16	6	19	43	3					101
24,5			14	27	18	31	57	7	3	1			158
25		1	4	19	12	59	83	13	6	2			199
25,5			1	5	1	20	38	12	2				79
26				8	1	29	46	13	1	1			99
26,5				4	2	30	36	13	12	3			100
27				1		19	32	22	15	6	3		98
27,5				5		12	44	21	20	7	1	1	111
28						6	27	12	24	14	2	1	86
28,5						6	25	12	19	19	3	1	85
29							15	11	6	13	2	1	48
29,5						3	16	14	13	9	5	3	63
30							7	12	15	2	5	3	44
30,5								3	7	2	3	3	18
31						1	1	6	10	1	3	1	23
31,5						1		3	6		2		12
32									3	1			4
32,5								1	2		1	1	5
33										1		1	2
33,5										1		1	2
34												1	1
34,5								1				1	2
35,5												1	1
36,5											1		1
Totalt	277	17	318	191	90	299	521	184	166	83	31	20	2197

Table 6: RV "Johan Hjort" 4–27 July 2005. Herring mean length, mean weight, numbers (millions) and biomass (thousands of tonnes) by age and maturity stages in the herring stocks in the Norwegian survey area.

wr	L_{mean}	W_{mean}	North Sea Autumn Spawners				Western Baltic Spring Spawners			
			No (mill)	%	Biom (10^3)	%	No (mill)	%	Biom (10^3)	%
1I	18,8	61,3	92	11,7	6	4,7	114	15,9	7	6,9
1M	22,8	100,9	9	1,1	1	0,7	11	1,6	1	1,1
2I	21,8	84,6	81	10,2	7	5,7	101	14,1	9	8,5
2M	24,1	122,3	62	7,8	8	6,2	74	10,4	9	9,0
3I	24,1	113,4	18	2,2	2	1,6	31	4,3	4	3,5
3M	25,3	161,4	90	11,3	14	11,9	91	12,7	15	14,5
4I	24,6	120,2	28	3,5	3	2,8				
4M	26,5	170,8	172	21,7	29	24,2	125	17,4	21	21,1
5	27,5	193,9	86	10,8	17	13,7	63	8,8	12	12,1
6	28,3	213,1	79	10,0	17	13,9	57	8,0	12	12,0
7	28,7	221,4	47	5,9	10	8,5	31	4,3	7	6,8
8	29,9	243,3	17	2,1	4	3,4	11	1,5	3	2,6
9+	30,9	252,5	12	1,6	3	2,6	8	1,1	2	1,9
Total	24,6	153,1	791	100	121	100	719	100	101	100
Immature	21,4	81,6	219	28	18	15	246	34	19	19
Mature	26,5	180,4	573	72	103	85	472	66	82	81

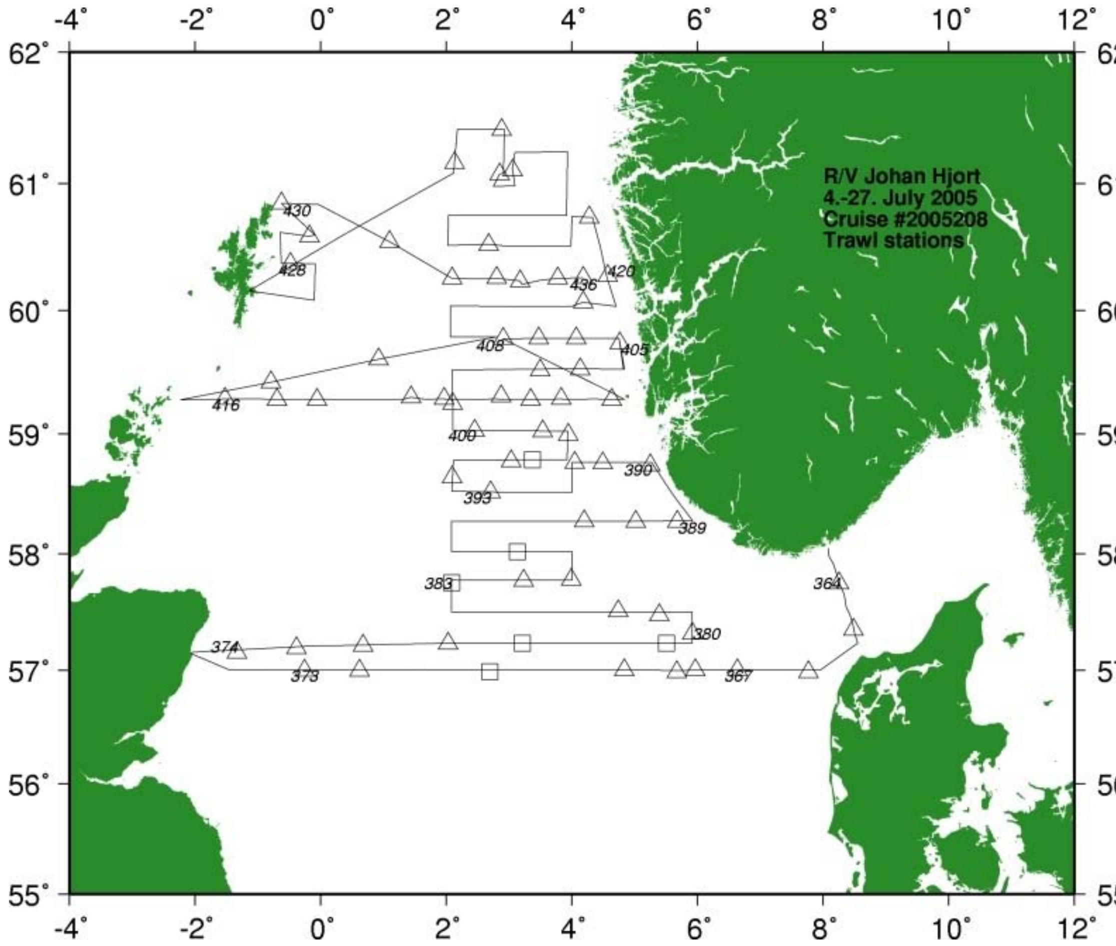

Figure 1: RV "Johan Hjort" 4 - 27 July 2005. Cruise track and fishing trawls undertaken during the acoustic survey.

△ : Pelagic trawl haul, □ : Bottom trawl haul

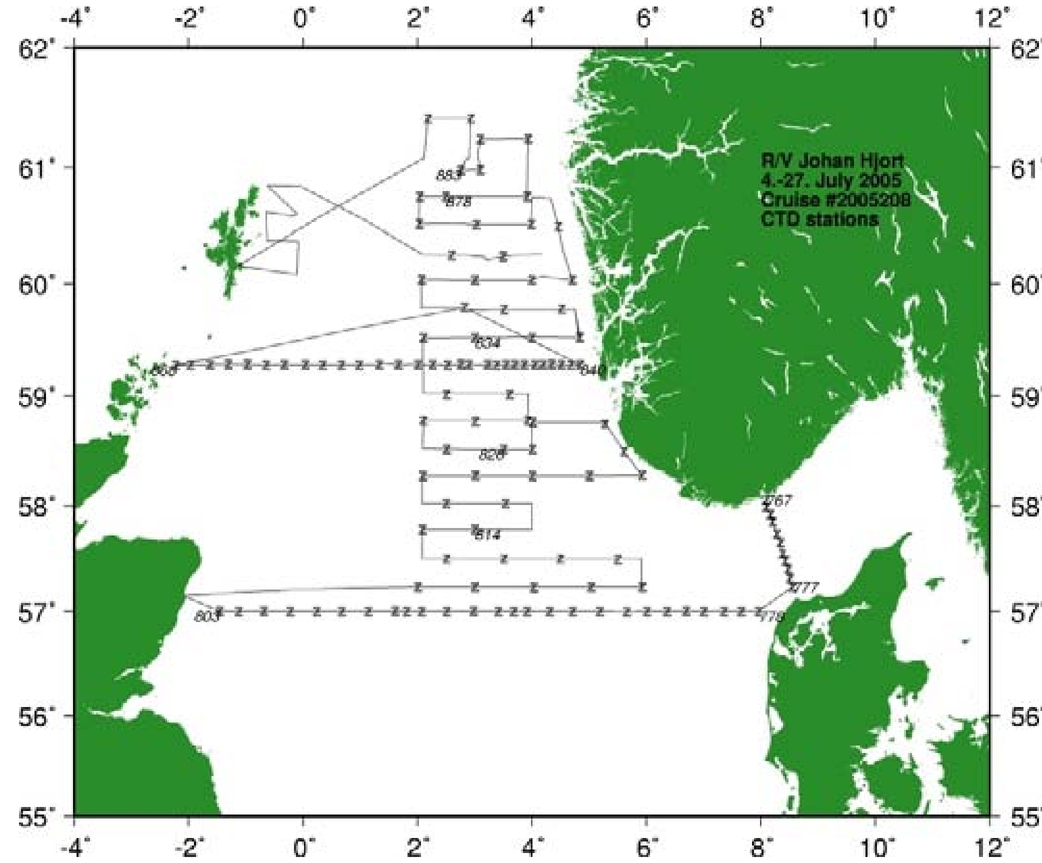

Figure 2: RV "Johan Hjort" 4-27 July 2005. Cruise track and CTD-stations undertaken during the acoustic survey.

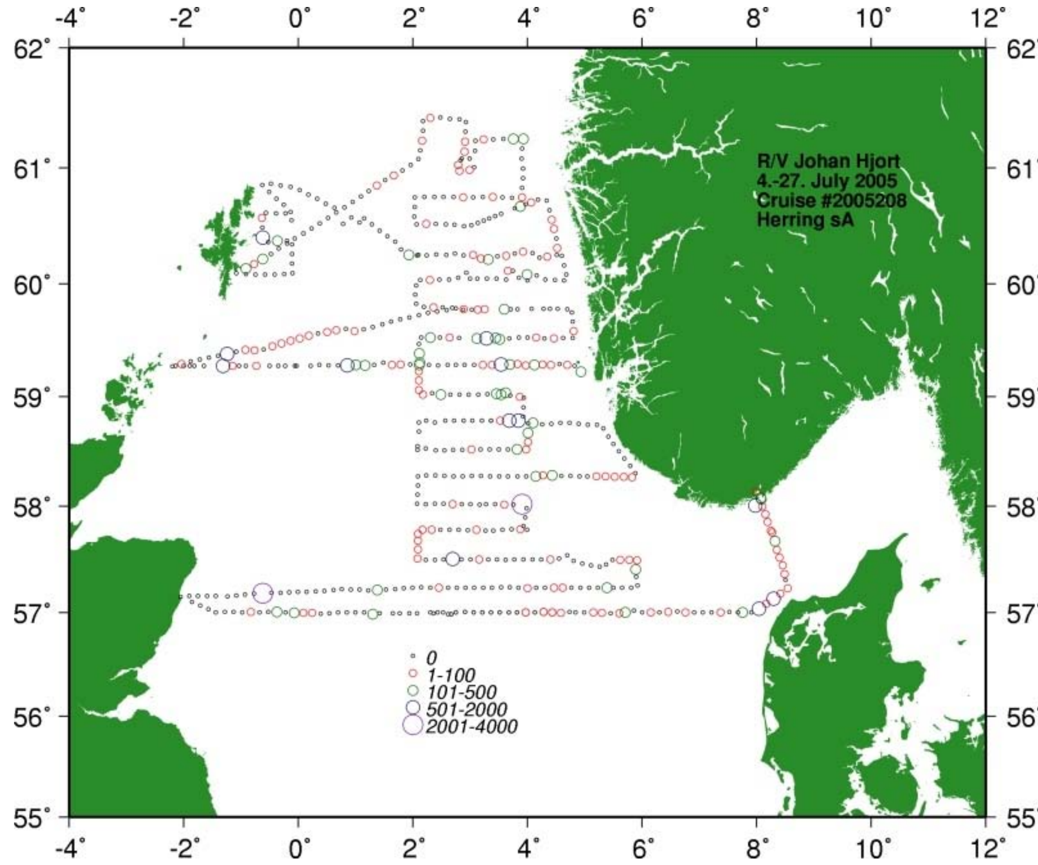

Figure 3: RV "Johan Hjort" 4-27 July 2005. Distribution of sA -values attributed to herring per 5 n.mi. along the cruise track.

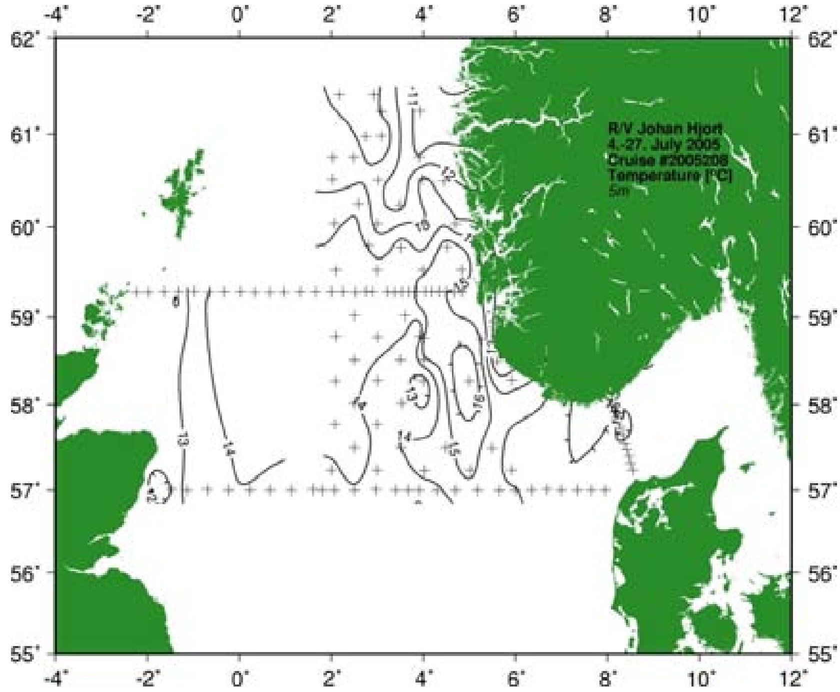

Figure 4a: RV "Johan Hjort" 4–27 July 2005. The horizontal distribution of temperature at 5 m.

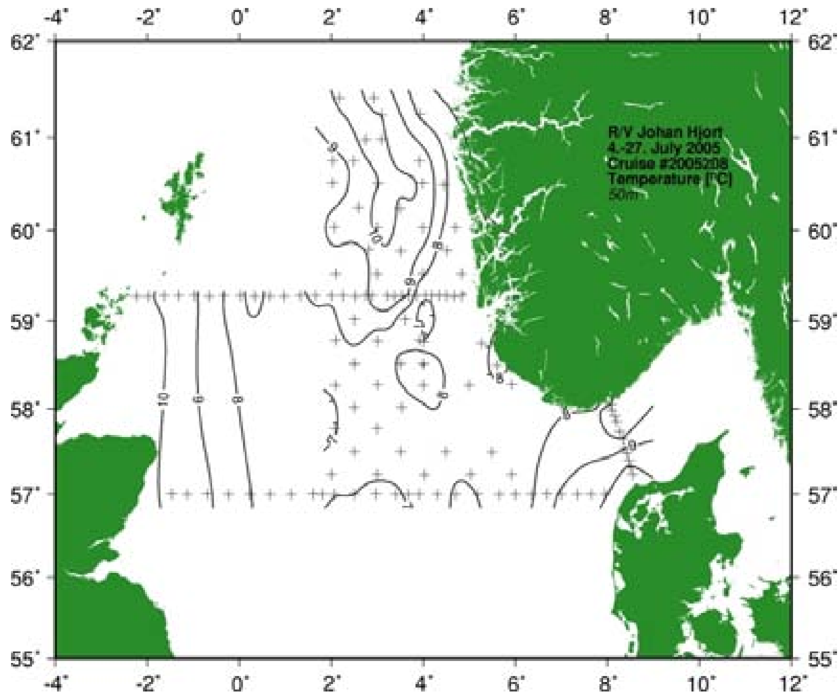

Figure 4b: RV "Johan Hjort" 4- 27 July 2005. The horizontal distribution of temperature at 50m depth.

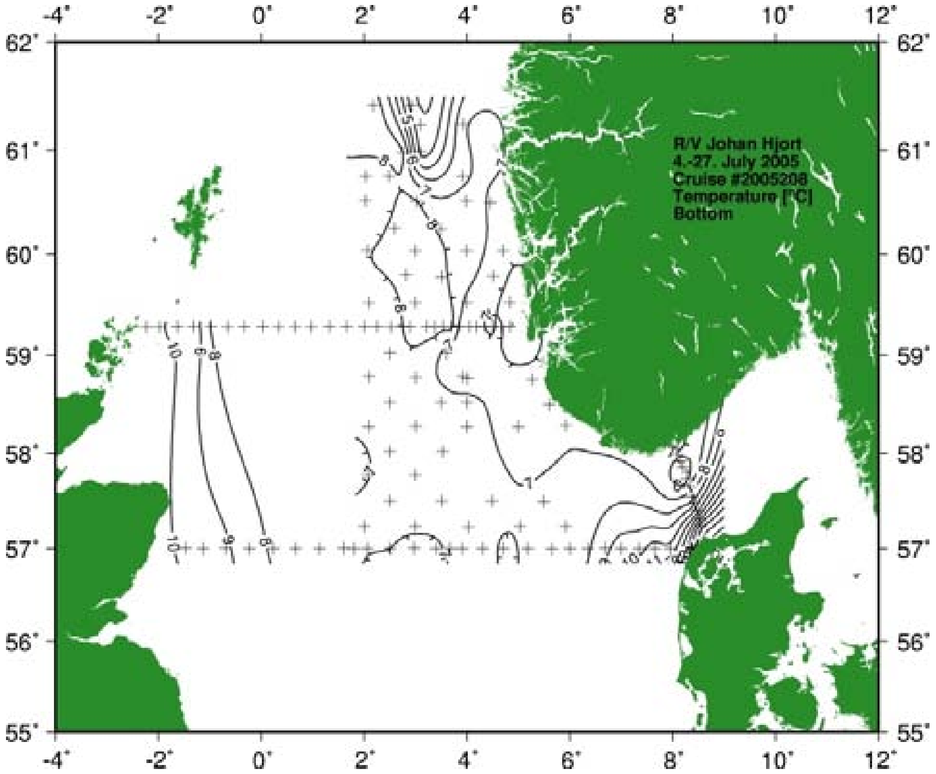

Figure 4c: RV "Johan Hjort" 4–27 July 2005.The horizontal distribution of temperature at bottom.

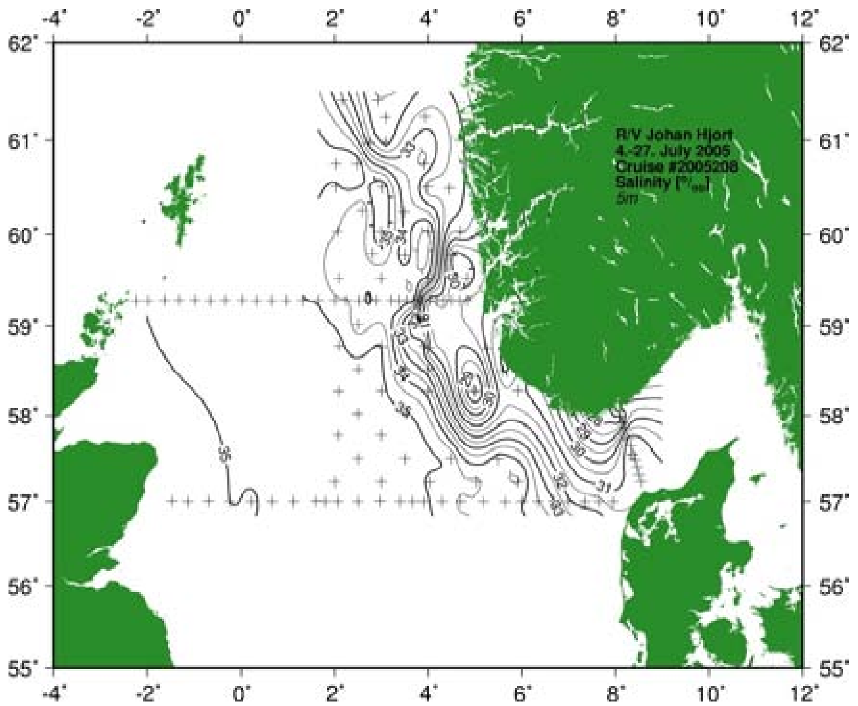

Figure 5a: RV "Johan Hjort" 4–27 July 2005. The horizontal distribution of salinity at 5 m.

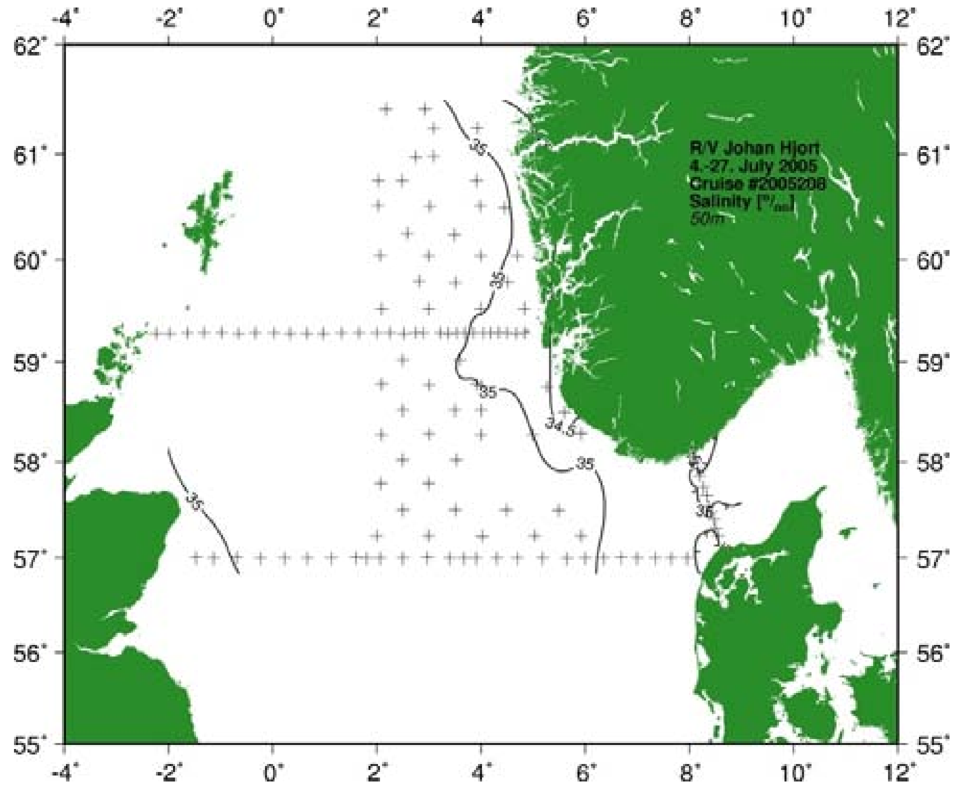

Figure 5b: RV "Johan Hjort" 4–27 July 2005. The horizontal distribution of salinity at 50 m depth.

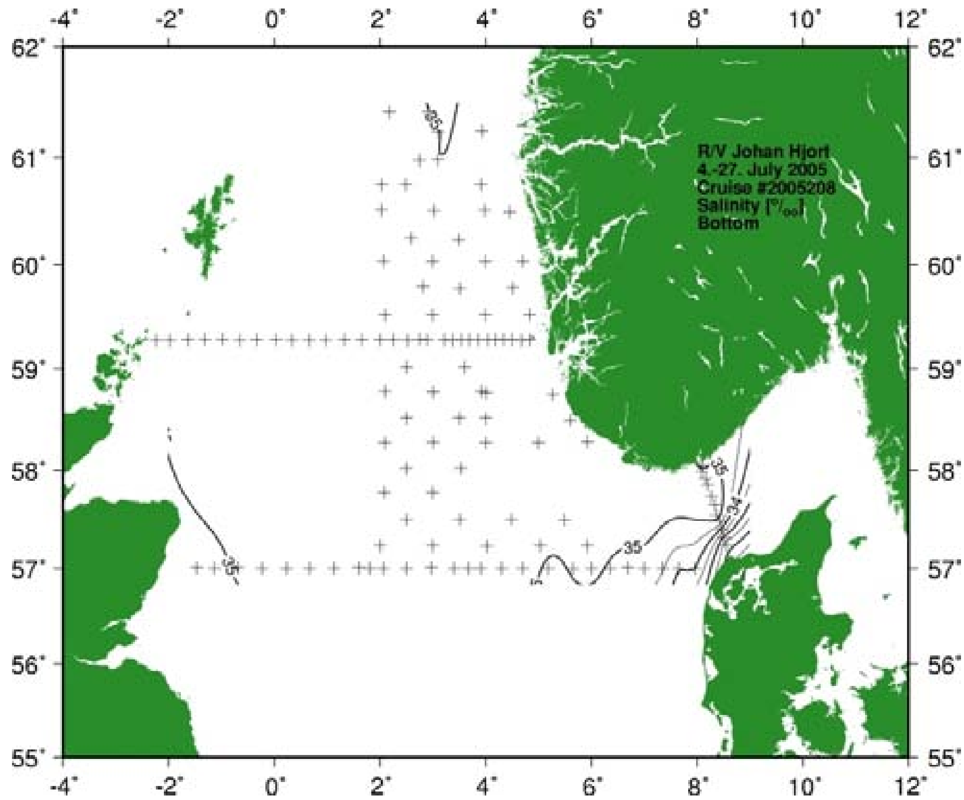

Figure 5c: RV "Johan Hjort" 4–27 July 2005. The horizontal distribution of salinity at bottom.

Annex 2D: Scotland (East)

Survey report for RV "Scotia"

28 June – 18 July 2005

P. G. Fernandes, FRS Marine Lab Aberdeen.

1. INTRODUCTION

Background

An acoustic survey for herring was carried out by FRS Marine Laboratory around the Orkney Shetland peninsula in the northern North Sea (ICES Division IV) from the 28 June to the 18 July 2005 on the FRV "Scotia". 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 coordinated 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 March 2006. This survey has been carried out by the Marine Laboratory at this time every year since 1984.

Objectives

1) To conduct an acoustic survey to estimate the abundance and distribution of herring in the north western North Sea and north of Scotland between 58º15-61.45'N and 4ºW to 2ºE, excluding Faroese waters.

2) To obtain echosounder trace identification using a pelagic trawl.

3) To obtain samples of herring for biological analysis, including age, length, weight, sex, maturity, ichthyophonus infection and fat content.

4) To obtain hydrographic data for comparison with the horizontal and vertical distribution of herring.

5) To obtain plankton samples for acoustic identification work.

6) To test the new multisampling pelagic cod end

2. SURVEY DESCRIPTION AND METHODS

2.1 Personnel

Paul Fernandes	(In Charge)
Sandy Robb	Fisheries Biologist
Robert Watret	Fisheries Biologist
Michael Stewart	Acoustic Technician
Marco Kienzle	Fisheries Biologist
Stephen Keltz	Fisheries Biologist
John Dunn	Oceanographic Technician
Jim Hunter	Oceanographic Technician
Marine Pomarede	PhD student, Imperial College
Tara Marshall	Aberdeen University, 1st pt
Sarah Clarke	MSc Student, Aberdeen University, 2nd pt

2.2 Narrative

All gear was loaded in Aberdeen on 27 June. Scientific staff joined the vessel at 09:00 on 28 June and it departed at 10:00 on the same day. A small meeting was held with all scientists to explain the objectives of the survey and to describe general operating procedures. The vessel then proceeded to the outskirts of Aberdeen Bay where the pelagic trawl was deployed to familiarise the crew with its deployment prior to it being used in earnest. The survey commenced just outside Aberdeen at 16:30 on 28 June. Transects progressed northwards along lines of latitude, at spacings of 15 or 7.5 nautical miles (n.mi.). Transect spacing was based on the results of previous surveys and transects were placed relative to ICES rectangles. Transects extended as far east as 1° 45E, and as far as safely possible to the west, on approaching the coast. Calibration of all four transducers took place in Scapa Flow on Thursday 30 June and the survey resumed afterwards on 1 July. A half landing took place on 8 July in Lerwick in accordance with rest provision for the working time directive and for the exchange of personnel (T. Marshall for S. Clarke). The vessel resumed surveying at 12:30 on 9 July. West of the Shetland Isles, transects extended from the coast to the shelf edge or longitude 4° west. The survey was completed on 17 July at 08:00. All four transducers were calibrated successfully once again in Scapa Flow on 17 July. The vessel returned to Aberdeen on the morning of 18 July.

2.3 Survey design

The survey track (Fig 2D.1) was selected to cover the area in two levels of sampling intensity based on agreed boundaries to the east, west and south, and the limits of herring densities found in previous years to the north and Northwest. A transect spacing of 15 nautical miles was used in most parts of the area with the exception of areas to the east of Shetland and west of Orkney where short additional transects were carried out at 7.5 n.mi. spacing. On the administrative boundaries of 2^{o}E the ends of the tracks were positioned at twice the track spacing from the area boundary, giving equal track length in any rectangle within the area. The between-track data was then 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 as close inshore as practical, those on average less than half a transect spacing from the coast were excluded from the analysis, those at greater distance were included in the analysis. The origin of the survey grid was selected randomly within a 15 n.mi. interval the track was then laid out with systematic spacing from the random origin. Where the 7.5 n.mi. transect spacing was used the same random origin was used.

2.4 Calibration

Two calibrations were carried out of the EK60 echosounder system used during the survey: one near the beginning of the survey on 30 June in Scapa Flow and one at the end of the survey on 17 July in Scapa Flow. Standard sphere calibrations were carried using 38.1mm diameter tungsten carbide sphere for 18, 38, 120 and 200 kHz. Agreement between the calibrations was better than 0.1dB with the exception of the 18 kHz (0.15 dB). The calibration settings and results for 38kHz are given in Table 2D.1.

2.5 Acoustic data collection

The acoustic survey on FRV “Scotia” was carried out using a Simrad EK60 multifrequency echosounder with all four transducers (18, 38, 120 and 200 kHz) mounted on the drop keel. For most of the survey the keel was kept at 3m extension placing the transducer at 8.5m depth. Data was archived for further data analysis which was carried out using Sonardata Echoview software and Marine Lab Analysis systems. Data were collected from 0200 to 2200 GMT. A total of 2650 n.mi. were surveyed and included in the analysis.

2.6 Biological data - fishing trawls

A total of 36 trawl hauls (positions shown in Fig 2D.1) were carried out during the survey on the denser echo traces. The fishing gear used throughout the survey was the PT160 pelagic trawl; in the latter half of the survey this was augmented by the addition of a three cod-end multisampling trawl. Each haul was monitored using a Simrad FS903 scanning netsonde and computer recordings of the netsonde video were archived to PC using screen capture software. The catch from 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 one per 0.5 cm class below 20.5 cm, three per 0.5cm class from 21-25.5cm and ten per 0.5 cm class for 26.0 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.

2.7 Hydrographic data

Surface temperature and salinity was collected throughout the survey. A variety of additional oceanographic data were collected including salinity, temperature, fluorescence, light transmission and optical particle counts. A total of 36 deployments of the ARIES (Automated Recording Instrumented Environmental Sampler) vehicle were made which, in addition to the above, collected integrated whole water column plankton data in two PUP nets and, on occasion, depth specific plankton samples.

2.8 Data analysis

Data from the echo integrator were averaged over quarter hour periods (2.5 n.mi. at 10 knots). Echo integrator data was collected from 12 m below the surface (transducer at 8.5 m depth) to 0.5 m above the seabed, for most of the survey. The data were divided into seven categories, by visual inspection of the echo-sounder paper record and the integrator cumulative output;

1) “herring traces”,

2) “probably herring traces”

3) “possible herring traces”

4) shallow herring schools above 50 m,

5) Norway pout

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

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

$$\text{gadoid TS} = 20\log_{10}L - 67.5 \text{ dB per individual}$$

$$TS = 20\log_{10}L - 84.9 \text{ dB per individual for mackerel}$$

The weight of herring at length was determined by weighing individual 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 herring schools the variable computation method available in Echoview was used. The multifrequency thresholding method described in earlier reports was used to isolate fish schools from other targets. The schools were then detected and finally identified according to the categories defined above by examination of school shape, echo intensity and the dB difference at 18, 38, 120 and 200 kHz.

Data were allocated to quarter statistical rectangles by their midpoint 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 EDSUs. Biological information was used in the post stratified method based on Kolmogorov Smirnov test (see MacLennan and Simmonds 2005). The length frequency data is given in Table 2D.4.

3. RESULTS

3.1 Acoustic data

The distribution of NASC values along the cruise track is shown in Figure 2D.2. The distribution of fish was different to previous years, with most of the fish being detected towards the southern end of the area and very little (none in fact) detected at the northern extremes. A number of large herring schools were detected towards the southern edge, between 58°30 and 59° just west of the meridian. Strong marks were also detected south west of Shetland and south west of Papa Bank (north west of Orkney). Many herring schools were of the typical tall pillar shape, but many were detected as diffuse layers very close to the seabed stretching for many miles. The new four frequency system on the drop keel worked extremely well, with the new 18 kHz in particular providing new insights into the identification of herring (generally improving its discrimination).

3.2 Biological data

Fishing exercises were generally successful; 36 trawl hauls were carried out, of which 28 contained herring (Figure 2D.1). The positions, dates and time of these are given in Table 2D.2. In addition to length frequency data, a total of 1915 herring were sampled for weight, sex, maturity and otoliths. A subset of these was sampled for fat content. The 28 hauls with significant numbers of herring were used to define five survey sub areas (Figure 2D.3). Table 2D.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 2D.4. The spatial distribution of mean length is shown in Figure 2D.3. Five age length keys, one per area, were constructed. There is again no evidence of icthyophonus in the population: not a single herring from the 1928 herring sampled were found to show macroscopic evidence of infection. The stratified weight at length data was used to define the weight-length relationship for herring, which was:

$$W = 0.00204\ L^{3.45}\ \text{g (L measured in cm)}$$

The proportions of 2, 3 and 4 ring herring that were mature were estimated at 94.5, 98.5 and 99.8% respectively.

3.3 Biomass and Abundance estimates

The total biomass estimates for the survey were:

Definitely herring	1,449,000 tonnes	66.3%
Probably herring	729,700 tonnes	33.4%
Herring at the surface	5,600 tonnes	0.3%
Total herring	**2,184,300 tonnes**	
Spawning stock biomass	**2,162,460 tonnes**	**99.0%**
Immature	21,220 tonnes	1.0%

The numbers and biomass of fish by quarter ICES statistical rectangle are shown in Figure 2D.4 A total estimate of 11,181 million herring or 2,184 thousand tonnes was calculated for the survey area. 2,162 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 found in the water depths and locations that are typical for this survey (east of Shetland; west of Orkney), however, the amount of herring seen in the southern part of the area were unusually high. A variety of fish traces were detected, including a large number of classic pillar shaped schools in the southern and eastern areas of the survey, and long continuous layers close to the seabed also in the southern region. Table 2D.6 shows the estimated herring numbers mean lengths, weights, biomass, and proportion mature at age and year class. The proportion of 4 ring herring was once again quite high, reflecting the dominance of the 2000 year class.

In addition to herring, a variety of other fish species were caught although examination of the catch by species (Table 2D.3) shows that aside from herring the numbers caught were very small. The dominant species other than herring were mackerel, followed by Norway pout, haddock and whiting. No cod were caught as by-catch in any of the hauls.

3.4 Ichthyophonus Infection

None of the 1928 fish examined for macroscopic evidence of ichthyophonus were found to be infected.

Table 2D.1: Simrad EK500 and analysis settings used on the "Scotia" herring acoustic survey 27/6-17/7/2002.

Transceiver Parameters	
Frequency	38 kHz
Sound speed	1493 m.s^{-1}
Max. Power	2000 W
Equivalent two-way beam angle	-20.9 dB
Default Transducer Sv gain	26.50 dB
3 dB Beamwidth	7.1°
Calibration details	
TS of sphere	-42.32 dB
Range to sphere in calibration	12.41
Measured NASC value for calibration	1974
Calibrated Sv gain	23.22
Calibration constant for MILAP (optional)	0.89 at -35 dB
EDSU	
Echoview integration cell size	15 minutes (approx 2.5 n.mi. at 10 knots)
Operation	
Ping interval	1.6 s at 250 m range 2.5 at 500 m range
Analysis settings	
Bottom margin (backstep)	0.5 m
Integration start (absolute) depth	12 m
Range of thresholds used	-70 dB on 38 -170 on combined blurred 38,120,200

Table 2D.2: Details of the fishing trawls taken during the "Scotia" herring acoustic survey, 28/06-18/07/2005: No. = trawl number; Trawl depth = depth (m) of headrope; Gear type P=pelagic, D=demersal, O=other; Duration of trawl (minutes); Use h=used to qualify herring acoustic data (blank if not); Total catch in kg.

No.	Date	Position	Time (UTC)	Water depth	Trawl Depth	Gear Type	Duration (mins)	Use	Total (kg)
208	28/06/2005	57°07N 1°19.26W	19:26	69	49	PT160	29		0
209	29/06/2005	57°38N 1°20.31E	14:44	89	69	PT160	29	h	1211
210	30/06/2005	57°38N 0°55.26W	3:58	111	91	PT160	19		
211	01/07/2005	58°34N 0°58.755W	9:25	106	86	PT160	14	h	3090
212	01/07/2005	58°34N 0°37.175W	12:00	129	109	PT160	23	h	2042
213	02/07/2005	58°49N 0°25.455W	08:51	145	125	PT160	31	h	620
214	03/07/2005	59°04N 0°49.31W	06:56	137	117	PT160	43	h	281
215	03/07/2005	59°04N 0°10.72E	11:32	127	107	PT160	44	h	1086
216	03/07/2005	59°04N 1°40.065E	18:17	115	95	PT160	50		
217	04/07/2005	59°19N 0°11.475W	07:42	142	122	PT160	31	h	885
218	04/07/2005	59°19N 1°30.87W	12:07	124	104	PT160	52		
219	04/07/2005	59°19N 1°22.055W	15:14	104	84	PT160	45	h	62
220	05/07/2005	59°34N 0°14.78W	08:07	134	114	PT160	59	h	84
221	05/07/2005	59°40N 1°44.83E	19:26	126	106	PT160	13	h	3717
222	06/07/2005	59°49N 0°11.715E	06:37	134	114	PT160	45	h	4010
223	06/07/2005	59°49N 1°30.095W	12:17	115	95	PT160+MS	73		
224	06/07/2005	60°02N 0°8.575W	19:39	138	118	PT160+MS	48		
225	07/07/2005	60°04N 0°48.42W	05:03	132	112	PT160	34	h	2687
226	07/07/2005	60°19N 1°5.635E	13:00	164	144	PT160+MS	72	h	138
227	09/07/2005	60°07N 1°31.115W	13:11	89	69	PT160+MS	20		
228	09/07/2005	60°32N 0°43.785W	17:36	100	80	PT160+MS	39	h	12
229	10/07/2005	60°39N 0°38.185W	03:55	97	77	PT160	21	h	508
230	10/07/2005	60°34N 0°11.01E	10:24	138	118	PT160	70		0
231	10/07/2005	60°34N 0°44.99E	14:22	137	117	PT160	36	h	266
232	11/07/2005	60°30N 0°53.535W	09:11	140	112	PT160	59	h	1166
233 C1	11/07/2005	61°04N 0°27.41E	15:54	156	138	PT160+MS	54	h	58
233 C2	11/07/2005	61°04N 0°27.41E	15:54	156	138	PT160+MS	54	h	197

No.	Date	Position	Time (UTC)	Water depth	Trawl Depth	Gear Type	Duration (mins)	Use	Total (kg)
234 C1	13/07/2005	61°59N 1°6.195W	06:40	117	87	PT160+MS	46	h	16
234 C2	13/07/2005	61°59N 1°6.195W	06:40	117	87	PT160+MS	46	h	66
235 C1	13/07/2005	60°48N 2°31.74W	14:07	166	146	PT160+MS	62		
235 C3	13/07/2005	60°48N 2°31.74W	14:07	166	146	PT160+MS	62		0
236 C1	14/07/2005	60°19N 2°10.23W	03:51	121	101	PT160+MS	55	h	21
236 C2	14/07/2005	60°19N 2°10.23W	03:51	121	101	PT160+MS	55	h	3
237 C1	14/07/2005	60°04N 3°10.725W	15:22	180	160	PT160+MS	55	h	7
237 C2	14/07/2005	60°04N 3°10.725W	15:22	180	160	PT160+MS	55		
238	15/07/2005	60°04N 1°32.71W	02:47	118	98	PT160+MS	72	h	444
239 C1	15/07/2005	59°49N 1°35.32W	07:28	120	100	PT160+MS	51	h	1272
239 C2	15/07/2005	59°49N 1°35.32W	07:28	120	100	PT160+MS	51	h	3
240	15/07/2005	59°34N 3°50.66W	17:14	118	88	PT160+MS	60		2
241	15/07/2005	59°34N 3°37.63W	21:59	140	120	PT160+MS	30	h	69
242 C1	16/07/2005	59°24N 3°30.12W	09:30	195	175	PT160+MS	49	h	1142
242 C2	16/07/2005	59°24N 3°30.12W	09:30	195	175	PT160+MS	49	h	82
243	17/07/2005	58°54N 3°49.5W	03:59	100	80	PT160+MS	29	h	15

Table 2D.3a: Total catch by species for trawl hauls from the "Scotia" acoustic survey 28/06 – 18/07/2005. Estimated total catch is given in kg and numbers by individual species.

Haul No	Est catch (kg)	Herring	Mackerel	Sprat	Blue Whiting	Norway Pout	Haddock	Whiting	Saithe	Grey gurnard	Snake pipefish	L.Argentine
		Clupea harengus	*Scomber scombrus*	*Sprattus sprattus*	*M. Poutassou*	*Trisopterus esmarki*	*Melanogrammus aeglefinus*	*Merlangius merlangus*	*Pollachius virens*	*Eutrigla gurnardus*	*Entelurus aequoreus*	*Argentina sphyraena*
208	0	0										
209	1200	9558								27		
210	<1	0			2	105	75	1			1	
211	3500	20100	350									
212	2100	13230										
213	700	3742	36									
214	320	1710	20									
215	1280	5467										
216	0											
217	1000	4128										
218	<1						1			13		
219	90	371	270				3	1		30		18
220	175	406	300			655	1	14	1			
221	4000	19370										
222	4800	17050	100									
223	<1							1				
224	3		6				1					
225	3000	11067	1									
226	180	558	2									
227	0					54						
228	15	64	1									
229	700	2508	1317									
230	5	1	31								1	
231	300	1037	17									
232	1200	4627	13				13				13	
233 C1	75	217			1	1	1		1			
233 C2	180	699										
234 C1	60	59	236			1		1	1			
234 C2	90	281	18				3	1				
235 C1	5								1	1		
235 C2	5	1	14									
236 C1	25	97					1					
236 C2	4	16										
237 C1	10	34										

Table 2D.3b: Total catch by species for trawl hauls from the "Scotia" acoustic survey 28/06 – 18/07/2005. Estimated total catch is given in kg and numbers by individual species.

Haul No	Est catch (kg)	Herring *Clupea harengus*	Mackerel *Scomber scombrus*	Sprat *Sprattus sprattus*	Blue Whiting *M. Poutassou*	Norway Pout *Trisopterus esmarki*	Haddock *Melanogrammus aeglefinus*	Whiting *Merlangius merlangus*	Saithe *Pollachius virens*	Grey gurnard *Eutrigla gurnardus*	Snake pipefish *Entelurus aequoreus*	L.Argentine *Argentina sphyraena*
237 C2	<1							3		2		
238 C2	600	2416	16									
239 C1	1350	6606	54					36				
239 C2	3	14										
240	10	10	38							14	3	
241	90	399				20						
242 C1	900	5616			24							
242 C2	90	423										
243	15	197	7									
237 C2	<1							3		2		

Table 2D.4a: Herring length frequency proportion for individual trawl hauls by Subarea (Figure 2D.3) for the "Scotia" acoustic survey (28/06 – 18/07/2005) length in cm, weight in g, calculated target strength in dB per individual using TS=-71.2+20log(L).

SUBAREA	I		II						IV							
Haul / Length	209	mean	211	212	213	214	219	mean	222	225	226	231	232	233	234	mean
19.0																
19.5	0.3	0.3														
20.0																
20.5	0.3	0.3														
21.0																
21.5	0.8	0.8														
22.0	2.0	2.0														
22.5	2.0	2.0														
23.0	3.1	3.1	0.2					0.0								
23.5	9.0	9.0	0.2					0.0								
24.0	19.2	19.2	1.2	3.6	0.5	0.6		1.2								
24.5	20.1	20.1	8.5	9.3	2.9	0.9	0.8	4.5								
25.0	24.3	24.3	14.9	16.8	7.4	6.1	3.5	9.7					0.3			0.0
25.5	11.0	11.0	17.9	14.7	15.7	12.6	13.5	14.9								
26.0	5.4	5.4	23.4	20.2	17.8	23.1	22.6	21.4							0.3	0.0
26.5	1.4	1.4	16.9	12.0	19.5	23.7	19.4	18.3								
27.0	0.6	0.6	9.2	12.7	16.2	17.8	18.9	15.0	2.1				0.9		0.9	0.5
27.5	0.6	0.6	4.5	4.8	8.6	10.5	10.8	7.8	7.9	1.5	1.2	1.6	1.4		2.9	2.4
28.0			1.7	4.1	5.2	2.3	6.2	3.9	8.5	6.0	4.0	3.2	5.5	0.2	4.1	4.5
28.5			1.2	1.1	2.6	1.5	2.7	1.8	10.9	12.0	12.0	6.4	9.8	1.6	5.6	8.3
29.0				0.2	2.1	0.6	1.1	0.8	18.8	20.2	17.5	13.8	11.8	5.0	6.5	13.4
29.5				0.5	1.0	0.3	0.5	0.4	16.1	16.9	18.7	13.5	13.3	10.9	11.8	14.4
30.0					0.5			0.1	16.1	20.8	18.4	18.0	18.7	18.9	17.6	18.4
30.5					0.2			0.0	9.1	11.1	12.3	16.1	13.8	20.0	12.9	13.6
31.0									7.0	6.0	8.6	12.5	12.1	18.9	15.9	11.6
31.5									2.6	3.9	3.1	9.3	7.8	8.6	11.8	6.7
32.0									0.6	0.6	2.8	2.9	2.3	7.3	5.0	3.1
32.5									0.3	0.9	1.2	1.6	0.9	4.3	2.9	1.7
33.0												0.3	1.2	3.0	0.6	0.7
33.5												0.6		1.4		0.3
34.0											0.3				0.9	0.2
34.5													0.3			0.0
35.0																
35.5																
36.0																
36.5															0.3	0.0
37.0																
Number	9,558		402	441	421	342	371		341	332	326	311	347	440	340	
L (cm)	25.00	25.00	26.41	26.44	26.98	26.92	27.08	26.76	29.81	30.08	30.23	30.57	30.40	31.18	30.74	30.43
W (g)	137.2	137.2	165.4	166.4	178.5	176.6	180.3	173.5	251.7	259.3	263.9	274.4	269.6	293.4	280.5	270.4
TS/id	43.23	43.23	42.76	42.75	42.57	42.60	42.54	42.64	41.71	41.63	41.59	41.49	41.53	41.32	41.44	41.53
TS/kg	34.61	34.61	34.95	34.96	35.09	35.07	35.11	35.04	35.72	35.77	35.80	35.87	35.84	35.99	35.92	35.85

Table 2D.4: continued. Herring length frequency proportion for individual trawl hauls by subarea (Figure 2D.3) for the “Scotia” acoustic survey (28/06 – 18/07/2005) length in cm, weight in g, calculated target strength in dB per individual using TS=-71.2+20log(L).

SUBAREA	II													V
Haul /Length	215	217	220	221	228	229	236	237	238	239	241	242	mean	
19.0														5.1
19.5														14.2
20.0												0.4	0.0	23.9
20.5														18.8
21.0														16.2
21.5														7.1
22.0												0.1	0.0	0.5
22.5														0.5
23.0														0.5
23.5														1.5
24.0										0.3	0.8		0.1	2.5
24.5											0.4	0.4	0.1	2.5
25.0	0.2		0.3	0.3					0.7	0.3	5.3	2.0	0.8	2.5
25.5	0.2	0.9	2.8	3.4		1.0			1.0	2.5	8.3	1.3	1.8	0.5
26.0	5.4	2.0	5.5	6.7	6.3	2.0	1.0		9.9	6.0	15.8	5.7	5.5	1.5
26.5	8.8	4.9	8.3	12.4	21.9	8.3	2.1	2.9	18.2	13.4	18.0	8.7	10.7	1.0
27.0	15.6	8.1	11.4	15.4	18.8	14.6	14.4	8.8	22.2	15.8	20.3	12.3	14.8	0.5
27.5	15.9	11.9	10.5	17.1	18.8	18.3	15.5	17.6	16.2	18.0	11.3	14.0	15.4	0.5
28.0	18.0	12.8	14.2	17.4	21.9	15.6	9.3	20.6	18.2	17.7	8.3	14.0	15.7	
28.5	12.2	14.8	8.6	12.1	9.4	13.6	12.4	17.6	8.3	9.8	4.5	11.9	11.3	
29.0	11.0	15.4	11.1	7.0	3.1	9.6	15.5	17.6	3.3	7.1	4.1	11.6	9.7	
29.5	6.8	11.9	8.3	4.0		7.3	9.3	8.8	1.0	3.3	2.3	7.6	5.9	
30.0	3.9	11.0	7.7	3.0		5.0	8.2		0.7	3.5	0.8	4.9	4.1	
30.5	2.0	3.5	7.1	0.3		3.3	8.2		0.3	1.4		1.9	2.3	
31.0		0.9	2.2			0.7	3.1			0.3		1.3	0.7	
31.5		1.5	0.9			0.7	1.0			0.5		0.9	0.5	
32.0		0.3	0.9	0.3				5.9				0.7	0.7	
32.5				0.3						0.3		0.1	0.1	
33.0												0.1	0.0	
33.5														
34.0														
34.5			0.3										0.0	
35.0														
35.5														
36.0														
36.5														
37.0														
Number	410	344	325	298	64	301	97	34	302	367	266	750		
L (cm)	28.41	29.03	28.78	28.13	27.84	28.57	29.08	28.91	27.79	28.16	27.36	28.46	28.38	21.43
W (g)	213.3	229.9	224.3	206.3	198.3	217.7	231.5	226.7	197.3	207.2	187.4	215.7	213.0	82.59
TS/id	42.12	41.94	42.01	42.21	42.30	42.07	41.92	41.97	42.32	42.20	42.45	42.10	42.13	44.55
TS/kg	35.41	35.55	35.51	35.35	35.28	35.45	35.57	35.53	35.27	35.36	35.18	35.44	35.42	33.72

Table 2D.5:FRV "Scotia" 28/06-18/07/2005 Numbers of herring otolithed at length and at age, lengths in mm measured to the nearest 0.5cm below, ages in winter rings (wr).

LEN/AGE WR	1	2I	2M	3I	3M	4I	4M	5	6	7	8	9+	GRAND TOTAL
190	3												3
195	5												5
200	4												4
205	3	1											4
210	3												3
215	3	1											4
220	2		1										3
225	1	2	1		1								5
230	1	2	1				1						5
235		1	4				1						6
240		2	8	2			7						19
245			11		7		4						22
250		3	13		9		8						33
255		1	8		20		14						43
260			10		17	1	22	2					52
265			4		26		22	1	1				54
270			2		21		32	5	2				62
275			5		42		111	27	23				208
280					40		111	40	25	2		1	219
285			1		19		96	54	38	2	2	1	213
290					10		82	51	45	1	4	1	194
295					7		46	44	58	6	5	4	170
300					2		27	41	67	4	5	6	152
305					1		19	42	53	6	10	3	134
310					1		8	18	47	4	7	9	94
315								15	38	11	10	12	86
320								9	21	7	9	14	60
325								3	7	8	9	9	36
330								1	3	1	4	3	12
335										1		2	3
340												4	4
345												2	2
350												1	1
355													
360													
365												1	1
Grand Total	25	13	69	2	223	1	611	353	428	53	65	72	1915

Table 2D.6: Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age (winter rings) and maturity obtained during the "Scotia" 28 June to 18 July 2005 herring acoustic survey. I= immature; M=mature; A=All.

YR CLASS	AGE/MATURITY	MEAN LENGTH(CM)	MEAN WEIGHT (G)	NUMBER (MILLIONS)	BIOMASS (MT)
2003	1A	20.3	72.68	94.94	6.9
2002	2I	23.35	117.03	60.61	7.09
2002	2M	25.49	156.85	1036.84	162.63
2001	3I	24	127.14	46.37	5.9
2001	3M	26.36	175.74	3027.9	532.14
2000	4I	26	166.68	8	1.33
2000	4M	27.03	192.12	4397.14	844.79
1999	5A	28.71	235.05	1113.82	261.8
1998	6A	29.28	251.32	1105.73	277.89
1997	7A	30.05	274.73	89.68	24.64
1996	8A	30.43	286.1	103.49	29.61
1995	9+	30.85	300.72	96.29	28.96
	Average	27.09	195.29		
			Total	11180.8	2183.45
			Spawning stock	10970.89	2162.46
			Immature	209.92	21.22

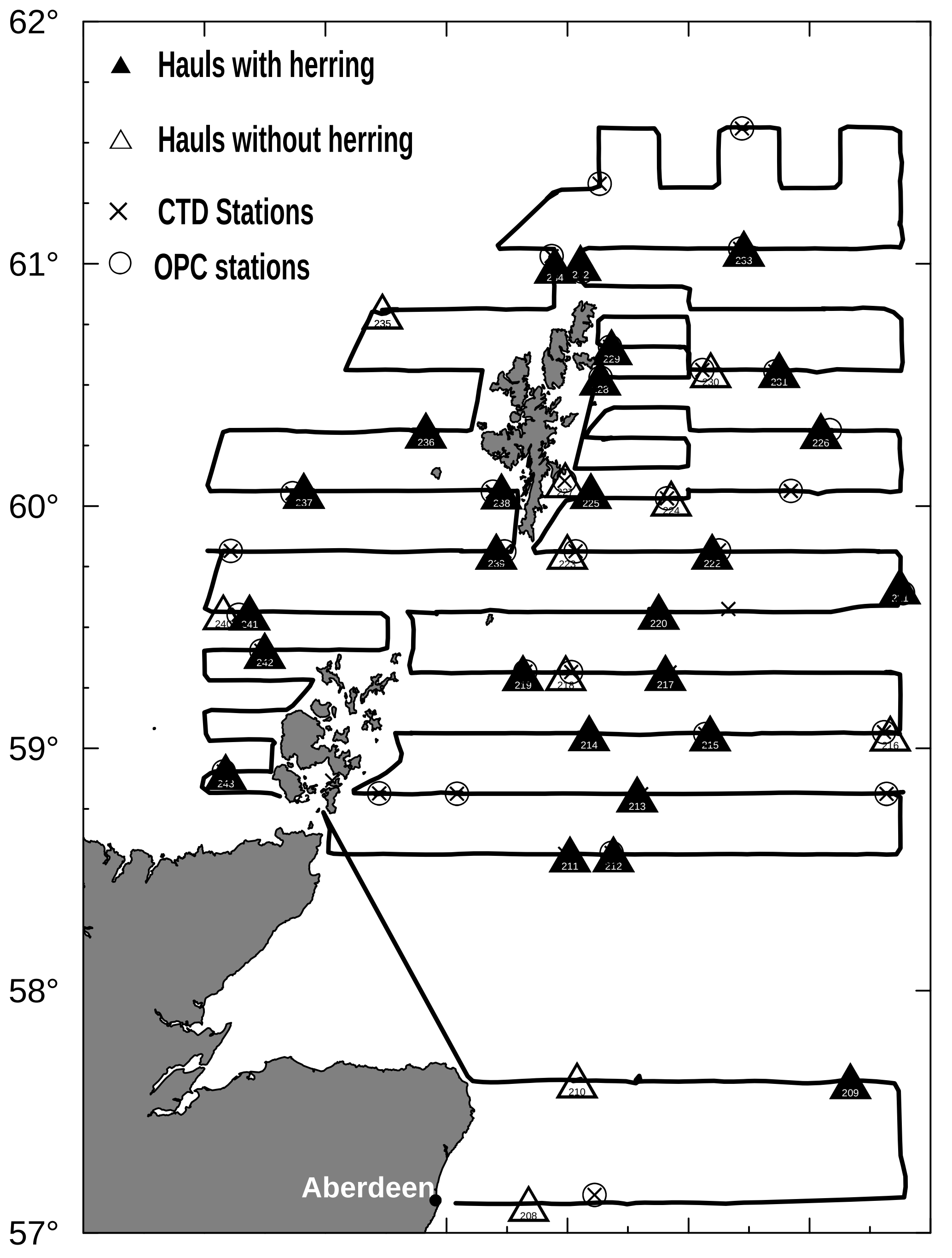

Figure 2D.1: Map of the North Sea showing the Cruise track (solid lines) of FRV "Scotia" for the acoustic survey 28 June-18 July 2005 indicating the location of trawl, CTD and OPC stations (symbols defined in legend).

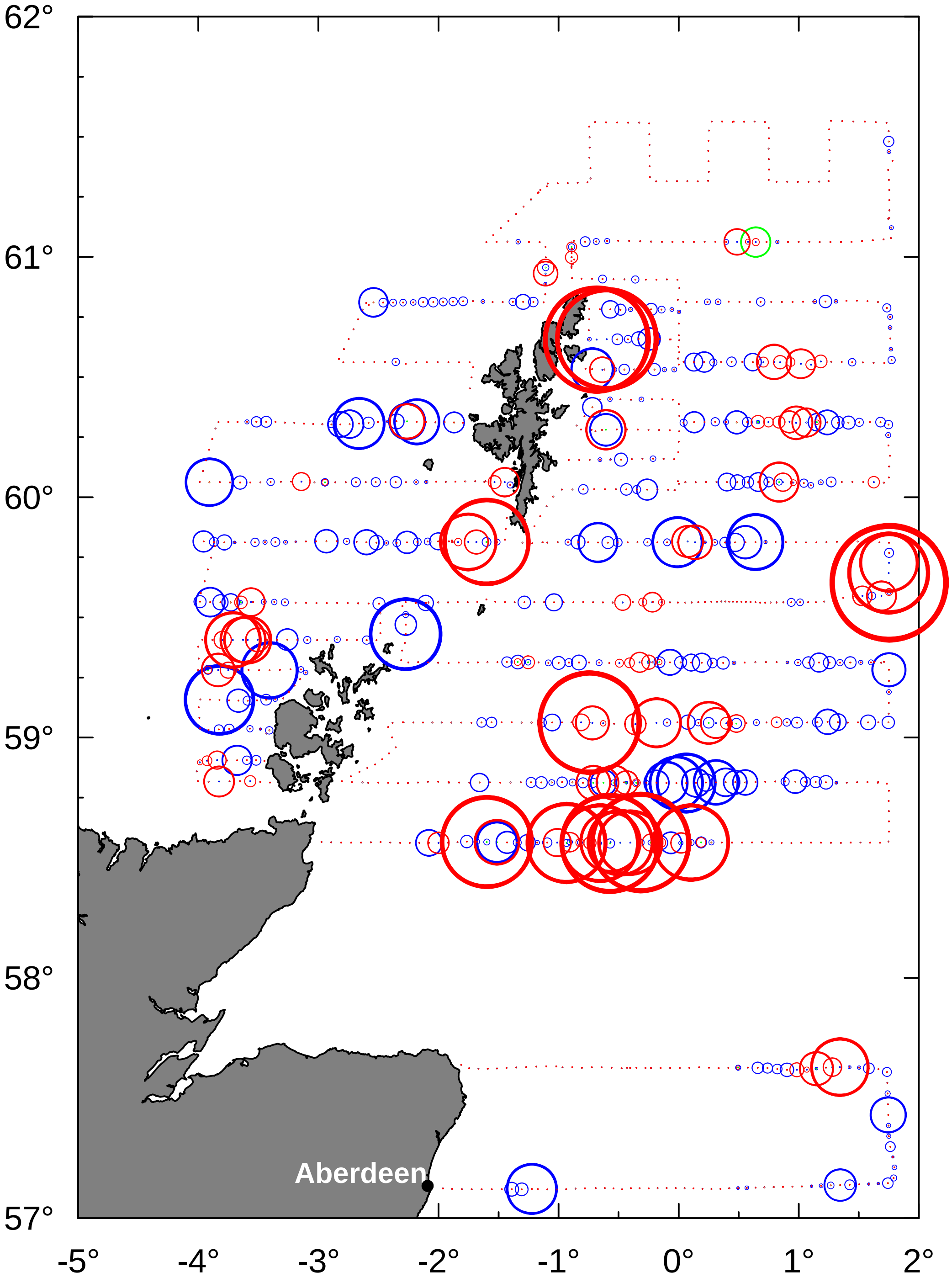

Figure 2D.2: Map of the North Sea showing the distribution of NASC values attributed to herring from the herring acoustic survey on FRV SCOTIA for 28 June–18 July 2005. NASC values proportional to circle area (max = 11863).

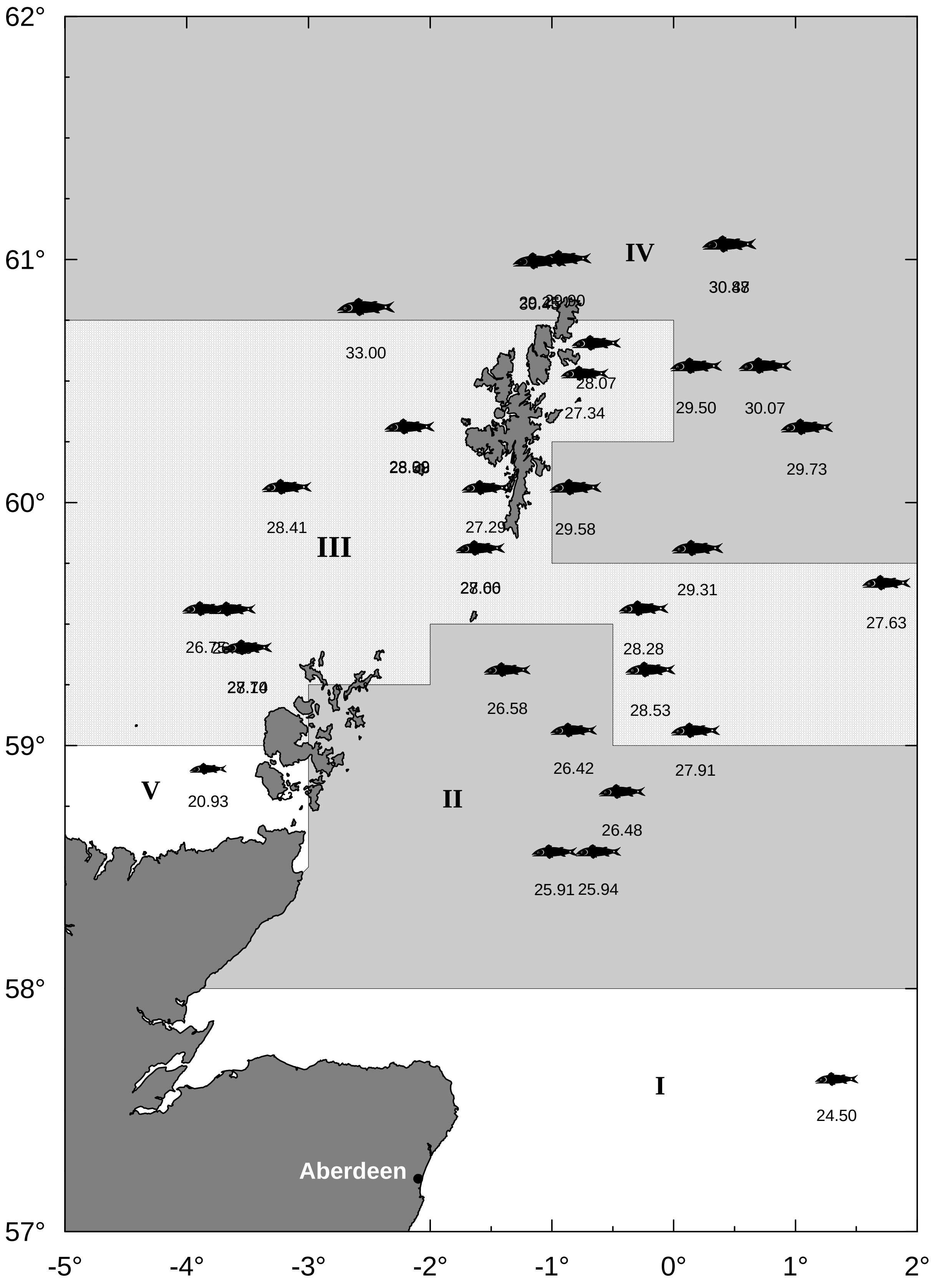

Figure 2D.3: Map of the North Sea showing the mean length of herring from pelagic trawl catches from FRV "Scotia" for 28 June-18 July 2005 trawl station numbers are given in Figure 2D.1 and details in Tables 2D.1 and 2D.2. The five analysis areas are shaded and numbered with roman numerals (I-V) and the length distributions, mean lengths, weights and target strengths are given by area in Table 2D.4.

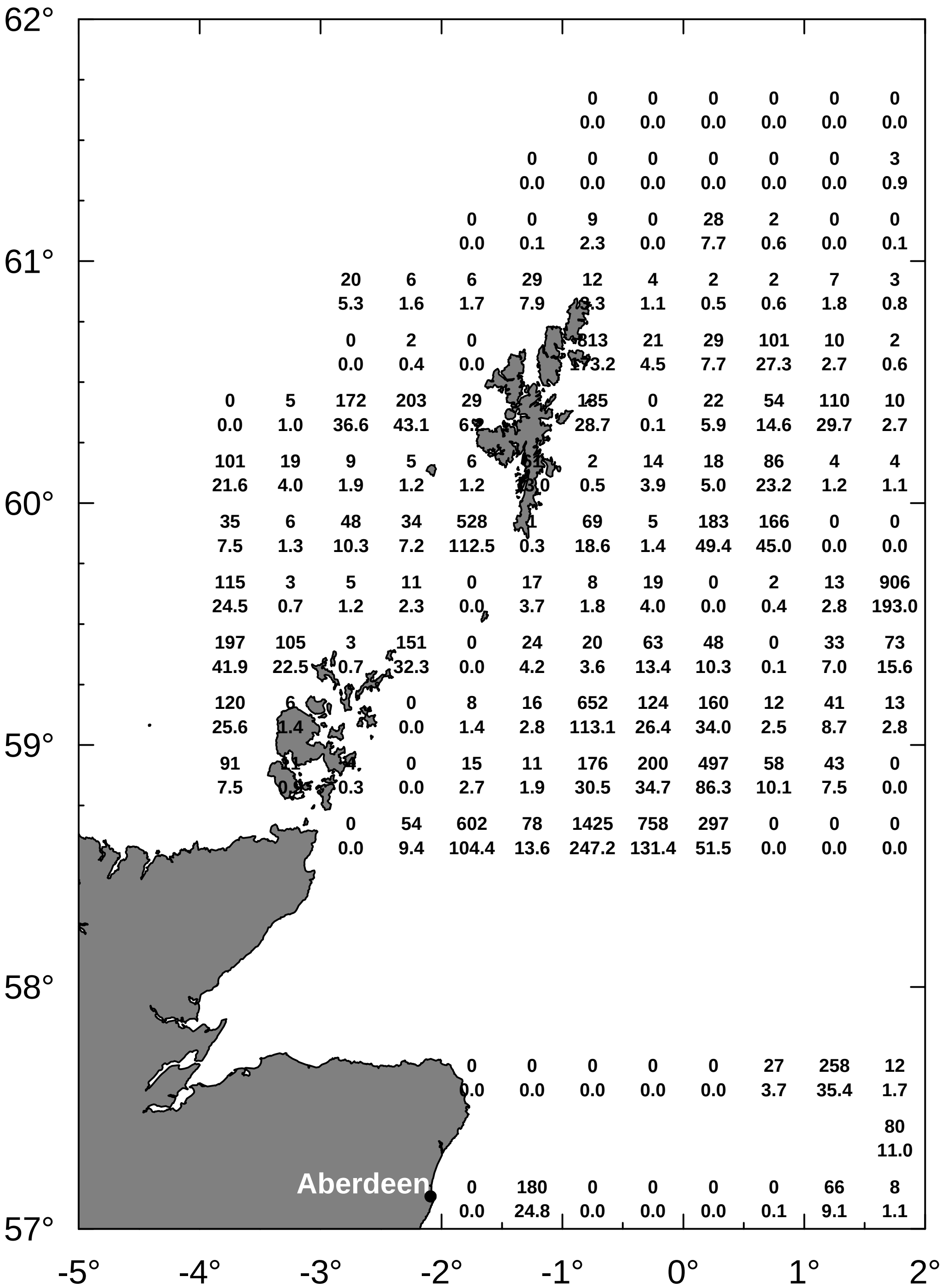

Figure 2D.4: Map of the North Sea showing the estimated numbers (millions) and biomass (thousands of tonnes) by quarter statistical rectangle from the herring acoustic survey on FRV "Scotia" for 28 June–18 July 2005.

Annex 2E: Netherlands

1. Introduction

The Netherlands Institute for Fisheries Research (RIVO) participates in the international North Sea hydro acoustic survey for herring since 1991. Participants in this survey are Scotland, Norway, Germany, Denmark and Netherlands. The survey is part of the EU data collection framework and is coordinated by the Planning Group fro Herring Surveys (PGHERS). 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 ICES Herring Assessment Working Group (HAWG) in its assessment of the population size. In this report the results are presented of the survey in the central North Sea, carried out by the Dutch vessel FRV “Tridens”.

Cruise plan

The survey is currently changing from a separate National survey approach with traditional area’s for each participant towards a more robust international survey with interlaced transects. The survey was split into two periods of 2 weeks. The planned cruise track and hydrographical positions are presented in figure 1.1. In order to avoid large time gaps between neighbouring transects covered by different participants, the survey was coordinated real-time during execution by a scientist (see chapter 2). The actual surveyed transects therefore differ from the planned transects.

2. Methods

2.1 Scientific Staff

RIVO staff

Sytse Ybema	(cruise leader)
Bram Couperus	(1st two weeks)
Jack Perdon	(1st two weeks)
Kees Bakker	(2nd two weeks)
Marcel de Vries	(2nd two weeks)
Sascha Fassler	(2nd two weeks)

Guest researchers

Karen Rappé	(1st two weeks)

2.2 Narrative

Week 26

On Monday 27 June at 13:40h “Tridens” left the port of Scheveningen and headed towards Scapa Flow. On its way the equipment for the calibration was prepared and 2 test hauls were conducted. Arrival at Scapa Flow was Wednesday at 06.00 GMT. Both 38kHz and 200kHz transducers were calibrated (for more detailed information see paragraph “Calibration”). At 15:00h “Tridens” steamed towards the beginning of the first transect. Just before the starting point some near bottom schools were seen as well as small pelagic schools. In the near bottom haul a mix of herring and Norway pout was found. Nothing was caught in the pelagic haul. Both 58.25N and 58.03N transects were covered on Thursday and Friday. Many cetaceans and birds were seen. Herring schools were sometimes big and dense, other times they was nothing more than some speckles near the bottom. 2 trawl hauls were made, both very successful. At the end of the 58.03N transect, some very small fish schools were seen, accompanied by many dolphins and birds. It was assumed that these schools were not herring. Arrival in Aberdeen at Saturday 2 July 10:00hrs.

Week 27

Departure from Aberdeen was on Monday 4 July at 00:00h heading for the 56.55N transect. Sailing towards the Devil's Hole lots of small surface schools were found accompanied by large amounts of diving birds and 3 hauls were made that day. The catches were mainly juvenile sandeel, haddock and small mackerel. The stomachs of the mackerel were filled with sandeel which was surprising because no sandeel was detected by the echosounder. The weather conditions got worse approaching the Devil's Hole area itself. In the area, quite some herring was observed, but between the holes no fish was actually present. In the first week, a test haul revealed a lot of herring in this same area. On the way back to shore (transect 56.32N south of the Devil's Hole) only once herring was observed in a large area. During this week, some improvements were made in the data flow onboard. Environmental, acoustic and CTD data are now not only stored automatically, but also an automated backup system is made using the improved LAN network facilities. A new software package, Ocean Data View, presents hydrographic data in a professional, yet easy way. Other experimental items of this program include plankton recording with the echo sounder in order to observe distribution patterns, vertical day/night movements and perhaps more, adding bird and cetacean observations in the distribution maps of the fish and conducting stomach observations of important fish species. Also was attempted to get satellite images of sea surface temperature and plankton distribution in the North Sea. Week 26 and 27 were also used to make a redecoration plan of the scientific technical rooms onboard.

Week 28

"Tridens" left Scheveningen port on Monday 11 July at 11:30h local time and headed to 53.40N 3.54E, the starting point. Only at the beginning of this transect small loose schools were seen near the bottom. Sprat was observed in a nearby catch. It was not until the end of this transect, in the "Sole Pit" itself that clear fish traces were observed. In agreement with the coordinator of this survey it was decided to cover an extra transect at 54.07N in eastern direction in stead of steaming north, directly to the next transect at 54.45N. At the beginning of this transect, just east of the Dogger Bank, small scattered schools were detected. Mostly sprat but also juvenile herring (8cm) was found while approaching the German Bight. A long transect was covered from the German Bight to the Firth of Forth, England. Surveying along this line, sprat being the main species in the catches was gradually replaced by herring. This week, a sandeel extraction algorithm was successfully implemented during live viewing of acoustic images. Continuous support from Sonardata helped us to better understand the Echoview post processing software. With the increasing possibilities of post processing, also the demand for more sufficient hardware increases along. Arrival at Edinburgh Saturday 16 July at 09:00hrs.

Week 29

Departure from Edinburgh Sunday 17 July at 24:00hrs. The final transect at 56.09N and a small leftover transect from the second week was covered in the two following days. The catches were mostly sprat mixed herring of different length groups but very few actual schools were observed in this area near the Devils Hole. Wednesday 21 July was used to cover an extra transect at 55.15 ending at the western side just south of the Farn Deep. Hardly any fish schools were observed but some distinct samples of mackerel, gurnard and sandeel were taken using the "acoustic sandeel extraction algorithm". On Thursday 21 July, the last day of surveying, the final transect in eastward direction on 54.44N was finished. The only haul targeted some small typical sprat schools near the bottom. Despite observed misses some of the schools could be caught and identified as sprat successfully. This was in contrast to the previous day when several attempts to catch sprat failed. On 18.31h the scientific part of the survey stopped and preparations were made for steaming back to Scheveningen. Arrival at Scheveningen Friday 22 July at 10:00hrs.

2.3 Survey design

The survey was carried out from 27 June to 22 July 2005, covering an area east of Scotland from latitude 54°40 to 58°25 North and from longitude 3° West (off the Scottish/English coast) to 3° East. An adapted survey design was applied, partly based on the herring distribution from previous years and the aim of a more international integrated survey. As a result, parallel transects along latitudinal lines were used with spacing between the lines set at 7.5, 15, 30 or even 55 nautical mile, depending on the expected distributions. Acoustic data from transects running north-south close to the shore (that is parallel to the depth isolines) were excluded from the dataset.

This year, PGHERS (Planning Group for Herring Surveys) had decided to experiment with interlaced transects in the whole survey area. This would result in a larger distance between individual vessel transects, but an area coverage of more than one vessel. Time coordination was therefore important. Every other day, individual vessels send their cruise progress to a scientific coordinator (who was stationed on the German mainland) and after consultation with this coordinator small cruise track adaptations were made to avoid any large time gaps. In “Tridens” case it was decided to compress some transects in order to have a better merge with the RV “Solea” in the south and that the RV “Tridens” would start its second half of the survey (week 28-29) in the south and to work up north.

In the final week, due to good weather and a relative low catches during the second week; the survey area was expanded in southern direction. An area west of the Dogger Bank was covered with standard (15nm interspacing) effort. An expansion in northern direction would have lead to a gap in time in the coverage of this northern area. The actual surveyed cruise track and trawl positions are presented in figure 2.3.1.

2.4 Calibration

The transducers in the towed body were checked before the survey. Three calibrations were executed in Scapa Flow, Orkney Islands. Calibration results are given in this report.

1) 38 kHz in the towed body: moderate results

2) 200 kHz in the towed body: bad results

3) 38 kHz hull mounted: moderate results

Two out of three calibrations were performed successful. The target strength values (TS) of all the reference targets were found too low.

During the calibration of the 38 kHz transducer, the target sphere was hard to manoeuvre into the acoustic beam. It took relatively long to perform the calibration of the 200 kHz. The TS value was more than 6dB lower than expected. The deviation from the expected beam-shape was relatively high (RMS 0.38). The cause of this low acoustic reflection is to be looked at.

Although the relatively low acoustic performance, the 200 KHz transducer was used for dual frequency species extraction. By performing the calibration, the experienced low acoustic values were compensated by the transceiver in the end.

2.5 Acoustic data collection

Data collection

A Simrad 38 kHz split beam transducer was operated in a towed body (type “Shark”) 6-7 m under the water surface. The settings of the EK60 are listed in this report. Acoustic data were collected with a Simrad EK60 scientific echo sounder. The EK60 received the vessel speed from the ship's GPS. A vessel speed of 10.5 knots was used on one engine without disturbing the acoustic image.

A ping rate of 1.0 sec was mistakenly used during the first week. The rest of the survey a ping rate of 0.6 sec was used. This ping rate has proven most suitable at depths of 50 - 150 m at which depth herring occur in most of the area, but a ping rate of 1 sec had no significant effect on data recording.

The data were logged in 1 nautical mile intervals.

Low threshold images of entire transects were stored for further qualitative analysis.

During a few days, the weather conditions allowed to use the hull mounted transducer in stead of the towed body. Using the hull mounted transducer, the vessel speed was increased (up to 12 knots, compared to 10 knots when using the towed body) and the saved time was used to perform an extra transect in the south.

This survey was also used to do some experiments with species separation by acoustic means. Using more than 1 acoustic frequency it may be possible to distinguish between herring and fish without a swim bladder, like sandeel and mackerel.

In the same way, plankton can be extracted from the total acoustic image in order to quickly draw distribution patterns of plankton. The algorithms used for this extraction were developed within the EU project "SIMFAMI".

2.6 Biological data collection

Fishing

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 echo sounder and to obtain biological samples of herring and sprat. In general, after it was decided to make a tow with a pelagic trawl, the vessel turned and fished back on its track line. If the recordings showed schools, a Simrad SD570 60kHz sonar was used to be able to track schools that were swimming away from the track line. In all hauls the footrope was very close to the ground with vertical net openings varying from 10 to 20 m (Table 2.6.1).

A Simrad FS20/25 trawl sonar (vertical and horizontal scan direction) was used to control the catch. During this cruise it was observed several times that small schools tend to avoid the net.

Table 2.6.1: Fishing power specifications during the June-July 2005 North Sea herring hydro acoustic survey on FRV "Tridens".

Vessel power (kW)	2940
Type	2000 meshes pelagic trawl
Panels	4
Headline (m)	64
Ground rope (m)	72
Sweeps (m)	100
Length (m)	140
Circumference (m)	400
Meshes in al panels (mm)	800 – 400 – 200 – 80
Codend (mm)	20
Height (m)	16
Wing spread (m)	45

Biological samples

Fish samples were divided into species by weight. Length measurements were taken to the 0.5 cm below for sprat, 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.

Also some mackerel and herring stomach contents were analysed to check the presence of sandeel in areas where it was uncertain if sandeel was present.

2.7 Hydrographical data

Hydrographical data have been collected in 48 stations, all at fixed locations (Figure 2.7.1 in this report). The Seabird CTD device, type SBE 9plus which was used in this survey, was successfully calibrated in advance by the manufacturer. Conductivity, temperature and depth were measured.

Data were analysed using SAS software and stored in an international OceanDataView format. Ocean dataView version 2.1 was used for gridded data presentation. The used “VG Gridding” analyzes the distribution of the data points and constructs a variable resolution, rectangular grid, where grid-spacing along X and Y directions varies according to data density.

In addition, some environmental variables were continuously measured by the ships own “Data acquisition system” (DAS). These continuous measuring sensors had not been calibrated and were used for the first time to compare results with Seabird CTD results.

2.8 Data handling, analysis and presentation

Data handling and presentation

The acoustic data were logged with Sonardata Echoview software, CTD and ship data were presented with Ocean Data View, fish data were analysed with SAS (SAS Institute inc.). From all data sources a daily automated backup was generated on a centralized drive.

Live viewing of environmental and acoustic data, using new or improved software techniques has improved the flexibility of the survey. Semi automated data analysis allows quick insight in the survey progress and finalizing data analysis is possible within several days. This prevents the possible loss of important time specific information.

Data analysis

The target species herring and sprat are often observed in mixed catches and since the schools of these species are often found to be similarly shaped the distribution in these areas was based on trawl catch distributions.

For each ICES rectangle, the species composition and length distribution were determined as the unweighted mean of all trawl results for this rectangle. From these distributions the mean acoustic cross section “sigma” was calculated according to the target strength-length relationships (TS) recommended by the ICES Planning Group for Herring Surveys (ICES 2000).

The acoustic values (S_A values) from each log interval were assigned to the following categories:

Table 2.8.1: Summary of assigned acoustic categories of fish species during the June-July 2005 North Sea herring hydro acoustic survey on FRV "Tridens".

	herring	sprat	mackerel	Norway pout	gadoids	sandeel	other
	"definitely herring"	"definitely sprat"	"mackerel"	"norway pout"	"gadoids"	"sand eel"	"pelagics"
	"probably herring"	"probably sprat"			Consisting of whiting and haddock		Consisting of mackerel, gurnards(!), juvenile gadoids, jellyfish and others
	"possibly herring"	"possibly sprat"					
TS=20log(L) -	71.2dB	71.2dB	86.9dB	67.1dB	67.4dB	93.7dB	

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 ("scrutinising"). For the analysis "definitely–" and "possibly herring/sprat" integrator counts were summed to obtain a "best herring/sprat" estimate.

Then the numbers of herring and sprat per ICES rectangle were calculated by dividing the S_A value in a rectangle by the overall sigma in the corresponding rectangle.

The biological samples, used for stock structure and biomass calculations, were grouped in 5 strata for herring and 1 stratum for sprat, based on similar length distribution and geographical position (Figure 2.8.1). 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.

All calculations were performed by SAS (SAS Institute) routines. Hydro acoustic – biological and hydrographical data are being stored in the HERSUR format.

3. Results

3.1 Acoustic data results

The acoustic response of herring is mostly quite strong and their presence evident. However, it remains difficult to distinguish between herring and sprat schools in areas where both have been observed in the catch. All echoes were recorded with a threshold of -80dB up to a depth of 150 meters below the transducer.

In most fishing hauls, small amounts of juvenile Norway pout, mackerel, jellyfish and other pelagic species were found resulting in corresponding low S_A values throughout the survey area for these species as a group. In contrast, most herring and sprat schools were distinctively shaped but in some areas schools were totally disaggregated.

Horizontal and vertical distribution patterns

Overall, most signals of herring were observed at absolute depths between 100 and 150meter whereas most sprat signals were recorded at depths ranging from 50 to 100 meters. The northern part of this year's survey area held most of the herring observed (Figure 3.1.1). Interlaced transects in this area were covered by FRV '"Scotia"', making a good description of the distribution pattern difficult. As in former years, a concentration of herring was observed around the Devil's Hole area. Sprat was found from the Devil's Hole area (55º30'N) to the south.

3.2 Trawl data results

In all, 28 trawl hauls have been conducted (figure 5 in this report). Herring was found in 20 hauls of which 18 samples were taken. Sprat was found in 10 hauls of which 10 samples were taken (see also 2.8 *Data analysis*). In 9 hauls herring was the most abundant species in weight. In 8 hauls sprat was the most abundant species. In haul 5 the meshes were stuck with sandeel indicating that this species would have been an abundant species in the catch if the mesh size had been smaller. Catch weights per haul and species are presented in table 3.2.1.

3.3 Biological data results

In total 723 biological samples of herring and 345 of sprat were collected and used for length, age and maturity keys (table 3.3.1).

Overall, most of the herring were mature 4 year olds. The strong 2000 year class is still clearly present. By the age of 4 (having 4 winter rings) almost all herring is mature where in 2004 this age was 3.

3.4 Biomass estimates

The stock biomass estimate of herring:

Total stock	344 thousand tonnes
Spawning stock	225 thousand tonnes

The stock biomass estimate of sprat:

Total stock	79 thousand tonnes
Spawning stock	62 thousand tonnes

Table 3.4.1 summarizes numbers and biomass for stratum A-E for herring. Table 3.4.2 summarizes numbers and biomass for the whole area for herring and sprat. Figure 3.4.1 shows the estimated numbers and biomass of herring by ICES rectangle.

3.5 Hydrographical measurements

Although survey intensity of most ICES rectangles covered by “Tridens” was relatively low, due to a more integrated survey approach this year, CTD measurements at surface showed comparable patterns with other data sources, such as the ship’s data acquisition system and infrared satellite images of the area. Cold water from the north/north-east reached as far as 56N (the Aberdeen transect) at surface level and 54N (Newcastle transect) at bottom depth following the depth line Newcastle – Skagerrak. Only in this cold water area mature herring was found. CTD data were stored in PGHERS (OceanDataview) format.

On board, several environmental variables were continuously measured such as water and air temperature, air pressure, wind speed and direction and more. Most of the used sensors had not been calibrated properly but nevertheless, the results of these measurements provided a more complete image of the surrounding surface environment.

4. Discussion

Results

Herring was not equally distributed over the survey area and the highest concentrations were found around the Devil Holes and the Aberdeen transect. For the first time “Tridens” also covered the area of the German Bight, where mainly small herring and sprat was found. Results should therefore not be compared directly with previous year’s results. The total biomass observed this survey mainly consisted of the 2000 year class from which 20% was still immature. This is something that rarely happens and is explained by the strength of the 2000 year class. After the weak 2001 and 2002 year class a new, weak 2003 year class appeared which contributed only 17% to the total biomass.

Survey design

During this year’s survey, PGHERS had decided to experiment with interlaced transects in the whole survey area. This new approach aims at a more internationally integrated and objective estimate of the herring stock. Despite these advantages, it proves very difficult to scrutinize interlaced transects without having catch and acoustic information on nearby transects. This year, a scientific coordinator was there to assemble and distribute results but no clear communication time table was followed by individual vessels. Active central coordination is therefore strongly recommended and frequent intership communication should be possible. This includes mailing of all sorts of trawl and acoustic results in a usable working format.

It is clear that the new survey design asks for more flexibility of individual vessels. Not only does this imply strong cooperation during the cruise but also joined survey planning of vessels covering each others area. The latter condition proves difficult for FRV “Tridens” to meet. In contrast to the other participating vessels, FRV “Tridens” is tied to weekly breaks while having to work closely together to 2 other research vessels in its area. A solution to this problem will be discussed shortly after this cruise as the Dutch participation in this research program should remain justified.

Calibration results

Towed Body 38 kHz

```
#  Calibration  Version   2.1.0.11
#
#  Date:  6/29/2005
#
#  Comments:
#    Towed body Scapa Flow
#
#  Reference Target:
#    TS                  -33.60 dB       Min. Distance         15.00 m
#    TS Deviation           4.0 dB       Max. Distance         21.00 m
#
#  Transducer:  ES38B  Serial No.   30501
#    Frequency            38000 Hz       Beamtype                Split
#    Gain                 26.23 dB       Two Way Beam Angle   -20.6 dB
#    Athw. Angle Sens.       21.90       Along. Angle Sens.      21.90
#    Athw. Beam Angle     7.04 deg       Along. Beam Angle    6.94 deg
#    Athw. Offset Angle   0.01 deg       Along. Offset Angle -0.06 deg
#    SaCorrection         -0.58 dB       Depth                 2.00  m
#
#  Transceiver:  GPT  38 kHz 009072017a3b 1 ES38B
#    Pulse Duration       1.024 ms       Sample Interval     0.192   m
#    Power                 2000  W       Receiver Bandwidth   2.43 kHz
#
#  Sounder Type:
#    EK60 Version  2.1.1
#
#  TS Detection:
#    Min. Value           -36.0 dB       Min. Spacing             100%
#    Max. Beam Comp.        6.0 dB       Min. Echolength           80%
#    Max. Phase Dev.          8.0        Max. Echolength          180%
#
#  Environment:
#    Absorption Coeff.   9.2 dB/km       Sound Velocity     1500.5 m/s
#
#  Beam Model results:
#    Transducer Gain    = 25.87 dB       SaCorrection       = -0.59 dB
#    Athw. Beam Angle   = 7.16 deg       Along. Beam Angle  = 7.01 deg
#    Athw. Offset Angle =-0.04 deg       Along. Offset Angle= 0.00 deg
#
#  Data deviation from beam model:
#    RMS =    0.21 dB
#    Max =    1.18 dB  No. =    86  Athw. =  0.8 deg  Along = -0.7 deg
#    Min =   -0.80 dB  No. =   116  Athw. =  1.5 deg  Along =  2.2 deg
#
#  Data deviation from polynomial model:
#    RMS =    0.20 dB
#    Max =    1.19 dB  No. =    86  Athw. =  0.8 deg  Along = -0.7 deg
#    Min =   -0.84 dB  No. =   116  Athw. =  1.5 deg  Along =  2.2 deg
```

Towed Body 200 kHz

```
#  Calibration  Version   2.1.0.11
#
#  Date:  6/29/2005
#
#  Comments:
#    towed body scapa flow
#
#  Reference Target:
#    TS                   -45.00 dB       Min. Distance          8.00 m
#    TS Deviation           8.0 dB       Max. Distance          9.00 m
#
#  Transducer:  ES200-7  Serial No.   116
#    Frequency            200000 Hz       Beamtype                Split
#    Gain                  26.80 dB       Two Way Beam Angle   -20.7 dB
#    Athw. Angle Sens.        23.00       Along. Angle Sens.      23.00
#    Athw. Beam Angle     7.00 deg       Along. Beam Angle    7.00 deg
#    Athw. Offset Angle   0.00 deg       Along. Offset Angle  0.00 deg
#    SaCorrection          0.00 dB       Depth                 2.00  m
#
#  Transceiver:  GPT 200 kHz 009072017a36 2 ES200-7
#    Pulse Duration       0.128 ms       Sample Interval     0.024   m
#    Power                  180  W       Receiver Bandwidth  15.73 kHz
#
#  Sounder Type:
#    EK60 Version  2.1.1
#
#  TS Detection:
#    Min. Value           -60.0 dB       Min. Spacing           100%
#    Max. Beam Comp.        6.0 dB       Min. Echolength         80%
#    Max. Phase Dev.           8.0       Max. Echolength        180%
#
#  Environment:
#    Absorption Coeff.  56.2 dB/km       Sound Velocity     1500.5 m/s
#
#  Beam Model results:
#    Transducer Gain    = 24.01 dB       SaCorrection       = -0.71 dB
#    Athw. Beam Angle   = 6.58 deg       Along. Beam Angle  = 6.65 deg
#    Athw. Offset Angle =-0.01 deg       Along. Offset Angle= 0.02 deg
#
#  Data deviation from beam model:
#    RMS =    0.39 dB
#    Max =    1.20 dB  No. =   250  Athw. =  0.1 deg  Along = -4.0 deg
#    Min =   -0.97 dB  No. =   279  Athw. =  0.6 deg  Along =  0.7 deg
#
#  Data deviation from polynomial model:
#    RMS =    0.38 dB
#    Max =    1.23 dB  No. =   250  Athw. =  0.1 deg  Along = -4.0 deg
#    Min =   -0.95 dB  No. =   136  Athw. =  2.3 deg  Along =  4.0 deg
```

Hull mounted 38 kHz

```
#  Calibration  Version   2.1.0.11
#
#  Date:  6/29/2005
#
#  Comments:
#    Hull mounted Scapa Flow
#
#  Reference Target:
#    TS                  -33.60 dB       Min. Distance         11.00 m
#    TS Deviation           4.0 dB       Max. Distance         18.00 m
#
#  Transducer:  ES38B  Serial No.   1234
#    Frequency            38000 Hz       Beamtype                Split
#    Gain                 25.87 dB       Two Way Beam Angle   -20.6 dB
#    Athw. Angle Sens.       21.90       Along. Angle Sens.      21.90
#    Athw. Beam Angle     7.16 deg       Along. Beam Angle    7.01 deg
#    Athw. Offset Angle  -0.04 deg       Along. Offset Angle  0.00 deg
#    SaCorrection         -0.59 dB       Depth                 2.00  m
#
#  Transceiver:  GPT  38 kHz 009072017a3b 1 ES38B
#    Pulse Duration       1.024 ms       Sample Interval     0.192   m
#    Power                 2000  W       Receiver Bandwidth   2.43 kHz
#
#  Sounder Type:
#    EK60 Version  2.1.1
#
#  TS Detection:
#    Min. Value           -38.0 dB       Min. Spacing           100%
#    Max. Beam Comp.        6.0 dB       Min. Echolength         80%
#    Max. Phase Dev.          8.0        Max. Echolength        180%
#
#  Environment:
#    Absorption Coeff.   9.2 dB/km       Sound Velocity     1500.5 m/s
#
#  Beam Model results:
#    Transducer Gain    = 24.43 dB       SaCorrection       = -0.47 dB
#    Athw. Beam Angle   = 6.88 deg       Along. Beam Angle  = 6.91 deg
#    Athw. Offset Angle =-0.03 deg       Along. Offset Angle=-0.10 deg
#
#  Data deviation from beam model:
#    RMS =    0.22 dB
#    Max =    0.72 dB  No. =   140  Athw. = -2.2 deg  Along = -4.2 deg
#    Min =   -0.63 dB  No. =    93  Athw. =  0.1 deg  Along = -4.0 deg
#
#  Data deviation from polynomial model:
#    RMS =    0.20 dB
#    Max =    0.63 dB  No. =   234  Athw. =  0.2 deg  Along = -0.5 deg
#    Min =   -0.59 dB  No. =     4  Athw. =  2.4 deg  Along = -1.1 deg
```

Simrad EK60 settings

Table B1: Simrad EK60 settings used on the June 2005 North Sea hydro acoustic survey for herring, FRV "Tridens". TB=Towed Body HM=Hull Mounted.

	Towed Body	Hull Mounted
Transceiver menu		
Absorption coefficient	9.2 dB/km	9.4 dB/km
Pulse duration	1.024 ms	1.024 ms
Bandwidth	2.43 kHz	2.43 kHz
Max Power	2000 W	2000 W
Two-way beam angle	-20.6 dB	-20.6 dB
3 dB Beam width	7.04 dg	7.03 dg
Calibration details		
Calibration details		
TS of sphere	-33.6 dB	-33.6 dB
Range to sphere in calibration	17.00 m	18.50 m
Transducer gain	26.23 dB	25.50 dB
Calibration factor for NASC's	-	-
Log/Navigation Menu		
Speed	Serial from ship's GPS	Serial from ship's GPS
Operation Menu		
Ping interval	0.6 s	0.6 s
Display/Printer Menu		
TVG	20 log R	20 log R
Integration line	N/A	N/A
TS colour min.	-50 dB	-50 dB
Sv colour min.	-70 dB	-70 dB

PGHERS output format

Table 2.6.1: Details of the trawl hauls taken during the June-July 2005 North Sea hydro acoustic survey for herring, FRV "Tridens".

haul	sample	date	position	ICES rectangle	time_UTC	haul_duration (min)	water_depth (m)	geardepth (m)	gear
0	5400420	28/06/2005	56.30N 01.44E	42F1	11:15	30	85.8	85	pelagic trawl
1	5400421	29/06/2005	58.25N 01.52W	45E8	17:30	68	94	94	pelagic trawl
2	5400422	29/06/2005	58.24N 01.56W	45E8	19:41	34	95	20	pelagic trawl
3	5400423	30/06/2005	58.25N 00.19W	45E9	09:13	30	114	100	pelagic trawl
4	5400424	01/07/2005	58.00N 01.03E	45F1	06:25	50	132	118	pelagic trawl
5	5400425	04/07/2005	56.55N 01.30W	42E8	06:40	60	62	0	pelagic trawl
6	5400426	04/07/2005	56.55N 00.58W	42E9	09:41	10	70	60	pelagic trawl
7	5400427	04/07/2005	56.55N 00.12W	42E9	15:10	20	70	60	pelagic trawl
8	5400428	05/07/2005	56.40N 01.28E	42F1	17:16	14	90	75	pelagic trawl
9	5400429	06/07/2005	56.32N 00.20E	42F0	07:39	86	79	0	pelagic trawl
10	5400430	07/07/2005	56.25N 00.45W	41E9	06:11	74	67	55	pelagic trawl
11	5400431	07/07/2005	56.25N 00.01W	41E9	10:43	62	72	40	pelagic trawl
12	5400432	11/07/2005	53.40N 03.38E	36F3	18:03	50	38	23	pelagic trawl
13	5400433	12/07/2005	54.05N 01.42E	37F1	18:00	77	77	15	pelagic trawl
14	5400434	13/07/2005	54.45N 03.32E	38F3	06:45	55	40	30	pelagic trawl
15	5400435	13/07/2005	54.45N 04.41E	38F4	12:06	41	42	35	pelagic trawl
16	5400436	13/07/2005	54.45N 05.59E	38F5	17:55	35	42	30	pelagic trawl
17	5400437	14/07/2005	55.40N 05.40E	40F5	06:50	40	51	36	pelagic trawl
18	5400438	14/07/2005	55.40N 05.11E	40F5	09:35	95	51	36	pelagic trawl
19	5400439	14/07/2005	55.40N 02.12E	40F2	20:20	20	82	68	pelagic trawl
20	5400440	15/07/2005	55.38N 00.02W	40E9	12:50	20	61	46	pelagic trawl
21	5400441	18/07/2005	56.10N 00.40W	41E9	09:50	93	72	58	pelagic trawl
22	5400442	19/07/2005	55.37N 01.54E	40F1	19:15	60	72	50	pelagic trawl
23	5400443	20/07/2005	55.14N 01.30E	39F1	07:43	47	40	26	pelagic trawl
24	5400444	20/07/2005	55.15N 00.05E	39F0	15:00	60	75	60	pelagic trawl
25	5400445	20/07/2005	55.15N 00.26W	39E9	15:37	17	76	62	pelagic trawl
26	5400446	20/07/2005	55.14N 00.49E	39F0	17:53	57	77	62	pelagic trawl
27	5400447	21/07/2005	55.03N 01.10W	39E8	06:55	55	65	49	pelagic trawl

Table 3.2.1: Trawl catches during the June-July 2005 North Sea hydro acoustic survey for herring, FRV "Tridens" in kg.

Haul	sample	Herring	Sprat	Mackerel	Grey_gurnard	Norway_pout	Haddock	Whiting	Snake_pipefish	Lesser_sand_eel	Raitt_s_sand_eel	Horse_mackerel	others
0	5400420	3167.96		6.32			5.72						0.00
1	5400421	171.99		2.52	0.30	85.23	1.15	0.21					0.00
2	5400422	0.10		0.48		0.07	0.01		0.03				1.68
3	5400423	12480.22		2.60									6.15
4	5400424	9843.63		3.82		0.12							2.56
5	5400425			1.35		0.00	0.00		0.06	0.03			3.50
6	5400426	0.10		207.88	2.06								0.00
7	5400427	20.80		1.12	1.46		17.38	1.21					0.00
8	5400428	1204.73			0.29								0.00
9	5400429	323.39		30.34	2.69			0.35					0.85
10	5400430		24.60	19.44	0.07	0.00	0.00		0.14				0.00
11	5400431			9.33	49.99			0.18					0.17
12	5400432		30.46	2.13								0.42	0.00
13	5400433	12.68	1736.46	0.12	0.25								0.17
14	5400434	112.96	793.73		19.07			0.03					0.47
15	5400435			0.80	7.24								0.00
16	5400436	8.23	830.68	1.36	8.30							1.17	0.14
17	5400437	48.12	176.38		7.69	0.00		0.11					0.78
18	5400438	3425.34	497.28		3.05								0.81
19	5400439	173.43			0.85			0.26					0.00
20	5400440	0.11		0.63	0.71		3.54	0.35					0.32
21	5400441	4.36	246.57		4.02		1.68						0.00
22	5400442			49.87	67.35								2.37
23	5400443										5.11		3.70
24	5400444			1.74	3.16		4.81	13.19					1.02
25	5400445	0.06		0.36	0.63			0.10					0.00
26	5400446	0.50	10.24	0.12	0.03	0.03	0.49	15.81					0.03
27	5400447	6.74	134.75					7.94					0.01

Table 3.2.2: Length frequency proportions of herring by haul during the July 2005 North Sea hydro acoustic survey for herring, FRV "Tridens".

length	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
7																		2.3										
7.5																	8.7	7.5										
8														37.5			13.0	26.4	0.6									
8.5														25.0			34.8	27.0	0.6									
9														20.8			8.7	27.6										
9.5																	4.3	5.7										
10																												
10.5																												
11																												
11.5																												
12																												
12.5																												
13																		0.6										
13.5																	4.3											
14															1.0			0.6										
14.5															1.9		8.7	0.6	8.3									3.0
15														4.2	24.0		4.3	0.6	19.9									4.5
15.5														8.3	37.5			0.6	34.0									6.0
16	0.8													4.2	28.8		4.3		28.8									6.0
16.5	1.6														5.8		4.3	0.6	5.1	0.5								5.3
17	7.1														1.0				2.6	3.2		4.8						9.0
17.5	3.6																4.3			5.9		3.2						11.3
18	6.7							0.6	0.5	1.4										18.9		12.9					22.2	9.8
18.5	8.3							5.6	1.9	2.1										22.7		6.5						5.3
19	13.0							22.6	7.4	0.7										24.9		17.7					22.2	4.5
19.5	13.4	1.2						25.4	9.7	0.7										13.5		8.1					44.4	7.5
20	10.7	6.2						33.3	12.0	4.1										4.9		3.2				100.0	11.1	13.5
20.5	10.3	4.3						9.0	17.6	1.4										3.8		11.3						4.5
21	8.7	8.0						2.8	16.7	3.4										1.1		4.8						2.3
21.5	2.4	8.6							15.3	3.4												1.6						0.8
22	0.8	4.9							7.9	0.7										0.5		4.8						0.8
22.5	1.6	3.7		0.5	1.2				5.6	2.8																		
23	0.4	2.5	100.0	1.0	1.2			0.6	2.3	4.1												1.6						0.8
23.5	0.4	5.6		0.5	1.7		100.0		0.5	7.6												1.6						0.8
24	2.8	9.3		3.3	7.5				0.9	11.0											100.0	4.8						3.0
24.5	2.0	13.0		12.0	18.5				0.9	19.3												6.5						0.8
25	3.6	9.3		15.3	25.4				0.9	18.6												1.6						0.8
25.5	1.2	13.0		17.2	23.1					6.2												1.6						
26	0.4	8.0		21.5	12.1					3.4												3.2						
26.5	0.4	0.6		13.4	5.2					5.5																		
27		1.2		9.1	2.9					2.1																		
27.5				3.3	1.2					0.7																		
28		0.6		1.9						0.7																		
28.5																												
29				0.5																								
29.5																												
30				0.5																								
30.5																												
31																												
31.5																												
32																												
32.5																												
33																												

Table 3.3.1a: Age/maturity-length key for herring – Stratum A,B,C,D and E. "Tridens", North Sea acoustic survey 2005.

stratum	lengthclass	0imm	1imm	1mat	2imm	2mat	3imm	3mat	4imm	4mat	5imm	5mat	6mat	7mat	8mat
A	7	4													
A	7.5	7													
A	8	9													
A	8.5	11													
A	9	7													
A	9.5	6													
A	10														
A	10.5														
A	11														
A	11.5														
A	12														
A	12.5														
A	13		1												
A	13.5		1												
A	14		2												
A	14.5		10												
A	15		12												
A	15.5		12												
A	16		11												
A	16.5		12												
A	17		5												
A	17.5		1												
A	18														
A	18.5														
A	19														
A	19.5														
A	20														
A	20.5														
A	21														
A	21.5														
A	22														
A	22.5														
A	23														
A	23.5														
A	24														
A	24.5														
A	25														
A	25.5														
A	26														
A	26.5														
A	27														
A	27.5														
A	28														
A	29														
A	30														

stratum	lengthclass	0imm	1imm	1mat	2imm	2mat	3imm	3mat	4imm	4mat	5imm	5mat	6mat	7mat	8mat
B	7														
B	7.5														
B	8	5													
B	8.5	5													
B	9	5													
B	9.5														
B	10														
B	10.5														
B	11														
B	11.5														
B	12														
B	12.5														
B	13														
B	13.5														
B	14														
B	14.5														
B	15		1												
B	15.5		2												
B	16		1												
B	16.5														
B	17														
B	17.5														
B	18														
B	18.5														
B	19														
B	19.5														
B	20														
B	20.5														
B	21														
B	21.5														
B	22														
B	22.5														
B	23														
B	23.5														
B	24														
B	24.5														
B	25														
B	25.5														
B	26														
B	26.5														
B	27														
B	27.5														
B	28														
B	29														
B	30														

stratum	lengthclass	0imm	1imm	1mat	2imm	2mat	3imm	3mat	4imm	4mat	5imm	5mat	6mat	7mat	8mat
C	7														
C	7.5														
C	8														
C	8.5														
C	9														
C	9.5														
C	10														
C	10.5														
C	11														
C	11.5														
C	12														
C	12.5														
C	13														
C	13.5														
C	14														
C	14.5														
C	15														
C	15.5														
C	16														
C	16.5														
C	17														
C	17.5														
C	18														
C	18.5														
C	19														
C	19.5		2												
C	20		5												
C	20.5		5												
C	21		4		1										
C	21.5		4		1										
C	22		3		2										
C	22.5		3		2	2	1								
C	23		1		4		2	1							
C	23.5				1	5	1			1					
C	24				3	4	1	1	4	2					
C	24.5					4	1	2	2	6					
C	25				1			2	5	7					
C	25.5					4		2		9					
C	26					3		1	1	9		1			
C	26.5							4		7					
C	27					2		2		6		2			
C	27.5							2		2			1	1	1
C	28									1			4		
C	29														1
C	30												1		

stratum	lengthclass	0imm	1imm	1mat	2imm	2mat	3imm	3mat	4imm	4mat	5imm	5mat	6mat	7mat	8mat
D	7														
D	7.5														
D	8														
D	8.5														
D	9														
D	9.5														
D	10														
D	10.5														
D	11														
D	11.5														
D	12														
D	12.5														
D	13														
D	13.5														
D	14														
D	14.5														
D	15														
D	15.5														
D	16		2												
D	16.5		4												
D	17		5												
D	17.5		7												
D	18		14												
D	18.5		20		1										
D	19		21												
D	19.5		19		2										
D	20		18		4										
D	20.5		12		10										
D	21		10		13										
D	21.5		4		12										
D	22		3		11										
D	22.5				11	2									
D	23		1		4	3	1	1		3					
D	23.5				1			2	1	4					
D	24				1	1		2	2	10					
D	24.5				1					12		3			
D	25							3		9		1			
D	25.5							1		4		3	1		
D	26							1		5			1		
D	26.5									4		1		1	
D	27											1	1		1
D	27.5											1			
D	28									1					
D	29														
D	30														

stratum	lengthclass	0imm	1imm	1mat	2imm	2mat	3imm	3mat	4imm	4mat	5imm	5mat	6mat	7mat	8mat
E	7														
E	7.5														
E	8														
E	8.5														
E	9														
E	9.5														
E	10														
E	10.5														
E	11														
E	11.5														
E	12														
E	12.5														
E	13														
E	13.5														
E	14														
E	14.5		4												
E	15		5												
E	15.5		5												
E	16		5												
E	16.5		6												
E	17		10												
E	17.5		10												
E	18		11		1										
E	18.5		8		2										
E	19		12												
E	19.5		10		4										
E	20		5		5	1									
E	20.5		4		4	2									
E	21		2		3										
E	21.5				1										
E	22				1	1									
E	22.5														
E	23							1							
E	23.5									1					
E	24								1	2		1			
E	24.5									1					
E	25													1	
E	25.5														
E	26														
E	26.5														
E	27														
E	27.5														
E	28														
E	29														
E	30														

Table 3.3.1b: Age/maturity-length key for sprat - Total area. "Tridens", North Sea acoustic survey 2005.

length	0imm	1imm	1mat	2imm	2mat	3imm	3mat	4imm	4mat	5imm	5mat	6imm	6mat	7imm	7mat	8imm	8mat
8.5				7													
9				14	1												
9.5				17	5												
10				19	21												
10.5				13	26		4										
11		3		10	35		3										
11.5			4	7	37		2										
12			1	3	35	1	4										
12.5			2	3	14		10										
13					12		7		1								
13.5					6		8										
14					4		6										

Table 3.4.1: Herring. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age and maturity per stratum obtained during the July 2005 North Sea hydro acoustic survey for herring, FRV "Tridens".

stratum	yearclass	age	mean_weight (g)	mean_length (cm)	numbers (millions)	biomass (1000 tonnes)	numbers (%)	biomass (%)
A	2004	0imm	4.02	8.43	111.41	0.45	41.85	9.43
A	2003	1imm	27.81	15.52	154.81	4.30	58.15	90.57
A	2003	1mat						
A	2002	2imm						
A	2002	2mat						
A	2001	3imm						
A	2001	3mat						
A	2000	4imm						
A	2000	4mat						
A	1999	5mat						
A	1998	6mat						
A	1997	7mat						
A	1996	8mat						
	immature				**266.22**	**4.75**	**100.00**	**100.00**
	mature				**0.00**	**0.00**	**0.00**	**0.00**
	total				**266.22**	**4.75**	**100.00**	**100.00**

stratum	yearclass	age	mean_weight (g)	mean_length (cm)	numbers (millions)	biomass (1000 tonnes)	numbers (%)	biomass (%)
B	2004	0imm	3.48	8.40	16.87	0.06	83.33	37.95
B	2003	1imm	28.47	15.50	3.37	0.10	16.67	62.05
B	2003	1mat						
B	2002	2imm						
B	2002	2mat						
B	2001	3imm						
B	2001	3mat						
B	2000	4imm						
B	2000	4mat						
B	1999	5mat						
B	1998	6mat						
B	1997	7mat						
B	1996	8mat						
	immature				**20.24**	**0.15**	**100.00**	**100.00**
	mature				**0.00**	**0.00**	**0.00**	**0.00**
	total				**20.24**	**0.15**	**100.00**	**100.00**

stratum	yearclass	age	mean_weight (g)	mean_length (cm)	numbers (millions)	biomass (1000 tonnes)	numbers (%)	biomass (%)
C	2004	0imm						
C	2003	1imm	76.13	21.01	199.57	15.19	10.20	5.75
C	2003	1mat						
C	2002	2imm	105.65	23.16	112.59	11.90	5.75	4.50
C	2002	2mat	136.82	24.96	312.36	42.74	15.96	16.18
C	2001	3imm	115.12	23.83	45.79	5.27	2.34	2.00
C	2001	3mat	148.08	25.55	226.55	33.55	11.58	12.70
C	2000	4imm	131.50	24.82	199.60	26.25	10.20	9.94
C	2000	4mat	147.41	25.53	795.64	117.28	40.66	44.40
C	1999	5mat	165.88	26.44	32.49	5.39	1.66	2.04
C	1998	6mat	207.27	28.20	20.53	4.25	1.05	1.61
C	1997	7mat	189.49	27.50	4.20	0.80	0.21	0.30
C	1996	8mat	205.63	28.14	7.32	1.50	0.37	0.57
	immature				**557.55**	**58.61**	**28.50**	**22.19**
	mature				**1399.08**	**205.51**	**71.50**	**77.81**
	total				**1956.64**	**264.12**	**100.00**	**100.00**

stratum	yearclass	age	mean_weight (g)	mean_length (cm)	numbers (millions)	biomass (1000 tonnes)	numbers (%)	biomass (%)
D	2004	0imm						
D	2003	1imm	55.35	19.36	377.44	20.89	56.77	42.33
D	2003	1mat						
D	2002	2imm	73.27	21.16	139.60	10.23	21.00	20.73
D	2002	2mat	105.76	23.11	6.53	0.69	0.98	1.40
D	2001	3imm	94.52	23.00	0.92	0.09	0.14	0.18
D	2001	3mat	121.42	24.54	17.99	2.18	2.71	4.43
D	2000	4imm	104.74	23.75	3.41	0.36	0.51	0.72
D	2000	4mat	123.48	24.72	96.34	11.90	14.49	24.11
D	1999	5mat	129.90	25.27	16.81	2.18	2.53	4.43
D	1998	6mat	139.37	26.07	3.59	0.50	0.54	1.01
D	1997	7mat	144.59	26.50	1.31	0.19	0.20	0.38
D	1996	8mat	150.92	27.00	0.92	0.14	0.14	0.28
	immature				**521.37**	**31.56**	**78.42**	**63.96**
	mature				**143.49**	**17.78**	**21.58**	**36.04**
	total				**664.85**	**49.34**	**100.00**	**100.00**

stratum	yearclass	age	mean_weight (g)	mean_length (cm)	numbers (millions)	biomass (1000 tonnes)	numbers (%)	biomass (%)
E	2004	0imm						
E	2003	1imm	45.26	18.06	403.63	18.27	79.58	72.62
E	2003	1mat						
E	2002	2imm	58.26	19.63	77.83	4.53	15.34	18.03
E	2002	2mat	69.31	20.51	10.51	0.73	2.07	2.90
E	2001	3imm						
E	2001	3mat	94.41	23.00	1.91	0.18	0.38	0.72
E	2000	4imm	108.53	24.00	1.91	0.21	0.38	0.82
E	2000	4mat	106.06	24.00	7.63	0.81	1.50	3.22
E	1999	5mat	106.01	24.00	1.91	0.20	0.38	0.80
E	1998	6mat						
E	1997	7mat	118.47	25.00	1.91	0.23	0.38	0.90
E	1996	8mat						
	immature				**483.37**	**23.01**	**95.30**	**91.47**
	mature				**23.86**	**2.15**	**4.70**	**8.53**
	total				**507.23**	**25.16**	**100.00**	**100.00**

Table 3.4.2a: Herring. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age and maturity obtained during the July 2005 North Sea hydro acoustic survey for herring, FRV "Tridens".

yearclass	age	mean_weight (g)	mean_length (cm)	numbers (millions)	biomass (1000 tonnes)	numbers (%)	biomass (%)
2004	0imm	3.95	8.43	128.28	0.51	3.76	0.15
2003	1imm	51.59	18.65	1138.82	58.75	33.35	17.10
2003	1mat						
2002	2imm	80.78	21.48	330.02	26.66	9.66	7.76
2002	2mat	134.05	24.78	329.40	44.16	9.65	12.85
2001	3imm	114.71	23.81	46.71	5.36	1.37	1.56
2001	3mat	145.72	25.46	246.45	35.91	7.22	10.45
2000	4imm	130.85	24.80	204.91	26.81	6.00	7.80
2000	4mat	144.49	25.43	899.60	129.99	26.34	37.84
1999	5mat	151.84	25.97	51.21	7.78	1.50	2.26
1998	6mat	197.16	27.88	24.12	4.75	0.71	1.38
1997	7mat	163.29	26.68	7.41	1.21	0.22	0.35
1996	8mat	199.53	28.01	8.24	1.64	0.24	0.48
immature				**1848.75**	**118.09**	**54.13**	**34.37**
mature				**1577.34**	**225.44**	**45.87**	**65.63**
total				**3426.09**	**343.53**	**100.00**	**100.00**

Table 3.4.2b: Sprat. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age and maturity obtained during the July 2005 North Sea hydro acoustic survey for herring, FRV "Tridens".

yearclass	age	mean_weight (g)	mean_length (cm)	numbers (millions)	biomass (1000 tonnes)	numbers (%)	biomass (%)
2004	1imm	10.13	11.00	103.29	1.05	1.40	1.32
2004	1mat	12.57	11.77	149.87	1.88	2.03	2.37
2003	2imm	8.67	10.37	1815.04	15.73	24.61	19.81
2003	2mat	11.09	11.22	4555.10	50.50	61.75	63.60
2002	3imm	13.22	12.00	17.31	0.23	0.23	0.29
2002	3mat	13.55	12.00	721.76	9.78	9.79	12.32
2001	4mat	16.73	13.00	13.75	0.23	0.19	0.29
immature				**1935.65**	**17.01**	**26.24**	**21.42**
mature				**5440.49**	**62.39**	**73.76**	**78.58**
total				**7376.13**	**79.40**	**100.00**	**100.00**

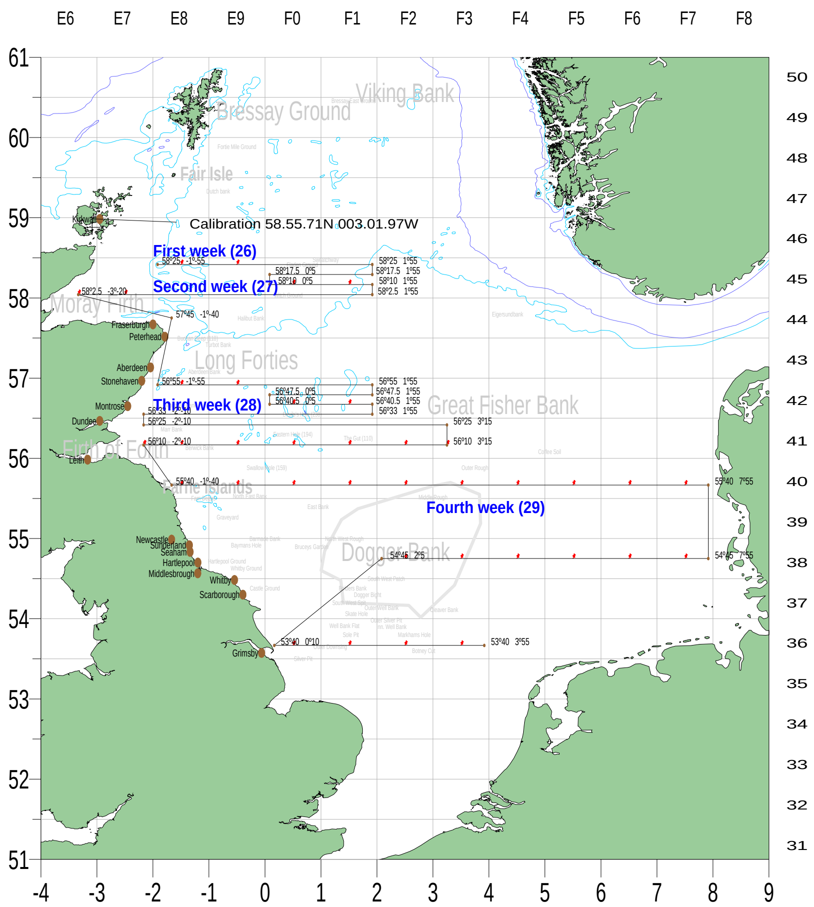

Figure 1.1: Map of planned cruise track and positions of hydrographical stations during the June-July 2005 North Sea herring hydro acoustic survey on FRV "Tridens".

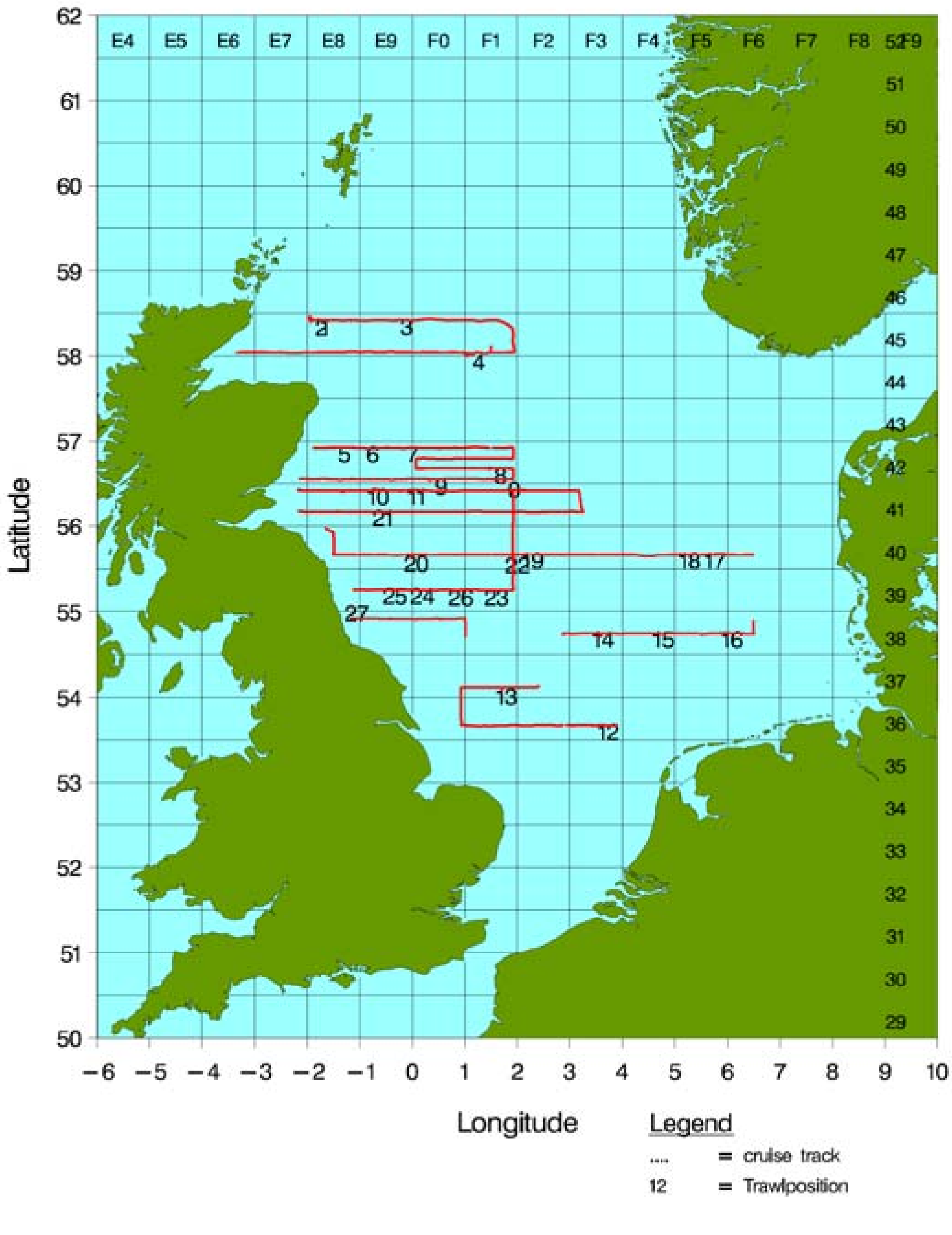

Figure 2.3.1: Map of surveyed cruise track and positions of trawl stations, during the June-July 2005 North Sea herring hydro acoustic survey on FRV "Tridens".

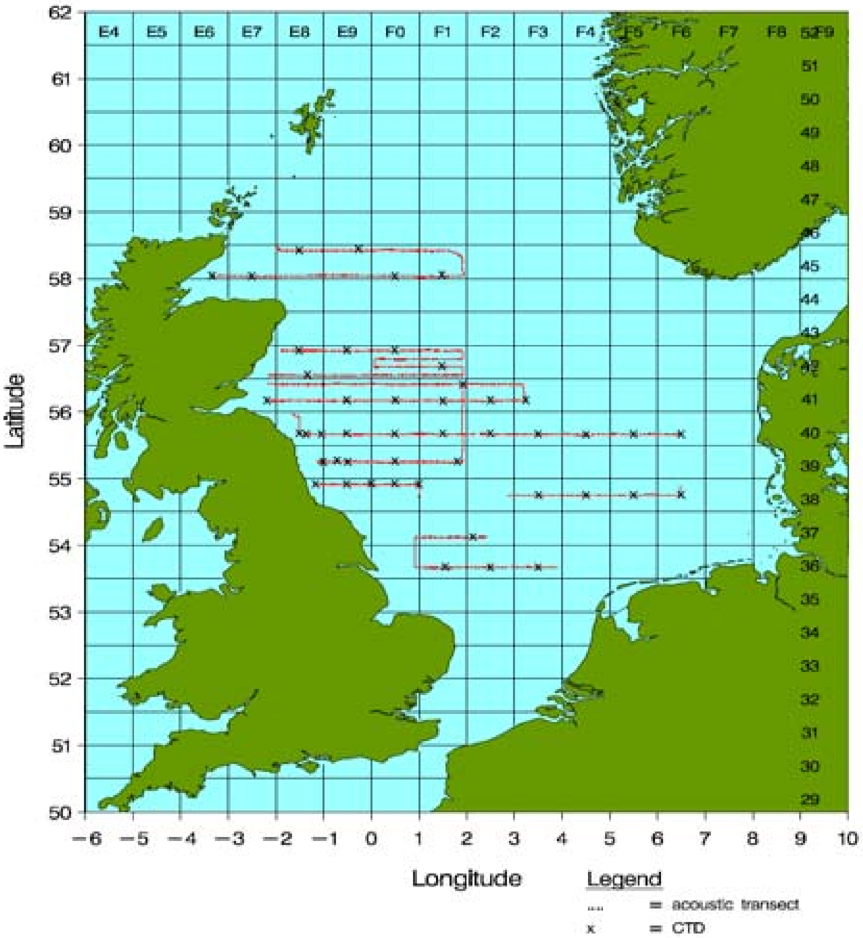

Figure 2.7.1: Positions of CTD stations during the July 2005 North Sea hydro acoustic survey: for herring by FRV "Tridens".

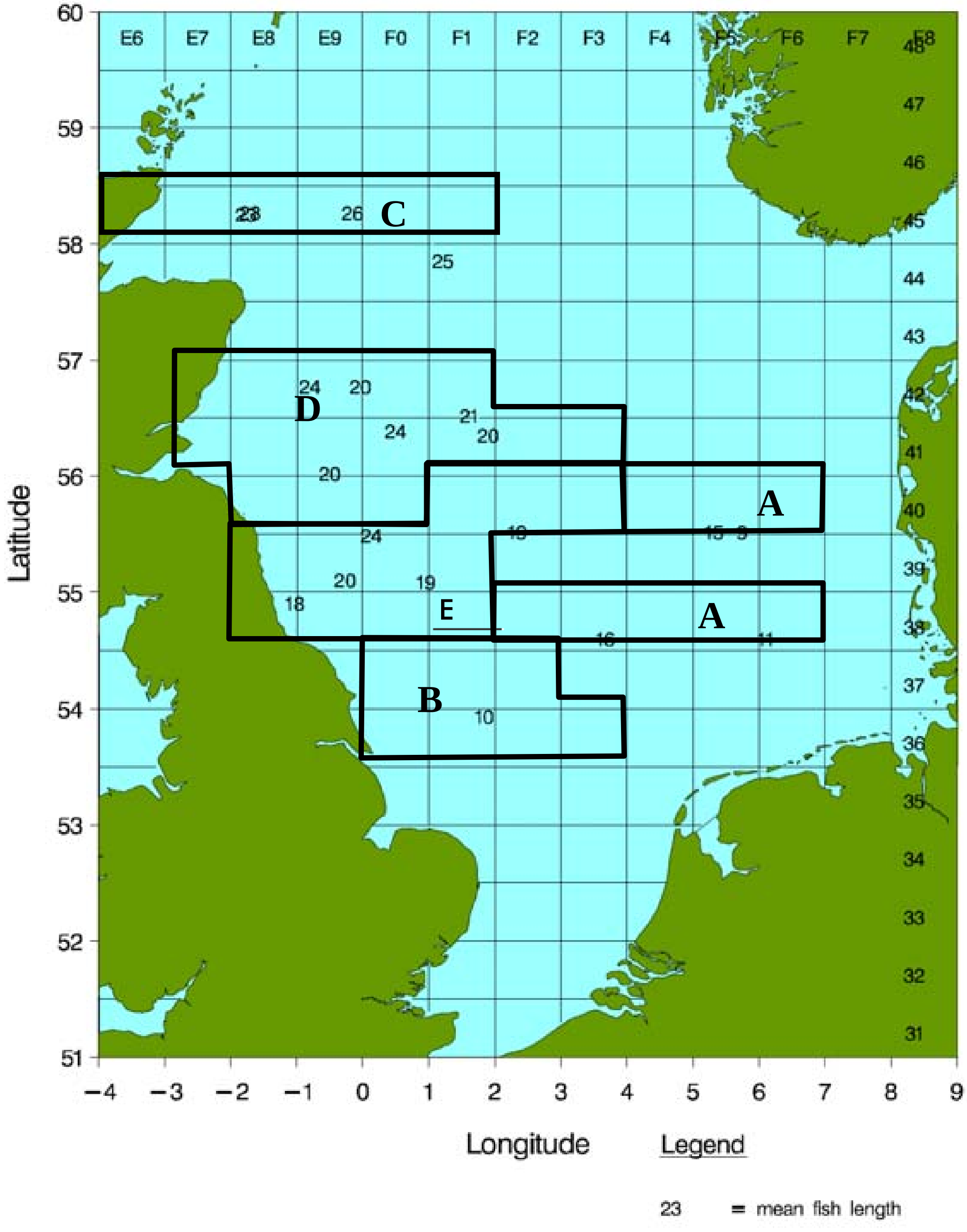

Figure 2.8.1: Post plot of herring mean length from FRV "Tridens", observed during the July 2005 North Sea hydro acoustic survey for herring. Strata-areas A to E are indicated.

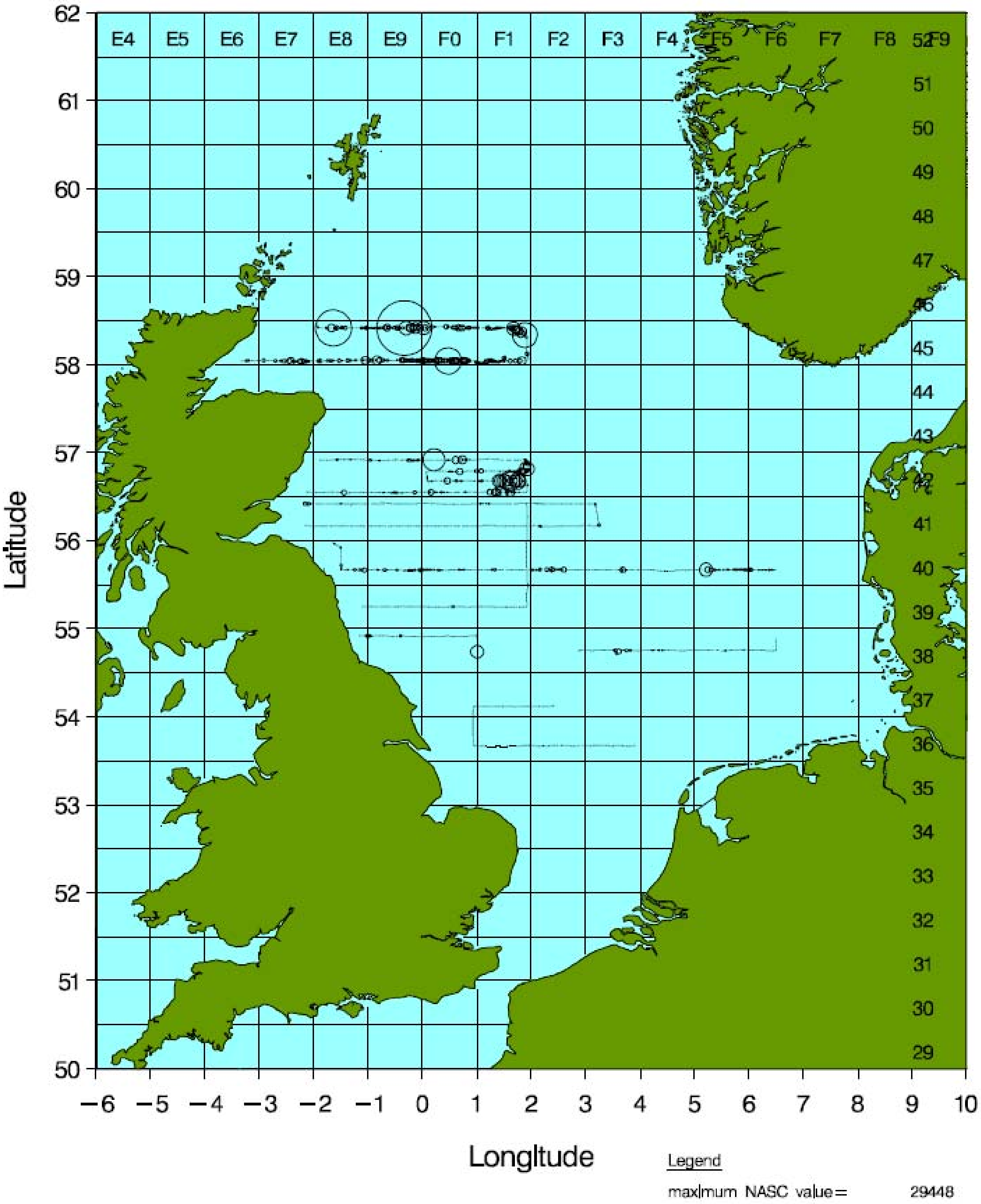

Figure 3.1.1a: Post plot showing the distribution of total herring S_A values (on a proportional square root scale relative to the largest value of 29448) obtained during the June-July 2005 North Sea herring hydro acoustic survey on FRV “Tridens”.

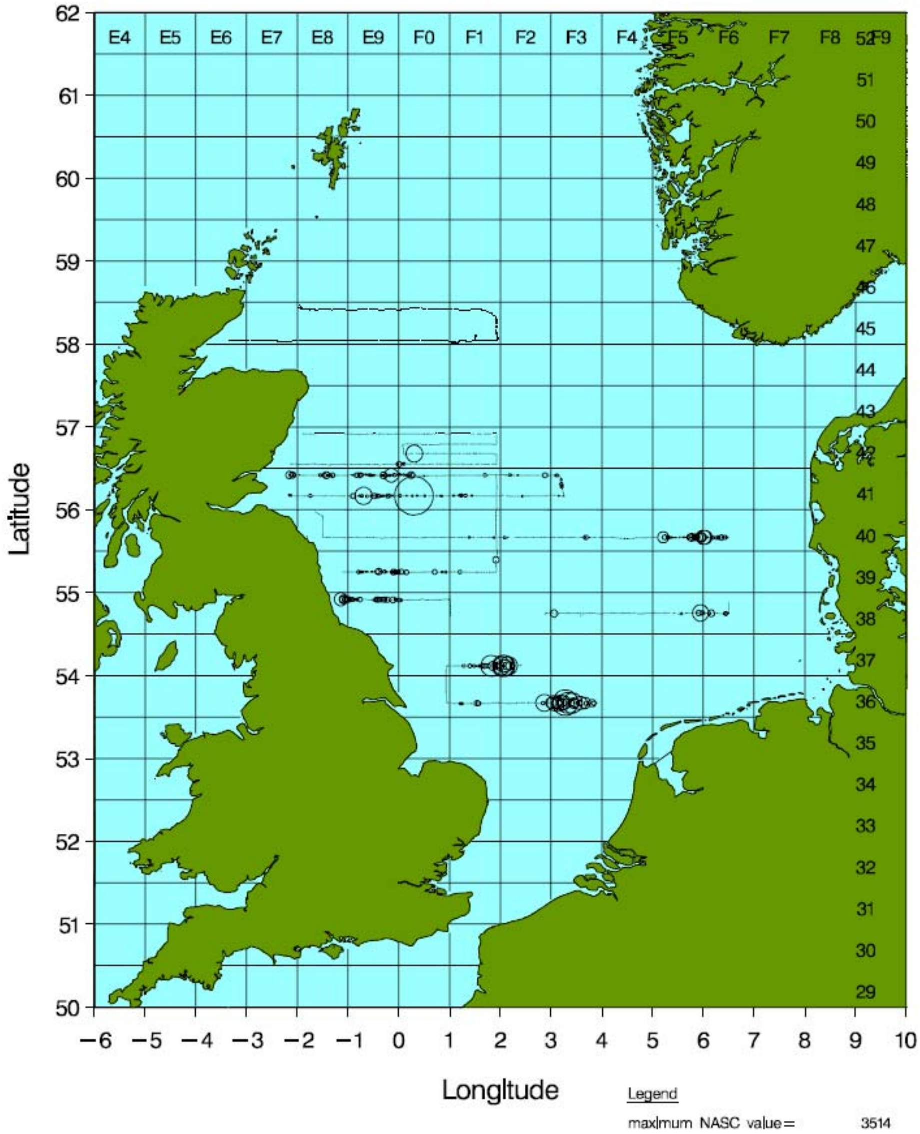

Figure 3.1.1b: Post plot showing the distribution of total sprat S_A values (on a proportional square root scale relative to the largest value of 3514) obtained during the June-July 2005 North Sea herring hydro acoustic survey on FRV "Tridens".

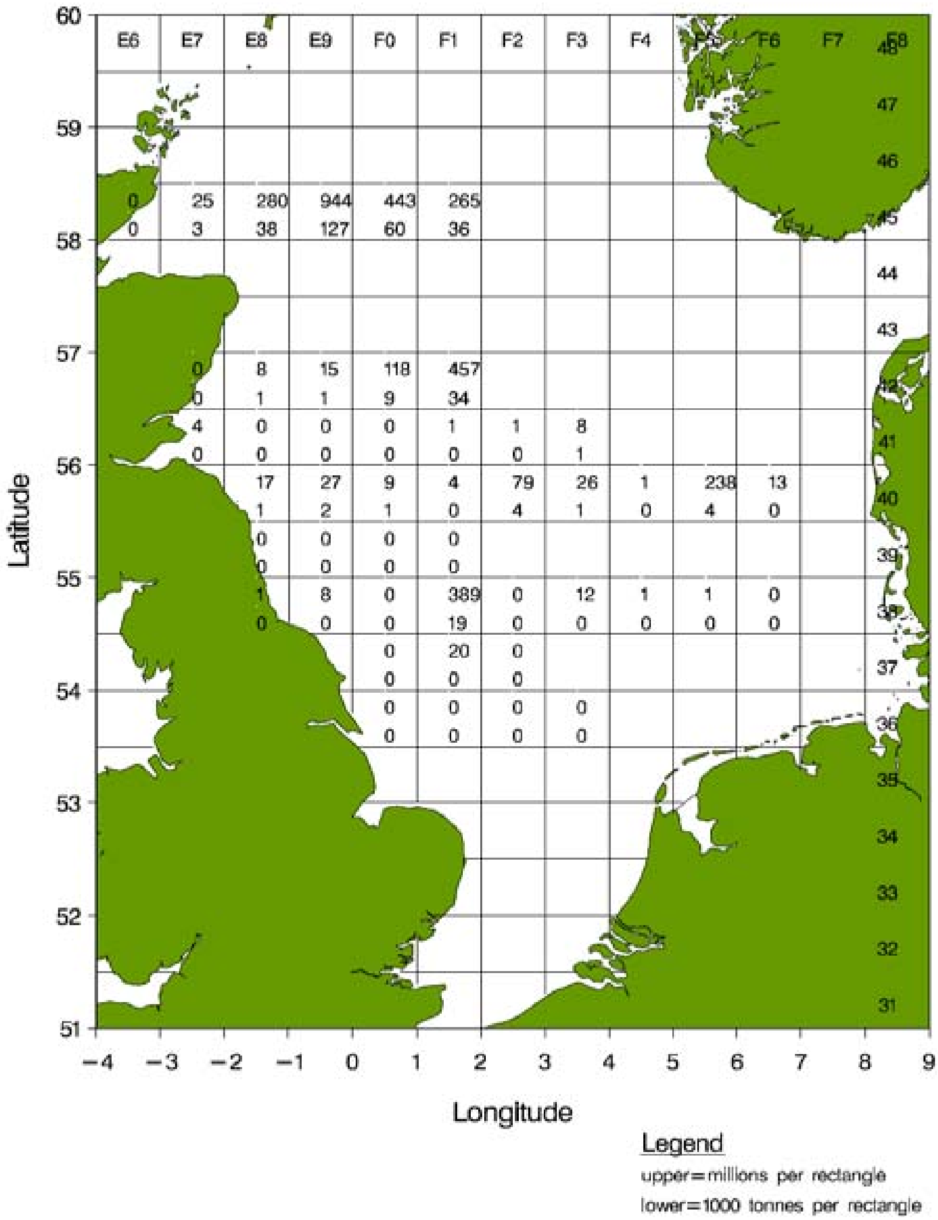

Figure 3.4.1: Estimated numbers of herring in millions (upper half square) and biomass in thousands of tonnes (lower half of square) by ICES rectangle. Results from the July 2005 North Sea hydro acoustic survey, FRV "Tridens".

Annex 2F: Germany

Survey report for FRV "Solea" cruise 544

International Herring Acoustic Survey in the North Sea

28 Jun 2005 – 19 Jul 2005

Christopher Zimmermann, Jens Ulleweit, Inst Sea Fisheries (ISH),

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1. INTRODUCTION

Context: "Solea" cruise 544 was conducted in the framework of the international hydroacoustic survey on pelagic fish in the North Sea, which is coordinated 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 Southern and South-Eastern North Sea. This area is regarded to be one of the main distribution areas for juvenile herring. Since 2001, PGHERS calculates a juvenile biomass index for the North Sea herring assessment, mainly based on the survey results from the SE North Sea and the Kattegat/Skagerrak area. During the last years, the survey area was significantly extended to the south (to about 52°N) in an attempt to reach the southern distribution limit of sprat, and this area was again covered this year. Following a recommendation by the parent planning group, the survey design for the international survey was altered: The German vessel interlaced with the Dutch vessel, and survey intensity (numbers of transects per ICES rectangle) was redistributed to increase the precision in areas with high variance and importance for the assessment and advice (of herring). The survey intensity therefore had to be reduced in most of the area covered by "Solea".

Objectives: Hydroacoustic recording of pelagic fish stocks for abundance and biomass estimation, biological sampling for the verification of echoes, calibration of the hydroacoustic equipment, hydrographic investigations, sampling of data and specimens for a number of national and international projects (BFA Fi: Univ. Aberdeen/ISH; Univ. Hamburg/GLOBEC; FTZ Büsum, IfM Kiel).

2. SURVEY DESCRIPTION and METHODS

2.1 Personnel

E. Götze	scientist in charge, hydroacoustics	IFF
M. Drenckow	hydroacoustics	IFF
J. Ulleweit	fishery biology	ISH
Mrs. G. Gentschow	fishery biology	ISH
J. Hartmann	fishery biology	ISH
S. Bednarz	fishery biology/cetacean observation	FTZ/Univ. Kiel
Ms. L. Lehnert	fishery biology/cetacean observation	FTZ/Univ. Kiel

2.2 Narrative

FRV "Solea" left the port of Cuxhaven on 28 June, and calibrated the hydroacoustic equipment under reasonable conditions on 29 June north-east of the Dogger Bank. Recording of hydroacoustic measurements started at the same day south of the Fisher Bank, in the north of the investigation area. Due to a technical failure of one winch, fishing could not be conducted until the afternoon of 30 June (Figure 1). The work then continued from north to south according to schedule. Weather conditions were very favourable throughout the survey, resulting in a relatively high number of fishing stations and a long survey track. An intercalibration with the second German vessel participating in ICES coordinated acoustic surveys, the "Walther Herwig III", was conducted during 11 July on "Solea's" survey track. The remaining time was used to survey the area in the southern North Sea/Eastern Channel and off the Frisian coast. The recordings were terminated in the afternoon of 18 July, and "Solea" reached her home port on the same evening, having sailed 3276 n.mi.

2.3 Survey design

The working area for the German vessel contributing to the survey was extended to the west and interlaced with the area covered by the Dutch vessel "Tridens". The survey effort was redistributed for the whole international survey, to increase the precision in areas with high variance and importance for the assessment and advice (of herring). The southern survey limit was chosen in order to reach a southern distribution limit of sprat in July. This would be a prerequisite for the development of a sprat biomass index in the near future using this acoustic survey. The survey area was confined to the southern and North Sea between 52°N and the 20 m depth contour off Frisia to the south, the 20 m depth line off the English coast to the west and off the German and Danish coast to the east, and 56.5°N (eastern part) and 55.5°N (western part) to the north, respectively.

Hydroacoustic measurements were conducted on east-west or north-south transects with 7.5, 15 or 30 n.mi. inter-transect distance (as done by other research vessels participating in the survey) on fixed latitudes. In general, each ICES statistical rectangle was surveyed with at least one transect, and with higher intensity where historically a high abundance or variability of abundance of juvenile herring or sprat had been detected.

2.4 Calibration

The hull mounted transducers (one in the keel, one in the starboard blister) were calibrated at the start of the survey (29 June) at open sea on 55°50'N and 005°00'E on 32 m water depth. The conditions were reasonable; the vessel was anchored, and tidal or wind induced currents were below 0.3 knots. The calibration procedure required less than 6 hrs for both transducers. Calibration methods are described in the 'Manual for Herring Acoustic Surveys in ICES Divisions III, IV and VI' (ver. 3.1, ICES CM 2003/G:03, Appendix 4). Important parameters and settings are listed in Table 1.

2.5 Intercalibration/Overlap area

An intercalibration of the two German vessels participating in the survey, FRV "Walther Herwig III" and FRV "Solea", was conducted on 11 July. Both vessels sailed in parallel with 0.5 n.mi. distance on easterly courses over 14 hrs (interrupted by four fishing stations). The vessels changed positions after each 50 n.mi. The fish distribution was favourable for the intercalibration, with two areas of dense schools and very little fish in-between. The detailed analyses yet to be conducted will show if the vessels' very different noise emission have an influence on the recordings.

2.6 Acoustic data collection

The acoustic investigations were performed during daylight (0400 to 1800 hrs UTC), using a Simrad EK60 echosounder with standard frequencies of 38 and 120 kHz. The echo telegrams were continuously recorded and evaluated using the EchoView 3 software package. 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' (ver. 3.1, ICES CM 2003/G:03, Appendix 4). Basic settings are documented in Table 1. The vessel was running at a speed of 10-11 knots. During cruise 544, "Solea" sailed 3199 n.mi. Of these, 2186 n.mi. could be used for acoustic data sampling.

2.7 Biological data - fishing trawls

For the identification of echo traces and further biological sampling, 41 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, approx. 8 m vertical opening, and mesh size in the codend 10 mm) was used both in the midwater and close to the bottom. The net was equipped with a Simrad trawl sonar FS20. Standard tow periods were 30 mins; however, they varied between 15 and 47 mins depending on the indications of net filling. 27 statistical rectangles have been sampled.

From each trawl, the mass of the total catch and species composition (on subsamples, if needed) was 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 (from 1093 herring, 1140 sprat, 47 anchovies and 5 sardines). If conditions did not allow conducting this work immediately after the haul, fish was frozen for further processing at the institute.

2.8 Hydrographic data

After most of the hauls and on additional hydrographic stations, vertical profiles of temperature, salinity and depth were recorded using a "Seabird SBE 19 plus- multiprobe" CTD (Figure 1). This year, no water samples for calibration have been taken.

2.9 Acoustic and visual recording of cetaceans

The abundance of harbour porpoise (*Phocoena phocoena*) in the North Sea was to be determined by means of visual (modified line transect method, Buckland *et al.* 2001) and acoustic methods (recording of harbour porpoise "clicks" in the range 110-140 kHz with a towed hydrophone chain). Due to interferences between the vessel's transducers and the hydrophones, recording was only conducted during night when the vessel sailed at about 3 kn speed and the EK60 was switched off. Samples of fish were taken to correlate harbour porpoise detections with prey abundance and prey energy content (fatty acids) as well as the porpoise position in the food chain (stable isotopes).

2.10 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 the EchoView 3 software package, using information from trawl hauls usually targeting specific schools. 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 EchoView software.

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 σ 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 (or more precisely the area with a water depth of more than 20 m), 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 not considered to be problematic for the identification of fish schools.

The highest nautical area scattering coefficients (NASCs) have been found in the inner German Bight, with a maximum mean value over 5 n.mi. of 5’621 $m^2 n.mi.^{-2}$). Figure 2 gives the NASC distribution on 5 n.mi. EDSUs for clupeids (herring and sprat combined).

3.2 Biological data

41 hauls with the pelagic trawl PSN388 have been deployed. Out of 39 rectangles covered during the survey, 27 have been sampled with trawl hauls (Figure 1 and Table 2). Valid results (at least one haul with more than 200 clupeids h^{-1} trawling) were obtained for 16 rectangles. Those were used for raising unsampled rectangles. The majority of the unsampled rectangles had no or only minimal NASCs. Total catch varied between 0.1 and 1370 kg.

Herring was mainly found in the north-eastern part of the area, but also on some spots in the west of the investigation area, while sprat was concentrated in warmer water close to the Frisian, English and Dutch coasts. Almost no fish could be observed in water colder than 10°C in the central north. The summer southern distribution limit for sprat in the Channel might have been reached.

24 species have been caught (mean 4 species per haul). Highest presence was recorded for grey gurnard (in 26 of 41 hauls), sprat (25) (21), herring (17) and mackerel (15). The main share of the total catch of approx. 5.6 tons could be attributed to sprat (72%), mackerel (8%), and herring (7%). (Table 3).

3.3 Biomass and abundance estimates

The total biomass estimates for the survey:

Total herring	**77'600 t**	(2004: 173'700 t)
Spawning stock biomass	168 t / 0.2%	(2004: 2'400 t / 1.4%)
Total sprat	**513'200 t**	(2004: 359'600 t tonnes)
Spawning stock biomass	360'700 t / 70%	(2004: 174'200 t / 48%)

The total abundance estimates for the survey:

Total herring	**6'600 mill**.	(2004: 13'800 mill.)
Spawning stock abundance	7.5 mill. / 0.1%	(2004: 0.02 mill. / 0.0%)
Total sprat	**72'500 mill.**	(2004: 51'600 mill.)
Spawning stock abundance	42'600 mill. / 28%	(2004: 14'300 mill. / 28%)

Note that these values are not directly comparable to values obtained in the last years as the survey area has been significantly altered. Compared to last year, herring abundance has halved. The age composition has again slightly changed to previous years' results. However, the vast majority (>99%) of herring in this area still consists of 0- and 1-wr (Age 1 and 2). Sprat biomass and abundance have been significantly increased as compared to 2004 and 2003. This may again be caused by a more northerly distribution of the sprat stock (and thus a better accessibility to the survey) this year. The fraction mature has also increased.

Detailed information on abundance and biomass by statistical rectangle can be found in Figure 4 and 5; abundance by age group and maturity given in Table 5 for herring, and in Table 6 for sprat.

3.4 Acoustic and visual recording of cetaceans

160 hrs of acoustic recordings and 120 hrs of visual observations were conducted. During these, four harbour porpoises and five individuals of other cetacean species have been detected. The towed hydrophone method was proven to work if the vessel's was switched off. All other work is ongoing.

3.5 Hydrographic data

Again a dense net of hydrography stations have been sampled: 74 vertical profiles have been recorded, with a maximum distance of about 30 n.mi. between any station. The water column was clearly stratified on the offshore stations in the north; surface temperatures ranged between 11° and 19°C (2004: 13.0 and 17.4°C), bottom temperatures were significantly lower (below 10 °C) when a thermocline was observed.

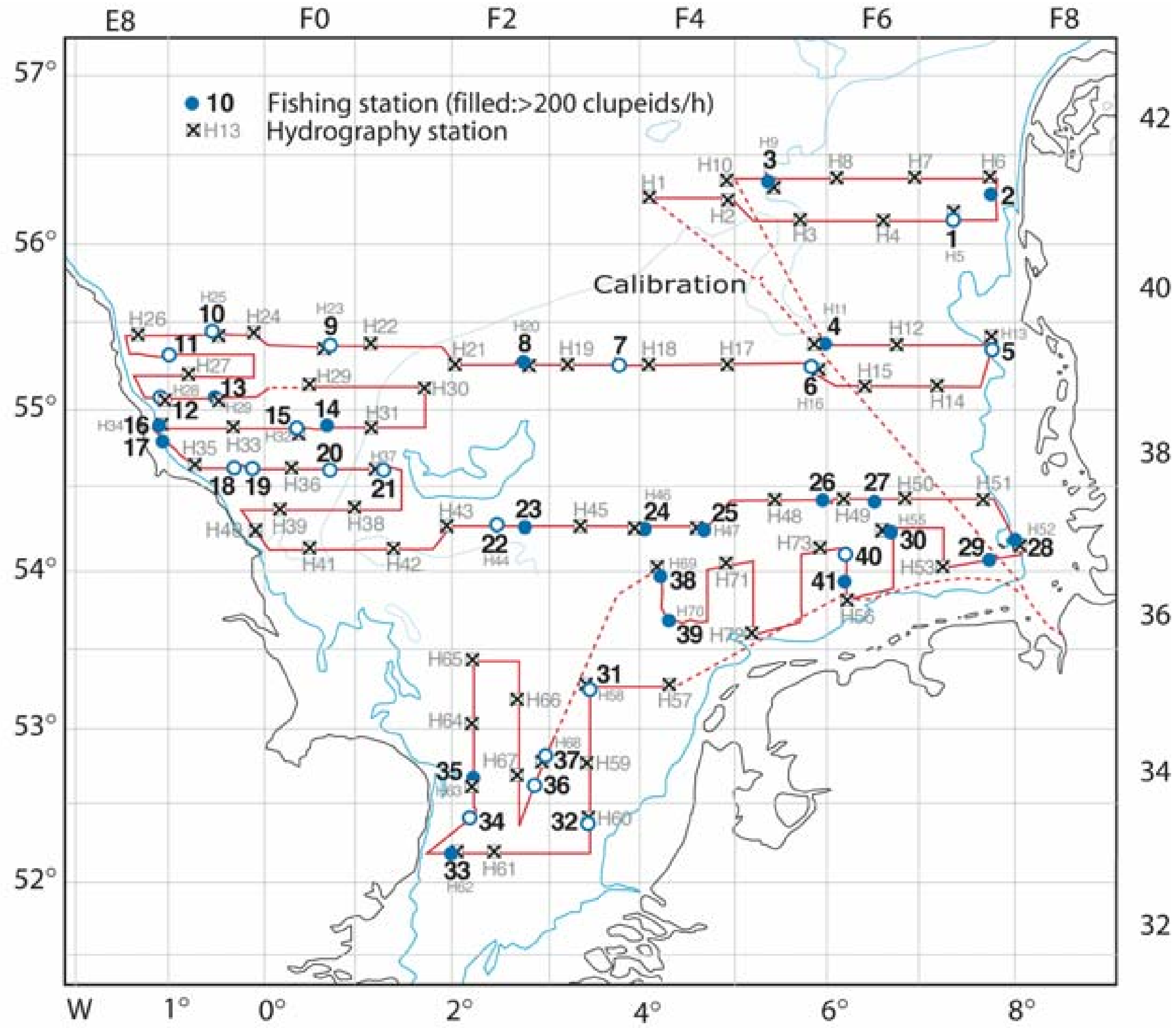

Figure 1: FRV "Solea", cruise 544: International hydroacoustic survey on herring in the North Sea, 28 June 2004 -19 July 2005: Cruise track, fishing stations and hydrographic stations. 20 and 50 m depth contour drawn.

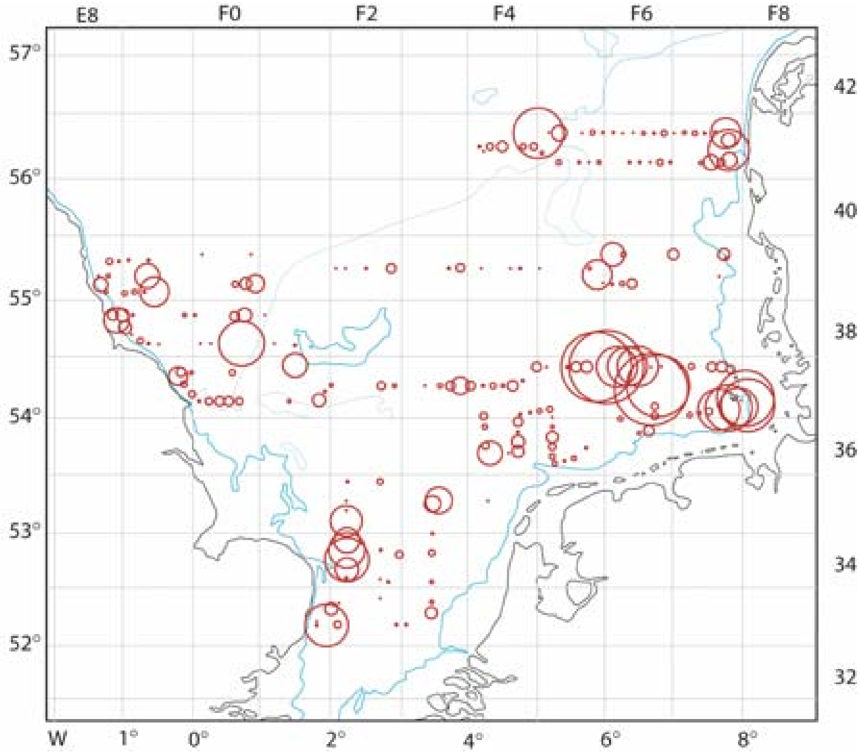

Figure 2: FRV "Solea", cruise 544: International hydroacoustic survey on herring in the North Sea, 28 June -19 July 2005: Post plot showing the distribution of total NASC values attributed to clupeoids (sum per 5 n.mi., on a proportional sq. root scale relative to the largest value of 5621 $m^2 n.mi.^{-2}$). Smallest dots indicate zero values.

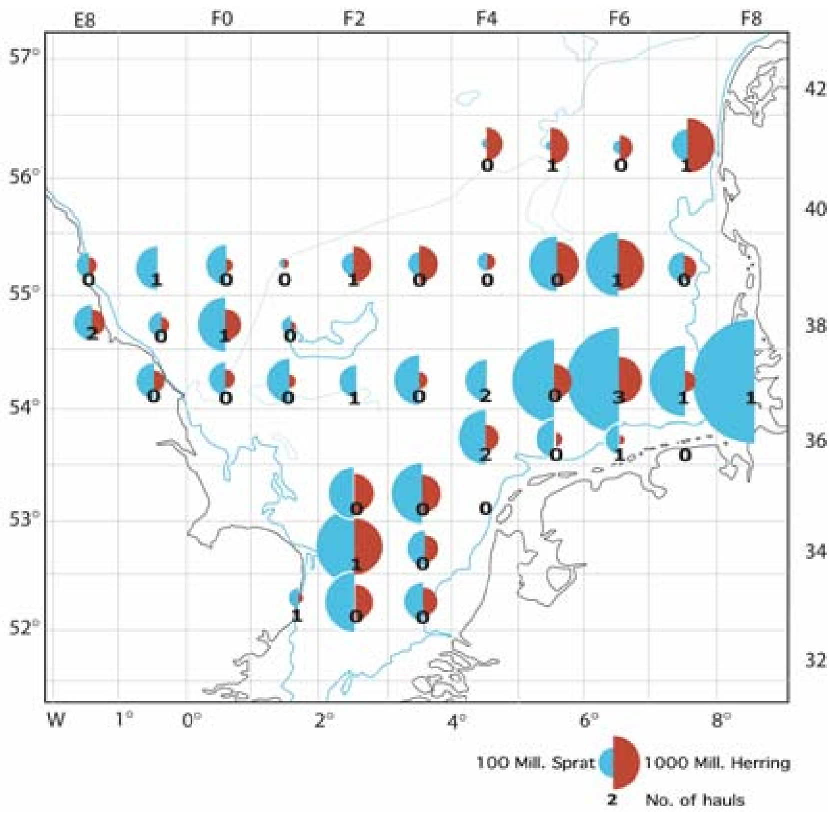

Figure 3: FRV "Solea", cruise 544: International hydroacoustic survey on herring in the North Sea, 28 June -19 July 2005: Abundance of herring and sprat (circle diameter is proportional to abundance), proportion of the two clupeoid species, and number of valid hauls per statistical rectangle.

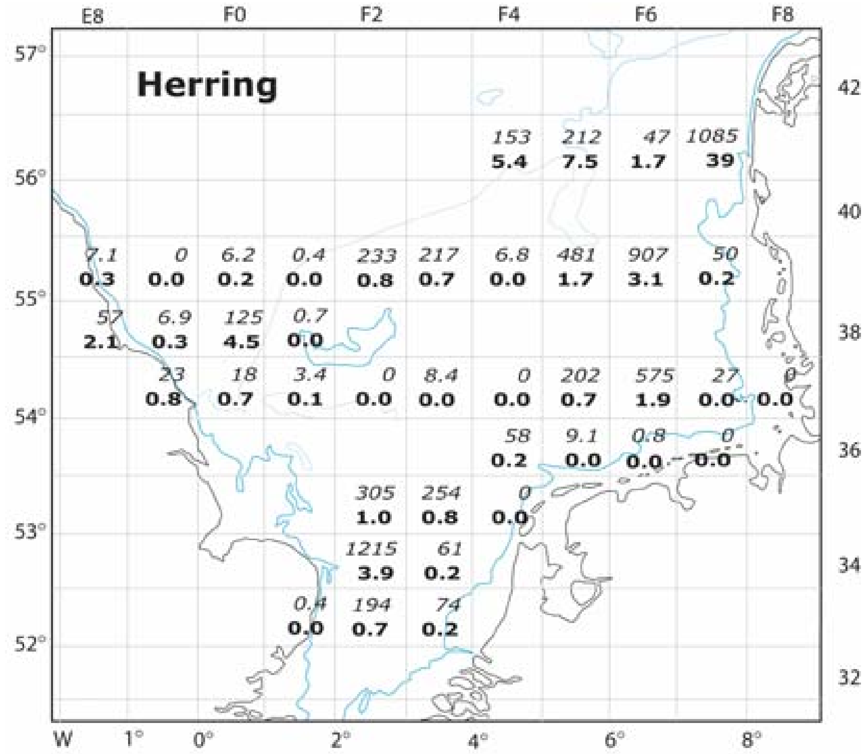

Figure 4: FRV "Solea", cruise 544: International hydroacoustic survey on herring in the North Sea, 28 June -19 July 2005: Abundance (Mill. individuals, upper value in italics) and biomass (thousand t, lower value in bold) of herring per statistical rectangle.

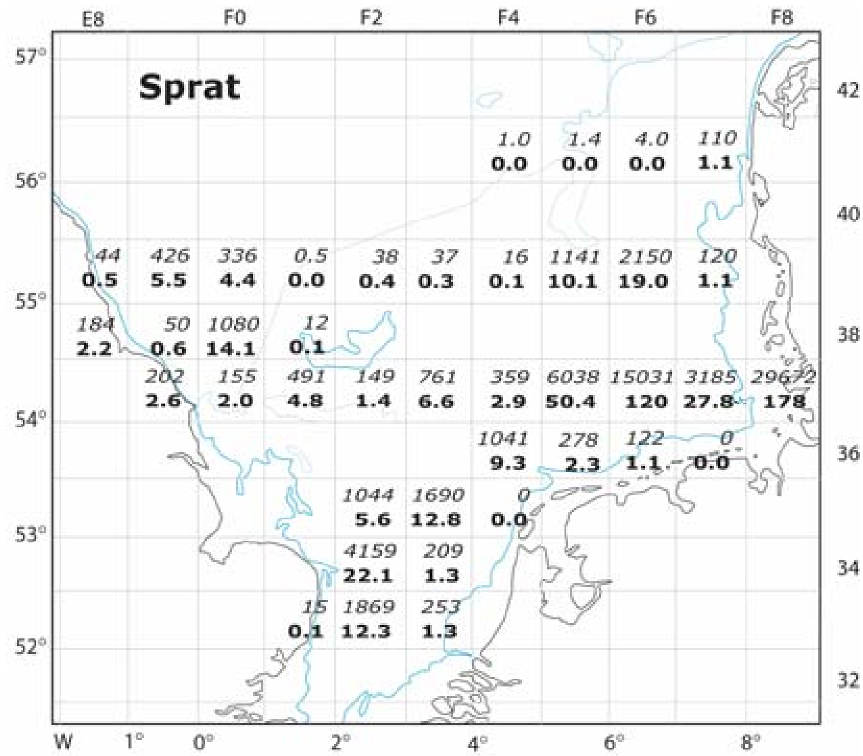

Figure 5: FRV "Solea", cruise 544: International hydroacoustic survey on herring in the North Sea, 28 June -19 July 2005: Abundance (Mill. individuals, upper value in italics) and biomass (thousand t, lower value in bold) of sprat per statistical rectangle.

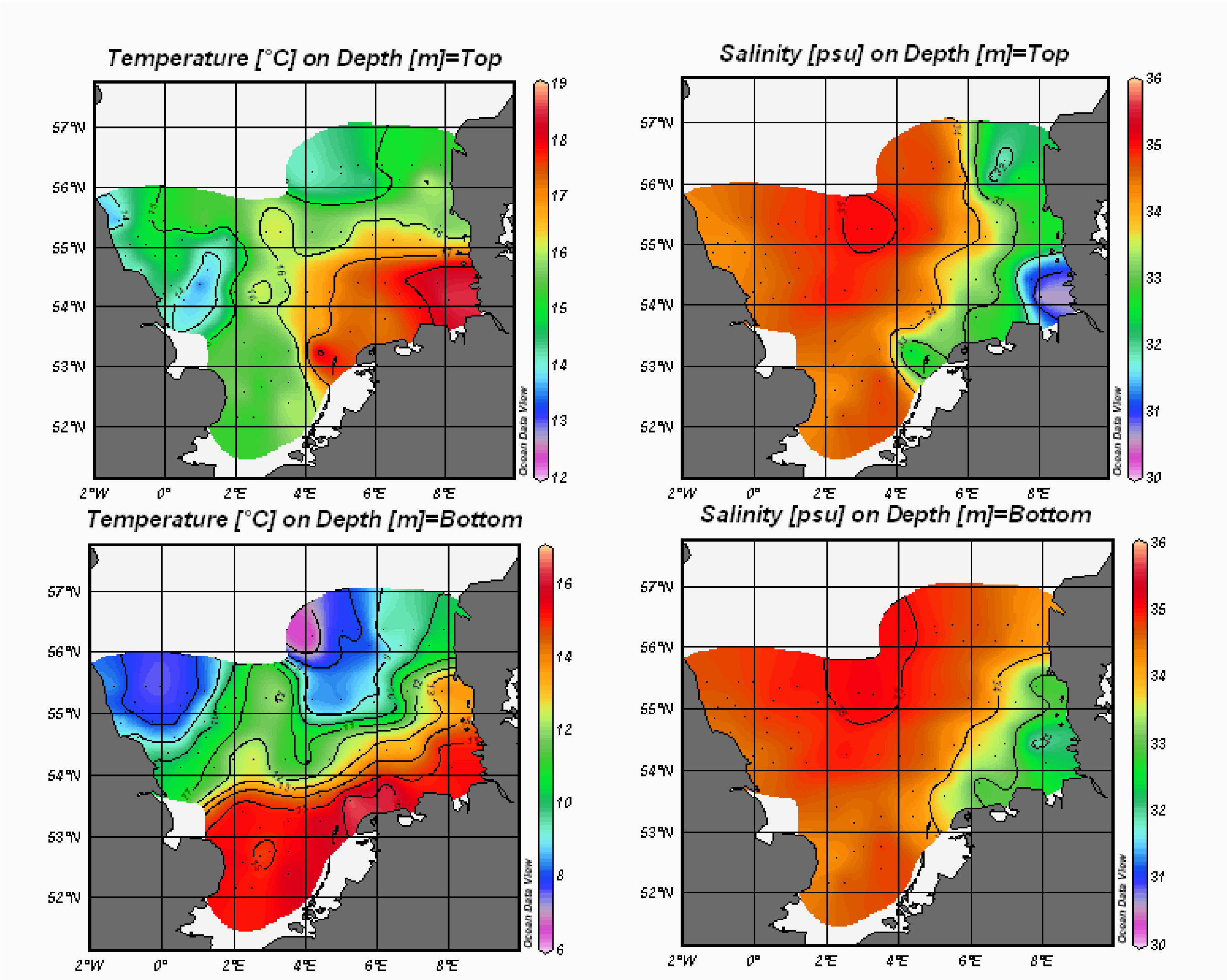

Figure 5: FRV "Solea", cruise 544: International hydroacoustic survey on herring in the North Sea, 28 June -19 July 2005: Temperature and salinity in different depth layers.

Table 1: FRV "Solea", cruise 544: International hydroacoustic survey on herring in the North Sea, 28 June - 19 July 2005: Simrad EK60 calibration report.

```
# Calibration Version 2.1.0.11
# Date: 2005-06-29
#
# Comments:
#   Dogger Bank Tail, 2. attempt, 55°50,11N 005°00,29E, Wind 4 m/s
#
# Reference Target:
#   TS                -33.40 dB     Min. Distance     14.00 m
#   TS Deviation       10.0 dB      Max. Distance     18.00 m
#
# Transducer: ES38B Serial No. 30545
#   Frequency              38000 HZ      Beamtype              Split
#   Gain                   26.50 dB      Two Way Beam Angle   -20.6 dB
#   Athw. Angle Sens.      21.90         Along. Angle Sens.    21.90
#   Athw. Beam Angle       7.10 deg      Along. Beam Angle     7.10 deg
#   Athw. Offset Angle     0.00 deg      Along. Offset Angle   0.00 deg
#   SaCorrection           0.00 dB       Depth                 0.00 m
#
# Transceiver: GPT 38 kHz 009072056b06 1 ES38B
#   Pulse Duration         1.024 ms      Sample Interval       0.191 m
#   Power                  2000 W        Receiver Bandwidth    2.43 kHz
#
# Sounder Type:
#   EK60 Version 2.1.0
#
# TS Detection:
#   Min. Value             -50.0 dB      Min. Spacing          100%
#   Max. Beam Comp.          6.0 dB      Min. Echolength        80%
#   Max. Phase Dev.          8.0         Max. Echolength       180%
#
# Environment:
#   Absorption Coeff.      9.8 dB/km     Sound velocity        1493.9 m/s
#
# Beam Model results:
#   Transducer Gain    =   26.02 dB      SaCorrection       = -0.56 dB
#   Athw. Beam Angle   =   6.88 deg      Along. Beam Angle  = 6.92 deg
#   Athw. Offset Angle =  -0.06 deg      Along. Offset Ang1e=-0.01 deg
#
# Data deviation from beam model:
#   RMS =  0.22 dB
#   Max =  0.72 dB  No. = 125  Athw. = 3.9 deg  Along =  3.2 deg
#   Min = -1.25 dB  No. = 161  Athw. = 1.9 deg  Along = -0.9 deg
#
# Data deviation from polynomial model:
#   RMS =  0.21 dB
#   Max =  0.52 dB  No. = 125  Athw. = 3.9 deg  Along =  3.2 deg
#   Min = -1.16 dB  NO. = 160  Athw. = 1.0 deg  Along = -1.5 deg
```

Table 2: FRV "Solea", cruise 544: International hydroacoustic survey on herring in the North Sea, 28 June – 19 July 2005: Trawl station data.

Stat	Haul	Rect	Date	Time of day (hhmm UTC)	Trawl	ShotPosLat (°°MM.MM)	ShotPosLon (°°MM.MM)	Water Depth (m)	Catch Depth (m)	Catch Time (min)
490	1	41F7	20050630	1448	PSN388	560653N	0072198E	26	11	30
493	2	41F7	20050701	0528	PSN388	561517N	0074995E	24	10	30
496	3	41F5	20050701	1439	PSN388	562242N	0052462E	55	48	30
500	4	39F6	20050702	0517	PSN388	552212N	0060103E	50	40	15
503	5	39F7	20050702	1215	PSN388	552012N	0074812E	22	11	30
506	6	39F5	20050703	0639	PSN388	551345N	0055204E	45	38	30
510	7	39F3	20050703	1514	PSN388	551486N	0034843E	42	30	30
512	8	39F2	20050704	0606	PSN388	551499N	0024903E	32	22	30
516	9	39F0	20050704	1409	PSN388	552172N	0004520E	100	55	32
519	10	39E9	20050705	0827	PSN388	552622N	0003173W	68	54	32
522	11	39E9	20050705	1505	PSN388	551887N	0005825W	97	67	30
524	12	39E8	20050706	1043	PSN388	550287N	0010629W	86	71	30
526	13	39E9	20050706	1404	PSN388	550289N	0002968W	72	62	15
531	14	38F0	20050707	1323	PSN388	545190N	0004312E	82	72	31
532	15	38F0	20050707	1513	PSN388	545184N	0002284E	81	70	30
535	16	38E8	20050708	0649	PSN388	545184N	0010453W	55	46	30
537	17	38E8	20050708	0840	PSN388	544761N	0010330W	48	37	30
539	18	38E9	20050708	1310	PSN388	543713N	0001673W	66	56	30
540	19	38E9	20050708	1436	PSN388	543687N	0000582W	64	43	47
541	20	38F0	20050709	0518	PSN388	543677N	0004421E	70	56	30
543	21	38F1	20050709	0815	PSN388	543687N	0011740E	36	24	31
551	22	37F2	20050710	1257	PSN388	541503N	0022882E	37	25	30
553	23	37F2	20050710	1458	PSN388	541490N	0024921E	49	38	30
555	24	37F4	20050711	0639	PSN388	541460N	0040539E	49	40	31
557	25	37F4	20050711	1108	PSN388	541491N	0044368E	47	39	30
561	26	37F6	20050712	0514	PSN388	542458N	0060256E	40	20	30
562	27	37F6	20050712	0759	PSN388	542491N	0063293E	38	27	15
565	28	37F8	20050713	0510	PSN388	541036N	0080323E	26	15	33
567	29	37F7	20050713	0743	PSN388	540302N	0074502E	37	27	20
569	30	37F6	20050713	1318	PSN388	541344N	0064432E	37	25	30
574	31	35F3	20050714	0711	PSN388	531433N	0033011E	26	16	34
576	32	33F3	20050714	1302	PSN388	522135N	0032963E	31	19	30
579	33	33F1	20050715	0607	PSN388	521023N	0015878E	39	31	31
581	34	33F2	20050715	1009	PSN388	522409N	0021331E	46	35	31
583	35	34F2	20050715	1236	PSN388	524010N	0021536E	43	32	30
588	36	34F2	20050716	1300	PSN388	523671N	0025444E	38	25	30
589	37	34F3	20050716	1459	PSN388	524807N	0030204E	39	27	30
592	38	36F4	20050717	0511	PSN388	535674N	0041570E	43	31	30
593	39	36F4	20050717	0745	PSN388	533980N	0042001E	37	30	30
598	40	37F6	20050718	0757	PSN388	540513N	0061496E	31	22	34
599	41	37F6	20050718	1009	PSN388	535573N	0061328E	30	18	20

Table 3: FRV "Solea", cruise 544: International hydroacoustic survey on herring in the North Sea, 28 June – 19 July 2005: 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	Haul	*Alloteuthis spp.*	*Alopias vulpinus*	*Alosa fallax*	*Ammodytes marinus*	*Arnoglossus laterna*	*Belone belone*	*Callionymus lyra*	***Clupea harengus***	*Echiichthys vipera*	***Engraulis encrasicolus***	*Entelurus aequoreus*	*Eutrigla gurnadus*	*Gadus morhua*	*Hyperoplus lanceolatus*	*Lampetra fluviatilis*	*Limanda limanda*	*Loligo forbesi*	*Merlangius merlangus*	*Pleuronectes platessa*	*Pomatoschistus minutus*	*Salmo salar*	***Sardina pilchardus***	*Scomber scombrus*	***Sprattus sprattus***	*Trachurus trachurus*	*Trisopterus luscus*	**Total**	No of Species	Herring (n in 60min haul)	Herring (% of clupeid catch)	Sprat (n in 60min haul)	Sprat (% of clupeid catch)	**Number of clupeids / 60min**
490	1												12.4										0.082	537.6		3.9		**553.9**	4	0	0	0	0	2
493	2				0.031				177.7				4.1		1.356									2.0	10.0			**195.2**	6	13544	95	1378	5	14922
496	3				0.014				43.5				0.1	0.166	0.08				0.002						0.2			**44.0**	7	3064	100	20	0	3084
500	4								102.7				1.6												436.6			**540.9**	3	113376	19	268792	81	382168
503	5												0.1											0.1				**0.2**	2					0
506	6								1.4				0.7					0.002	0.001									**2.1**	4	102	100	0	0	102
510	7				0.002				0.4				5.3						0.02									**5.8**	4	50	100	0	0	50
512	8								3.3					0.192				0.006							1.6			**5.0**	4	2064	68	334	32	2398
516	9												3.3															**3.3**	1					0
519	10												0.7															**0.7**	1					0
522	11																												0					0
524	12											0.006							1.384					0.9				**2.3**	3					0
526	13	0.008											0.5					0.001	0.412						67.3			**68.3**	5	0	0	17852	100	17852
531	14								8.3				0.2												30.9			**39.4**	3	447	21	3859	79	4306
532	15												0.1															**0.1**	1					0
535	16								52.9	0.11									0.982						87.1			**141.1**	4	1888	38	14212	62	16100
537	17								93.7	0.08			1.1						0.232						20.8			**115.9**	5	3494	82	3302	18	6796
539	18									0.32		0.002	1.6						0.418									**2.3**	4					0
540	19									0.04			2.3						0.26									**2.6**	3					0
541	20									0.02			12.4						0.192					0.1	0.0			**12.8**	5	0	0	6	100	6
543	21				109.4																							**109.4**	1					0
551	22									0.07			1.1															**1.1**	2					0
553	23				0.018								0.7					0.028	0.002						228.8			**229.6**	5	0	0	44708	100	44708
555	24												0.4												197.0			**197.4**	2	0	0	61866	100	61866
557	25												0.7												112.0			**112.8**	2	0	0	25878	100	25878
561	26			0.452					40.2															0.4	1317.7			**1358.7**	4	23846	3	428788	97	452634
562	27												0.3												19.5			**19.7**	2	0	0	8172	100	8172
565	28				0.024						2.252		0.1											2.2	90.1			**94.6**	5	0	0	23258	98	23345
567	29								4.0				0.1												819.1			**823.2**	3	2583	0	302217	100	304800
569	30			0.822		0.008	0.358	0.038	14.3				0.2				0.12		0.052	0.066					1352.0	2.5		**1370.4**	11	7706	1	387978	99	395684
574	31									0.02									0.002	0.148				0.1	0.6			**0.9**	5	0	0	72	100	72
576	32				11.03					0.61					0.05									0.6				**12.3**	4					0
579	33		180						14.3	0.32									0.182					46.2	285.5			**526.5**	6	2212	5	81246	95	83458
581	34								1.3	1.38									0.964					1.3	0.6			**5.6**	5	17	69	64	31	81
583	35			0.548					6.2	3.76									0.096		0.024	0.54			51.3		0.002	**62.5**	8	8482	11	33376	89	41858
588	36									0.19									0.006									**0.2**	2					0
589	37									0.14									0.032					0.1				**0.3**	3					0
592	38												0.1												154.8	0.2		**155.0**	3	0	0	31332	100	31332
593	39								4.4								0.146							7.6	38.6	527.9		**578.7**	5	2438	10	12334	90	14772
598	40				18.91								0.4						0.004					0.4	0.0	0.1		**19.8**	6	0	0	2	100	2
599	41			0.26					3.3						1.058	0.036								3.6	249.2	32.2		**289.6**	7	582	1	84405	99	84987
Total		0.008	180	2.082	139.4	0.008	0.358	0.038	571.9	7.06	2.252	0.008	50.4	0.358	2.544	0.036	0.266	0.037	5.243	0.214	0.024	0.54	0.082	603.2	5571.3	566.7	0.002	**7704**	26	4357	9	53219	91	57576

Table 4a: FRV "Solea", cruise 544: International hydroacoustic survey on herring in the North Sea, 28 June – 19 July 2005: Herring length frequency proportion (%) by trawl haul. Length in cm.

Stat		493	496	500	506	510	512	531	535	537	561	567	569	579	581	583	593	599
Haul		2	3	4	6	7	8	14	16	17	26	29	30	33	34	35	39	41
Length/Rect	Total	41F7	41F5	39F6	39F5	39F3	39F2	38F0	38E8	38E8	37F6	37F7	37F6	33F1	33F2	34F2	36F4	37F6
4.75	**0.1**															2		
5.25	**0.4**															7		
5.75	**1.9**															29		
6.25	**2.4**		0			8	1						7			36	4	
6.75	**1.3**		1	5		20	11				11		21			11	15	
7.25	**6.0**		1	34		16	52				37		29			4	27	
7.75	**24.9**		2	41		8	32				32		29				28	20
8.25	**26.8**			18			4				21	83	7	8			20	
8.75	**14.5**			2			1							17		7	5	40
9.25	**1.4**											17	7	17			1	
9.75	**1.3**													25		4	1	
10.25	**0.5**													25				
10.75	**0.4**																	
11.25	**0.0**																	
11.75	**0.0**																	
12.25	**0.0**																	20
12.75	**0.1**	1																
13.25	**0.1**	6						0										
13.75	**0.6**	26	1		2													
14.25	**2.8**	35	6	1	4			2										
14.75	**4.2**	24	26		45	8		7										
15.25	**3.2**	6	37		39	4		16	2	0								
15.75	**1.6**	1	22		10	12		31	1									
16.25	**0.8**		4			24		17	3	0				8				
16.75	**0.4**	1						12	1	2								
17.25	**0.2**							4	3	4								
17.75	**0.2**							6	4	12								
18.25	**0.4**							3	13	24								
18.75	**0.9**							0	30	29								
19.25	**1.3**							0	20	21								
19.75	**0.9**								16	4								
20.25	**0.4**								4	2								
20.75	**0.1**								2	0					11			
21.25	**0.0**																	
21.75	**0.0**								1									
22.25	**0.0**								1									
22.75	**0.0**																	
23.25	**0.0**																	
23.75	**0.0**																	
24.25	**0.0**														11			
24.75	**0.0**														22			
25.25	**0.0**								1									
25.75	**0.0**														44			
26.25	**0.0**																	
26.75	**0.0**																	
27.25	**0.0**																	
27.75	**0.0**														11			
Total n ('000)	**64.1**	6.8	1.5	28.3	0.1	0.0	1.0	0.2	0.9	1.7	11.9	0.9	3.9	1.1	0.0	4.2	1.2	0.2
mean length	**12.7**	14.8	15.4	8.2	15.5	11.7	7.9	16.6	19.3	19.1	8.1	8.9	7.9	10.5	25.5	6.4	8.1	11.8

Table 4b: FRV "Solea", cruise 544: International hydroacoustic survey on herring in the North Sea, 28 June -19 July 2005: Sprat length frequency proportion (%) by trawl haul. Length in cm.

Stat		493	496	500	512	526	531	535	537	541	553	555	557	561	562	565	567	569	574	579	581	583	592	593	598	599
Haul		2	3	4	8	13	14	16	17	20	23	24	25	26	27	28	29	30	31	33	34	35	38	39	40	41
Length/Rect	Total	41F7	41F5	39F6	39F2	39E9	38F0	38E8	38E8	38F0	37F2	37F4	37F4	37F6	37F6	37F8	37F7	37F6	35F3	33F1	33F2	34F2	36F4	36F4	37F6	37F6
3.75	**0.0**																					1				
4.25	**0.0**																					2				
4.75	**0.1**																					4				
5.25	**0.1**																					3				
5.75	**0.0**																					2				
6.25	**0.0**																					1				
6.75	**0.0**																					2				
7.25	**0.3**											0						0				10				
7.75	**1.3**			1								4		0				0				37		0		
8.25	**3.9**			3								13		6				1		9		25		8		
8.75	**13.4**			33								19	2	23	1		3	6		25		6		15		1
9.25	**24.2**			32					1		0	23	6	29	3	9	31	24		28		3	0	27		13
9.75	**24.0**			19	2						3	16	18	22	10	64	46	26		9		1	3	30		29
10.25	**15.3**			8	17			1	4		15	12	21	14	20	22	18	21		8		1	20	14		17
10.75	**7.6**	4		3	47		1	4	12	33	29	6	22	4	29	4	2	12		6		1	35	3	100	10
11.25	**5.0**	23	50	2	25	6	6	20	30	33	30	3	17	0	24			7	2	8			21	0		11
11.75	**2.6**	43			4	20	30	32	26	33	15	1	8	0	10			1	15	5			14	1		12
12.25	**1.3**	25			2	33	28	29	16		5	2	5		1				22	2	9		4	0		5
12.75	**0.5**	3			2	25	20	8	7		1	0	1						41		9		3			2
13.25	**0.2**	2				10	9	5	2		1		0						17		39		1			1
13.75	**0.1**					4	5		1		0										30					
14.25	**0.0**		50			1	1		1										2		12					
14.75	**0.0**								1																	
Total n ('000)	**783.2**	0.7	0.0	67.2	0.2	4.5	2.0	7.1	1.7	0.0	22.4	32.0	12.9	214.4	2.0	12.8	100.7	194.0	0.0	42.0	0.0	16.7	15.7	6.2	0.0	28.1
mean length	**10.8**	11.8	12.8	9.3	10.9	12.4	12.3	11.9	11.6	11.3	11.1	9.4	10.6	9.4	10.7	9.9	9.7	9.9	12.6	9.6	13.4	7.6	11.0	9.5	10.8	10.5

Table 5: FRV "Solea", cruise 544: International hydroacoustic survey on herring in the North Sea, 28 June -19 July 2005: Age/maturity-length key for herring (sampled numbers not raised to the abundance in the survey area

WR:	0	1	1	2	2	3	4	5	6	
Maturity:	i	i	m	i	m	m	m	m	m	
Length (cm)										Sum
4.75	1									1
5.25	3									3
5.75	9									9
6.25	11									11
6.75	21									21
7.25	43									43
7.75	50									50
8.25	48									48
8.75	43									43
9.25	16									16
9.75	9									9
10.25	4									4
10.75	3									3
12.75	1									1
13.25		3								3
13.75		8	1							9
14.25		19								19
14.75		32								32
15.25		55								55
15.75		51								51
16.25		38								38
16.75		37								37
17.25		18		1						19
17.75		22								22
18.25		19								19
18.75		18								18
19.25		12		2						14
19.75		11								11
20.25		9		2						11
20.75		8		2						10
21.25		3		1	1					5
22.25						2				2
22.75							1			1
23.75							3			3
24.25							1			1
24.75							1			1
25.25							4			4
25.75								1		1
26.25							1	3	1	5
28.25								1		1
Sum	**262**	**363**	**1**	**8**	**1**	**2**	**11**	**5**	**1**	**654**

Table 6: FRV "Solea", cruise 544: International hydroacoustic survey on herring in the North Sea, 28 June -19 July 2005: Age/maturity-length key for sprat (sampled numbers not raised to the abundance in the survey area) separately for the area west and east of 3°E.

	Stations east of 3°E (Rect. F3- F8)					Stations west of 3°E (Rect. E8-F2)					
Age	**1**	**1**	**2**	**3**	**Sum**	**1**	**1**	**2**	**2**	**3**	**Sum**
Maturity	**i**	**m**	**m**	**m**		**i**	**m**	**i**	**m**	**m**	
Length (cm]											
6.25						1					**1**
6.75						2					**2**
7.25	3				**3**	8					**8**
7.75	12	1			**13**	10					**10**
8.25	23	10			**33**	19	1				**20**
8.75	18	31			**49**	9	11				**20**
9.25	13	67			**80**	9	7				**16**
9.75	8	74			**82**	7	13		1		**21**
10.25	2	68			**70**	2	33	1	4		**40**
10.75		56	1		**57**	3	33		7		**43**
11.25		53	2		**55**	1	45		10	2	**58**
11.75		50	9		**59**		41		14	1	**56**
12.25		29	21		**50**		21		29	1	**51**
12.75		6	22		**28**		4		32	6	**42**
13.25		2	11	2	**15**		4		35	8	**47**
13.75									19	10	**29**
14.25			2		**2**					8	**8**
Sum	**79**	**447**	**68**	**2**	**596**	**71**	**213**	**1**	**151**	**36**	**472**

Annex 3: Survey Report for RV 'Solea'

04.-21.10.2005

Federal Research Centre for Fisheries, Germany

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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 coordinated within the frame of the **Baltic International Acoustic Survey.** The reported acoustic survey is conducted every year to supply the ICES:

'Herring Assessment Working Group for the Area South of 62°N (HAWG)' and

'Baltic Fisheries Assessment Working Group (WGBFAS)'

with an index value for the stock size of herring and sprat, respectively, in the Western Baltic area (Subdivisions 22, 23 and 24).

2 METHODS

2.1 Personnel

Participants/Calibration of acoustic equipment/04.-06.10.2005:

Dr. E. Bethke	Inst. for Fishing Technology and Fishery Economics, Hamburg
M. Drenckow	Inst. for Fishing Technology and Fishery Economics, Hamburg
E. Götze	Inst. for Fishing Technology and Fishery Economics, Hamburg, Cr. Leader
M. von Klinkowström	Inst. for Fishing Technology and Fishery Economics, Hamburg
M. Sasse	Inst. for Fishing Technology and Fishery Economics, Hamburg

Participants/Acoustic survey/06.-21.10.2005:

A. Gebel	Institute for Baltic Sea Fisheries, Rostock,
E. Götze	Inst. for Fishing Technology and Fishery Economics, Hamburg
Dr. T. Gröhsler	Institute for Baltic Sea Fisheries, Rostock, Cr. Leader
T. Hoth	Student, University Rostock
M. Koth	Institute for Baltic Sea Fisheries, Rostock
S.-E. Levinsky	DIFRES, Charlottenlund, Denmark

2.2 Narrative

The 548th cruise of RV "Solea" represents the 18th subsequent survey. RV "Solea" left the port of Rostock/Warnemünde on 4 October 2005. The joint German-Danish acoustic survey covered the area of Subdivisions 21, 22, 23 and 24. The survey ended on 21 October 2005 in Rostock/Marienehe.

2.3 Survey design

The ICES statistical rectangles were used as strata for all Subdivisions (ICES 2003). The area was 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 zigzag track was used to cover all depth strata regularly. The survey covered an area of 13,895 n.mi.[2]. The cruise track (Figure 1) totally reached a length of 1,356 nautical miles.

2.4 Calibration

The hull mounted transducer ES38B was calibrated on 5th October 2005 south of Isle of Moen at a water depth of 21 m. The calibration procedure was carried out as described in the 'Manual for the Baltic International Acoustic Surveys (BIAS)' (ICES 2003).

2.5 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 EK60 on 38 kHz (120 kHz). The specific settings of the hydroacoustic equipment were used as described in the 'Manual for the Baltic International Acoustic Surveys (BIAS)' (ICES 2003). The post-processing of the stored echosignals was done by EchoView 3.10. The mean volume back scattering values (s_v) 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.

2.6 Biological data – fishing stations

Trawling was done with the pelagic gear 'PSN388' in the 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. Samples of herring and sprat were frosted for additional investigations (e.g. determining sex, maturity, age). The hydrographic condition was investigated after each trawl haul by a CTP-O_2 probe.

2.7 Data analysis

The pelagic target species sprat and herring are usually distributed in mixed layers in combination with other species so that the integrator readings cannot be allocated 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 acoustic cross section σ was calculated according to the following target strength-length (TS) relation:

Clupeoids	TS = 20 log L (cm) - 71.2	(ICES 1983)
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 (s_A) and the rectangle area, divided by the corresponding mean cross section. The total number was separated into herring and sprat according to the mean catch composition.

In accordance with the guidelines in the 'Manual for the Baltic International Acoustic Surveys (BIAS)' (ICES 2003) the further calculation was performed in the following way:

Fish species considered:

- *Aphia minuta,*
- *Engraulis encrasicolus,*
- *Gadus morhua,*
- *Gasterosteus aculeatus*,

- *Merlangius merlangius and*
- *Trachurus trachurus.*

Exclusion of trawl hauls with low catch level:

- Haul No. 24 (43G1/SD 21) and
- Haul No. 44 (39G0/SD 22).

Usage of neighbouring trawl information for rectangles, which are only containing acoustic investigations:

- 41GO (SD 21) filled with Haul No. 29 (41G1/SD21) and Haul No. 30 (41G1/SD21),
- 43G2 (SD 21) filled with Haul No. 18 (42G2/SD 21) and Haul No. 19 (43G1/SD 21),
- 37G0 (SD 22) filled with Haul No. 41 (38G0/SD 22),
- 40F9 (SD 22) filled with Haul No. 46 (40G0/SD 22),
- 40G1 (SD 22) filled with Haul No. 48 (40G0/SD 22) and
- 37G4 (SD 24) filled with Haul No. 4 (37G3/SD 24) Haul No. 5 (38G4/SD 24).

3 RESULTS

3.1 Biological data

In total 51 trawl hauls were carried out (14 hauls in Subdivision 21, 17 hauls in Subdivision 22, 4 hauls in Subdivision 23 and 16 hauls in Subdivision 24). 2,022 herring and 1,148 sprat were frozen for further investigations (e.g. determining sex, maturity, age).

The results of the catch composition by Subdivision are presented in Tables 1-4. In contrast to last years results anchovies and sardine were caught only in low numbers or were not recorded in the northern part of Subdivision 22 and southern part of the Kattegat (SD 21). For the first time a spotted snake blenny (*Leptoclinus maculatus*), which is normally distributed more northerly in cold waters, was caught in the northern part of Subdivision 22.

The length distributions of herring and sprat of the years 2004 and 2005 are presented by Subdivision in Figures 2 and 3. As in the year before, the new incoming herring year class (ca. <16 cm) is dominating in Subdivision 22 and 24. Last years high fraction of one year old herring (ca. 16-20 cm) was not detected in 2005. For the first time a higher amount of young herring occurred in the northern part of Subdivision 23.

The length distributions of sprat in 2004 and 2005 show except for the results in Subdivision 23 a complete different picture in all other areas (Figure 4). Compared to last year the contribution of young sprat (<10 cm) increased in Subdivisions 22 and 24 and decreased in Subdivision 21. The new incoming year class is in 2005 now even dominating in Subdivision 24.

3.2 Acoustic data

The survey statistics concerning the survey area, the mean s_A, the mean scattering cross section σ, the estimated total number of fish, the percentages of herring and sprat per Subdivision/rectangle are shown in Table 5.

The horizontal distribution of s_A values is quite similar compared to last year’s results and is typical for the distribution pattern in autumn:

- The highest values were observed in the Sound (SD 23), which is at the same time characterised by lower amounts of fish densities in the most northern part.

- A quite homogeneous spatial distribution was found in the Arkona Basin (SD 24).
- Higher fish concentrations were detected around Rügen Island. These high fish densities were not found last year but they were typical in former years.
- The small fish densities measured in the Belt Sea (SD 22) and in the SW Kattegat.

3.3 Abundance estimates

The total abundance of herring and sprat are presented in Table 5. The estimated number of herring and sprat by age group and Subdivision/rectangle are given in Table 6 and Table 9. The corresponding mean weights by age group and Subdivision/rectangle are shown in Table 7 and Table 10. The estimates of herring and sprat biomass by age group and Subdivision/rectangle are summarised in Table 8 and Table 11.

The herring stock was estimated to be 6.2 x 10^9 fish or about 220.4 x 10^3 tonnes in Subdivisions 21-24. For the included area of Subdivisions 22-24 the number of herring was calculated to be 5.4 x 10^9 fish or about 197.7 x 10^3 tonnes. The abundance estimates were dominated by young herring as in former years (Figure 2 and Table 6). Adult herring, which was concentrated in former years mostly in the Sound, could during the last three years also be found in deeper areas of the Arkona Sea.

The estimated sprat stock was 9.49 x 10^9 fish or 97.9 x 10^3 tonnes in Subdivisions 21-24. For the included area of Subdivisions 22-24 the number of sprat was calculated to be 7.61 x 10^9 fish or 72.6 x 10^3 tonnes. The abundance estimates of sprat were dominated as in former years (except for 2004) by young sprat (Figure 3 and Table 9).

4 DISCUSSION

The total number of herring in Subdivisions 22-24 slightly decreased by 6% compared to the results in 2004. This overall small decrease is characterised by lower numbers in all areas (Subdivision 22: -25.1%, Subdivision 23: -0.3% and Subdivision 24: -2.3%).

As in 2004 the age-groups 0-1 in numbers are the main contributors in Subdivisions 22-24 (2005: 74% and 2004: 73%).

The age groups 2-4 in numbers constitutes in 2005 as in 2004 21%. The actual contribution of the age-group 0 in Subdivisions 22-24 is 62% in numbers and 17% in biomass (2004: 56% in numbers and 13% in biomass).

The total biomass in Subdivisions 22-24 reached about the same level compared to last year (192.1 x 10^3 t). This year’s slight decrease in numbers and the increase in biomass at the same time were mainly caused by a higher fraction of older fish in Subdivision 24.

The overall abundance of sprat in the Western Baltic (Subdivisions 22-24) maintained about last years low level (2005/2004: +6%). This year’s lower abundance estimate in Subdivision 22 (-3%) was compensated by higher estimates in Subdivision 23 (+191%) and Subdivision 24 (+7%). In contrast to last years results, which were characterised by extremely low 0-group estimates, this year’s results are again dominated by the new incoming year-class (2005: 57%; 2004: 12%). The increase of the 0-group in numbers was mainly caused by higher estimates in Subdivisions 22 and 24, which were about 3.3 and 5.8 times higher than in 2004. The actual contribution of the age-group 0 in Subdivisions 22-24 is 30% in biomass (2004: 4%).

5 REFERENCES

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

ICES. 2003. Report of the Baltic International Fish Survey Working Group. ICES CM 2003/G:05 Ref.: D, H.: Annex 3.

Foote, K.G., Aglen, A. and Nakken, O. 1986. Measurement of fish target strength with a split-beam echosounder. J.Acoust.Soc.Am. 80(2): 612–621.

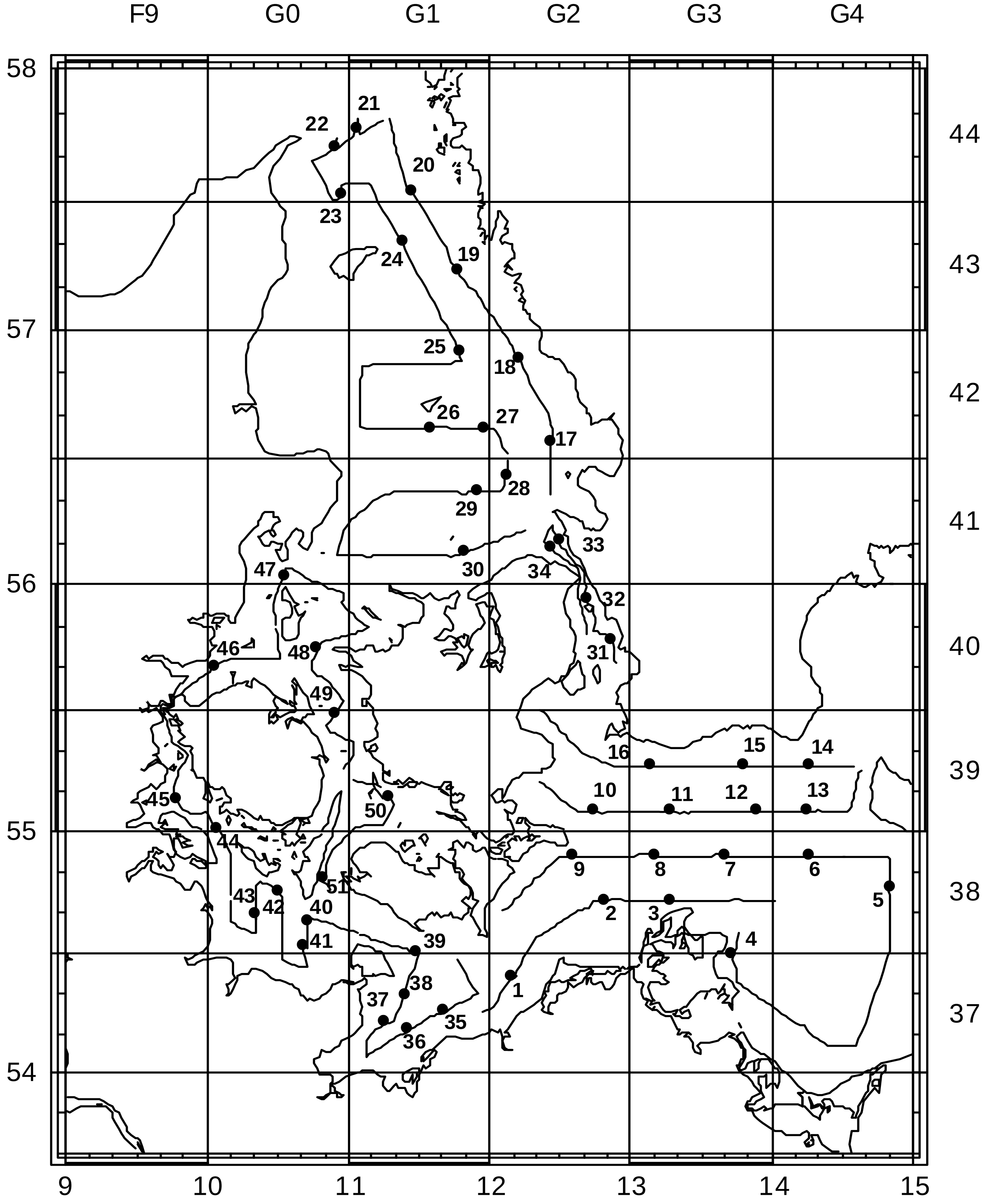

Figure 1: Cruise track and trawl positions of RV "Solea"in October 2005.

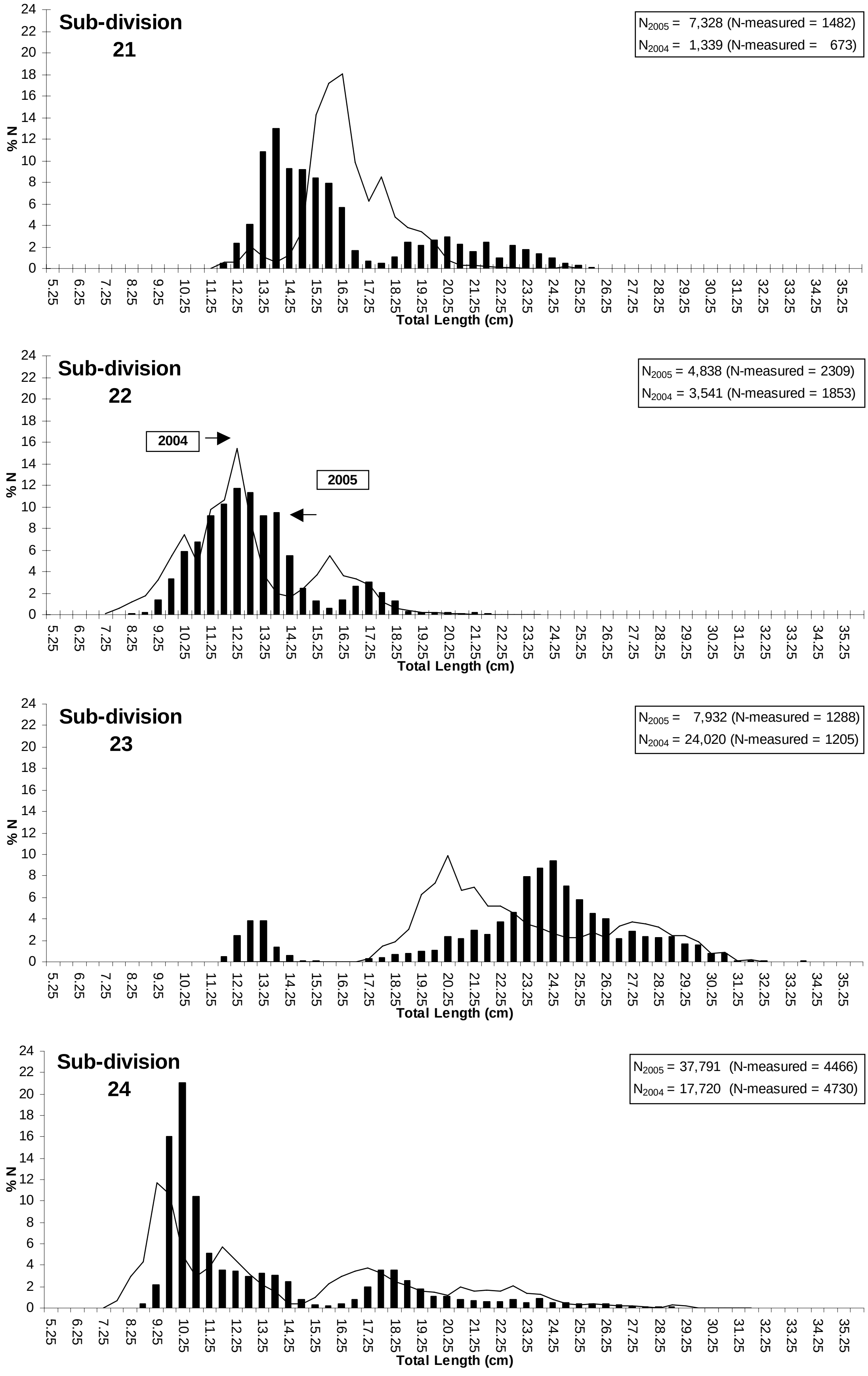

Figure 2 Length distribution of herring in Sub-divisions 21, 22, 23 and 24 in 2004 (=line) and in 2005 (=bar)

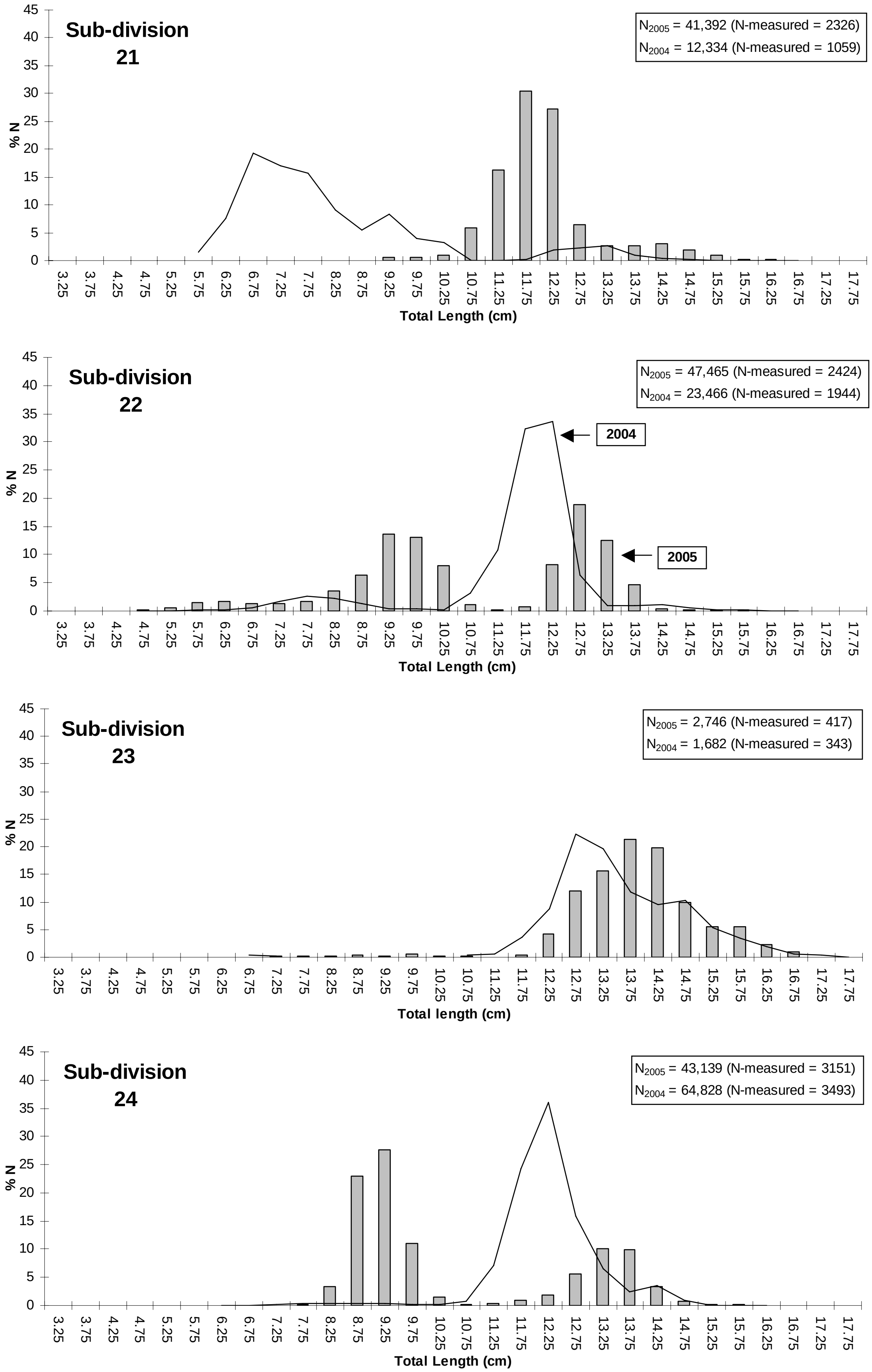

Figure 3 Length distribution of sprat in Sub-divisions 21, 22, 23 and 24 in 2004 (=line) and in 2005 (=bar)

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

Haul No.	Hol 17	Hol 18	Hol 19	Hol 20	Hol 21	Hol 22	Hol 23	Hol 24	Hol 25
Species/ICES Rectangle	42G2	42G2	43G1	44G1	44G1	44G0	44G0	43G1	42G1
APHIA MINUTA	0.04	+	+	+	+	+		+	+
BELONE BELONE						0.30			
MACROPIPUS HOLSATUS			0.01	+		0.02	0.06		
CLUPEA HARENGUS	4.09	0.05	14.03	46.50	0.25	0.16	28.72	0.53	6.89
CYCLOPTERUS LUMPUS					1.89				
ELEDONE				0.02					0.01
ENGRAULIS ENCRASICOLUS	0.16		0.19	0.03	0.06	0.29			
ENTELURUS AEQUOREUS						+			
EUTRIGLA GURNARDUS				0.11					
GADUS MORHUA									
GASTEROSTEUS ACULEATUS						+			
LIMANDA LIMANDA									
LOLIGO FORBESI		0.01		0.03	1.12	0.70		0.03	0.52
MAUROLICUS MUELLERI						+			
MERLANGIUS MERLANGUS	0.17	0.93	0.01	1.96	0.52	1.09	0.15	0.23	6.36
MERLUCCIUS MERLUCCIUS	+	0.10							
MYSIDACEA			+	+					0.01
PLEURONECTES PLATESSA						0.13			
POMATOSCHISTUS MINUTUS		+	+	+	+	+		0.01	
SCOMBER SCOMBRUS				0.36		0.10	0.42		0.36
SPRATTUS SPRATTUS	28.75	2.29	0.69	2.57	3.52	86.10	250.92	0.17	8.08
SYNGNATHUS ROSTELLATUS				+					
TRACHINUS DRACO	0.10	0.22				0.09			11.83
TRACHURUS TRACHURUS	0.15	0.24	0.06	0.29	0.09	0.05	0.06	0.02	0.06
Total	**33.46**	**3.84**	**14.99**	**51.87**	**7.45**	**89.03**	**280.33**	**0.99**	**34.12**
Medusae	0.0	3.2	2.8	2.4	0.8	0.0	1.1	0.0	1.3

Haul No.	Hol 26	Hol 27	Hol 28	Hol 29	Hol 30	Total
Species/ICES Rectangle	42G1	42G1	41G2	41G1	41G1	
APHIA MINUTA	+		+		+	**0.04**
BELONE BELONE						**0.30**
MACROPIPUS HOLSATUS						**0.09**
CLUPEA HARENGUS	0.12	1.73	1.14	124.24	1.92	**230.37**
CYCLOPTERUS LUMPUS						**1.89**
ELEDONE		+			0.01	**0.04**
ENGRAULIS ENCRASICOLUS	2.15	0.74	0.03	0.81	0.04	**4.50**
ENTELURUS AEQUOREUS						+
EUTRIGLA GURNARDUS		0.11				**0.22**
GADUS MORHUA		5.05				**5.05**
GASTEROSTEUS ACULEATUS						+
LIMANDA LIMANDA				0.03		**0.03**
LOLIGO FORBESI	0.05	0.14	0.13		0.21	**2.94**
MAUROLICUS MUELLERI						+
MERLANGIUS MERLANGUS	0.10	3.76	0.01	1.16	0.09	**16.54**
MERLUCCIUS MERLUCCIUS						**0.10**
MYSIDACEA						**0.01**
PLEURONECTES PLATESSA						**0.13**
POMATOSCHISTUS MINUTUS	+	+	+		0.01	**0.02**
SCOMBER SCOMBRUS		67.60				**68.84**
SPRATTUS SPRATTUS	0.42	59.40	35.15	76.81	0.86	**555.73**
SYNGNATHUS ROSTELLATUS						+
TRACHINUS DRACO	0.50	1.12	0.86	3.07	0.42	**18.21**
TRACHURUS TRACHURUS	0.06	0.06	0.18	0.05	0.07	**1.44**
Total	**3.40**	**139.71**	**37.50**	**206.17**	**3.63**	**906.49**
Medusae	2.1	0.0	0.7	2.0	2.0	**18.2**

+ = < 0.01 kg

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

Haul No.	Hol 35	Hol 36	Hol 37	Hol 38	Hol 39	Hol 40	Hol 41	Hol 42	Hol 43
Species/ICES Rectangle	37G1	37G1	37G1	37G1	38G1	38G0	38G0	38G0	38G0
AGONUS CATAPHRACTUS						0.01			
APHIA MINUTA									
CHELON LABROSUS	30.02								
CLUPEA HARENGUS	7.32	4.38	2.18	14.04	5.58	0.70	7.57	5.92	19.19
ENGRAULIS ENCRASICOLUS		0.04		0.08	0.04	0.04	0.20		0.13
GADUS MORHUA	20.53	30.70	44.86	1.17		0.01	15.46	0.06	4.65
GASTEROSTEUS ACULEATUS					+		+		
LEANDER									
LEPTOCLINUS MACULATUS									
LIMANDA LIMANDA						0.57	0.73	0.06	
LOLIGO FORBESI						+			
MERLANGIUS MERLANGUS	2.19	0.51	42.64	0.54	0.01		0.29		
MULLUS SURMULETUS									
MYOXOCEPHALUS SCORPIUS									
PLATICHTHYS FLESUS									
POMATOSCHISTUS MINUTUS					+	+			
SCOMBER SCOMBRUS				0.42					
SPRATTUS SPRATTUS	0.92	29.10	93.75	99.39	0.01	0.21	7.83	0.93	128.13
SYNGNATHUS ROSTELLATUS									
TRACHINUS DRACO									
TRACHURUS TRACHURUS		0.03	0.09		0.04	0.01	0.73	0.06	
TRISOPTERUS ESMARKI									
ZOARCES VIVIPARUS									
Total	**60.98**	**64.76**	**183.52**	**115.64**	**5.68**	**1.55**	**32.81**	**7.03**	**152.10**
Medusae	7.9	7.1	15.8	11.3	6.6	10.2	1.8	5.0	2.5

Haul No.	Hol 44	Hol 45	Hol 46	Hol 47	Hol 48	Hol 49	Hol 50	Hol 51	Total
Species/ICES Rectangle	39G0	39F9	40G0	41G0	40G0	39G0	39G1	38G0	
AGONUS CATAPHRACTUS									**0.01**
APHIA MINUTA				0.25	0.04	0.05	+		**0.34**
CHELON LABROSUS									**30.02**
CLUPEA HARENGUS		0.37	0.06	0.51	0.14	0.06	0.71	1.10	**69.83**
ENGRAULIS ENCRASICOLUS	0.02	0.10	0.07	0.06		0.02			**0.80**
GADUS MORHUA	0.01		0.02		0.05	0.04		8.88	**126.44**
GASTEROSTEUS ACULEATUS	0.06	0.38	0.03	+	+	+	+		**0.47**
LEANDER								+	**+**
LEPTOCLINUS MACULATUS			+						**+**
LIMANDA LIMANDA		0.14	0.04	+			0.13	0.70	**2.37**
LOLIGO FORBESI			+	+	0.07	0.05		+	**0.12**
MERLANGIUS MERLANGUS		0.15	0.26	0.05	0.04				**46.68**
MULLUS SURMULETUS				0.01					**0.01**
MYOXOCEPHALUS SCORPIUS			0.06						**0.06**
PLATICHTHYS FLESUS				0.16					**0.16**
POMATOSCHISTUS MINUTUS			0.01	+	+	+	+	+	**0.01**
SCOMBER SCOMBRUS									**0.42**
SPRATTUS SPRATTUS	+	11.31	35.44	0.09	0.12	0.02	68.40	0.58	**476.23**
SYNGNATHUS ROSTELLATUS		+	+	+		+			**+**
TRACHINUS DRACO				0.01					**0.01**
TRACHURUS TRACHURUS			0.07	0.10	0.08	0.08		0.10	**1.39**
TRISOPTERUS ESMARKI				+	0.01				**0.01**
ZOARCES VIVIPARUS			0.01						**0.01**
Total	**0.09**	**12.45**	**36.07**	**1.24**	**0.55**	**0.32**	**69.24**	**11.36**	**755.39**
Medusae	2.0	1.1	0.0	1.5	10.2	3.1	3.1	20.2	**109.5**

+ = < 0.01 kg

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

Haul No. **Species/ICES Rectangle**	**Hol 31** **40G2**	**Hol 32** **40G2**	**Hol 33** **41G2**	**Hol 34** **41G2**	**Total**
APHIA MINUTA			0.01	0.01	**0.02**
MACROPIPUS HOLSATUS	0.02				**0.02**
CLUPEA HARENGUS	217.86	536.78	7.28	11.80	**773.72**
ENGRAULIS ENCRASICOLUS				0.01	**0.01**
GADUS MORHUA	30.34	41.06			**71.40**
GASTEROSTEUS ACULEATUS			+	+	**+**
LOLIGO FORBESI			0.02	+	**0.02**
MERLANGIUS MERLANGUS	1.82	5.43	0.16	+	**7.41**
POMATOSCHISTUS MINUTUS			+	+	**+**
SPRATTUS SPRATTUS	3.20	47.06	0.24	0.46	**50.96**
TRACHINUS DRACO		0.21	0.03	0.02	**0.26**
TRACHURUS TRACHURUS			0.06	0.14	**0.20**
Total	**253.24**	**630.54**	**7.80**	**12.44**	**904.02**
Medusae	0.7	0.5	2.0	1.9	**5.2**

+ = < 0.01 kg

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

Haul No. **Species/ICES Rectangle**	**Hol 1** **37G2**	**Hol 2** **38G2**	**Hol 3** **38G3**	**Hol 4** **37G3**	**Hol 5** **38G4**	**Hol 6** **38G4**	**Hol 7** **38G3**	**Hol 8** **38G3**	**Hol 9** **38G2**
BELONE BELONE				0.56					
CLUPEA HARENGUS	2.39	25.19	121.04	8.17	2.53	4.53	29.41	99.62	39.46
CRANGON		+							
CYCLOPTERUS LUMPUS									
ENGRAULIS ENCRASICOLUS	0.02								0.03
GADUS MORHUA	0.03	13.60	1.91		0.01	2.87	0.90		17.17
GASTEROSTEUS ACULEATUS		+		6.20	0.11	0.06	0.07	0.07	0.03
GOBIUS NIGER	+								
LIMANDA LIMANDA	0.54								0.11
MERLANGIUS MERLANGUS	0.77		1.09			0.67	5.19	4.96	0.05
OSMERUS EPERLANUS				0.06					
PLATICHTHYS FLESUS	0.25	0.16				0.15			
PLEURONECTES PLATESSA	0.20							0.60	
POMATOSCHISTUS MINUTUS		+			+		+	+	0.01
RHINONEMUS CIMBRIUS								0.06	
RUTILUS RUTILUS				0.15					
SPRATTUS SPRATTUS	1.97	1.69	92.02	42.19	4.39	27.80	114.12	3.39	8.56
TRACHURUS TRACHURUS	0.01	0.01						0.02	0.02
Total	**6.18**	**40.65**	**216.06**	**57.33**	**7.04**	**36.08**	**149.69**	**108.72**	**65.44**
Medusae	25.7	18.2	0.0	15.9	9.4	12.5	3.5	0.0	8.7

Haul No. **Species/ICES Rectangle**	**Hol 10** **39G2**	**Hol 11** **39G3**	**Hol 12** **39G3**	**Hol 13** **39G4**	**Hol 14** **39G4**	**Hol 15** **39G3**	**Hol 16** **39G3**	**Total**
BELONE BELONE								**0.56**
CLUPEA HARENGUS	45.10	103.85	8.07	25.00	55.60	134.01	50.20	**754.17**
CRANGON								**+**
CYCLOPTERUS LUMPUS		0.28						**0.28**
ENGRAULIS ENCRASICOLUS								**0.05**
GADUS MORHUA	7.66	5.77	4.48	5.79	3.77	12.06	3.63	**79.65**
GASTEROSTEUS ACULEATUS			0.08	0.02	+	+		**6.64**
GOBIUS NIGER								**+**
LIMANDA LIMANDA		0.16						**0.81**
MERLANGIUS MERLANGUS	2.68		1.37	4.57				**21.35**
OSMERUS EPERLANUS								**0.06**
PLATICHTHYS FLESUS								**0.56**
PLEURONECTES PLATESSA		0.16						**0.96**
POMATOSCHISTUS MINUTUS	0.41	0.01		+	+		+	**0.43**
RHINONEMUS CIMBRIUS								**0.06**
RUTILUS RUTILUS								**0.15**
SPRATTUS SPRATTUS	32.48	4.53	0.42	19.58	0.17	14.05	2.06	**369.42**
TRACHURUS TRACHURUS	0.07							**0.13**
Total	**88.40**	**114.76**	**14.42**	**54.96**	**59.54**	**160.12**	**55.89**	**1235.28**
Medusae	0.0	0.0	18.5	2.7	0.0	0.5	8.4	**123.8**

+ = < 0.01 kg

Table 5 Survey statistics RV "SOLEA" October 2005

Sub-division	ICES Rectangle	Area (nm²)	Sa (m²/NM²)	Sigma (cm²)	N total (million)	Herring (%)	Sprat (%)	NHerring (million)	NSprat (million)
21	41G0	108.1	52.6	1.903	29.88	35.08	48.26	10.48	14.42
21	41G1	946.8	115.2	1.903	573.10	35.08	48.26	201.06	276.59
21	41G2	432.3	148.0	1.480	432.29	1.92	96.98	8.29	419.23
21	42G1	884.2	59.7	1.994	264.69	13.06	53.28	34.58	141.02
21	42G2	606.8	111.0	1.308	514.93	3.94	61.96	20.30	319.04
21	43G1	699.0	112.5	2.056	382.41	88.89	5.76	339.92	22.03
21	43G2	107.0	103.2	2.116	52.19	44.58	24.59	23.26	12.83
21	44G0	239.9	280.0	1.325	506.97	2.99	95.66	15.16	484.96
21	44G1	580.5	133.7	1.619	479.47	44.34	40.67	212.61	195.02
	Total	4,604.6			3,235.9			865.7	1,885.1
22	37G0	209.9	282.1	1.815	326.28	40.36	50.43	131.68	164.54
22	37G1	723.3	496.6	2.430	1,477.93	24.53	71.62	362.59	1,058.44
22	38G0	735.3	88.8	1.950	334.91	48.77	45.33	163.34	151.81
22	38G1	173.2	75.0	1.436	90.46	96.21	0.40	87.03	0.36
22	39F9	159.3	92.4	0.499	295.16	0.61	94.75	1.81	279.68
22	39G0	201.7	30.9	0.334	186.64	3.79	3.03	7.07	5.66
22	39G1	250.0	69.0	0.898	192.07	0.69	99.19	1.32	190.51
22	40F9	51.3	17.7	0.765	11.87	0.03	98.99	0.00	11.75
22	40G0	538.1	26.9	0.800	180.97	1.24	52.78	2.25	95.51
22	40G1	174.5	42.3	0.533	138.37	2.46	6.56	3.40	9.07
22	41G0	173.1	43.0	0.186	400.38	1.27	0.51	5.09	2.04
	Total	3,389.7			3,635.0			765.6	1,969.4
23	40G2	164.0	2,910.1	5.975	798.77	77.12	20.86	615.99	166.60
23	41G2	72.3	859.9	1.631	381.27	75.92	6.79	289.48	25.87
	Total	236.3			1,180.04			905.47	192.47
24	37G2	192.4	199.8	1.556	247.01	41.67	42.32	102.92	104.55
24	37G3	167.7	1,198.8	0.678	2,964.83	7.60	65.44	225.45	1,940.16
24	37G4	875.1	160.9	1.037	1,357.68	16.65	64.45	226.08	875.03
24	38G2	832.9	244.3	2.512	810.10	71.77	26.19	581.41	212.13
24	38G3	865.7	556.6	1.719	2,803.74	51.77	47.48	1,451.51	1,331.15
24	38G4	1,034.8	115.9	1.509	794.80	19.32	74.64	153.52	593.25
24	39G2	406.1	183.9	1.960	381.09	42.81	55.16	163.15	210.19
24	39G3	765.0	355.4	3.581	759.17	78.49	13.40	595.90	101.74
24	39G4	524.8	192.4	3.435	293.94	72.17	26.27	212.14	77.20
	Total	5,664.5			10,412.36			3,712.08	5,445.40
22-24	Total	9,290.5			15,227.44			5,383.13	7,607.24
21-24	Total	13,895.1			18,463.37			6,248.79	9,492.38

Table 6 Estimated numbers (millions) of herring RV "SOLEA" October 2005

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total
21	41G0	5,35	2,53	2,10	0,42	0,08					10,48
21	41G1	102,55	48,63	40,30	8,15	1,44					201,07
21	41G2	6,78	1,43	0,05	0,04						8,30
21	42G1	21,78	11,04	1,45	0,32						34,59
21	42G2	9,27	4,94	5,09	1,02						20,32
21	43G1	312,82	26,38	0,54	0,18						339,92
21	43G2	10,70	5,56	5,83	1,17						23,26
21	44G0	13,75	1,42								15,17
21	44G1	204,34	7,89	0,32	0,06						212,61
	Total	687,34	109,82	55,68	11,36	1,52	0,00	0,00	0,00	0,00	865,72
22	37G0	121,67	7,66	1,83	0,21	0,22	0,09				131,68
22	37G1	269,57	72,96	13,99	3,93	0,81	1,33				362,59
22	38G0	150,49	11,28	1,41	0,08	0,06	0,02				163,34
22	38G1	86,35	0,29	0,26		0,13					87,03
22	39F9	1,74	0,07								1,81
22	39G0	7,07									7,07
22	39G1	1,32									1,32
22	40F9										0,00
22	40G0	0,76	0,73	0,64		0,13					2,26
22	40G1	1,13		1,89		0,38					3,40
22	41G0	3,07	1,30	0,05	0,34	0,34					5,10
	Total	643,17	94,29	20,07	4,56	2,07	1,44	0,00	0,00	0,00	765,60
23	40G2	1,35	59,15	207,92	133,83	84,38	52,01	47,22	18,76	11,36	615,98
23	41G2	253,64	15,44	12,82	3,93	1,76	1,14	0,54	0,15	0,04	289,46
	Total	254,99	74,59	220,74	137,76	86,14	53,15	47,76	18,91	11,40	905,44
24	37G2	89,67	9,08	1,44	1,95	0,66	0,05	0,08			102,93
24	37G3	222,85	1,20	0,79	0,48	0,05	0,06	0,02			225,45
24	37G4	202,73	14,01	4,30	3,66	0,66	0,51	0,20			226,07
24	38G2	287,69	178,24	52,94	37,56	16,89	5,41	2,54		0,13	581,40
24	38G3	1.098,04	122,49	103,97	71,62	27,04	15,06	11,25	1,21	0,84	1.451,52
24	38G4	136,13	10,08	3,20	2,83	0,55	0,43	0,16	0,15		153,53
24	39G2	100,73	31,82	15,34	9,29	3,41	1,68	0,81		0,07	163,15
24	39G3	200,62	127,46	120,67	77,29	32,39	17,10	14,42	3,16	2,79	595,90
24	39G4	84,32	23,25	34,31	35,41	15,21	8,03	9,48	1,28	0,85	212,14
	Total	2.422,78	517,63	336,96	240,09	96,86	48,33	38,96	5,80	4,68	3.712,09
22-24	Total	3.320,94	686,51	577,77	382,41	185,07	102,92	86,72	24,71	16,08	5.383,13
21-24	Total	4.008,28	796,33	633,45	393,77	186,59	102,92	86,72	24,71	16,08	6.248,85

Table 7 Herring mean weight (g) per age group RV "SOLEA" October 2005

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total
21	41G0	17,58	51,08	72,89	69,72	128,04					39,67
21	41G1	17,58	51,08	72,89	69,72	128,04					39,67
21	41G2	22,72	34,67	48,34	49,05						25,03
21	42G1	18,70	40,51	56,61	53,20						27,56
21	42G2	19,82	49,81	54,49	54,50						37,53
21	43G1	21,21	27,96	59,37	59,37						21,82
21	43G2	21,21	50,20	54,54	54,55						38,17
21	44G0	23,20	24,11								23,29
21	44G1	17,25	24,99	54,52	54,52						17,60
	Total	19,42	41,93	68,60	66,01	128,04					26,24
22	37G0	12,90	32,73	51,20	48,66	48,15	55,17				14,73
22	37G1	11,00	33,76	53,75	66,18	44,53	56,97				18,07
22	38G0	12,69	32,22	51,76	47,47	48,15	55,17				14,41
22	38G1	11,53	27,29	49,83		49,83					11,75
22	39F9	13,12	32,45	32,45							13,87
22	39G0	11,09									11,09
22	39G1	9,28									9,28
22	40F9										
22	40G0	19,22	28,51	63,92		49,83					36,71
22	40G1	14,12		64,93		49,83					46,32
22	41G0	16,46	35,60	36,66	98,00	129,00					34,47
	Total	11,87	33,46	54,66	67,42	60,53	56,83				16,20
23	40G2	11,43	68,55	99,32	123,91	159,68	178,28	193,52	211,71	239,82	129,69
23	41G2	13,12	47,04	80,54	108,11	142,01	123,53	176,37	188,92	187,04	20,85
	Total	13,11	64,10	98,23	123,46	159,32	177,11	193,33	211,53	239,64	94,89
24	37G2	8,74	33,90	44,16	37,61	34,43	40,13	41,26			12,21
24	37G3	7,59	33,76	50,59	43,29	48,55	50,32	41,81			7,97
24	37G4	9,79	34,06	46,53	36,84	38,37	49,21	40,87			12,63
24	38G2	10,06	35,93	51,68	42,54	41,95	53,83	48,42		84,97	25,40
24	38G3	8,42	36,92	63,05	75,31	88,15	94,07	121,45	155,03	102,14	21,46
24	38G4	11,00	34,00	49,02	42,59	46,52	67,06	50,34	190,00		14,38
24	39G2	9,87	36,64	60,37	56,52	51,91	58,81	53,14		84,97	24,13
24	39G3	13,60	37,14	66,74	76,41	91,73	102,63	129,16	180,58	184,98	48,83
24	39G4	12,90	36,92	74,71	96,43	113,99	117,67	142,98	169,02	131,35	57,92
	Total	9,45	36,42	63,20	71,58	83,11	94,47	122,45	172,94	156,10	26,77
22-24	Total	10,20	39,02	76,28	90,22	118,33	136,62	161,48	202,47	215,32	36,72
21-24	Total	11,78	39,42	75,61	89,52	118,41	136,62	161,48	202,47	215,32	35,27

Table 8 Herring total biomass (t) per age group RV "SOLEA" October 2005

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total
21	41G0	94,1	129,2	153,1	29,3	10,2					415,9
21	41G1	1.802,8	2.484,0	2.937,5	568,2	184,4					7.976,9
21	41G2	154,0	49,6	2,4	2,0						208,0
21	42G1	407,3	447,2	82,1	17,0						953,6
21	42G2	183,7	246,1	277,4	55,6						762,8
21	43G1	6.634,9	737,6	32,1	10,7						7.415,3
21	43G2	226,9	279,1	318,0	63,8						887,8
21	44G0	319,0	34,2								353,2
21	44G1	3.524,9	197,2	17,4	3,3						3.742,8
	Total	13.347,6	4.604,2	3.820,0	749,9	194,6	0,0	0,0	0,0	0,0	22.716,3
22	37G0	1.569,5	250,7	93,7	10,2	10,6	5,0				1.939,7
22	37G1	2.965,3	2.463,1	752,0	260,1	36,1	75,8				6.552,4
22	38G0	1.909,7	363,4	73,0	3,8	2,9	1,1				2.353,9
22	38G1	995,6	7,9	13,0		6,5					1.023,0
22	39F9	22,8	2,3								25,1
22	39G0	78,4									78,4
22	39G1	12,2									12,2
22	40F9										0,0
22	40G0	14,6	20,8	40,9		6,5					82,8
22	40G1	16,0		122,7		18,9					157,6
22	41G0	50,5	46,3	1,8	33,3	43,9					175,8
	Total	7.634,6	3.154,5	1.097,1	307,4	125,4	81,9	0,0	0,0	0,0	12.400,9
23	40G2	15,4	4.054,7	20.650,6	16.582,9	13.473,8	9.272,3	9.138,0	3.971,7	2.724,3	79.883,7
23	41G2	3.327,8	726,3	1.032,5	424,9	249,9	140,8	95,2	28,3	7,5	6.033,2
	Total	3.343,2	4.781,0	21.683,1	17.007,8	13.723,7	9.413,1	9.233,2	4.000,0	2.731,8	85.916,9
24	37G2	783,7	307,8	63,6	73,3	22,7	2,0	3,3			1.256,4
24	37G3	1.691,4	40,5	40,0	20,8	2,4	3,0	0,8			1.798,9
24	37G4	1.984,7	477,2	200,1	134,8	25,3	25,1	8,2			2.855,4
24	38G2	2.894,2	6.404,2	2.735,9	1.597,8	708,5	291,2	123,0		11,0	14.765,8
24	38G3	9.245,5	4.522,3	6.555,3	5.393,7	2.383,6	1.416,7	1.366,3	187,6	85,8	31.156,8
24	38G4	1.497,4	342,7	156,9	120,5	25,6	28,8	8,1	28,5		2.208,5
24	39G2	994,2	1.165,9	926,1	525,1	177,0	98,8	43,0		5,9	3.936,0
24	39G3	2.728,4	4.733,9	8.053,5	5.905,7	2.971,1	1.755,0	1.862,5	570,6	516,1	29.096,8
24	39G4	1.087,7	858,4	2.563,3	3.414,6	1.733,8	944,9	1.355,5	216,3	111,7	12.286,2
	Total	22.907,2	18.852,9	21.294,7	17.186,3	8.050,0	4.565,5	4.770,7	1.003,0	730,5	99.360,8
22-24	Total	33.885,0	26.788,4	44.074,9	34.501,5	21.899,1	14.060,5	14.003,9	5.003,0	3.462,3	197.678,6
21-24	Total	47.232,6	31.392,6	47.894,9	35.251,4	22.093,7	14.060,5	14.003,9	5.003,0	3.462,3	220.394,9

Table 9 Estimated numbers (millions) of sprat RV "SOLEA" October 2005

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	41G0	0,13	11,37	2,44	0,39	0,05	0,05				14,43
21	41G1	2,41	218,07	46,73	7,39	0,94	0,96	0,09			276,59
21	41G2		330,45	73,37	11,44	1,92	1,82	0,22			419,22
21	42G1	0,32	80,08	40,33	14,07	3,87	2,21	0,14			141,02
21	42G2	1,88	271,02	40,65	4,82	0,55	0,11				319,03
21	43G1		11,83	7,25	2,22	0,53	0,21				22,04
21	43G2	0,05	8,92	2,88	0,75	0,17	0,06				12,83
21	44G0	1,86	427,87	49,98	4,49	0,60	0,15				484,95
21	44G1	6,25	174,32	13,47	0,69	0,15	0,13				195,01
	Total	12,90	1.533,93	277,10	46,26	8,78	5,70	0,45	0,00	0,00	1.885,12
22	37G0	49,96	4,49	67,60	42,07	0,42					164,54
22	37G1	375,20	14,87	407,71	253,41	7,24					1.058,43
22	38G0	57,55	3,48	55,66	34,73	0,39					151,81
22	38G1	0,36									0,36
22	39F9	279,62	0,06								279,68
22	39G0	4,24	0,08	0,65	0,69						5,66
22	39G1	189,15	0,36	0,59	0,41						190,51
22	40F9	11,75	0,01								11,76
22	40G0	50,72	2,20	29,56	12,84	0,19					95,51
22	40G1	0,57	0,41	5,62	2,44	0,04					9,08
22	41G0		0,15	1,26	0,63						2,04
	Total	1.019,12	26,11	568,65	347,22	8,28	0,00	0,00	0,00	0,00	1.969,38
23	40G2	0,92	36,54	86,77	30,13	6,59	4,38		1,25		166,58
23	41G2	16,25	6,33	2,49	0,67	0,08	0,06				25,88
	Total	17,17	42,87	89,26	30,80	6,67	4,44	0,00	1,25	0,00	192,46
24	37G2	51,89	7,24	29,92	8,67	5,02	1,10			0,70	104,54
24	37G3	1.867,59	40,74	30,24	1,58						1.940,15
24	37G4	511,75	71,80	216,16	45,14	19,14	6,90			4,14	875,03
24	38G2	147,98	6,92	39,75	10,85	4,40	1,34			0,89	212,13
24	38G3	467,88	77,21	540,56	137,92	70,91	19,77			16,91	1.331,16
24	38G4	190,89	74,69	242,18	51,75	21,03	8,26			4,45	593,25
24	39G2	58,03	9,30	98,41	23,61	13,76	3,30			3,78	210,19
24	39G3	4,73	9,41	59,87	15,25	8,46	2,05			1,97	101,74
24	39G4	0,02	6,08	46,37	14,35	7,64	1,22			1,52	77,20
	Total	3.300,76	303,39	1.303,46	309,12	150,36	43,94	0,00	0,00	34,36	5.445,39
22-24	Total	4.337,05	372,37	1.961,37	687,14	165,31	48,38	0,00	1,25	34,36	7.607,23
21-24	Total	4.349,95	1.906,30	2.238,47	733,40	174,09	54,08	0,45	1,25	34,36	9.492,35

Table 10 Sprat mean weight (g) per age group RV "SOLEA" October 2005

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	41G0	4,60	13,68	15,55	17,84	19,97	22,61	28,14			14,09
21	41G1	4,60	13,68	15,55	17,84	19,97	22,61	28,14			14,09
21	41G2		14,11	15,57	17,71	19,27	23,25	28,14			14,54
21	42G1	6,38	14,08	18,31	20,50	22,39	23,87	28,14			16,31
21	42G2	5,23	12,95	14,20	15,49	17,97	20,03				13,11
21	43G1		14,56	18,50	19,83	21,11	20,03				16,59
21	43G2	4,98	13,34	17,46	19,31	20,78	20,03				14,72
21	44G0	5,84	12,14	13,21	17,03	22,28	24,00				12,29
21	44G1	5,43	10,85	12,68	18,11	25,01	26,29				10,85
	Total	5,32	12,92	15,29	18,42	21,09	23,25	28,14			13,43
22	37G0	6,46	13,69	15,04	15,50	16,71					12,52
22	37G1	6,39	13,54	16,10	16,36	19,00					12,70
22	38G0	5,83	14,01	15,06	15,34	16,71					11,60
22	38G1	5,59									5,59
22	39F9	2,80	8,65								2,80
22	39G0	1,56	14,89	14,89	14,89						4,89
22	39G1	6,58	10,40	13,25	14,89						6,63
22	40F9	5,15	8,65								5,15
22	40G0	5,45	11,67	14,69	15,33	16,71					9,80
22	40G1	10,25	11,70	14,69	15,33	16,71					14,46
22	41G0		13,02	13,99	14,60						14,11
	Total	5,33	13,39	15,78	16,10	18,71					10,41
23	40G2	7,24	15,44	18,87	22,17	23,47	22,50		28,12		19,00
23	41G2	4,65	12,98	17,64	18,62	20,31	20,19				8,38
	Total	4,79	15,08	18,84	22,09	23,43	22,47		28,12		17,57
24	37G2	4,67	12,59	15,16	16,96	19,00	15,36			16,85	10,12
24	37G3	4,79	10,03	11,51	15,09	0,00	0,00				5,01
24	37G4	4,90	12,12	14,71	15,57	16,56	14,90			16,81	8,85
24	38G2	5,56	13,11	15,36	16,34	17,19	15,65			16,79	8,55
24	38G3	5,20	13,12	15,61	16,26	17,02	15,64			16,82	11,97
24	38G4	5,60	12,48	14,75	15,49	16,41	14,86			16,77	11,66
24	39G2	5,74	13,34	15,94	16,30	16,96	16,03			16,84	13,13
24	39G3	5,66	13,02	15,64	16,54	17,25	15,76			16,85	15,23
24	39G4	7,67	13,03	16,01	17,23	17,69	16,02			16,98	16,18
	Total	4,96	12,30	15,23	16,11	16,99	15,42			16,82	8,95
22-24	Total	5,05	12,70	15,55	16,37	17,34	16,06		28,08	16,82	9,55
21-24	Total	5,05	12,87	15,52	16,50	17,53	16,82	28,00	28,08	16,82	10,32

Table 11 Sprat total biomass (t) per age group RV "SOLEA" October 2005

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	41G0	0,6	155,5	37,9	7,0	1,0	1,1				203,1
21	41G1	11,1	2.983,2	726,7	131,8	18,8	21,7	2,5			3.895,8
21	41G2		4.662,6	1.142,4	202,6	37,0	42,3	6,2			6.093,1
21	42G1	2,0	1.127,5	738,4	288,4	86,6	52,8	3,9			2.299,6
21	42G2	9,8	3.509,7	577,2	74,7	9,9	2,2				4.183,5
21	43G1		172,2	134,1	44,0	11,2	4,2				365,7
21	43G2	0,2	119,0	50,3	14,5	3,5	1,2				188,7
21	44G0	10,9	5.194,3	660,2	76,5	13,4	3,6				5.958,9
21	44G1	33,9	1.891,4	170,8	12,5	3,8	3,4				2.115,8
	Total	68,5	19.815,4	4.238,0	852,0	185,2	132,5	12,6	0,0	0,0	25.304,2
22	37G0	322,7	61,5	1.016,7	652,1	7,0					2.060,0
22	37G1	2.397,5	201,3	6.564,1	4.145,8	137,6					13.446,3
22	38G0	335,5	48,8	838,2	532,8	6,5					1.761,8
22	38G1	2,0									2,0
22	39F9	782,9	0,5								783,4
22	39G0	6,6	1,2	9,7	10,3						27,8
22	39G1	1.244,6	3,7	7,8	6,1						1.262,2
22	40F9	60,5	0,1								60,6
22	40G0	276,4	25,7	434,2	196,8	3,2					936,3
22	40G1	5,8	4,8	82,6	37,4	0,7					131,3
22	41G0		2,0	17,6	9,2						28,8
	Total	5.434,5	349,6	8.970,9	5.590,5	155,0	0,0	0,0	0,0	0,0	20.500,5
23	40G2	6,7	564,2	1.637,3	668,0	154,7	98,5		35,1		3.164,5
23	41G2	75,6	82,2	43,9	12,5	1,6	1,2				217,0
	Total	82,3	646,4	1.681,2	680,5	156,3	99,7	0,0	35,1	0,0	3.381,5
24	37G2	242,3	91,2	453,6	147,0	95,4	16,9			11,8	1.058,2
24	37G3	8.945,8	408,6	348,1	23,8					0,0	9.726,3
24	37G4	2.507,6	870,2	3.179,7	702,8	317,0	102,8			69,6	7.749,7
24	38G2	822,8	90,7	610,6	177,3	75,6	21,0			14,9	1.812,9
24	38G3	2.433,0	1.013,0	8.438,1	2.242,6	1.206,9	309,2			284,4	15.927,2
24	38G4	1.069,0	932,1	3.572,2	801,6	345,1	122,7			74,6	6.917,3
24	39G2	333,1	124,1	1.568,7	384,8	233,4	52,9			63,7	2.760,7
24	39G3	26,8	122,5	936,4	252,2	145,9	32,3			33,2	1.549,3
24	39G4	0,2	79,2	742,4	247,3	135,2	19,5			25,9	1.249,7
	Total	16.380,6	3.731,6	19.849,8	4.979,4	2.554,5	677,3	0,0	0,0	578,1	48.751,3
22-24	Total	21.897,4	4.727,6	30.501,9	11.250,4	2.865,8	777,0	0,0	35,1	578,1	72.633,3
21-24	Total	21.965,9	24.543,0	34.739,9	12.102,4	3.051,0	909,5	12,6	35,1	578,1	97.937,5

Annex 4: ICES Coordinated Acoustic Survey of ICES Divisions IIIa, IVa, IVb, IVc and VIa (North) 2005 Results

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ICES COORDINATED ACOUSTIC SURVEY OF

ICES DIVISIONS IIIa, IVa, Ivb, IVc AND VIa (NORTH)

2005 Results

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ABSTRACT

Six surveys were carried out during late June and July covering most of the continental shelf north of 51.5°N in the North Sea and to the west of Scotland to a northern limit of 62°N. The eastern edge of the survey area was bounded by the Norwegian and Danish, Swedish and German coasts, and to the west by the shelf edge between 200 and 400 m depth. The surveys are reported individually in the report of the planning group for herring surveys, and this combined report has been prepared from the data from all surveys. The combined survey results provide spatial distributions of herring abundance by number and biomass at age by statistical rectangle; and distributions of mean weight and fraction mature at age.

The estimates of North Sea autumn spawning herring SSB are reasonably consistent with previous years, at 1.9 million tonnes and 9,500 millions herring individuals. The survey again shows two well-above average year classes of herring (1998 and 2000). Growth of the 2000 year class seems still to be slower than average. Individuals of this year class are smaller and lighter than the 1998 year class at the same age. Now 96% are mature at age 4 compared to 65% at age 3 and 100% for previous year classes at this age. This compares with fairly typical values in 2005 for 2 and 3 wr herring of 76% and 97% respectively

The estimates of Western Baltic spring spawning herring SSB are 80,000 tonnes and 530 million herring which is a decrease following last years increase. The Western Baltic survey

produces a rather noisy signal and the indications are that the stock has declined to a level comparable to that between 1996 and 2000.

The West of Scotland estimates of SSB are 190,000 tonnes and 1.1 billion herring. This is a substantial reduction from last years estimate. Total adult mortality estimated from the survey is rather variable but high in the last two years. The mean mortality over the last 6 years has been approximately 0.4, this is a higher than the assessment indicates. The survey puts the stock at a low level relative to recent history. The abundant 1998 year class is now depleted; the 2000 year class is the strongest remaining one and there is no sign of incoming year classes.

INTRODUCTION

Six surveys were carried out during late June and July covering most of the continental shelf north of 51.5^{o}N in the North Sea and to the west of Scotland to a northern limit of 62^{o}N. The eastern edge of the survey area was bounded by the Norwegian and Danish, Swedish and German coasts, and to the west by the shelf edge between 200 and 400 m depth. The surveys are reported individually in Appendices IIa-f of the report of the Planning Group For Herring Surveys (ICES, 2004). The vessels, areas and dates of cruises are given below and in Figure 1:

VESSEL	PERIOD	AREA	RECTANGLES
FV Enterprise (SCO)	28 June – 18 July	56°- 60°30'N, 3° - 10° W	41E0-E3, 42E0-E3, 43E0-E3, 44E0-E3, 45E0-E4, 46E1-E5, 47E2-E7, 48E3-E7, 49E4-E8, 50E5-E6
Johan Hjort (NOR)	04 July – 27 July	56°30'- 62° N, 2° - 6° E	42F6-F7, 43F2-F5, 44F2-F5, 45F2-F5, 46F2-F4, 47F2-F4, 48F2-F4, 49F2-F4, 50F2-F4, 51F2-F4, 52F2-F4, plus overlap area A
"Scotia" (SCO)	28 June – 18 July	57° - 62° N, 2/4° W - 2°E	43E8-F1, 44E6-F1, 46E6-F1, 47E6-F1, 48E6-F1, 49E6-F1, 50E6-F1, 51E7-F1, 52E8-F1, 52E9-F1
"Tridens" (NED)	28 June – 23 July	53°30' – 58°30' N, Eng/ Sco to Den/Ger coasts	36F0-F3, 38F2-F7, 40E8-F7, 41E7-F3, 42E7-F1, 45E6-F1
"Solea" (GER)	28 June – 19 July	52° - 56°30' N, Eng to Den/Ger coasts	33F1-F3, 34F2-F3, 35F2-F4, 36F4-F7, 37E9-F8, 38E9-F1, 39E8-F7, 41F4-F7
"Dana" (DEN)	29 June – 12 July	Kattegat north of 56° + Skagerrak and North Sea north of 56°30' N, east of 6° E	41G1-G3, 42F6-F7, 42G0-G3, 43F6-G2, 44F6-G1, 45F8-G1, 46F9-G0

The data have been combined to provide an overall estimate. Estimates of numbers at age, maturity stage and mean weights at age are calculated as weighted means of individual survey estimates by ICES statistical rectangle. The weighting applied is proportional to the length of survey track for each vessel that has covered each statistical rectangle. The data have been combined and estimates of North Sea autumn spawning herring, Western Baltic spring spawning herring, and West of Scotland (VIa_{north}) herring are provided.

METHODS

The acoustic surveys were carried out using Simrad EK60, EK500 and EY500 38 kHz sounder echo-integrator with transducers mounted on the hull, drop keel and towed bodies. Further data analysis was carried out using either BI500, Echoview or Echoann software. The survey track was selected to cover the area giving a basic sampling intensity over the whole area 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 some relatively high density sections, east and west of Shetland, in the Skagerrak where short additional transects were carried out at 7.5 nmi spacing, and in most of the southern North Sea, where transect spacing was reduced to 30 nmi.

The following target strength to fish length relationships have been used to analyse the data:

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

A small often low density area of 4 ICES stat rectangles (42F2-F5) has been omitted from the survey. These have been filled in by interpolation using a linear combination of the surrounding rectangles. These contribute a negligible (<1%) change to all ages in all stocks except for age 1wr of North Sea Autumn spawning herring were the difference is about +6%, see Table 1.

Combined Acoustic Survey Results for 2004

The estimates of North Sea autumn spawning herring SSB are reasonably consistent with previous years, at 1.9 million tonnes and 9,600 millions herring (Table 2). The survey again shows two well-above average year classes of herring (1998 and 2000). Growth of the 2000 year class seems still to be slower than average, individuals of this year class are smaller and lighter than the 1998 year class at the same age. In 2005 96% of this year class are mature at age 4 compared to 65% when this year class was age 3wr. previous year classes were 100% mature at age 4 wr. This reduced maturation compares with fairly typical values for fraction mature for younger year classes 2 and 3 wr herring of 76% and 97% respectively

The survey again shows two well- above average year classes of herring (the 1998 and 2000 year classes) in the North Sea, which is consistent with the observation of these large year classes observed in the MIK and IBTS surveys and the acoustic survey last year (ICES 2005). The 2005 estimate of the 2000 year class in the North Sea suggests it is 1.3 times higher than the 1998 year class at age 4wr, this is comparable with previous estimates. 2001 is observed as close to the long term mean with the 2002 and 3 year classes estimated as the lowest in the time series. These estimates are comparable with earlier estimates of these year classes in this and other surveys.

The estimates of Western Baltic spring spawning herring SSB are 81,000 tonnes and 530 million herring (Table 3) which is a small decrease following last years small increase. The Western Baltic survey produces a rather noisy signal and the indications are that the stock has declined slightly over the last three years to a level comparable to that between 1996 and 2000.

The West of Scotland estimates of SSB are 190,000 tonnes and 1.1 billion herring (Table 4). This is a substantial reduction from last years estimate, though the survey is perhaps even more noisy that the Western Baltic Spring Spawner’s survey. Total adult mortality estimated from the survey is rather variable but high in the last two years. The mean total mortality over the last 6 years has been approximately 0.4, this is a higher than the 2005 assessment indicates (ICES 2005). The survey puts the stock at a low level relative to recent history. The abundant 1998 year class is now depleted; the 2000 year class is the strongest remaining one and there is no sign of incoming year classes. The pattern of abundant and small year classes is similar to the North Sea, large year classes in 1998 and 2000 and low abundance in 2002/3.

The spatial distributions of the abundance (numbers and biomass) of autumn spawning herring are shown in Figure 2. The distribution of numbers by age is shown in Figure 3 for 1 ring, 2 ring and 3+ ring autumn spawning herring. The survey provides estimates of maturity and weight at age: the mean weight at age for 1 and 2 ring herring along with the proportion mature for 2 and 3 ring herring are shown in Figure 4. The spatial distribution of mature and immature autumn spawning herring is shown in Figures 5 and 6 respectively. The spatial distributions of the abundance (numbers and biomass) of Western Baltic spring spawning herring are shown in Figure 7. The distribution of numbers by age is shown in Figure 8 for 1 ring, 2 ring and 3+ ring. The mean weight at age for 1 and 2 ring herring along with the proportion mature for 2 and 3 ring herring are shown in Figure 9. The spatial distribution of mature and immature Western Baltic spring spawning herring is shown in Figures 10 and 11 respectively.

The time series of abundance for all three stocks, North Sea autumn spawners, Western Baltic spring spawners and West of Scotland herring are given in Tables 5, 6 and 7 illustrated in Figures 12, 13 and 14 respectively. In each of them, a 3 year running mean is included to show the general trend more clearly.

References

ICES. 2004. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 2005/ACFM:10.

ICES. 2003. Report of the planning group for herring surveys. ICES CM 2003/G:05.

Table 1: Estimating values for the missing section (done but not shown yet).

NS Autumn Spawning stock				WB Spring spawning stock		
Age	w/o fillin	with fillin	% change	w/o fillin	with fillin	% change
0	5009.8	5015.9	0.12%	0	0.0	
1	2921.3	3112.5	6.14%	2671	2687.0	0.60%
2	1880.2	1890.2	0.53%	1333	1342.1	0.66%
3	3435.3	3436.4	0.03%	463	463.5	0.11%
4	5604.3	5609.3	0.09%	201	201.3	0.08%
5	1210.8	1211.3	0.05%	102	102.5	0.01%
6	1172.0	1172.3	0.02%	84	83.6	0.01%
7	139.7	139.9	0.13%	37	37.2	0.01%
8	126.4	126.5	0.07%	12	12.4	0.02%
9+	106.7	106.7	0.00%	9	9.0	0.00%

Table 2: Total numbers (millions of fish) and biomass (thousands of tonnes) of North Sea autumn spawning herring in the area surveyed in the acoustic surveys July 2005, with mean weights, mean lengths and fraction mature by age ring.

AGE (RING)	NUMBERS	BIOMASS	MATURITY	WEIGHT(G)	LENGTH (CM)
0	5015.9	16.0	0.00	3.2	7.9
1	3112.5	134.7	0.01	43.3	17.5
2	1890.2	255.4	0.76	135.1	24.5
3	3436.4	587.8	0.97	171.0	26.2
4	5609.3	1014.4	0.96	180.8	26.6
5	1211.3	276.8	1.00	228.5	28.5
6	1172.3	290.3	1.00	247.6	29.2
7	139.9	35.3	1.00	252.6	29.5
8	126.5	34.7	1.00	274.4	30.2
9+	106.7	31.5	1.00	295.1	30.7
Immature	8920.4	234.8			
Mature	9577.8	1867.9			
Total	21821.0	2676.9			

Table 3: Total numbers (millions of fish) and biomass (thousands of tonnes) of Western Baltic spring spawning herring in the area surveyed in the acoustic surveys July 2005, with mean weights, mean length and fraction mature by age ring.

AGE (RING)	NUMBERS	BIOMASS	MATURITY	WEIGHT(G)	LENGTH (CM)
0	0.0	0.0	0.00		
1	2687.0	105.9	0.01	39.42	17.1
2	1342.1	100.1	0.11	74.59	21.0
3	463.5	46.6	0.30	100.5	23.0
4	201.3	28.9	0.63	143.7	24.3
5	102.5	16.5	1.00	160.9	26.2
6	83.6	14.9	1.00	177.7	26.9
7	37.2	7.5	1.00	202.3	28.0
8	12.4	2.9	1.00	230.3	29.3
9+	9.0	2.1	1.00	227.7	28.8
Immature	4265.4	227.5			
Mature	534.8	80.9			
Total	4938.6	325.3			

Table 4: Total numbers (millions of fish) and biomass (thousands of tonnes) of autumn spawning of West of Scotland herring in the area surveyed in the acoustic surveys July 2005, with mean weights, mean lengths and fraction mature by age ring.

AGE (RING)	NUMBERS	BIOMASS	MATURITY	WEIGHT(G)	LENGTH (CM)
0	0.0	0.0	0.00		
1	50.2	3.8	0.00	75.1	20.6
2	243.4	31.6	0.84	129.6	24.7
3	230.3	35.4	1.00	153.8	26.1
4	423.1	70.4	1.00	166.5	26.8
5	245.1	44.2	1.00	180.2	27.5
6	152.8	29.2	1.00	191.1	28.0
7	12.6	2.7	1.00	212.5	29.0
8.00	39.0	7.9	1.00	203.0	28.6
9+	26.8	6.1	1.00	228.4	29.7
Immature	89.2	8.3			
Mature	1103.8	187.5			
Total	1423.3	231.3			

Table 5: Estimates of North Sea autumn spawners (millions) at age from acoustic surveys, 1984-2005. For 1984-1986 the estimates are the sum of those from the Division IVa summer survey, the Division IVb autumn survey, and the Divisions IVc, VIId winter survey. The 1987 to 2004 estimates are from the summer survey in Divisions IVa,b and IIIa excluding estimates of Division IIIa/Baltic spring spawners. For 1999 and 2000 the Kattegat was excluded from the results because it was not surveyed. Smoothed Z are those estimated over 2 years providing an estimate of total mortality that is less noisy.

AGE (RINGS)	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	551	726	1,639	13,736	6,431	6,333	6,249	3,182	6,351	10,399	3,646	4,202	6,198	9,416	4,449	5,087	24,735	6,837	23,055	9,829	5,183	3,113
2	3,194	2,789	3,206	4,303	4,202	3,726	2,971	2,834	4,179	3,710	3,280	3,799	4,557	6,363	5,747	3,078	2,922	12,290	4,875	18,949	3,415	1,890
3	1,005	1,433	1,637	955	1,732	3,751	3,530	1,501	1,633	1,855	957	2,056	2,824	3,287	2,520	4,725	2,156	3,083	8,220	3,081	9,191	3,436
4	394	323	833	657	528	1,612	3,370	2,102	1,397	909	429	656	1,087	1,696	1,625	1,116	3,139	1,462	1,390	4,189	2,167	5,609
5	158	113	135	368	349	488	1,349	1,984	1,510	795	363	272	311	692.1	982.4	506.4	1,006	1,676	794.6	675.1	2,590	1,211
6	44	41	36	77	174	281	395	748	1,311	788	321	175	98.7	259.2	445.2	313.6	482.5	449.6	1,031	494.8	317.1	1,172
7	52	17	24	38	43	120	211	262	474	546	238	135	82.8	78.6	170.3	138.6	266.4	169.6	244.4	568.3	327.6	139.9
8	39	23	6	11	23	44	134	112	155	178	220	110	132.9	78.3	45.2	54.3	120.4	97.7	121	145.5	342.1	126.5
9+	41	19	8	20	14	22	43	56	163	116	132	84	206	158.3	121.4	87.2	97.2	58.9	149.5	177.7	185.6	106.7
Total	5,478	5,484	7,542	20,165	13,496	16,377	18,262	12,781	17,173	19,326	13,003	11,220	18,786	22,028	16,104	15,107	34,928	26,124	39,881	38,110	23,722	16,805
$Z_{2+/3+}$	.	0.91	0.57	1.02	0.81	0.11	0.10	0.57	0.36	0.72	1.19	0.51	0.42	0.38	0.75	0.51	0.31	0.37	0.48	0.58	0.62	0.44
Smooth $Z_{2+/3+}$	.	-	0.74	0.79	0.91	0.46	0.11	0.34	0.47	0.54	0.96	0.85	0.46	0.40	0.56	0.63	0.41	0.34	0.42	0.53	0.60	0.53
SSB ('000 t)	807	697	942	817	897	1,637	2,174	1,874	1,545	1,216	1,035	1,082	1446.2	1,780	1,792	1,534	1,833	2,622	2,948	2,999	2,584	1,868

Table 6: Numbers (millions) of Western Baltic Spring Spawning herring at age (rings) from acoustic surveys 1989 to 2005. The 1999 survey was incomplete due to the lack of participation by RV DANA.

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0		31		3,853	372	964						
1		135		277	103	5	2,199	1,091	128	138	1367	1509
2	1,105	1,497	1,864	2,092	2,768	413	1,887	1,005	715	1,682	1143	1891
3	714	549	1,927	1,799	1,274	935	1,022	247	787	901	523	674
4	317	319	866	1,593	598	501	1,270	141	166	282	135	364
5	81	110	350	556	434	239	255	119	67	111	28	186
6	51	24	88	197	154	186	174	37	69	51	3	56
7	16	10	72	122	63	62	39	20	80	31	2	7
8+	4	5	10	20	13	34	21	13	77	53	1	10
Total	2,288	2,680	5,177	10,509	5,779	3,339	6,867	2,673	2,088	3,248	3,201	4,696
3+ group	1,183	1,017	3,313	4,287	2,536	1,957	2,781	577	1,245	1,428	691	1,295

YEAR	2001	2002	2003	2004	2005
0				0.0	
1	66	3346	1833	1,668	2,687
2	641	1576	1110	929.6	1,342
3	452	1392	394.6	726.0	463.5
4	153	524	323.4	306.9	201.3
5	96	88	103.4	183.7	102.5
6	38	40	25.2	72.1	83.6
7	23	18	12.0	21.5	37.2
8+	12	19	5.4	18.0	21.4
Total	1,481	7,002	3,807	3,926	4,939
3+ group	774	2,081	864	1,328	910

Table 7: Numbers at age (millions) and SSB of West of Scotland Autumn Spawning herring at age (rings) from acoustic surveys 1987, 1991 to 2005. In 1997 the survey was carried out one month early in June as opposed to July when all the other surveys were carried out

AGE	1987	1991	1992	1993	1994	1995	1996	1997#	1998
1	249.1	338.3	74.3	2.8	494.2	441.2	41.2	792.3	1,221.7
2	578.4	294.5	503.4	750.3	542.1	1,103.4	576.5	641.9	794.6
3	551.1	327.9	211.0	681.2	607.7	473.2	802.5	286.2	666.8
4	353.1	367.8	258.1	653.1	285.6	450.3	329.1	167.0	471.1
5	752.6	488.3	414.8	544.0	306.8	153.0	95.4	66.1	179.1
6	111.6	176.3	240.1	865.2	268.1	187.1	60.6	49.5	79.3
7	48.1	98.7	105.7	284.1	406.8	169.1	77.4	16.3	28.1
8	15.9	89.8	56.7	151.7	173.7	236.5	78.2	29.0	13.9
9+	6.5	58.0	63.4	156.2	131.9	201.5	114.8	24.4	36.8
SSB:	273.0	452.0	351.5	866.2	533.7	452.1	370.3	140.9	375.9

AGE	1999	2000	2001	2002	2003	2004	2005		
1	534.2	447.6	313.1	424.7	438.8	564.0	50.2		
2	322.4	316.2	1,062.0	436.0	1039.4	274.5	243.4		
3	1,388.8	337.1	217.7	1,436.9	932.5	760.2	230.3		
4	432.0	899.5	172.8	199.8	1471.8	442.3	423.1		
5	308.0	393.4	437.5	161.7	181.3	577.2	245.1		
6	138.7	247.6	132.6	424.3	129.2	55.7	152.8		
7	86.5	199.5	102.8	152.3	346.7	61.8	12.6		
8	27.6	95.0	52.4	67.5	114.3	82.2	39.0		
9+	35.4	65.0	34.7	59.5	75.2	76.3	26.8		
SSB:	460.2	500.5	359.2	548.8	739.2	395.9	167.5		

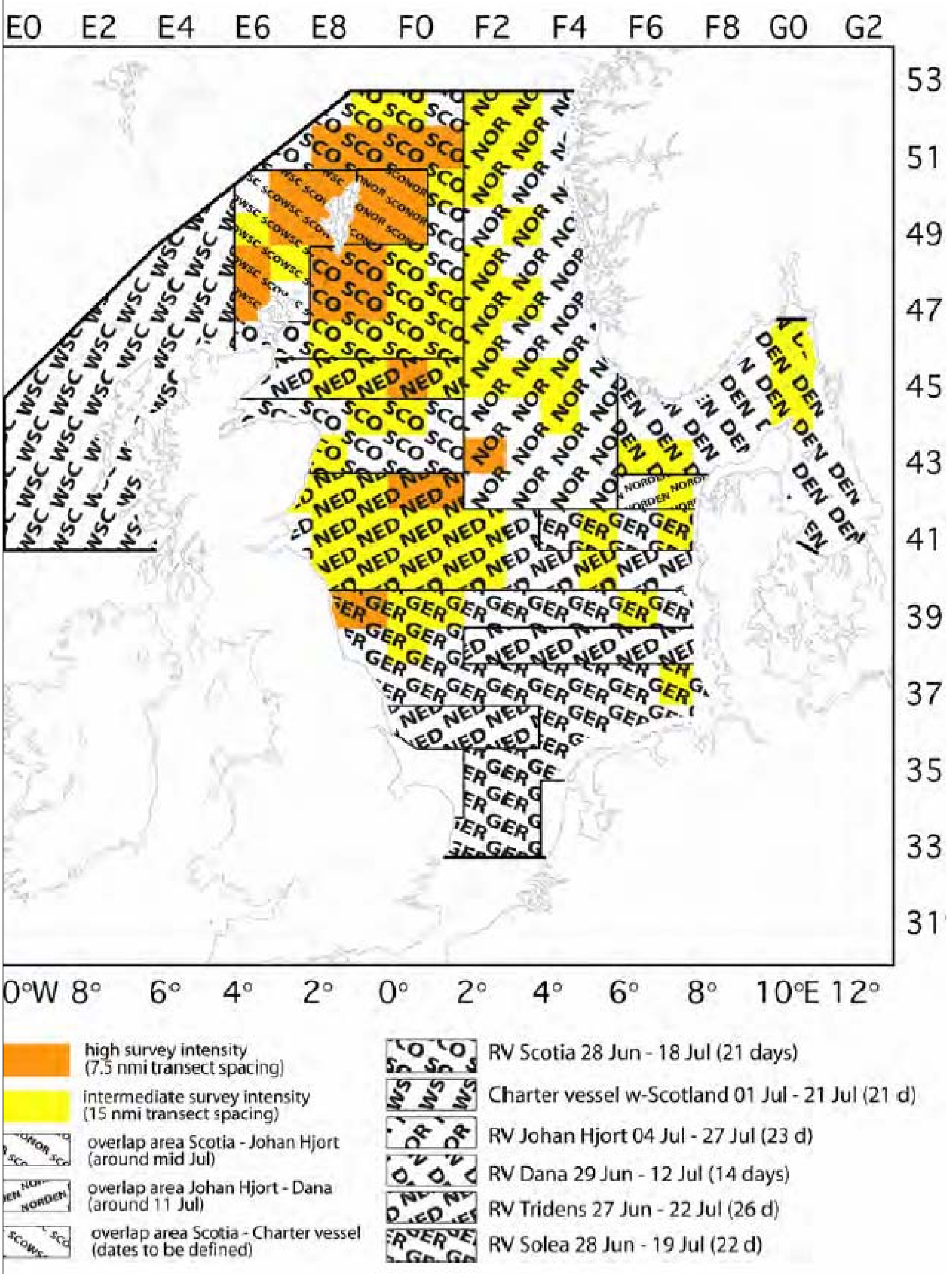

Figure 1: Layout of the herring acoustic survey in the North Sea, Divs. IIIa and VIaN in 2005.

Suggested effort distribution is indicated per rectangle, based on an analysis of the contribution to the herring assessment and advice (Simmonds *et al.* 2004). Map source: GEBCO, 200 m depth contour drawn.

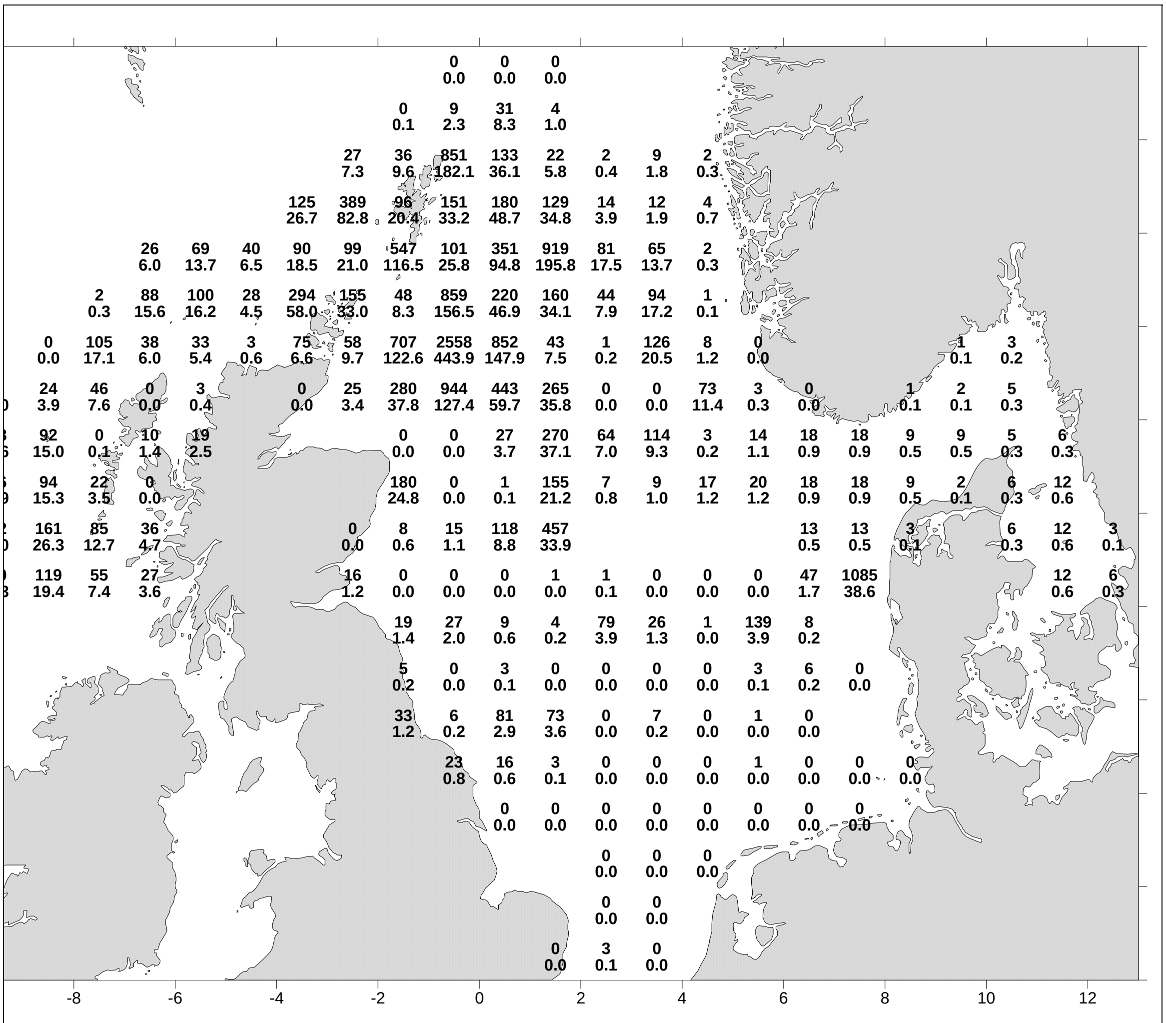

Figure 2: Abundance of Autumn spawning herring 1-9+ from combined acoustic survey July 2005. Numbers (millions) (upper figure) and biomass (thousands of tonnes) (lower figure).

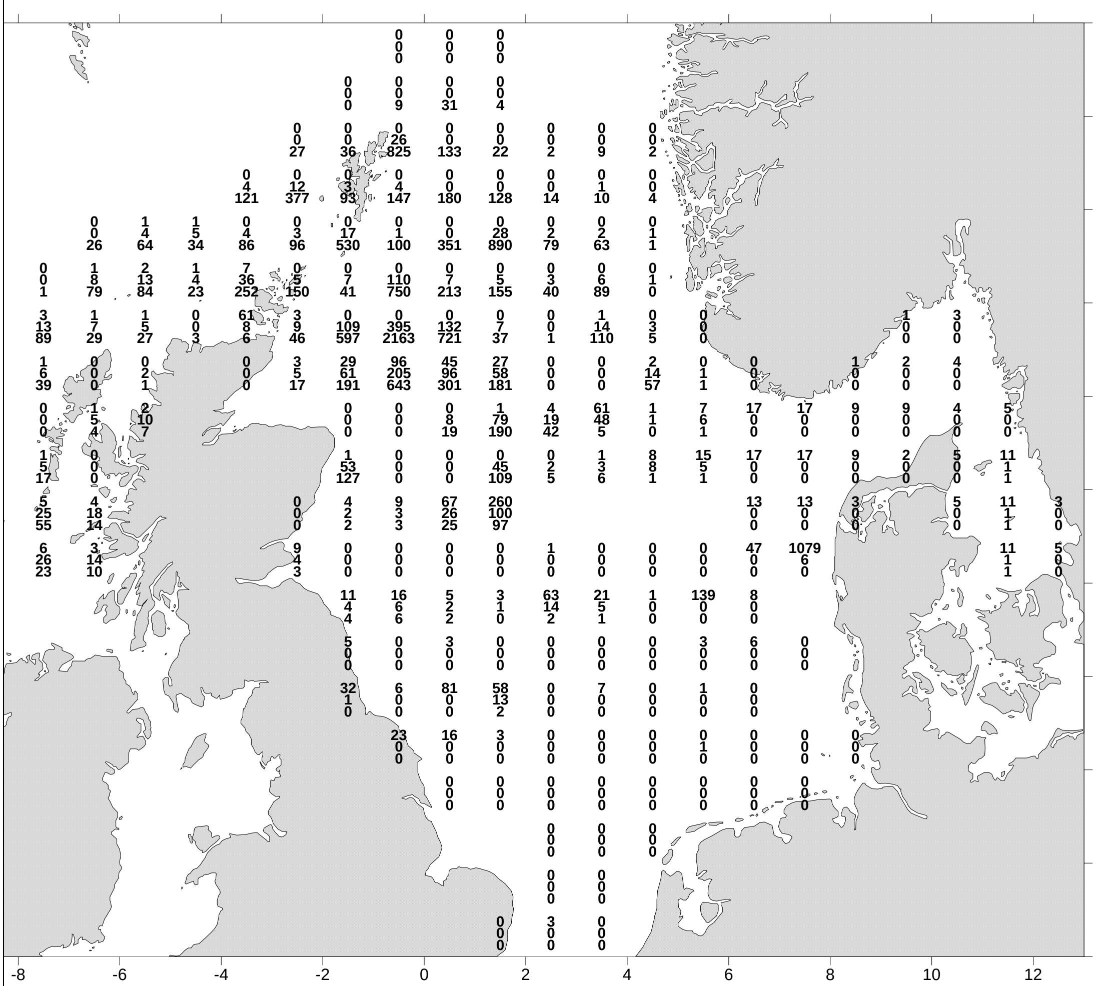

Figure 3: Numbers (millions) of Autumn spawning herring from combined acoustic survey June - July 2005. 1 ring (upper figure), 2 ring (centre figure), 3+ (lower figure).

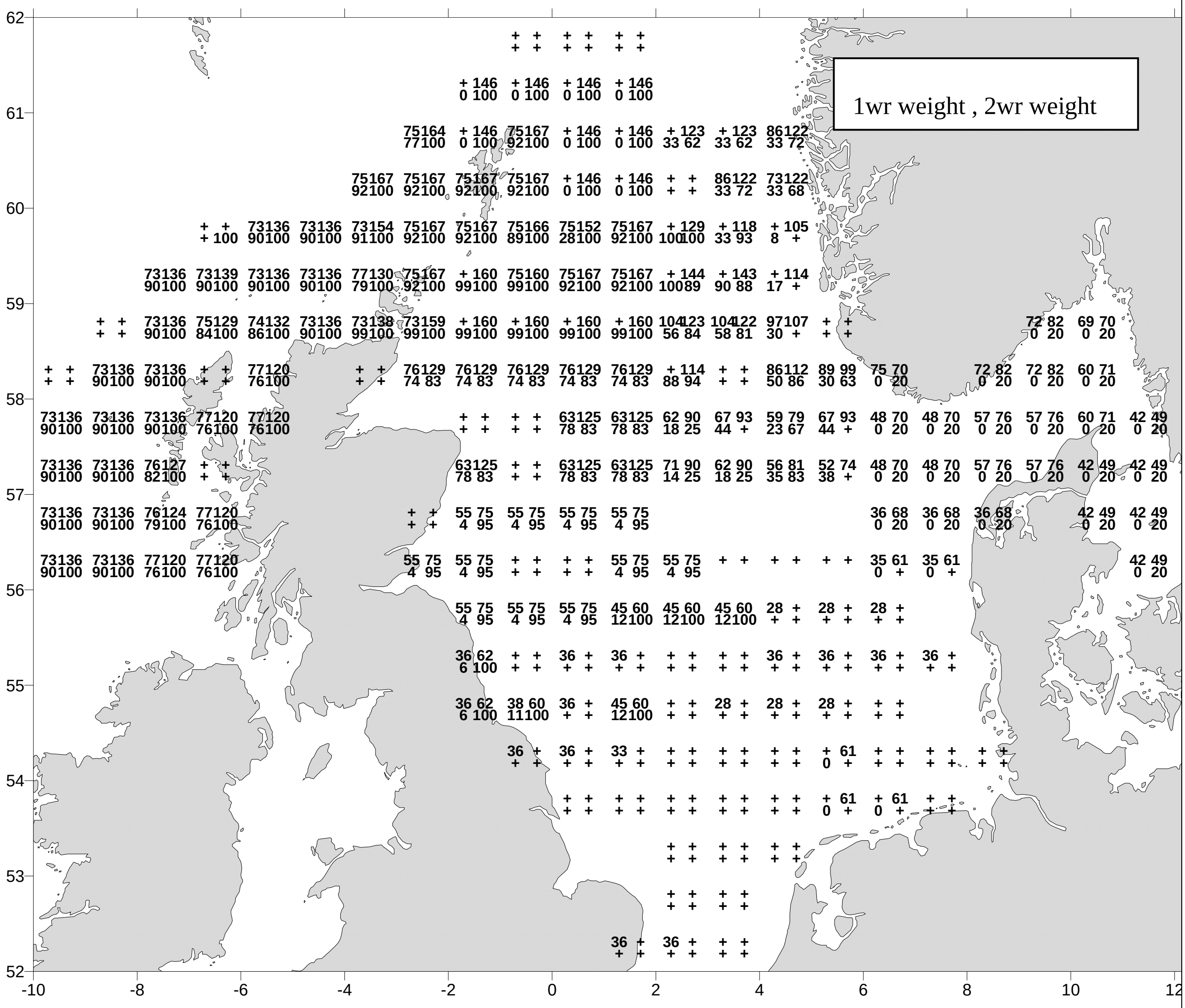

Figure 4: Mean weight and maturity of Autumn spawning herring from combined acoustic survey June - July 2005. Four values per ICES rectangle, percentage mature (lower),2 ring (left), 3 ring (right), mean weights gram (upper),1 ring (left) ,2 ring (right) ,0 indicates measured percentage mature, + indicates surveyed with zero abundance blank indicates an unsurveyed rectangle.

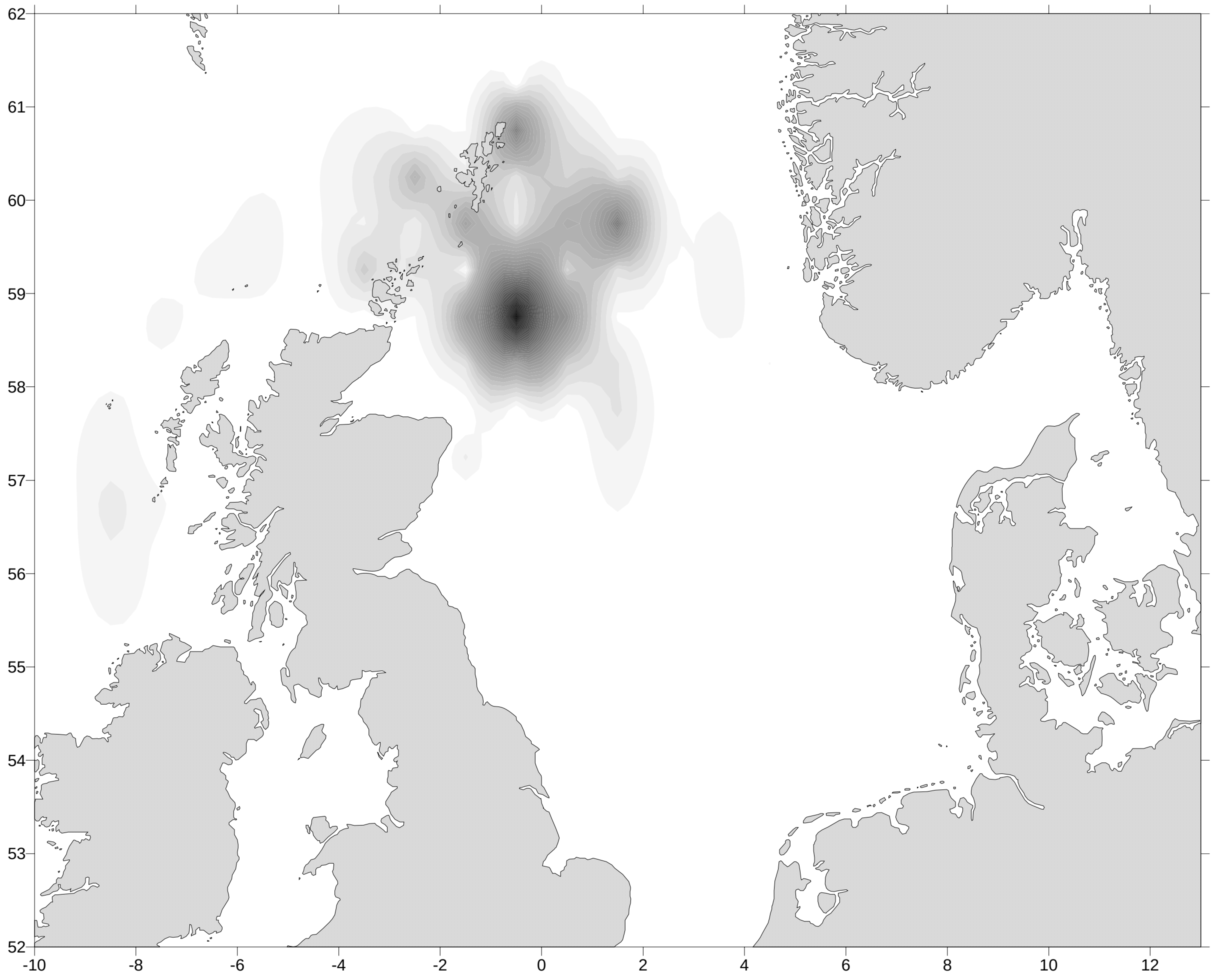

Figure 5: Biomass of mature autumn spawning herring from combined acoustic survey June -July 2005.

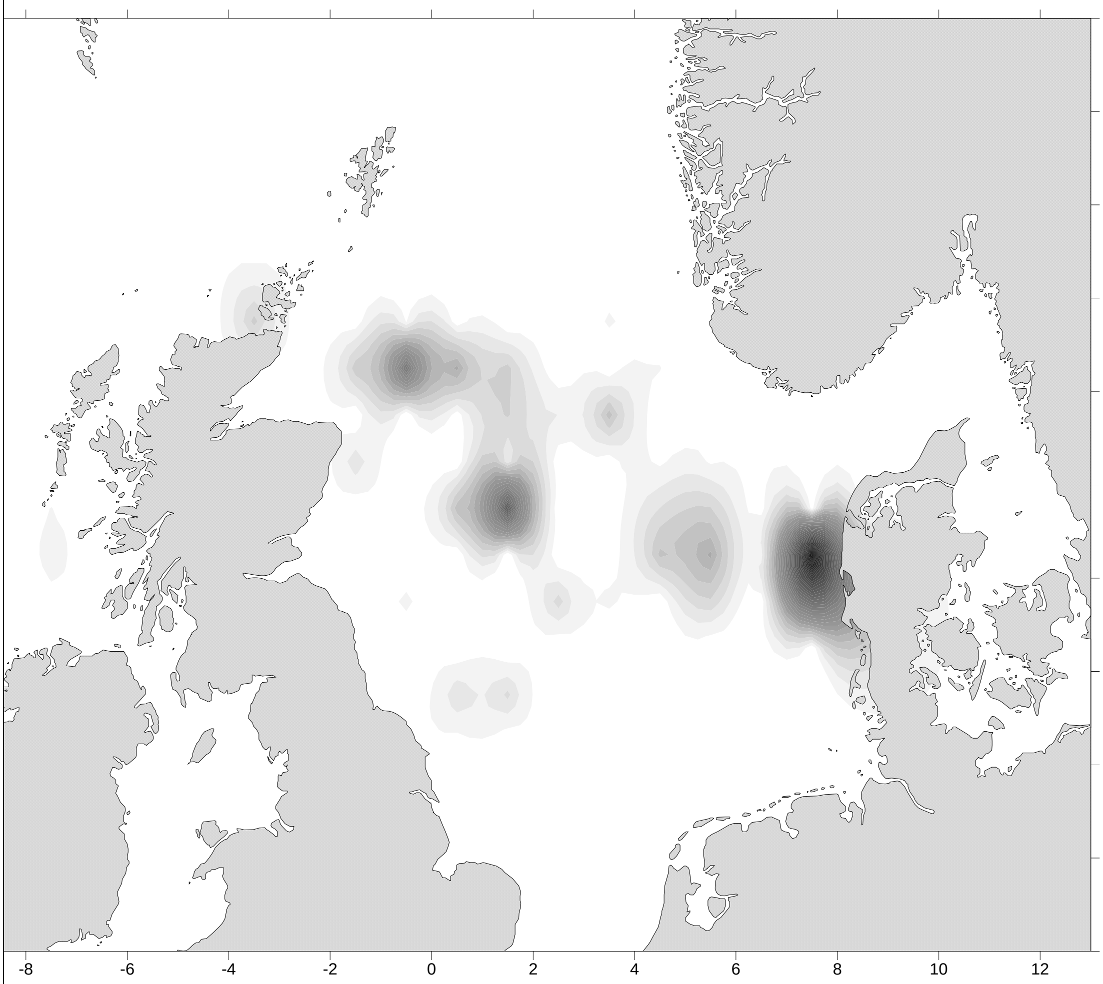

Figure 6: Biomass of immature autumn spawning herring from combined acoustic survey June -July 2005.

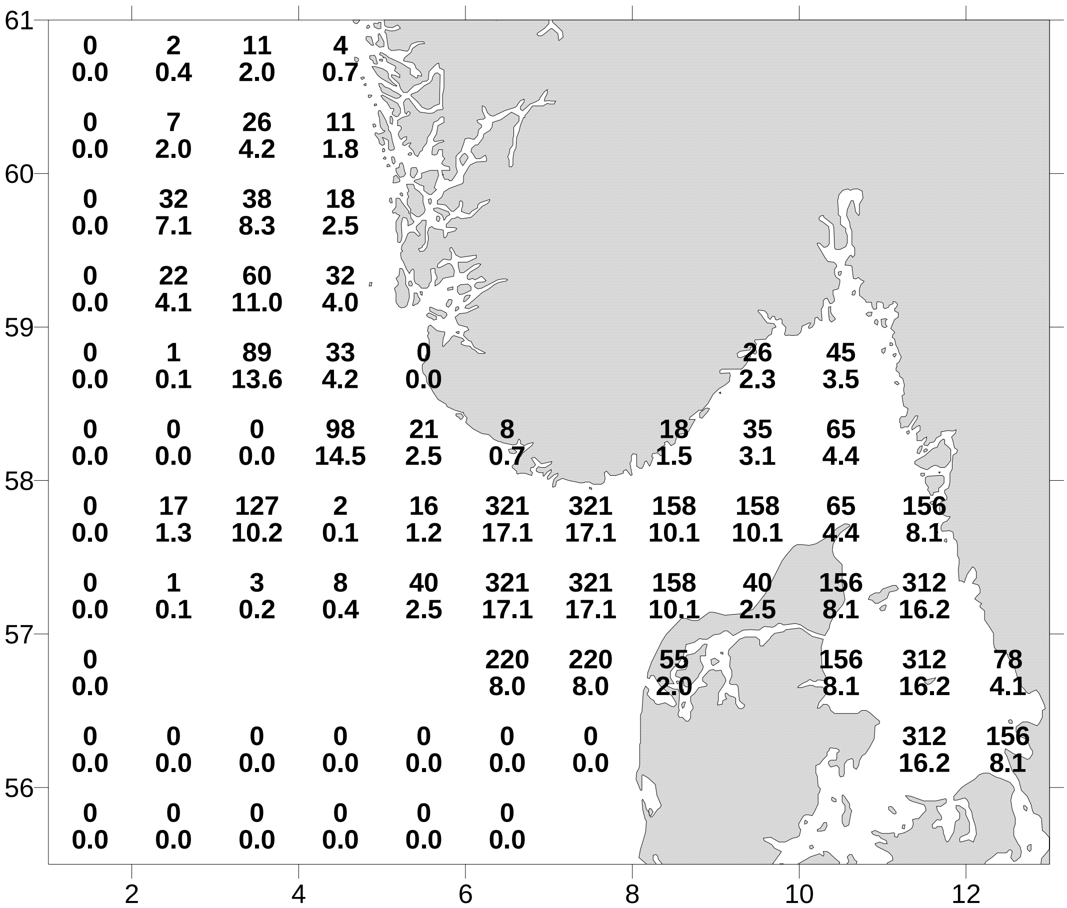

Figure 7: Numbers (millions) (upper) and biomass (thousands of tonnes) (lower) of Western Baltic spring spawning herring from combined acoustic survey June - July 2005.

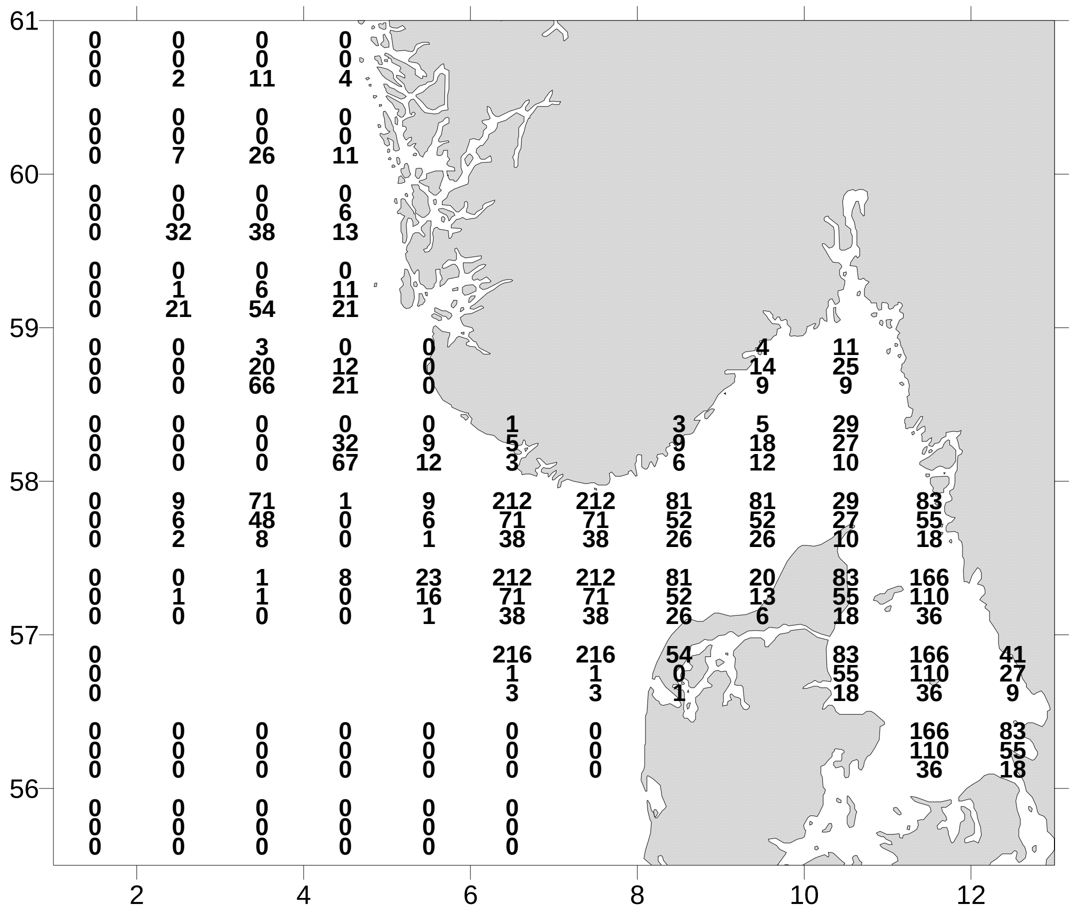

Figure 8: Numbers (millions) of Western Baltic spring spawning herring from combined acoustic survey June - July 2005. 1 ring (upper figure), 2 ring (centre figure), 3+ (lower figure).

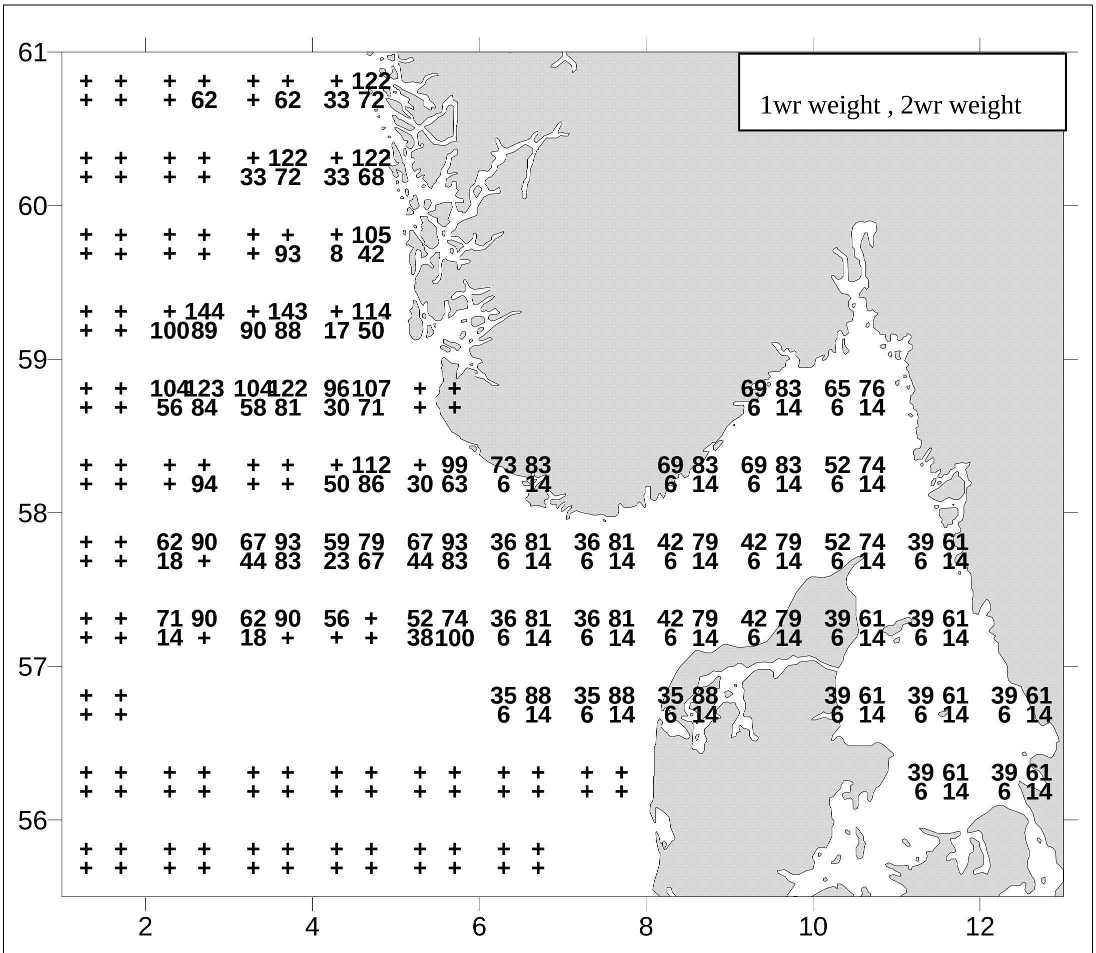

Figure 9: Mean weight and maturity of Western Baltic spring spawning herring from combined acoustic survey June - July 2005. Four values per ICES rectangle, percentage mature (lower),2 ring (left), 3 ring (right), mean weights gram (upper),1 ring (left) ,2 ring (right) ,0 indicates measured percentage mature, + indicates surveyed with zero abundance blank indicates an unsurveyed rectangle.

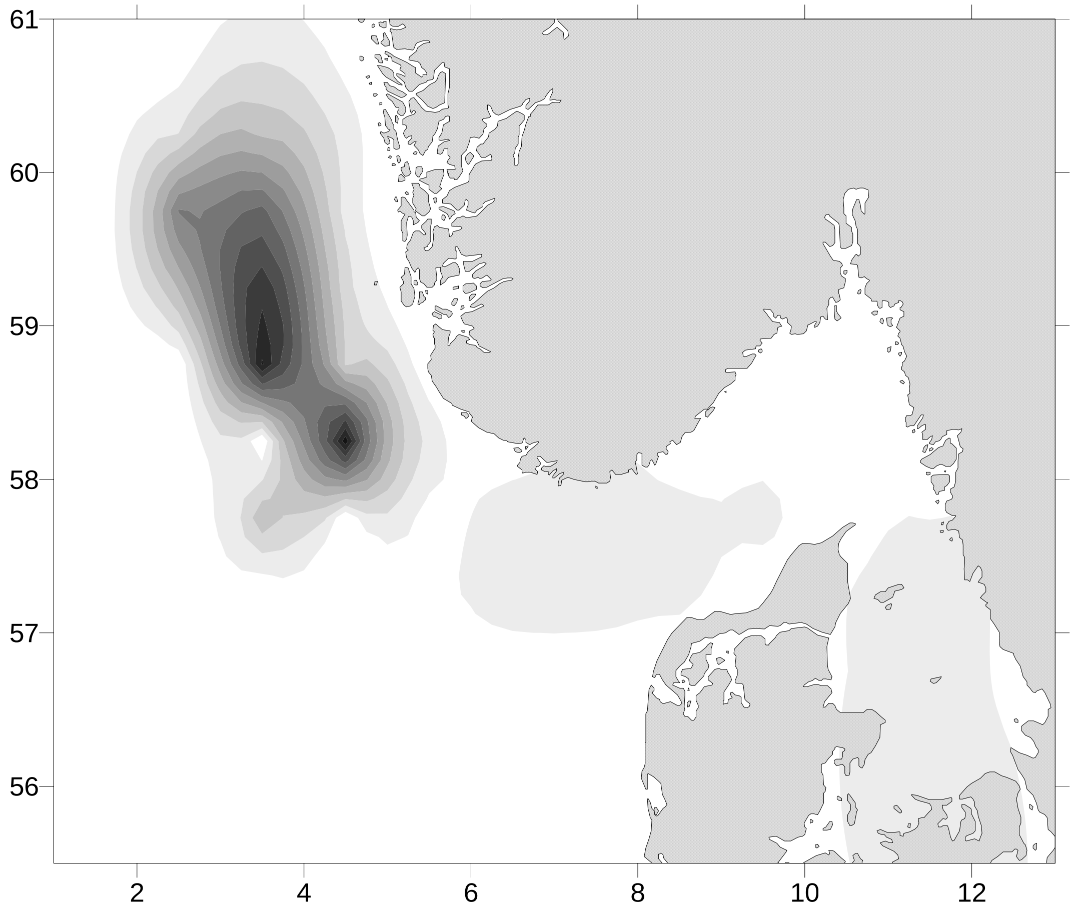

Figure 10: Biomass of mature Western Baltic spring spawning herring from combined acoustic survey July 2005. Numbers of herring.

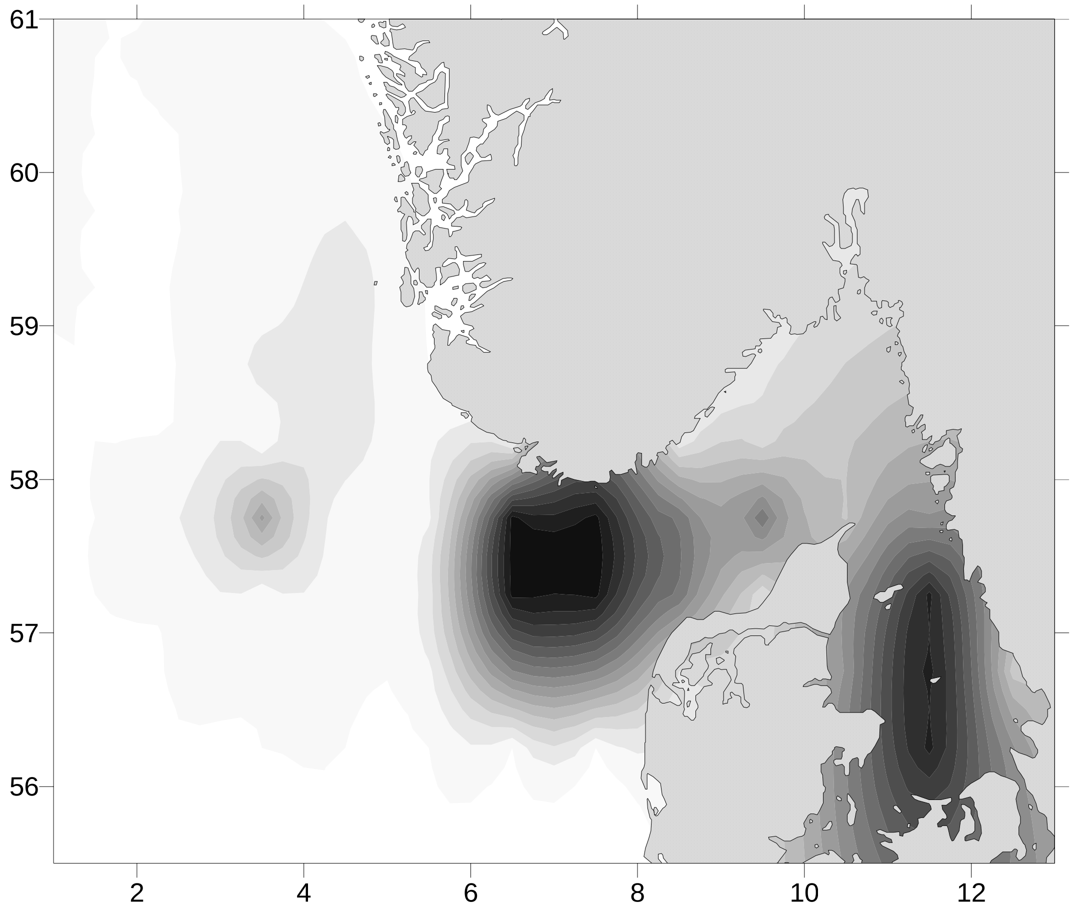

Figure 11: Biomass of immature Western Baltic spring spawning herring from combined acoustic survey July 2005. Numbers of herring.

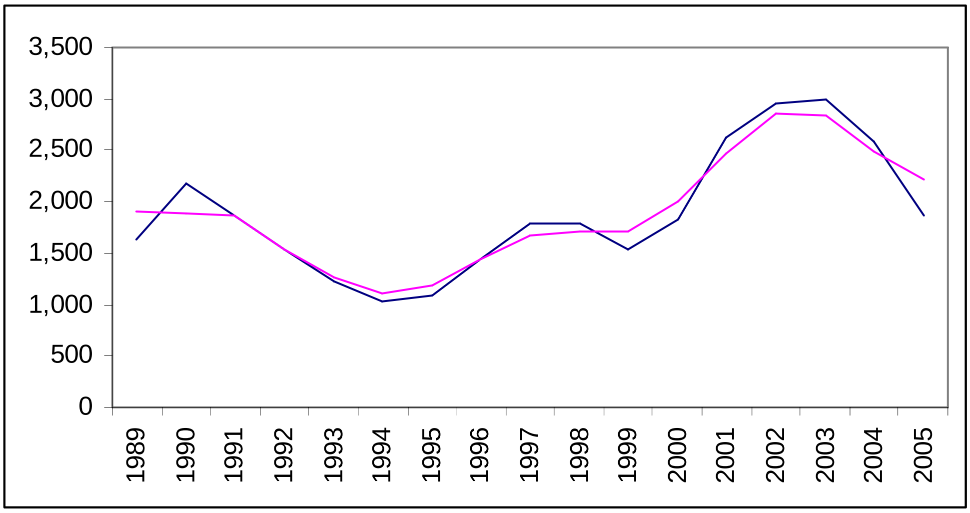

Figure 12: Time series of SSB of North Sea autumn spawning herring with three year running mean.

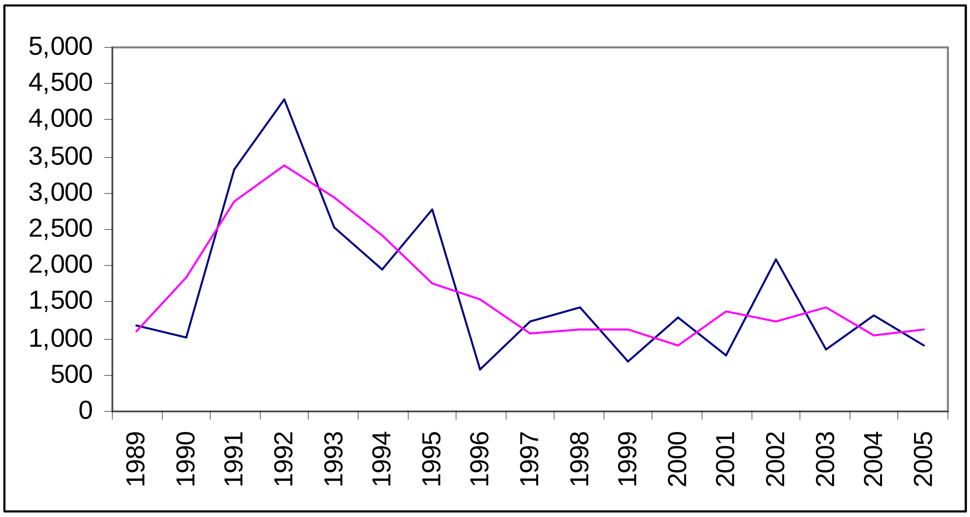

Figure 13: Time series of 3+ abundance of Western Baltic spring spawning herring with three year running mean.

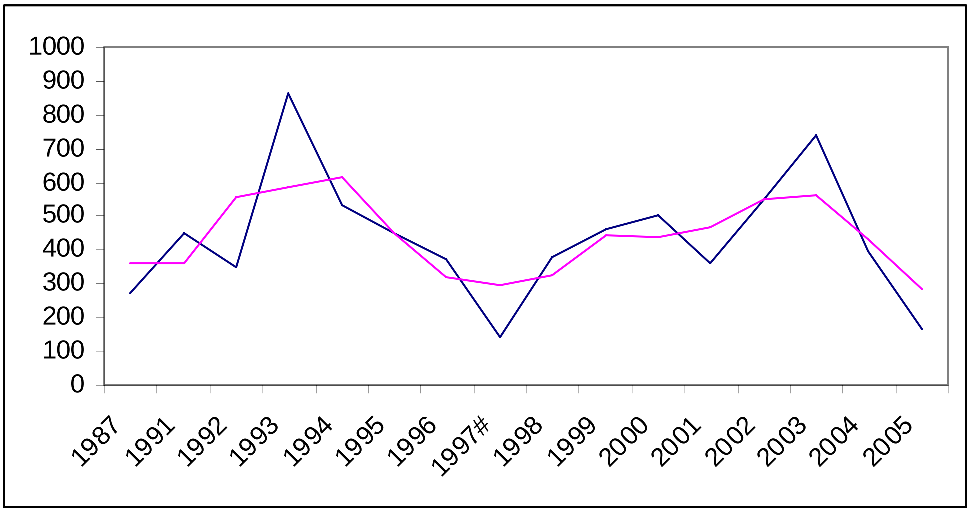

Figure 14: Time series of SSB of West of Scotland herring with three year running mean.

Annex 5: Manual for the International Herring Larvae Surveys south of 62° North – Version 24.01.06

Version 2: 24.01.06

MANUAL

for

THE INTERNATIONAL HERRING LARVAE SURVEYS

SOUTH OF 62° NORTH

Nackthai (GULF III)

GULF VII

January 2006

1. Introduction

The ICES programme of international herring larval surveys in the North Sea and adjacent areas is in operation since 1967. The main purpose of this programme is to provide quantitative estimates of herring larval abundance, which are used as a relative index of changes of the herring spawning stock biomass in the assessment.

The larvae surveys are carried out in specific time periods and areas, following the autumn and winter spawning activity of herring from north to south. Catch data together with specific information like haul position, survey area etc. are reported to the ICES International Herring Larvae database annually. The database contains information about the surveys conducted since 1972.

This manual should describe most aspects of the methods used in the surveys. It should summarize the status-quo of the surveys and should form a basis for discussion which, if any, modifications in methodology and changes in survey design become necessary.

2. Sampling

2.1 Sampling strategy

The aim is to sample the major herring spawning grounds in the appropriate areas in an approximate 10 by 10 nautical miles grid. The station grid is based on the positions given in Anon. (1985). This grid should include every square that is known to contain herring larvae less than 10 mm. The areas should be sampled in the half month periods. Wherever possible, hauls should be done within the centre of the 10*10 nm rectangle.

In areas with high densities of small larvae (more than 1000 larvae per haul) at least two extra samples should be taken within this specific 10 x10 nm grid.

If there is a shortage of time during the survey, the scientist in charge should give higher priority to stations which are presumed to represent areas with higher densities of larvae instead of areas with are believed to have lower densities.

2.2 Sampling locations

The herring larval abundance is surveyed in four different areas: the Orkney/Shetland area, the Buchan region, the Central North Sea and the Southern North Sea. The first two areas should be covered twice while the last both should be covered for three times. In total there are 10 sampling units which must be surveyed for a complete coverage of the herring spawning activity. The survey period and locations are given in Table 1. The positions of the stations for each specific sampling area are described in the Annex.

All other locations, e.g. IVa North and IVa South and VIIb, which were part of the surveys up to the 90s, are not sampled anymore since 1994. Also the forth sampling period in the Central North Sea (16.10. – 31.10.) is omitted from the surveys since 1999.

Table 2.2.1: Sampling locations and periods

AREA / PERIOD	1–15 SEPTEMBER	16–30 SEPTEMBER	1–15 OCTOBER
Orkney / Shetland	yes	yes	no sampling required
Buchan	yes	yes	no sampling required
Central North Sea	yes	yes	yes
	16–31 DECEMBER	**1–15 JANUARY**	**16–31 JANUARY**
Southern North Sea	yes	yes	yes

Sampling should preferably take place in the centre of the squares. In case stations have to be shifted it must be made sure that they are still in the required 10*10 nm rectangle.

Stations should be given a number which allocates them to a standard 30 x 30 nm rectangle. This is based on the ICES code for statistical rectangles (Anon. 1977) followed by a letter from a to i which allocates them to the respective 10 x 10 nm sampling grid within that rectangle. These station numbers are given in the tables of standard positions for each sampling unit in the Annex (Table 6.1.1.– 6.4.3)

Participants in the surveys should notify the Chairman of the Working Group as soon as the allocation of vessel time to the herring larval surveys is known. Any necessary adjustments could then be considered and arranged at PGHERS.

3. Sampling Gear

3.1 Standard sampler

Prior to 2004 a GULF III sampler or one of its national modifications was the standard sampler in the herring larvae surveys. In period 2004/05, the Netherlands introduced a GULF VII sampler instead, while Germany still uses the GULF III. Possible biases introduced by this change in gear type are object by a study scheduled for May 2006. The results of this study have to be included in this manual as soon as they are available.

Samplers should be fitted with a 280 or 300 µ mesh size net. They should be equipped with depth recorder and two flow meters, one internal and one external. The internal flowmeter should be fitted in a standard position in the nose cone, which can be repeated on each survey. The external flowmeter should be mounted to the sampler in a way that the flowmeter is not object to sampler induced turbulence.

Hydrographical measurements can be obtained by a CTD mounted to the GULF samplers.

3.2 Calibration

The theoretical volume of water accepted by a plankton sampler in free flow (i.e. without a filtering cone) can be expressed as the product of the area of the mouth opening and the distance towed. For flowmeter calibration, the sampler should be deployed well below the ships keel and towed for a known distance (e.g. 1 nm obtained from GPS) on a horizontal path at 5 knots through the water. This calibration must be reproduced also on a reciprocal course.

The new electronic flowmeters mounted on the Dutch GULF VII are less vulnerable to drift. Therefore it has been decided to have a calibration each year to check if there is drift in the flowmeters. The flowmeters will be fitted together on a pole and put under water from the side of a whitboat. Time, position and speed will be measured using a GPS and flowmeter revolutions will be noted. Any changes will be reported in the datasheets.

The nose cones of the different modification of GULF III samplers used in the past in the surveys are not designed in the same way. Thus each of these samplers has different inherent sampler efficiency and these results in different theoretical volumes accepted. The sampler efficiency was calculated from measurements done in a flume tank by measuring the actual volume accepted in free flow at the operational speed of 5 knots. An efficiency factor exists for each sampler type.

The GULF VII has also been subjected to flume tank experiments. From these an efficiency factor has been derived.

3.3 Method of deployment

The standard towing speed is 5 knots through the water. Hauls should be “double oblique hauls” from the sea surface to within at least 5 metres of the seabed (irrespective of depth) and back to the surface. Whenever weather conditions are moderate, a distance of the sampler to the seabed within 3 metres is preferable. Shooting and hauling the gear should be continuous and the profile should be as uniform as possible. As a proxy, 10 m of the water column should be sampled for 1 1/2 minute, both while shooting and hauling. The time from the sampler going below the surface until it comes back should be measured and reported as haul duration. Samples can be taken working throughout the available 24 hour periods. Sampling on sediment banks or shallow stations should be avoided. Instead, the station should be transferred for some distances within the same rectangle to ensure a water depth of at least 15 m.

4. Treatment of samples

4.1 Washing the net

After hauling the sampler should be placed in an upright position on deck to ensure that no part of the sample is running out from the net basket back into the net. The net should be gently spoiled with sea water before removing the sampling bag. Washing with a too powerful jet can cause severe damage to the larvae.

4.2 Sample fixation

The standard fixative is a 4% buffered formaldehyde solution in water (fresh or distilled). This solution is approximately isotonic with seawater and should be used in preference to 4% formaldehyde in seawater. The sample should not come in contact with formaldehyde strength in excess of 4%; therefore water should be added to the sample first whenever higher concentrations are used to produce the 4% solution directly in the sample jar.

The 4% formaldehyde should be made up as follows: 1 part of 40% formaldehyde and 9 parts of water. An appropriate buffer of 7 – 8 is to be used (e.g. 2 gram borax added to 98 ml of 40% formaldehyde).

The plankton volume should not exceed 50% of the volume of the jar. If the sample contains more plankton, additional jars should be used for storage.

Fixation should take place immediately after retrieval of the sample from the tow net and before any sub sampling.

4.3 Stations with high records of small larvae

To ensure that stations with high densities of small larvae are recognize early enough to conduct additional sampling within that square, the samples should be checked directly after each haul. If the sample is believed to contain more than 1000 small larvae (<10 mm), at least two additional stations in that square are recommended. These stations should be placed around 2 miles from the centre of the 10x10 nm grid.

4.4 Sorting and measuring

Prior to sorting larvae must be exposed for at least 48 hours into the conservation fluid to ensure proper fixation. After sorting, larvae should be stored again in a 4% formaldehyde-water solution to keep larvae shrinkage comparable.

It is advisable that all larvae are sorted and counted in all samples. However, if this is not possible sub sampling techniques may be used. The larvae tend to aggregate with plankton and other larvae, thus splitting the sample just in two halves is preferred instead of multiple splitting.

Whenever available, a sub sample of at least 200 larvae per station should be measured. All larvae should be measured as total length and to millimetre below (e.g. 10 mm size-group ranges from 10.00 to 10.99 mm).

Yolk-sac larvae should be included in the measurements. If yolk-sac larvae are detected in the samples, their number should be reported to aid in the localization of spawning grounds.

For identification of clupeid larvae Russell (1976) can be recommended. For species identification of herring and sprat, myotomes should be counted from a reasonable amount in all size groups in a sample.

5. Data Treatment

5.1 Data Sheet

For each station the minimum amount of information is the station and haul number, position, date and time (UTC), haul duration, flowmeter revolutions, bottom and sampler depth, water bottom temperature and ship’s direction. For the whole cruise information on gear type and flowmeter calibration is needed. After finalization of larvae measurements information about the length distribution must be given for each specific station. An example for the data sheet is given in the Annex 6.5.

5.2 Calculations

The numbers of larvae per square metre at each station can be calculated as:

$$n / m^2 = \frac{larvae\ \ per\ sample\ (n) * bottom\ depth\ (m)}{volume\ \ filtered\ (m^3)}$$

The volume filtered is obtained from the formula:

$$Volume\ \ filtered\ \ = \frac{area\ of\ \ mouth\ opening\ (m^2)*efficieny\ \ factor*flowmeter\ revolutions}{flowmeter\ calibration\ constant}$$

5.3 Data exchange

The International Herring Larvae Database is held at the Leibniz Institute of Marine Sciences in Kiel, Germany. Excel Spreadsheets with the requested data should be sent to the Institute as soon as they are available. Reporting should be done not later than the third week in February to ensure that there is enough time for the necessary database update and the specific calculation procedures prior to the Meeting of the Herring Assessment Working Group (HAWG).

5.4 Database

The herring larval data is updated annually since 1972. The database contains the following information:

- general heading information listing the area surveyed, the survey vessel, the flowmeter calibration in revolutions per metre, the type of gear and the survey dates
- Location and sampling details, e.g. the date and position of the haul, the time (UTC) of the haul, the sampler and bottom depths, the hauls duration and the total number of larvae taken in the haul
- the length distributions of the measured larvae
- larvae abundance estimates for the relevant length classes at each station (n/m²)

5.5 Larvae Abundance Index

The calculation procedure for the larval abundance index (LAI) follows in principle the procedure described in the IHLS documentation (Anon. 1995).

Four spawning areas are distinguished and sampled separate. In order to define how complete the area and time units have been sampled, a coverage value is defined and expressed as percentage standard positions sampled within each unit:

$$Coverage_{Year,Unit} = \frac{sampled\ positions_{Year,Unit}}{standard\ positions\ in\ the\ area\ definition\ file_{Unit}} * 100$$

For each year and standard position the measured larvae are aggregated into the following three length frequency distribution groupings:

5mm ≤ larvae < 10 mm	(< 11 mm for the Southern North Sea)
10 mm ≤ larvae ≤ 15 mm	(11 mm ≤ larvae ≤ 16 mm for the SNS)
15mm ≤ larvae ≤ 24 mm	(16 mm ≤ larvae ≤ 24 mm for the SNS)

Larvae numbers per square metre are calculated for each year and position by the formulae given below for three time periods separately. The differences in these formulae reflect changes in the information given for flowmeter calibrations:

a) 1972 – 1980

$$n/m^2_{Year,10x10\ rectangle} = grouped\ LFD * \left(\frac{Total\ n/m^2}{Total\ LFD * Efficieny\ Factor} \right)$$

b) 1981 – 1982

$$Raising\ Factor = \frac{total\ n\ caught}{total\ LFD}$$

$$Calibration\ Factor = \frac{flowmeter\ calibration * bottom\ depth}{flowmeter\ revolutions * pi * \left(\frac{aperture}{2} \right)^2 * efficiency\ \ factor}$$

$$n/m^2_{Year,10*10\ rectangle} = grouped\ LFD * raising\ \ factor * calibration\ \ factor$$

c) from 1983 onwards

$$Raising\ Factor = \frac{total\ n\ caught}{total\ measured}$$

$$Calibration\ Factor = \frac{flowmeter\ calibration * bottom\ depth}{flowmeter\ revolutions * pi * \left(\frac{aperture}{2}\right)^2 * efficiency\ \ factor}$$

$$n/m^2_{Year,10*10\ rectangle} = grouped\ LFD * raising\ \ factor * calibration\ \ factor$$

In case of replicate sampling within a 10*10 nm rectangle and time period, the number of larvae obtained is averaged. If sampling was done within a three days interval, the number of larvae within this three days interval is average first. Afterwards the number of larvae for all observations at this station within the half month period is averaged.

The number of larvae per square metre at each station is used to calculate mean numbers of larvae per m² for each 10*20nm rectangle (consists of 9 stations in total). These values are raised by the sea surface corresponding to that rectangle, i.e.

$$\overline{n/m^2_{\ Year,10\ \ *20\ \ rectangle}} = \frac{1}{n}\sum n/m^2_{\ Year,10\ \ *10\ \ rectangle}$$

$$LAI_{Year,10*20\ rectangle} = \overline{n/m^2_{Year,10*20\ rectangle}} * Area_{10*20\ rectangle}$$

These estimates are summed up to calculate larval abundance indices and related coefficients of variance (CVs) for each LAI unit and year, i.e.

$$LAI_{Year,Unit} = \sum LAI_{Year,10*20\ rectangle}$$

$$CV(LAI_{Year,Unit}) = \frac{\sigma(LAI_{Year,Unit})}{LAI_{Year,Unit}} * 100$$

where $\sigma(LAI_{Year,\ Unit})$ is the standard deviation and $\overline{LAI_{Year,Unit}}$ the mean Larval abundance index calculated per year and unit.

The methods used for the calculation of abundance indices are described in Rohlf *et al*. (1998) in detail.

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6. Appendix

6.1. Surveys in the Orkney/Shetland area

Table 6.1.1: Positions in Orkney/Shetlands, 01.09. – 15.09. (Area code B1)

LATITUDE	LONGITUDE	ICES-CODE		LATITUDE	LONGITUDE	ICES-CODE
59°55N	03°50W	48E6a		59°05N	01°30W	47E8h
59°55N	03°30W	48E6b		59°05N	01°10W	47E8i
59°55N	03°10W	48E6c		58°55N	03°50W	46E6a
59°55N	02°50W	48E7a		58°55N	03°30W	46E6b
59°55N	02°30W	48E7b		58°55N	02°30W	46E7b
59°55N	02°10W	48E7c		58°55N	02°10W	46E7c
59°55N	01°50W	48E8a		58°55N	01°50W	46E8a
59°55N	01°30W	48E8b		58°55N	01°30W	46E8b
59°55N	01°10W	48E8c		58°55N	01°10W	46E8c
59°45N	03°50W	48E6d		58°45N	03°50W	46E6d
59°45N	03°30W	48E6e		58°45N	03°30W	46E6e
59°45N	03°10W	48E6f		58°45N	02°50W	46E7d
59°45N	02°50W	48E7d		58°45N	02°30W	46E7e
59°45N	02°30W	48E7e		58°45N	02°10W	46E7f
59°45N	02°10W	48E7f		58°45N	01°50W	46E8d
59°45N	01°50W	48E8d		58°45N	01°30W	46E8e
59°45N	01°30W	48E8e		58°45N	01°10W	46E8f
59°45N	01°10W	48E8f		58°35N	03°50W	46E6g
59°35N	03°50W	48E6g		58°35N	03°30W	46E6h
59°35N	03°30W	48E6h		58°35N	03°10W	46E6i
59°35N	03°10W	48E6i		58°35N	02°50W	46E7g
59°35N	02°50W	48E7g		58°35N	02°30W	46E7h
59°35N	02°30W	48E7h		58°35N	02°10W	46E7i
59°35N	02°10W	48E7i		58°35N	01°50W	46E8g
59°35N	01°50W	48E8g		58°35N	01°30W	46E8h
59°35N	01°30W	48E8h		58°35N	01°10W	46E8i
59°35N	01°10W	48E8i		58°25N	03°10W	45E6c
59°25N	03°50W	47E6a		58°25N	02°50W	45E7a
59°25N	03°30W	47E6b		58°25N	02°30W	45E7b
59°25N	03°10W	47E6c		58°25N	02°10W	45E7c
59°25N	02°50W	47E7a		58°25N	01°50W	45E8b
59°25N	02°30W	47E7b		58°25N	01°30W	45E8b
59°25N	02°10W	47E7c		58°25N	01°10W	45E8c
59°25N	01°50W	47E8a		58°15N	03°10W	45E6f
59°25N	01°30W	47E8b		58°15N	02°50W	45E7d
59°25N	01°10W	47E8c		58°15N	02°30W	45E7e
59°15N	03°50W	47E6d		58°15N	02°10W	45E7f
59°15N	03°30W	47E6e		58°15N	01°50W	45E8d
59°15N	03°10W	47E6f		58°15N	01°30W	45E8e
59°15N	02°30W	47E7e		58°15N	01°10W	45E8f
59°15N	02°10W	47E7f		58°05N	03°30W	45E6h
59°15N	01°50W	47E8d		58°05N	03°10W	45E6i
59°15N	01°30W	47E8e		58°05N	02°50W	45E7g
59°15N	01°10W	47E8f		58°05N	02°30W	45E7h
59°05N	03°50W	47E6g		58°05N	02°10W	45E7i
59°05N	03°30W	47E6h		58°05N	01°50W	45E8g
59°05N	02°30W	47E7h		58°05N	01°30W	45E8h
59°05N	02°10W	47E7i		58°05N	01°10W	45E8i
59°05N	01°50W	47E8g				

Table 6.1.2: Positions in Orkney/Shetlands, 15.09. – 30.09. (Area code B2)

LATITUDE	LONGITUDE	ICES-CODE		LATITUDE	LONGITUDE	ICES-CODE
59°55N	03°30W	48E6b		59°05N	01°30W	47E8h
59°55N	03°10W	48E6c		59°05N	01°10W	47E8i
59°55N	02°50W	48E7a		58°55N	03°50W	46E6a
59°55N	02°30W	48E7b		58°55N	03°30W	46E6b
59°55N	02°10W	48E7c		58°55N	02°30W	46E7b
59°55N	01°50W	48E8a		58°55N	02°10W	46E7c
59°55N	01°30W	48E8b		58°55N	01°50W	46E8a
59°55N	01°10W	48E8c		58°55N	01°30W	46E8b
59°45N	03°30W	48E6e		58°55N	01°10W	46E8c
59°45N	03°10W	48E6f		58°45N	03°50W	46E6d
59°45N	02°50W	48E7d		58°45N	03°30W	46E6e
59°45N	02°30W	48E7e		58°45N	02°50W	46E7d
59°45N	02°10W	48E7f		58°45N	02°30W	46E7e
59°45N	01°50W	48E8d		58°45N	02°10W	46E7f
59°45N	01°30W	48E8e		58°45N	01°50W	46E8d
59°45N	01°10W	48E8f		58°45N	01°30W	46E8e
59°35N	03°50W	48E6g		58°45N	01°10W	46E8f
59°35N	03°30W	48E6h		58°35N	03°50W	46E6g
59°35N	03°10W	48E6i		58°35N	03°30W	46E6h
59°35N	02°50W	48E7g		58°35N	03°10W	46E6i
59°35N	02°30W	48E7h		58°35N	02°50W	46E7g
59°35N	02°10W	48E7i		58°35N	02°30W	46E7h
59°35N	01°50W	48E8g		58°35N	02°10W	46E7i
59°35N	01°30W	48E8h		58°35N	01°50W	46E8g
59°35N	01°10W	48E8i		58°35N	01°30W	46E8h
59°25N	03°50W	47E6a		58°35N	01°10W	46E8i
59°25N	03°30W	47E6b		58°25N	03°10W	45E6c
59°25N	03°10W	47E6c		58°25N	02°50W	45E7a
59°25N	02°50W	47E7a		58°25N	02°30W	45E7b
59°25N	02°30W	47E7b		58°25N	02°10W	45E7c
59°25N	02°10W	47E7c		58°25N	01°50W	45E8a
59°25N	01°50W	47E8a		58°25N	01°30W	45E8b
59°25N	01°30W	47E8b		58°25N	01°10W	45E8b
59°25N	01°10W	47E8c		58°15N	03°10W	45E6f
59°15N	03°50W	47E6d		58°15N	02°50W	45E7d
59°15N	03°30W	47E6e		58°15N	02°30W	45E7e
59°15N	03°10W	47E6f		58°15N	02°10W	45E7f
59°15N	02°30W	47E7e		58°15N	01°50W	45E8d
59°15N	02°10W	47E7f		58°15N	01°30W	45E8e
59°15N	01°50W	47E8d		58°15N	01°10W	45E8f
59°15N	01°30W	47E8e		58°05N	03°30W	45E6h
59°15N	01°10W	47E8f		58°05N	03°10W	45E6i
59°05N	03°50W	47E6g		58°05N	02°50W	45E7g
59°05N	03°30W	47E6h		58°05N	02°30W	45E7h
59°05N	02°30W	47E7h		58°05N	02°10W	45E7i
59°05N	02°10W	47E7i		58°05N	01°50W	45E8g
59°05N	01°50W	47E8g		58°05N	01°30W	45E8h
				58°05N	01°10W	45E8i

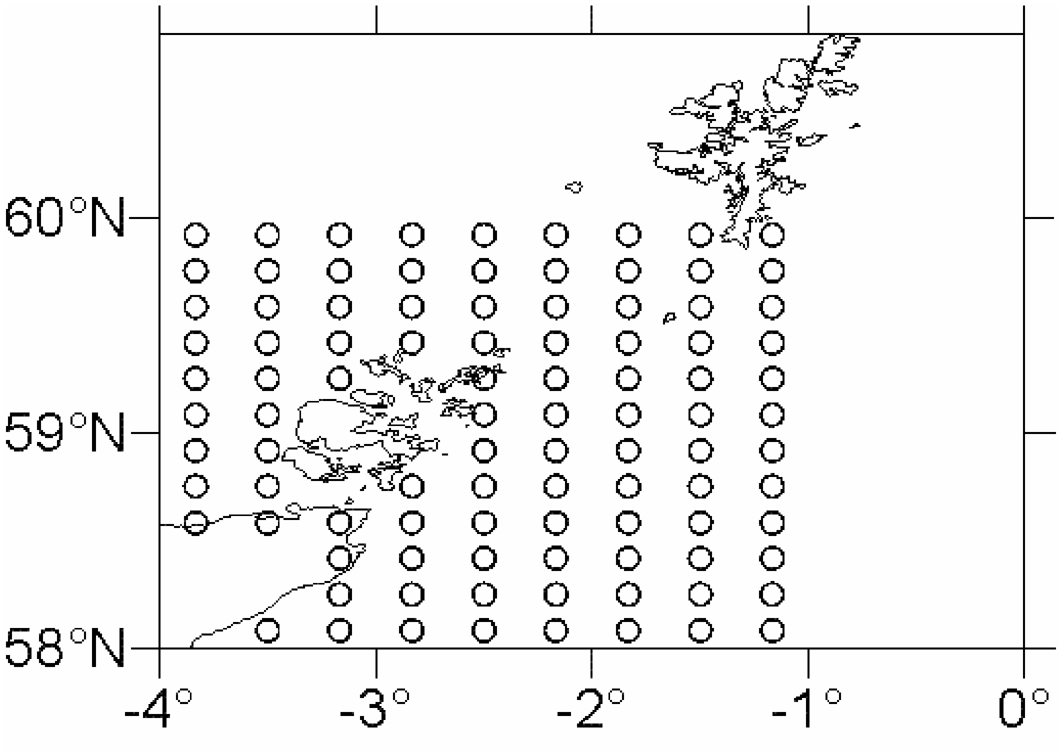

Figure 6.1.1: Station grid in Orkney/Shetlands, 01.09. – 15.09.

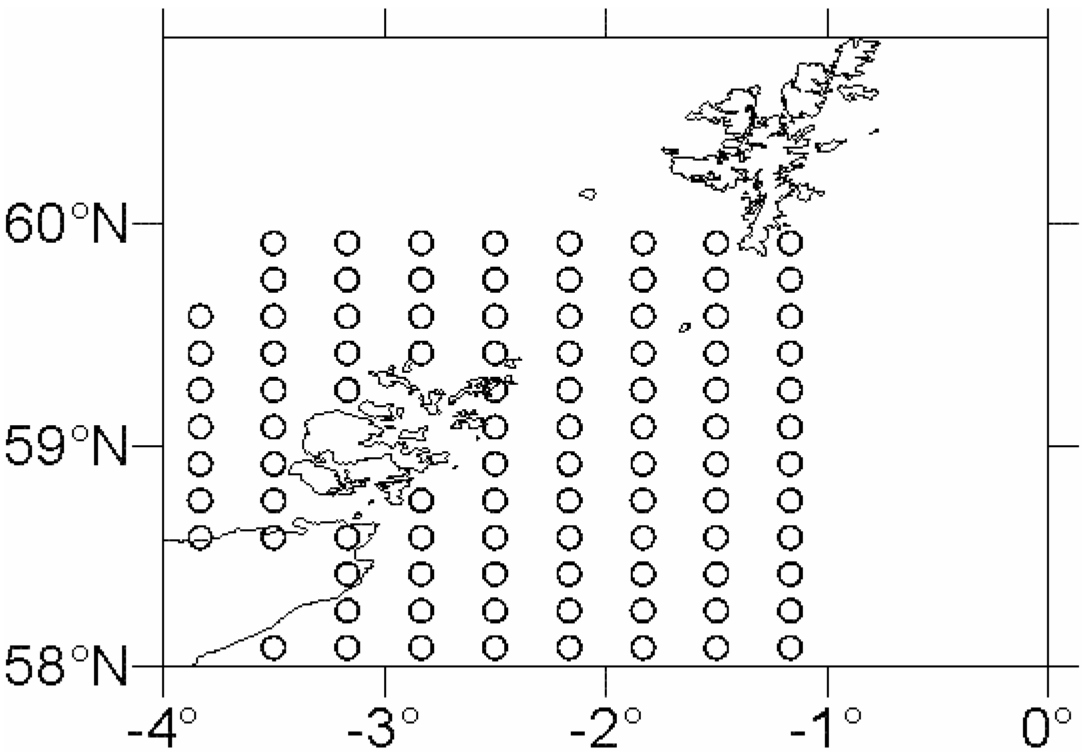

Figure 6.1.2: Station grid in Orkney/Shetlands, 15.09. – 30.09.

6.2 Surveys in the Buchan area

Table 6.2.1: Positions in the Buchan-Area, 01.09. – 15.09. (Area code C1)

LATITUDE	LONGITUDE	ICES-CODE		LATITUDE	LONGITUDE	ICES-CODE
57°55N	03°50W	44E6a		57°05N	00°50W	43E9g
57°55N	03°30W	44E6b		57°05N	00°30W	43E9h
57°55N	03°10W	44E6c		57°05N	00°10W	43E9i
57°55N	02°50W	44E7a		56°55N	02°10W	42E7c
57°55N	02°30W	44E7b		56°55N	01°50W	42E8a
57°55N	02°10W	44E7c		56°55N	01°30W	42E8b
57°55N	01°50W	44E8a		56°55N	01°10W	42E8c
57°55N	01°30W	44E8b		56°55N	00°50W	42E9a
57°55N	01°10W	44E8c		56°55N	00°30W	42E9b
57°55N	00°50W	44E9a		56°55N	00°10W	42E9c
57°45N	03°50W	44E6d		56°45N	02°10W	42E7f
57°45N	03°30W	44E6e		56°45N	01°50W	42E8d
57°45N	03°10W	44E6f		56°45N	01°30W	42E8e
57°45N	02°50W	44E7d		56°45N	01°10W	42E8f
57°45N	02°30W	44E7e		56°45N	00°50W	42E9d
57°45N	02°10W	44E7f		56°45N	00°30W	42E9e
57°45N	01°50W	44E8d		56°45N	00°10W	42E9f
57°45N	01°30W	44E8e		56°35N	02°10W	42E7i
57°45N	01°10W	44E8f		56°35N	01°50W	42E8g
57°45N	00°50W	44E9d		56°35N	01°30W	42E8h
57°35N	01°50W	44E8g		56°35N	01°10W	42E8i
57°35N	01°30W	44E8h		56°35N	00°50W	42E9g
57°35N	01°10W	44E8i		56°35N	00°30W	42E9h
57°35N	00°50W	44E9g		56°35N	00°10W	42E9i
57°25N	01°50W	43E8a		56°25N	02°10W	41E7c
57°25N	01°30W	43E8b		56°25N	01°50W	41E8a
57°25N	01°10W	43E8c		56°25N	01°30W	41E8b
57°25N	00°50W	43E9a		56°25N	01°10W	41E8c
57°25N	00°30W	43E9b		56°25N	00°50W	41E9a
57°25N	00°10W	43E9c		56°15N	02°30W	41E7e
57°15N	01°50W	43E8d		56°15N	02°10W	41E7f
57°15N	01°30W	43E8e		56°15N	01°50W	41E8d
57°15N	01°10W	43E8f		56°15N	01°30W	41E8e
57°15N	00°50W	43E9d		56°15N	01°10W	41E8f
57°15N	00°30W	43E9e		56°15N	00°50W	41E9d
57°15N	00°10W	43E9f		56°05N	02°10W	41E7i
57°05N	01°50W	43E8g		56°05N	01°50W	41E8g
57°05N	01°30W	43E8h		56°05N	01°30W	41E8h
57°05N	01°10W	43E8i		56°05N	01°10W	41E8i
				56°05N	00°50W	41E9g

Table 6.2.2: Positions in the Buchan-Area, 16.09. – 30.09. (Area code C2)

Latitude	Longitude	ICES-Code
57°55N	02°50W	44E7a
57°55N	02°30W	44E7b
57°55N	02°10W	44E7c
57°55N	01°50W	44E8a
57°55N	01°30W	44E8b
57°55N	01°10W	44E8c
57°55N	00°50W	44E9a
57°45N	02°50W	44E7d
57°45N	02°30W	44E7e
57°45N	02°10W	44E7f
57°45N	01°50W	44E8d
57°45N	01°30W	44E8e
57°45N	01°10W	44E8f
57°45N	00°50W	44E9d
57°35N	01°50W	44E8g
57°35N	01°30W	44E8h
57°35N	01°10W	44E8i
57°35N	00°50W	44E9g
57°25N	01°50W	43E8a
57°25N	01°30W	43E8b
57°25N	01°10W	43E8c
57°25N	00°50W	43E9a
57°25N	00°30W	43E9b
57°25N	00°10W	43E9c
57°15N	01°50W	43E8d
57°15N	01°30W	43E8e
57°15N	01°10W	43E8f
57°15N	00°50W	43E9d
57°15N	00°30W	43E9e
57°15N	00°10W	43E9f
57°05N	01°50W	43E8g
57°05N	01°30W	43E8h
57°05N	01°10W	43E8i
57°05N	00°50W	43E9g
57°05N	00°30W	43E9h
57°05N	00°10W	43E9i
56°55N	02°10W	42E7c
56°55N	01°50W	42E8a
56°55N	01°30W	42E8b
56°55N	01°10W	42E8c
56°55N	00°50W	42E9a
56°55N	00°30W	42E9b
56°55N	00°10W	42E9c
56°45N	02°10W	42E7f
56°45N	01°50W	42E8d
56°45N	01°30W	42E8e
56°45N	01°10W	42E8f
56°45N	00°50W	42E9d
56°45N	00°30W	42E9e
56°45N	00°10W	42E9f
56°35N	02°10W	42E7i
56°35N	01°50W	42E8g
56°35N	01°30W	42E8h
56°35N	01°10W	42E8i
56°35N	00°50W	42E9g
56°35N	00°30W	42E9h
56°35N	00°10W	42E9i
56°25N	02°10W	41E7c
56°25N	01°50W	41E8a
56°25N	01°30W	41E8b
56°25N	01°10W	41E8c
56°25N	00°50W	41E9a
56°15N	02°30W	41E7e
56°15N	02°10W	41E7f
56°15N	01°50W	41E8d
56°15N	01°30W	41E8e
56°15N	01°10W	41E8f
56°15N	00°50W	41E9d
56°05N	02°10W	41E7i
56°05N	01°50W	41E8g
56°05N	01°30W	41E8h
56°05N	01°10W	41E8i
56°05N	00°50W	41E9g

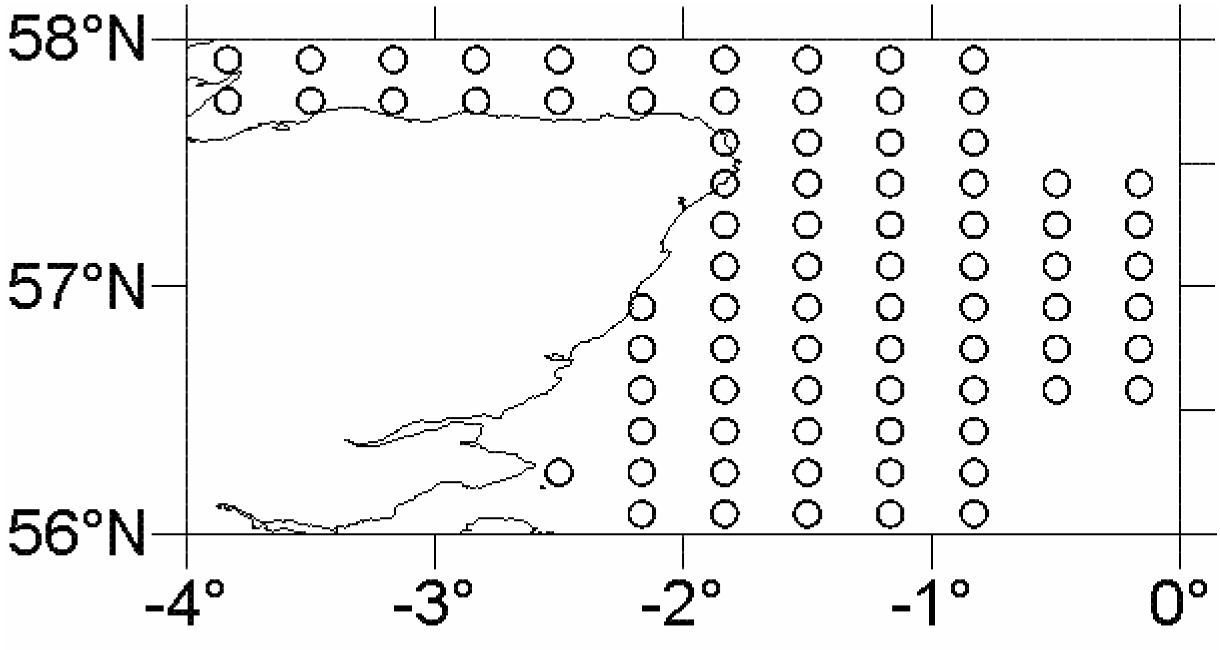

Figure 6.2.1: Station grid in the Buchan-Area, 01.09. – 15.09.

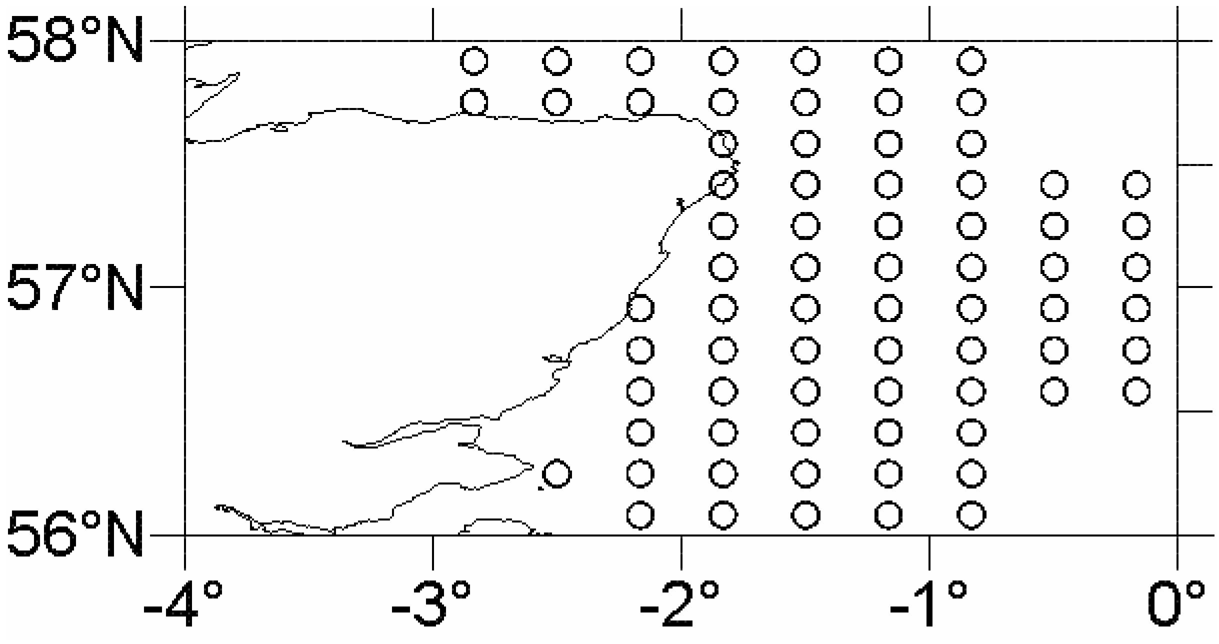

Figure 6.2.2: Station grid in the Buchan-Area, 15.09. – 30.09.

6.3 Surveys in the Central North Sea

Table 6.3.1: Positions in the Central North Sea, 01.09. – 15.09. (Area code D1)

Latitude	Longitude	ICES-Code	Latitude	Longitude	ICES-Code
55°55N	01°50W	40E8a	54°35N	00°50W	38E9g
55°55N	01°30W	40E8b	54°35N	00°30W	38E9h
55°55N	01°10W	40E8c	54°35N	00°10W	38E9i
55°55N	00°50W	40E9a	54°35N	00°10E	38F0g
55°45N	01°50W	40E8d	54°35N	00°30E	38F0h
55°45N	01°30W	40E8e	54°35N	00°50E	38F0i
55°45N	01°10W	40E8f	54°35N	01°10E	38F1g
55°45N	00°50W	40E9d	54°25N	00°10W	37E9c
55°35N	01°30W	40E8h	54°25N	00°10W	37F0a
55°35N	01°10W	40E8i	54°25N	00°30W	37F0b
55°35N	00°50W	40E9g	54°25N	00°50W	37F0c
55°35N	00°30W	40E9h	54°25N	01°10W	37F1a
55°25N	01°30W	39E8b	54°15N	00°10W	37E9f
55°25N	01°10W	39E8c	54°15N	00°10E	37F0d
55°25N	00°50W	39E9a	54°15N	00°30E	37F0e
55°15N	01°30W	39E8e	54°15N	00°50E	37F0f
55°15N	01°10W	39E8f	54°15N	01°10E	37F1d
55°15N	00°50W	39E9d	54°05N	00°10E	37F0g
55°05N	01°10W	39E8i	54°05N	00°30E	37F0h
55°05N	00°50W	39E9g	54°05N	00°50E	37F0i
55°05N	00°30W	39E9h	54°05N	01°10E	37F1g
54°55N	01°10W	38E8c	53°55N	00°10E	36F0a
54°55N	00°50W	38E9a	53°55N	00°30E	36F0b
54°55N	00°30W	38E9b	53°55N	00°50E	36F0c
54°55N	00°10W	38E9c	53°55N	01°10E	36F1a
54°45N	01°10W	38E8f	53°45N	00°10E	36F0d
54°45N	00°50W	38E9d	53°45N	00°30E	36F0e
54°45N	00°30W	38E9e	53°45N	00°50E	36F0f
54°45N	00°10W	38E9f	53°45N	01°10E	36F1d
54°45N	00°10E	38F0d	53°35N	00°30E	36F0h
54°45N	00°30E	38F0e	53°35N	00°50E	36F0i
54°45N	00°50E	38F0f	53°35N	01°10E	36F1g

Table 6.3.2: Positions in the Central North Sea, 16.09. – 30.09. (Area code D2)

Latitude	Longitude	ICES-Code
55°55N	01°50W	40E8a
55°55N	01°30W	40E8b
55°55N	01°10W	40E8c
55°55N	00°50W	40E9a
55°45N	01°50W	40E8d
55°45N	01°30W	40E8e
55°45N	01°10W	40E8f
55°45N	00°50W	40E9d
55°35N	01°30W	40E8h
55°35N	01°10W	40E8i
55°35N	00°50W	40E9g
55°25N	01°30W	39E8b
55°25N	01°10W	39E8c
55°25N	00°50W	39E9a
55°15N	01°30W	39E8e
55°15N	01°10W	39E8f
55°15N	00°50W	39E9d
55°05N	01°10W	39E8i
55°05N	00°50W	39E9g
55°05N	00°30W	39E9h
54°55N	01°10W	38E8c
54°55N	00°50W	38E9a
54°55N	00°30W	38E9b
54°55N	00°10W	38E9c
54°45N	01°10W	38E8f
54°45N	00°50W	38E9d
54°45N	00°30W	38E9e
54°45N	00°10W	38E9f
54°45N	00°10E	38F0d
54°35N	00°50W	38E9g
54°35N	00°30W	38E9h
54°35N	00°10W	38E9i
54°35N	00°10E	38F0g

Latitude	Longitude	ICES-Code
54°35N	00°30E	38F0h
54°35N	00°50E	38F0i
54°35N	01°10E	38F1g
54°25N	00°10W	37E9c
54°25N	00°10E	37F0a
54°25N	00°30E	37F0b
54°25N	00°50E	37F0c
54°25N	01°10E	37F1a
54°25N	01°30E	37F1b
54°15N	00°10W	37E9f
54°15N	00°10E	37F0d
54°15N	00°30E	37F0e
54°15N	00°50E	37F0f
54°15N	01°10E	37F1d
54°15N	01°30E	37F1e
54°05N	00°10E	37F0g
54°05N	00°30E	37F0h
54°05N	00°50E	37F0i
54°05N	01°10E	37F1g
54°05N	01°30E	37F1h
53°55N	00°10E	36F0a
53°55N	00°30E	36F0b
53°55N	00°50E	36F0c
53°55N	01°10E	36F1a
53°55N	01°30E	36F1b
53°45N	00°10E	36F0d
53°45N	00°30E	36F0e
53°45N	00°50E	36F0f
53°45N	01°10E	36F1d
53°45N	01°30E	36F1e
53°35N	00°30E	36F0h
53°35N	00°50E	36F0i
53°35N	01°10E	36F1g
53°35N	01°30E	36F1h

Table 6.3.3: Positions in the Central North Sea, 01.10. – 15.10. (Area code D3)

Latitude	Longitude	ICES-Code
55°55N	01°50W	40E8a
55°55N	01°30W	40E8b
55°55N	01°10W	40E8c
55°55N	00°50W	40E9a
55°55N	00°30W	40E9b
55°55N	00°10W	40E9c
55°45N	01°50W	40E8d
55°45N	01°30W	40E8e
55°45N	01°10W	40E8f
55°45N	00°50W	40E9d
55°45N	00°30W	40E9e
55°45N	00°10W	40E9f
55°35N	01°30W	40E8h
55°35N	01°10W	40E8i
55°35N	00°50W	40E9g
55°35N	00°30W	40E9h
55°35N	00°10W	40E9i
55°25N	01°30W	39E8b
55°25N	01°10W	39E8c
55°25N	00°50W	39E9a
55°25N	00°30W	39E9b
55°25N	00°10W	39E9c
55°15N	01°30W	39E8e
55°15N	01°10W	39E8f
55°15N	00°50W	39E9d
55°15N	00°30W	39E9e
55°15N	00°10W	39E9f
55°05N	01°10W	39E8i
55°05N	00°50W	39E9g
55°05N	00°30W	39E9h
55°05N	00°10W	39E9i
54°55N	01°10W	38E8c
54°55N	00°50W	38E9a
54°55N	00°30W	38E9b
54°55N	00°10W	38E9c
54°55N	00°10E	38F0a
54°55N	00°30E	38F0b
54°55N	00°50E	38F0c
54°55N	01°10E	38F1a
54°55N	01°30E	38F1b
54°55N	01°50E	38F1c
54°45N	01°10W	38E8f
54°45N	00°50W	38E9d
54°45N	00°30W	38E9e
54°45N	00°10W	38E9f
54°45N	00°10E	38F0d
54°45N	00°30E	38F0e
54°45N	00°50E	38F0f
54°45N	01°10E	38F1d
54°35N	00°50E	38F0i
54°35N	01°10E	38F1g
54°35N	01°30E	38F1h
54°35N	01°50E	38F1i
54°25N	00°10W	37E9c
54°25N	00°10E	37F0a
54°25N	00°30E	37F0b
54°25N	00°50E	37F0c
54°25N	01°10E	37F1a
54°25N	01°30E	37F1b
54°25N	01°50E	37F1c
54°25N	02°10E	37F2a
54°25N	02°30E	37F2b
54°15N	00°10W	37E9f
54°15N	00°10E	37F0d
54°15N	00°30E	37F0e
54°15N	00°50E	37F0f
54°15N	01°10E	37F1d
54°15N	01°30E	37F1e
54°15N	01°50E	37F1f
54°15N	02°10E	37F2d
54°15N	02°30E	37F2e
54°05N	00°10E	37F0g
54°05N	00°30E	37F0h
54°05N	00°50E	37F0h
54°05N	01°10E	37F1g
54°05N	01°30E	37F1h
54°05N	01°50E	37F1i
54°05N	02°10E	37F2g
54°05N	02°30E	37F2h
53°55N	00°10E	36F0a
53°55N	00°30E	36F0b
53°55N	00°50E	36F0c
53°55N	01°10E	36F1a
53°55N	01°30E	36F1b
53°55N	01°50E	36F1c
53°55N	02°10E	36F2a
53°55N	02°30E	36F2b
53°55N	02°50E	36F2c
53°45N	00°10E	36F0d
53°45N	00°30E	36F0e
53°45N	00°50E	36F0f
53°45N	01°10E	36F1d
53°45N	01°30E	36F1e
53°45N	01°50E	36F1f
53°45N	02°10E	36F2d
53°45N	02°30E	36F2e
53°45N	02°50E	36F2f
53°35N	00°30E	36F0h

Table 6.3.3 continued: Positions in the Central North Sea, 01.10. – 15.10. (Area code D3)

Latitude	Longitude	ICES-Code
54°45N	01°30E	38F1e
54°45N	01°50E	38F1f
54°35N	00°30W	38E9h
54°35N	00°10W	38E9i
54°35N	00°10E	38F0g
54°35N	00°30E	38F0h

Latitude	Longitude	ICES-Code
53°35N	00°50E	36F0i
53°35N	01°10E	36F1g
53°35N	01°30E	36F1h
53°35N	01°50E	36F1i
53°35N	02°10E	36F2g
53°35N	02°30E	36F2h
53°35N	02°50E	36F2i

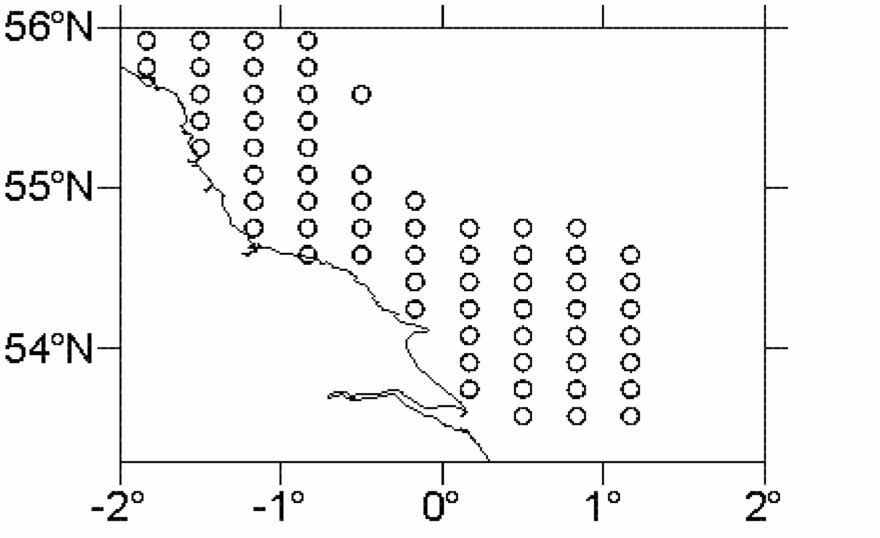

Figure 6.3.1: Station grid in the Central North Sea, 01.09. – 15.09.

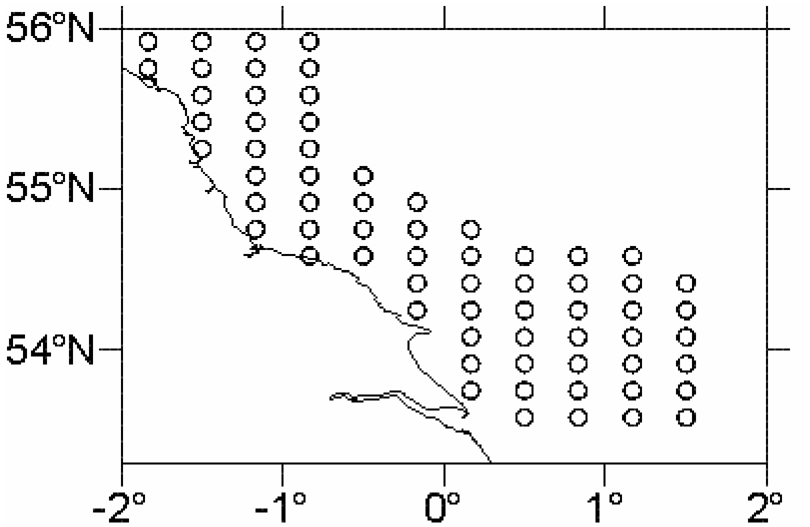

Figure 6.3.2: Station grid in the Central North Sea, 16.09. – 30.09.

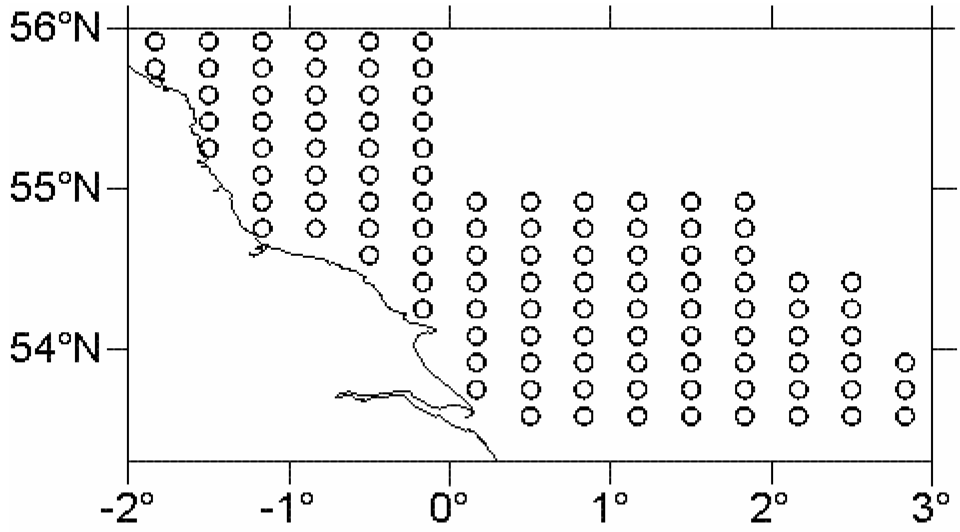

Figure 6.3.3: Station grid in the Central North Sea, 01.10. – 15.10.

6.4 Surveys in the Southern North Sea

Table 6.4.1: Positions in the Southern North Sea, 16.12. – 31.12. (Area code E1)

LATITUDE	LONGITUDE	ICES-CODE
51°55N	02°30E	33F2a
51°55N	02°50E	33F2b
51°55N	03°10E	33F2c
51°45N	02°10E	33F3a
51°45N	02°30E	33F3b
51°45N	02°50E	33F3c
51°45N	03°10E	33F4a
51°35N	01°50E	33F2d
51°35N	02°10E	33F2e
51°35N	02°30E	33F2f
51°35N	02°50E	33F3d
51°35N	03°10E	33F3e
51°25N	01°50E	33F3f
51°25N	02°10E	33F4d
51°25N	02°30E	33F2g
51°25N	02°50E	33F2h
51°15N	01°50E	33F2i
51°15N	02°10E	33F3g
51°05N	01°30E	33F3h
51°05N	01°50E	33F3i
50°55N	01°10E	32F2a
50°55N	01°30E	32F2b
50°45N	00°50E	32F2c
50°45N	01°10E	32F3a
50°45N	01°30E	32F3b
50°35N	00°10E	32F1f
50°35N	00°30E	32F2d
50°35N	00°50E	32F2e
50°35N	01°10E	32F2f
50°35N	01°30E	32F3d
50°25N	00°10E	32F3e
50°25N	00°30E	32F1i
50°25N	00°50E	32F2g
50°25N	01°10E	32F2h
50°25N	01°30E	32F2i
50°15N	00°10W	32F3g
50°15N	00°10E	31F1c
50°15N	00°30E	31F2a
50°15N	00°50E	31F2b
50°15N	01°10E	31F2c
50°05N	00°30W	31F1f
50°05N	00°10W	31F2d
50°05N	00°10E	31F2e
50°05N	00°30E	31F1h
50°05N	00°50E	31F1i
50°05N	01°10E	30F1a
49°55N	00°30W	30F1b
49°55N	00°10W	30F0f
49°55N	00°10E	30F1d
49°55N	00°30E	30F1e
49°55N	00°50E	30F0h
49°45N	00°30W	30F0i
49°45N	00°10W	30F1g
49°45N	00°10E	30F1h
49°35N	00°30W	29F0a
49°35N	00°10W	29F0b
49°25N	00°30W	29F0c
49°25N	00°10W	29F1a

Table 6.4.2: Positions in the Southern North Sea, 01.01. – 15.01. (Area code E2).

LATITUDE	LONGITUDE	ICES-CODE
52°25N	02°50E	33F2c
52°25N	03°10E	33F3a
52°25N	03°30E	33F3b
52°15N	02°30E	33F2e
52°15N	02°50E	33F2f
52°15N	03°10E	33F3d
52°15N	03°30E	33F3e
52°15N	03°50E	33F3f
52°15N	04°10E	33F4d
52°05N	02°30E	33F2h
52°05N	02°50E	33F2i
52°05N	03°10E	33F3g
52°05N	03°30E	33F3h
52°05N	03°50E	33F3i
51°55N	02°30E	32F2b
51°55N	02°50E	32F2c
51°55N	03°10E	32F3a
51°55N	03°30E	32F3b
51°45N	02°10E	32F2d
51°45N	02°30E	32F2e
51°45N	02°50E	32F2f
51°45N	03°10E	32F3d
51°45N	03°30E	32F3e
51°35N	01°50E	32F1i
51°35N	02°10E	32F2g
51°35N	02°30E	32F2h
51°35N	02°50E	32F2i
51°35N	03°10E	32F3g
51°25N	01°50E	31F1c
51°25N	02°10E	31F2a
51°25N	02°30E	31F2b
51°25N	02°50E	31F2c
51°15N	01°50E	31F1f
51°15N	02°10E	31F2d
51°15N	02°30E	31F2e
51°05N	01°30E	31F1h
51°05N	01°50E	31F1i

LATITUDE	LONGITUDE	ICES-CODE
50°55N	01°10E	30F1a
50°55N	01°30E	30F1b
50°45N	00°50E	30F0f
50°45N	01°10E	30F1d
50°45N	01°30E	30F1e
50°35N	00°30E	30F0h
50°35N	00°50E	30F0i
50°35N	01°10E	30F1g
50°35N	01°30E	30F1h
50°25N	00°10E	29F0a
50°25N	00°30E	29F0b
50°25N	00°50E	29F0c
50°25N	01°10E	29F1a
50°25N	01°30E	29F1b
50°15N	00°10W	29E9f
50°15N	00°10E	29F0d
50°15N	00°30E	29F0e
50°15N	00°50E	29F0f
50°15N	01°10E	29F1d
50°05N	00°30W	29E9h
50°05N	00°10W	29E9i
50°05N	00°10E	29F0g
50°05N	00°30E	29F0h
50°05N	00°50E	29F0i
50°05N	01°10E	29F1g
49°55N	00°30W	28E9b
49°55N	00°10W	28E9c
49°55N	00°10E	28F0a
49°55N	00°30E	28F0b
49°55N	00°50E	28F0c
49°45N	00°30W	28E9e
49°45N	00°10W	28E9f
49°45N	00°10E	28F0d
49°35N	00°30W	28E9h
49°35N	00°10W	28E9i
49°25N	00°30W	27E9b
49°25N	00°10W	27E9c

Table 6.4.3: Positions in the Southern North Sea, 15.01. – 31.01. (Area code E3)

Latitude	Longitude	ICES-Code
52°25N	02°10E	33F2a
52°25N	02°30E	33F2b
52°25N	02°50E	33F2c
52°25N	03°10E	33F3a
52°25N	03°30E	33F3b
52°25N	03°50E	33F3c
52°25N	04°10E	33F4a
52°15N	02°10E	33F2d
52°15N	02°30E	33F2e
52°15N	02°50E	33F2f
52°15N	03°10E	33F3d
52°15N	03°30E	33F3e
52°15N	03°50E	33F3f
52°15N	04°10E	33F4d
52°05N	02°10E	33F2g
52°05N	02°30E	33F2h
52°05N	02°50E	33F2i
52°05N	03°10E	33F3g
52°05N	03°30E	33F3h
52°05N	03°50E	33F3i
51°55N	02°10E	32F2a
51°55N	02°30E	32F2b
51°55N	02°50E	32F2c
51°55N	03°10E	32F3a
51°55N	03°30E	32F3b
51°45N	01°50E	32F1f
51°45N	02°10E	32F2d
51°45N	02°30E	32F2e
51°45N	02°50E	32F2f
51°45N	03°10E	32F3d
51°45N	03°30E	32F3e
51°35N	01°50E	32F1i
51°35N	02°10E	32F2g
51°35N	02°30E	32F2h
51°35N	02°50E	32F2i
51°35N	03°10E	32F3g
51°25N	01°50E	31F1c
51°25N	02°10E	31F2a
51°25N	02°30E	31F2b
51°25N	02°50E	31F2c
51°15N	01°50E	31F1f
51°15N	02°10E	31F2d

Latitude	Longitude	ICES-Code
51°15N	02°30E	31F2e
51°05N	01°30E	31F1h
51°05N	01°50E	31F1i
50°55N	01°10E	30F1a
50°55N	01°30E	30F1b
50°45N	00°50E	30F0f
50°45N	01°10E	30F1d
50°45N	01°30E	30F1e
50°35N	00°30E	30F0h
50°35N	00°50E	30F0i
50°35N	01°10E	30F1g
50°35N	01°30E	30F1h
50°25N	00°10E	29F0a
50°25N	00°30E	29F0b
50°25N	00°50E	29F0c
50°25N	01°10E	29F1a
50°25N	01°30E	29F1b
50°15N	00°30W	29E9e
50°15N	00°10W	29E9f
50°15N	00°10E	29F0d
50°15N	00°30E	29F0e
50°15N	00°50E	29F0f
50°15N	01°10E	29F1d
50°05N	00°30W	29E9h
50°05N	00°10W	29E9i
50°05N	00°10E	29F0g
50°05N	00°30E	29F0h
50°05N	00°50E	29F0i
50°05N	01°10E	29F1g
49°55N	00°30W	28E9b
49°55N	00°10W	28E9c
49°55N	00°10E	28F0a
49°55N	00°30E	28F0b
49°55N	00°50E	28F0c
49°45N	00°30W	28E9e
49°45N	00°10W	28E9f
49°45N	00°10E	28F0d
49°35N	00°30W	28E9h
49°35N	00°10W	28E9i
49°35N	00°10E	28F0g
49°25N	00°30W	27E9b
49°25N	00°10W	27E9c

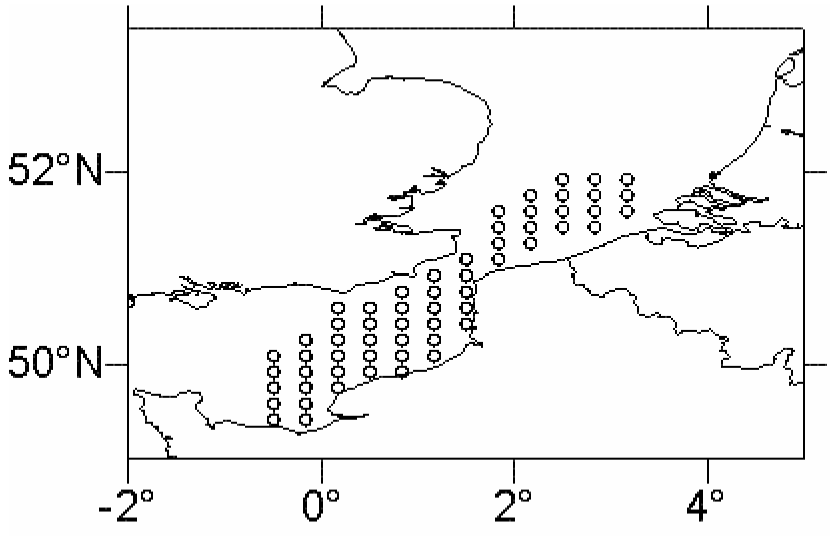

Figure 6.4.1: Station grid in the Southern North Sea, 16.12. – 31.12.

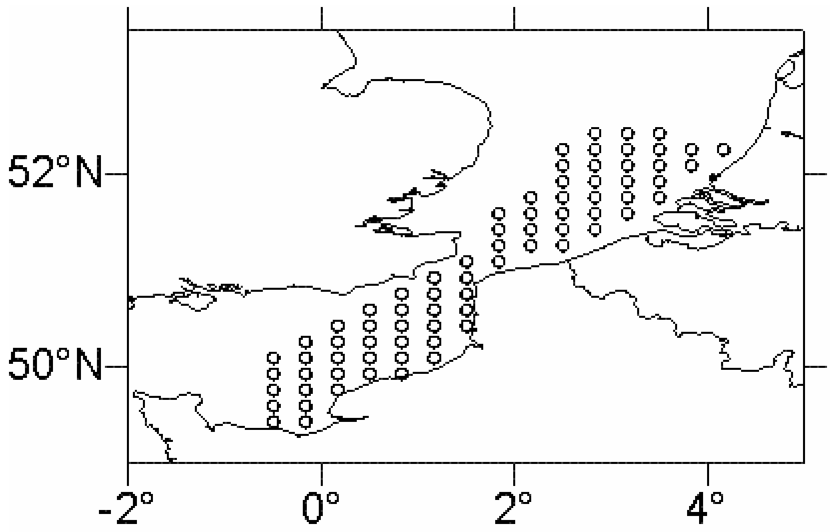

Figure 6.4.2: Station grid in the Southern North Sea, 01.01. – 15.01.

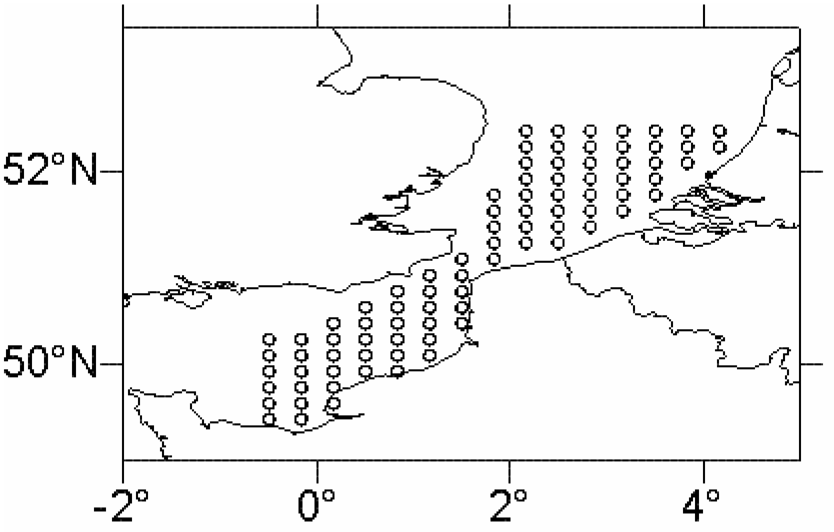

Figure 6.4.3: Station grid in the Southern North Sea, 16.01. – 31.01.

6.5 Data sheet

INPUT SHEET ICES LARVAE SURVEYS

Country	**Germany**
Area	**Or/Shet**
Year	**2002**
Vessel	**Alkor**
Start of survey	**16. Sep**
Sampling gear	**Nackthai**
End of survey	**06. Okt**
Aperture (mm)	**200**
Calibration (rev/m)	**41,688**
Sampler efficiency	**1,000**

Country	Gear	Aper	Cal	Eff	Stat number	Date	Latitude	Longitude	E/W	UTC	Flowmeter revol.	Sampler depth (m)	Bottom depth (m)	Bottom temp (°C)	Duration (min.sec.)	Ship course
FRG_B2	Nackthai	200	41,688	1,00	1226	180902	5805	0110	W	1647	192290	103	106	10,6	2642	249
FRG_B2	Nackthai	200	41,688	1,00	1227	180902	5805	0130	W	1802	097240	073	076	12,6	1437	269
FRG_B2	Nackthai	200	41,688	1,00	1228	180902	5805	0150	W	1908	132358	086	089	12,6	1850	269
FRG_B2	Nackthai	200	41,688	1,00	1229	180902	5805	0210	W	2019	074597	064	067	13,3	1108	269

Haul	Raised length distribution (per mm) of total larvae in sample																			Total caught			Total larvae
number	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	>=24	Non yolk	Yolk	Total	measured
001	0	0	0	0	1	4	15	23	23	21	6	4	8	5	4	0	0	0	0	0	_	_	114	110
002	0	0	0	1	0	5	30	40	37	23	13	7	5	2	3	1	2	0	0	0	_	_	170	165
003	0	2	8	8	1	2	5	15	30	29	14	7	3	0	1	0	1	0	0	0	_	_	127	120
004	0	0	0	0	1	0	0	0	1	3	11	5	6	4	4	8	1	0	0	0	_	_	45	44

Annex 6: Working Paper of ICES Planning Group for Herring Surveys (PGHERS)

24/01/2006–27/01/2006

BALTIC SEA HERRING LARVAE SURVEYS IN THE MAIN SPAWNING AREA – EVALUATION OF THE PREVIOUS DATA

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The Rügen spring spawning herring is currently the most important herring stock in the western Baltic Sea (ICES Division IIIa and Subdivisions 22-24). For the German fisherman of Mecklenburg/Vorpommern and of the east coast of Schleswig/Holstein it is the basis for their fishing on herring. Greifswalder Bodden and Strelasund at the German coast are the most important spawning areas.

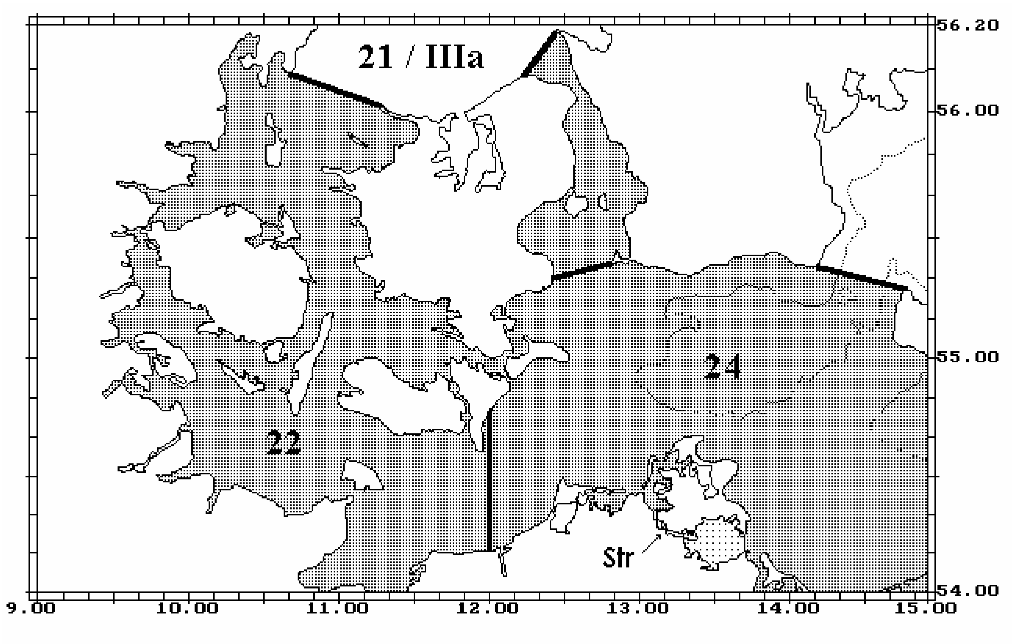

Figure 1: Horizontal distribution of Rügen spring spawning herring larvae [dotted] and age group 0 and 1 [shaded] in the western Baltic Sea. Str = Strelasund.

Quantitative studies based on larvae surveys in the main spawning area of the Rügen spring spawning herring are part and parcel of assessment work. They were already done in the former East German Institute for Deep Sea Fishery Rostock. One can still find them as part of the recruitment studies in the Institute for Baltic Sea Fishery Rostock. With the aim of providing fishery independent information on the dynamics of the stock the year-class index N30 has been estimated every year since 1977 based on weekly repeated larvae surveys in the main spawning area. Unlike other time series of herring larvae surveys, this was developed to provide an index of recruitment. Brielmann (1981; 1986; and 1989) found a strong correlation between N30 and year-class strength in the western Baltic herring. N30 is created by projecting forward the abundance of surviving larvae at 30 mm length, based on the field estimates of previous growth and mortality of each hatching cohort (Klenz in ICES 2004). High values of N30 are expressions of strong incoming year-classes. Small indices stand for weak incoming year-classes. It is used in the assessment and forecast of the spring spawning herring.

The GERMAN HERRING LARVAE PROGRAMME supplies a good prediction of the stock recruitment at a very early date in the respective year (Brielmann 1981; 1989) (Klenz in ICES 2004). It is included in the list of necessary surveys for sampling data for fishery-independent stock assessments in the frame of the EU Council regulation 1543/2000 and 1639/2001 (National Data Sampling Programme).

Figure 2: Sampling herring larvae aboard the RV "Clupea".

The importance of the fishery-independent recruitment-index has been increased since a stock-related assessment is proposed for the Baltic herring. After the evaluation by the "ICES Planning Group for Herring Surveys" (PGHERS) it has been proposed as a fishery-independent tuning series for the assessment of the western Baltic herring by the ICES Working Group for "Herring Assessment for the Area South of 62° N" (HAWG) (ICES 2004). PGHERS encouraged searching and collating any data from the surveys between 1977 and 1991, which could be possibly found in old reports and grey literature (ICES 2004).

When doing some research we discovered that the raw data are lost because of the political changes in Germany and the liquidation of the former East German Institute for Deep Sea Fisheries in 1991. The recruitment indices for 1977 to 1987 (see Table 1) were only available in grey literature (Brielmann 1989).

From 1988 onwards the procedure to obtain growth and survival rates was changed. The new modified methods for estimating the recruitment index provide to more precise N30 values (Müller and Klenz 1994).

Because of the missing raw data for the period 1977-1987 it can not be assessed whether the different methods used before 1988 and from 1988 onwards will result in different outputs of N30. The new procedure can not be applied to data before 1988.

In 1988 and 1989 no weekly repeated sampling in the main spawning area took place. So the estimated growth rates and survival rates as input data for the estimation of N30 became unsafe. From 1990 onwards the data can be taken as reliable.

HAWG does a stock-related assessment for the herring in Division IIIa and Subdivision 22-24 including the estimation of the recruits of AG 0 from 1991 onwards (see Figure 3). Therefore a correlation coefficient for the recruitment index N30 and the numbers of AG 0 as output from ICA final run can not be estimated for the whole period since 1977.

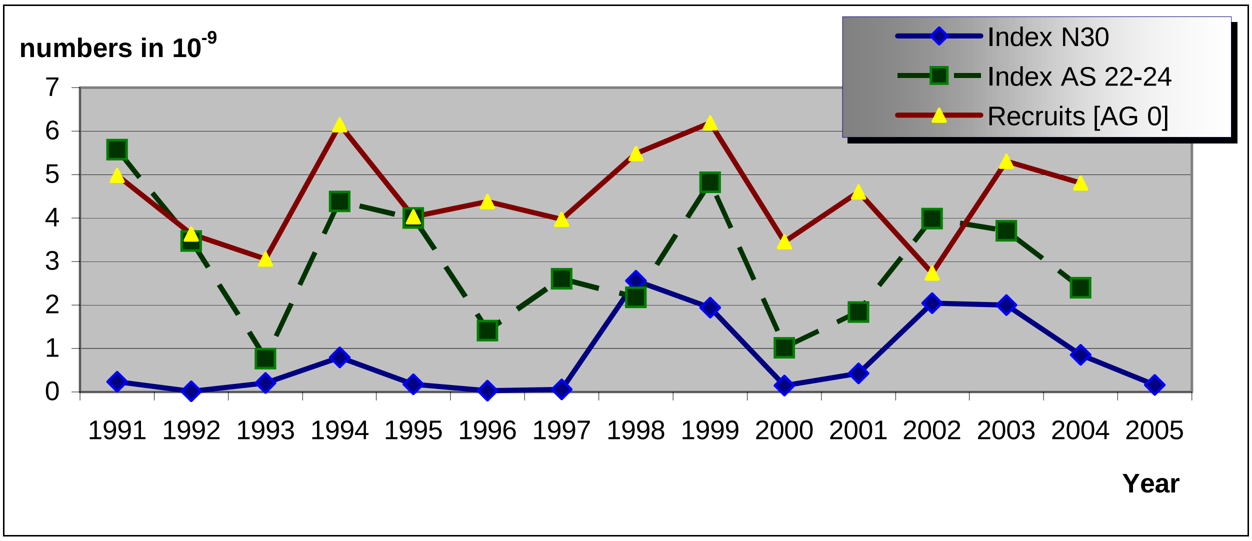

Figure 3: Larvae index [N30], index of international acoustic surveys (September/October) [SD 22-24] and recruits of AG 0 (estimated by ICES HAWG) in the period 1991–2005.

Former analyses (see Table 2) showed that the larvae index N30 is correlated both the numbers of recruits in AG 0 in the main nursery area and different year-class indices.

Since some correlations include the periods of both procedures for the estimation of N30 one can accept that the two procedures end in the same dimension of N30. There is no possibility to assess the accuracy of N30 in the period 1977-1987 because of missing raw data.

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Table 1. Results of herring larvae surveys in the Greifswalder Bodden and Strelasund from 1977 to 2005.

N30 = recruitment index (index of year-class strength); S = total surviving rate; S1 = surviving rate of youngest larvae.

Year	Number of surveys per spawning season	Number of sampled herring larvae per spawning season	Mean abundance of herring larvae [$\bar{N}m^{-2}$]	Larvae index (N30) [10^{-9}] 4)	Mean survival rate per day (S / S1) [%]	Mean growth rate per day [$mm\ d^{-1}$]
1977	3			**2.0**		
1978	3			**0.1**		
1979	3			**2.2**		
1980	7			**0.36**		
1981	6			**0.2**		
1982	2			**0.18**		
1983	4			**1.76**		
1984	4			**0.29**		
1985	5			**1.67**		
1986	5			**1.50**		
1987 1)	4			**1.37**		
1988 2)	9 (6) 5)	31,789	9.19	**1.223**	96 / 100	0.54
1989 2)	8 (7) 5)	17,605	3.93	**0.063**	82 / 83	0.55
1990	7	21,420	2.68	**0.057**	89 / 93	0.56
1991 6)	10	78,797	7.47	**0.236**	91 / 93	0.48
1992	9	33,944	6.60	**0.018**	80 / 71	0.48
1993	8	81,433	14.35	**0.199**	79 / 75	0.53
1994 3)	10	286,951	41.86	**0.788**	93 / 90	0.47
1995	10	235,600	31.68	**0.171**	77 / 64	0.53
1996	7	304,783	77.05	**0.031**	81 / 77	0.44
1997	11	157,978	26.16	**0.054**	76 / 73	0.43
1998	9	128,977	25.42	**2.553**	92 / 96	0.63
1999	10	195,163	34.30	**1.945**	91 / 95	0.59
2000	10	34,997	6.29	**0.151**	87 / 91	0.68
2001	10	89,091	16.49	**0.421**	92 / 98	0.53
2002	9	75,026	17.40	**2.051**	94 / 94	0.48
2003	10	74,283	14.60	**2.005**	97 /100	0.51
2004	10	64,328	13.10	**0.860**	91 / 95	0.60
2005	9	81,513	18.60	**0.162**	89 / 96	0.51

1) **Data for 1977-1987 published in Brielmann, N. (1989). Rapp. P.-v. Reun. Cons. int. Explor. Mer, 190, p. 273, Table 3.**

2) **Only samples of the outer net were available.**

3) **Since 1994 only samples of the outer net have been processed because of optimisation of the labour efficiency.**

4) **Publ. by HAWG in ICES CM 2005/ACFM: 16, page 228, Table 3.3.5.**

5) **( ) Number of cruises considered for estimation of recruitment index N30**

6) **HAWG ICA-Run first from 1991, because catch data available first from 1991**

Table 2: Overview about the correlation analyses of larvae index N30, other year-class indices and numbers in AG 0 in the stock.

PUBLISHED BY	NUMBERS IN AG 0 IN ICES-DIVISION AND ICES-SUBDIVISIONS	YEAR-CLASS INDICES	PERIOD FOR CORRELATION ANALYSIS
Brielmann (1989)	ICES SD 22 + 24	N30	1977–1986
Oeberst, Müller, Klenz (1996)	ICES SD 22 + 24	N30 + other	1977–1994
Müller (2000)		N30 + other	1981–1999 (except 1986-1988)
Oeberst, Klenz (2003)	ICES-Div. IIIa and SD 22 + 24	N30 + other	1992–2001 (except 1998)

Annex 7: Evaluating the potential of the Torry Fish Fat Meter for measuring lipid content of herring (*Clupea harengus* L.) at sea

PGHERS Meeting, 24-27 January 2006, Rostock, Germany

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Introduction

Fish store their lipids in different locations depending on the species. Cod (*Gadus morhua*) and other gadoid fish store lipids in the liver, whilst oily fish, like herring (*Clupea harengus* L.), store fat in the muscles and mesenteries (Sheridan, 1988; Lambert and Dutil, 1997; Marshall *et al*., 2000). Fat reserves undergo annual cycles of accumulation and depletion (Bradford, 1993; Adams, 1999; Henderson *et al*., 2000; Marshall *et al*., 2000). Fish stockpile lipid stores for overwintering and spawning (Bradford, 1993; Adams, 1999; Pangle and Sutton, 2005). A larger, better quality store of lipids equates with a higher fecundity and better quality eggs (Rajasilta, 1992; Henderson *et al*., 2000; Marshall *et al*., 2000). Fish with a higher reserve of lipids are also believed to mature sooner than those with lower levels of stored fat (Rajasilta, 1992; Henderson *et al*., 2000; Nielsen *et al*., 2005).

There are two main categories of methods that measure lipid contents of oily fish: invasive (or destructive), and non-invasive (or non-destructive). Invasive means of measuring lipid values include such chemical analyses of tissue as Soxhlet and Fosslet extraction, and Bomb calimetry. Non-invasive techniques include Near infrared reflectance (NIR) spectrometry, Nuclear magnetic resonance (NMR), and the Torry Fish Fat Meter (TFFM) (Distell Inc., Lothian, Scotland). Previous studies have found there to be advantages and shortcomings to each of these non-invasive methods. Nielsen *et al*. (2005) found that NIR and the TFFM were inferior to NMR at predicting lipid contents. However, cooler temperatures (approximately 2˚C) are required to ensure the accuracy of NIR and NMR, whereas the TFFM is not subject to such constraints (Nielsen *et al*., 2005). Vogt *et al*. (2002) compared NIR and TFFM and found that TFFM was cheaper than NIR, that each analysis was quicker when done with the TFFM, and that both were on a similar level when it came to ease of use and the amount of training required to be able to use them.

The TFFM utilises microwave emissions to measure the water content of fish, and converts this to the lipid content via the inverse relationship between the two (Kent *et al*., 1992). Distell have pre-programmed calibrations for different fish species into each meter, so that each calibration is species-dependent. Crossin and Hinch (2005) found the TFFM provided “highly accurate measures of gross somatic energy and lipid level percentages" of Pacific salmon. It is also portable, easy to use, and generates readings very rapidly.

The purpose of this working document is to summarize the results of two studies carried out in the lab in 2004 and 2005, and in the field in 2005, which evaluated the suitability of the TFFM for investigating spatial and temporal changes in lipid content of North Sea herring (*Clupea harengus*). The fish used in the 2004 and 2005 lab studies were fished from the Shetland stock by commercial ships, at (or close to) Shetland- Fair Isle, the spawning ground of the stock (Heath *et al.*, 1997). The fish were delivered to Caley Fisheries Group in Peterhead, and a box of fresh, iced fish was transported to Aberdeen. Secondly this working document will briefly summarize the aims of our participation in several herring acoustic surveys in 2006.

Operational aspects of TFFM

The fat meter used in this study was the Distell Model 692 Fish Fat Meter. The TFFM has a number of available settings apart from that of the species of fish being sampled. It can be adjusted to measure the fat content of different types of fillet. The meter can also be used to analyse samples of varying sizes- from one individual reading to the average of eight readings (N1 and N8, respectively). The setting used in this study was "Herring-1" which represents the fat content of trimmed fillets, excluding the skin. Prior to sampling, the precision of the TFFM should be checked using the calibration check pad supplied by Distell. When measuring fat content, any excess moisture on the skin of the fish should be dried, as it can influence the estimated lipid value. When positioning meter, the sensor strip should be placed on the skin below the dorsal fin- or whichever area is being measured (Figure 1). Lipid contents of a representative number of herring sampled should be assessed with Soxhlet extraction to affirm the accuracy of the TFFM's readings.

2004 lab study

Morphometric indices are often used as proxies for the amount of stored energy (i.e. condition), however this assumption is rarely tested. The aims of the 2004 study were to compare two morphometric condition indices of herring (Fulton's K and Somatic K) with the corresponding TFFM fat content values to determine whether the indices were accurate indicators of condition, and whether any of the indices showed the seasonal variation in fat. The muscle tissues of a sub-sample of the fish were analysed by Soxhlet extraction to assess the calibration of the TFFM.

Biological data (length, weight etc) were collected to calculate Fulton's and Somatic K, and one TFFM reading was taken from the left side of each (whole) fish. The morphometric indices were then compared to the correspondent TFFM readings. One TFFM reading (whole fish) was taken from a fish from each size class, and the lipid content was later analysed by Soxhlet extraction.

There was a very weak positive correlation between Fulton's K and the TFFM lipid content in the 2004 data ($r^2 = 0.041$, $n = 209$, $P = 0.003$) (Figure 2a). The correlation between Somatic K and the TFFM fat contents was slightly more significant than that of Fulton's K ($r^2 = 0.17$, $n = 209$, $P < 0.0001$).

There was a significant, positive correlation between the TFFM and Soxhlet analyses of the lipid content ($r^2 = 0.65$, $n = 42$, $P < 0.0001$) (Figure 3a). The equation for the relationship between TFFM and Soxhlet for N1 was as follows:

Equation 1. $\text{TFFM} = 1.24 \times \text{Soxhlet} + 1.93$

Seasonal variation in the 2004 TFFM readings showed the average values for each size class increased until the peak at the third sampling day, and from then on, the lipid content decreased till the last sampling day, which showed an increase in all available size classes (Figure 4a). The obvious outlier on the first sampling day is believed to be a matjes herring.

The results of this study suggest that Fulton's K is perhaps a poor indicator of condition, and that the TFFM is a more accurate, rapid and informative proxy for assessing condition of herring. It also demonstrates the seasonal variability of fat deposition and utilisation associated with the onset of gonadal development in preparation for spawning.

2005 lab study

The 2005 lab study aimed to assess whether there were any differences between TFFM readings taken from a whole fish compared to those taken from the fish when gutted. As in 2004, TFFM readings were compared to the corresponding Fulton's K values, and seasonal variations in TFFM values were also plotted.

The comparison of the 2005 lab study's Fulton's K and TFFM lipid content showed that there was a very weak positive correlation between the two ($r^2 = 0.01$, $n = 169$, $P = 0.16$) (Figure 2b).

There was a significant, positive correlation between TFFM and Soxhlet estimates of the lipid content of the 2005 lab data ($r^2 = 0.53$, $n = 55$, $P < 0.0001$) (Figure 3b). The relationship between the two is described by the following equation:

Equation 2. FFM = 6.03 x Soxhlet + 1.09

The TFFM values in the seasonal investigation generally increased till the third sampling day, from which point on, the average lipid content decreased until the last sampling day, where an increase was evident (Figure 4b).

There was a strong, significant correlation between the 2005 lab study's TFFM readings of the same fish, when it was whole and gutted ($r^2 = 0.9$, $n = 46$, $P < 0.0001$) (Figure 5). This indicates that there is no significant difference between taking readings from whole or gutted fish.

The results of this study also indicate that Fulton's K does not reveal the amount of stored energy of herring, whereas the TFFM appears to demonstrate the condition more accurately. The TFFM also showed the seasonal variation in lipid deposition and utilisation.

2005 field study

The primary aim of the 2005 field study was to determine how well the TFFM could be incorporated into an already established onboard sampling routine, and to develop a sampling protocol for using the TFFM in the field (see Appendix 1). A secondary aim was to compare the TFFM lipid contents with the correspondent condition factors (Fulton's and Somatic K), and to map the average lipid contents. In the trial run of the TFFM onboard the "Scotia", the methodology adopted was to take two readings of gutted herring- one on each side of the body, and the average of the two readings was recorded. This was done once all the biological data had been collated, so it did not interfere with the established sampling protocol.

There was a weak positive correlation between Fulton's K and the TFFM lipid content ($r^2 = 0.17$, $n = 904$, $P < 0.001$) (Figure 6a). The Somatic K and TFFM lipid contents had only a slightly stronger correlation than that of the Fulton's K and TFFM, but again it was a weak, positive correlation ($r^2 = 0.28$, $n = 904$, $P < 0.001$) (Figure 6b).

Comparison between lab and field study

There was a distinct offset between the 2004 lab study's and 2005 field study's Fulton's- and Somatic K values. The fish used in the 2004 study had higher Fulton's K values compared to those used in the field study. However, the corresponding TFFM values were relatively similar. These ranged from 2.1 to 29.7 in 2004, and 1.8 to 28.5 in 2005 (Figure 7). The Fulton's K values from 2004 ranged from 0.964 to 1.552, while those from 2005 ranged from 0.641 to 1.196. The Somatic K values ranged between 0.843 and 1.378 in 2004 and between 0.551 and 0.946 in 2005. This difference between each year's Fulton's- and Somatic K is perhaps due to differences in temporal sampling (the 2004 study was carried out over a period of two months, whereas the 2005 field study was carried out in two weeks), or spatial sampling, or due to differences in girth caused by differences in maturation stages.

Future Plans

The overall aim of our proposed field study in 2006 is to determine whether lipids impose a threshold on the onset of maturation in North Sea herring. It is also the aim to construct a "fat map" of the North Sea herring stocks: a spatial representation of the average fat values for a given size class of herring within the sample area. Therefore, any spatial, and perhaps temporal, variations in fat content should become evident. This could then be related to environmental factors- such as prey abundance.

The intention is to integrate the TFFM into the onboard sampling routine of as many participating vessels in the 2006 acoustic survey of the North Sea herring, as possible. As shown by the trial run on the "Scotia", using the TFFM on a vessel is feasible, and does not interrupt a protocol such as the one utilised by the "Scotia" crew. The TFFM accurately measures lipid content of both whole and gutted herring. Therefore if it were necessary to insert the use of the TFFM at a point when either a whole or gutted fish were available, in order to cause as little disruption of the routine as possible, this would not have any adverse affect on the accuracy and validity of the readings. For any vessel agreeing to have one of our samplers onboard, a sampling protocol could be provided beforehand for inclusion in the cruise plan. It is important that the TFFM readings correspond with the biological data of each fish. Therefore a copy of the information collected by the crew would be needed to properly compare data and to complete our analyses. Some information we would need includes: would the crew be taking all the weight measurements (e.g. somatic weight, gonad weight, liver weight), removing the otoliths, and attempting to accurately assess the maturity stage of each individual? If the budget allows, the intention would be for gonads of some individuals to be removed for later histological analysis, so the ship's sampling protocol would have to allow for this to be done whilst providing information on the correspondent biological data.

Thus far, there are at least four potential candidates interested in participating in this field study including two PhD students, and two fourth year students who would use the data for their Honours projects. In the weeks prior to embarkation, a group training session would be held to calibrate the equipment and review the sampling protocol, etc.

The funding agencies we have applied to for support include: Fisheries Society of the British Isles (FSBI) research grant, The Royal Society's equipment grant, the Natural Environment Research Council's (NERC) New Investigators grant, and the Nuffield Undergraduate research bursary for one of the Undergraduate candidates. We will hear the results of several of these competitions before the cruises in 2006.

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Figure 1: Positioning of the TFFM on herring. Sensor strip is placed below the dorsal fin, along the lateral line. Photos taken from the 2004 lab study.

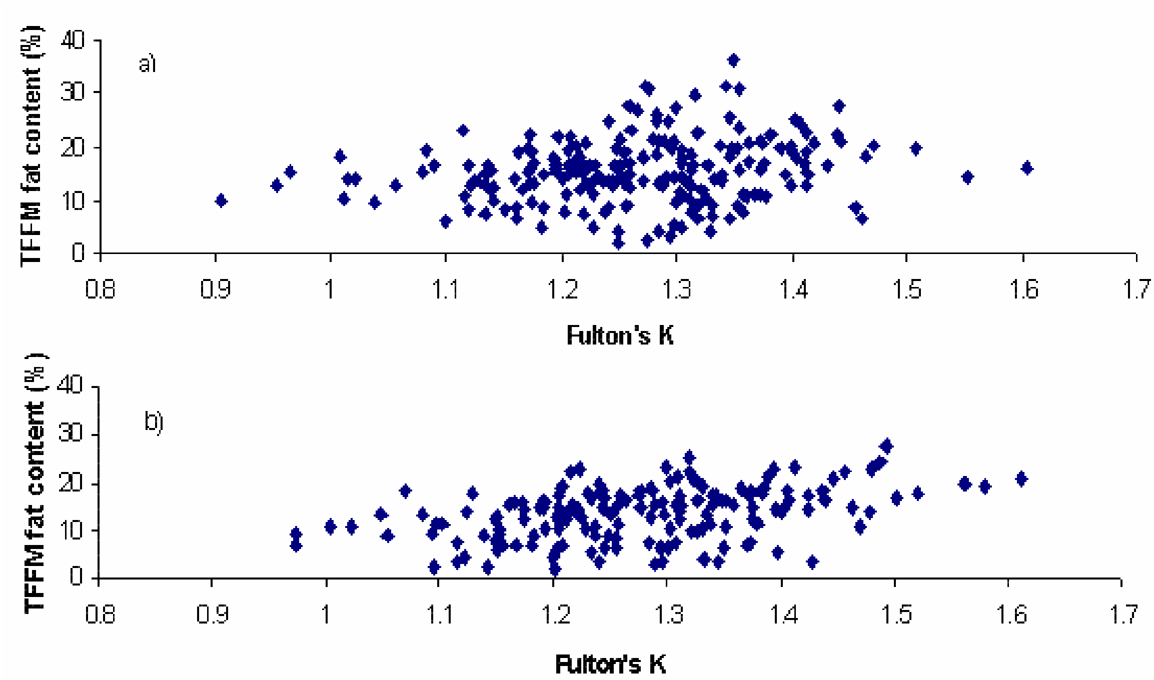

Figure 2: Correlation between Fulton's K and a) TFFM lipid content (%) (r^2 = 0.041) from the 2004 data, and b) average TFFM lipid content of two readings (%) (r^2 = 0.01) from the 2005 lab data.

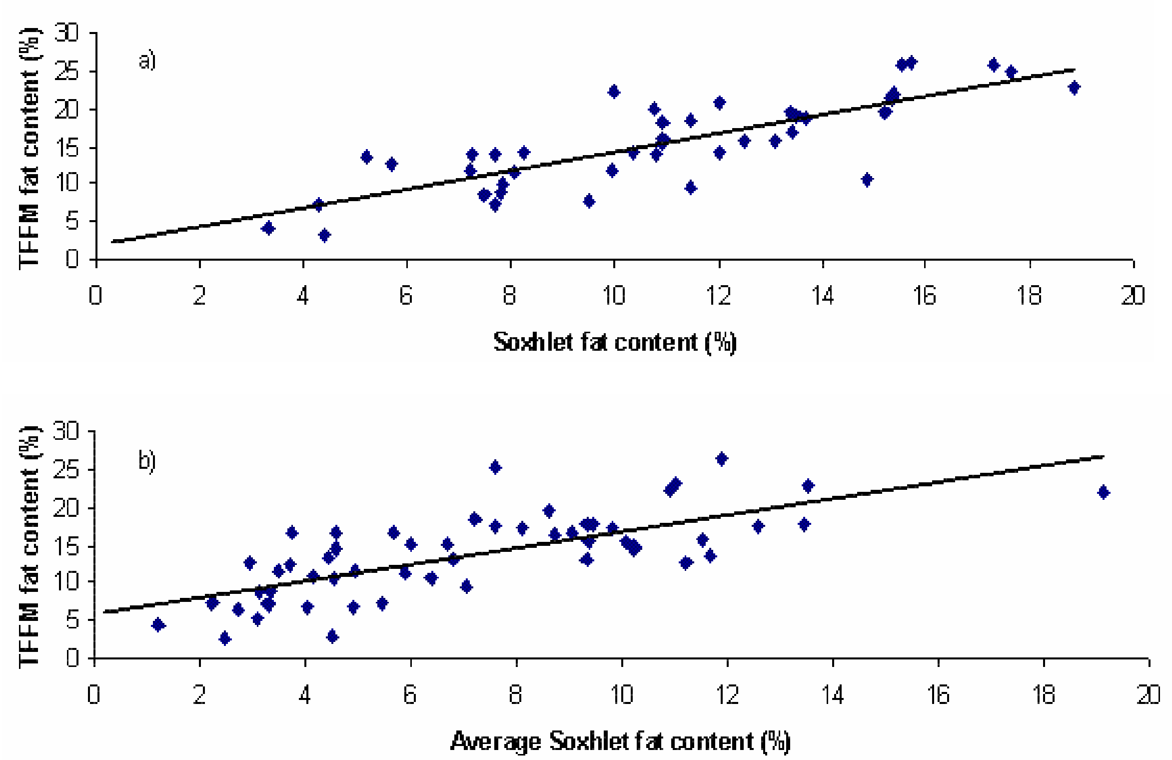

Figure 3: Correlation between TFFM and Soxhlet lipid contents' for the a) 2004 data (r^2 = 0.65), and b) 2005 lab data (one TFFM reading per fish; average of triplicate Soxhlet samples) ($r^{2\,=}$ 0.53).

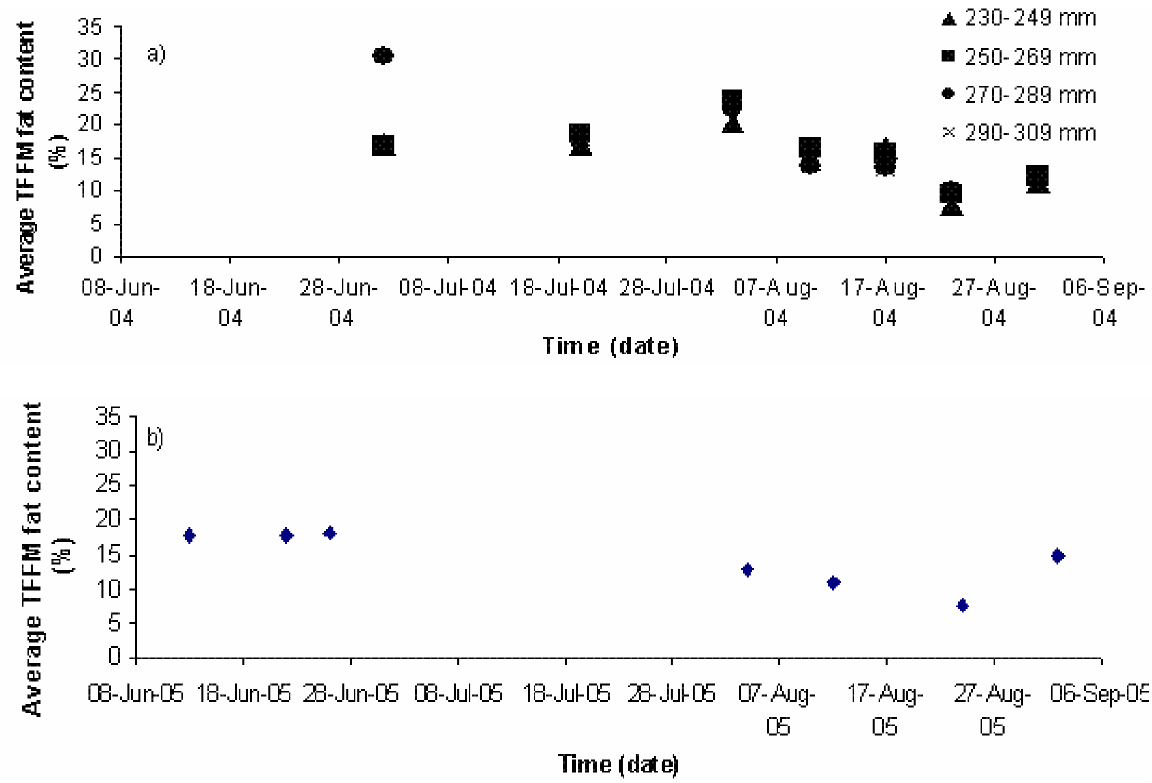

Figure 4: Average a) TFFM lipid contents of each size class over time, from the 2004 study, and c) TFFM of all size classes from the 2005 lab study, over time.

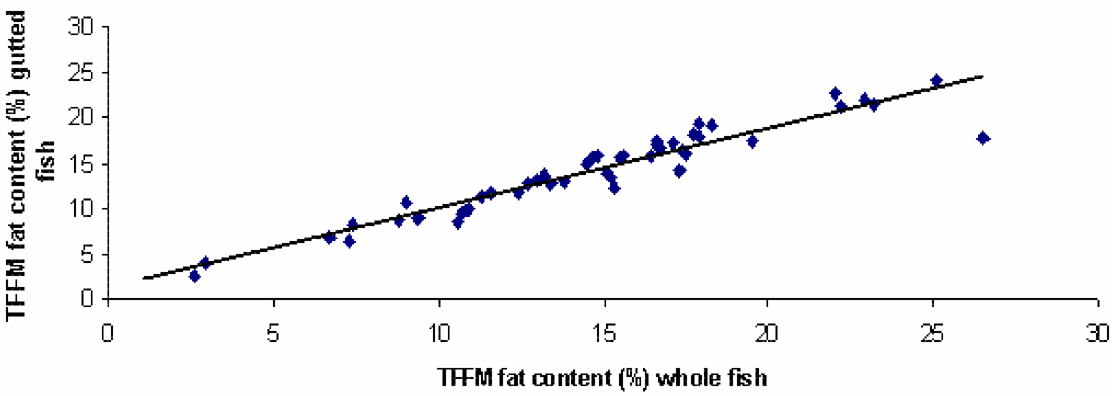

Figure 5: Correlation between the 2005 study's TFFM readings (average of two readings- one from each side of the fish) of gutted fish and whole fish ($r^2 = 0.9$).

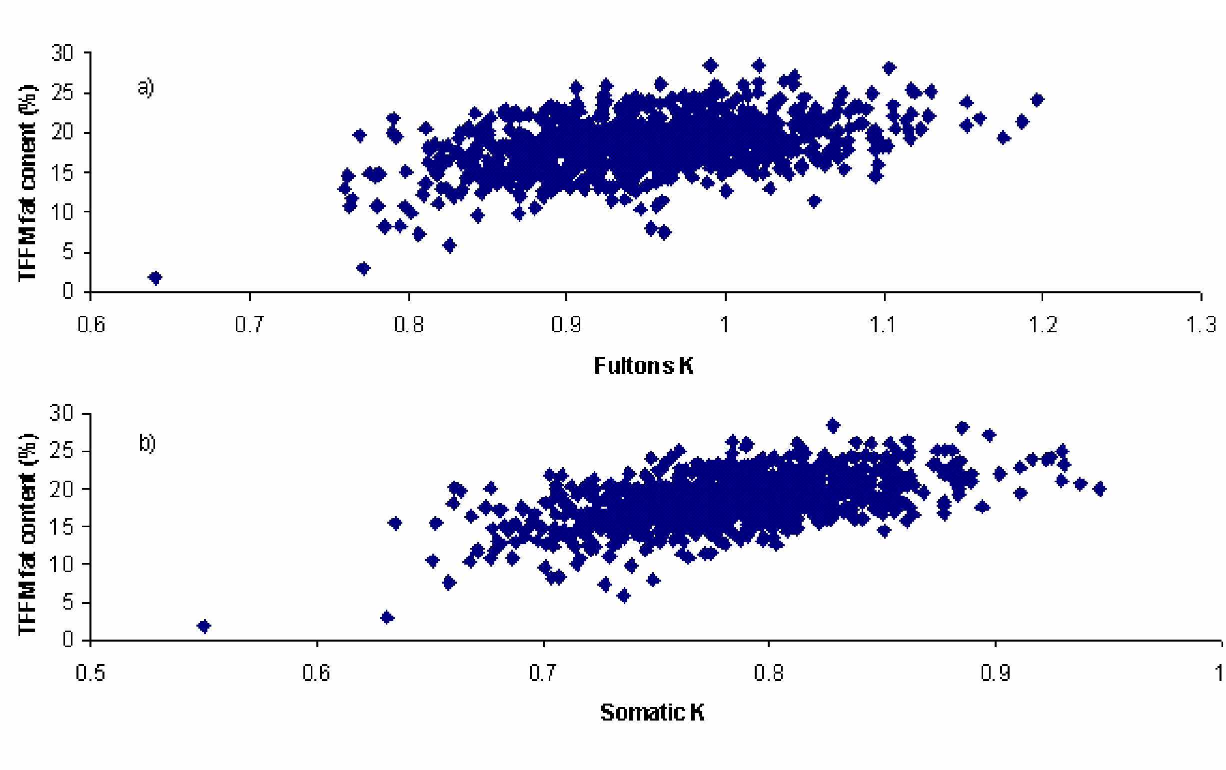

Figure 6: Correlation between a) TFFM lipid content (%) and Fulton's K (r2 = 0.17), and b) TFFM lipid content (%) and Somatic K (r2 = 0.28), from the "Scotia" field data.

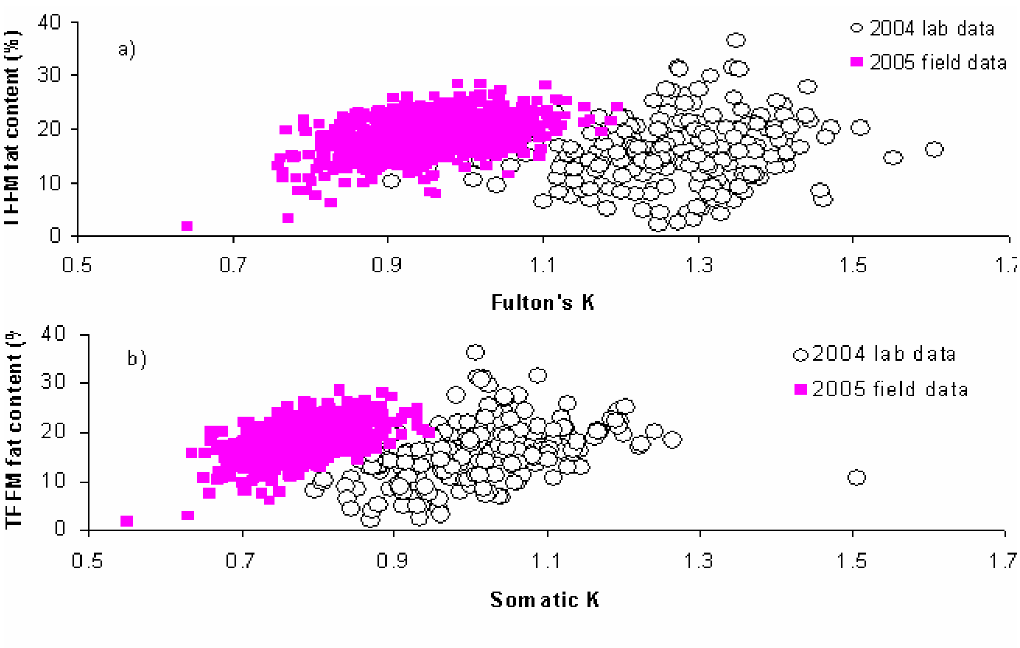

Figure 7: Comparison of 2004 and 2005's TFFM values against a) Fulton's K and b) Somatic K.

Annex

Sampling protocol onboard "Scotia" 2005 Herring Acoustic Survey

Methods

1) Prior to fish coming into the lab, perform calibration check with the calibration pad provided, and record result.

2) Remove excess moisture from herring using paper towel. Place meter on lateral line, just below dorsal fin with midpoints of the microstrip and fin in alignment.

3) Press "Read" button and allow meter reading to stabilize, then release button (S1- or side one).

4) Turn fish over and repeat (above) on other side to get S2.

5) Record average value (of S1 and S2) provided by the meter on the sampling form beside the fish ID number.

6) Continue taking measurements on all fish in trawl sample. Wipe sensor strip with a paper towel frequently (e.g. every 10 fish) to prevent scales and moisture accumulating.

7) When finished, repeat calibration pad exercise and complete table on the sampling form.

8) Wipe meter clean and, if you have not been running it from external power source, plug it in to re-charge.

Samples for calibration curves

9) Identify fish with lowest and highest fat content, and randomly select a third (halfway between these two values). Note ID's, and put a piece of paper on the carcasses to indicate that these are to be kept aside for taking muscle tissue samples.

10) Fillet fish identified in step 9 according to guidelines for "Herring-1" provided by Distell. Try to retain all (or most) flesh as part of sample.

11) Remove excess fat from belly walls and top of dorsal region. Trim and skin fillet.

12) Mince fillet using handheld blender until homogenized and use spatula to ensure all tissue is together. Blend once more.

13) Label sample bags with trawl station number, fish ID, and replicate number (3 in total).

14) Transfer approx. 10 g of paste into sample bag (use scales to check, but does not have to be precise). Repeat for other two replicates and put samples into freezer.

15) At end of sampling day, put all sample bags into one single ziplock bag that has been labelled with the year, cruise and date.

16) At end of cruise, transfer samples to freezers in Aberdeen as quickly as possible.