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Report of the Working Group for International Pelagic Surveys (WGIPS)

19-22 January 2010

Galway, Ireland

ICES International Council for the Exploration of the Sea
CIEM Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

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Executive summary

The Working Group for International Pelagic Surveys (WGIPS, formerly PGIPS) met at the Marine Institute, Galway, Ireland from 19.01.10 - 22.01.10 under the chairman Karl-Johan Stæhr (DTU-Aqua, Hirtshals, Denmark) to coordinate acoustic and larvae surveys in the North Sea, Malin Shelf and Western Baltic; to combine recent survey results for assessment purposes and to clarify parameters influencing these calculations. The group consisted of 11 participants from 7 different nations (one person took part in the meeting by correspondence).

Review of larvae surveys in 2009/2010: Six survey métiers were covered in the North Sea. The herring larvae sampling period was still in progress at the time of WGIPS meeting, thus sample examination and larvae measurements have not yet been completed. 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 2010. The same is true for Larvae Surveys from the Baltic.

Results from larvae survey in the Irish Sea indicate a similar distribution pattern for 2009 as seen in previous years, with highest abundance of herring larvae to the east and north of the Isle of Man. The point estimate of production in the northeastern Irish Sea was below the time-series average.

North Sea, West of Scotland and Malin Shelf summer acoustic surveys in 2009: Seven acoustic surveys were carried out during late June and July 2009 covering the North Sea, West of Scotland and Malin Shelf area. The estimate of the North Sea, autumn spawning herring, spawning stock is at 2.6 million tonnes. This is a third higher than the previous year (1.8 million tonnes).

The West of Scotland estimate of SSB is 579 000 tonnes. This is lower than last year's estimate. The abundance is not dominated by immature fish; however, the present year class is the highest for the past four years. The abundance by year class is consistent with previous years and also with results from the adjacent North Sea area. The 2000 year class is still very large.

This is the second year of the synoptic survey, covering what is currently considered the Malin Shelf population of herring. The estimate provided comprises four herring stocks to the west of the British Isles: the West of Scotland in Division VIaN; the Clyde; Division VIaS and VIIb,c; and the Irish Sea. Due to late submission of data from the survey covering the Clyde and the Irish Sea stocks, those results were not included in this report. The Malin Shelf estimate of SSB, excluding the Clyde stock and the Irish Sea, was 593 000 tonnes. This is largely dominated by the West of Scotland estimate.

The estimates of Western Baltic spring-spawning herring SSB were 205 000 tonnes, which is lower than last year's estimate. The stock is dominated by 1 and 2 ring fish; however abundances, of 1 and 2 ringers, are considerably less than those dating back to 2002.

Sprat: In most recent years, there has been a downward trend in North Sea sprat. In 2009, the total biomass was estimated at 556 000 tonnes, which is an increase of 105% when compared to 2008. The majority of the stock consists of mature fish. The sprat stock is dominated by 1- and 2-year old fish representing more than 98% of the biomass.

In Division IIIa, sprat was abundant in the Kattegat only. No sprat was observed in the Skagerrak area. The biomass has significantly decreased to 36 500 tonnes.

Western Baltic acoustic surveys in autumn 2009: A joint German-Danish acoustic survey was carried out with RV "Solea" in the Western Baltic in October 2009. The estimate of Western Baltic spring-spawning herring is about 81 200 tonnes in Subdivisions 22–24 and is dominated by young herring as in previous years. The present overall estimates are low, both in terms of abundance and biomass, when compared to the long-term mean. The estimated total sprat stock is around 43 400 tonnes and there are indications of a weak upcoming year class.

1 Opening of the meeting

The Working Group for International Pelagic Surveys met in Galway, Ireland, from 19–22 January 2010 to:

a) combine the 2009 survey data to provide indices of abundance for the population of herring and sprat within the area, using the FishFrame Acoustics database;

b) coordinate the timing, area and effort allocation and methodologies for acoustic and larvae surveys for herring and sprat in the North Sea, the Malin Shelf and the Western Baltic in 2010;

c) examine the interpretation of echograms between the participants of the 2009 acoustic surveys to ensure quality control and proper exchange of experience;

d) review the progress of FishFrame development in stage 1 and 2;

e) review and consider the incorporation of new models of depth based target strength for Atlantic herring, herring in the North Sea, the Malin Shelf and IIIa.

WGIPS will report by 15 March 2010 (via SSGESST) for the attention of SCICOM, WGSIUR, ACOM and HAWG.

2 Adoption of the agenda

The agenda was presented and adopted by WGIPS on the very first day. Participants contact details are listed in Annex 1, the agenda is given in Annex 2.

The following persons attended WGIPS:

Name	Function	Country
Karl-Johan Stæhr	Chair	Denmark
Cindy van Damme	common member	Netherlands
Eberhard Götze	common member	Germany
Norbert Rohlf	common member	Germany
Phil Copland	common member	UK
Eric Armstrong	common member	UK
Cecilie Kvamme	common member	Norway
Ciaran O'Donnell	Host	Ireland
Sascha Fässler	common member	Netherlands
Pieter-Jan Schon*	common member	UK
Dominik Gloe	Invited by chair	Germany

***by correspondence**

3 Herring larvae surveys

3.1 Review of larvae surveys in 2009

3.1.1 Western Baltic

The Rügen herring larvae survey (RHLS) has been conducted by the German Institute of Baltic Sea Fisheries (vTI-OSF), Rostock, and its predecessor since 1977. It delivers a unique, high-resolution dataset on the herring larvae ecology in the Western Baltic, both temporally (weekly sampling over most of the spawning season) and spatially

(35 standard stations over a small area considered to be the main spawning area of this stock, the Greifswalder Bodden). The recruitment index derived from the survey is based on the number of larvae passing a certain length (20 mm) between two sampling events and thus not dependent of the identification of cohorts. Calculation procedures have been reviewed and re-established in recent years and the recalculated index for the time-series from 1991 onwards has been used by HAWG since 2008 as the only 0-group recruitment index for the assessment of Western Baltic Spring-spawning herring.

The 2009 herring spawning season in the Greifswalder Bodden started in late February as in previous years, but with a massive immigration of spawning fish. The local fishery on the spawning ground took its quota within 6 weeks, due to the excellent fishing conditions on the one hand and a significantly reduced TAC for 2009 on the other. Spawning was observed until late May, and the larvae survey was conducted over 16 weeks, from mid-March through to the end of June. The recruitment index derived from the 518 stations sampled is 6464 Million and thus about four times higher than that of 2008 (Table 3.1.1). It is also above the geometric mean of the time-series (5190 Mill including 2009).

Table 3.1.1. N20 recruitment index for Western Baltic Spring-spawning herring, derived from the Rügen herring larvae survey. Note that the 2007 value was updated (from 1900 Mill.).

YEAR	N20 (MILL)
1992	1060
1993	3044
1994	12515
1995	7930
1996	21012
1997	4872
1998	16743
1999	20364
2000	3026
2001	4845
2002	11324
2003	5507
2004	5640
2005	3887
2006	3774
2007	1829
2008	1622
2009	6464

Spawning herring were again observed to migrate into the Greifswalder Bodden from late summer until December 2009. Larvae sampling campaign was conducted in mid-November to identify the origin and spawning type of these fish.

3.1.2 North Sea

In the reporting period, the Netherlands and Germany participated in the larvae surveys. In total six out of ten area/period combinations were covered in the North Sea, as given below. In the second half of September most of the Orkney/Shetland area was sampled twice. There are also 48 stations in the Buchan area where information from double sampling will become available from the Netherlands and Germany.

Table 3.1.2.1. Areas and periods covered during the 2008/2009 herring larvae surveys:

AREA / PERIOD	1–15 SEPTEMBER	16–30 SEPTEMBER	1–15 OCTOBER
Orkney / Shetland	--	Germany	
Buchan	--	Netherlands/ Germany	
Central North Sea	--	Netherlands	--
	16–31 DECEMBER	1–15 JANUARY	16–31 JANUARY
Southern North Sea	Netherlands	Germany	Netherlands

The herring larvae sampling was still in progress during the WGIPS 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 of the final larvae survey results.

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 2010.

3.1.3 Irish Sea

Herring larvae surveys of the northern Irish Sea (ICES area VIIaN) have been carried out by the Agri-Food and Biosciences Institute (AFBI), formerly the Department of Agriculture and Rural Development for Northern Ireland (DARD), in November each year since 1993. The surveys have been carried out onboard the RV "Corystes" since 2005, and prior to that on the smaller RV "Lough Foyle".

Sampling is carried out on a systematic grid of stations covering the spawning grounds and surrounding regions in the NE and NW Irish Sea (Figure 3.1.3.1). Larvae are sampled using a Gulf-VII high-speed plankton sampler with 280 µm net. Mean catch-rates (nos.m^{-2}) are calculated over stations to give separate indices of abundance for the NE and NW Irish Sea. Larval production rates (standardized to a larva of 6 mm), and birth-date distributions, are computed based on the mean density of larvae by length class. A growth rate of 0.35 mm day^{-1} and instantaneous mortality of 0.14 day^{-1} are assumed based on estimates made in 1993–1997.

The results for 2009 indicate a similar distribution pattern to previous years, with the highest abundance of herring larvae being to the east and north of the Isle of Man (Figure 3.1.3.1). The point estimate of production in the northeastern Irish Sea for 2009 (1.69 x 10^{12} larvae) was below the time-series average. The index is used as an indicator of spawning-stock biomass in the assessment of Irish Sea herring by the Herring Assessment Working Group (HAWG).

The 2010 survey is scheduled to take place 8–19 November.

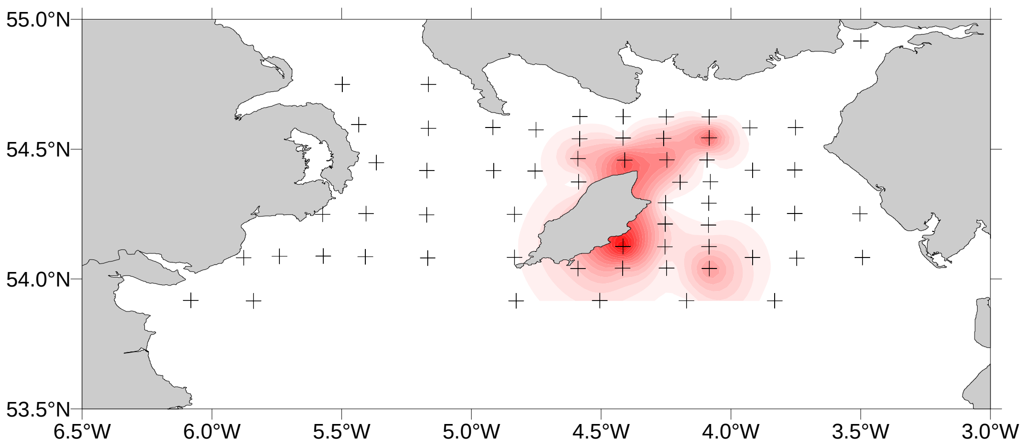

Figure 3.1.3.1. Estimates of larval herring abundance in the Northern Irish Sea in 2009. Crosses indicate sampling stations. Areas of shading are proportional to larva abundance (maximum = 182 per m²).

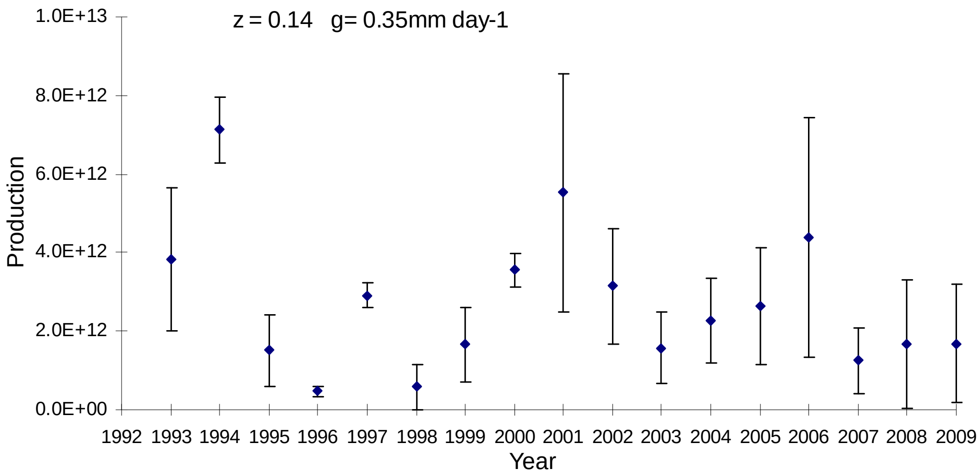

Figure 3.1.3.2. Estimates of larval herring production in the NE Irish Sea from 1993 to 2009. Error bars denote 1 standard error (calculated from coefficients of variation of the estimates of abundance, but not including uncertainty in growth or mortality).

3.2 Coordination of larvae surveys in 2010

At present, for the larvae surveys in the North Sea, only the participation of the Netherlands and Germany is confirmed in the upcoming period. Due to limited ship time, coverage of the Orkney/Shetland area will not be possible in the first time window, but will be covered in the second time window by Germany. The Netherlands are able to cover the Buchan area and the Central North Sea in the second time window. The coverage of the last time window 1–15 October will not be possible in any of the areas. A preliminary timetable for the next sampling period is presented as follows:

Table 3.2.1. Areas and periods for the 2010 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

Survey results should be sent to Norbert Rohlf (vTI, Institute of Sea Fisheries, Hamburg), for inclusion into the IHLS database. SF is responsible to calculate and report the summarized results and the updated series of MLAI-values to the HAWG.

3.3 Workshop on the Identification of Clupeid Larvae (WKIDCL)

Herring Larvae surveys provide essential data for the assessment of pelagic stocks in the North Sea, the Irish Sea and the western Baltic (Divisions VIIaN, IV, VIa, IIIa, and Western Baltic). They are currently carried out by different countries and the results of these surveys are of direct importance for the herring assessment.

In recent years, abundance of anchovies and sardines has again increased in the North Sea, and there is evidence to believe that these species also spawn there. With regards to climate change, the occurrence of sprat larvae may have shifted northwards as well. Since clupeid larvae can easily be misidentified, effective quality control and proper larvae identification is essential to the survey results.

In 2010 a workshop was proposed to take place in Hamburg, Germany. However, due to a small number of participants, the workshop had to be cancelled. A training exercise was organized at IMARES instead, where Matthias Kloppmann from vTI-SF, Hamburg showed how to correctly identify clupeid larvae. One technician from MSSML, Scotland and 4 technicians from IMARES, the Netherlands, participated in the exercise.

During this training course a review of available information on the identification of clupeid larvae was carried out and an agreed identification key based on the literature was set up. Participants realized in the discussions that there could be more sources of misidentification than anticipated. The group felt that the training course was helpful for their daily practise. Thus the group and WGIPS recommend a workshop for participants involved in herring larvae surveys. This workshop on the identification of Ichthyoplankton, especially clupeid larvae, should take place in IJmuiden, The Netherlands, in 2011 with the following terms of reference:

a) review available information on the identification of clupeid fish larvae, giving special consideration to larvae's appearance with ongoing development
b) identify sources of misidentification of clupeid larvae
c) establish an agreed identification key for participants in clupeid larvae surveys, e.g. for the IHLS in the North Sea, the Irish Sea, the IBTS (MIK index), the Rügen HLS and the Norwegian Spring-spawning herring larvae surveys.

4 Acoustic surveys

4.1 Combined estimates of the acoustic survey

4.1.1 North Sea, West of Scotland and Malin Shelf summer acoustic survey

The surveys are reported individually in the Appendices 5A-5H of this report. A combined report has been prepared from the data from all surveys, attached as Annex 6. 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 Norwegian part of the survey had a cut in survey time, resulting in an inadequate coverage of the survey area, as only 16 of a total of 39 squares (41%) were covered (Figure 6.1). Seven uncovered squares were interpolated from estimates in neighbouring squares. For interpolation it was required that at least four neighbour squares were covered by the cruise. Finally, 16 squares of the survey were not included in the total estimate. It must be emphasized that the interpolation process reduce the quality of the estimate, and the participants are asked to ensure that coverage of the agreed survey areas, as shown in table 4.3.1.1 is completed as far as possible.

The estimate of the North Sea, autumn spawning herring, spawning stock is approximately a third higher compared to the previous year, at 2.6 million tonnes and 12 888 million herring. The survey continues to show the particularly strong 2000 year class of herring. Growth of this 2000 year class still seems to be slower than average: individuals of this year class were of a smaller mean length and mean weight than the younger 2001 year class.

The estimates of Western Baltic spring-spawning herring SSB were 205 000 tonnes and 1 602 million herring, which is lower than last year's estimate. The stock is dominated by 1 and 2 ring fish; however this year's estimated abundance of 1 and 2 ringers is considerably less than those dating back to 2002.

The West of Scotland estimates of SSB are 579 000 tonnes and 2 560 million herring. This was lower compared to the estimates from the previous year, which was the second highest in the time-series. Once again the survey did not detect many immature fish. The youngest year class observed in the survey represents the strongest in the past four years. To ensure that the west of Scotland results were consistent with the time-series, they were derived from squares above 56°N only.

This is the second year of the synoptic survey, covering what is currently considered the Malin Shelf population of herring was carried out for the second year. This provided an estimate comprising four herring stocks to the west of the British Isles: the West of Scotland in Division VIaN; the Clyde; Divisions VIaS and VIIb, c; and the Irish Sea. Due to late submission, results from the survey covering the Clyde and the Irish Sea stocks are not reported here. The Malin Shelf estimate of SSB reported here therefore covers the West of Scotland herring stock in Division VIaN and the stock in Division VIaS and VIIb, c. The SSB estimate was 593 000 tonnes and 2 647 million fish and is largely dominated by the West of Scotland estimate.

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 2009, with mean weights and mean lengths by age ring.

Age (ring)	Numbers	Biomass	Maturity	weight(g)	Length (cm)
0	13,554	95	0.00	7.0	10.0
1	4,655	260	0.04	55.9	18.3
2	5,632	832	0.89	147.7	24.8
3	2,553	532	1.00	208.3	27.4
4	1,023	242	1.00	236.3	28.4
5	1,077	249	1.00	231.5	28.3
6	674	162	1.00	239.6	28.5
7	638	169	1.00	265.5	29.4
8	1,142	285	1.00	249.2	28.8
9+	578	174	1.00	262.7	29.5
Immature	18,639	407		21.8	12.4
Mature	12,888	2,591		201.1	27.0
Total	31,526	2,998	0.41	95.1	18.4

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 2009, with mean weights, mean length and fraction mature by age ring.

Age (ring)	Numbers	Biomass	Maturity	weight(g)	Length (cm)
0					
1	565	27	0.32	47.5	17.7
2	398	49	0.77	122.7	23.4
3	205	30	0.95	149.1	25.4
4	161	30	0.99	182.9	27.0
5	82	17	1.00	213.3	28.3
6	86	21	1.00	248.3	29.1
7	39	10	1.00	272.1	29.8
8+	65	20	1.00	304.7	30.3
Immature	490	31		63.5	19.0
Mature	1,113	174		156.2	24.7
Total	1,602	205	0.69	127.9	23.0

Table 4.1.1.3. Total numbers (millions) and biomass (thousands of tonnes) of autumn spawning of West of Scotland herring in the area surveyed in the acoustic surveys July 2009, with mean weights, mean lengths and fraction mature by age ring.

AGE (RING)	NUMBERS	BIOMASS	MATURITY	WEIGHT(G)	LENGTH (CM)
0					
1	346	20	0.00	59.0	18.5
2	187	28	0.70	151.5	24.8
3	264	55	1.00	206.4	27.5
4	430	96	1.00	223.3	28.3
5	374	87	1.00	233.1	28.6
6	219	51	1.00	231.2	28.6
7	187	43	1.00	231.8	28.6
8	500	116	1.00	232.3	28.6
9+	456	109	1.00	238.2	28.8
Immature	403	26		64.9	19.0
Mature	2,560	579		226.2	28.4
Total	2,962	605	0.86	204.2	27.1

Table 4.1.1.4. Total numbers (millions) and biomass (thousands of tonnes) of Malin Shelf herring in the area surveyed in the acoustic surveys July 2009, with mean weights, mean lengths and fraction mature by age ring.

AGE (RING)	NUMBERS	BIOMASS	MATURITY	WEIGHT(G)	LENGTH (CM)
0					
1	773	45	0.00	58.9	18.6
2	265	38	0.67	143.3	24.5
3	274	56	0.99	204.1	27.4
4	444	98	1.00	222.1	28.2
5	380	89	1.00	233.0	28.6
6	225	52	1.00	231.5	28.6
7	193	45	1.00	232.4	28.6
8	500	116	1.00	232.3	28.6
9+	456	109	1.00	238.2	28.8
Immature	863	55		63.8	19.0
Mature	2,647	593		224.1	28.3
Total	3,510	648	0.75	184.7	26.0

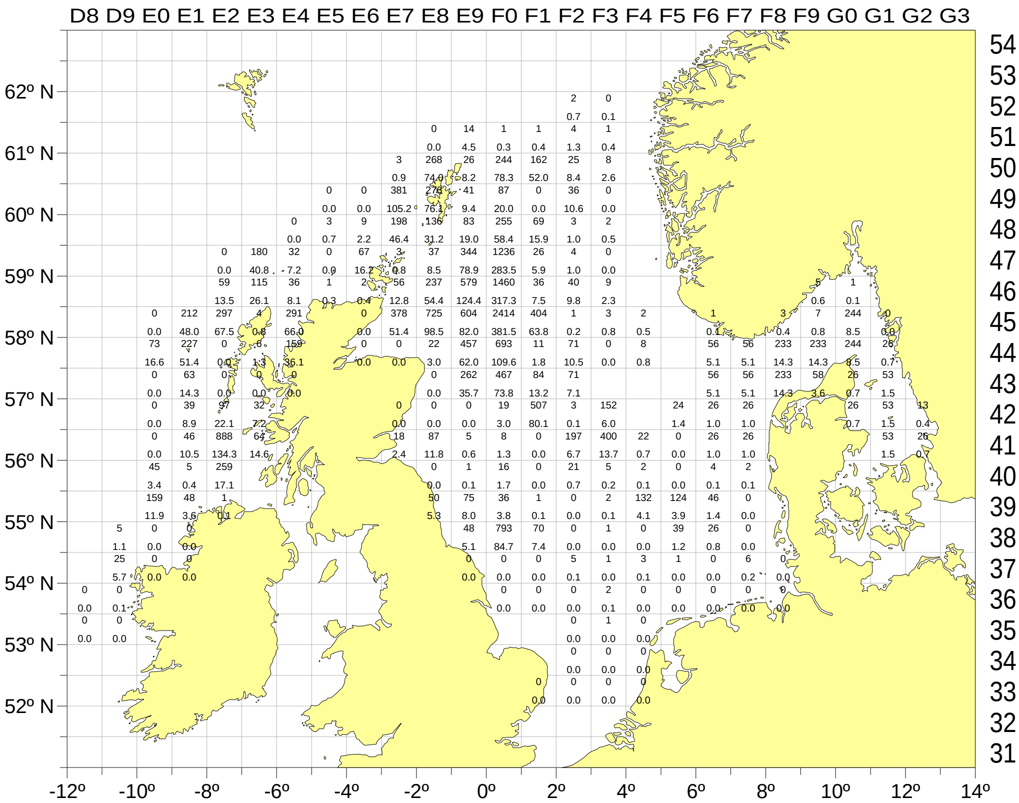

Figure 4.1.1.1. Abundance of autumn spawning herring (winter ring 1–9+) from the combined acoustic survey in June-July 2009. Numbers (millions, upper figure) and biomass (thousands of tonnes, lower figure). Blank and interpolated rectangles are not surveyed. Interpolated rectangles are mark in Figure 6.1, Annex 6.

4.1.2 Western Baltic acoustic survey

A joint German-Danish acoustic survey was carried out with RV "Solea" 2–21 October 2009 in the Western Baltic. This survey is traditionally coordinated within the framework of the Baltic International Acoustic Survey 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 in the Western Baltic area. As in previous years, acoustic recording and trawling was done only during the night. An EK60 echosounder with a hull mounted ES38B transducer and EchoView4 integrator software were used to collect and process acoustic data. The cruise track was 1245 nautical miles long and is representative for an area of 12 400 nautical square miles. To identify the target species and determine the length and weight of fish, 49 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 CTD-O_2 probe.

The herring stock in Subdivisions 21–24 was estimated to be 4.1 x 10^9 fish or about 90.1 x 10^3 tonnes. For the area including only Subdivisions 22–24, the number of herring was calculated to be 3.5 x 10^9 fish or about 81.2 x 10^3 tonnes. The abundance estimate was dominated by young herring as in former years. The present estimates of herring numbers, equal last year's results, but at the same time show a sharp decline in biomass (over 30%). It should be noted that last year this herring stock was also at an extremely low level compared to the long-term mean.

The estimated sprat stock in Subdivisions 21–24 was 6.1 x 10^9 fish or 44.3 x 10^3 tonnes. For the area including only Subdivisions 22–24 the number of sprat was calculated to be 6.0 x 10^9 fish or 43.4 x 10^3 tonnes. The present record low estimates of sprat in numbers and biomass are caused by a

- comparatively weak new year-class,
- further diminishing importance of the last strong year-class of 2006.

A detailed survey report is provided in Annex 5.

4.2 Sprat in the North Sea and Division IIIa

Sprat data were available from RV "Solea", RV "Tridens" and RV "Dana". RV "Scotia" and RV "Johan Hjort" observed no sprat in the northern North Sea. In the acoustic surveys 2009 sprat concentrated in the southeastern parts of the North Sea, with highest abundances and biomass in a wide area between 3° and 8° E and between 53° and 55° N. The survey area was again limited down to 52° N. There is no indication that the southern limit of the sprat stock distribution has been reached; it is likely that sprat can be found even further south in the English Channel. The sprat distribution in the North Sea in terms of abundance and biomass is shown in Figure 4.2.1.

The total abundance in 2009 was estimated to 65,191 million individuals and the biomass 556 kt (Table 4.2.1). This is an increase by 105% in terms of biomass when compared to last year (ICES, 2009) and the highest estimate of the 2000–2009 time-series (Table 4.2.2). In terms of abundance, it is the second highest estimate. In 2006–2008, there was a downward trend in North Sea sprat (Table 4.2.2). The majority of the stock consists of mature sprat. The sprat stock is dominated by 1- and 2-year old fish representing more than 98% of the biomass.

An age-disaggregated time-series of North Sea sprat abundance and biomass (ICES area IVa-c), as obtained from the acoustic survey, is given in Table 4.2.2. Note that for 2003, information on sprat distribution is available from one nation only.

In Div. IIIa, sprat was abundant in the Kattegat only (ICES squares 41G1-G2, 42G0-G2, 43G0-G1 and 44G1). No sprat was observed in the Skagerrak area (43F8-F9, 44F8-F9). The abundance was estimated to 2,233 million individuals (Table 4.2.3), a significant increase compared to 775 million sprat in 2008. The biomass was estimated to 36,500 tonnes. Most sprat were three-year old fish, and 80% of them were immature.

Table 4.2.1. Sprat in the North Sea: Abundance, biomass, mean weight and mean length by age and maturity from summer 2009 North Sea acoustic survey.

Age	Abundance (million)	Biomass (1000 t)	mean weight (g)	mean length (cm)
1i	20,219	102	5.1	8.9
1m	27,301	244	8.9	10.7
2i	3,298	19	5.6	9.2
2m	13,190	170	12.9	12.0
3m	1,153	20	17.2	13.4
4m	30	1	23.8	14.6
immature	23,517	121	5.1	8.9
mature	41,674	435	10.4	11.2
grand total	65,191	556	8.5	10.4

Table 4.2.2. Time-series of sprat abundance and biomass (ICES areas IVa-c) as obtained from summer North Sea acoustic survey. The surveyed area has increased over the years. Only figures for the last 5 years are roughly comparable. In 2003, information on sprat abundance is available from one nation only.

	Abundance (million)					Biomass (1000 t)				
Year/Age	0	1	2	3+	sum	0	1	2	3+	sum
2009	0	47,520	16,488	1,183	65,191	0	346	189	21	556
2008	0	17,165	7,410	549	25,125	0	161	101	9	271
2007	0	37,250	5,513	1,869	44,631	0	258	66	29	353
2006*	0	21,862	19,916	760	42,537	0	159	265	12	436
2005*	0	69,798	2,526	350	72,674	0	475	33	6	513
2004*	17,401	28,940	5,312	367	52,019	19	267	73	6	366
2003*	0	25,294	3,983	338	29,615	0	198	61	6	266
2002	0	15,769	3,687	207	19,664	0	167	55	4	226
2001	0	12,639	1,812	110	14,561	0	97	24	2	122
2000	0	11,569	6,407	180	18,156	0	100	92	3	196

*** re-calculated by the means of FishFrame.**

Table 4.2.3. Sprat in Division IIIa: Abundance, biomass, mean weight and length by age and maturity from summer 2009 North Sea acoustic survey-

Age	Abundance (Million)	Biomass (1000 t)	Mean Weight (g)	Mean length (cm)
1i	169.5	1.8	10.7	11.6
2i	408.0	6.1	14.9	12.9
2m	24.4	0.4	14.9	12.9
3i	980.6	16.2	16.6	13.4
3m	226.3	3.7	16.6	13.4
4i	183.0	3.6	19.4	14.1

Age	Abundance (million)	Biomass (1000 t)	Mean weight (g)	Mean length (cm)
4m	96.1	1.9	19.4	14.1
5m	127.9	2.4	19.2	14.4
6m	18.0	0.4	20.0	14.8
immature	1,741.1	27.7	15.9	13.2
mature	492.6	8.8	17.9	13.8
total	2,233.7	36.5	16.3	13.3

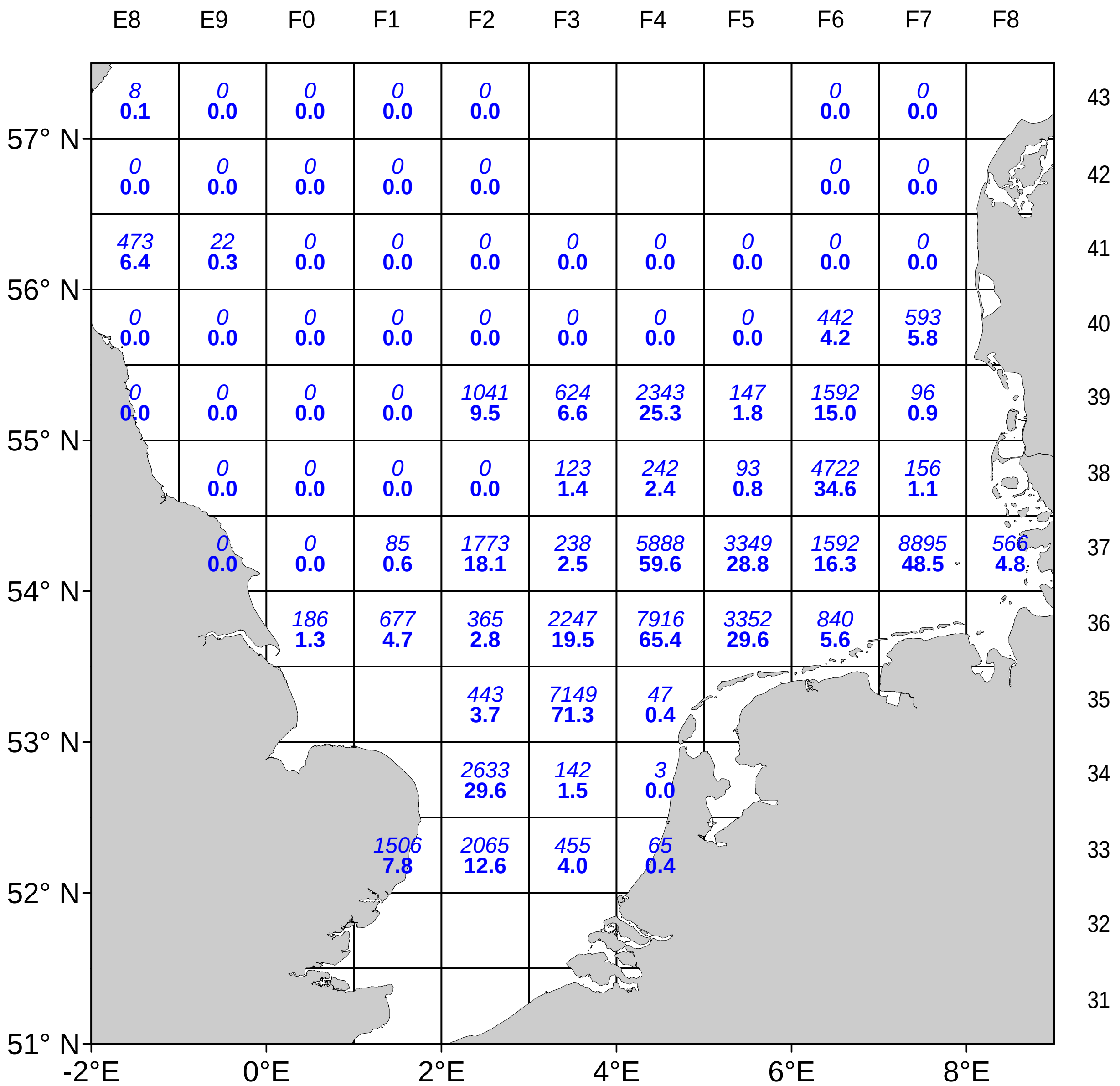

Figure 4.2.1. North Sea Sprat. Abundance (upper figure, in millions) and biomass (lower figure, in 1000 t) per statistical rectangle as obtained by the acoustic survey 2009. Blank rectangles are not sampled.

4.3 Coordination of acoustic surveys in 2010

4.3.1 North Sea, West of Scotland and Malin Shelf

In general, participants are asked to ensure that coverage of the agreed survey areas, as shown in table 4.3.1.1, is completed as far as possible. Sampling effort within those general areas should be directed as indicated from results of recent surveys, to ensure adequate, detailed coverage reflecting the likely stock distribution. Interlacing of adjacent surveys is encouraged where considered appropriate, but only when it can be achieved without reducing the effectiveness of each individual survey.

Participants in 2010 should exchange tentative cruise tracks prior to the survey, for further coordination. **Copies of all cruise tracks should also be sent to Paul Fernandes, Aberdeen, not later than 30 May 2010**; he will then contact individual cruise leaders to discuss possible amendments.

Additionally, vessels should be in daily radio contact during the cruise at **1730** hrs **UTC** on MW frequency 3333 KHz 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 allow the coordinator to adapt other nations cruise tracks and to avoid gaps. Due to the long distances between the vessels while surveying, some participants have difficulties in receiving the radio communication. Thus, e-mails with cruise track and trawl information should be exchanged every second day. Cruise leaders should circulate their e-mail addresses for the duration of the cruise, **particularly** if it is not their normal contact address. **Phil Copland and Bram Couperus have agreed to act as coordinators during the 2010 survey. They can be reached by e-mail or phone between 25 June and 1 July, and will initiate the radio communication from 1 July onwards**.

Acoustic surveys in the North Sea, West of Scotland and the Malin Shelf in 2010 will be carried out in the periods and areas given in Table 4.3.1.1 and Figure 4.3.1.1.

Table 4.3.1.1. Time periods, areas and rectangles to be covered in the 2010 acoustic surveys

Vessel	Period	Area	Rectangles
Celtic Explorer (IRE)	18 June – 07 July	53°30′-57°N ,11.3°-6.30°W	34D9-E0, 35D8-E0, 36D8-E0, 37D9-E1, 38D9-E1, 39E1-F3, 40D9-E2, 41D9-E2, 42D9-E2
Charter west Sco (SCO)	28 June – 19 July	55°30′-60°30′N, 4°-10°W	41E0-E3, 42E0-E3, 43E0-E3, 44E0-E3, 45E0-E4, 46E2-E5, 47E2-E5, 48E4-E5, 49E5
Johan Hjort (NOR)	1 July -2 August	56°30′-62°N, 2°-6°E	42F2-F5, 43F2-F5, 44F2-F5, 45F2-F5, 46F2-F4, 47F2-F4, 48F2-F4, 49F2-F4, 50F2-F4, 51F2-F4, 52F2-F4
Scotia (SCO)	28 June – 18 July	58°30′-62°N, 4°W-2°E	45E6-F1, 46E6-F1, 47E6-F1, 48E6-F1, 49E6-F1, 50E7-F1, 51E8-F1
Tridens (NED) PBVO	28 June – 23 July	54°– 58°30′N, 4° W–2°/ 6°E	37E9-F1, 38E8-F1, 39E8-F1, 40E8-F5, 41E7-F5, 42E7-F1, 43E7-F1, 44E6-F1, 45E6-F1
Solea (GER) DBFH	25 June – 13 July	52°-56°N, Eng to Den/Ger coasts	33F1-F4, 34F2-F4, 35F2-F4, 36F0-F7, 37F2-F8, 38F2-F7, 39F2-F7, 40F6-F7
Dana (DEN) OXBH	2 July – 15 July	Kattegat and North of 56°N, east of 6°E	41 F6-F7, 41G1-G2, 42F6-F7, 42G0-G2, 43F6-G1, 44F6-G1, 45F8-G1, 46F9-G0
Corystes (NIR)	12 July – 16 July	Clyde/North Channel	40E3–40E5, 39E3-E5, 38E4

Borders of survey areas between the west of Scotland charter vessel and RV "Scotia" may be moved if required. An overlap will also occur between RV "Celtic Explorer" and RV "Corystes" at least in Rectangle 39E3. An overlap between the Scottish charter vessel and "Celtic Explorer" will be attempted but will depend on the timing of the survey and the days at sea available to the Scottish charter vessel. Ireland will expand survey effort northwards to 57ºN in line with recommendations from SGHERWAY. Transect spacing will be adjusted accordingly to account for the increased area coverage in 2010 and will be confirmed during the planning phase.

The survey effort, e.g. transect spacing in the areas, should be the same as in most recent years (Figure 4.3.1.2). However, with regard to the reduced herring stock size, the spatial fish distribution in 2010 may differ from the historical picture. Thus participants should be encouraged to adapt their survey effort, avoiding a misbalance between transect spacing and occurrence of fish schools.

The North Sea sprat stock should continue to be surveyed properly. This requires that the southern boundary of the survey area be kept at 52°N.

The results from the national acoustic surveys in June-July 2010 will be collated and the result of the entire survey will be combined at the next WGIPS. Individual or combined survey results for sprat and herring should be uploaded to FishFrame NorthSea module (FFN) no later than **20 December 2010**. This deadline should also allow the members of the group to prepare as much of their contributions to the final report as possible prior to the meeting and free up time for plenary discussions and data quality control. Participants should also be prepared to additionally deliver their remaining raw data to the stage 1 module.

Malin Shelf Surveys

It was proposed that a subgroup should be established during WGIPS meetings to coordinate planning, effort allocation and logistics for this area. SGHERWAY has requested that additional sampling be undertaken during the 2010 survey within the Malin shelf area.

1) Ireland has agreed that they will extend their survey area to 57°N to accommodate SGHERWAY's request.

2) The collection of additional morphological and biological samples was discussed by the members of the Malin shelf subgroup present at WGIPS. Ireland stated that they could accommodate the requirements if protocols could be made available detailing the techniques and equipment required. Scotland felt that the additional sampling might prove difficult unless additional staff could be physically accommodated on the charter vessel to carry out the tasks. Northern Ireland has not yet responded to the request. Ireland was appointed as survey coordinator in 2010 by the participants in the Malin Shelf surveys. They should maintain contact between vessels at sea; communicate and coordinate planning of cruise tracks, transect interlacing areas, temporal progression and survey effort in the planning phase and communicate plans to WGIPS chair.

It was proposed that a two day post cruise meeting should be established soon after the survey to compile and collate combined survey data and to upload it to FishFrame. The meeting would allow members to evaluate survey data and discuss issues arising from the survey and conclude on recommendations to improve survey precision.

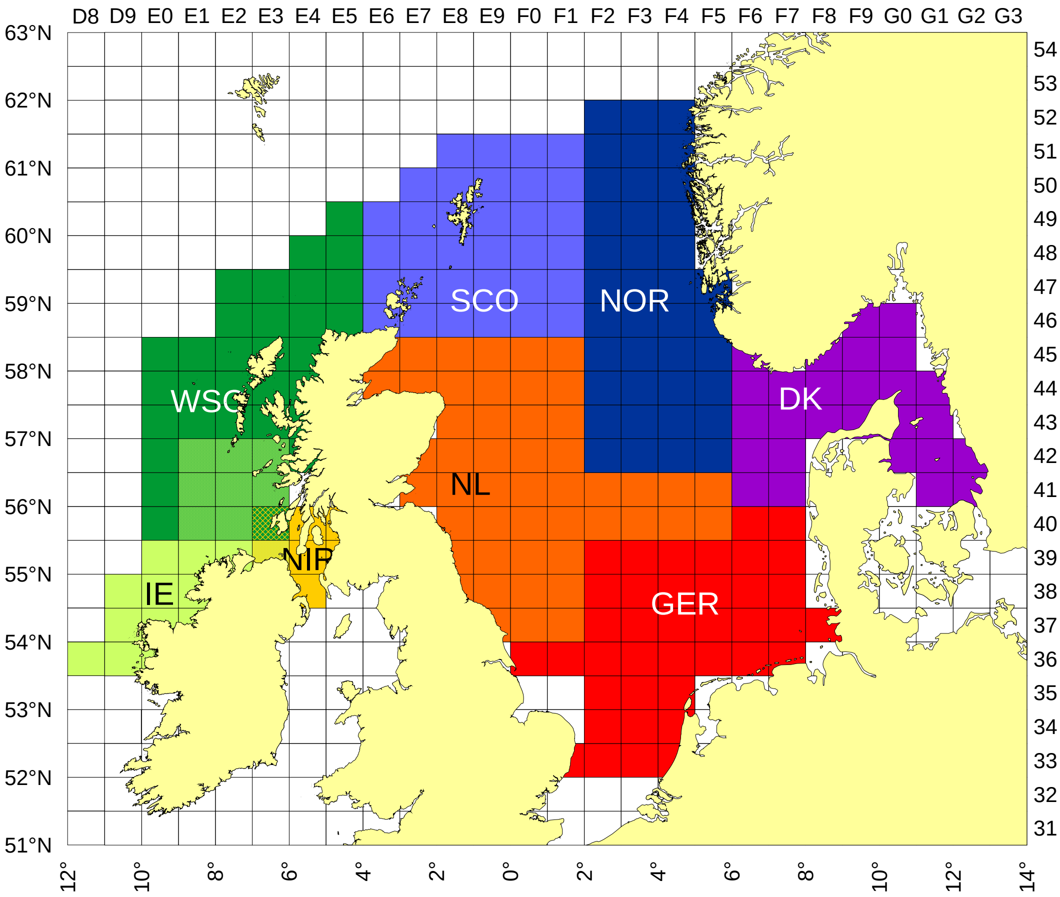

Figure 4.3.1.1. Survey area layouts for all participating vessel in the 2010 acoustic survey of the North Sea and adjacent areas. (NIR = Corystes; IE = Celtic Explorer; WSC = West of Scotland charter; SCO = Scotia; NOR = Johan Hjort; DK = Dana; NL = Tridens; GER = Solea).

4.4 Hydrographic data

In the last years, no hydrographic data were collected by the members of WGIPS. The group decided to continue data collection for further analysis of dependencies in fish distribution. Dominik Gloe agreed to put together and process the hydrographic data.

4.5 Workshop on sexual maturity staging of herring and sprat (WKMSHS)

In 2011 a workshop on sexual maturity staging of herring will be organized in Denmark. The term of reference include a proposal to standardized maturity scales for herring and sprat for common use among laboratories including a comparison of existing scales and identification of reliable maturity determination criteria for females and males. WGIPS supports the workshop and encourages WGIPS members to participate in the workshop.

4.6 Request from WGWIDE on acoustic data on mackerel

WGWIDE, at its meeting in 2009, has recommended that acoustic data on mackerel from the North Sea herring survey should be stored and made available for scrutinizing by acoustic experts.

Acoustic data to be used for mackerel investigations shall be collected together on 38 and 200 kHz echosounders. For the acoustic survey in Skagerrak, Kattegat, the North

Sea, West of Scotland and the Malin Shelf area, only the Netherlands, Scotland, Norway and Ireland are collecting data with the two needed frequencies.

During the meeting, data from the Netherlands in 2009 were collected and stored on an external hard disk for transport to DTU-Aqua for further analyses. Data from Scotland and Ireland from 2009 were available, but due to technical problems during the meeting, they will be transferred to DTU-Aqua later. The Norwegian member of the working group advised that a Norwegian member of WGWIDE should try to collect the needed data direct from the Norwegian Marine Data Centre at IMR.

5 Review and update of PGIPS manuals

The manual for the international herring larvae surveys is regularly updated and changes in the recent version of the manual compared to the previous version can be found in Table 5.1.

Table 5.1. Changes in the manual compared to the previous version

VERSION 3	VERSION 3.1 2010
2.1 In areas with high densities at least two extra samples should be taken in the same 10*10 rectangle	In practise this has not always been proven to be possible. Therefore, the text has been changed to 'survey participants should try to take two extra samples'.
4.4 At least 200 larvae should be measured from the sample	Due to time constraints because of the timing of the assessment group meeting this is not possible and participants should try to measure at least 100 larvae.

WGIPS has not updated the acoustic manual during this meeting. The last version 3.3 of the manual for the acoustic surveys was introduced in 2005. The hardware description is mainly based on the echosounder EK500. This sounder has now been largely replaced by EK60. Regarding the new hardware EK60 there are lacks in the most basic requirements concerning calibration and instrument settings. These deficiencies should be rectified as soon as possible. Generally a new basic revision of the rules and regulations in WGIPS acoustic surveys is highly recommended.

6 FishFrame

6.1 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:

- Stage I: Basic, disaggregated fisheries and acoustics data.
- 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. Stage I and III has been finished. In 2007 PGHERS began using FishFrame as the groups' standard calculation procedure.

6.2 FishFrame Performance and outlook

Under the “Studies for carrying out the common fisheries policy: Open call for tenders No MARE/2008/10. Lot 1.” a proposal was put forward to fund developments in the FishFrame database: more specifically, “The establishment of a data portal and warehouse for regional coordination of the sampling of data used for fish stock assessment and fisheries management.” The partners in this proposal were the coordinator, Danish Technical University/ Danish Institute for Fisheries Research (DTU-AQUA); Centre for Environment, Fisheries & Aquaculture Science (Cefas), England (UK); Institut Français pour la Recherche et l’Exploitation de la Mer (Ifremer), France; Fisheries Research Services (FRS), Scotland (UK); Wageningen Institute for Marine Resources and Ecosystem Studies (IMARES), The Netherlands; and Instituto Ricerche Economiche per la Pesca e l’Acquacoltura (IREPA ONLUS), Italy

For upgrading to version 5 for acoustics and to develop new estimation modules, EU did not grant the funding. The acoustic surveys are still in the previous version 4.3 of FishFrame. A new version 5.0 has been deployed for commercial fisheries data. Version 5.0 offers a range of new features and is browser and platform independent for the user.

The decision by DTU-Aqua not to develop the acoustic part of FishFrame further than ver. 4.3 has a number of implications for the WGIPS.

At the moment FishFrame is a very important tool for WGIPS as it is used for compilation of the combined survey result for herring and sprat by area based on the the national survey results (stage 3 data) entered in Fish Frame.

In FishFrame ver 4.3 the Pivot tables is running in a web-component that comes along with office 2000. Microsoft changed the interface of this component in office 2003 cutting the backwards compatibility. This means that only computers with office 2000 are able to produce the output tables to be used for the WG-report.

WGIPS has during the meeting experienced that contact had to be made to operator at DTU-Aqua to refresh the FishFrame server to make the program running for production of tables whenever small changes in input data has been made.

Furthermore WGIPS recognized problems with stock detail data in cases where one ship have divided a rectangle up in more than one BiologicalRectangle: The Stock-Age-Maturity distributions in each BiologicalRectangle should include all the same Stock-Age-Maturities. Since fractions of zero are not allowed; 0.000000001 can be used as a “hack”. Example:


```
<StockDetail Year="2009" Ship="CEN" Species="161722" Stock="her-vian" Age="1" AgePlusGroup="-" Maturity="I" MaturityDetermination="M" Rectangle="00X0" SubStatisticalRectangle="X" BiologicalSubArea="A">
        <Fraction>0.5</Fraction>
        <MeanWeight>94.000183</MeanWeight>
        <MeanLength>215.000000</MeanLength>
</StockDetail>
<StockDetail Year="2009" Ship="CEN" Species="161722" Stock="her-vian" Age="2" AgePlusGroup="-" Maturity="I" MaturityDetermination="M" Rectangle="00X0" SubStatisticalRectangle="X" BiologicalSubArea="A">
        <Fraction>0.5</Fraction>
                <MeanWeight>150.001056</MeanWeight>
        <MeanLength>249.375000</MeanLength>
</StockDetail>
```

```
<StockDetail Year="2009" Ship="CEN" Species="161722" Stock="her-vian" Age="1" AgePlusGroup="-" Maturity="I" MaturityDetermination="M" Rectangle="00X0" SubStatisticalRectangle="X" BiologicalSubArea="B">
    <Fraction>1.0</Fraction>
    <MeanWeight>94.000183</MeanWeight>
    <MeanLength>215.000000</MeanLength>
</StockDetail>
```

Should be changed to:

```
<StockDetail Year="2009" Ship="CEN" Species="161722" Stock="her-vian" Age="1" AgePlusGroup="-" Maturity="I" MaturityDetermination="M" Rectangle="00X0" SubStatisticalRectangle="X" BiologicalSubArea="A">
    <Fraction>0.5</Fraction>
    <MeanWeight>94.000183</MeanWeight>
    <MeanLength>215.000000</MeanLength>
</StockDetail>
<StockDetail Year="2009" Ship="CEN" Species="161722" Stock="her-vian" Age="2" AgePlusGroup="-" Maturity="I" MaturityDetermination="M" Rectangle="00X0" SubStatisticalRectangle="X" BiologicalSubArea="A">
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        <MeanWeight>150.001056</MeanWeight>
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    <Fraction>0.000000001</Fraction>
    <MeanWeight>94.000183</MeanWeight>
    <MeanLength>215.000000</MeanLength>
</StockDetail>
```

WGIPS has FishFrame as its only platform for producing the combined results for the surveys based on national survey results (Stage 3) data. WGIPS furthermore wants to have FishFrame as the database for storing the raw acoustic and biological data (Stage 1). WGIPS do not find that a total compilation of the acoustic result based on stage 1 data should be made within FishFrame but in an external program based on data exported from FishFrame.

Therefore the working group recommends that DTU-Aqua is asked to give an estimate of the cost for:

1) Making export of tables from stage 3 platform-independent.

2) Possibility to refresh server after data updates without operator assistance

3) A feedback showing successful data erasure

4) A full update of FishFrame Acoustic to ver. 5 level

7 Modelling depth-dependent target strength of herring

A simple relationship of the form TS = 20log10(L)-b20 is currently used to estimate mean target strength (TS) from fish length (L) using a species-specific value for b20. The TS-L relationship currently applied to estimate abundances of North Sea herring (*Clupea harengus*) was determined empirically about 30 years ago: Nakken and Olsen (1977) ensonified stunned and tethered herring at 38 kHz and determined a mean TS-L relationship of TS = 13.6log10(L)-62.8. Edwards and Armstrong (1981) measured the TS at 38 kHz of live herring in a cage at 17.5 m depth. They obtained mean TS of -33.8 dB per kg of fish. The Planning Group on ICES – Co-ordinated Herring and Sprat Acoustic Surveys (ICES, 1982) subsequently converted Nakken and Olsen's (1977) TS-L relationship into TS per kg (-34.6 dB per kg) and decided that the mean of the two TS estimates (-34.2 dB per kg) should be used together with length-weight data from northwest North Sea herring to derive TS = 20log10(L)-71.2 (dB).

There is evidence that pressure (and thus fish depth) modulates the TS of Atlantic herring (Edwards *et al.,* 1984; Ona, 2003) and this dependence will bias acoustic survey results if not taken into account (Løland *et al.,* 2007). Herring are physostomes and thus do not have a gas gland that enables them to alter the swimbladder volume actively. Their swimbladder will therefore decrease in volume with increasing water pressure, leading to a steady decrease in TS with increasing depth. Using magnetic resonance imaging (MRI) observations of a herring in a pressure chamber, Fässler *et al.* (2009a) showed that the decrease in swimbladder volume with pressure is in accordance with Boyle's law. However, the swimbladder compression with depth is not isometric: the cross sectional surface contracts more slowly than the volume.

Fässler *et al.* (2009b) described a method that uses acoustic backscatter models to predict mean TS as a function of fish orientation, size, physical properties and acoustic frequency. Distributions of unknown model parameters (tilt angle distribution, swimbladder volume at the sea surface, and precision of the mean TS estimate) were estimated in a Bayesian framework by fitting backscatter models to mean TS data of herring at depth. Posterior distributions of model parameters were then used with the error propagation properties of the Bayesian framework to simulate backscattering by herring (Figure 7), while quantifying the precision of the TS estimate. Using these methods together with mean TS data for North Sea herring at depth (Edwards *et al.,* 1984) and the Kirchhoff Ray Mode backscatter model (Clay and Horne, 1994), abundance and biomass of North Sea herring were calculated for the area covered by Scotland in 2007. The resulting total abundance was 23% higher than the one estimated using the conventional depth-independent TS-L relationship (ICES, 2008). Correspondingly, total biomass calculated using the Bayesian model was higher by 57% than the official estimate (ICES, 2008). 95% confidence intervals were also available from these models.

In order to use a depth-based TS model to analyse acoustic data it is important to collect Nautical Area Scattering Coefficients (NASCs) stratified by depth. To facilitate this participating nations would be required to record acoustic Equivalent Distance Sampling Unit (EDSU) herring data at a depth resolution of at least 5 m. Currently several countries (Germany, Denmark, and Norway) already collect acoustic data by depth bins (resolution 1 m). Irish acoustic data are collected as mean school depth for each allocated school over each 1 nautical mile ESDU. Because all participating nations have now the required processing power and software readily available it would just be a matter of storing depth and species based Proportion Region to Cell (PRC) NASCs. Consultation with the FishFrame developing consortium confirmed the possibility to implement data in the requested depth-stratified format. Required information would be: the proportion of NASC within each EDSU for each 5 m depth interval throughout the water column. While development of the database to further versions is pending due to lack of finances, all nations should for now make available acoustic data ready to be put into the desired format. Depth-dependency of TS could be implemented into the abundance and biomass estimation within FishFrame by using a smoothed surface fitted to the model estimates given in Figure 7. To include estimates in the assessment of herring abundance for the whole North Sea stock, abundances would have to be calculated for the whole survey area.

A potential switch over to the new method applying the depth-dependent Bayesian TS model into the North Sea herring assessment would require a parallel data collection for over one generation of fish ages (approx. 5 years). At the same time other sources of error (e.g. acoustic extinction, dead zone, or multiple scatter) could also be considered.

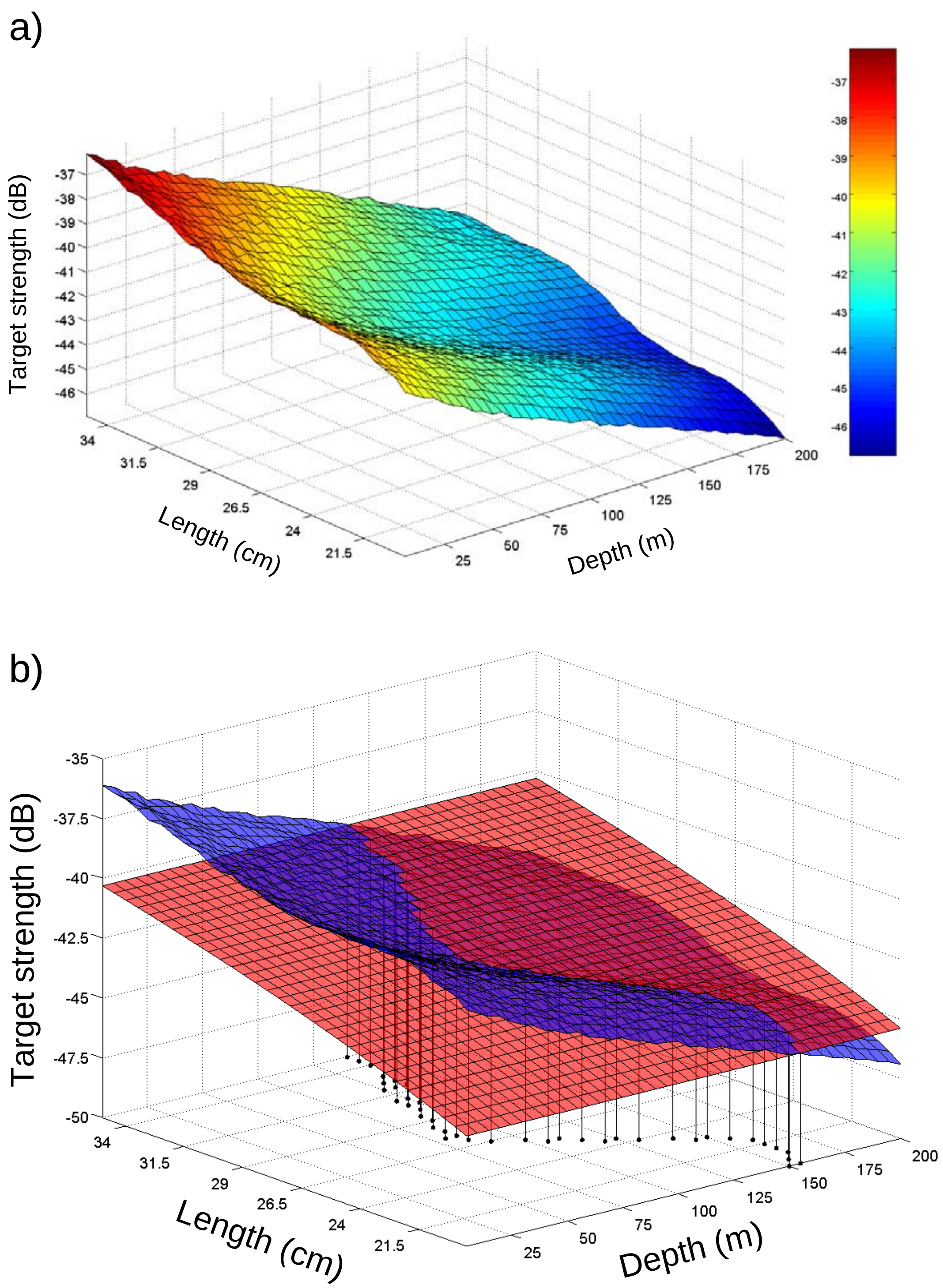

Figure 7. The surface of herring mean target strength (TS) values for given fish lengths and water depths predicted by the Bayesian TS model (a) is shown in blue colour in (b). The red surface in (b) represents TS values from the depth-independent TS-L relationship currently used to assess acoustic survey data for herring. Black circles indicate fish lengths and water depths where the two surfaces intersect.

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Annex 2: Agenda

Agenda for ICES WGIPS, Galway, 19–22 January 2010

Tuesday 19.01.10, 09:00

- Start of meeting
- Status on data availability
- Review of individual larvae surveys 2009
- Herring larvae determination workshop
- Coordination of larvae surveys 2010 (ToR b)

14:00

- Work allocation to review and update PGIPS manuals for larvae and acoustic surveys (in subgroups if necessary, ToR b), will be continued during the meeting every then and now
- Review of individual acoustic surveys 2009 and echogram interpretation exercise (ToR c)

Wednesday 20.01.10, 09:00

- More individual acoustic surveys and echograms
- Status and future of FishFrame (ToR d)
- Herring maturity staging workshop 2011
- Coordination of the acoustic survey in 2010 (ToR b)

14:00

- Joint estimate of the NS acoustic survey for herring and sprat (ToR a)
- Conclusion on review interpretation of echograms (ToR c)

Thursday 21.01.10, 09:00

- Review and consideration on incorporation of new models of depth based target strength in the acoustic survey (ToR e)
- Recommendations

14:00

- Collation of material for the final report
- Recommendations
- Review of combined report

Friday, 22.01.10, 09:00

- Review of final report
- 12:00
- End of meeting

Annex 3: WGIPS terms of reference for the next meeting

The Working Group for International Pelagic Surveys (WGIPS) chaired by Karl-Johan Stæhr, Denmark, will meet at the Marine Research Institute, Bergen, 17–21 January 2011 to:

a) combine the 2010 survey data to provide indices of abundance for the population of herring and sprat within the area, using 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, the Malin Shelf and the Western Baltic in 2011;

c) examine the interpretation of echograms between the participants of the 2010 acoustic surveys to ensure quality control and proper exchange of experience;

d) review the progress of FishFrame;

e) review and consider the incorporation of new models of depth based target strength for Atlantic herring, herring in the North Sea, the Malin Shelf and IIIa.

WGIPS will report by XXX March 2011 (via SSGESST) for the attention of the SCICOM, WGISUR, ACOM and 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	Term of reference a) and b) Surveys for herring are currently carried out by six different countries, covering the whole of the North Sea, Western Baltic, the west coast of Scotland and the Malin Shelf. Effective coordination and quality control for these surveys is essential and while data combination can be managed by mail, a meeting is required to ensure that the larvae database is being used correctly and that the acoustic surveys are being carried out and analysed on a consistent basis. Term of reference c) Interpretation of echograms is subject to different national institutes. Exchange of experience is one of the vital interest of the WG to enable all involved participants a comparable background information and to reduce the risk of loss of information due to changing personnel. Term of reference d) FishFrame is the standard software for index calculation and data archiving used by WGIPS. New developments may require a meeting to familiarise all participants with these tools. Term of reference e) At present, no correction is made for any change in depth depending swimbladder volmue of the target strength of herring. Incorporation of such models could have huge impacts on the abundance and biomass estimates. Thus the group should have scientific guidance on this modern approach.
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 ACOM with information required for responding to requests for advice/information from NEAFC and EC DG MARE.
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 Organizations	None

Annex 4: Recommendations

Note that the recommendations below are sorted so that recommendation 1 to 5 is addressed to parties outside the WGIPS and recommendation 6 to 11 is addressed to the expert group members. Bold text refers to specific action required by WGIPS members.

RECOMMENDATION	FOR FOLLOW UP BY:
1. WGIPS recommends that consideration be given to incorporating depth into new target strength models for North Sea herring. The FishFrame database will have to be modified to accept input data in the form of NASC proportions by 5 m depth intervals for every EDSU. Existing and future acoustic data should be put into this format by all participating nations, to be included as depth stratified acoustic data in FishFrame stage 3.	Expert Group members and DTU-Aqua
2. WGIPS recommends that the Malin shelf combined synoptic surveys be continued. A short post-cruise meeting should be held soon after the survey to compile and discuss the following; data submission problems, compilation of a joint Malin Shelf survey cruise report (Scotland, Ireland and N. Ireland survey data combined), discuss survey issues and plan for the following years survey prior to the WGIPS meeting.	SCICOM, Expert Group members
3. WGIPS recommends that the EU commision provide funding to facilitate a transfer of the SIMFAMI database to an open access format	EU commision
4. WGIPS recommends that DTU-aqua is asked to give a cost estimate for making export of tables from stage 3 platform-independent. Possibility to refresh server after data update without operator assistance. Feedback showing successful data erasure. A full update of fishframe acoustics to version 5 level.	DTU-Aqua
5. WGIPS recommends a workshop in 2011 on the identification of (clupeid) larvae to ensure data quality and especially deal with possible misidentifications of sprat, herring and other fish larvae.	SCICOM, SGESST and Expert group members
6. WGIPS recommends that **all participants in the International North Sea Herring Acoustic Survey should exchange trawl data soon after the surveys have been completed**. In cases where 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
7. For the 2011 meeting, WGIPS recommends that all **participants should bring echograms** for interpretation transparancy.	Expert group members
8. All participants in the 2010 herring acoustic survey should upload their survey estimates to the Fishframe database by 20 December 2010 for stage 3.	Expert group members
9. WGIPS recommends **that cruise leaders participating in the International North Sea Herring Acoustic Survey should radio contact each other every day at 1730 UTC. Communication should be through medium frequency radio at 3333 kHz. In addition, e-mail correspondence should be exchanged every second day.**	Expert group members
10. To determine possible shifts in spawningWGIPS recommends that all areas in the herring larvae surveys should be covered.	Expert group members
11. WGIPS recommends participants in the herring surveys should participate in the workshop on Sexual maturity staging of herring and sprat (WKMSHS) in 2011	Expert group members

Annex 5: 2009 Individual Acoustic Survey Reports

ANNEX 5A: West of Scotland

Survey report for MFV *Quantus*

29 June - 18 July 2009

Eric Armstrong, Marine Scotland-Science, Marine Laboratory, Aberdeen

1. INTRODUCTION

An acoustic survey for herring was carried out by the Marine Laboratory on the west coast of Scotland (ICES Division VIa(N)) from the 29 June to 18 July 2009. The survey was conducted on the chartered fishing vessel MFV *Quantus*. 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 and to the west of the British Isles to provide an age disaggregated abundance index for use in the assessment process. The assessments will be carried out by the ICES Herring Assessment Working Group (HAWG) to be held in March 2010.

This survey has been carried out every year, at this time, by the Marine Laboratory, since 1991. With the exception of 1991 and 1997 the survey has always been conducted using chartered commercial fishing vessels.

2. SURVEY DESCRIPTION and METHODS

2.1 Personnel

Eric Armstrong	Cruise Leader
Craig Davis	
Melanie Harding	
Michelle Hay	
Michael Stewart	

2.2 Narrative

Loading of the vessel and installation of a wet lab container and equipment was carried out on the 23 June. The vessel left Fraserburgh at 0030 on the 30 June and proceeded to Loch Eriboll for a calibration. Survey work began at Cape Wrath at 0300 hrs on the morning of the 30 June. The survey continued in generally good weather until 10 July when the vessel steamed to Ullapool for a mid cruise break and a crew change. The vessel departed at 1500 hrs on the 11th July sailing to the head of Loch Broom where a second calibration was carried out, finishing at 2100 hrs, at which point the vessel sailed to the Butt of Lewis to complete the northern part of the survey area. The survey continued from the 11th covering the full survey area up to 60°N 4°W. The survey was successfully completed at 1300 hrs on the 17 July. The vessel then steamed to Fraserburgh for off loading of personnel and equipment on the morning of the 18 July. No time was lost due to weather or mechanical breakdown.

2.3 Survey design

The survey design (Figure IIA.1) was selected to cover the area in two levels of sampling intensity based on herring densities found in previous years. 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° 30′ N, and the shelf break in the west to approx. 250 m depth and the Scottish coast or the 4° W line in the east. Two tracks were executed between 55° 30′ N and 56°N for comparison with the survey conducted in Irish waters.

2.4 Calibration

Two good calibrations were carried out, at the beginning (29 June) in Loch Eriboll and in the middle (11th July) in Loch Broom. All calibrations were carried out in ideal conditions, and the constants for the 38 kHz integrating frequency agreed with each other (Table IIA.1). All procedures were according to those defined in the survey manual.

2.5 Acoustic data collection

The survey was carried out using a Simrad EK60 38 kHz sounder echo integrator, the system settings are given in Table IIA.1. Further data analysis was carried out using SonarData Echoview and Marine Laboratory Analysis systems. Data from the echo integrator were summed over quarter hour periods (2.5 nautical miles at 10 knots). The survey was generally restricted to hours of daylight between 0300 hrs and 2300 hrs UTC. A total of 2495 nautical miles of 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 (*.raw,*.evi) and stored on DVD and external hard drive.

2.6 Biological data - fishing trawls

24 trawl hauls (Figure IIA.1 and Tables IIA.2 and IIA.3) were carried out opportunistically during the survey on the denser echotraces. All trawls were carried out using a PT160 pelagic trawl with a 20 mm codend liner. A scanning netsonde was mounted on the headline. Each haul was sampled for length, age, maturity and weight of individual herring. Up to 542 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.

2.7 Data analysis

EDSUs were defined by 15 minute intervals which represented 2.5 nautical miles per EDSU, assuming a survey speed of 10 knots. The data were divided into four categories: "definitely herring traces"; "probably herring traces" "surface 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 15′.

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

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

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

For gadoids TS = $20\log_{10}L$-67.5 dB per individual

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

The herring data from the trawl hauls were used to divide the area into two strata based on length distributions and geographic criteria. The two regions (Figure IIA.3) were:

I. Greater part of Survey

II. Haul 9

Trawling in the Inner Minch area was again very difficult, except in the most northerly and southerly parts, due to seabed conditions likely to cause net damage. The length frequencies are presented in Table IIA.4. The overall age length key is presented in Table IIA.5.

3. RESULTS

3.1 Acoustic data

The geographical distributions of the NASC values assigned to herring are presented in Figure IIA.2. Large quantities of herring were detected around St Kilda and north of the area in the middle of the shelf. The main areas of concentration were north of 57^{o} 30′ N along the shelf and south and east of Barra Head.

3.2 Biological data

A total of 24 trawl hauls were carried out. Table IIA.2 gives the positions and characteristics of these trawl hauls and Table IIA.3 gives their species composition. 9 hauls contained sufficient herring to define the 2 survey subareas (Figure IIA.3). Herring were present in 9 hauls and difficulty was found in catching herring traces seen. With the exception of the area south of Barra Head, all major concentrations were adequately characterized from these trawls. One haul was dominated by boar fish (haul 12), six with mainly mackerel (hauls 3, 7, 11, 21, 22 and 23), and four hauls which caught nothing (hauls 8, 19, 20 and 24).

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

$$W = 0.0045.L^{3.2185} \qquad \text{L measured in cm}$$

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

3.3 Biomass estimates

The results for ICES Division VIa(N) were:

Definitely herring	296,399 tonnes	49%
Probably herring	235,909 tonnes	39%
Surface herring	72,587 tonnes	12%
Total herring biomass	**604,895 tonnes**	
Total herring numbers	2,961 million	
Spawning stock biomass	578,757 tonnes	95.68%
Immature	26,139 tonnes	4.32%

A breakdown of the estimates by age class is given in Table IIA.6. The survey included all of ICES Division VIa(N).

4. DISCUSSION

The stock estimate for VIa(N) has decreased by approximately 24% from 2008 (from 791,488 tonnes to 604,895 tonnes).

The abundance by year class is consistent with previous years and also with results from the adjacent North Sea area. There were a significant number of 4 and 8 ring fish seen on the survey (15% by number and 16% by weight for 4 ring, 17% by number and 19% by weight for 8 ring).

The distributions were broadly similar to previous years, with the significant quantities of fish seen south and east of Barra Head and all along the shelf edge north of St Kilda.

5. REFERENCES

ICES. 1994. Report of the Planning Group for Herring Surveys. ICES CM 1994/H:3. 26 pp.

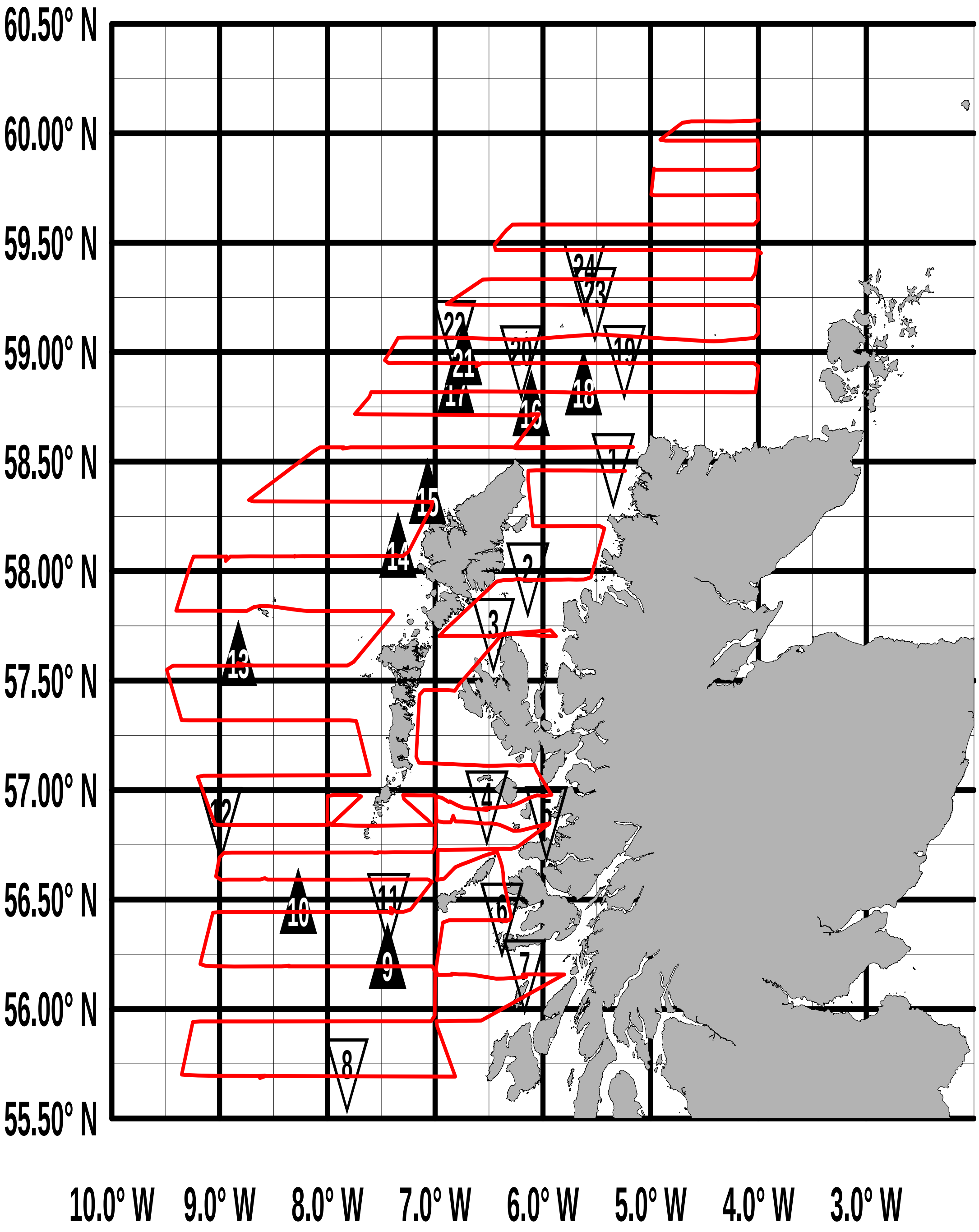

Figure IIA.1. Map of the west of Scotland showing cruise track and positions of fishing trawls undertaken during the July 2009 west coast acoustic survey on MFV *Quantus*. Filled triangles indicate trawls in which significant numbers of herring were caught, whilst open triangles indicate trawls with few or no herring.

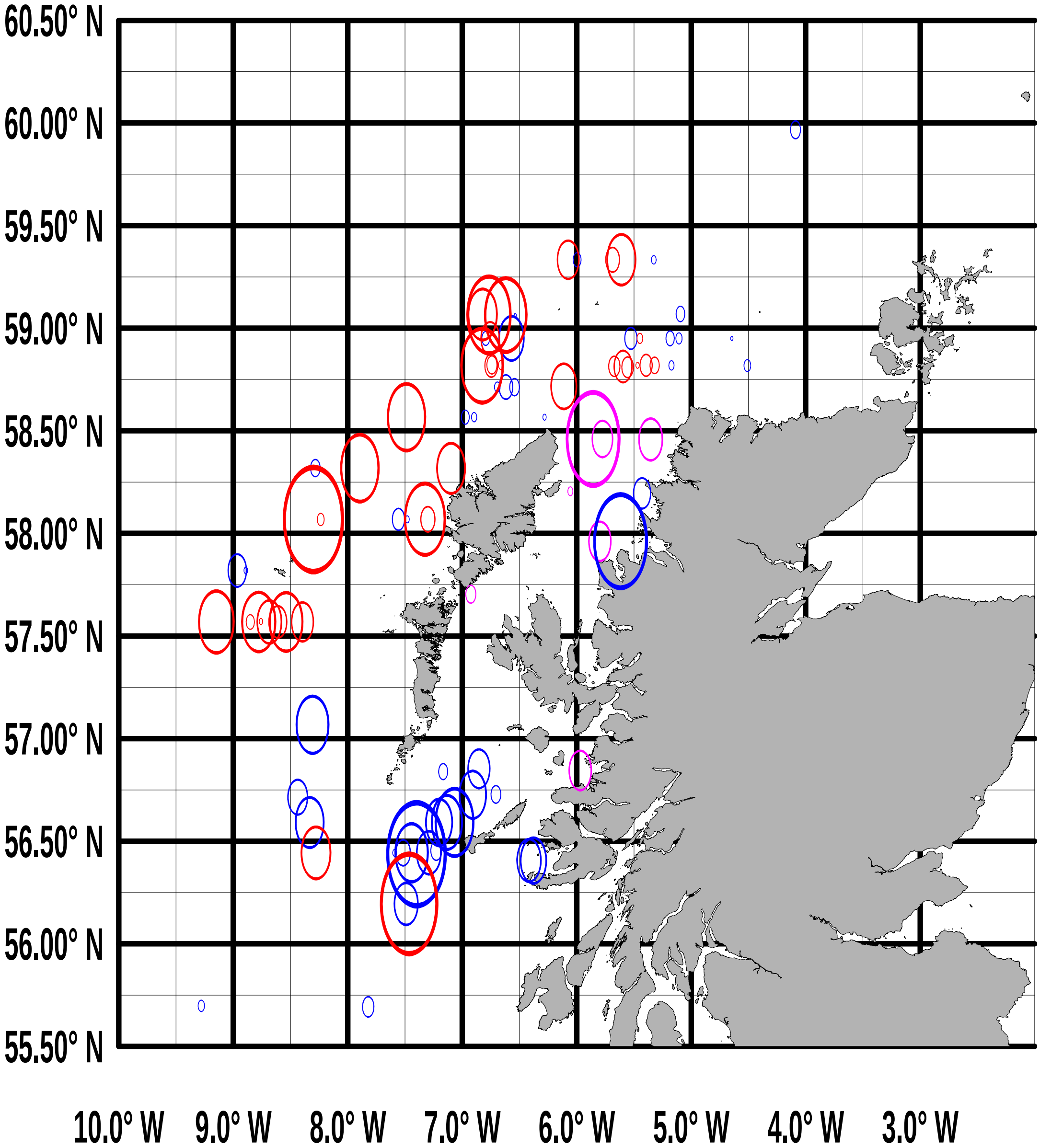

Figure IIA.2. Map of the west of Scotland with a post-plot showing the distribution of herring NASC values (on a proportional square root scale relative to a value of 7500) obtained during the July 2009 west coast acoustic survey on MFV *Quantus*. Red circles are 'Definitely herring', blue 'Probably herring' and pink 'Surface herring'.

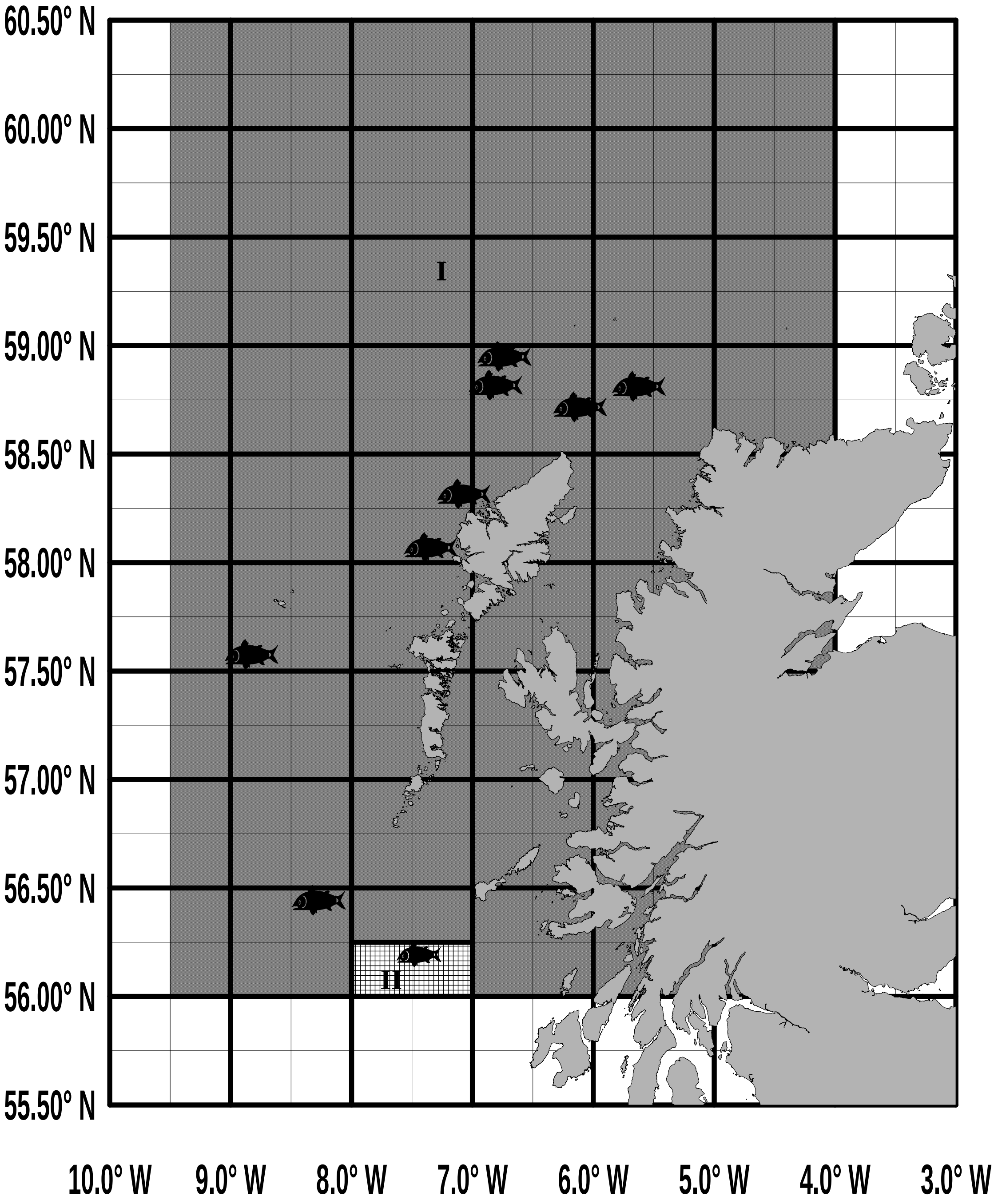

Figure IIA.3. Map of the west of Scotland with a post-plot showing the mean length of herring caught in the trawl hauls carried out during the July 2009 west coast acoustic survey on MFV *Quantus*, along with the area strata (indicated by shaded areas with Roman numerals I and II used for combining data from the trawl hauls

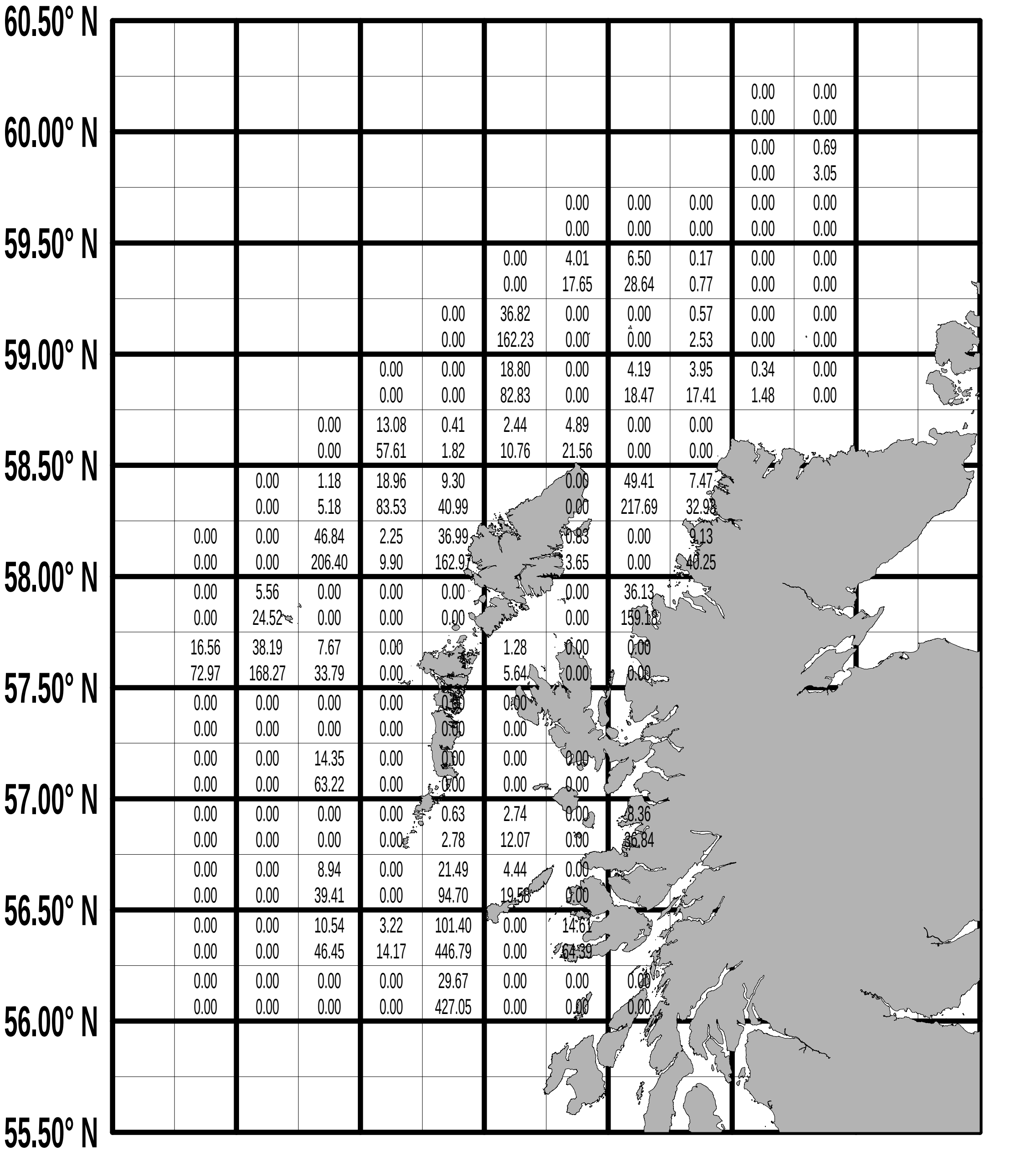

Figure IIA.4. Map of the west of Scotland with a plot showing the herring numbers in millions (bottom) and biomass in thousands of tonnes (top) by quarter ICES rectangle obtained during the July 2009 west coast acoustic survey on MFV *Quantus*.

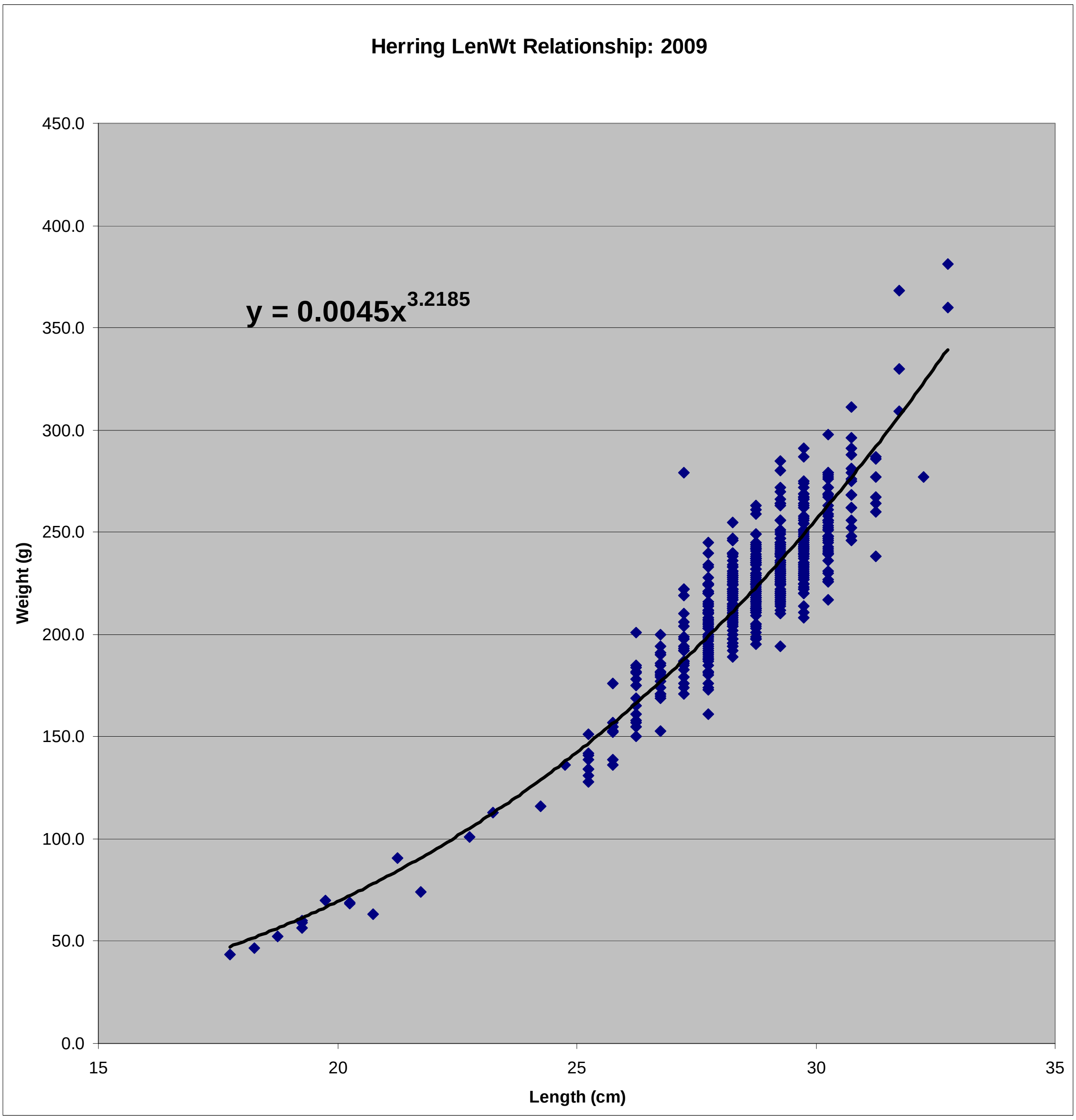

Figure IIA.7. Weight-length relationship obtained during the July 2009 west coast acoustic survey on MFV *Quantus*.

Table IIA.1. Simrad EK60 and analysis settings used on the July 2009 west coast of Scotland herring acoustic survey on MFV *Quantus*. Calibrations a) Loch Eriboll 29 June; and b) Loch Broom 10 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	1501.7, 1496.
Max. Power	2000 W
Equivalent two-way beam angle	-21 dB
Default Transducer Sv gain	22.47 dB
3 dB Beamwidth	7.1°
Calibration details	
TS of sphere	-42.4 dB
Range to sphere in calibration	9.61m, 9.62m.
Measured NASC value for calibration	3553a, 3576b.
Calibration factor for NASCs	1
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 IIA.2. Details of the fishing trawls taken during the west Coast acoustic survey, July 2009; Trawl depth = depth (m) of headrope; Gear type P=pelagic; Duration of trawl (minutes); Total catch (number of baskets); Use H=used to qualify herring acoustic data, (blank if not).

Haul	Date	Latitude	Longitude	Time	Dura-tion	Water Depth	Trawl Depth	Gear Type	Use	Total Catch
1	30/6	58° 27 ' N	5° 22 ' W	03 : 17	21	72	64	PT160		<1
2	30/6	57° 57 ' N	6° 09 ' W	14 : 34	25	46	38	PT160		<1
3	30/6	57° 42 ' N	6° 25 ' W	20 : 30	30	80	72	PT160		4
4	1/7	56° 55 ' N	6° 32 ' W	17 : 47	16	88	80	PT160		<1
5	2/7	56° 51 ' N	5° 57 ' W	05 : 42	13	52	44	PT160		<1
6	2/7	56° 24 ' N	6° 24 ' W	16 : 51	21	79	71	PT160		<1
7	3/7	56° 09 ' N	6° 09 ' W	04 : 59	22	45	37	PT160		2
8	3/7	55° 42 ' N	7° 50 ' W	18 : 31	18	81	73	PT160		0
9	4/7	56° 12 ' N	7° 28 ' W	17 : 44	30	109	101	PT160	H	1
10	5/7	56° 27 ' N	8° 18 ' W	09 : 59	29	147	139	PT160	H	1
11	5/7	56° 26 ' N	7° 26 ' W	14 : 13	17	104	96	PT160		<1
12	7/7	56° 51 ' N	9° 02 ' W	06 : 04	37	150	142	PT160		30
13	8/7	57° 34 ' N	8° 46 ' W	04 : 47	63	158	150	PT160	H	20
14	9/7	58° 04 ' N	7° 19 ' W	08 : 45	20	121	113	PT160	H	20
15	9/7	58° 19 ' N	7° 05 ' W	12 : 10	17	94	86	PT160	H	5
16	12/7	58° 43 ' N	6° 09 ' W	07 : 27	43	118	110	PT160	H	7
17	12/7	58° 49 ' N	6° 47 ' W	18 : 14	28	149	141	PT160	H	18
18	13/7	58° 49 ' N	5° 39 ' W	04 : 13	23	74	66	PT160	H	40
19	13/7	58° 57 ' N	5° 14 ' W	15 : 56	14	90	82	PT160		0
20	13/7	58° 57 ' N	6° 14 ' W	19 : 51	28	75	67	PT160		0
21	14/7	58° 57 ' N	6° 46 ' W	03 : 22	25	154	146	PT160	H	7
22	14/7	59° 04 ' N	6° 48 ' W	09 : 40	22	156	148	PT160		5
23	15/7	59° 13 ' N	5° 34 ' W	06 : 12	35	87	79	PT160		2
24	15/7	59° 20 ' N	5° 36 ' W	16 : 22	18	103	95	PT160		0

Table IIA.3. Catch compositions by trawl haul on the west coast herring acoustic survey. MFV *Quantus* (29 June - 18 July 2009).

	HAUL NO	1	2	3	4	5	6	7	8	9	10	11	12
Herring	*Clupea harengus*									31	116		
Sprat	*Sprattus sprattus*						5						
Mackerel	*Scomber scombrus*			494	2	65	23	254		174		154	
Haddock	*Melanogrammus aeglefinus*			6						3			
Whiting	*Merlangius merlangus*			7		10	1			4			
Cod	*Gadus morhua*			1									
Norway Pout	*Trisopterus esmarki*									131	83		
Poor Cod	*Trisopterus minutus*			11		4							
Blue Whiting	*Micromesistius poutassou*					1							
Lesser Argentine	*Argentina sphyraena*												
Lemon Sole	*Microstomus kitt*									1			
Plaice	*Pleuronectes platessa*												
Common Dab	*Limanda limanda*												
Grey Gurnard	*Eutrigla gurnardus*			1									
Red Gurnard	*Aspitrigla cuculus*			1						7			
Hake	*Merluccius merluccius*				2					1			
Lesser Spotted Dogfish	*Scyliorhinus canicula*			1						1			
Boar Fish	*Capros aper*									5			7650
Norway Haddock	*Sebastes viviparus*												540
Straightnose rabbitfish	*Rhinochimaera atlantica*												

Table IIA.3 (cont.). Catch compositions by trawl haul on the west coast herring acoustic survey. MFV *Quantus* (29 June - 18 July 2009)

	HAUL NO	13	14	15	16	17	18	19	20	21	22	23	24
Herring	*Clupea harengus*	2320	2434	377	507	2194	4295			205	11		
Sprat	*Sprattus sprattus*												
Mackerel	*Scomber scombrus*		701	455		486	1734			904	741	403	
Haddock	*Melanogrammus aeglefinus*				62							1	
Whiting	*Merlangius merlangus*				11							6	
Cod	*Gadus morhua*												
Norway Pout	*Trisopterus esmarki*												
Poor Cod	*Trisopterus minutus*												
Blue Whiting	*Micromesistius poutassou*												
Lesser Argentine	*Argentina sphyraena*				3								
Lemon Sole	*Microstomus kitt*				3								
Plaice	*Pleuronectes platessa*				13								
Common Dab	*Limanda limanda*				31								
Grey Gurnard	*Eutrigla gurnardus*				81								
Red Gurnard	*Aspitrigla cuculus*												
Hake	*Merluccius merluccius*				3								
Lesser Spotted Dogfish	*Scyliorhinus canicula*												
Boar Fish	*Capros aper*												
Norway Haddock	*Sebastes viviparus*												
Straightnose rabbitfish	*Rhinochimaera atlantica*										2		

Table IIA.4. Herring length frequency proportion by trawl haul by sub- area for west coast acoustic survey MFV *Quantus* (29 June - 18 July 2009). Length in cm, weight in g, TS=target strength in dB.

	I									II	
	10	13	14	15	16	17	18	21	MEAN	9	MEAN
17.50									0.00	0.16	0.16
18.00									0.00	0.26	0.26
18.50									0.00	0.10	0.10
19.00									0.00	0.10	0.10
19.50									0.00	0.13	0.13
20.00									0.00	0.06	0.06
20.50									0.00	0.00	0.00
21.00									0.00	0.06	0.06
21.50			0.00						0.00	0.00	0.00
22.00			0.00						0.00	0.00	0.00
22.50			0.00						0.00	0.03	0.03
23.00			0.00						0.00	0.03	0.03
23.50			0.00						0.00	0.00	0.00
24.00			0.00						0.00	0.03	0.03
24.50	0.01		0.00						0.00	0.00	0.00
25.00	0.02		0.01				0.01		0.00	0.03	0.03
25.50	0.01		0.02	0.00	0.00		0.01		0.01	0.00	0.00
26.00	0.03	0.01	0.04	0.00	0.00	0.00	0.03		0.02	0.00	0.00
26.50	0.02	0.01	0.05	0.01	0.01	0.00	0.03		0.02	0.00	0.00
27.00	0.03	0.03	0.05	0.07	0.02	0.00	0.05	0.00	0.03	0.00	0.00
27.50	0.08	0.11	0.15	0.15	0.08	0.03	0.07	0.02	0.09	0.00	0.00
28.00	0.23	0.24	0.23	0.27	0.14	0.22	0.13	0.08	0.19	0.00	0.00
28.50	0.18	0.31	0.29	0.26	0.29	0.30	0.23	0.26	0.27	0.00	0.00
29.00	0.21	0.24	0.13	0.14	0.19	0.29	0.21	0.35	0.21	0.00	0.00
29.50	0.16	0.05	0.02	0.09	0.20	0.10	0.16	0.18	0.10	0.00	0.00
30.00	0.03	0.00	0.00	0.01	0.04	0.02	0.05	0.08	0.03	0.00	0.00
30.50	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.00	0.01	0.00	0.00
31.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
31.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
32.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Number	116	2320	2434	377	507	2196	4295	205		31	
mean length	28.85	28.87	28.44	28.73	29.18	29.17	28.99	29.47	28.90	19.81	19.81
mean weight	226.08	225.70	215.57	222.53	233.94	233.39	229.70	241.41	226.96	69.48	69.48
TS/individual	-41.99	-41.99	-42.12	-42.03	-41.89	-41.90	-41.95	-41.81	-41.98	-45.22	-45.22
TS/kilogramme	-35.53	-35.53	-35.45	-35.50	-35.59	-35.58	-35.56	-35.64	-35.54	-33.64	-33.64

Table IIA.5. Age/maturity-length key for herring (numbers of fish sampled MFV *Quantus,* 29 June - 18 July 2009).

	NUMBER AT AGE/MATURITY											
LENGTH (CM)	0	1I	2I	2M	3	4	5	6	7	8	9+	GRAND TOTAL
17.5		1										1
18		1										1
18.5		1										1
19		1										1
19.5		1										1
20		1										1
20.5												
21			1									1
21.5		1										1
22												
22.5			1									1
23			1									1
23.5												
24					1							1
24.5			1									1
25			1	7								8
25.5				8		1						9
26				10	2	1	1					14
26.5				7	9	1				1		18
27				3	7	6	3	1		1	1	22
27.5				4	21	14	9	5	4	6	9	72
28					8	24	7	8	7	18	8	80
28.5					5	11	15	9	8	19	13	80
29					2	13	12	6	5	19	23	80
29.5					3	5	18	6	6	16	24	78
30					1	6	5	6	4	11	9	42
30.5					1		5	1	2	2	5	16
31							2	2			4	8
31.5												
32									1			1
32.5											2	2
Grand Total		7	5	39	60	82	77	44	37	93	98	542

Table IIA.6. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age and maturity obtained during the MFV *Quantus* 2009 herring acoustic survey.

Total Area						
Age(ring)	Mean Length (cm)	Mean Weight(g)	Numbers x10^6	%	Biomass x 10^3 T	%
1	18.49	58.97	346	11.68	20	3.37
2I	21.96	101.26	57	1.92	6	0.95
2M	26.09	173.36	130	4.39	23	3.73
3	27.54	206.43	264	8.92	55	9.01
4	28.27	223.29	430	14.53	96	15.88
5	28.65	233.06	373	12.61	87	14.39
6	28.58	231.25	219	7.40	51	8.37
7	28.60	231.75	187	6.30	43	7.15
8	28.63	232.30	500	16.87	116	19.19
9+	28.85	238.17	456	15.40	109	17.96
Mean	27.09	220.29				
Total			2961.72	100.00	604.90	100.00
Immature			402.55	13.59	26.14	4.32
Mature			2559.17	86.41	578.76	95.68

ANNEX 5B: Denmark

Acoustic Herring Survey report for RV "DANA"

30 June2009 – 13 July 2009

Karl Johan Stæhr

DTU-Aqua, National Institute of Aquatic Resources

1. INTRODUCTION

Since 1991 the DTU National Institute of Aquatic Resources (DTU AQUA) 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 2009-survey with RV "DANA", covering the Skagerrak and Kattegat, was conducted in the period July 2 to July 13 2009, while calibration was done during 30 June to 2 July 2009.

2. SURVEY

Personnel

During calibration 30/6 – 2/7–2009

Karl-Johan Stæhr (cruise leader)
Bo Lundgren (assisting cruise leader)
Torben Filt Jensen
Thyge Dyrnesli
Peter Faber
Frederik Mathisen
Mads Larsen
Dennis Lisbjerg

During acoustic monitoring 2/7 - 13/7–2009

Karl-Johan Stæhr (cruise leader)
Torben Filt Jensen (assisting cruise leader)
Bo Lundgren
Lise Sindahl
Jette Sandsted
Helle Andersen
Nina Fuglsang
Thyge Dyrnesli

Narrative

The survey of RV "Dana" started on June 30 at 12.00 hours with departure from Hirtshals heading towards Bornö in Gullmar Fjord, Sweden for calibration of the acoustic equipment. The vessel was anchored at Bornö in the Gullmar Fjord, Sweden early evening at the June 30. The calibration was initiated in the morning on 1 July and continued until July 2 in the morning.

At July 2 at noon the scientific crew was exchanged outside the harbour of Skagen. After the short break at Skagen, RV "Dana" steamed towards the northwesterly corner of the survey area in Skagerrak. The acoustic integration was initiated on 2 July at 21,58 UTC at 57º52'N, 06º57'E.

The western Skagerrak area was covered during the period July 2 – 8, eastern Skagerrak during July 9 – 10 and Kattegat during July 11 – 13. The acoustic integration was ended at 57º26'N, 10º44'E at 06.00 UTC. RV "Dana" arrived at Hirtshals at 15.00 UTC on July 13.

On July 10 the survey was stopped from 06 to 11 UTC to go to Hirtshals for the repair of a trawlwinch.

Totally the survey covered about 2000 nautical miles. Data from the 38 kHz echosounder were recorded mainly using the 38 kHz paravane transducer running at depths of 3 – 5 m, the depth 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 the latter data are strongly dependent on the weather conditions, but this year the weather was calm, so no data had to be excluded due to the weather. During trawling hull-mounted transducers were used for all three frequencies.

Survey design

The survey was carried out in the Kattegat and in the Skagerrak, east of 6° E and north of 56° N (Figure 1). The area is split into 8 subareas.

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 limitations regarding available periods and places for fishing (late morning, early afternoon and immediately before and after midnight; and a limited amount of fishable positions for bottom-trawl hauls) this structure cannot not be kept strictly. The transects along the Swedish coast 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 pattern adapted to the depth curves and the relatively heavy ship traffic.

Calibration

The echosounders were calibrated at Bornö in the Gullmar Fjord, Sweden during June 30-July 2 2009. The calibration was performed according to the procedures established for 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. The 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 on the towed body close to results from previous years. The calibration and setup data of the EK60 38 kHz used during the survey are shown in Table 1.

The impedance data for the hull-mounted 38kHz transducer showed that two of the four segments had a significantly lower values than normal. The transducer is from 1985 and it is recommended to change it at the next docking of the vessel. Data from this transducer was not used for integration during this survey.

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. They have not been directly used for the survey estimate, but as an aid during judging when distinguishing between fish and plankton. The acoustic data were recorded as raw data on hard disk 24 hours a day also during fishing operations, but data taken during fishing periods 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 are 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, but these data are not used for the integration.

Biological data - fishing trawls

The 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 were carried out using an EXPO trawl (16 mm in the codend). Trawling was carried out in the time intervals 1000 to 1600 and 2030 to 0300 UTC , usually two day hauls (pelagic on larger depth and demersal in shallow waters) and two night hauls (mostly surface or midwater). The strategy was to cover most depth zones within each geographical stratum with trawl hauls. 1 hour hauls were used as a standard during the survey.

The total weight of each catch was estimated and the catch sorted into species. Total weight per species and length measurements were made. 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 and frozen for individual determination of length, weight, age, race (North Sea autumn spawners or Baltic Sea spring spawners) and maturity in land. Fourier Shape Analyses calibrated to icro-structure formed in the otoliths 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.

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 similar to trawl hauls and shown in Figure 2.

Data analysis

The raw data are 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 are done for a fixed set of layers (3–6 m, 6- 10, 10 – 20 etc.) for each mile, using special judging software. It allows ignoring data from 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 subarea (56E06 – 58E08, C – E in Figure 1) the mean backscattering 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 Division III, IV, and IVa (ICES, 2000):

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 = 20 log L – 84.9 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-age and length weight relationships by race for the herring were made based on the single fish sampled in each haul and frozen for later for race 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 1619. The number of ESDU per stratum is given in Table 2. Table 2 also shows the mean Sa and mean TS per stratum used in the abundance estimation. The outline of the strata is shown in Figure 1 and the cruise track for the survey is shown in Figure 2.

Historically, herring and sprat have not been observed in midwater trawl hauls at depths below 150 meters. Therefore, layers below 150 meter have been excluded from the estimation.

The relative herring density in numbers per nm^2 along the cruise track is shown in Figure 3. The distribution of herring is in 2009 primarily distributed in ICES squares 44F9, 44G0, 44G1 and partly in 45G1. This distribution is quite different from 2008 when the main concentration was further west (west of 8° E; see Figure 4). The main concentration is also geographically more concentrated than in 2007 when the large concentrations were found both in Kattegat and along the Danish coast in Skagerrak (see Figure 5).

3.2 Biological data

During the survey in 2009 34 hauls were conducted, 20 surface hauls and 14 bottom hauls. The geographical distribution of hauls is shown in Figure 2 and details on the hauls and catches are given in Table 3 and 4.

The total catch for the survey was 16.6 tons .Herring was present in 29 hauls with a total catch of 6.1 tons. In 2009, like in 2007 and 2008, herring was fished best during daytime in surface hauls in the deeper parts of Skagerrak. Length distributions of herring per haul are given in Table 5.

Sprat was present in the hauls in Kattegat (stratum F) where they contributed to the catch with 5.2%. . For the total survey area herring, mackerel and sprat contributed to the total catch by 36%, 10% and 1% respectively.

Based on the frozen single fish samples from each haul, where race 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. For North Sea autumn spawners specimens with maturity stage ≥3 and age ≥5 are regarded as mature and for Baltic spring spawners specimens with maturity stage ≥2 and age ≥5 are regarded as mature.

North Sea autumn spawners:

Skagerrak

WR	0	1i	1m	2i	2m	3i	3m	4i	4m	5	6
%	100.00	99.49	0.51	54.67	45.33	50.00	50.00	60.00	40.00	100.00	100.00

Kattegat

WR	0	1i	1m	2i	2m
%	100.00	99.30	0.70	100.00	0.00

North Sea (Strata 560E06)

WR	0	1i	1m	2i	2m
%	100	96.77419	3.225806	100	0

Baltic Sea spring spawners:

Skagerrak

WR	0	1i	1m	2i	2m	3i	3m	4i	4m	5	6	7	8	9	10	11	12	13
%	100.00	90.54	9.46	28.87	71.13	4.61	95.39	1.33	98.67	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Kattegat

wr	0	1i	1m	2i	2m	3i	3m	4i	4m	5	6
%	100.00	93.49	6.51	22.00	78.00	10.34	89.66	9.09	90.91	100.00	100.00

North Sea (Strata 560E06)

WR	0	1i	1m	2i	2m	3i	3m
%	100.00	21.74	78.26	0.00	100.00	0.00	100.00

3.3 Biomass estimates

The total herring biomass estimate for the Danish acoustic survey with RV "Dana" in June-July 2009 is 304,298 tonnes of which 51.8% or 157,707 tonnes are North Sea autumn spawners and 48.2% or 146,590 tonnes are Baltic Sea spring spawners.

For the total number of herring the survey results give 11,005 mill. of which 87,9% are North Sea autumn spawners and 12.1% are Baltic Sea spring spawners.

The estimated total number of herring, mean weight, mean length and biomass per age and maturity stage in each of the surveyed strata are given in Table 6 and 7 for North Sea autumn spawners and Baltic spring spawners respectively.

A comparison for the results of the last three years surveys are given in the text table below.

	2006	2007	2008	2009
Autumn spawners				
Number in mill.	1530	4443	4473	9679
Biomass in tons	98786	315176	80469	157707

	2006	2007	2008	2009
Spring spawners				
Number in mill.	6407	8847	7367	1326
Biomass in tons	471850	614048	450505	146590

From 2006 to 2007 there was an increase in the abundance of autumn spawners of 190% and in the biomass of 219%. The age structure in the abundance for 2006 and 2007 showed the same pattern with 86% and 91% of the total abundance as 1 WR for the two years respectively (see Table 7). This increase corresponds to an overall increase of the abundance of autumn spawners in the survey area.

From 2007 to 2008 the abundance of autumn spawners showed an increase of 0.7% whereas the biomass showed a decrease of 74%. As it can be seen from Table 7 this contradictory development between abundance and biomass is the result of a dramatic change in age composition of the abundance from 2007 to 2008. In 2007 1 WR contributed to 91% of the abundance of autumn spawners, whereas the 0 WR contributes to 88% of the abundance in 2008 (Table 7).

From 2008 to 2009 the abundance of autumn spawners showed an increase of 116% and the biomass showed an increase of 96%. As it can be seen from table 7 the abundance in 2009 is dominated by 0 and 1 WR (81 and 19% respectively. The abundance of 0 WR are the double of what was seen in 2008 and 1 WR are than 4 times the abundance in 2008.

For spring spawners no large changes in the age structure over the years from 2006 to 2008 have been seen. From 2008 to 2009 there has been a decrease in abundance of 82% and for the biomass of 67%. From Table 8 it can be seen that the major part of the difference in abundance between 2008 and 2009 lies in a decrease in abundance of 0–3 WR

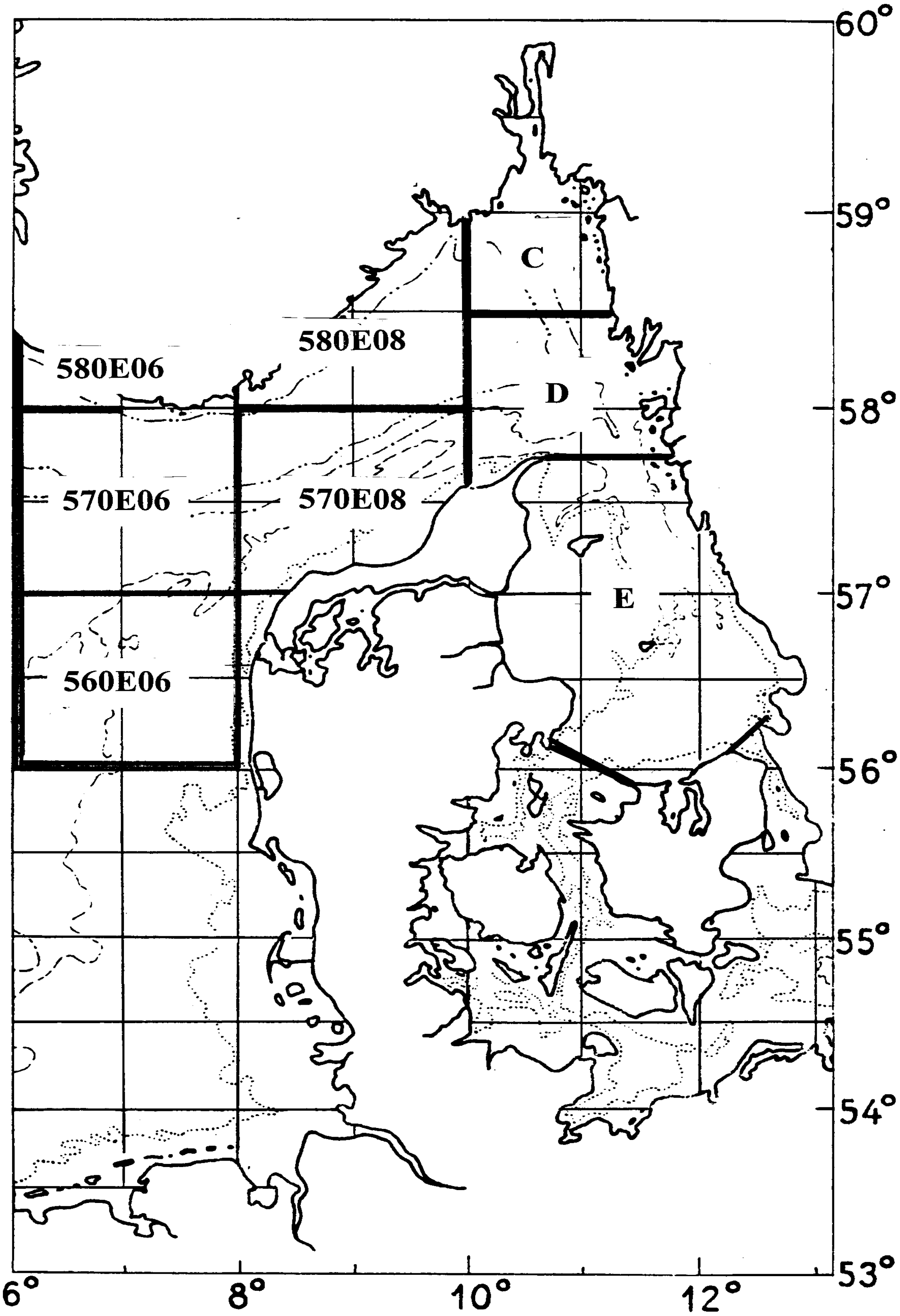

Figure 5B.1. Map showing the survey area for the Danish acoustic survey with RV "Dana" in June-July 2009. The map shows the subareas used in the abundance estimation.

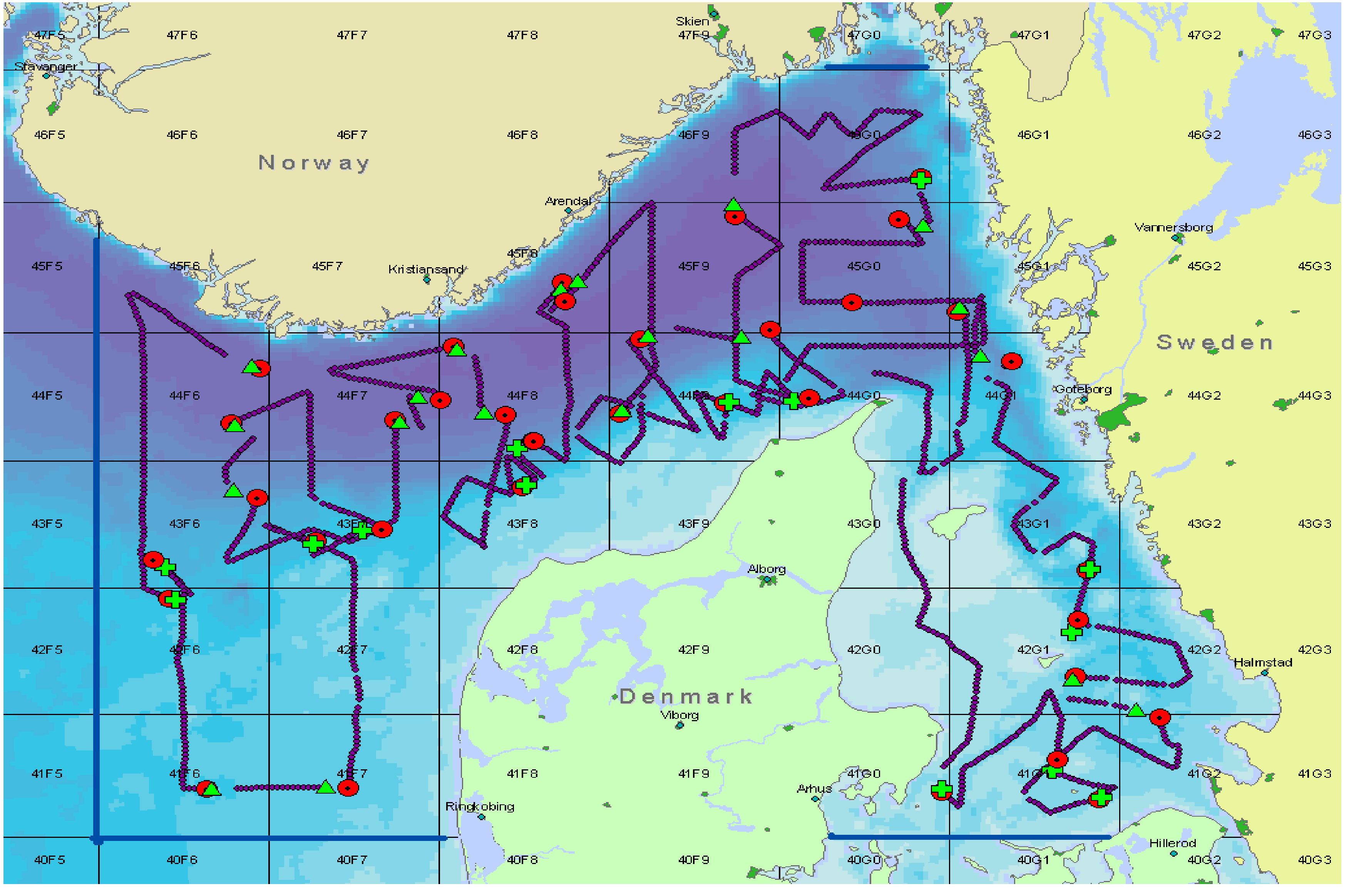

Figure 5B.2. Map showing cruise track and trawl stations during the Danish acoustic survey with RV "Dana" in June-July 2009.

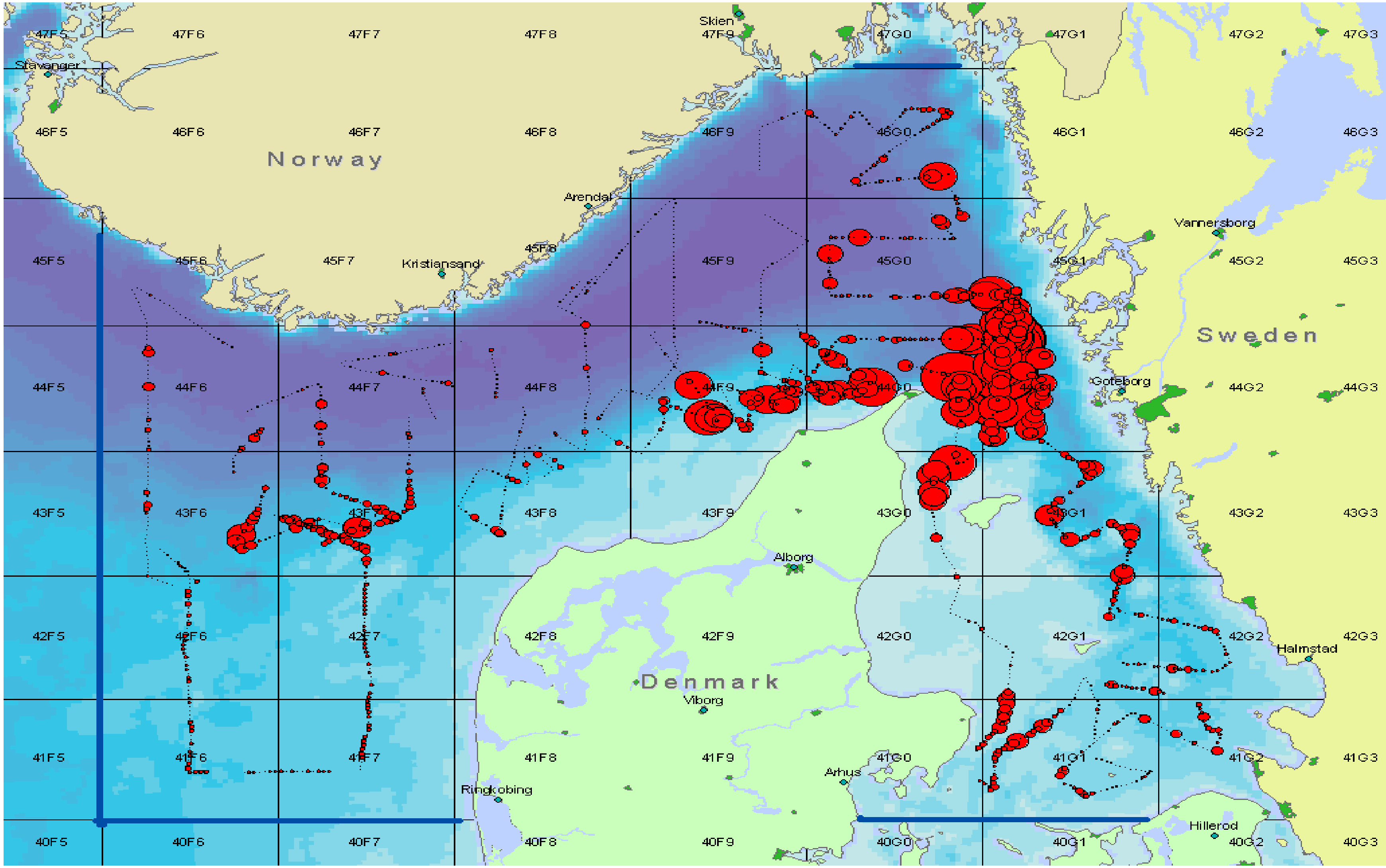

Figure 5B.3. Relative herring density (in numbers per nm²) along the track of the June-July 2009 Danish acoustic survey in the eastern North Sea, Skagerrak and Kattegat. Red circles indicate relative density of herring per ESDU.

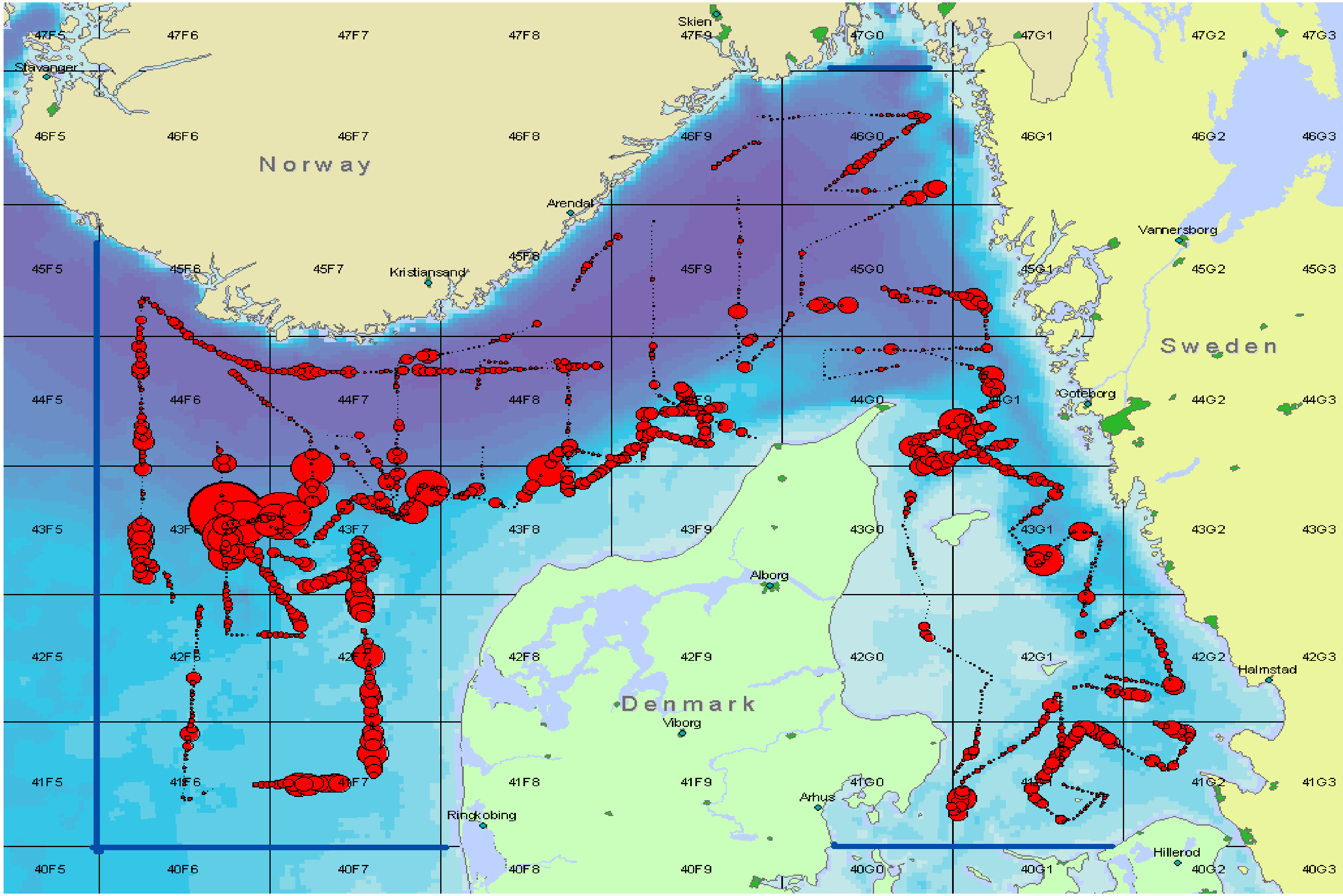

Figure 5B.4. Relative herring density (in numbers per nm²) along the track of the June-July 2008 Danish acoustic survey in the eastern North Sea, Skagerrak and Kattegat. Red circles indicate relative density of herring per ESDU.

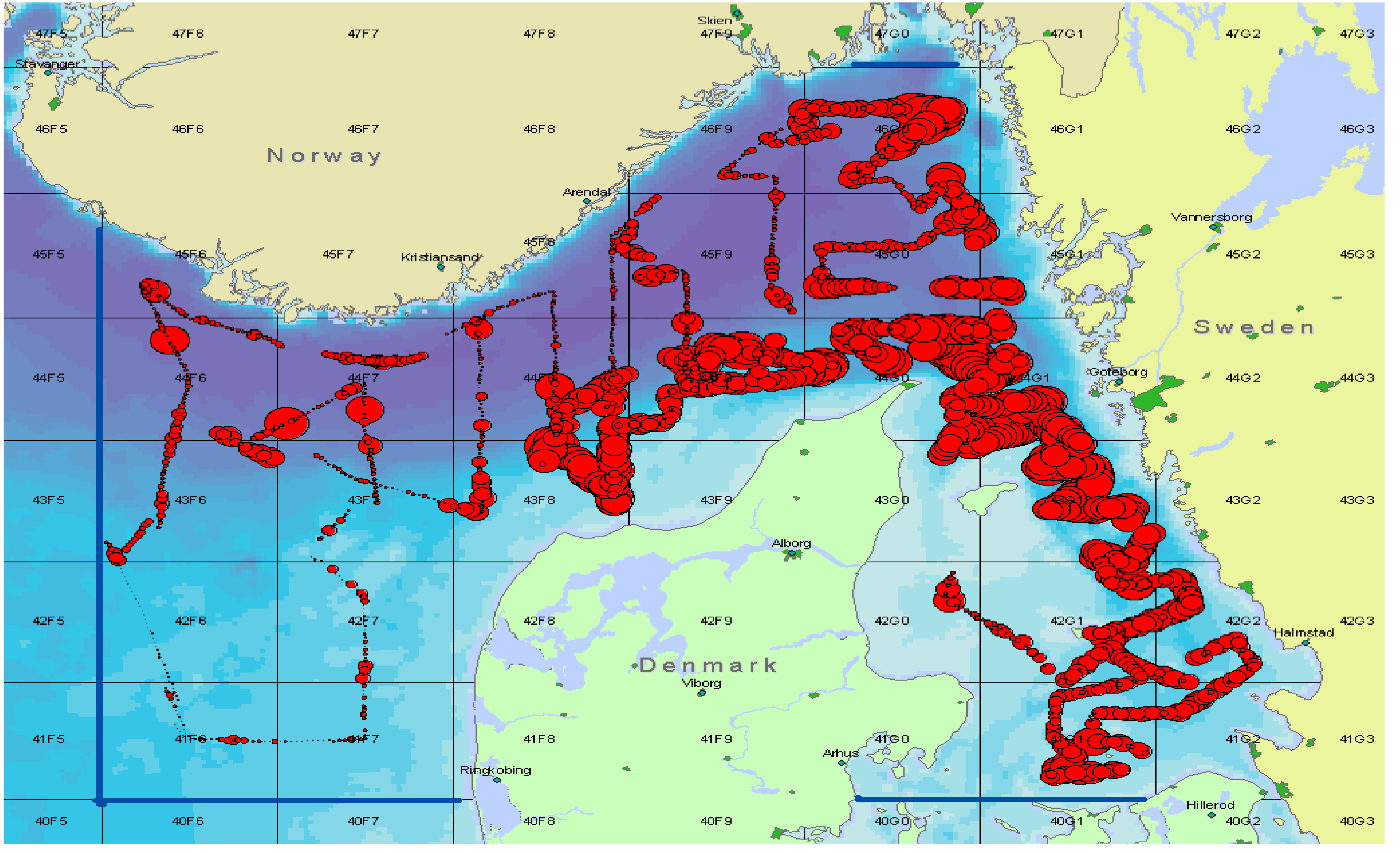

Figure 5B.5. Relative herring density (in numbers per nm²) along the track of the June-July 2007 Danish acoustic survey in the eastern North Sea, Skagerrak and Kattegat. Red circles indicate relative density of herring per ESDU.

Table 5B.1. Simrad EK60 and analysis settings used during the Acoustic Herring Survey with RV "Dana" Cruise July 2009.

Transceiver Menu	
Frequency	38 kHz
Sound speed	1508 m.s^{-1}
Max. Power	2000 W
Equivalent two-way beam angle	-20.5 dB
Default Transducer Sv gain	25.40 dB
3 dB Beamwidth	6.9°
Calibration details	
TS of sphere	-33.6 dB
Range to sphere in calibration	9.56 m
Measured NASC value for calibration	19300 m^2/nmi^2
Calibration factor for NASCs	1.00
Absorption coeff	6.063 dB/km
Log Menu	
Distance	1,0 nautical mile 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 5B.2 Survey statistics for the Danish acoustic survey with RV "Dana" in June-July 2009.

Stratum	Artea, Nm*2	Logs	Hauls	meanSa	meanTs
560E06	3980	121	4	9.33E+08	5.78E+08
570E06	3600	317	7	4.92E+08	3.41E+08
570E08	3406	315	9	6.69E+08	3.25E+09
580E06	209	24	1	3.98E+07	5.51E+08
580E08	1822	139	5	6.22E+07	1.91E+09
C	988	79	3	2.27E+07	8.21E+08
D	1837	208	6	1.41E+08	1.26E+09
E	5228	406	7	4.24E+08	1.22E+09

Table 5B.3. Trawl haul details for the Danish acoustic survey with RV "Dana" in June-July 2009.

Date	Haul	Time	ICES	Position		Trawl Direction	Wire length	Trawl type	Cath depth	Mean depth	Total catch	Main Species	Trawling speed	Trawling duratin	Wind speed	Sea state
dd-mm-yy	no.	UTC	Square	Latitude	Longitude	deg.	m		m	m	kg		Kn	min,	m/s	
02-07-09	179	22:51	44F6	57.52.064 N	006.54.321 E	296	325	Fotö	Surface	392	440	Krill	3.2	59	0	1
03-07-09	283	10:31	42F6	56.57.399 N	006.27.345 E	90	300	Expo	Bottom	55	116	Haddock, Cod	2.9	60	3	1
03-07-09	296	12:56	43F6	57.04.968 N	006.23.707 E	314	300	Expo	Bottom	56	94	Haddock	2.1	60	3	0
03-07-09	361	20:53	41F6	56.11.794 N	006.40.490 E	88	400	Fotö	Surface	40	161	Mackerel	3.8	60	4	0
04-07-09	383	00:15	41F7	56.12.272 N	007.20.730 E	90	400	Fotö	Surface	29	680	Horse mackerel, Mackerel	3.7	60	2	0
04-07-09	470	10:41	43F7	57.10.454 N	007.16.244 E	189	300	Expo	Bottom	51	58	Whiting, Cod	2.8	60	5	2
04-07-09	485	13:19	43F7	57.13.893 N	007.33.680 E	83	300	Expo	Bottom	52	510	Haddock	3.2	60	8	3
04-07-09	546	21:11	44F6	57.38.547 N	006.48.576 E	127	320	Fotö	Surface	295	720	Herring	3.8	60	11	4
05-07-09	564	00:16	43F6	57.23.242 N	006.48.229 E	111	320	Fotö	Surface	94	200	Mackerel, Herring	4.3	60	12	4
05-07-09	645	10:56	44F7	57.39.279 N	007.46.620 E	106	340	Fotö	Surface	292	68	Herring	4.1	60	12	4
05-07-09	660	13:32	44F7	57.45.099 N	007.53.231 E	103	350	Fotö	Surface	454	80	Large medusa	4.1	60	13	4
05-07-09	712	21:22	44F8	57.56.127 N	008.06.710 E	113	320	Fotö	Surface	485	124	Large medusa, Krill	3.4	60	9	4
06-07-09	729	00:12	44F8	57.41.503 N	008.16.591 E	101	320	Fotö	Surface	241	190	Herring	3.6	60	9	4
06-07-09	816	10:39	43F8	57.24.324 N	008.31.326 E	58	240	Expo	Bottom	38	149	Greater sandeel, Gurnard	2.8	60	6	3
06-07-09	830	13:13	44F8	57.33.176 N	008.28.130 E	65	400	Expo	Bottom	101	3500	Norw ay pout	3.0	60	9	3
06-07-09	889	21:27	45F8	58.09.843 N	008.43.524 E	197	350	Fotö	Surface	428	200	Pearlside, Large medusa	4.2	60	6	3
07-07-09	905	00:15	45F8	58.11.855 N	008.49.301 E	200	375	Fotö	Surface	417	150	Pearlside, Large medusa	4.1	60	5	3
07-07-09	989	10:59	44F9	57.41.937 N	009.05.131 E	41	425	Fotö	Surface	91	9	Large medusa	4.0	60	3	3
07-07-09	1080	21:21	45F9	57.59.133 N	009.14.089 E	67	430	Fotö	Surface	448	565	Herring	4.0	60	5	2
08-07-09	1099	00:12	45F9	57.58.967 N	009.47.316 E	69	475	Fotö	Surface	119	555	Herring, Mackerel	4.2	60	6	2
08-07-09	1186	10:32	44F9	57.43.851 N	009.42.675 E	56	220	Expo	Bottom	38	2500	Herring	3.1	60	3	2
08-07-09	1199	12:59	44G0	57.44.109 N	010.05.476 E	73	400	Expo	Bottom	82	300	Whitting	3	60	3	2
08-07-09	1263	22:00	46F9	59.29.386 N	009.44.384 E	359	420	Fotö	Surface	480	340	Mackerel	4.2	60	2	2
09-07-09	1369	10:37	46G0	58.34.990 N	010.50.412 E	190	400	Expo	Bottom	89	400	Norw ay pout	2.5	60	10	3
09-07-09	1381	13:21	45G0	58.24.736 N	010.51.122 E	282	330	Fotö	Surface	154	47	Large Medusa, Herring	3.4	60	5	3
10-07-09	1627	21:01	45G1	58.05.847 N	011.04.128 E	54	420	Fotö	Surface	81	820	Mackerel, Herring, Horse Mackerel	4.0	60	3	3
11-07-09	1648	01:13	44G1	57.54.568 N	011.11.456 E	96	420	Fotö	Surface	59	1350	Herring	4.1	60	9	3
11-07-09	1735	10:36	43G1	57.04.661 N	011.49.639 E	26	320	Expo	Bottom	54	610	Large Medusa, Herring	2.4	60	9	4
11-07-09	1759	14:04	42G1	56.49.662 N	011.43.298 E	36	240	Expo	Bottom	54	400	Herring	2.7	60	9	4
11-07-09	1813	21:09	42G1	56.38.118 N	011.44.106 E	38	400	Fotö	Surface	32	400	Large Medusa, Herring	4.1	60	8	4
12-07-09	1832	00:12	42G2	56.30.855 N	012.06.289 E	60	210	Fotö	Surface	37	Invalid		2.4	60	2	3
12-07-09	1917	10.29	41G1	56.09.799 N	011.53.748 E	42	240	Expo	Bottom	27	200	Large medusa	2.9	60	1	3
12-07-09	1934	13:12	41G1	56.16.387 N	011.36.494 E	26	190	Expo	Bottom	30	160	Sprat	2.6	60	3	2
12-07-09	1994	20:49	41G0	56.11.890 N	010.57.656 E	2	275	Expo	Surface	19	599	Large Medusa, Herring, Sprat	3.2	60	9	3

Table 5B.4. Catch composition in trawl hauls for the Danish acoustic survey with RV "Dana" in June-July 2009.

	Station	179	283	296	361	383	470	485	546	564	645	660	712
	ICES sq.	44F6	42F6	43F6	41F6	41F7	43F7	43F7	44F6	43F6	44F7	44F7	44F8
	Gear	Fotö	Expo	Expo	Fotö	Fotö	Expo	Expo	Fotö	Fotö	Fotö	Fotö	Fotö
	Fishing depth	Surface	Bottom	Bottom	Surface	Surface	Bottom	Bottom	Surface	Surface	Surface	Surface	Surface
	Total depth	392	55	56	40	29	51	52	295	94	292	454	485
	Day/Night	N	D	D	N	N	D	D	N	N	D	D	N
	Total catch	440	116	94	161	680	58	510	720	200	68	80	124
Herring	*Clupea harengus*	29.381	0.112	18.8	0.028	0.108	0.216	0.04	633.609	71.8	22.464	2.674	0.284
Norway pout	*Trisopterus esmarki*		0.266										
Large Medusa	*Medusa, spp*	57.645	0.338		2.418		0.682		16.317	29.6	35.2	67	83.21
Mackerel	*Scomber scombrus*	3.956			110.3	251.015			36.766	87.1	1.17	0.242	4
Krill	*Euphausidae spp.*	333.116							0.821				33.085
Horse mackerel	*Trachurus trachurus*				1.902	404.119							
Haddock	*Melanogrammus aeglefinus*		33.132	8.256			5.764	375.565		0.016		0.01	
Invertebrates	*Inv*		0.308	3.042			1.878	0.062					
Cod	*Gadus Morhua*		31.504	8.56			9.225	99.814					
Sprat	*Sprattus sprattus*												
Whiting	*Merlangius merlangus*	0.707	2.15	5.956	0.026		9.435	18		0.092	0.138	0.422	0.772
Gurnard	*Trigala spp.*		5.61	4.116	42.6	22	4.016			0.23			
Saithe	*Pollachius virens*	3.4											
Dab	*Limanda limanda*		2.364	18.8			3.552	0.81					
Garfish	*Belone belone*					0.182			30.5	11.5	1.776	4.26	2.5
Lumpsucker	*Cyclopterus lumpus*	1.552			1.37				1.812		6.96	4.95	
Plaice	*Pleuronectes platessa*		3.006	5.772			3.716	5.468					
Greater sandeel	*Hyperoplus lanceolatus*		9.34	0.036			1.334						
Long rough dab	*Hippoglosides plattessoides*			1.638			0.384	0.094					
Hake	*Merluccius merluccius*		5.9	2.462			7.1						
Common weaver	*Trachinus draco*												
Lemon sole	*Microstomus kitt*		10.495	1.224			5.712	0.658					
Sandrrl	*Ammodytes marinus*			0.144									
Anglerfish	*Lophiuspiscatorius*		3.106	6			1.994						
Halibut	*Hippoglossus hippoglossus*		7.9					2.884					
Pearlside	*Mauorolicus muelleri*	9.69							0.005				
Blue whiting	*Micromesistius poutassou*	0.452							0.17				0.21
	Cephalopoda sp		0.132	0.074	0.038		1.048	5.11		0.04			
Picked Dogfish	*Squalus acanthias*												
Wolffish	*Anarhichas lupus*			5.9				1.172					
Turbot	*Psetta maxima*				2.014		1.886						
Tarry ray	*Raja radiata*			2.87									
Flounder	*Platichthys flesus*												
Gray sole	*Glyptocephalus cynoglossus*						0.35						
Twaite shad	*Alosa fallax*					1.97							
Brill	*Scophthalmus rhombe*												
Sculpin	*Myoxocephalus scorpius*												
Poor cod	*Trisopterus minutus*			0.116									
	Myxine glutinosa												
Pilchard	*Sardina pilchardus*					0.606							
Norway lobster	*Nephrops norvegicus*												
	Lycodes vahli												
Anchovy	*Engraulis encrasicolus*												
Lamprey	*Petromyzon marinus*	0.1											
	Leptoclinus maculatus												
Snake blenny	*Lumpenus lampretaeformis*												
	Callionymus maculatus						0.012						

Table 5B.4 continued.

	Station	729	816	830	889	905	989	1080	1099	1186	1199	1263	1369
	ICES sq.	44F8	43F8	44F8	45F8	45F8	44F9	45F9	45F9	44F9	44G0	46F9	46G0
	Gear	Fotö	Expo	Expo	Fotö	Fotö	Fotö	Fotö	Fotö	Expo	Expo	Fotö	Expo
	Fishing depth	Surface	Bottom	Bottom	Surface	Surface	Surface	Surface	Surface	Bottom	Bottom	Surface	Bottom
	Total depth	241	38	101	462	417	91	448	129	38	82	480	89
	Day/Night	N	D	D	N	N	D	N	N	D	D	N	D
	Total catch	190	149	3,500	200	150	9	565	555	2,500	300	340	400
Herring	*Clupea harengus*	100.7		11.67		3.678		346.867	292.417	2424.452	21.49	0.32	66.19
Norway pout	*Trisopterus esmarki*			3068.222							21.815		70.269
Large Medusa	*Medusa, spp*	20.329	5.534		40.244	50.36	7.36	16.714	9.514	2.94	0.815	51.05	
Mackerel	*Scomber scombrus*	1.358			16.8	1.422	1.092	136.472	196.373			160.2	
Krill	*Euphausidae spp.*	55.444			128.472	90.95		51.935	43.863			85.98	
Horse mackerel	*Trachurus trachurus*												
Haddock	*Melanogrammus aeglefinus*		0.202	94.937	0.014	0.078				2.168	25.962		7.723
Invertebrates	*Inv*		0.508	90.338						4.891	11.206		220.569
Cod	*Gadus Morhua*		4.234	83.274						6.635	22.848		1.318
Sprat	*Sprattus sprattus*												
Whiting	*Merlangius merlangus*	0.29	2.504	13.337	0.57	0.402	0.118	0.133	0.182	25.01	47.166		18.332
Gurnard	*Trigala spp.*		42.4	1.183						2.568			
Saithe	*Pollachius virens*		3.846	87.5							12.6	6	
Dab	*Limanda limanda*		1.52							16.434	26.079		
Garfish	*Belone belone*	5.52			1.5	0.304		3.648	12.49			1.75	
Lumpsucker	*Cyclopterus lumpus*	5.4			6	2.156	0.42	8.575	0.162			34.7	2.244
Plaice	*Pleuronectes platessa*		1.852	0.32						4.344	51.6		0.4
Greater sandeel	*Hyperoplus lanceolatus*		66.5										
Long rough dab	*Hippoglosides plattessoides*			16.885						0.488	42.349		2.511
Hake	*Merluccius merluccius*		6.15	29.1						7.355			2.642
Common weaver	*Trachinus draco*	0.096											
Lemon sole	*Microstomus kitt*		0.284	2.154						0.974	7.605		0.25
Sandrrl	*Ammodytes marinus*		11.482										
Anglerfish	*Lophiuspiscatorius*												
Halibut	*Hippoglossus hippoglossus*												
Pearlside	*Mauorolicus muelleri*	0.084			0.3	0.31		0.165					
Blue whiting	*Micromesistius poutassou*	0.778			6.1			0.39					
	Cephalopoda sp		0.218							0.336			
Picked Dogfish	*Squalus acanthias*					0.34							7.062
Wolffish	*Anarhichas lupus*												
Turbot	*Psetta maxima*		1.42										
Tarry ray	*Raja radiata*									1.406			0.126
Flounder	*Platichthys flesus*												
Gray sole	*Glyptocephalus cynoglossus*			1.08							0.648		
Twaite shad	*Alosa fallax*												
Brill	*Scophthalmus rhombe*												
Sculpin	*Myoxocephalus scorpius*												
Poor cod	*Trisopterus minutus*										0.917		
	Myxine glutinosa										0.902		
Pilchard	*Sardina pilchardus*												
Norway lobster	*Nephrops norvegicus*												0.234
	Lycodes vahli												
Anchovy	*Engraulis encrasicolus*												
Lamprey	*Petromyzon marinus*												
	Leptoclinus maculatus												0.07
Snake blenny	*Lumpenus lampretaeformis*												
	Callionymus maculatus												

Table5B. 4. continued.

	Station	1381	1627	1648	1735	1759	1813	1832	1917	1934	1994	
	ICES sq.	45G0	45G1	44G1	43G1	42G1	42G1	41G2	41G1	41G1	41G0	
	Gear	Fotö	Fotö	Fotö	Expo	Expo	Fotö	Fotö	Expo	Expo	Expo	
	Fishing depth	Surface	Surface	Surface	Bottom	Bottom	Surface	Surface	Bottom	Bottom	Surface	
	Total depth	154	81	59	54	54	32	37	27	30	20	
	Day/Night	D	N	N	D	D	N	N	D	D	N	
	Total catch	47	820	1,350	610	400	400	Invalid	200	160	599	Total
Herring	*Clupea harengus*	14.194	196.441	1208.797	143.63	283.233	60.9		1	3.27	98.06	6056.825
Norway pout	*Trisopterus esmarki*		0.405		0.038	0.028						3161.043
Large Medusa	*Medusa, spp*	30.8	1.92	16.057	375.134	72.122	294.872		187.918	30.8	409.295	1916.188
Mackerel	*Scomber scombrus*		503.415	67.584	0.87	0.672	6.150				0.298	1587.255
Krill	*Euphausidae spp.*				74.677							898.343
Horse mackerel	*Trachurus trachurus*		117.459	50.522			6.15					580.152
Haddock	*Melanogrammus aeglefinus*	0.004			0.47	0.571				0.018	0.54	555.43
Invertebrates	*Inv*				1.867	5.275			2.226	14.1		356.27
Cod	*Gadus Morhua*				0.42				0.04	0.258		268.13
Sprat	*Sprattus sprattus*				0.344	0.67	10.28		4.856	92.7	83.849	192.699
Whiting	*Merlangius merlangus*	0.104	0.008		4.878	7.331	0.216		0.224	5.328	0.171	164.002
Gurnard	*Trigala spp.*				0.22	0.605	0.168			0.426	0.116	126.258
Saithe	*Pollachius virens*											113.346
Dab	*Limanda limanda*				0.46	19.1			0.556	8.37	0.21	98.255
Garfish	*Belone belone*		0.352	7.01			1.994					85.286
Lumpsucker	*Cyclopterus lumpus*	1.85			1.892	1.72			0.318		0.276	82.357
Plaice	*Pleuronectes platessa*				2.858	0.46			0.14	1.148	1.02	82.104
Greater sandeel	*Hyperoplus lanceolatus*				0.648	0.05					0.04	77.948
Long rough dab	*Hippoglosides plattessoides*				0.502	0.216				0.234		65.301
Hake	*Merluccius merluccius*				0.406							61.115
Common weaver	*Trachinus draco*					7.585	25.3		1.498		2.744	37.223
Lemon sole	*Microstomus kitt*				0.176	0.3						29.832
Sandrrl	*Ammodytes marinus*											11.626
Anglerfish	*Lophiuspiscatorius*											11.1
Halibut	*Hippoglossus hippoglossus*											10.784
Pearlside	*Mauorolicus muelleri*											10.554
Blue whiting	*Micromesistius poutassou*											8.1
	Cephalopoda sp								0.76			7.756
Picked Dogfish	*Squalus acanthias*											7.402
Wolffish	*Anarhichas lupus*											7.072
Turbot	*Psetta maxima*										0.764	6.084
Tarry ray	*Raja radiata*								0.094			4.496
Flounder	*Platichthys flesus*									2.498	0.586	3.084
Gray sole	*Glyptocephalus cynoglossus*											2.078
Twaite shad	*Alosa fallax*											1.97
Brill	*Scophthalmus rhombe*				0.19						1.016	1.206
Sculpin	*Myoxocephalus scorpius*								0.364	0.8		1.164
Poor cod	*Trisopterus minutus*					0.028						1.061
	Myxine glutinosa											0.902
Pilchard	*Sardina pilchardus*											0.606
Norway lobster	*Nephrops norvegicus*				0.32							0.554
	Lycodes vahli					0.3						0.3
Anchovy	*Engraulis encrasicolus*						0.16					0.16
Lamprey	*Petromyzon marinus*											0.1
	Leptoclinus maculatus											0.07
Snake blenny	*Lumpenus lampretaeformis*					0.034						0.034
	Callionymus maculatus											0.012

Table 5B.5. Measured length distribution of herring by haul for the Danish acoustic survey with RV "Dana" in June-July 2009.

Station	179	283	296	361	383	470	485	546	564	645	660	712	729	830	905	1080	1099	1186
ICES sq.	44F6	42F6	43F6	41F6	41F7	43F7	43F7	44F6	43F6	44F7	44F7	44F8	44F8	44F8	45F8	45F9	45F9	44F9
Gear	Fotö	Expo	Expo	Fotö	Fotö	Expo	Expo	Fotö	Fotö	Fotö	Fotö	Fotö	Fotö	Expo	Fotö	Fotö	Fotö	Expo
Fishing depth	Surface	Bottom	Bottom	Surface	Surface	Bottom	Bottom	Surface	Surface	Surface	Surface	Surface	Surface	Bottom	Surface	Surface	Surface	Bottom
Total depth	392	55	56	40	29	51	52	295	94	292	454	485	241	101	417	448	129	38
Day/Night	N	D	D	N	N	D	D	N	N	D	D	N	N	D	N	N	N	D
Total catch,kg	440	116	94	161	680	58	510	720	200	68	80	124	190	3500	150	565	555	2500
Total catch Herring,kg	29381	0.112	18.8	0.028	0.108	0.216	0.040	633609	71.8	22464	2674	0.284	100.7	11392	3678	364867	292417	2424.45
Sample Herring,kg	29381	0.112	18.8	0.028	0.108	0.216	0.040		69447	22464	2674	0.284	66452	11392	3678	99057	84728	34.527
Length in cm																		
5.5																		
6																		
6.5																		
7																		
7.5			5															
8		1	11															
8.5		1	40			5												
9		3	64			10												
9.5		2	47			6												
10		1	17			5												
10.5						1												
11																		
11.5																		
12																		
12.5																		
13																		
13.5																		
14			2															
14.5			2															1
15			1											2				3
15.5			2	1										1				5
16			38										1					21
16.5	2		99						19					1		1		9
17	3		116						28					1				24
17.5	6		94		1		1		61				7	3				60
18	7		35						73				1	7				90
18.5	15		11			1		4	90	1			8	20				113
19	10		7					2	87	2			5	18		1	1	108
19.5	11		1					4	78	4			10	13		4	8	78
20	10							7	82	2	1		16	13	1	4	6	60
20.5	15		1					4	77	1	1		20	13		10	12	27
21	15	1	1		1			7	42	6		2	15	12		13	23	14
21.5	15							12	48	11	1		32	9		24	31	13
22	32		1					11	55	10	2	1	32	11		35	35	4
22.5	17		1					28	35	17	1		30	4	1	39	63	1
23	22		1					25	20	10	1		27	7	1	38	51	2
23.5	20							22	23	15	3		30	3		35	46	2
24	15		1					24	15	13			19		1	33	44	1
24.5	12							27	14	6			29	1	1	45	39	
25	7							30	6	7	1		26	2	1	47	30	
25.5	7							35	10	12	3		28	1	1	42	33	
26	4							32	9	5	1		25		2	40	30	
26.5	8							45		4			22		3	36	21	
27	5							32	6	5			25		1	34	29	
27.5	2							43	2	8	2		26		2	42	22	
28	4							25		7	2		17	1	3	31	16	
28.5	3							34	1	3	1		17		3	22	16	
29	6							32	1	8			14			18	14	
29.5	2							24		4			5			15	14	
30	1							15		2			4			8	2	
30.5								11	1				2			3	2	
31								12					2			3	2	
31.5																	1	
32								3		1						1		
32.5	1							1										
Total no.	277	9	598	1	2	28	1	551	883	164	20	3	495	143	21	624	591	636
Mean Length	22.4	10.4	14.6	15.5	19.3	9.6	17.5	26.0	20.1	24.4	24.5	21.3	24.1	20.2	26.1	25.1	24.4	18.7

Table 5B.5. Continued.

Station	1199	1263	1369		1381	1627		1648		1735		1759		1813		1917	1934	1994
ICES sq.	44G0	46F9	46G0		45G0	45G1		44G1		43G1		42G1		42G1		41G1	41G1	41G0
Gear	Expo	Fotö	Expo		Fotö	Fotö		Fotö		Expo		Expo		Fotö		Expo	Expo	Expo
Fishing depth	Bottom	Surface	Bottom		Surface	Surface		Surface		Bottom		Bottom		Surface		Bottom	Bottom	Surface
Total depth	82	480	89		154	81		59		54		54		32		27	30	20
Day/Night	D	N	D		D	N		N		D		D		N		D	D	N
Total catch,kg	300	340	400		47	820		1350		610		400		400		200	160	599
Total catch Herring,kg	21.49	0.32	60366	5.824	14.194	79906	123.54	786.83	421.97	127942	15688	253833	29400	14.7	46.2	1006	3.27	98.6
Sample Herring,kg	3.778	0.32	0.992	5.824	14194	4.304	30.5	4.514	27.246	4895	15688	4466	16589	2766	21.27	1006	3.27	19.623
Length in cm																		
5.5																		
6																		
6.5																		
7																		
7.5	19		3															
8	153		8			6								5				
8.5	276		17			19								3			4	
9	192		26			77		5				27		17			13	
9.5	85		38			127		36				61		30			35	
10	12		38			153		87		5		60		74			51	
10.5	5		14			109		145		55		197		106			111	
11	1		3			59		87		191		209		90			81	
11.5			1			34		86		150		26		23			25	
12						17		46		73		7		3			1	
12.5						3		14		21	1		2					
13									1	3			2		1			
13.5									3		2		34					
14									12		6		81					
14.5							3		42		8		156		2			
15									62		14		112		1		1	
15.5									48		5		42		1	1		3
16									61		10		33		1		2	22
16.5									67		3		24		4	2		113
17							1		62		2		21		24	1	3	183
17.5							2		86		5		22		90	2	3	162
18							4		46		7		10		132	2	4	56
18.5				2			5		40		9		7		106	1	1	10
19				2			8		21		11		6		57	2	1	4
19.5		1		3	2		14		8		10		3		26	1		
20				2			21		11		27		4		31		1	
20.5				3	2		25		8		36		3		15			
21				5	2		35		4		45		2		9	4		
21.5				6	8		43		2		26		2		7	1	2	
22				6	12		29		6		17		2		1			2
22.5				8	8		27		4		9		2		1			
23		1		7	14		21		2		4							
23.5				7	7		18		6		2							
24				3	7		16		2		3				1			
24.5				3	7		8		2		1							
25				1	3		5		3									
25.5				1	8		8		2				1					
26					4		7		1									
26.5				1	11		6		1		1							
27		1			8		5											
27.5					3		1		1									
28					4		1						1					
28.5							1											
29							1		1									
29.5							1											
30																		
30.5																		
31																		
31.5																		
32																		
32.5																		
Total no.	743	3	148	60	110	604	316	506	615	498	264	587	572	351	510	17	339	555
Mean Length	8.7	23.2	9.4	22.2	24.1	10.0	22.0	10.8	17.1	11.3	19.6	10.5	15.3	10.4	18.4	18.7	10.8	17.2

Table 5B.6. Abundance, mean weight, mean length and biomass by age group and subarea for North Sea autumn spawning herring in the Danish acoustic survey with RV "Dana" in June-July 2009

Numbers in millions											
	WR										
Strata	0	1i	1m	2i	2m	3i	3m	4i	4m	5	6
580E06	0	0.688877	0.003501	0.051104	0.042379	0.01018	0.01018	0	0	0	0
570E06	31.06361	171.0214	0.869232	23.39247	19.39864	3.709209	3.709209	0	0	0	0
580E08	0	9.646501	0.049029	2.263806	1.877303	0.137408	0.137408	0.318755	0.212504	0.261824	0.046534
570E08	108.0899	743.6838	3.779841	4.788262	3.970754	0.153006	0.153006	0.408108	0.272072	0.271035	0.055769
C	260.153	0.586728	0.002982	0.033011	0.027375	0	0	0	0	0	0
D	3864.972	480.1174	2.440241	1.897663	1.573672	0.078612	0.078612	0.512175	0.34145	0.37262	0
E	3409.909	275.324	1.938902	0.303746	0	0	0	0	0	0	0
560E06	138.3324	100.5406	3.351353	1.801204	0	0	0	0	0	0	0
Biomass in ton											
	WR										
Strata	0	1i	1m	2i	2m	3i	3m	4i	4m	5	6
580E06	0	50.75784	0.257981	7.019824	5.821318	2.071547	2.071547	0	0	0	0
570E06	132.5619	11987.5	60.92755	3865.998	3205.95	729.7679	729.7679	0	0	0	0
580E08	0	970.3719	4.932005	354.7811	294.2087	25.51769	25.51769	62.20684	41.47123	52.57189	12.51759
570E08	448.5365	44954.51	228.4854	605.2088	501.8804	28.43904	28.43904	80.15794	53.43863	54.34424	15.00198
C	1478.302	46.87994	0.238272	4.854056	4.025315	0	0	0	0	0	0
D	29197.17	16094.95	81.80406	288.3228	239.097	13.75718	13.75718	101.8426	67.89507	74.39242	0
E	27961.32	7627.155	53.71236	31.89329	0	0	0	0	0	0	0
560E06	615.4524	3868.201	128.94	90.42041	0	0	0	0	0	0	0
Mean length in cm											
	WR										
Strata	0	1i	1m	2i	2m	3i	3m	4i	4m	5	6
580E06	0.00	19.58	19.58	24.10	24.10	28.00	28.00	0.00	0.00	0.00	0.00
570E06	9.01	19.56	19.56	25.21	25.21	27.44	27.44	0.00	0.00	0.00	0.00
580E08	0.00	21.98	21.98	24.94	24.94	26.75	26.75	27.54	27.54	27.71	31.00
570E08	8.66	18.69	18.69	23.27	23.27	26.76	26.76	27.68	27.68	27.71	31.00
C	9.44	20.63	20.63	25.30	25.30	0.00	0.00	0.00	0.00	0.00	0.00
D	10.43	15.60	15.60	24.74	24.74	26.50	26.50	27.61	27.61	27.69	0.00
E	10.75	14.98	14.98	23.50	23.50	0.00	0.00	0.00	0.00	0.00	0.00
560E06	9.01	17.02	17.02	18.30	18.30	0.00	0.00	0.00	0.00	0.00	0.00
Mean weight in g											
	WR										
Strata	0	1i	1m	2i	2m	3i	3m	4i	4m	5	6
580E06	0.00	73.68	73.68	137.36	137.36	203.50	203.50	0.00	0.00	0.00	0.00
570E06	4.27	70.09	70.09	165.27	165.27	196.74	196.74	0.00	0.00	0.00	0.00
580E08	0.00	100.59	100.59	156.72	156.72	185.71	185.71	195.16	195.16	200.79	269.00
570E08	4.15	60.45	60.45	126.39	126.39	185.87	185.87	196.41	196.41	200.51	269.00
C	5.68	79.90	79.90	147.04	147.04	0.00	0.00	0.00	0.00	0.00	0.00
D	7.55	33.52	33.52	151.94	151.94	175.00	175.00	198.84	198.84	199.65	0.00
E	8.20	27.70	27.70	105.00	105.00	0.00	0.00	0.00	0.00	0.00	0.00
560E06	4.45	38.47	38.47	50.20	50.20	0.00	0.00	0.00	0.00	0.00	0.00

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Table 5B.7. Abundance, mean weight, mean length and biomass by age group and subarea for Baltic Sea spring-spawning herring in the Danish acoustic survey with RV "Dana" in June-July 2008

Number in millions																		
	WR																	
Strata	0	1i	1m	2i	2m	3i	3m	4i	4m	5	6	7	8	9	10	11	12	13
580E06	0	0.164451	0.017181	0.244813	0.603232	0.020268	0.419386	0.004216	0.313401	0.192633	0.023753	0	0	0.01018	0	0	0	0
570E06	0	54.97762	5.74393	39.42384	97.14241	6.406288	132.5609	1.553009	115.4403	51.60876	44.12637	15.50616	11.37886	1.723057	2.162766	1.161041	0	1.520387
580E08	0	0	0	5.140794	12.66719	0.419149	8.673162	0.103269	7.676345	3.760147	2.286826	0.709197	0.16086	0.239065	0.046141	0	0	0
570E08	0	79.55254	8.311459	17.25201	42.50985	0.887137	18.3569	0.173225	12.87642	6.385305	3.680667	1.123925	0.205618	0.281966	0.065937	0	0	0
C	0	0	0	0.752594	1.85443	0.046638	0.965041	0.008472	0.629751	0.089266	0.02888	0.02888	0.02888	0	0	0	0	0
D	0	1.012524	0.105786	19.16085	47.21333	1.015757	21.01836	0.198697	14.7698	5.021978	3.509424	1.262183	0.232536	0.387166	0.122249	0	0	0
E	0.943303	145.2348	10.11128	5.938938	21.05623	0.553964	4.801023	0.180652	1.806519	0.675895	0.647134	0	0	0	0	0	0	0
560E06	0	42.25811	152.1292	0	1.801203	0	0.720481	0	0	0	0	0	0	0	0	0	0	0
Biomass in ton																		
	WR																	
Strata	0	1i	1m	2i	2m	3i	3m	4i	4m	5	6	7	8	9	10	11	12	13
580E06	0	11.37461	1.188393	22.9798	56.62343	2.360789	48.85017	0.584172	43.42345	31.6572	6.151951	0	0	3.18634	0	0	0	0
570E06	0	2957.403	308.9824	4600.122	11334.94	968.1876	20034.04	281.3814	20916.02	10405.26	10057.51	3507.759	3236.487	427.8568	607.2392	323.9304	0	437.8715
580E08	0	0	0	641.0336	1579.54	62.19962	1287.054	18.98351	1411.107	777.3141	461.696	152.3672	39.928	58.64704	12.68878	0	0	0
570E08	0	4839.288	505.5973	1798.205	4430.871	123.7389	2560.443	31.58784	2348.029	1287	751.0273	249.6635	51.70862	69.16725	18.13268	0	0	0
C	0	0	0	76.66795	188.9138	6.038621	124.953	1.335083	99.24115	16.75842	4.216529	5.833827	4.563093	0	0	0	0	0
D	0	75.36048	7.873483	1951.807	4809.354	133.6241	2764.99	32.20565	2393.954	1046.924	665.9069	267.593	36.74064	92.17639	33.61848	0	0	0
E	18.13044	4812.735	335.0638	390.7809	1385.496	51.63575	447.5098	22.67194	226.7194	43.0316	89.47846	0	0	0	0	0	0	0
560E06	0	1631.354	5872.875	0	135.4505	0	86.45772	0	0	0	0	0	0	0	0	0	0	0
Mean length in cm																		
	WR																	
Strata	0	1i	1m	2i	2m	3i	3m	4i	4m	5	6	7	8	9	10	11	12	13
580E06	0.00	19.35	19.35	22.08	22.08	24.02	24.02	25.07	25.07	26.23	29.71	0.00	0.00	32.50	0.00	0.00	0.00	0.00
570E06	0.00	18.35	18.35	23.31	23.31	25.59	25.59	27.07	27.07	27.93	29.01	29.31	30.76	30.82	30.77	30.00	0.00	29.50
580E08	0.00	0.00	0.00	23.45	23.45	25.25	25.25	26.93	26.93	27.96	27.87	28.29	30.37	29.53	31.50	0.00	0.00	0.00
570E08	0.00	18.68	18.68	22.41	22.41	24.85	24.85	26.98	26.98	27.80	28.06	28.55	30.45	29.54	31.50	0.00	0.00	0.00
C	0.00	0.00	0.00	22.59	22.59	24.63	24.63	25.92	25.92	26.82	26.00	27.50	27.50	0.00	0.00	0.00	0.00	0.00
D	0.00	20.28	20.28	22.60	22.60	24.58	24.58	26.06	26.06	28.04	27.52	28.17	27.50	29.22	31.50	0.00	0.00	0.00
E	13.69	16.53	16.53	20.64	20.64	22.76	22.76	24.47	24.47	27.55	25.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
560E06	0.00	17.10	17.10	21.50	21.50	24.00	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean weight in g																		
	WR																	
Strata	0	1i	1m	2i	2m	3i	3m	4i	4m	5	6	7	8	9	10	11	12	13
580E06	0.00	69.17	69.17	93.87	93.87	116.48	116.48	138.56	138.56	164.34	259.00	0.00	0.00	313.00	0.00	0.00	0.00	0.00
570E06	0.00	53.79	53.79	116.68	116.68	151.13	151.13	181.18	181.18	201.62	227.93	226.22	284.43	248.31	280.77	279.00	0.00	288.00
580E08	0.00	0.00	0.00	124.70	124.70	148.39	148.39	183.83	183.83	206.72	201.89	214.84	248.22	245.32	275.00	0.00	0.00	0.00
570E08	0.00	60.83	60.83	104.23	104.23	139.48	139.48	182.35	182.35	201.56	204.05	222.14	251.48	245.30	275.00	0.00	0.00	0.00
C	0.00	0.00	0.00	101.87	101.87	129.48	129.48	157.59	157.59	187.74	146.00	202.00	158.00	0.00	0.00	0.00	0.00	0.00
D	0.00	74.43	74.43	101.86	101.86	131.55	131.55	162.08	162.08	208.47	189.75	212.01	158.00	238.08	275.00	0.00	0.00	0.00
E	19.22	33.14	33.14	65.80	65.80	93.21	93.21	125.50	125.50	63.67	138.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
560E06	0.00	38.60	38.60	75.20	75.20	120.00	120.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 5B.8. Age distribution in estimate of autumn spawners during the Danish acoustic survey with RV "Dana" in June-July from 2006 to 2009 given as number per age and strata in mill.and % of total abundance given by age and strata.

Autumn spawners in 2006

Number in millions

	WR							
Strata	0	1	2	3	4	5	6	Totalt
580E06	0	0	0	0	0	0	0	0
570E06	0	313.2245	77.82016	1.310689	0	0	0	392.3554
580E08	0	72.47082	5.607853	0	0	0.280924	0	78.3596
570E08	30.98883	425.0991	40.40881	2.000434	0	0	0	498.4972
C	0	125.2478	21.22575	0	0	0.317077	0	146.7906
D	0	265.6062	13.03738	1.528584	0	0	0	280.1722
E	6.566309	107.84	17.38965	1.233393	0	0	1.086413	134.1158
560E06	0	0	0	0	0	0	0	0
All stratas	37.55514	1309.488	175.4896	6.073101	0	0.598001	1.086413	1530.291

Age distribution in % of total abundance

	WR						
Strata	0	1	2	3	4	5	6
580E06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
570E06	0.00	79.83	19.83	0.33	0.00	0.00	0.00
580E08	0.00	92.48	7.16	0.00	0.00	0.36	0.00
570E08	6.22	85.28	8.11	0.40	0.00	0.00	0.00
C	0.00	85.32	14.46	0.00	0.00	0.22	0.00
D	0.00	94.80	4.65	0.55	0.00	0.00	0.00
E	4.90	80.41	12.97	0.92	0.00	0.00	0.81
560E06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
All stratas	2.45	85.57	11.47	0.40	0.00	0.04	0.07

Autumn spawners in 2007

Number in millions

	WR							
Strata	0	1	2	3	4	5	6	Totalt
580E06	0	4.275523	0.777364	0	0	0	0	5.052887
570E06	0	121.3957	56.68901	5.730107	0.081208	0	0	183.896
580E08	0	59.14779	26.5337	0	0	0	0	85.68149
570E08	0	753.575	118.4236	0	0	0	0	871.9986
C	0	75.62764	7.928773	0	0	0	0	83.55641
D	0	1365.499	109.4435	5.590177	0	0	0	1480.533
E	0	1542.982	46.9248	7.764333	0	0	0	1597.671
560E06	0	134.8495	0	0	0	0	0	134.8495
All stratas	0	4057.353	366.7207	19.08462	0.081208	0	0	4443.239

Age distribution in % of total abundance

	WR						
Strata	0	1	2	3	4	5	6
580E06	0.00	84.62	15.38	0.00	0.00	0.00	0.00
570E06	0.00	66.01	30.83	3.12	0.04	0.00	0.00
580E08	0.00	69.03	30.97	0.00	0.00	0.00	0.00
570E08	0.00	86.42	13.58	0.00	0.00	0.00	0.00
C	0.00	90.51	9.49	0.00	0.00	0.00	0.00
D	0.00	92.23	7.39	0.38	0.00	0.00	0.00
E	0.00	96.58	2.94	0.49	0.00	0.00	0.00
560E06	0.00	100.00	0.00	0.00	0.00	0.00	0.00
All stratas	0.00	91.32	8.25	0.43	0.00	0.00	0.00

Autumn spawners in 2008

Numbers in millions

	WR							
Strata	0	1	2	3	4	5	6	Totalt
580E06	0	5.759368	5.270526	1.137006	0	0	0	12.1669
570E06	0	233.3463	44.01544	10.12295	1.827048	0.97172	1.166064	291.4496
580E08	0	14.77055	0.798776	0.95387	0	0	0	16.5232
570E08	0	30.46026	35.50228	15.28281	12.22556	0	0	93.47091
C	0	16.99621	1.806051	0.289902	0	0	0	19.09216
D	11.87653	61.8407	12.27512	3.655343	1.158641	0.706254	0	91.51258
E	2347.35	13.78818	1.011825	3.668854	0	0	0	2365.818
560E06	1556.124	26.99296	0	0	0	0	0	1583.117
All stratas	3915.35	403.9546	100.68	35.11073	15.21125	1.677974	1.166064	4473.151

Age distribution in % of total abundance

	WR						
Strata	0	1	2	3	4	5	6
580E06	0.00	47.34	43.32	9.35	0.00	0.00	0.00
570E06	0.00	80.06	15.10	3.47	0.63	0.33	0.40
580E08	0.00	89.39	4.83	5.77	0.00	0.00	0.00
570E08	0.00	32.59	37.98	16.35	13.08	0.00	0.00
C	0.00	89.02	9.46	1.52	0.00	0.00	0.00
D	12.98	67.58	13.41	3.99	1.27	0.77	0.00
E	99.22	0.58	0.04	0.16	0.00	0.00	0.00
560E06	98.29	1.71	0.00	0.00	0.00	0.00	0.00
All stratas	87.53	9.03	2.25	0.78	0.34	0.04	0.03

Autumn sawners in 2009

Numbers in millions

	WR							
	0	1	2	3	4	5	6	Total
580E06	0	0.692378	0.093482	0.020359	0	0	0	0.806219
570E06	31.06361	171.8907	42.79111	7.418417	0	0	0	253.1638
580E08	0	9.69553	4.141109	0.274816	0.531259	0.261824	0.046534	14.95107
570E08	108.0899	747.4636	8.759016	0.306012	0.680179	0.271035	0.055769	865.6255
C	260.153	0.58971	0.060386	0	0	0	0	260.8031
D	3864.972	482.5577	3.471334	0.157225	0.853625	0.37262	0	4352.385
E	3409.909	277.2629	0.303746	0	0	0	0	3687.476
560E06	138.3324	103.8919	1.801204	0	0	0	0	244.0256
All Strata	7812.52	1794.044	61.42139	8.176829	2.065063	0.90548	0.102303	9679.236

Age distribution in % of total abundance

	WR						
	0	1	2	3	4	5	6
580E06	0.00	85.88	11.60	2.53	0.00	0.00	0.00
570E06	12.27	67.90	16.90	2.93	0.00	0.00	0.00
580E08	0.00	64.85	27.70	1.84	3.55	1.75	0.31
570E08	12.49	86.35	1.01	0.04	0.08	0.03	0.01
C	99.75	0.23	0.02	0.00	0.00	0.00	0.00
D	88.80	11.09	0.08	0.00	0.02	0.01	0.00
E	92.47	7.52	0.01	0.00	0.00	0.00	0.00
560E06	56.69	42.57	0.74	0.00	0.00	0.00	0.00
All Strata	80.71	18.53	0.63	0.08	0.02	0.01	0.00

Table 5B.9. Age distribution in estimate of spring spawners during the Danish acoustic survey with RV "Dana" in June-July from 2006 to 2009 given as number per age and strata.

Spring spawners in 2007															
Numbers in millions															
	WR														
Strata	0	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
580E06	0	0.593178	10.7057	6.516733	6.757213	1.130936	0.912556	0.101399	0.101399	0	0	0	0	0	26.81911
570E06	0	38.75708	240.7347	133.2967	63.69759	22.19022	4.991084	3.714054	0.876192	0	0	0	0	0	508.2576
580E08	0	18.15803	104.6477	52.34023	31.99871	11.00413	2.016351	0.263722	1.235087	0.473737	0	0	0	0	222.1377
570E08	0	523.5698	651.6374	295.6745	141.2997	52.41417	12.07789	3.483336	4.914179	2.662495	0	0	0	0	1687.734
C	0	500.8124	329.7239	87.72303	27.4259	6.0958	1.20621	0	1.401935	0	0	0	0	0	954.3891
D	0	531.7442	612.8719	161.5708	51.79789	10.30695	0	0	1.758777	0	0	0	0	0	1370.05
E	0	2138.608	1676.057	193.0519	129.388	42.03677	11.33461	18.16506	1.374893	0	0	0	0	0	4210.016
560E06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All stratas	0	3752.242	3626.378	930.1738	452.365	145.179	32.5387	25.72757	11.66246	3.136233	0	0	0	0	8979.403
													Total 4-13 WR		670.609
Spring spawners in 2008													Total 0-3 WR		8308.794
Numbers in millions															
	WR														
Strata	0	1	2	3	4	5	6	7	8	9	10	11	12	13	total
580E06	0	4.747417	22.36477	11.44426	4.644294	1.626579	0.23028	0	0	0	0	0	0	0	45.0576
570E06	0	2263.746	377.9704	116.5931	51.42066	23.76703	13.53144	5.641147	2.240824	0.168337	0.142474	0	0	0	2855.221
580E08	0	49.78858	59.89797	36.89878	7.153356	5.018811	1.894965	0.9969	0.476556	0.132367	0	0	0	0	162.2583
570E08	0	701.722	228.784	147.1977	71.33349	46.00456	41.0344	15.90546	6.888062	5.642334	0	0	0	0	1264.512
C	0	108.7159	96.90216	26.0226	7.21751	5.06947	0.579803	0.339799	0	0	0.337388	0	0	0	245.1846
D	1.378056	124.7084	151.8888	59.98314	20.05135	11.58314	3.955683	1.210712	0	0	0.28923	0	0	0	375.0485
E	23.86369	216.22	125.1047	41.38228	11.35295	6.158667	3.854107	0.451898	0.678876	0.362604	0	0	0	0	429.4297
560E06	81.1742	1903.126	5.624591	0	0	0	0	0	0	0	0	0	0	0	1989.925
All stratas	106.4159	5372.774	1068.537	439.5218	173.1736	99.22826	65.08069	24.54592	10.28432	6.305642	0.769092	0	0	0	7366.637
													Total 4-13 WR		379.3875
Spring spawners in 2009													Total 0-3 WR		6987.249
Number in millions															
	WR														
Strata	0	1	2	3	4	5	6	7	8	9	10	11	12	13	total
580E06	0	0.181632	0.848045	0.439654	0.317617	0.192633	0.023753	0	0	0.01018	0	0	0	0	2.013513
570E06	0	60.72155	136.5663	138.9672	116.9933	51.60876	44.12637	15.50616	11.37886	1.723057	2.162766	1.161041	0	1.520387	582.4357
580E08	0	0	17.80798	9.092311	7.779615	3.760147	2.286826	0.709197	0.16086	0.239065	0.046141	0	0	0	41.88214
570E08	0	87.86399	59.76186	19.24404	13.04964	6.385305	3.680667	1.123925	0.205618	0.281966	0.065937	0	0	0	191.663
C	0	0	2.607024	1.011678	0.638223	0.089266	0.02888	0.02888	0.02888	0	0	0	0	0	4.432833
D	0	1.118311	66.37418	22.03412	14.96849	5.021978	3.509424	1.262183	0.232536	0.387166	0.122249	0	0	0	115.0306
E	0.943303	155.346	26.99517	5.354987	1.98717	0.675895	0.647134	0	0	0	0	0	0	0	191.9497
560E06	0	194.3873	1.801203	0.720481	0	0	0	0	0	0	0	0	0	0	196.909
All stratas	0.943303	499.6188	312.7617	196.8644	155.7341	67.73399	54.30306	18.63034	12.00675	2.641433	2.397093	1.161041	0	1.520387	1326.317
													Total 4-13 WR		316.1282
													Total 0-3 WR		1010.188

Annex 5C: Norway

ICES coordinated acoustic survey on Herring and Sprat in the North Sea

RV "Johan Hjort", 13 – 21 July 2009

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1. INTRODUCTION

In 2009, the Norwegian Institute of Marine Research (IMR) carried out the Norwegian part of the ICES coordinated herring and sprat acoustic survey for the North Sea and adjacent areas. This acoustic survey is planned and coordinated by the Planning Group for International Pelagic Surveys (PGIPS 2009). Six countries cooperate in surveying the North Sea and Div. IIIa for an acoustic abundance estimation of herring and sprat. The Norwegian herring acoustic area was defined as the area between 56°30′ and 62°N and between 2° and 6°E. During early spring the IMR decided to reduce the survey effort due to economical reasons and the survey was realized by covering only parts of this area. The ICES squares originally planned with the densest coverage were chosen as the Norwegian contribution. Data from the present 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 2010.

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

a) To conduct an acoustic survey to estimate the abundance and distribution of herring and sprat in the northeastern part of the North Sea, between 57°00′and 62° N, and between 2° and 5° E.
b) To obtain biological samples. Herring were sampled for data on length, weight, age, sex, maturity and vertebrae count and infection by Ichthyphonus

In addition, 10 people, doing whale observations along the transects, were onboard. This, however, had no influence on the survey design.

2. SURVEY DESCRIPTION AND METHODS

2.1 Personnel

Else Torstensen	(Cruise leader, 13–21 July)
Cecilie Kvamme	(Scientist, 13–21 July)
Bjarte Kvinge	(Acoustic operator, 13 – 21 July)
Ingve Fjeldstad	(Acoustic operator, 13 – 21 July)
Annlaug Haugsdal	(Technician – pelagic fish, 13 – 21 July)
Anne-Liv Johnsen	(Technician – pelagic fish, 13 – 21 July)
Jan de Lange	(Technician – pelagic fish, 13 – 21 July)

2.2 Narrative

RV "Johan Hjort" left Stavanger at 1400 UTC 13 July 2009 and set the course south-east. Due to the reduction in available ship time, original plans had to be reduced. We started the acoustic survey at the Fladen Bank (43F2) at 0352 UTC 14 July in the position 57°11′N 03°04′E. The vessel then continued with east-west transects from south to north. The survey finished 21 July at 0431 UTC in position 61°02′N 03°50′E and the vessel proceeded to Bergen where "Johan Hjort" docked around 1000 UTC. Figure 1 gives the cruise track and distribution of trawl haul stations. In general the weather conditions were good.

The present report gives the results from the survey area covered by the Norwegian survey. Remember that the survey area, because of cut in survey time, does not cover the Norwegian survey area as agreed by the PGIPS meeting entirely (PGIPS 2009).

Samples of 25 herring from 2 stations between 57–58°N were frozen for later analysis at the Norwegian National Institute of Nutrition and Seafood Research (NIFES).

2.3 Survey design

The survey was carried out in systematically parallel east-west transects progressing northwards from N57° to N62°. The cut in survey time resulted in an inadequate coverage of the survey area, as only 16 of a total of 39 squares (41%) were covered adequately. The covered cells were the cells recommended by PGIPS to be covered with the highest effort, i.e. 7.5 nautical miles and 15 nautical mile spacing (marked with red and magenta in figure 4.3.1.2. in the PGIPS report – PGIPS 2009).

2.4 Calibration

Calibration of the echosounders was not performed. The sounders on board "Johan Hjort" have turned out to be stable and the settings used were from the calibration made in February 2009. The main settings for the 38 kHz transceiver are given in Table 1.

2.5 Acoustic data collection

The acoustic survey onboard RV "Johan Hjort" was carried out using a SIMRAD ER60 38 kHz sounder and an ES38B SK transducer 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). These data were used to present the frequency responses as guidance in the scrutiny of the acoustic data for species allocations. The mean volume backscattering values (S_V) were integrated pr nm intervals from 9–13 m (depending on weather conditions and the use of keel) below the surface to 0.5 m above the seabed. The speed of the vessel during the acoustic sampling was about 9 knots. The acoustic data were archived on an external hard drive. The acoustic recordings were scrutinized twice per day using the new Post Processing System LSSS (ver. 1.2.2; *Large Scale Survey System*, Korneliussen *et al.*, 2006).

2.6 Biological data - fishing trawl hauls

Trawling was carried out for supporting the species identification of acoustic scatters and for biological sampling. For pelagic trawling an Aakra trawl or a Harstad trawl was used, and the hauls were monitored by a SCANMAR TE40–2 (PL; narrow-beam) and depth sensor D1200. For bottom trawling a Campelen shrimp trawl with rock-hopper gear was used.

The catches were sampled for species composition by number and weights. Individual biological samples (length, weight) of the most important species were taken according to the IMR fish sampling manual (Mjanger *et al.*, 2008). Herring were examined for sex, maturity (8 point scale), fat, stomach content, vertebrae count and macroscopic evidence of *Ichthyophonus* infection. Otoliths were taken for age determination (number of winter rings).

2.7 Hydrographic data

A CTD station was taken at each trawl station. The general hydrographical situation was mapped during a specific survey early in July (survey RV G.M.Dannevig-2009307).

2.8 Acoustic data analysis

Data from the post-processing LSSS (sA) were averaged per 1 nm. The acoustic data were allocated to the following categories: herring, demersal fish, pelagic fish and plankton. To calculate integrator conversion factors the target strengths of the target species herring and sprat, 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 (e.g. frequency response – Korneliussen *et al.*, 2006). 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" (east of 2°E). No system for workable stock discrimination on individual herring during the survey is available. The proportions of Baltic spring spawners and North Sea autumn spawners by age were calculated by applying the formula

WBSS= ((56.5-VS (sample))/(56.5–55.8)) (ICES, 1999)

WBSS is the proportion of WBSS and VS(sample) is the mean vertebrae count of the sample. 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

The survey track, trawl hauls and CTD stations are presented in Figure 1.

3.1 Acoustic data

3.1.1 Herring

The distribution of sA-values assigned to herring, are presented as mean values (from 1 n.mi intervals) per ICES square in Figure 2. Herring were scattered distributed in the area in general low densities. The highest mean sA recorded by ICES rectangle was 175 (46F2) followed by sAs of 54 in 43F2 and 30 in 50F2. Pelagic trawling was mainly based on random positions regularly chosen for trawling at the surface, i.e. not based on echo registration (65%). In the "Norwegian area" herring tend to keep close to the surface and may thus be underestimated. Most of the schools were small and occurred scattered throughout the area, either close to the surface or near bottom.

Few “classical” herring schools were observed this year, neither near bottom nor higher up in the water column.

Norway pout occurred as dense aggregations and in great quantities over most of the area, contributing to a high level of confusion in allocation to species, i.e. herring or Norway pout, as they can be very similar also in frequency response (Fässler *et al.*, 2007).

3.1.2 Sprat

No sprat was observed by RV “Johan Hjort”. This is the same situation as has been seen the last years.

3.2 Biological data

A total of 34 valid trawl hauls were carried out, of which all (27 PT and 7 BT) were taken in the “herring” area (Figure 1, Table 2). In general 30 min hauls were made. Catch composition per haul is given in Table 3. Herring were present in 3 hauls of sample size >20 herring. The length distributions of herring are presented in Table 4. A total of 222 herring were length measured and 134 aged (winter rings in otoliths). No herring was observed to be infected by Ichthyophonus.

3.3 Abundance and Biomass estimates

3.4.1 Herring

The geographical distribution of the sA-values assigned to herring, are presented in Figure 2. It was generally low amounts of herring, but the highest values were encountered in the central area, between 57°N and 59N. Total number of herring was 441 million (about 10% of 2008 estimate) of which 37% was North Sea Autumn Spawners (NSAS).

Total biomass of **NSAS** was estimated to 32 100 tonnes and the spawning-stock biomass as 27 600 tonnes. These estimates are much lower than the respective biomasses from the Norwegian area last year: 239 000 t and 95 000 t, respectively, but this is probably partly a result of the reduced coverage in 2009. The proportions of mature 2- and 3-ringers by numbers were estimated at 100%, thus much higher than the proportions estimated in 2008: 54 and 99%, respectively. Of the estimated numbers of 1-ringers, 4% was classified as maturing (2008: 7%). The 1-ringers dominated the North Sea autumn spawners in numbers, making 34%, whereas only 14.8% of the biomass. In biomass, the 7+-group dominated with its 48%.

The total biomass of **WBSS** was 58 300 tonnes, a large reduction since last year (173 000 tonnes). This must however also be seen in the light of the reduced coverage of the Norwegian 2009 survey.

Few good acoustic marks of herring schools were observed and the majority of the trawling positions were 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.

Table 5 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 2009.

3.5 Hydrography

A total of 34 CTD stations were sampled (Figure 1).

The hydrographical data are part of a general monitoring program of IMR/ICES, and will be analysed and published separately.

4. References

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Table 5C.1. RV "Johan Hjort", survey 2009207. International acoustic survey on herring in the North Sea, 13–21 July 2009. Simrad ER60 and analysis settings used.

Transceiver Menu	**38 kHz**
Absorption coefficient (dB/km)	10.3 dB/km
Pulse duration (ms)	1.024 ms
Bandwidth (kHz)	2.43 kHz
Max power (W)	2000 W
Two-way beam angle (dB)	-20.6 dB
3 dB Beam width (deg) - along ship	6.91°
3 dB Beam width (deg) - athwart ship	6.83°
Calibration details	
TS of sphere	-34.3 dB
Range to sphere in calibration	20.1 m
TS transducer gain	26.92 dB
Sa correction	-0.59 dB
Log / Navigation Menu	
Speed	Serial from ship's GPS
Operation Menu	
Ping interval	1 s

Table 5C.2. RV "Johan Hjort", survey 2009207, 13–21 July 2009. Trawl stations in the North Sea. PT = Pelagic Trawl, BT = Bottom Trawl. H: herring sample (≥ 20 herring), h: herring present, but not a full biological sample. Gear code: 3270 = Campelen shrimp trawl with rock-hopper gear, 3513 = Harstad trawl without large floats, 3532 = Aakra trawl, 3533 = Aakra trawl with large floats. Type: 1 = random position at surface, 2 = trawling on acoustic registration.

Date	Trawl haul no	Type	Gear code	Lat	Long	ICES sq	Time (UTC)	Water depth (m)	Trawl depth, max (m)	Duration (min)	Herring	Total catch (kg)
20090714	BT245	2	3270	57.050	2.592	43F2	0715	71	72	5		106
20090714	PT246	2	3513	57.182	2.905	43F2	1327	68	35	29		2
20090714	PT247	1	3533	57.403	2.648	43F2	2103	78	0	30		56
20090715	PT248	1	3533	57.648	3.940	44F3	0221	75	0	32	H	96
20090715	BT249	2	3270	57.667	4.725	45F4	0637	82	83	18		88
20090715	PT250	1	3533	58.160	2.320	45F2	2141	74	0	30	h	900
20090716	PT251	1	3533	58.165	2.833	45F2	0021	73	0	32		411
20090716	BT252	2	3270	58.162	4.043	45F4	0530	122	123	25	h	323
20090716	BT253	2	3270	58.432	2.993	45F2	1745	107	109	12		46
20090716	PT254	1	3533	58.432	2.280	45F2	2104	86	0	33	h	609
20090716	PT255	1	3533	58.572	2.067	46F2	2344	89	0	34		601
20090717	PT256	2	3532	58.687	2.280	46F2	0211	100	80	37		28
20090717	BT257	2	3270	58.680	2.678	46F2	0450	108	108	26	H	600
20090717	PT258	2	3532	58.683	2.800	46F2	0711	115	60	30		63
20090717	BT259	2	3270	58.938	2.913	46F2	1048	125	130	37	h	1200
20090717	PT260	2	3532	59.202	2.083	47F2	1641	119	70	31		37
20090717	PT261	1	3533	59.183	2.223	47F2	1859	120	0	30	h	127
20090717	PT262	2	3513	59.187	2.765	47F2	2210	116	30	30	h	439
20090718	PT263	1	3533	59.195	3.327	47F3	0140	155	0	30	h	224
20090718	PT264	1	3533	59.423	3.888	47F3	0649	277	0	31		117
20090718	PT265	1	3533	59.815	2.938	48F2	1809	108	0	32	h	45
20090718	PT266	1	3533	59.932	2.293	48F2	2156	113	0	31		124
20090719	PT267	1	3533	60.093	2.688	49F2	0142	97	0	31	h	246
20090719	PT268	1	3533	60.205	3.893	49F3	0708	292	0	31		198
20090719	PT269	1	3533	60.430	3.123	49F3	1214	137	0	32	h	703
20090719	BT270	2	3270	60.688	2.827	50F2	1522	124	125	30		209
20090719	PT271	1	3533	60.933	2.352	50F2	2138	125	0	27	H	1000
20090720	PT272	1	3533	61.080	2.833	50F2	0118	289	0	30	h	678
20090720	PT273	1	3533	61.400	2.128	51F2	0701	292	0	27	h	74
20090720	PT274	1	3533	61.907	2.327	52F2	1150	379	0	31	h	802
20090720	PT275	1	3533	61.908	3.337	52F3	1614	379	0	31	h	4997
20090720	PT276	1	3533	61.718	3.858	52F3	1952	286	0	34		2982
20090720	PT277	1	3533	61.408	3.858	51F3	2323	362	0	31		300
20090721	PT278	1	3533	61.153	3.825	51F3	0220	347	0	32	h	501

Table 5C.3. RV "Johan Hjort" 13–21 July 2009. Catch composition in the trawl hauls (kg).

Species	Trawl haul no	BT245	PT246	PT247	PT248	BT249	PT250	PT251	BT252	BT253	PT254	PT255	PT256	BT257	PT258	BT259
	Serial no	24301	24302	24303	24304	24305	24306	24307	24308	24309	24310	24311	24312	24313	24314	24315
	ICES area	43F2	43F2	43F2	44F3	45F4	45F2	45F2	45F4	45F2	45F2	46F2	46F2	46F2	46F2	46F2
	Total catch (kg)	106.07	2.19	56.08	95.65	87.63	900.00	411.24	323.26	45.55	608.89	600.54	27.98	599.95	63.03	200.36
Herring	*Clupea harengus*				76.48		16.92		1.60		0.63			22.83		0.09
Mackerel	*Scomber scombrus*		2.19	55.40	10.20		883.08	350.00			600.00	600.00	20.00			0.41
Horse Mackerel	*Trachurus trachurus*															
Blue whithing	*Micromesistius poutassou*															
Saithe	*Pollachius virens*								5.73							8.43
Cod	*Gadus morhua*					13.32			5.10					14.70		5.53
Haddock	*Melanogrammus aeglefinus*	1.28			0.00	6.66			19.37	4.45				30.08		0.25
Whiting	*Merlangius merlangus*	4.89			0.01	0.84			5.63				2.58	22.75		3.06
Ling	*Molva molva*								1.27	0.35						
Pollack	*Pollachius pollachius*								3.63							
Hake	*Merluccius merluccius*								3.58	2.06				8.60		0.16
Norway pout	*Trisopterus esmarkii*	90.00				60.33			251.00	37.99			5.08	486.20		136.00
Poor cod	*Trisopterus minutus*								1.31							
Silvery pout	*Gadiculus argenteus*								0.85							
Dab	*Limanda limanda*	6.60				0.45										
Long rough dab	*Hippoglossoides platessoides*	3.30							11.60					5.00		9.76
Lemon sole	*Microstomus kitt*								1.87	0.04				1.55		
Megrim	*Lepidorhombus whiffiagonis*															
Grey gurnards	*Eutrigla gurnardus*				7.75	4.33		13.84			3.61	0.54	0.15	1.05		
E.Atlantic gurnards	*Triglidae*															
Argentine	*Argentina sphyraena*					0.18			0.06	0.03				7.20		
Greater argentine	*Argentina silus*															27.61
Lumpsucker	*Cyclopterus lumpus*			0.47				42.84							28.66	
Medusae	*Hydroida*				1.17	1.50		4.56	10.00	0.10	4.65		0.17		34.37	8.72
Other				0.21	0.04	0.02			0.67	0.53						0.36

Table 5C.3. RV "Johan Hjort" 13–21 July 2009. Continued.

Species	Trawl haul no	**PT260**	**PT261**	**PT262**	**PT263**	**PT264**	**PT265**	**PT266**	**PT267**	**PT268**	**PT269**	**BT270**	**PT271**	**PT272**	**PT273**	**PT274**
	Serial no	24316	24317	24318	24319	24320	24321	24322	24323	24324	24325	24326	24327	24328	24329	24330
	ICES area	47F2	47F2	47F2	47F3	47F3	48F2	48F2	49F2	49F3	49F3	50F2	50F2	50F2	51F2	52F2
	Total catch (kg)	37.30	127.28	438.60	224.12	117.36	45.04	123.19	246.19	198.46	702.91	208.77	999.96	676.89	74.11	802.30
Herring	*Clupea harengus*		2.92	0.59	0.29		0.37		1.99		2.52		116.30	1.88	5.73	2.30
Mackerel	*Scomber scombrus*		94.50	28.22	180.00	41.97	22.00	119.42	240.00	126.00	700.00	2.56	856.05	590.78	65.87	713.15
Horse Mackerel	*Trachurus trachurus*				0.98			1.26	2.91	4.04			13.88	81.09	2.00	84.00
Blue whithing	*Micromesistius poutassou*				4.33											
Saithe	*Pollachius virens*				8.53							47.54				
Cod	*Gadus morhua*															
Haddock	*Melanogrammus aeglefinus*	12.39				0.02	0.01							0.14	0.01	
Whiting	*Merlangius merlangus*			0.46												
Ling	*Molva molva*											1.20				
Pollack	*Pollachius pollachius*											2.50				
Hake	*Merluccius merluccius*			8.86												
Norway pout	*Trisopterus esmarkii*			400.00								150.00				
Poor cod	*Trisopterus minutus*															
Silvery pout	*Gadiculus argenteus*											0.17				
Dab	*Limanda limanda*											0.17				
Long rough dab	*Hippoglossoides platessoides*											0.43				
Lemon sole	*Microstomus kitt*											0.44				
Megrim	*Lepidorhombus whiffiagonis*											0.08				
Grey gurnards	*Eutrigla gurnardus*	0.88	1.27	0.48			0.94		1.28	0.26	0.39	2.55				
E.Atlantic gurnards	*Triglidae*							0.72								
Argentine	*Argentina sphyraena*											0.75				
Greater argentine	*Argentina silus*															
Lumpsucker	*Cyclopterus lumpus*	4.030	0.192			15.020	0.032			8.165				3		2.848
Medusae	*Hydroida*	20.00	28.40			60.00	20.00	1.78		60.00			13.73		0.50	
Other					30.00	0.35	1.70					0.40				

Table 5C.3. RV "Johan Hjort" 13–21 July 2009. Continued.

Species	Trawl haul no	PT275	PT276	PT277	PT278
	Serial no	24331	24332	24333	24334
	ICES area	52F3	52F3	51F3	51F3
	Total catch (kg)	4997.27	2982.26	300.09	500.97
Herring	*Clupea harengus*	0.37			0.97
Mackerel	*Scomber scombrus*	4860.00	2900.00	207.02	445.28
Horse Mackerel	*Trachurus trachurus*	136.00	72.00	53.18	22.55
Blue whithing	*Micromesistius poutassou*			6.46	
Saithe	*Pollachius virens*			9.45	
Cod	*Gadus morhua*				
Haddock	*Melanogrammus aeglefinus*				
Whiting	*Merlangius merlangus*				
Ling	*Molva molva*				
Pollack	*Pollachius pollachius*				
Hake	*Merluccius merluccius*				
Norway pout	*Trisopterus esmarkii*				
Poor cod	*Trisopterus minutus*				
Silvery pout	*Gadiculus argenteus*				
Dab	*Limanda limanda*				
Long rough dab	*Hippoglossoides platessoides*				
Lemon sole	*Microstomus kitt*				
Megrim	*Lepidorhombus whiffiagonis*				
Grey gurnards	*Eutrigla gurnardus*				
E.Atlantic gurnards	*Triglidae*				
Argentine	*Argentina sphyraena*				
Greater argentine	*Argentina silus*				
Lumpsucker	*Cyclopterus lumpus*	0.91	9.26		1.25
Medusae	*Hydroida*		1.00	18.89	30.92
Other				5.10	

Table 5C.4. RV "Johan Hjort" 13–21 July 2009. Herring length (cm) distribution in trawl hauls. The grey shades mark the samples that are merged and used for 57–58°N, 58–59.5°N and 59.5–62°N (from left side).

Trawl station	PT248	PT250	BT252	PT254	BT257	BT259	PT261	PT262	PT263	PT265	PT267	PT269	PT271	PT272	PT273	PT274	PT275	PT278
ICES sq	44F3	45F2	45F4	45F2	46F2	46F2	47F2	47F2	47F3	48F2	49F2	49F3	50F2	50F2	51F2	52F2	52F3	51F3
Length (cm)																		
15.0	1																	
15.5																		
16.0	1																	
16.5	2																	
17.0	1																	
17.5	3																	
18.0	6																	
18.5	8																	
19.0	8																	
19.5	7																	
20.0	11						1											
20.5	6																	
21.0	16				1													
21.5	4				1													
22.0	7				1	1												
22.5	5																	
23.0	1				1		1											
23.5	7	1			1		1											
24.0					1		2											
24.5		1			3		2											
25.0	3				1		3											
25.5	2			1			1											
26.0	1				3		1											
26.5				1	5		3											
27.0					1													
27.5							1											
28.0					5													
28.5			1		8		1					1						
29.0					8							1						
29.5					18													
30.0			1		8													
30.5					12				1				3		2			
31.0			2		2							1	5		2			1
31.5				1				1				1	6		8			
32.0			1		3					1			8	1	1			
32.5					1			1			4	1	27	2	2	1		1
33.0												1	20	1		1		
33.5											1	2	15	2	1	2		
34.0											1		5			1	1	
34.5												1	4		1			
35.0													3					
35.5													1			1		
36.0													3					1
36.5																1		
37.0																		
Grand total	100	2	5	3	84	1	17	2	1	1	6	9	100	6	17	6	1	3
Mean length	20.7	24.3	30.8	28.1	28.8	22.3	25.3	32.3	30.8	32.3	33.2	32.1	33.1	33.1	32.0	34.3	34.3	33.6
Mean weight	87.7	141.0	319.4	211.3	271.8	92.0	171.6	293.5	289.0	366.0	331.8	280.1	330.5	313.3	337.3	328.4	365.0	322.7

Table 5C.5. RV "Johan Hjort" 13–21 July 2009. 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.

			North Sea Autmn Spawners				Western Baltic Spring Spawners			
Age	L_{mean}	W_{mean}	No (mill)	%	Biom (10^3)	%	No (mill)	%	Biom (10^3)	%
1I	20.4	82.8	53.9	32.7	4.5	14.0	62.6	22.7	5.1	8.8
1M	22.3	108.0	2.4	1.5	0.3	0.8	3.1	1.1	0.3	0.6
2I	24.0	111.0	0.0	0.0	0.0	0.0	3.6	1.3	0.4	0.7
2M	24.9	167.8	32.9	20.0	4.2	13.1	82.1	29.7	15.1	25.9
3I	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3M	27.4	232.8	10.2	6.2	2.4	7.4	7.6	2.8	1.8	3.1
4I	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4M	30.0	299.0	1.4	0.9	0.4	1.3	5.7	2.1	1.7	2.9
5I	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5M	30.2	275.1	6.5	3.9	1.8	5.7	14.3	5.2	3.9	6.7
6I	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6M	29.8	296.4	10.0	6.1	3.0	9.4	31.4	11.4	9.3	15.9
7I	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7M	31.1	319.8	12.2	7.4	4.0	12.4	20.0	7.2	6.3	10.8
8	30.2	314.5	17.6	10.7	5.7	17.6	31.4	11.4	9.7	16.7
9+	31.8	329.7	17.6	10.7	5.9	18.2	14.3	5.2	4.7	8.0
Total	26.1	205.1	164.8	100.0	32.1	100.0	276.1	100.0	58.3	100.0
Immature	20.5	83.7	53.9	32.7	4.5	14.0	66.2	24.0	5.5	9.5
Mature	28.2	250.6	110.9	67.3	27.6	86.0	209.9	76.0	52.8	90.5

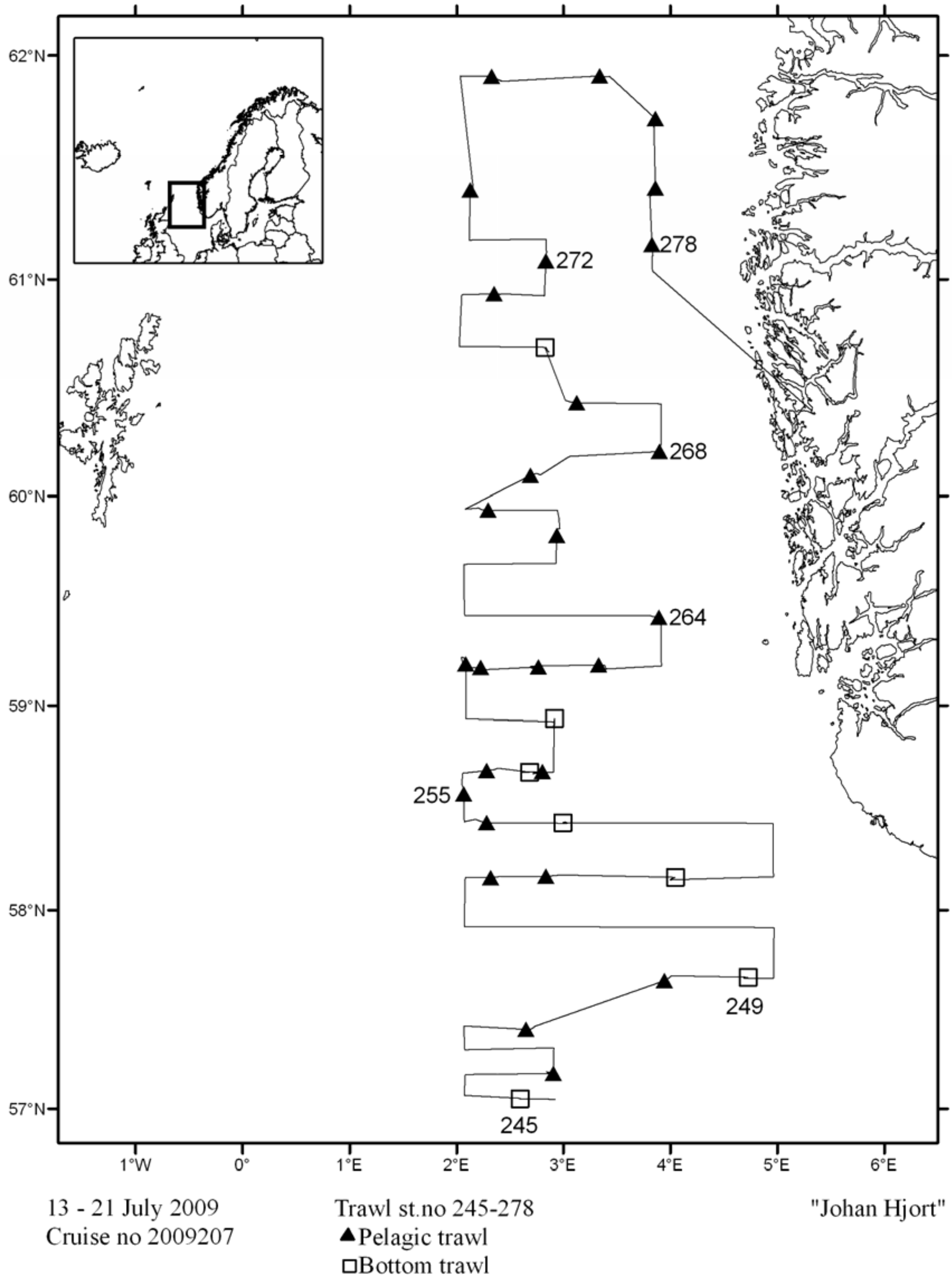

Figure 5C.1. RV "Johan Hjort" 13–21 July 2009. Cruise track and fishing trawl hauls. CTD stations were taken at each trawl haul.

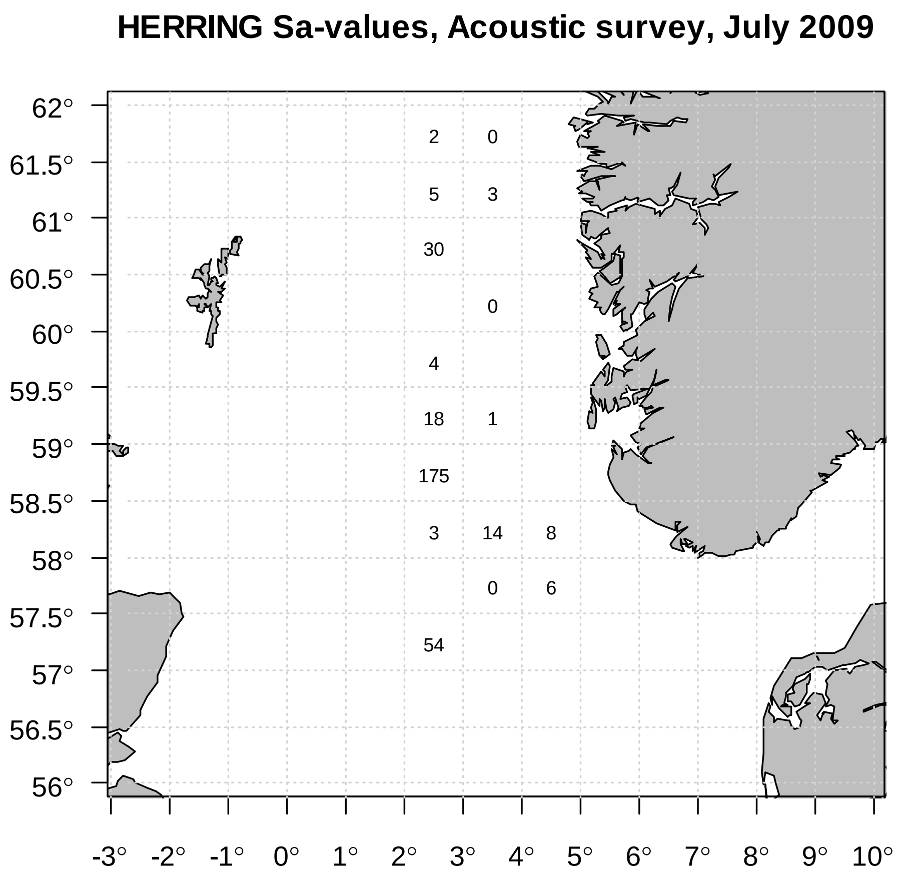

Figure 5C.2. RV "Johan Hjort" 13–21 July 2009. Mean values per ICES square of sA (NASC) values attributed to herring per 1 nautical mile along the cruise track.

ANNEX 5D: Scotland (East)

Survey report for RV Scotia

28 June – 16 July 2009

P. J. Copland, 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 Div IV) from the 28 June to 16 July 2009 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 2010. This survey is part of a continuous series carried out by the Marine Laboratory annually since 1984.

Objectives

1) To conduct an acoustic survey to estimate the abundance and distribution of herring in the northwestern North Sea and north of Scotland between 58º 30'N - 62°N and 4ºW to 2ºE, excluding Faroese waters.
2) To obtain biological samples for 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 to map the distribution and abundance of zooplankton.
6) To investigate distribution of hake by opportunistic trawling between 2200 and 0200.

2. SURVEY DESCRIPTION AND METHODS

2.1 Personnel

Phil Copland	(In Charge)
Stephen Keltz	Fisheries Biologist
Owen Goudie	Fisheries Biologist
Rui Catarino	Fisheries Biologist
John Stewart	Observer, Scottish Pelagic Fishermans Association
Fiona McIntyre	Student, Aberdeen University
Jim Hunter	Oceanographic Technician (Part 1)
Charlotte Main	Fisheries Biologist (Part 1)
Bruce McIver	Fisheries Biologist (Part 1)

Paul Fernandes	Fisheries Biologist (Part 2)
Chris Hall	Oceanographic Technician (Part 2)
Darius Kaminski	Fisheries Biologist (Part 2)

2.2 Narrative

All gear was loaded in Aberdeen between 24 and 26 June. Scotia departed at 0900 on 28 June. A short meeting was held with all scientists to explain the objectives of the survey, to describe general operating procedures and discuss risk assessments for tasks. Deployments of the PT160 pelagic trawl with multicodend sampler and the OCEAN sampler were conducted en route to Scapa Flow to familiarise staff with the handling of the equipment.

Calibration of the hull mounted transducers took place in Scapa Flow between 2330 on 28 June and 0600 on 29 June. "Scotia" then made her way to east of the Pentland Firth to the first survey transect beginning the survey at 1000. Transects extended as far east as 1° 45E, and as far as safely possible to the west, on approaching the coast. A large haul of herring, estimated at 2 tonnes, caused the loss of one of the multisampler codends on 1 July as it was being recovered aboard.

A half landing took place on 6 July in Lerwick in accordance with the rest provision for the Working Time Directive and to allow for the exchange of personnel (Jim Hunter, Bruce McIver and Charlotte Main left and Paul Fernandes, Chris Hall and Darius Kaminski joined the vessel). The Scotia crew fabricated another codend for the multi sampler during the half landing using material on board and netting sent from Aberdeen. They also added strengthening lines to each codend to avoid a repetition of the net failure. The damage to the multisampler codend led to a more restricted use of the system for the remainder of the cruise in areas where it was noted that large shoals might be encountered.

Scotia resumed surveying at 1000 on 7 July. Time was lost due to poor weather on the 9 July when a strong Northerly gale forced Scotia to heave to for approx 10 hours until the gale had subsided. Recurring problems with both netsonde systems and the starboard netsonde winch caused the loss of a small amount of time during the cruise but repairs to both systems proved effective and they worked well for the remainder of the trip.

The survey was completed on 15 July at around 0920. A second calibration was carried out in Scapa Flow on 15 July, which confirmed the first calibration results for the transducers. Scotia returned to Aberdeen on the morning of 16 July.

2.3 Survey design

The survey track (Fig IID.1) was selected to cover the area with three 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. In the extreme South East corner of the survey area, short additional transects were carried out at 7.5 nautical miles spacing. Due to lack of allocated survey time the 7.5 nautical mile transects normally undertaken to the East of Shetland could not be accommodated. On the administrative boundaries of 2°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 were then included in the data analysis. Transects at the shelf break were continued to the limits of the 300 m contour and the transect ends omitted from the analysis. Transects at the coast were continued as close inshore as practical, those which were on average less than half a transect spacing from the coast were excluded from the analysis, those at a greater distance were included in the analysis. The origin of the survey grid was selected randomly within a sampling interval; the track was then laid out with systematic spacing from the random origin. Where a 7.5nm transect spacing was used the same random origin was used (as a proportion of the inter-transect space).

2.4 Calibration

Two calibrations were carried out of the EK60 echosounder system used during the survey: one at the beginning of the survey on 28 and 29 June (overnight) and one at the end of the survey on 15 July, both in Scapa Flow. Standard sphere calibrations were carried out using 38.1mm diameter tungsten carbide sphere for 18, 38, 120 and 200 kHz. Agreement between the calibrations for 38 kHz was approximately 0.40 dB. The calibration settings and results for 38 kHz are given in Table IID.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 8.5 m depth. Data was archived for further data analysis which was carried out using Sonardata Echoview software and Marine Lab Analysis (MILAP) systems during and after the cruise. Data were collected from 0200 to 2200 GMT. A total of approximately 870 EDSU and 2030 nautical mile of acoustic survey track were included in the analysis.

2.6 Biological data - fishing trawls

A total of 37 trawl hauls (positions shown in Fig IID.1) were carried out during the survey on the denser echotraces. Seven of these were tows, between 22:00 and 02:00, targeting hake but these proved largely unsuccessful with only one hake being caught. Only 12 hauls generated hauls of more than 30 herring. A number of trawls were directed at aggregations which proved to be juvenile gadoids, Norway Pout and euphausids. The fishing gear used throughout the survey was the PT160 pelagic trawl augmented by the addition of a three codend version of the same trawl. Each haul was monitored using a Simrad FS903 scanning netsonde. 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 0.5 cm class from 21–25.5 cm 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 were collected throughout the survey using the ships thermosalinograph. At each trawl station, salinity and temperature were taken with a Seabird 19plus Conductivity, Temperature, Depth (CTD) recorder, mounted in an OCEAN sampler. Integrated whole water column plankton samples, as filtered by a 200 micron net, were also collected at each hydrographic station. A total of 31 deployments of the OCEAN sampler vehicle were taken to provide at least one set of samples in each statistical rectangle that was surveyed.

2.8 Data analysis

Data from the echo integrator were averaged over quarter hour **E**quivalent **D**istance **S**ampling **U**nits (EDSU of approximately 2.5 nautical miles at 10 knots). Echo integrator data were 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 multifrequency thresholding method described in earlier reports was used to isolate echotraces of fish schools (with swimbladders) from other targets. These fish schools were then detected using the Shapes algorithm contained in Echoview and finally identified according to the five categories defined below by trawling and examination of school shape, echo intensity and the dB difference at 18, 38, 120 and 200 kHz:

1) Definitely herring traces,
2) Probably herring traces
3) Possible herring traces
4) Surface Herring
5) Herring / Norway pout Mixture

"Definitely herring" echotraces were identified on the basis of captures of herring from the fishing trawls which had sampled the echotraces directly, and/or as echotraces which had the typical characteristics of "definite" herring traces (very high intensity, narrow, inverted tear-shaped echotraces, either directly on the bottom or in midwater, with a dB difference profile typical of fish with swimbladders).

"Probably herring" were attributed to medium sized or small echotraces which had the physical and acoustic characteristics of "definite" herring traces, but had not been directly fished on.

"Possibly herring" were attributed to echotraces which had some characteristics of herring schools but were not typical due either to the location or depth, and/or because they were present in areas where only other fish had been caught and their dB difference profile was atypical of herring schools.

"Surface Herring" were attributed to echotraces encountered near the surface which had the dB difference profile of "definite" herring traces. These could not be fished on due to the limitations of the fishing gear.

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

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

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

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

Data were allocated to quarter statistical rectangles by their midpoint location. An analysis was carried out in the national calculation programme (MILAP) at quarter rectangle resolution. Estimates of density were obtained as the arithmetic mean of all values weighted by the distance covered in the EDSU to accommodate the shorter

EDSUs. Biological information was used in the post-stratified method based on a Kolmogorov Smirnov test (see MacLennan and Simmonds 2005 pg 341).

3. RESULTS

3.1 Acoustic data

The distribution of NASC values along the cruise track is shown in Figure IID.2. The distribution of fish differed little from 2008, with most herring schools again being detected in the South East of the survey area. Very little was detected at the Northern extremes and little too was detected West of Shetland. There continue to be were very few inshore traces to the East of Shetland which had been a feature in surveys prior to 2008. Some herring schools were of the typical tall pillar shape, but many were detected as smaller schools very close to the seabed. Surface schools were detected in larger numbers than had previously seen. Overall NASC values were larger but did not differ significantly from the previous year with only a few values exceeding 10000 m^2.nautical $mile^{-2}$ (in 2008 the maximum NASC was 7000 m^2.nautical $mile^{-2}$).

3.2 Biological data

Fishing was generally successful and 37 trawl hauls were carried out (Figure IID.1). The positions, dates and time of these are given in Table IID.2. In addition to length frequency data, a total of 2825 herring were sampled for weight, sex, maturity and otoliths; a subset of these were sampled for fat content. The 12 hauls with significant numbers of herring were used to define five survey subareas (Figure IID.3):

I/ SOU	Area in South East bounded by 0.5° W - 3° E and 58° 30′- 58°45′ N. Mean length 27.07cm
II/MID	Central area encompassing East of Orkney and East of Shetland to 60° 30′N. Mean length 28.45cm
III/WST	Western Area to West of Orkney to 60° N. Mean length 28.84cm
IV/NWS	Northern area to North and West of Shetland. Mean length 30.18cm
V/NEA	Northern area to North and East of Shetland. Mean length 31.63cm

Table IID.3 shows the total catch by species. The length frequency distributions, mean lengths, weights and target strengths for each haul and for each subarea are shown in Table IID.4. The spatial distribution of mean length is shown in Figure IID.3. Five age length keys, one per area, were constructed. The stratified weight at length data were used to define a single weight-length relationship for herring for the survey area, which was:

$$W = 0.0052\, L^{3.1924}$$

where:

W = weight (g)

L = length (cm to greater 0.5 cm)

The proportions of 2, 3 and 4 ring herring that were mature were estimated at 82.8, 99.65 and 100% respectively.

(Attention should be brought to two fish which were classified as immature although they were aged at 7 and 10 years respectively. Classification of such fish for statistical purposes remains an area of some concern as to whether they are to be considered as part of the spawning-stock biomass when they were incapable of spawning at that time)

In areas where Herring/Pout mixtures were found the stratified weight at length data were used to define the weight-length relationship for Norway Pout, which was:

$$W = 0.00521\ L^{3.149}$$

where:

W = weight (g)

L = length (real)

3.3 Biomass and Abundance estimates

The total biomass estimates for the survey were:

Total herring	1,514,084 tonnes	
Spawning stock biomass	1,483,835 tonnes	98.0%
Immature	30,249 tonnes	2%

The numbers and biomass of fish by quarter ICES statistical rectangle are shown in Figure IID.4. A total estimate of 6,342 million herring or 1.514 million tonnes was calculated for the survey area; 1.48 million tonnes of these were mature. Table IID.6 shows the estimated herring numbers mean lengths, weights, biomass, and proportion mature at-age and year class.

The proportions, by weight, for fish as scrutinised were:

Definitely herring	48.4%
Probably herring	31.5%
Possibly herring	5.4%
Surface herring	13.1%
Mixture	1.6%

In addition to herring, a variety of other fish species were caught, although examination of the catch by species (Table IID.3) shows that, aside from herring, the numbers caught were very small. The dominant species, by numbers, after herring were Norway pout, followed by mackerel and grey gurnard. 6 hake were caught during the survey. No cod were caught as a bycatch in any of the hauls.

3.4 Ichthyophonus Infection

Two of the 2825 fish examined for macroscopic evidence of ichthyophonus were found to be infected.

Multisampler codend

The multisampler worked well throughout the survey with only occasional glitches. The faults generally created uncertainty in whether the bars had been deployed successfully. Almost invariably the release mechanism had been found to have worked on recovery of the gear. However, the net design of the sampler proved inadequate to recover the catch on two occasions. The netting was incapable of taking loads of around 3 tonnes on both occasions and the samples were either lost completely or only a small amount retained. Strengthening panels and selvedges will be fitted to the sampler codends before the 2010 survey and the design will incorporate a weak area of netting to retain some catch while mitigating damage to the sampler by allowing excessive loads to slip.

Table 5D.1. Simrad EK60 and analysis settings and calibration results from the Scotia herring acoustic survey 28 June - 16 July 2009.

Transceiver Parameters		
Frequency	38 kHz	
Sound speed	1500 m.s^{-1}	
Max. Power	2000 W	
Equivalent two-way beam angle	-20.9 dB	
Default Transducer Sv gain	23.95 dB	
3 dB Beamwidth	7.1°	
Calibration details		
	28 June 2009	**15 July 2009**
TS of sphere	-42.33 dB	-42.33
Range to sphere in calibration	12.648 m	13.36
Measured NASC value for calibration	1985	2046
Calibrated Sv gain	23.24*	23.64
Calibration constant for MILAP (optional)	1.1005 at -35 dB	
EDSU		
Echoview integration cell size	15 minutes (approx 2.5 nautical mile at 10 knots)	
Operation		
Ping interval	1 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	

*** an average of 23.44 dB was used for the analysis of the survey.**

Table 5D.2. Details of the fishing trawls taken during the Scotia herring acoustic survey, 28 June - 16 July 2008: No. = trawl number; Trawl depth = depth (m) of headrope; Gear type PT160 = pelagic trawl + MS = multisampler; Duration of trawl (minutes); Use H =used to qualify herring acoustic data (blank if not); Total catch in kg.

Haul No.	Date	Time (UTC)	Position Mid Point	Water depth	Trawl Depth	Gear	Duration	Use	Weight
202 C1	29/06/2009	1216	58°38.52 N, 2°10.32W	81	81	PT 160 + MS	20		0
203 C1	29/06/2009	1513	58°38.51 N, 1°49.41W	94	87	PT 160 + MS	25		103
204 C1	29/06/2009	2145	58°38.68 N, 1°15.01W	109	100	PT 160 + MS	30		0
205 C1	30/06/2009	0638	58°34.32 N, 0°17.77W	138	129	PT 160 + MS	22		1
206 C2	30/06/2009	0829	58°34.33 N, 0°12.48W	140	123	PT 160 + MS	38		88
207 C1	30/06/2009	1719	58°41.79 N, 0°10.49E	152	131	PT 160 + MS	29		0
208 C1	30/06/2009	1953	58°41.52 N, 0°10.36W	133	119	PT 160 + MS	19	H	69
209 C1	30/06/2009	2309	58°42.21 N, 0°26.9W	128	100	PT 160 + MS	30		2
210 C1	01/07/2009	0617	58°48.87 N, 0°26.53W	124	115	PT 160 + MS	45	H	89
211 C1	01/07/2009	1032	58°49.37 N, 0°18.17E	132	116	PT 160 + MS	15		Net burst
212 C1	01/07/2009	2223	58°53.48 N, 0°55.78E	130	121	PT 160 + MS	30		2
213	02/07/2009	0516	58°56.88 N, 0°22.22E	153	129	PT 160	27	H	7000
214	02/07/2009	0908	58°56.51 N, 0°12.57W	127	118	PT 160	37	H	7000
215	02/07/2009	1421	58°53.06 N, 1°14.36W	113	104	PT 160	36		0
216	02/07/2009	2121	59°3.61 N, 2°21.3W	75	66	PT 160	30		0
217	03/07/2009	0706	59°8.57 N, 0°49.53W	137	128	PT 160	31		0
218	03/07/2009	1234	59°8.65 N, 0°19.63E	135	126	PT 160	39		0
219	03/07/2009	1446	59°8.62 N, 0°31.84E	132	126	PT 160	30	H	2000
220	03/07/2009	2255	59°23.62 N, 1°29.04E	113	94	PT 160	30		7
221	04/07/2009	0555	59°23.62 N, 0°25.2E	140	122	PT 160	34	H	3000
222	04/07/2009	0939	59°24 N, 0°13.51W	140	128	PT 160	49	H	387
223	04/07/2009	2234	59°38.43 N, 0°2.69W	130	121	PT 160	30		1
224	05/07/2009	0400	59°38.7 N, 0°4.15W	140	118	PT 160	60	H	34
225	05/07/2009	1734	59°53.52 N, 0°16.35E	133	124	PT 160	38		69
226	05/07/2009	2054	59°53.36 N, 0°16.06W	118	109	PT 160	48	H	16
227	07/07/2009	2222	60°25.34 N, 1°18.53E	137	113	PT 160	30		5
228 C1	08/07/2009	0800	60°25.18 N, 0°3.16E	147	118	PT 160 + MS	38		17
229	08/07/2009	1647	60°23.41 N, 0°39.52W	97	81	PT 160	20		30
230 C1	10/07/2009	1241	60°53.5 N, 0°18.55W	140	128	PT 160 + MS	55	H	10
231 C1	10/07/2009	1715	61°3.61 N, 0°45.21W	150	136	PT 160 + MS	33		5
231 C2	10/07/2009	1715	61°3.61 N, 0°45.21W	150	136	PT 160 + MS	33		5
232 C1	11/07/2009	1620	61°23.59 N, 0°11.44E	174	154	PT 160 + MS	11		0
233 C1	12/07/2009	1258	60°23.58 N, 1°50.04W	113	76	PT 160 + MS	32		16
234 C1	12/07/2009	1419	60°23.63 N, 1°53.78W	88	82	PT 160 + MS	46		180
234 C2	12/07/2009	1419	60°23.63 N, 1°53.78W	88	82	PT 160 + MS	46	H	400
235	13/07/2009	0744	60°10.83 N, 2°16.8W	100	92	PT 160	44		45
236 C1	13/07/2009	1656	59°53.42 N, 2°31.92W	82	73	PT 160 + MS	31		0
237 C1	14/07/2009	1735	59°23.8 N, 3°44.84W	146	124	PT 160 + MS	49	H	20
237 C2	14/07/2009	1735	59°23.8 N, 3°44.84W	146	103	PT 160 + MS	49		15
238	15/07/2009	0529	58°54.46 N, 3°55.19W	90	81	PT 160 + MS	22		0

Haul No.	Date	Time (UTC)	Position Mid Point	Water depth	Trawl Depth	Gear	Duration	Use	Weight
Hake tows shown in grey.									

Table 5D.3a. Total catch by species for trawl hauls from the Scotia acoustic survey 28 June - 16 July 2009.

Estimated total catch is given in kg and numbers by individual species

	Est catch (Kgs)	Herring	Mackerel	Horse Mackerel	Saithe	Blue Whiting	Haddock	Whiting	Grey gurnard	Hake	N.Pout
		Clupea harengus	*Scomber scombrus*	*Trachurus trachurus*	*Pollachius virens*	*M. Poutassou*	*Melanogrammus aeglefinus*	*Merlangius merlangus*	*Eutrigla gurnardus*	*Merluccius merluccius*	*Trisopterus esmarki*
202 C1	0										
203 C1	103.4						158	21	808		
204 C1	0										
205 C1	0.8										21
206 C2	88.0	1						1			3031
207 C1	0.3	2					2	1			
208 C1	69.2	356									
209 C1	1.8	N/A									
210 C1	89	843				1					7
211 C1	Net burst >3000										
212 C1	1.6						1	1			
213	7000.0	28557									
214	7000.0	31088									317
215	0.0										
216	0.3								4		
217	0.0										
218	0.1										
219	2000	8339						1			9712
220	6.8						5.4KG	1.4KG			
221	3000	12786									
222	386.8	1523	23		1		5	3			1421
223	0.8							1			
224	33.6	93									
225	69.2	3					1	3		3	2450
226	16.1	47					10	2		2	72
227	4.6									1	
228	17.31				1			1			
229	30		15								850
230 C1	10	32									
231 C1	4.8										
231 C2	5.4										
232 C1	0										
233 C1	16.4		2								5056
234 C1	180		865								
234 C2	400	1417									

	Est catch (Kgs)	Herring	Mackerel	Horse Mackerel	Saithe	Blue Whiting	Haddock	Whiting	Grey gurnard	Hake	N.Pout
		Clupea harengus	*Scomber scombrus*	*Trachurus trachurus*	*Pollachius virens*	*M. Poutassou*	*Melanogrammus aeglefinus*	*Merlangius merlangus*	*Eutrigla gurnardus*	*Merluccius merluccius*	*Trisopterus esmarki*
235	45.38	2	175						1		
236 C1	0										
237 C1	20	40	4					37	1		3
237 C2	15.2		62						2		
238 C1	0										
Totals	20616	85129	1146	0	2	1	177	72	816	6	22940

Hake tows in grey	Catch not measured

Table 5D.4a. Herring length frequency percentage for individual trawl hauls by subarea (Figure IID.3) for the *Scotia* acoustic survey (28 June - 16 July 2009) length in cm, weight in g, calculated target strength in dB per individual using TS=-71.2+20log(L).

REGION	I/SOU				II/MID				
Length (cm)	208	210	213	214	219	221	222	224	226	mean
21.5	0.00				0.00			0.01		0.00
22.0	0.01				0.01		0.00	0.01		0.00
22.5	0.01				0.01		0.00	0.00		0.00
23.0	0.01				0.00		0.00	0.00		0.00
23.5	0.01				0.02	0.00	0.00	0.01		0.00
24.0	0.01	0.00	0.00		0.03	0.01	0.00	0.03		0.01
24.5	0.04	0.00	0.00		0.05	0.01	0.00	0.03		0.01
25.0	0.10	0.01	0.01	0.01	0.05	0.01	0.02	0.02	0.02	0.02
25.5	0.10	0.03	0.01	0.02	0.05	0.02	0.01	0.03	0.00	0.02
26.0	0.09	0.05	0.01	0.01	0.05	0.01	0.04	0.04	0.02	0.02
26.5	0.14	0.09	0.03	0.09	0.07	0.03	0.08	0.02	0.17	0.06
27.0	0.15	0.14	0.08	0.15	0.07	0.04	0.14	0.02	0.00	0.10
27.5	0.15	0.23	0.17	0.26	0.10	0.15	0.21	0.14	0.15	0.19
28.0	0.10	0.21	0.17	0.22	0.13	0.17	0.19	0.22	0.15	0.19
28.5	0.05	0.11	0.19	0.12	0.13	0.17	0.15	0.14	0.19	0.15
29.0	0.03	0.06	0.12	0.07	0.11	0.16	0.08	0.05	0.11	0.11
29.5	0.01	0.02	0.09	0.04	0.07	0.13	0.03	0.13	0.11	0.07
30.0	0.00	0.02	0.05	0.01	0.02	0.04	0.02	0.02	0.02	0.03
30.5	0.00	0.00	0.02	0.01	0.01	0.02	0.01	0.04	0.02	0.01
31.0	0.00	0.00	0.02	0.00	0.01	0.01	0.00	0.01	0.02	0.01
31.5	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
32.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
33.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Number	356	843	28557	31088	8341	12784	1523	93	47	
mean length	27.07	28.09	28.79	28.22	27.75	28.78	28.15	28.27	28.67	28.45
mean weight	196.04	219.68	238.03	222.68	213.81	238.04	221.44	226.61	235.22	229.37
TS/individual	-42.54	-42.22	-42.01	-42.19	-42.31	-42.01	-42.20	-42.15	-42.04	-42.11

Table 5D.4a continued. Herring length frequency percentage for individual trawl hauls by subarea (Figure IID.3) for the *Scotia* acoustic survey (28 June - 16 July 2009) length in cm, weight in g, calculated target strength in dB per individual using TS=-71.2+20log(L).

REGION	III/WST	IV/NWS	V/NEA
Length (cm)	237	234	230
21.5			
22.0			
22.5			
23.0			
23.5			
24.0			
24.5			
25.0	0.03		
25.5	0.03		
26.0	0.05		
26.5	0.05		
27.0	0.08	0.00	
27.5	0.15	0.02	
28.0	0.13	0.04	0.03
28.5	0.03	0.11	0.03
29.0	0.18	0.15	0.09
29.5	0.15	0.24	0.00
30.0	0.10	0.18	0.06
30.5	0.03	0.12	0.13
31.0	0.00	0.05	0.13
31.5	0.00	0.04	0.16
32.0	0.00	0.02	0.16
32.5	0.00	0.01	0.16
33.0	0.03	0.00	0.03
33.5	0.00	0.00	0.03
Number	40.00	1417	32
mean length	28.84	30.18	31.63
mean weight	240.19	275.99	321.21
TS/individual	-41.99	-41.60	-41.19

Table 5D.5. FRV "Scotia" 28 June - 16 July 2009. Numbers of herring otolith at length and at-age, lengths in cm measured to the nearest 0.5 cm below, ages in winter rings (wr).

	Age Class											
Length(cm)	1I	2I	2M	3I	3M	4	5	6	7	8	9+	Total
21.5	3											3
22	4	2										6
22.5	6	1	1		1							9
23	2	3										5
23.5	4	8										12
24	3	14	4									21
24.5		11	5	1								17
25		13	19		1							33
25.5		8	25	1	1	1						36
26		3	25		4	2	2	1	1			38
26.5		1	24		8	4	4	3				44
27			9		16	6	6	2		6		45
27.5			4		25	4	7	5	3	9		57
28			5		27	9	18	13	4	22	5	103
28.5			3		32	18	8	10	8	22		101
29			1		19	10	18	10	13	20	9	100
29.5					5	23	10	5	17	21	9	90
30						6	5	7	12	25	12	67
30.5					1	2	8	4	11	11	11	48
31						4		1	7	7	10	29
31.5							2		5	5	9	21
32							1		3		8	12
32.5								2	2		5	9
33								2	1	1		4
33.5										1		1
Total	22	64	125	2	140	89	89	65	87	150	78	911

Table 5D.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 - 16 July 2009 herring acoustic survey. I= immature; M=mature; A=All.

Year	Age	Mean Length (cm)	Mean Weight (gm)	Numbers (10^6)	Biomass (Kt)
2007	1A	22.8	120.8	32	3.9
2006	2I	24.7	154	159	24.5
2006	2M	26.3	190	765	145.2
2005	3I	25.1	163	5	0.8
2005	3M	27.8	224	1348	301.5
2004	4	28.7	248	729	180.9
2003	5	28.3	239	728	173.9
2002	6	28.6	248	517	128.1
2001	7M	29.5	273	527	143.8
2000	8	28.8	251	1003	252.0
1999	9+	30.5	300.9	527	158.5
			Total	6342 *	1514 *
			SSB	6143 *	1484 *
			Immature	199	30

*** NB. Two "immature" fish were found at-age's 7 years and 10 years. These have not been included in this table. This would add 4.0 (10^6) to numbers and 1.2(Kt) to Biomass**

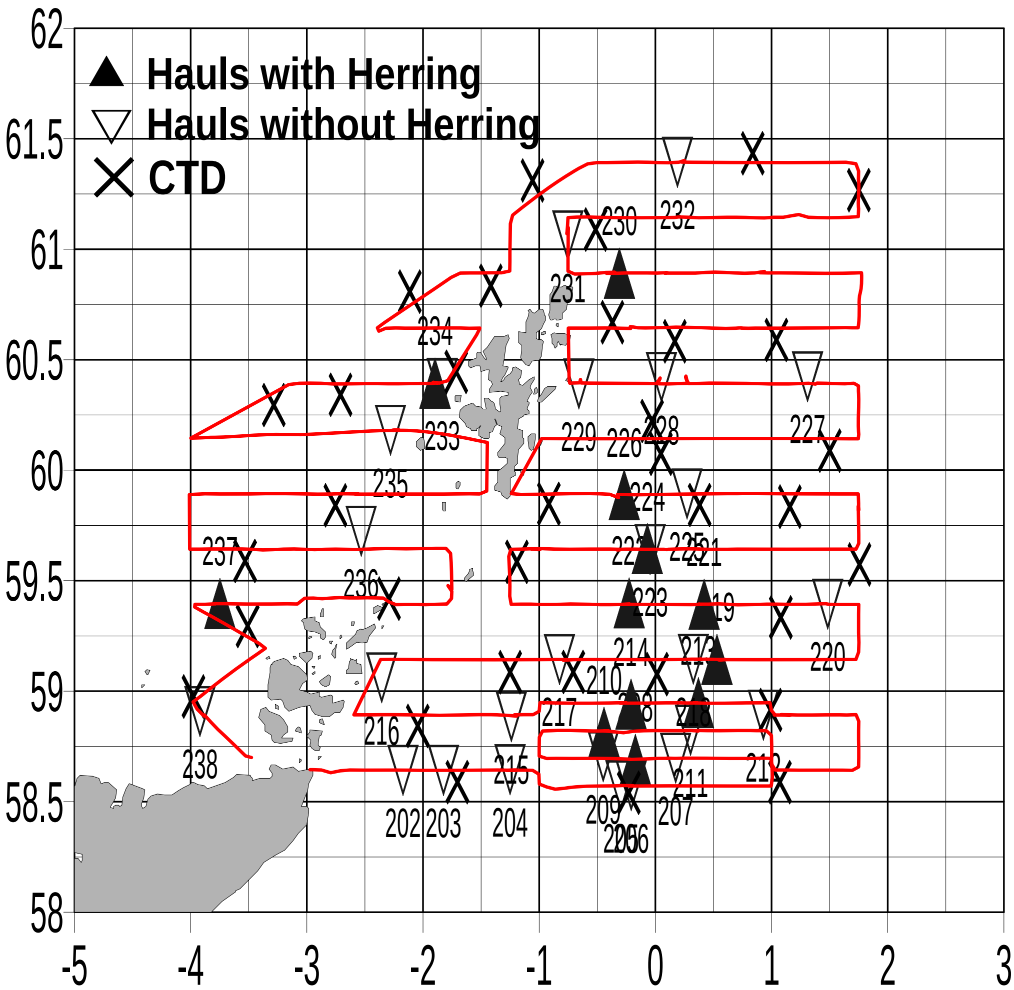

Figure 5D.1. Map of the North Sea showing the cruise track (solid lines) of FRV "Scotia" for the acoustic survey 28 June - 16 July 2009 indicating the location of trawl and CTD stations (symbols defined in legend).

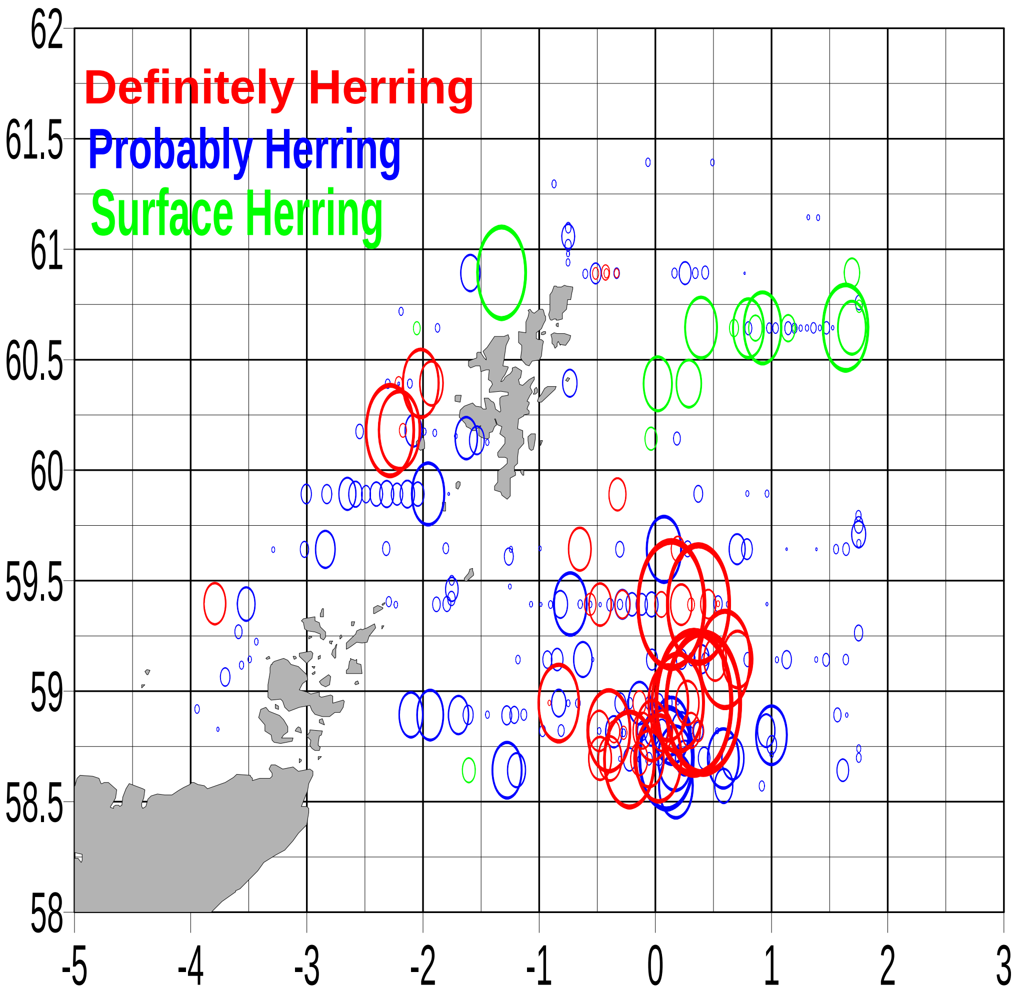

Figure 5D.2. Map of the North Sea showing the distribution of NASC values attributed to herring from the herring acoustic survey on FRV "Scotia" for 28 June - 16 July 2009. NASC values proportional to circle area (max = 11,362).

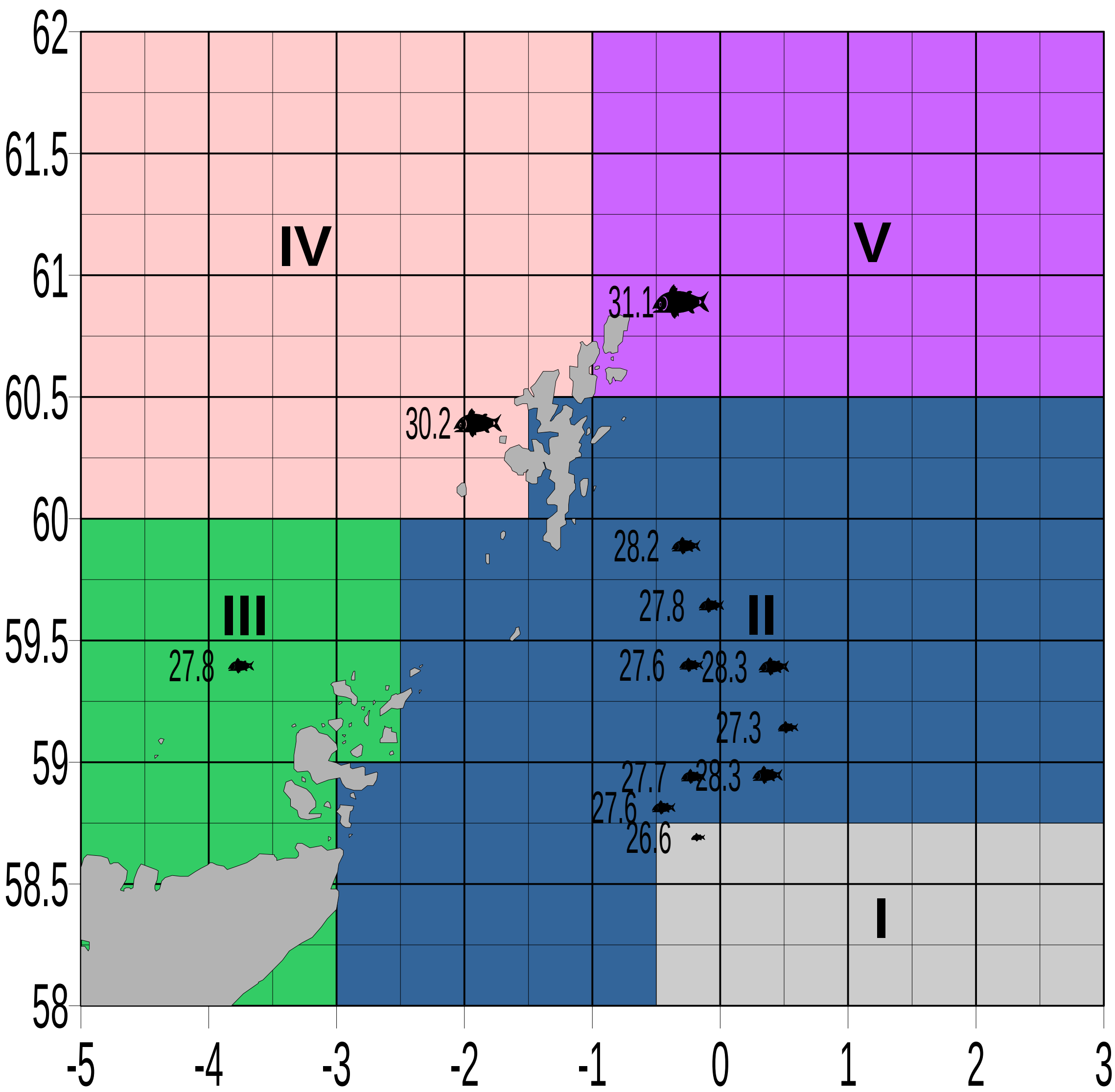

Figure 5D.3. Map of the North Sea showing the mean length of herring from pelagic trawl catches from FRV "Scotia" for 29 June - 16 July 2009 trawl station numbers are given in Figure IID.1 and details in Tables IID.1 and IID.2. The five analysis areas are shaded and numbered with roman numerals (I-V) and the length distributions, mean lengths, weights and target strengths are given by area in Table IID.4.

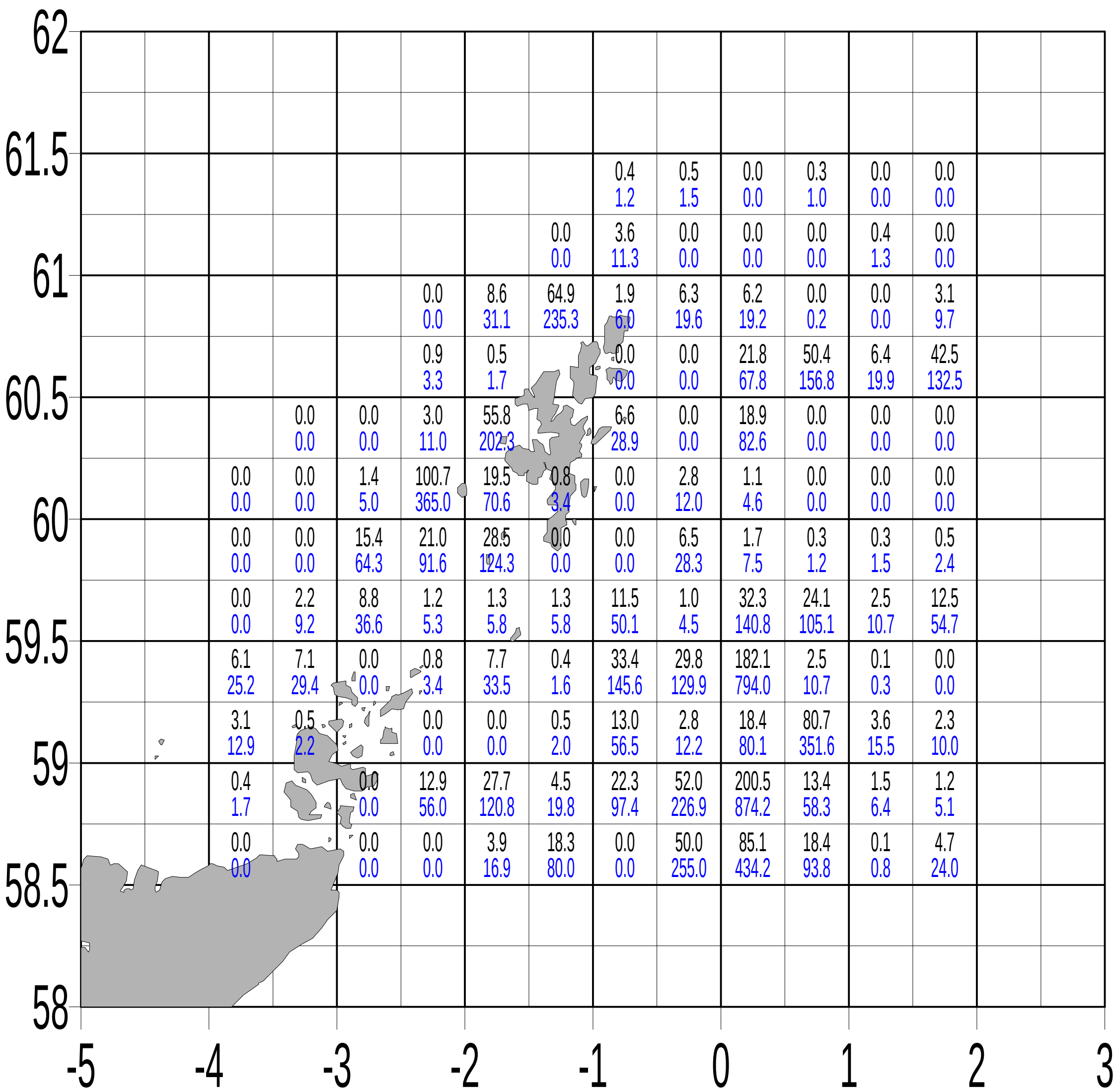

Figure 5D.4. Map of the North Sea showing the estimated numbers (millions in blue, lower figures) and biomass (thousands of tonnes in black upper figures) by quarter statistical rectangle from the herring acoustic survey on FRV "Scotia" for 28 June - 16 July 2009.

ANNEX 5E: The Netherlands

Survey report for RV *Tridens*

29 June - 24 July 2009

A.S. Couperus, IMARES, IJmuiden

1. Introduction

The Dutch Institute for Marine Resources and Ecosystem Studies (IMARES) participated in the international North Sea hydro acoustic survey for herring since 1991. Participants in this survey are Scotland, Norway, Germany, Denmark and The Netherlands. The survey is part of the EU data collection framework and is coordinated by the Working Group for International Pelagic Surveys (WGIPS, formerly PGIPS/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 RV "Tridens".

Cruise plan

The survey was split into two periods of 2 weeks. The planned cruise track and hydrographical positions are presented in Figures 1a and 1b. The actual surveyed transects may differ from the planned transects.

2. Methods

2.1 Scientific Staff

IMARES STAFF	WK 26	WK 27	WK 28	WK 29
Bram Couperus (cruise leader 1st half)	x	x	x	x
Kees Bakker (cruise leader 2nd half)			x	x
Dirk Burggraaf			x	x
Ronald Bol	x	x		
Hendrik-Jan Westerink	x	x		
Sven Gastauer	x	x	x	x
Martijn de Jongh	x			
Kristina Raab			x	x

2.2 Narrative

Departure Monday 29/6 11:30 from Scheveningen, Dutch summertime. Two test hauls were carried out near the Devil Holes. "Tridens" steamed up to Scapa Flow (Scotland) for the calibration. On its way the equipment for the calibration was prepared and two test hauls were conducted. During the first days of sailing, the scientific crew had to deal with a lot of technical problems. Arrival at Scapa Flow on Wednesday morning 1 July. The 38 kHz transducers were calibrated. The calibration of the 200 kHz was not successful: the measurements were extremely variable. The survey started on 2 July 3:00 UTC at the western point of the 58°20N transect. The first haul was at 58°18N-1°05W revealing Norway Pout and Mackerel. Likewise haul 5 (58°04N – 1°00W) targeting small red schools at the bottom, consisted of Norway Pout. On Thursday and Friday the 58°18 and 58°05 transects were covered under perfect weather conditions. There was a lot of herring! The part of the 57°48 transect that is in the Moray Firth was skipped due to time constraints. From Saturday evening till Monday morning the "Tridens" was in Aberdeen. On Monday morning the survey restarted at 57°48N – 1*47W in eastern direction. A few hauls targeted at small schools at the surface and the bottom was carried out. The survey schools consisted mainly of young haddock and whiting. The red schools close to the bottom consisted of Norway Pout. During the second week of the survey the 57°48, 57°18 and 56°48 transect were covered. Herring showed up, mainly in the eastern part of the area. On Wednesday evening 8 July the wind increased. Next morning the wind was NW7. A haul was carried out on herring after which "Tridens" headed for Scheveningen for the weekend; arrival 8:30 on Friday.

"Tridens" left the port again on Monday 13 July 10:30 and the survey started again on Tuesday morning at 55°48n – 1°29E heading east in the German bight. Wednesday morning we found out that the transducer cable was damaged. The survey switched temporally to the hull mounted transducer during the time it took to plug in the spare cable. The intention to collect fishing data in every rectangle in the German bight could not be fulfilled because the trawl sonar was damaged right on that part of the transect. There were not many recordings though. On 16 July a transect was shifted to the north to cover a rectangle for the Norwegian vessel. In that part of the transect some adult and young herring as well as sprat was encountered. Friday evening at 20:00 "Tridens" entered the port of Leith for the weekend. On Monday 20 July the survey started again at 55°48N – 1°35W. During the rest of the transect some young herring and sprat was recorded in the western end. After reaching the western end of the 55*18 transect "Tridens" sailed during the night towards the eastern end of the 54°48N transect in order to sail it in western direction and after that the last transect in eastern direction.

The survey revealed relatively much herring with a much more southern distribution than in previous years. On Thursday 23 July a final haul was carried out south of Inner bank on small red schools at the bottom. On the trawl sonar no schools were seen entering the net. The catch consisted of grey gurnard and sprat. The survey ended at 14:30; arrival in Scheveningen early Friday morning.

2.3 Survey design

The actual survey was carried out from 2 to 23 July 2009, covering an area east of Scotland from latitude 54◎20 to 58◎20 North and from longitude 3◎ West (off the Scottish/English coast) to 6◎ East between 55°30 and 56°30. Following the survey design since 2005, an adapted survey design was applied, partly based on the herring distribution from previous years. As a result, parallel transects along latitudinal lines were used with spacing between the lines set at 15 or 30, depending on the expected distributions. Acoustic data from transects running north–south close to the shore (that is parallel with the depth isolines) were excluded from the dataset. The actual cruise track, trawl - and hydrographical station positions is presented in Figure 1.

2.4 Calibration of acoustic equipment

The calibration of the 38 kHz transducer mounted in the towed body (28887) was executed as planned. When the calibration of the spare transducer was started, it turned out that two quadrants were missing. After investigation, it turned out that the break was at the epot where the cable enters the transducer, meaning that reparation was not possible. Therefore the hull mounted 38 kHz transducer was calibrated as well. The calibration of the 200 kHz transducer gave problems: although the new gain looked like a reasonable value, the variation was far too big resulting in a RMS of approximately 1. A fifth session with a smaller distance (5m instead of 8m) gave hardly better results (RMS=0.8). We concluded that the 200 kHz could not be used for (multi frequency) analysis.

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 Table 1. Acoustic data were collected with a Simrad EK60 scientific echosounder and logged with Sonardata Echoview software in 1 nautical mile intervals. The EK60 received the vessel speed from the ship's GPS. A vessel speed of 10.0 knots was used.

All echoes were recorded with a threshold of -80dB up to a depth of 150 meters below the transducer. A ping rate of 0.6 sec was used during the entire survey. This ping rate has proven most suitable at depths of 50 - 150 m at which depth herring occur in most of the area.

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 codend. Fishing was carried out when there was doubt about the species composition of recordings observed on the echosounder and to obtain biological samples of herring and sprat. In general, after it was decided to 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 (specifications are listed in the PGHERS manual).

A Furuno FS20/25 trawl sonar (vertical and horizontal scan direction) was used to control the catch.

Biological samples

For all fish:

- Total species weight of the catch
- 150 to 250 specimens for individual length measurement Depending of the catch weight, a subsample technique is used, based on weights.

Stratified samples of 5 fish per length class were taken from the 150–250 herring and sprat. The following parameters are sampled from these fish:

- Age of herring and sprat, by means of otolith reading
- Gender
- Maturity stage

2.7 Hydrographical data

Hydrographical data have been collected in 48 stations, all at fixed locations (Figure 1b). A Seabird CTD device, type SBE 9plus in combination with a corresponding water sampler 9plus in combination with a corresponding Seabird SBE 32C carousel water sampler was used in this survey. It had been successfully calibrated in advance by the manufacturer. Conductivity, temperature and depth were measured.

2.8 Data handling, analysis and presentation

Data analysis

The echograms were scrutinized with Sonardata Echoview software.

In stratum A and D (Figure 2) herring and sprat were observed in mixed concentration. In these strata, the assignment of NASC's was based on trawl catch distributions.

For each ICES rectangle, species composition and length distribution were determined as the un-weighted 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.

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 NASC in a rectangle by the overall sigma in the corresponding rectangle.

The biological samples, used for stock structure and biomass calculations were grouped in 4 strata for herring and 1 stratum for sprat, based on similar length frequency distribution in the area (Figure 2). 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.

3. Results

3.1 Acoustic data results

Largest herring concentrations were found in the northeastern part of the Dutch survey area (Figure 3a). Sprat was found just offshore the Firth of Forth (rectangle with highest concentration: 41E8) and in the southernmost rectangles of the survey area (rectangle with highest concentration: 37F0; Figure 3b). There was a lot more herring observed in the Dutch area compared to previous years.

3.2 Trawl data results

In all, 26 trawl hauls have been conducted. Herring was found in 18 hauls of which 10 samples of more than 20 herring were taken. Sprat was found in 6 hauls. The trawl list is presented in Table 2a, the catch weights per haul and species are presented in Table 2b and the length frequency proportions are presented in Table 2c. Norway pout was observed in trawls again for the first time since about 10 years. The biological samples contained total 772 herring which were collected and used for length, age and maturity keys. Gonads of herring were generally observed to be better developed compared to the previous 3 years.

3.3 Stock estimates

The stock biomass estimate of herring found in the "Tridens" survey area:

Immature	171.8 thousand tonnes
Spawning stock	1039.1 thousand tonnes

The stock biomass estimate of sprat found in the "Tridens" survey area:

Immature	0.5 thousand tonnes
Spawning stock	13.4 thousand tonnes

Figure 4 shows the estimated numbers and biomass of herring by ICES rectangle in the area surveyed by RV "Tridens". Table 3 summarizes stock estimates per stratum and Table 4 summarizes the sub stock estimates for herring and sprat.

Table 5E.1. Simrad EK60 calibration settings used on the June 2009 North Sea hydro acoustic survey for herring, RV "Tridens".

```
#  Calibration  Version   2.1.0.12
#  Date:  1–7-2009
#
#  Comments:
#    Scapa Flow
#
#  Reference Target:
#    TS                  -33.60 dB       Min. Distance         11.00 m
#    TS Deviation           5.0 dB       Max. Distance         14.00 m
#
#  Transducer:  ES38B  Serial No.   28887
#    Frequency            38000 Hz       Beamtype                Split
#    Gain                 25.21 dB       Two Way Beam Angle   -20.6 dB
#    Athw. Angle Sens.       21.90       Along. Angle Sens.      21.90
#    Athw. Beam Angle     6.81 deg       Along. Beam Angle    6.80 deg
#    Athw. Offset Angle   0.00 deg       Along. Offset Angle -0.05 deg
#    SaCorrection         -0.71 dB       Depth                 0.00  m
#
#  Transceiver:  GPT  38 kHz 009072017a3b 1–1 ES38B
#    Pulse Duration       1.024 ms       Sample Interval     0.193   m
#    Power                 2000  W       Receiver Bandwidth   2.43 kHz
#
#  Sounder Type:
#    EK60 Version  2.2.0
#
#  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.   9.0 dB/km       Sound Velocity     1505.6 m/s
#  Beam Model results:
#    Transducer Gain    = 25.23 dB       SaCorrection       = -0.69 dB
#    Athw. Beam Angle   = 6.82 deg       Along. Beam Angle  = 6.85 deg
#    Athw. Offset Angle =-0.01 deg       Along. Offset Angle=-0.07 deg
#  Data deviation from beam model:
#    RMS =    0.28 dB
#    Max =    0.91 dB  No. =   193  Athw. =  1.3 deg  Along =  2.6 deg
#    Min =   -0.74 dB  No. =   212  Athw. = -3.1 deg  Along =  2.5 deg
#  Data deviation from polynomial model:
#    RMS =    0.26 dB
#    Max =    0.70 dB  No. =   112  Athw. =  0.0 deg  Along = -1.6 deg
#    Min =   -0.69 dB  No. =   212  Athw. = -3.1 deg  Along =  2.5 deg
```

Table 5E.2a. Details of the trawl hauls taken. "Tridens", North Sea acoustic survey 2009.

haul	day	month	year	hour	minute	haul duration	lat	lon	depth	geardepth	wind direction	wind force	gear
1	2	7	2009	8	0	90	58.2	0.33	114	Bottom	180	0	pelagic trawl
2	2	7	2009	12	50	45	58.2	-0.35	120	Bottom	359	2	pelagic trawl
3	2	7	2009	18	30	40	58.2	0.33	149	Bottom			pelagic trawl
4	3	7	2009	9	0	32	58.04	0.57	144	Bottom	90	1	pelagic trawl
5	3	7	2009	17	15	32	58.04	-0.57	116	Bottom	359	2	pelagic trawl
6	6	7	2009	8	40	50	57.46	1.46	67	midwater	45	2	pelagic trawl
7	6	7	2009	11	36	22	57.45	-1.25	88	Bottom	45	2	pelagic trawl
8	6	7	2009	20	2	28	57.46	0.41	122	Bottom	45	2	pelagic trawl
9	7	7	2009	12	4	88	57.17	0.51	94	Bottom	0	7	pelagic trawl
10	8	7	2009	6	42	88	56.57	-2.03	56	surface	0	12	pelagic trawl
11	9	7	2009	4	58	54	56.47	1.02	92	Bottom	0	12	pelagic trawl
12	14	7	2009	12	15	45	55.48	3.42	51	Bottom	180	2	pelagic trawl
13	14	7	2009	16	57	29	55.48	4.45	24	midwater	225	2	pelagic trawl
14	15	7	2009	13	57	51	55.48	5.34	47	midwater	225	2	pelagic trawl
15	15	7	2009	13	57	42	56.18	3.21	71	Bottom	225	2	pelagic trawl
16	16	7	2009	13	57	97	56.39	1.31	96	Bottom	359	2	pelagic trawl
17	16	7	2009	15	5	125	56.38	1.19	89	Bottom	359	2	pelagic trawl
18	17	7	2009	11	45	31	56.17	-1.23	62	Bottom	68	12	pelagic trawl
19	20	7	2009	11	55	95	55.47	-0.45	84	midwater	270	4	pelagic trawl
20	20	7	2009	5	5	56	55.31	1.42	81	midwater	270	3	pelagic trawl
21	21	7	2009	13	45	60	55.17	0.2	88	Bottom	180	4	pelagic trawl
22	22	7	2009	8	50	60	54.48	0.56	70	Bottom	225	9	pelagic trawl
23	22	7	2009	11	35	15	54.48	0.38	75	Bottom	158	9	pelagic trawl
24	22	7	2009	17	20	75	54.47	-0.37	64	Bottom	203	7	pelagic trawl
25	22	7	2009	18	15	35	54.47	-0.3	64	Bottom	203	7	pelagic trawl
26	23	7	2009	7	20	31	54.17	0.4	52	midwater	203	7	pelagic trawl

Table 5E.2b. Trawl catches. "Tridens", North Sea acoustic survey 2009 in kg.

haul no	herring	N. pout	other gadoids	mackerel	sprat	others
1		51.213	1.08	1.08		2.949
2	1500	0.171				
3	9650		1.375	1.375		2
4	2624.8		33.8	33.8		
5		8451.529	1.17	1.17		
6			2.91	2.91		0.122
7	0.012	862.95	74.674	74.674	0.006	0.02
8	1465.4					
9			1.005	1.005		44.8
10			0.214	0.214	1.25	0.099
11	3134.5					
12	0.095		0.036	0.036		1.642
13	0.04		0.204	0.204		17698.53
14	16.2		3.5	3.5	4.631	42.662
15	1257.599					
16	24.6	40.1				4.725
17	71.4					
18	8.96				12.573	
19	0.1				7.35	9.775
20						22.52
21	1598.764		0.956	0.956	0.956	
22	0.376		3.526	3.526	0.056	0.692
23	67.7		0.815	0.815		1.465
24			1.93	1.93		25.839
25			36.885	36.885		2.64
26	0.164		2.827	2.827	3.9	67.128

Table 5E.2c. Length frequency proportions of herring by haul. "Tridens", North Sea acoustic survey 2009.

length/haul-no proportion %	2	3	4	8	11	14	15	16	17	18	19	21	23
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.55	0.00	0.00
6.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54.55	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.82	0.00	0.00
7.5	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	9.09	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	1.78	0.29	0.00	0.00	0.00	0.00	0.00	0.00
8.5	0.00	0.00	0.00	0.00	0.00	0.00	2.04	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	16.87	0.29	0.00	0.00	0.00	0.00	0.00	0.00
9.5	0.00	0.00	0.00	0.00	0.00	24.33	0.29	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	17.76	0.29	0.00	0.00	0.00	0.00	0.00	0.00
10.5	0.00	0.00	0.00	0.00	0.00	27.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	3.73	0.58	0.00	0.00	0.00	0.00	0.00	0.00
11.5	0.00	0.00	0.00	0.00	0.00	1.95	0.29	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14.5	0.00	0.00	0.00	0.00	0.00	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	1.95	5.54	0.00	0.00	0.00	0.00	0.00	0.00
15.5	0.00	0.00	0.00	0.00	0.00	1.24	16.91	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.71	29.74	0.00	0.00	0.00	0.00	0.00	0.00
16.5	0.00	0.00	0.00	0.00	0.00	0.36	22.16	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.18	14.87	0.00	0.00	0.00	0.00	0.00	1.06
17.5	0.00	0.00	0.00	0.00	0.00	0.00	3.50	0.00	0.00	0.00	0.00	0.00	3.19
18	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.00	0.00	0.00	0.00	0.00	8.87
18.5	0.00	0.00	0.00	0.00	0.00	0.00	1.17	0.42	0.51	0.00	0.00	0.00	7.09
19	0.00	0.00	0.00	0.00	0.50	0.00	1.17	0.00	0.00	0.52	0.00	0.00	12.77
19.5	0.00	0.00	0.00	0.00	1.51	0.00	0.00	2.08	0.51	0.00	0.00	0.57	10.99
20	0.00	0.00	0.00	0.00	0.50	0.00	0.00	5.42	0.51	0.00	0.00	1.15	12.77
20.5	0.00	0.00	0.00	0.00	2.51	0.00	0.00	11.67	0.51	2.59	0.00	0.00	7.80
21	0.00	0.00	0.00	0.00	2.51	0.00	0.00	10.83	1.03	5.70	0.00	0.00	8.51
21.5	0.00	0.00	0.00	0.00	6.03	0.00	0.00	15.42	2.56	18.65	0.00	2.87	9.22
22	0.00	0.00	0.55	0.67	4.02	0.00	0.00	15.83	2.56	21.76	0.00	4.02	4.26
22.5	0.00	0.00	0.55	2.00	5.53	0.00	0.00	10.83	3.59	24.35	0.00	10.34	4.61
23	0.00	0.00	0.55	0.67	7.04	0.00	0.00	12.08	2.05	16.06	0.00	10.92	4.26
23.5	0.55	0.00	1.09	1.33	3.52	0.00	0.00	3.75	7.69	3.63	0.00	5.17	1.42
24	0.55	0.58	1.64	2.67	6.53	0.00	0.00	3.33	9.23	3.11	0.00	5.75	1.06
24.5	1.10	2.34	8.20	4.67	11.56	0.00	0.00	4.17	8.72	2.07	0.00	6.32	0.71
25	12.15	4.09	8.74	4.00	11.56	0.00	0.00	2.08	9.23	1.04	0.00	5.75	1.06
25.5	17.13	7.02	13.11	14.00	9.05	0.00	0.00	0.42	15.38	0.00	0.00	9.77	0.35
26	14.36	9.94	16.39	13.33	8.54	0.00	0.00	1.25	10.26	0.00	0.00	5.17	0.00
26.5	13.81	6.43	14.21	9.33	7.54	0.00	0.00	0.00	10.26	0.00	0.00	5.75	0.00
27	11.60	12.28	14.21	17.33	4.02	0.00	0.00	0.42	5.64	0.00	0.00	5.17	0.00
27.5	13.81	17.54	8.20	10.67	4.02	0.00	0.00	0.00	3.59	0.00	0.00	8.05	0.00
28	9.94	19.30	7.10	12.00	2.51	0.00	0.00	0.00	3.59	0.52	0.00	3.45	0.00
28.5	4.42	16.37	3.83	5.33	0.50	0.00	0.00	0.00	2.56	0.00	0.00	8.62	0.00
29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29.5	0.00	3.51	1.09	2.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.00
30	0.55	0.58	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
no in sample	181	171	183	150	199	563	343	240	195	193	22	174	282

Table 5E.3. Age/maturity-length keys for herring –Stratum A - D. "Tridens", North Sea acoustic survey 2009.

Stratum A							
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2008im	0.0		0	0.0	0.000	0.0
0M	2008ad	0.0		0	0.0	0.000	0.0
1I	2007im	0.0	85.8	575	22.5	49.359	14.2
1M	2007ad	0.0	94.5	145	5.7	13.743	4.0
2I	2006im	0.0	91.8	108	4.2	9.908	2.9
2M	2006ad	0.0	144.3	1310	51.2	188.915	54.3
3I	2005im	0.0		0	0.0	0.000	0.0
3M	2005ad	0.0	213.5	236	9.2	50.460	14.5
4I	2004im	0.0		0	0.0	0.000	0.0
4M	2004ad	0.0	200.9	91	3.5	18.217	5.2
5I	2003im	0.0		0	0.0	0.000	0.0
5M	2003ad	0.0	194.0	27	1.0	5.193	1.5
6M	2002	0.0	181.0	37	1.5	6.716	1.9
7M	2001	0.0	173.0	29	1.2	5.094	1.5
8M	2000	0.0		0	0.0	0.000	0.0
9M	1999	0.0		0	0.0	0.000	0.0
10M	1998	0.0		0	0.0	0.000	0.0
11M	1997	0.0		0	0.0	0.000	0.0
12+	<1997	0.0		0	0.0	0.000	0.0
Mean		0.0	153.2				
Total				2558	100.0	347.606	100.0
Immature				683	26.7	59.268	17.1
Mature				1875	73.3	288.338	82.9

Stratum B							
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2008im	0.0		0	0.0	0.000	0.0
0M	2008ad	0.0		0	0.0	0.000	0.0
1I	2007im	0.0	77.6	349	7.6	27.070	3.8
1M	2007ad	0.0	105.7	29	0.6	3.018	0.4
2I	2006im	0.0	93.6	190	4.1	17.764	2.5
2M	2006ad	0.0	148.9	2591	56.2	385.797	53.5
3I	2005im	0.0		0	0.0	0.000	0.0
3M	2005ad	0.0	190.7	831	18.0	158.543	22.0
4I	2004im	0.0		0	0.0	0.000	0.0
4M	2004ad	0.0	219.9	164	3.6	36.085	5.0
5I	2003im	0.0		0	0.0	0.000	0.0
5M	2003ad	0.0	212.6	235	5.1	49.984	6.9
6M	2002	0.0	197.2	83	1.8	16.282	2.3
7M	2001	0.0	225.5	49	1.1	10.967	1.5
8M	2000	0.0	227.9	54	1.2	12.403	1.7
9M	1999	0.0		0	0.0	0.000	0.0
10M	1998	0.0	242.0	10	0.2	2.531	0.4
11M	1997	0.0		0	0.0	0.000	0.0
12+	<1997	0.0	0.0	22	0.5	0.000	0.0
Mean		0.0	161.8				
Total				4607	100.0	720.443	100.0
Immature				539	11.7	44.834	6.2
Mature				4068	88.3	675.609	93.8

Table 5E.3. Continued. Age/maturity-length keys for herring –Stratum A - D. "Tridens", North Sea acoustic survey 2009.

Stratum C							
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2008im	0.0	7.0	628	49.1	4.384	16.3
0M	2008ad	0.0		0	0.0	0.000	0.0
1I	2007im	0.0	34.6	651	50.9	22.499	83.7
1M	2007ad	0.0		0	0.0	0.000	0.0
2I	2006im	0.0		0	0.0	0.000	0.0
2M	2006ad	0.0		0	0.0	0.000	0.0
3I	2005im	0.0		0	0.0	0.000	0.0
3M	2005ad	0.0		0	0.0	0.000	0.0
4I	2004im	0.0		0	0.0	0.000	0.0
4M	2004ad	0.0		0	0.0	0.000	0.0
5I	2003im	0.0		0	0.0	0.000	0.0
5M	2003ad	0.0		0	0.0	0.000	0.0
6M	2002	0.0		0	0.0	0.000	0.0
7M	2001	0.0		0	0.0	0.000	0.0
8M	2000	0.0		0	0.0	0.000	0.0
9M	1999	0.0		0	0.0	0.000	0.0
10M	1998	0.0		0	0.0	0.000	0.0
11M	1997	0.0		0	0.0	0.000	0.0
12+	<1997	0.0		0	0.0	0.000	0.0
Mean		0.0	20.8				
Total				1279	100.0	26.883	100.0
Immature				1279	100.0	26.883	100.0
Mature				0	0.0	0.000	0.0

Stratum D							
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2008im	0.0		0	0.0	0.000	0.0
0M	2008ad	0.0		0	0.0	0.000	0.0
1I	2007im	0.0	65.7	452	41.5	29.720	25.6
1M	2007ad	0.0		0	0.0	0.000	0.0
2I	2006im	0.0	97.0	115	10.5	11.120	9.6
2M	2006ad	0.0	122.2	317	29.1	38.698	33.4
3I	2005im	0.0		0	0.0	0.000	0.0
3M	2005ad	0.0	155.0	84	7.7	12.952	11.2
4I	2004im	0.0		0	0.0	0.000	0.0
4M	2004ad	0.0	174.6	31	2.9	5.465	4.7
5I	2003im	0.0		0	0.0	0.000	0.0
5M	2003ad	0.0	187.3	24	2.2	4.522	3.9
6M	2002	0.0	210.8	17	1.6	3.605	3.1
7M	2001	0.0		0	0.0	0.000	0.0
8M	2000	0.0	200.3	50	4.5	9.919	8.6
9M	1999	0.0		0	0.0	0.000	0.0
10M	1998	0.0		0	0.0	0.000	0.0
11M	1997	0.0		0	0.0	0.000	0.0
12+	<1997	0.0		0	0.0	0.000	0.0
Mean		0.0	151.6				
Total				1089	100.0	116.003	100.0
Immature				567	52.1	40.840	35.2
Mature				522	47.9	75.162	64.8

Table 5E.4. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) herring breakdown by age and maturity obtained during the July 2009 North Sea hydro acoustic survey for herring, FRV "Tridens".

Total area (all strata summarized)					
Age	Year	Number (millions)	%	Biomass (1000 tons)	%
0I	2008im	628	6.6	4.384	0.4
0M	2008ad	0	0.0	0.000	0.0
1I	2007im	2027	21.3	128.649	10.6
1M	2007ad	174	1.8	16.761	1.4
2I	2006im	412	4.3	38.792	3.2
2M	2006ad	4218	44.2	613.410	50.7
3I	2005im	0	0.0	0.000	0.0
3M	2005ad	1151	12.1	221.955	18.3
4I	2004im	0	0.0	0.000	0.0
4M	2004ad	286	3.0	59.767	4.9
5I	2003im	0	0.0	0.000	0.0
5M	2003ad	286	3.0	59.700	4.9
6M	2002	137	1.4	26.603	2.2
7M	2001	78	0.8	16.061	1.3
8M	2000	104	1.1	22.322	1.8
9M	1999	0	0.0	0.000	0.0
10M	1998	10	0.1	2.531	0.2
11M	1997	0	0.0	0.000	0.0
12+	<1997	22	0.2	0.000	0.0
Total		9534	100.0	1210.935	100.0
Immature		3068	32.2	171.825	14.2
Mature		6466	67.8	1039.110	85.8

Table 5E.5. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) sprat breakdown by age and maturity obtained during the July 2009 North Sea hydro acoustic survey for herring, FRV "Tridens".

		Total area (all strata summarized)			
Age	Year	Number (millions)	%	Biomass (1000 tons)	%
1I	2008im	54	5.5	0.440	3.2
1M	2008ad	285	28.9	3.437	24.6
2I	2007im	8	0.8	0.087	0.6
2M	2007ad	487	49.3	7.278	52.1
3I	2006im	0	0.0	0.000	0.0
3M	2006ad	113	11.5	2.241	16.0
4I	2005im	0	0.0	0.000	0.0
4M	2005ad	21	2.2	0.493	3.5
5I	2004im	0	0.0	0.000	0.0
5M	2004ad	0	0.0	0.000	0.0
6M	2003im	0	0.0	0.000	0.0
7M	2003ad	0	0.0	0.000	0.0
8M	2002	0	0.0	0.000	0.0
9M	2001	0	0.0	0.000	0.0
10M	2000	0	0.0	0.000	0.0
11M	1999	0	0.0	0.000	0.0
12	1998	0	0.0	0.000	0.0
13	1997	0	0.0	0.000	0.0
14+	<1997	19	2.0	0.000	0.0
Total		987	100.0	13.975	100.0
Immature		62	6.3	0.528	3.8
Mature		925	93.7	13.448	96.2

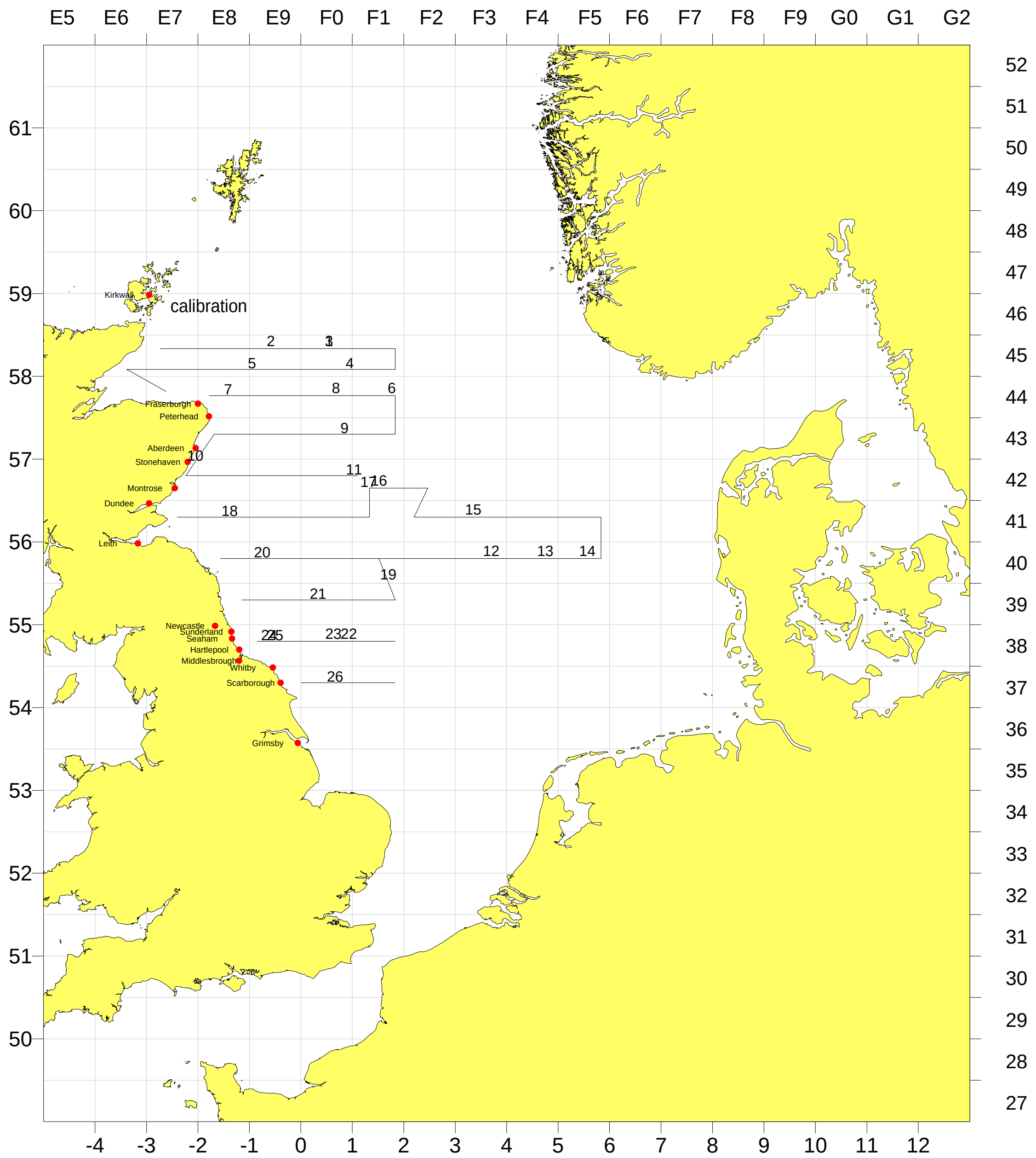

Figure 5E.1a. Map of executed cruise track and positions of trawl stations (open squares with numbers) and hydrographical stations (crosses) during the June-July 2009 North Sea herring hydro acoustic survey on RV "Tridens".

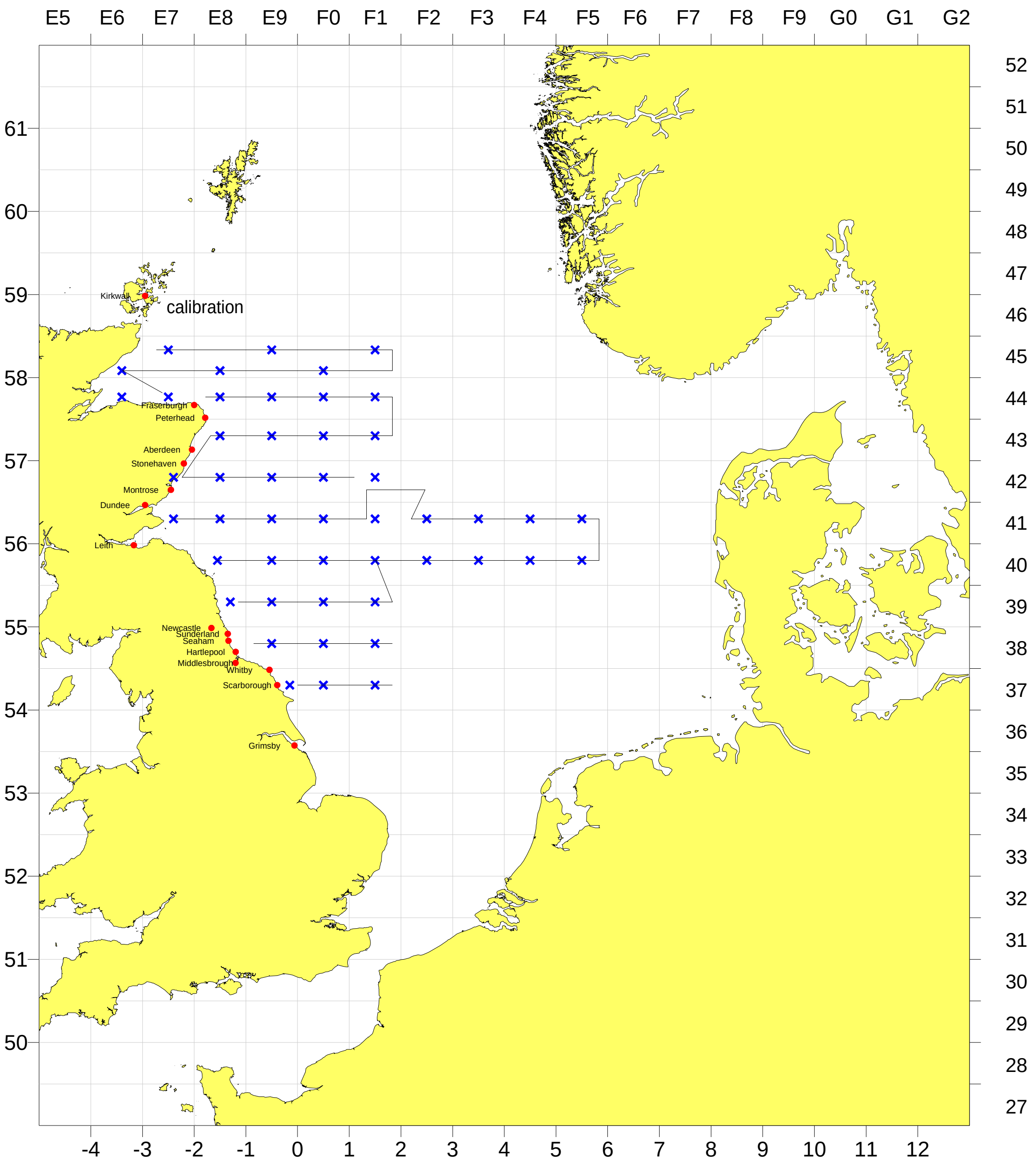

Figure 5E.1b. Map of hydrographical stations (crosses) during the June-July 2009 North Sea herring hydro acoustic survey on RV "Tridens".

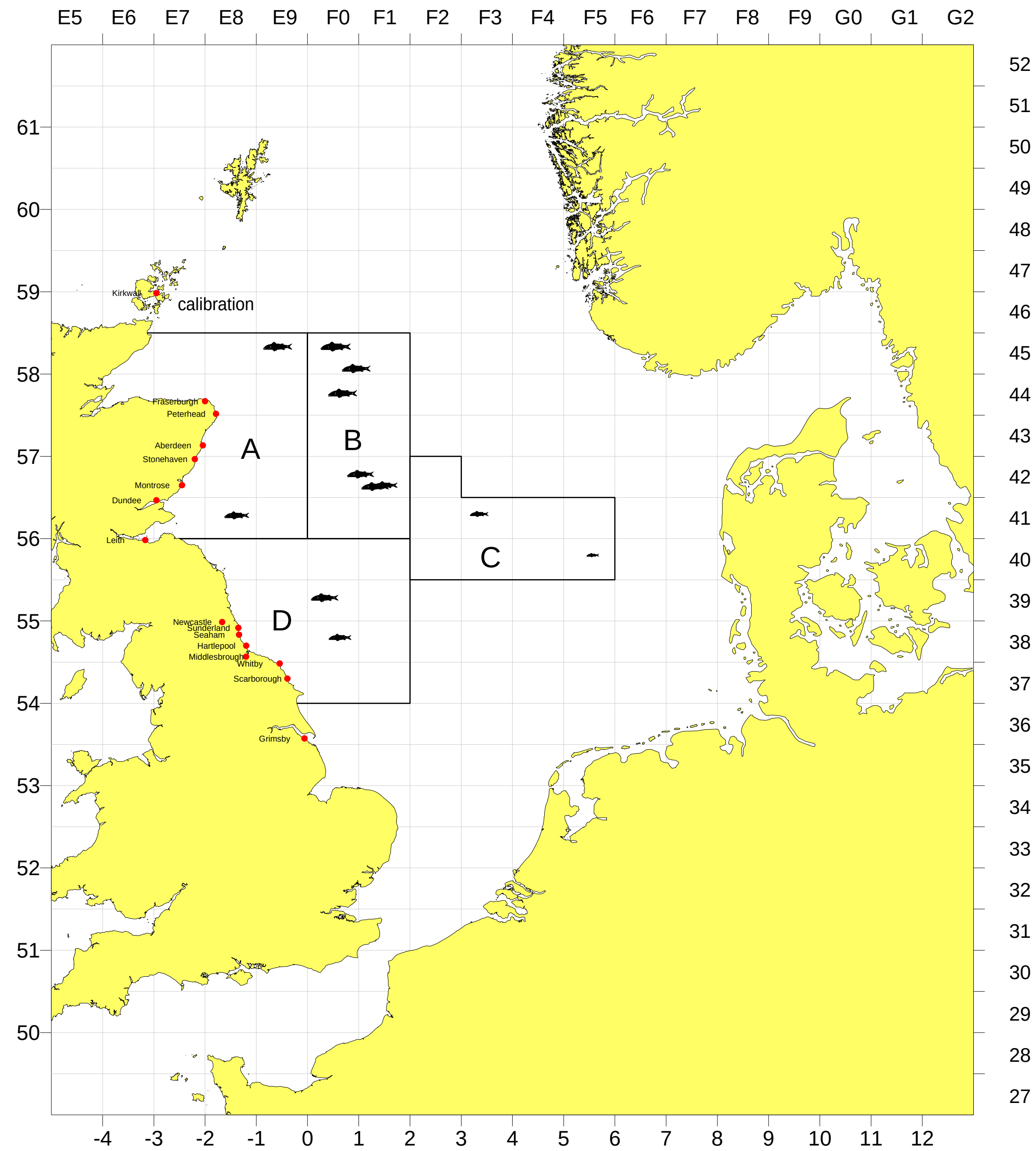

Figure 5E.2. Geographical strata (A-D) used to pool mean weights and relative mean lengths of herring in order to raise NASC's by rectangle to numbers and biomass during the July 2009 North Sea hydro acoustic survey for herring by RV "Tridens".

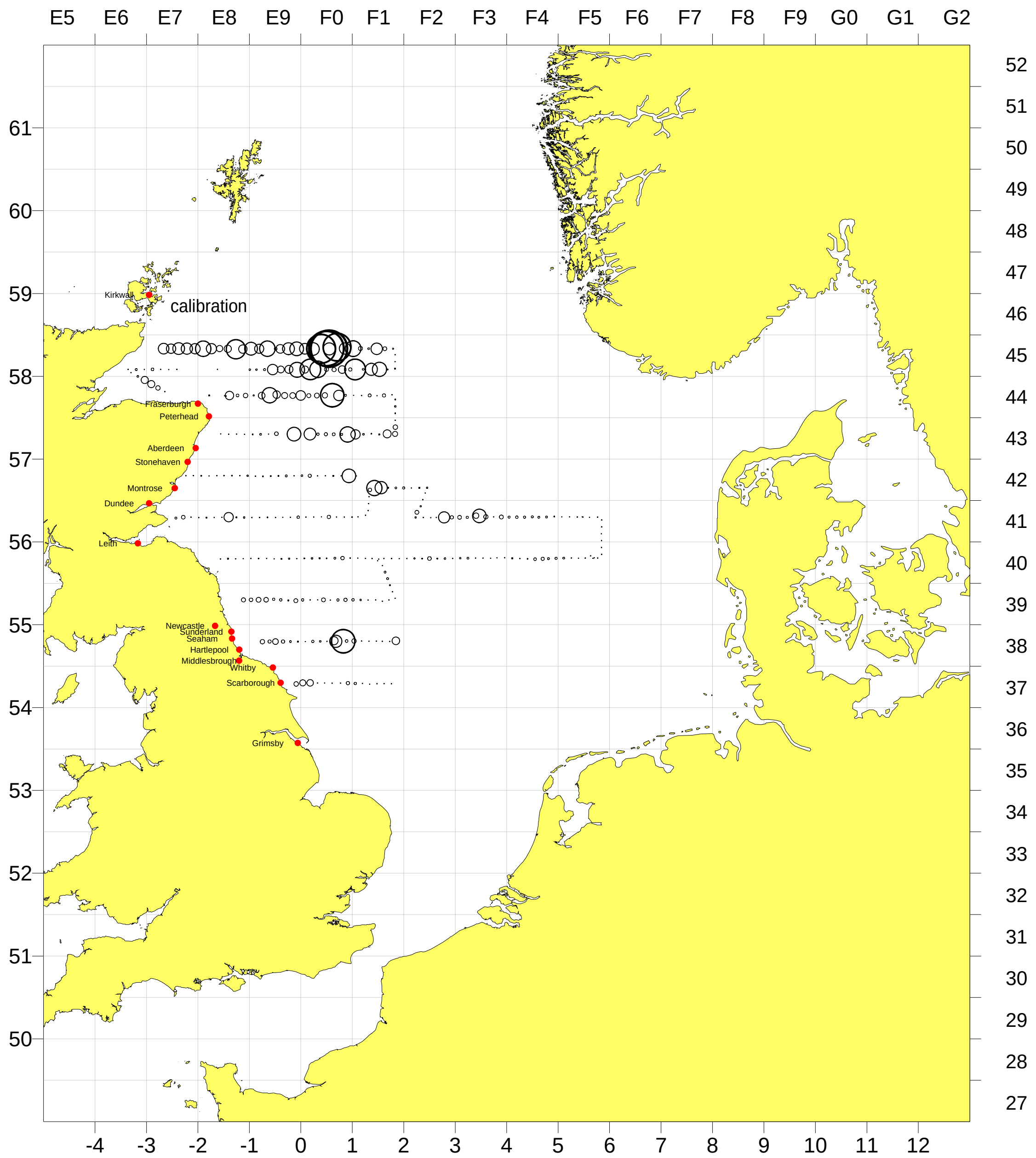

Figure 5E.3a. Post plot showing the distribution of total herring NASC's at 5 nautical mile intervals (on a proportional square root scale relative to the largest value of 15673 m² nautical mile⁻²), obtained during the June-July 2009 North Sea herring hydro acoustic survey on RV "Tridens".

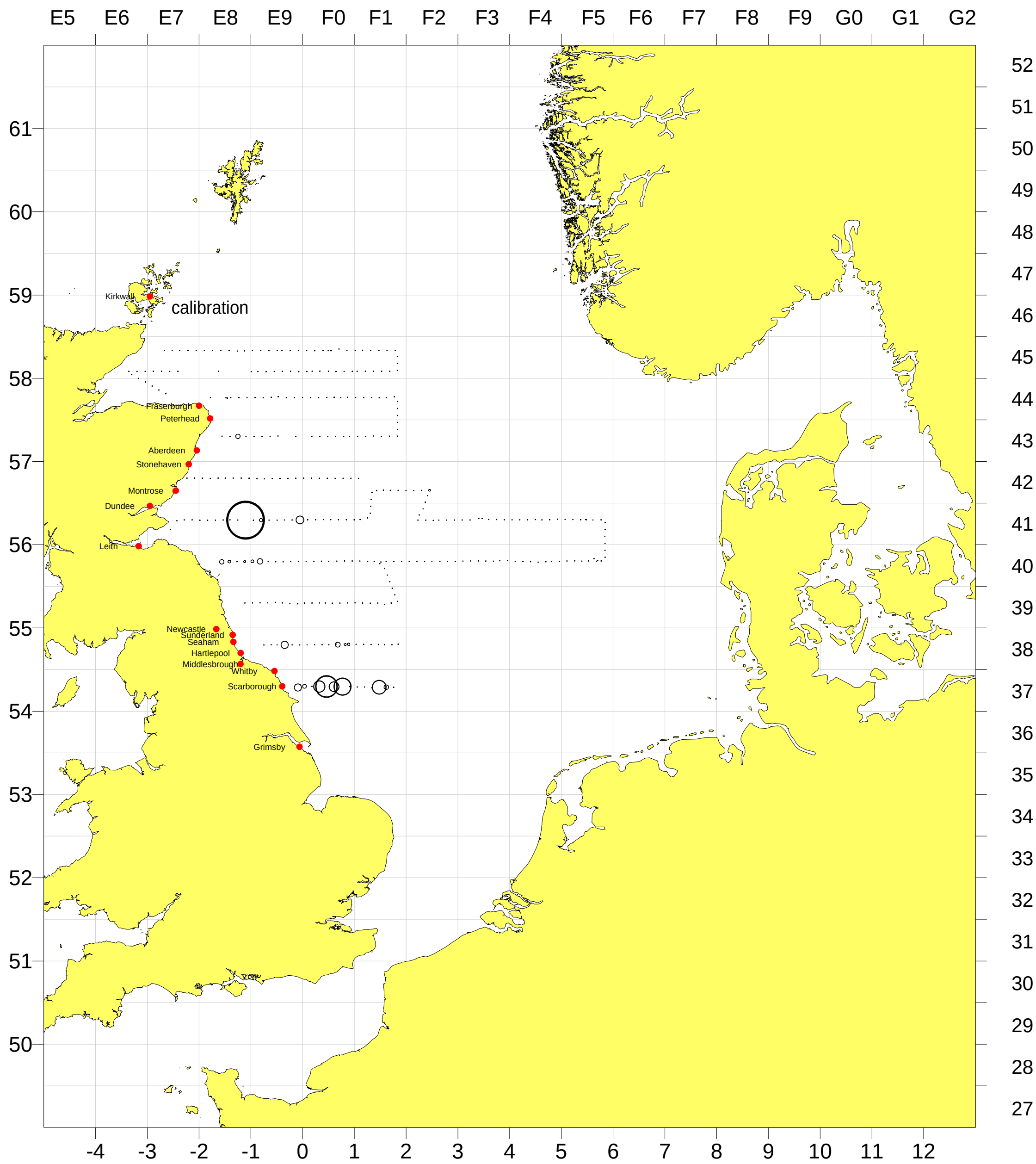

Figure 5E.3b. Post plot showing the distribution of total sprat NASC's at 5 nautical mile intervals (on a proportional square root scale relative to the largest value of 2247 m² nautical mile⁻²), obtained during the June-July 2009 North Sea herring hydro acoustic survey on RV "Tridens".

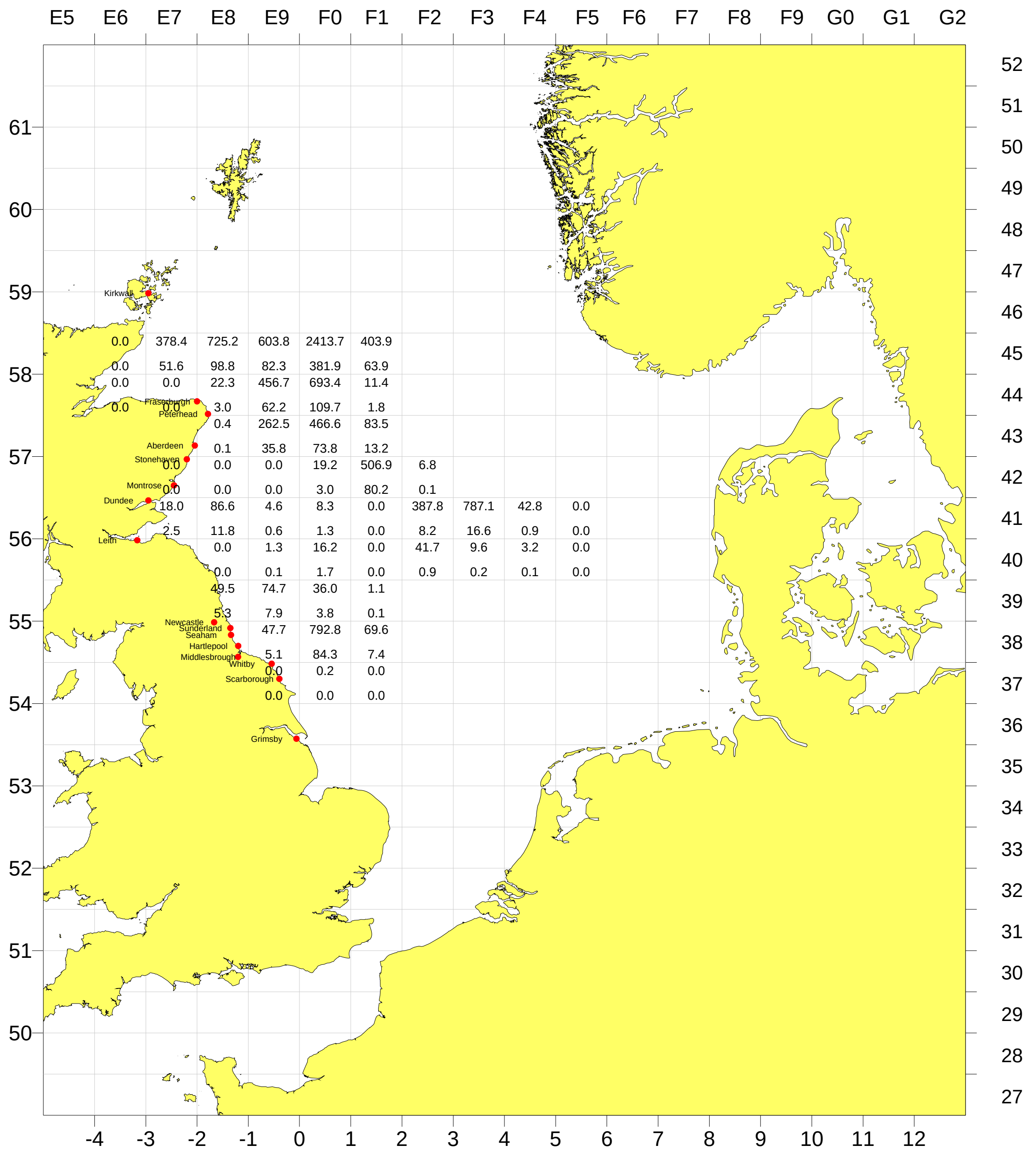

Figure 5E.4. Estimated numbers of herring in millions (upper half square) and biomass in thousands of tonnes (lower half of square) by ICES rectangle. Results from the July 2009 North Sea hydro acoustic survey, RV "Tridens".

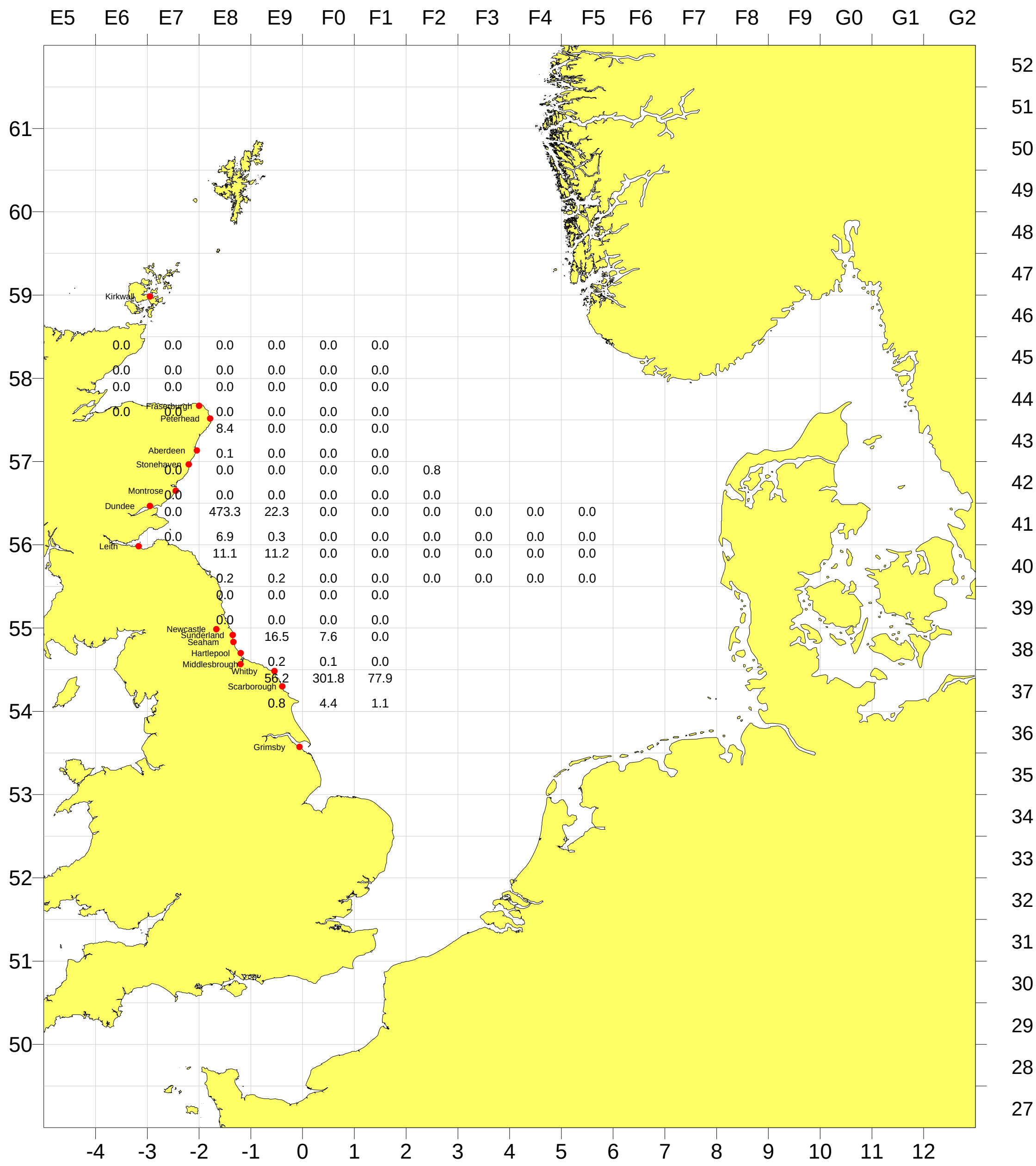

Figure 5E.5. Estimated numbers of sprat in millions (upper half square) and biomass in thousands of tonnes (lower half of square) by ICES rectangle. Results from the July 2009 North Sea hydro acoustic survey, RV "Tridens".

ANNEX 5F: Germany

Survey report for FRV "Solea"

International Herring Acoustic Survey in the North Sea

26 June 2009 – 15 July 2009

Norbert Rohlf and Eberhard Götze,

vTI-SF, Institute of Sea Fisheries, Hamburg

1 INTRODUCTION

Background: FRV "Solea" cruise 607 was conducted in the framework of the international hydroacoustic survey on pelagic fish in the North Sea, which is coordinated by the ICES Working Group for International Pelagic Surveys (WGIPS). Further contributors to the quasi-synoptic survey are the national fisheries research institutes of Scotland, Norway, Denmark, Ireland, Northern Ireland and The Netherlands. The results are delivered to the ICES herring assessment working group. Since 1984 they represent an important fishery-independent dataset (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 covered this year again. The survey effort is comparable to last year.

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 specimen.

2 SURVEY DESCRIPTION and METHODS

2.1 Personnel

Eberhard Götze	Scientist in charge, acoustics	vTI-SF
Michael Drenkow	Acoustics	vTI-SF
Norbert Rohlf	Biologist	vTI-SF
Thurid Otto	Biologist	vTI-SF
Marthe Otto	Biologist	vTI-SF
Dominik Gloe	Biologist	IHF Hamburg

2.2 Narrative

FRV "Solea" left port of Cuxhaven on 26 June. Calibration of the hydroacoustic equipment was conducted successfully the next morning south of Fischer Bank and the survey transect started in the afternoon. Acoustic measurements and fishing activities were conducted without any disturbances until 10 July, when weather conditions became unfavourable and make a one day break necessary. Due to upcoming time constrains, survey transects had to shorten for some miles in rectangles 36F4 (where results from previous days were already available) and in 38F6 and 38F7 (which are yielded low abundances in previous years). These small cuts allowed a complete coverage of all rectangles in the study area. Recordings were terminated at noon of 14 July in the area of Helgoland and FRV "Solea" reached her home port the same afternoon.

2.3 Survey design

The working area for the German vessel contributing to the survey concentrated in the central and southern parts of the North Sea. The survey effort was comparable to last year. The southern survey limit was chosen in order to reach a southern distribution limit of sprat in July. The survey area was confined to the southern and central 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°00' N to the north, respectively.

Hydroacoustic measurements were conducted on east-west or north–south transects with 15 or 30 nautical miles 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 calibration of the acoustic equipment was carried out at open sea in the morning of 27 June 2009. Water depth was 22 m. The position 55 ° 45' N, 007 ° 29' E was chosen close to the planned starting point of the survey. Initially there was a windspeed of 5 Bft and strong water currents had disturbed the measurements considerably. But at noon weather conditions had improved and the measurements could be completed rapidly. The transducers for 38 and 120 kHz were calibrated successfully. The obtained parameters were close to the results in last year. 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 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. Echo telegrams were continuously recorded and evaluated using the EchoView 4 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. The cruise track (Figure 1) totally reached a length of 1890 nautical miles

2.6 Biological data - fishing trawls

For the identification of echotraces and further biological sampling, 46 trawl hauls were conducted either on specific large schools (after turning the ship) or, if small schools occurred frequently, on the survey track. On board RV "Solea", a small pelagic trawl (PSN388, approx. 8 m vertical opening, and 10 mm mesh size in the codend) was used both in midwater trawls and close to the bottom. The net was equipped with Simrad trawl sonar FS20. Standard tow periods were 30 minutes;

however, they varied between 10 and 32 minutes depending on the indication of net filling. 27 statistical rectangles had been sampled.

From each trawl, total catch weight and species composition (on subsamples, if necessary) were determined. Length frequency distributions were produced for each species. Length-stratified samples (10 samples per half cm class per ICES stat rectangle) of herring, sprat, anchovies and sardines were taken for maturity determination (4 point scale), sex and individual body mass. Fish were deep-frozen for later otolith removal and age determination.

2.7 Hydrographic data

Hydrographic data were sampled just prior or after fishing activities, or at least in distances of approximately 30 nautical miles (Figure 2). At each of these stations, vertical profiles of temperature, salinity and depth were recorded using a "Seabird SBE 19 plus-multiprobe" CTD. Water samples for calibration purposes were taken on every station.

2.8 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 with the EchoView 4 software package, using information from trawl hauls usually targeting specific schools. Herring and sprat were exclusively found in characteristic "pillars". The NASC attributed to clupeids 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. It is not possible to distinguish between herring and sprat within clupeid schools. To allocate the integrator readings to a single species, species composition was based on the trawl results.

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 within 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

The identification of the echotraces was carried out by aimed trawling. Herring and sprat was found only in the presence of characteristic "poles" or small clouds. These indications were not homogeneously distributed over larger areas. Small regions with partially high NASC were followed again by nearly empty areas. Only 27% of all sampled miles had a NASC greater than zero and half of the total NASC originates from 20 sampling intervals.

Compared to the last years the fish indications were spread out over larger areas and the intensity was higher. This is consistent with the significantly higher catch results.

High fish densities were found again in the vicinity of the island Helgoland. Another area of concentrations was located SE of Dogger Bank in the ICES rect. 36F4 and 37F4, where the density of fish was much higher than usual. In contrast, the former concentrations in SW part of the survey area were missing. Figure 2 gives the NASC distribution on a basis of 5 nautical miles EDSUs for clupeids (herring and sprat combined).

3.2 Biological data

The pelagic trawl PSN388 has been deployed at 46 stations. 39 rectangles were covered during the acoustic survey, of which 27 have been sampled with trawl hauls (Figure 1 and Table 2). Valid results (> 200 clupeids h-1 trawling) were obtained for all 27 rectangles. Those were used to raise unsampled rectangles. The majority of the unsampled rectangles had no or only minimal NASCs. Total catch varied between 0.2 and 831.5 kg (standardized to 30 minutes trawl duration).

Herring was relatively rare during the survey and larger herring schools were almost exclusively found in the northeastern parts of the investigation area (in Danish waters and in the German bight). All herring were immature 0- and 1-wr fish. Spratt was more uniformly distributed, with highest densities around Helgoland and southeast of Dogger-Bank. As in last year, the high sprat concentrations in the southwest were missing. There is some likelihood that summer southern distribution limit for sprat in the Channel was reached during the survey.

Trawling resulted in 22 different species (Table 3). Spratt showed the highest presence (in 43 trawls out of 46) and was the most abundant in terms of biomass (14,700 kg, equal to 91% of the total catch weight). Total catch of herring was 967 kg. Herring were present in 36 hauls, and their total catch is comparable to last year. Catches yielded larger quantities of mackerel *Scomber scombrus* and grey gurnard *Eutriglia gurnardus*. No Snake-pipefish (*Entelurus aequorius*) were caught in 2009. Other species occurred only on occasion.

3.3 Biomass and abundance estimates

Herring total biomass: 41 538 t (2008: 63 058 t; 2007: 253 425 t)

Herring spawning-stock biomass: 0 t / 0% (2008: 746 t / 1.2%; 2007: 49 213 t / 19.4%)

Herring total abundance: 5 354 mill. (2008: 3 775 mill; 2007: 28 670 mill.)

Herring spawning stock abundance: 0 mill. / 0% (2008: 0.0082 mill. / 0.2%; 2007: 0.374 mill. / 1.3%)

Sprat total biomass : 558 448 t (2008 : 263 700 t ; 2007: 319 200 t tonnes)

Sprat spawning-stock biomass: 437 248 t / 78% (2008: 221 022 t / 84%; 2007: 208 460 t / 65%)

Sprat total abundance: 66 002 mill. (2008: 24 600 mill.; 2007: 41 250 mill.)

Sprat spawning stock abundance 42 067 mill. / 64% (2008: 18 900 mill. / 77%; 2007: 21 570 mill. / 52%)

Compared to last year, herring abundance has increased almost 1/3, while the biomass has decreased by the same order of magnitude. In recent years the vast majority of herring in this area had always been young 0- and 1-wr fish (Age 1 and 2). Following this tendency, summer survey 2009 was characterized by the absence of adult herring.

Abundance and biomass of sprat has increased. Compared to 2008, the total biomass has doubled and the abundance almost tripled. In numbers, 35% of sprat was immature fish. Detailed information on abundance and biomass by statistical rectangle can be found in Figure 3 and 5. Mean length (cm) for herring and sprat per statistical rectangle is given in Figure 4 and 6, respectively.

3.4 Hydrographic data

In addition to the trawl hauls a dense net of hydrographic stations was conducted during the survey. Temperature and salinity profiles were measured on 66 stations with a maximum distance of approximately 30 nautical miles between stations. The maximum surface temperature was 18 ° C in the centre of the study area. Compared to previous years, there was a sharp drop in temperature in upper water layers. Near the coastline the water column had constantly 14° C from surface to bottom layers. In the northern part relatively cold water of 8 °C was found in the deep-water layers.

With respect to salinity no strong vertical stratification was observed. The horizontal distribution showed the usual decrease in a southeasterly direction down to 31 PSU in the Elbe estuary. Oxygen deficiency was not observed.

4 Tables and Figures

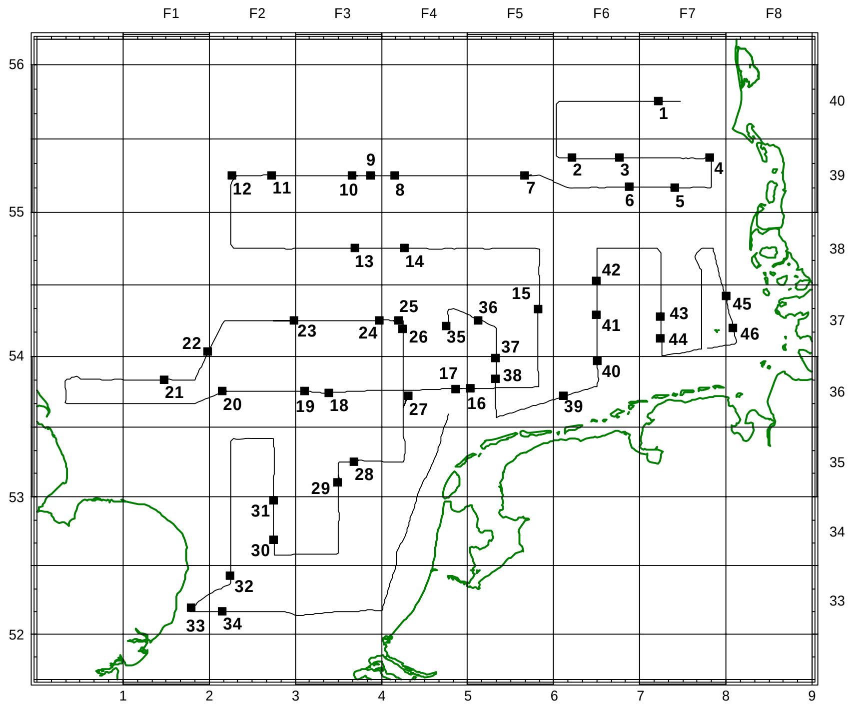

Figure 1a. FRV "Solea", cruise 607, herring acoustic survey: Cruise track and fishing stations(blackmarks).

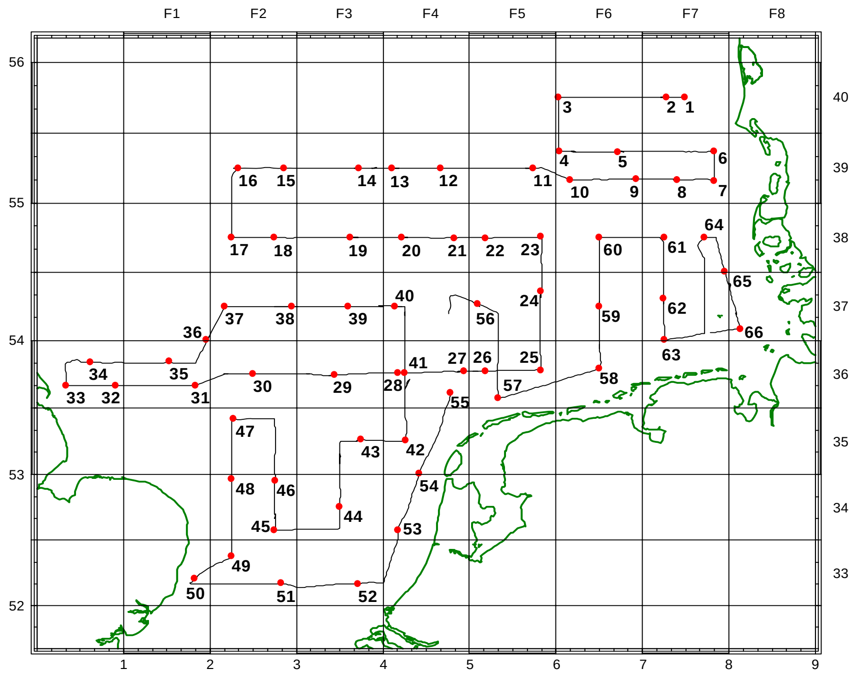

Figure 1b. FRV "Solea", cruise 607, herring acoustic survey: CTD profiles (red circles).

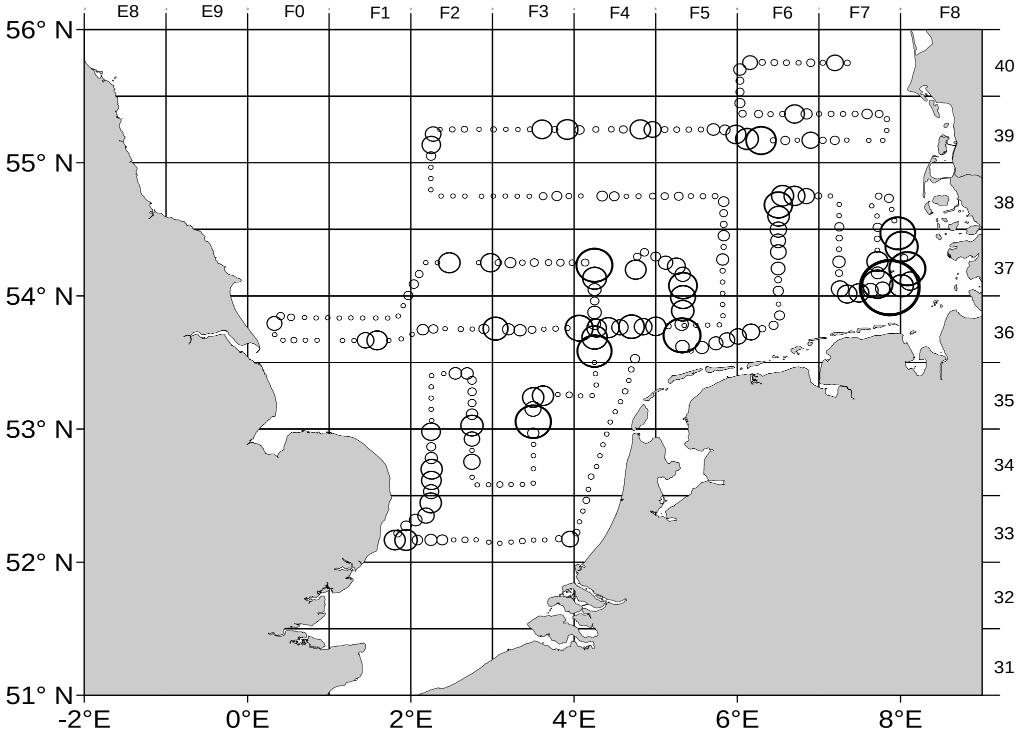

Figure 2. FRV "Solea", cruise 607: Distribution of total NASC values attributed to clupeoids (sum per 5 nautical miles, on a proportional square root scale relative to the largest value of 38921 m² 5n.mi.-²). Smallest dots indicate zero values.

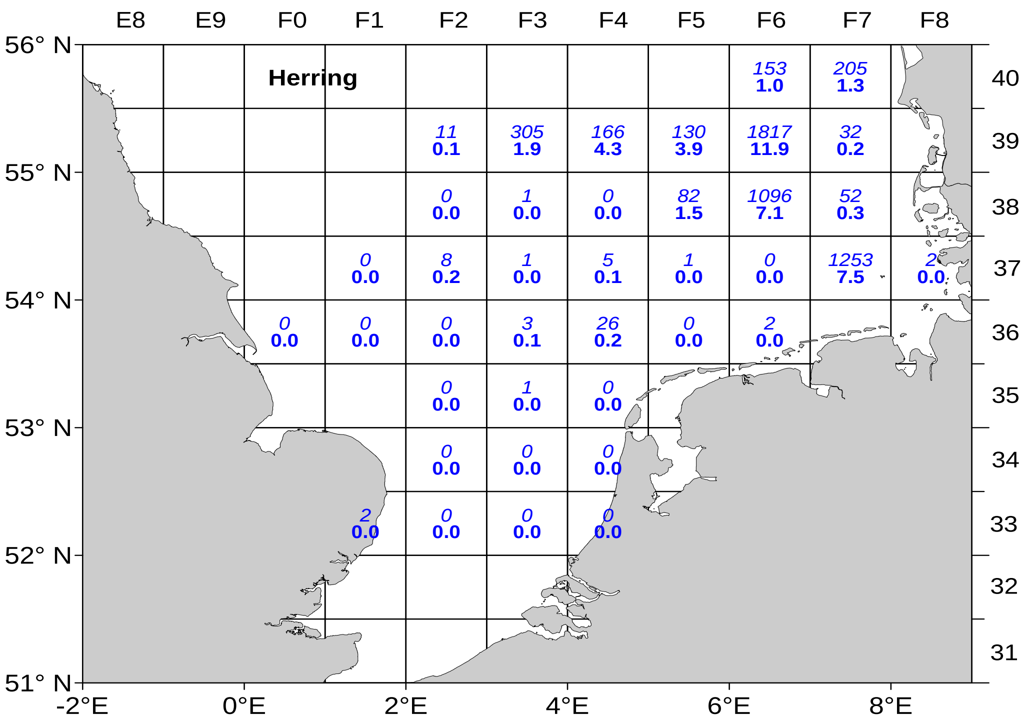

Figure 3. FRV "Solea", cruise 607: Abundance (Mill. individuals, upper value in italics) and biomass (thousand t, lower value in bold) of herring per statistical rectangle.

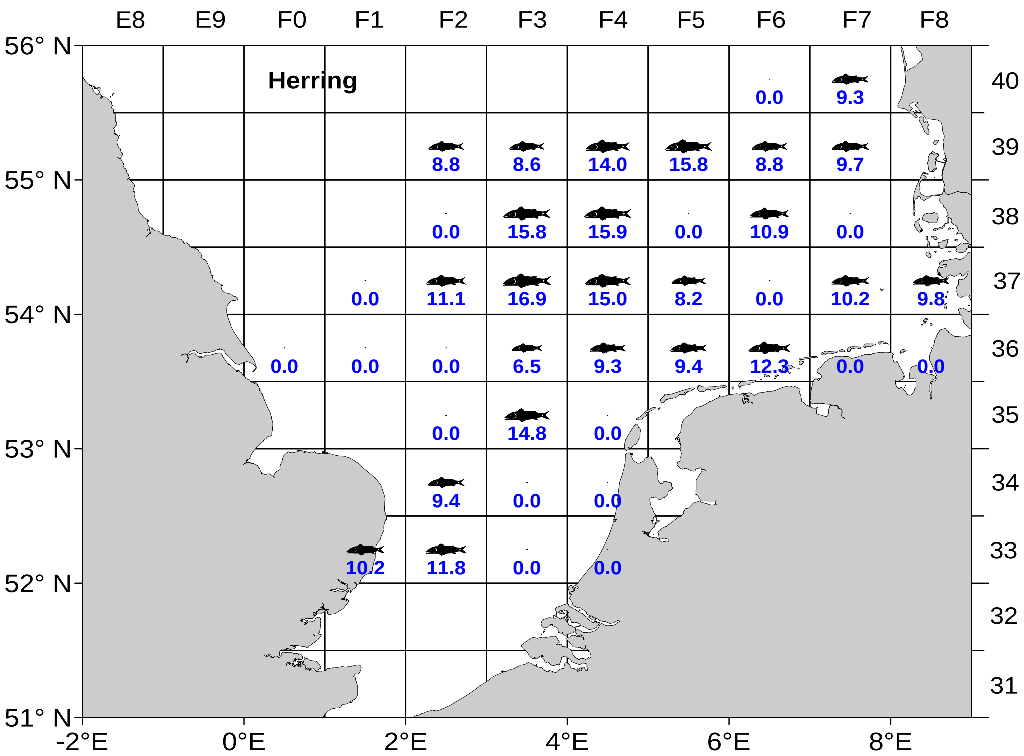

Figure 4. FRV "Solea", cruise 607: Mean length of herring (cm) per statistical rectangle as obtained from trawl catches.

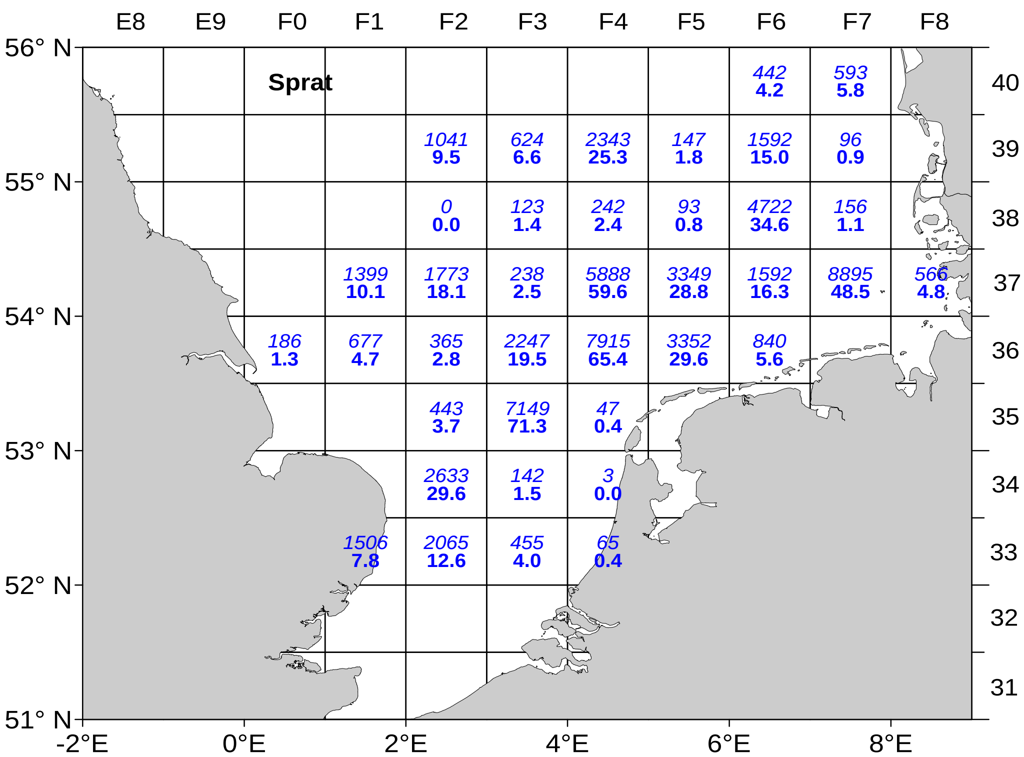

Figure 5. FRV "Solea", cruise 607: Abundance (Mill. individuals, upper value in italics) and biomass (thousand t, lower value in bold) of sprat per statistical rectangle.

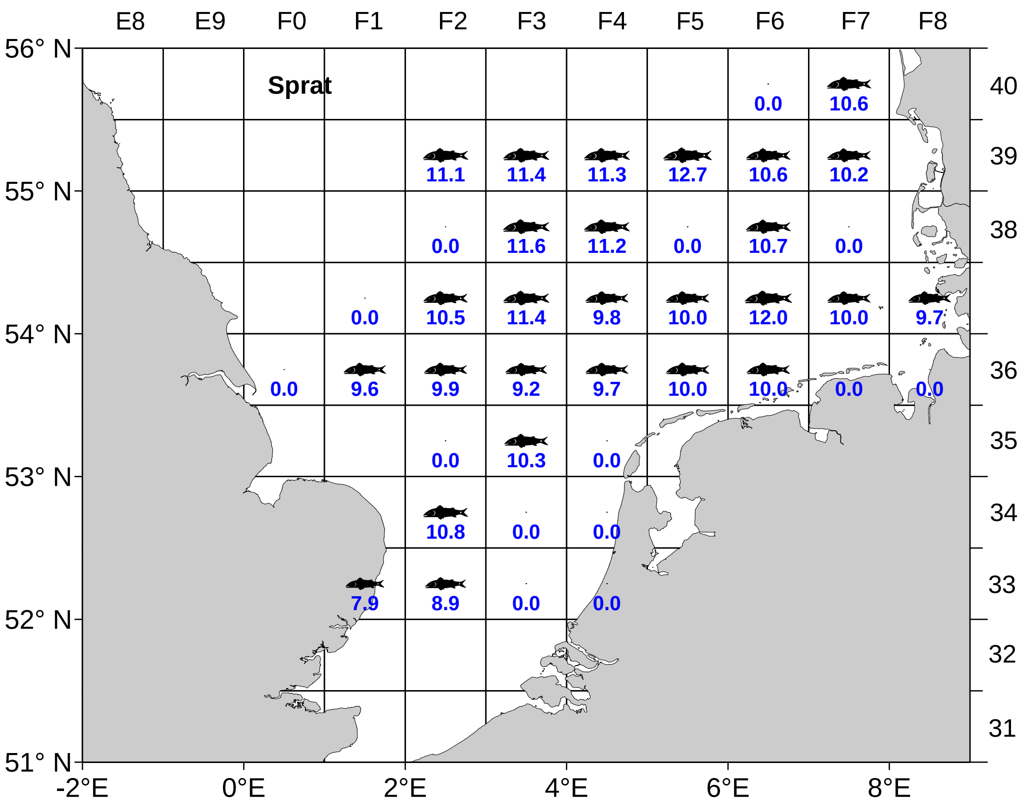

Figure 6. FRV "Solea", cruise 607: Mean length of sprat (cm) per statistical rectangle as obtained from trawl catches.

Table 1. FRV "Solea", cruise 607. Simrad EK60 calibration report.

Calibration Version 2.1.0.11

Date: 2009–06–27

Comments:

2. Calib. 38 kHz 55°45062N 007°29.455E

Reference Target:

TS	-33.60 dB	Min. Distance	12.50 m
TS Deviation	6.0 dB	Max. Distance	15.50 m

Transducer: ES38B Serial No. 30545

Frequency	38000 Hz	Beamtype	Split
Gain	26.27 dB	Two Way Beam Angle	-20.6 dB
Athw. Angle Sens.	21.90	Along. Angle Sens.	21.90
Athw. Beam Angle	7.01 deg	Along. Beam Angle	6.97 deg
Athw. Offset Angle	-0.07 deg	Along. Offset Angle	-0.02 deg
s_ACorrection	-2.06 dB	Depth	0.00 m

Transceiver: GPT 38 kHz 009072056b06 1 ES38B

Pulse Duration	1.024 ms	Sample Interval	0.193 m
Power	2000 W	Receiver Bandwidth	2.43 kHz

Sounder Type:

EK60 Version 2.1.1

TS Detection:

Min. Value	-50.0 dB	Min. Spacing	100%
Max. Beam Comp.	6.0 dB	Min. Echolength	80%
Max. Phase Dev.	4.0	Max. Echolength	180%

Environment:

Absorption Coeff.	8.8 dB/km	Sound Velocity	1505.0 m/s

Beam Model results:

Transducer Gain =	26.32 dB	SaCorrection =	-0.57 dB
Athw. Beam Angle =	6.88 deg	Along. Beam Angle =	6.85 deg
Athw. Offset Angle=	-0.08 deg	Along. Offset Angle=	-0.01 deg

Data deviation from beam model:

RMS =	0.31 dB		
Max = 1.15 dB	No. = 18	Athw. = -4.0 deg Along =	3.2 deg
Min = -1.75 dB	No. = 213	Athw. = 3.7 deg Along =	-3.1 deg

Data deviation from polynomial model:

RMS =	0.28 dB		
Max = 1.43 dB	No. = 18	Athw. = -4.0 deg Along =	3.2 deg
Min = -1.57 dB	No. = 213	Athw. = 3.7 deg Along =	-3.1 deg

Table 2. Trawl station data of FRV "Solea" during cruise 607 (26.06. – 15.07.09.).

STATION	HAUL	RECTANGLE	DATE	TIME	TRAWL	SHOT POS	SHOT POS	WATER	CATCH	CATCH
				(UTC)	type	Latitude	Longitude	depth (m)	depth (m)	time (min)
365	1	40F7	20090627	1257	PSN388	554494N	0071331E	28	18	30
368	2	39F6	20090628	0703	PSN388	552200N	0061313E	50	40	30
369	3	39F6	20090628	0959	PSN388	552199N	0064618E	36	17	30
370	4	39F7	20090628	1430	PSN388	552199N	0074940E	22	12	30
372	5	39F7	20090629	0505	PSN388	550979N	0072492E	24	14	30
373	6	39F6	20090629	0723	PSN388	551012N	0065328E	34	17	30
375	7	39F5	20090629	1241	PSN388	551496N	0054023E	46	36	30
377	8	39F4	20090630	0504	PSN388	551476N	0040980E	45	35	30
378	9	39F3	20090630	0644	PSN388	551497N	0035279E	27	42	31
379	10	39F3	20090630	0824	PSN388	551501N	0034033E	34	20	30
381	11	39F2	20090630	1226	PSN388	551501N	0024371E	31	23	30
382	12	39F2	20090630	1434	PSN388	551505N	0021631E	36	28	30
386	13	38F3	20090701	0854	PSN388	544502N	0034177E	46	38	31
387	14	38F4	20090701	1150	PSN388	544497N	0041641E	50	40	30
391	15	37F5	20090702	0628	PSN388	541957N	0054995E	40	32	30
394	16	36F5	20090702	1320	PSN388	534636N	0050265E	36	25	30
395	17	36F4	20090702	1459	PSN388	534608N	0045242E	38	30	30
397	18	36F3	20090703	0636	PSN388	534444N	0032358E	40	30	30
398	19	36F3	20090703	0834	PSN388	534497N	0030695E	45	36	30
400	20	36F2	20090703	1238	PSN388	534503N	0020939E	30	20	35
405	21	36F1	20090704	1049	PSN388	535010N	0012882E	32	15	30
406	22	36F1	20090704	1414	PSN388	540184N	0015956E	86	73	30
408	23	37F2	20090705	0545	PSN388	541499N	0025966E	56	43	30
410	24	37F3	20090705	1019	PSN388	541493N	0035921E	46	38	30
411	25	37F4	20090705	1207	PSN388	541499N	0041252E	50	42	33
412	26	37F4	20090705	1351	PSN388	541140N	0041495E	50	42	30
414	27	36F4	20090706	0506	PSN388	534298N	0041899E	40	26	30
416	28	35F3	20090706	1036	PSN388	531510N	0034125E	26	18	31
417	29	35F3	20090706	1337	PSN388	530611N	0033023E	30	20	30
420	30	34F2	20090707	0807	PSN388	524142N	0024518E	45	35	15
421	31	34F2	20090707	1045	PSN388	525841N	0024511E	38	28	15
424	32	33F2	20090708	0703	PSN388	522550N	0021473E	42	20	30
425	33	33F1	20090708	0945	PSN388	521151N	0014810E	30	10	30
426	34	33F2	20090708	1220	PSN388	520997N	0020971E	43	24	30
432	35	37F4	20090711	0717	PSN388	541240N	0044560E	47	29	30
433	36	37F5	20090711	1023	PSN388	541491N	0050767E	44	27	30
434	37	36F5	20090711	1325	PSN388	535902N	0052013E	38	27	30
435	38	36F5	20090711	1449	PSN388	535047N	0051973E	34	26	30
437	39	36F6	20090712	0553	PSN388	534316N	0060733E	25	11	30
439	40	36F6	20090712	0905	PSN388	535799N	0063056E	28	20	30
441	41	37F6	20090712	1201	PSN388	541739N	0063023E	38	30	15
442	42	38F6	20090712	1359	PSN388	543157N	0063039E	39	31	20
445	43	37F7	20090713	0642	PSN388	541631N	0071466E	40	32	30
446	44	37F7	20090713	0835	PSN388	540744N	0071499E	36	28	30
450	45	37F8	20090714	0456	PSN388	542519N	0080063E	18	4	10
451	46	37F8	20090714	0642	PSN388	541185N	0080501E	26	12	10

TabLE. 3. FRV "Solea", cruise 607. Species distribution per haul (catch in kg per 30 min.).

RECTANGLE	STATION	kg total	ALOSA FALLAX	AMMODYTES MARINUS	BUGLOSSIDIUM LUTEUM	CALLIONYMUS LYRA	CLUPEA HARENGUS	CRYSTALLOGOBIUS	CYCLOPTERUS LUMPUS	ECHIICHTHYS VIPERA	ENGRAULIS ENCRASICOLUS	EUTRIGLA GURNARDUS	GADUS MORHUA	HYPEROPLUS IMMACULATUS	HYPEROPLUS LANCEOLATUS
40F7	365	481.0					83.4					6.1		0.0	
39F6	368	112.5		0.0			47.0					1.7			
39F6	369	105.2		0.0			92.6					8.7			0.1
39F7	370	26.3										0.0			
39F7	372	175.1		0.1			13.6					4.0			0.1
39F6	373	117.9					67.6					1.8			0.0
39F5	375	505.8		0.0			315.2	0.0				3.6			
39F4	377	84.4					9.7					4.1			
39F3	378	7.6		0.1			0.4	0.0	0.0			4.4			
39F3	379	8.9		0.2			0.0					3.6			
39F2	381	3.4								0.1		2.7			
39F2	382	194.8		0.1			0.9			0.1		3.9			
38F3	386	378.1					10.1	0.0				1.1	2.2		
38F4	387	175.0					0.7					1.3			
37F5	391	246.3				0.0	0.3					1.3			
36F5	394	404.4			0.0						0.1	0.4			
36F4	395	727.9					0.1					0.1			
36F3	397	256.2				0.0	0.6					0.4			
36F3	398	254.3				0.0	28.0					0.7			
36F2	400	192.3		0.0						0.4		1.3			0.4
36F1	405	0.2								0.1		0.2			
36F1	406	98.6		0.0											
37F2	408	60.1		0.0			0.5	0.0				0.7			
37F3	410	278.0					3.9					2.8			
37F4	411	249.6					1.2					3.5			
37F4	412	525.1					1.9					2.1	2.3		
36F4	414	469.6					1.0					0.1			
35F3	416	119.2										0.4			
35F3	417	831.5					0.0								0.0
34F2	420	1496.9					0.1			0.6		0.2			0.1
34F2	421	771.8					31.8			0.3					
33F2	424	47.4								1.3					
33F1	425	31.9					0.1			1.2					
33F2	426	44.4					0.0			3.5					
37F4	432	88.9					0.0					0.4			
37F5	433	117.9				0.0	0.9	0.0				0.4			
36F5	434	437.7					1.5			0.1		0.5			
36F5	435	289.9					0.0			0.1	0.0				
36F6	437	178.2					0.8				0.1				0.3
36F6	439	357.6					3.3								6.3
37F6	441	1158.0													
38F6	442	877.1					156.5					0.3			0.0
37F7	445	250.1	0.3				22.9				14.1	0.5	3.9		
37F7	446	818.5					69.0				2.3				
37F8	450	640.9									3.1				0.1
37F8	451	1390.3				0.1	1.8				0.4				0.1
total		16086.7	0.3	0.6	0.0	0.2	967.3	0.0	0.0	7.7	20.1	63.0	8.5	0.0	7.5
proportion (%)			0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.1	0.4	0.1	0.0	0.0
number of catches			1	10	1	5	36	5	1	11	7	33	3	1	11
presence (%)			2.2	21.7	2.2	10.9	78.3	10.9	2.2	23.9	15.2	71.7	6.5	2.2	23.9

Table 3 continued: FRV "Solea", cruise 607. Species distribution per haul (catch in kg per 30 min.).

RECTANGLE	STATION	kg total	*LIMANDA LIMANDA*	*MERLANGIUS MERLANGUS*	*MERLUCCIUS MERLUCCIUS*	*MUSTELUS ASTERIAS*	*PETROMYZON MARINUS*	*PLEURONECTES PLATESSA*	*PSETTA MAXIMA*	*SALMO SALAR*	*SCOMBER SCOMBRUS*	*SPRATTUS SPRATTUS*	*TRACHURUS TRACHURUS*	*TRISOPTERUS LUSCUS*	Number of Species
40F7	365	481.0	0.1	0.0							5.5	385.6	0.3		3
39F6	368	112.5		0.5	2.1							61.2			3
39F6	369	105.2		0.0						3.1		0.8			4
39F7	370	26.3		0.0							1.0		25.3		1
39F7	372	175.1		0.0								154.4	2.9		4
39F6	373	117.9		0.0								48.4			3
39F5	375	505.8	0.1	0.2								186.8			4
39F4	377	84.4	0.3	0.1								70.3			2
39F3	378	7.6		0.0								2.6			5
39F3	379	8.9		0.0							0.1	5.0			3
39F2	381	3.4	0.6												2
39F2	382	194.8		1.1				1.0		1.2	1.6	184.4	0.5		4
38F3	386	378.1		0.5								364.2	0.1		4
38F4	387	175.0		0.4				0.6				172.0			2
37F5	391	246.3	0.6	0.7							0.3	243.0			3
36F5	394	404.4	2.3	0.9		1.6					2.8	393.7	2.6		3
36F4	395	727.9	0.5	2.1							0.3	724.5	0.3		2
36F3	397	256.2	0.5	1.3							104.0	149.5			3
36F3	398	254.3	0.2	60.1					1.2		0.6	163.0	0.6		3
36F2	400	192.3	0.2	0.0								189.9	0.1		4
36F1	405	0.2		0.0											2
36F1	406	98.6		0.6								98.0			1
37F2	408	60.1	0.1	0.0					4.1		0.2	54.5			4
37F3	410	278.0		0.6							0.7	270.0			2
37F4	411	249.6		2.8					1.2			240.9			2
37F4	412	525.1	0.1	1.6								517.0			3
36F4	414	469.6								0.2		468.4			2
35F3	416	119.2									0.7	118.1			1
35F3	417	831.5									0.4	831.0			2
34F2	420	1496.9		0.0							6.0	1490.0			4
34F2	421	771.8										739.7			2
33F2	424	47.4		0.0								46.0			1
33F1	425	31.9									5.6	25.0		0.0	2
33F2	426	44.4		0.0								40.9			2
37F4	432	88.9										88.5		0.0	2
37F5	433	117.9									0.4	116.0	0.2	0.0	4
36F5	434	437.7		0.0							2.7	424.3	8.6		3
36F5	435	289.9									0.5	280.0	9.4		3
36F6	437	178.2		0.0							3.0	174.0	0.0		3
36F6	439	357.6		0.0							10.6	335.0	2.4		2
37F6	441	1158.0		0.1							1.6	1146.0	10.2		0
38F6	442	877.1	0.8	5.2							1.2	712.8	0.2		3
37F7	445	250.1	0.3	0.5			0.0				1.7	200.5	5.4		5
37F7	446	818.5									1.7	745.0	0.6		2
37F8	450	640.9									1.7	636.0			2
37F8	451	1390.3										1387.9			4
total		16086.7	6.6	79.5	2.1	1.6	0.0	1.6	6.5	4.4	154.7	14684.9	69.6	0.0	
proportion (%)			0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	1.0	91.3	0.4	0.0	
number of catches			14	34	1	1	1	2	3	3	25	43	18	3	
presence (%)			30.4	73.9	2.2	2.2	2.2	4.3	6.5	6.5	54.3	93.5	39.1	6.5	

Table 4°. FRV "Solea", cruise 607. Herring length frequency (%) by trawl haul (length in cm).

	STAT:	365	368	369	372	373	375	377	378	379	382	386	387	391	395	397	398	408
	Haul:	1	2	3	5	6	7	8	9	10	12	13	14	15	17	18	19	23
Length	Rect:	40F7	39F6	39F6	39F7	39F6	39F5	39F4	39F3	39F3	39F2	38F3	38F4	37F5	36F4	36F3	36F3	37F2
(cm)	Total																	
3.25	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
3.75	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0
4.25	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0
4.75	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
5.25	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	6
5.75	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	6
6.25	1.2	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	10	3
6.75	1.0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	12	10
7.25	1.6	1	0	0	0	0	0	0	11	0	6	0	0	0	0	0	15	13
7.75	3.7	9	3	18	2	1	0	2	19	0	12	0	0	0	0	0	13	6
8.25	7.2	11	10	44	11	11	0	4	24	0	19	0	0	0	0	0	13	0
8.75	10.2	20	18	31	10	32	0	4	20	25	24	0	5	0	0	0	5	3
9.25	14.2	20	30	3	14	33	1	2	13	25	22	0	0	0	100	0	1	0
9.75	23.6	15	21	2	16	17	2	4	7	50	12	0	0	0	0	0	0	3
10.25	15.7	12	10	0	27	5	1	2	2	0	3	0	0	0	0	0	0	0
10.75	5.9	10	0	0	14	0	0	2	0	0	0	0	0	0	0	0	0	0
11.25	1.8	1	0	0	4	0	0	2	0	0	0	0	0	0	0	0	0	0
11.75	0.9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.25	0.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.75	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13.25	0.5	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
13.75	0.3	0	0	0	0	0	0	0	0	0	0	1	5	0	0	0	0	3
14.25	0.4	0	0	0	0	0	0	4	0	0	0	1	0	0	0	0	0	0
14.75	0.9	0	1	0	0	0	4	23	0	0	0	7	5	9	0	0	0	3
15.25	1.8	0	1	0	0	0	18	10	0	0	0	24	9	9	0	7	0	23
15.75	2.1	0	1	0	0	0	23	10	2	0	0	29	14	64	0	7	0	6
16.75	2.2	0	2	0	0	0	29	13	0	0	1	23	23	9	0	27	0	13
18.75	1.3	0	1	0	0	0	16	13	0	0	0	8	27	0	0	20	0	0
19.25	0.6	0	1	0	0	0	3	0	0	0	0	2	9	0	0	13	0	0
19.75	0.3	0	0	0	0	0	2	0	0	0	0	1	5	0	0	13	0	0
20.25	0.1	0	0	0	0	0	0	0	0	0	0	1	0	9	0	13	0	0
20.75	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21.25	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21.75	0.0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
22.25	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
total n	100.0	203	493	232	97	230	158	48	123	4	190	338	22	11	1	15	263	31
mean		9.3	9.7	8.4	9.7	9.1	15.8	14.0	8.5	9.4	8.8	15.8	15.9	15.9	9.3	16.9	6.5	11.1

Table 4a continued: FRV "Solea", cruise 607. Herring length frequency (%) by trawl haul (length in cm).

	410	411	412	414	417	420	421	425	426	432	433	434	435	437	439	442	445	446	451
	24	25	26	27	29	30	31	33	34	35	36	37	38	39	40	42	43	44	46
Length	37F3	37F4	37F4	36F4	35F3	34F2	34F2	33F1	33F2	37F4	37F5	36F5	36F5	36F6	36F6	38F6	37F7	37F7	37F8
(cm)																			
3.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.25	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.75	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.25	0	0	0	29	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
6.75	0	0	0	13	0	0	0	0	0	0	13	2	0	0	0	0	0	0	0
7.25	0	5	0	16	0	0	0	0	0	14	21	9	0	0	0	0	0	0	0
7.75	0	0	0	11	0	0	6	0	0	43	22	5	0	0	0	0	0	0	0
8.25	0	0	0	8	0	0	14	11	0	29	21	7	0	0	0	0	0	0	0
8.75	0	0	0	5	0	0	24	11	0	14	11	11	0	0	0	1	0	0	17
9.25	0	0	0	3	0	0	30	0	0	0	4	23	0	0	0	1	7	4	23
9.75	0	0	0	2	0	0	12	11	0	0	4	23	100	3	0	5	48	30	37
10.25	0	0	0	0	0	0	6	33	0	0	0	11	0	17	0	27	31	38	14
10.75	0	0	0	0	0	0	1	11	0	0	1	2	0	43	1	36	9	21	3
11.25	0	0	0	0	0	0	1	0	0	0	0	2	0	24	3	14	2	6	0
11.75	0	0	0	0	0	0	0	22	100	0	0	0	0	6	15	5	1	2	0
12.25	0	0	0	0	0	0	0	0	0	0	0	0	0	1	33	5	1	1	3
12.75	0	0	0	0	0	0	0	0	0	0	0	0	0	6	16	2	0	0	0
13.25	0	0	0	0	0	0	1	0	0	0	0	0	0	0	15	1	0	0	0
13.75	0	0	3	0	0	0	0	0	0	0	0	0	0	0	6	1	0	0	3
14.25	1	0	16	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0
14.75	1	3	13	1	100	0	1	0	0	0	0	0	0	0	3	0	0	0	0
15.25	2	15	16	1	0	0	1	0	0	0	1	0	0	0	2	0	0	0	0
15.75	3	33	27	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0
16.75	19	23	13	0	0	0	1	0	0	0	0	5	0	0	2	0	0	0	0
18.75	33	13	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19.25	23	3	3	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0
19.75	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.25	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.75	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
21.25	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21.75	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
total n	98	39	64	311	1	1	2460	9	1	7	140	44	1	72	102	341	3540	200	35
mean	16.9	15.7	15.5	7.2	14.8	17.3	9.4	10.2	11.8	8.0	7.9	9.4	9.8	11.1	12.8	10.9	10.1	10.3	9.8

Table 4b. FRV "Solea", cruise 607. Sprat length frequency (%) by trawl haul (length in cm).

Length (cm)	Stat: / Haul: / Rect: / Total	365 / 1 / 40F7	368 / 2 / 39F6	369 / 3 / 39F6	372 / 5 / 39F7	373 / 6 / 39F6	375 / 7 / 39F5	377 / 8 / 39F4	378 / 9 / 39F3	379 / 10 / 39F3	382 / 12 / 39F2	386 / 13 / 38F3	387 / 14 / 38F4	391 / 15 / 37F5	394 / 16 / 36F5	395 / 17 / 36F4	397 / 18 / 36F3	398 / 19 / 36F3	400 / 20 / 36F2	406 / 22 / 36F1	408 / 23 / 37F2	410 / 24 / 37F3
4.75	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.25	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.75	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.25	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.75	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.25	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
7.75	1.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0
8.25	3.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	0	0	0	0
8.75	7.8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	3	8	0	0
9.25	10.7	0	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	19	38	1	0
9.75	14.4	7	25	6	28	0	0	2	0	0	1	2	1	9	1	6	2	2	42	38	16	4
10.25	17.9	37	34	24	54	15	1	10	10	3	8	7	8	36	3	23	7	1	28	10	44	8
10.75	17.3	38	25	36	15	42	5	33	40	18	40	19	29	47	17	35	17	0	7	3	28	29
11.25	10.8	15	6	24	1	34	5	25	24	41	32	20	32	7	28	24	29	0	1	1	6	23
11.75	6.0	3	1	5	0	7	6	16	11	25	15	17	22	1	27	10	29	0	0	0	1	11
12.25	3.0	0	0	3	0	0	15	4	5	6	3	16	5	0	16	0	11	1	0	1	1	9
12.75	2.6	0	0	1	0	0	26	3	2	4	0	10	2	0	4	1	4	0	0	0	2	9
13.25	2.2	0	0	0	0	0	28	4	4	1	0	5	0	0	3	0	2	0	0	0	1	5
13.75	1.4	0	0	1	0	0	13	3	3	1	0	3	0	0	1	0	0	0	0	0	0	2
14.25	0.4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
14.75	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.25	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
total n	100.0	588	265	80	210	238	231	241	252	235	243	242	252	292	229	219	258	224	286	260	255	351
mean		10.6	10.2	10.8	10.2	10.9	12.7	11.3	11.2	11.4	11.1	11.6	11.2	10.5	11.6	10.8	11.4	8.4	9.9	9.6	10.5	11.4

Length (cm)	411 / 25 / 37F4	412 / 26 / 37F4	414 / 27 / 36F4	416 / 28 / 35F3	417 / 29 / 35F3	420 / 30 / 34F2	421 / 31 / 34F2	424 / 32 / 33F2	425 / 33 / 33F1	426 / 34 / 33F2	432 / 35 / 37F4	433 / 36 / 37F5	434 / 37 / 36F5	435 / 38 / 36F5	437 / 39 / 36F6	439 / 40 / 36F6	441 / 41 / 37F6	442 / 42 / 38F6	445 / 43 / 37F7	446 / 44 / 37F7	450 / 45 / 37F8	451 / 46 / 37F8
4.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.25	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
5.75	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
6.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.75	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
7.25	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0
7.75	0	1	3	0	0	0	0	1	39	3	0	0	1	0	0	0	0	0	0	0	0	0
8.25	2	4	18	0	0	0	9	22	22	6	6	5	9	2	0	0	0	0	0	0	0	0
8.75	9	9	45	0	2	0	37	48	15	35	14	28	29	12	21	0	0	0	0	1	1	8
9.25	14	16	24	0	5	0	39	21	4	41	30	34	26	19	58	6	0	0	0	10	18	36
9.75	26	30	8	3	26	0	10	5	3	14	34	24	16	22	20	24	0	6	17	51	42	41
10.25	21	25	1	50	37	0	2	1	0	0	11	7	11	20	0	30	2	32	52	34	30	13
10.75	15	11	1	32	25	0	0	1	0	0	4	1	7	14	0	15	5	30	27	2	9	2
11.25	7	4	0	7	3	0	0	0	0	0	1	1	1	9	0	6	19	26	1	0	0	0
11.75	3	0	0	5	1	2	0	0	0	0	0	0	0	2	0	4	31	4	2	0	0	0
12.25	1	1	0	2	1	7	0	1	0	0	0	0	0	1	0	6	16	1	0	0	0	0
12.75	0	0	0	0	0	17	1	0	0	0	0	0	0	0	0	6	14	1	0	0	0	0
13.25	1	0	0	0	0	28	0	1	0	0	0	0	0	0	0	1	10	0	0	0	0	0
13.75	0	0	0	0	0	29	1	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0
14.25	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
14.75	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
total n	229	302	235	207	210	261	241	197	282	261	262	264	235	255	246	270	251	286	242	302	178	229
mean	10.1	9.8	8.9	10.6	10.3	13.4	9.2	8.9	7.9	9.0	9.5	9.3	9.3	10.0	9.3	10.6	12.0	10.7	10.3	9.9	9.9	9.58

Table 5. FRV "Solea", cruise 607. Age/maturity-length key for herring (sampled numbers not raised to the abundance in the survey area).

WR	0	1	
Maturity	I	I	
Length (cm)			Sum
5.25	1		1
5.75	6		6
6.25	28		28
6.75	37		37
7.25	62		62
7.75	83		83
8.25	92		92
8.75	103		103
9.25	104		104
9.75	110		110
10.25	90		90
10.75	56		56
11.25	45		45
11.75	33		33
12.25	24	1	25
12.75	24	1	25
13.25	14	7	21
13.75	8	18	26
14.25	5	31	36
14.75	2	69	71
15.25	1	77	78
15.75	1	73	74
16.25		84	84
16.75	1	70	71
17.25	1	42	43
17.75		28	28
18.25	1	10	11
18.75		3	3
19.25		1	1
19.75		3	3
20.25		2	2
20.75		2	2
21.25		1	1
21.75			
22.25		1	
total	931	524	1454

Table 6. FRV "Solea", cruise 607. Age/maturity-length key for sprat (sampled numbers not raised to the abundance in the survey area).

AGE	1	1	2	2	3	4	
MATURITY	I	M	I	M	M	M	
Length (cm)							Sum
6.25	1	0	0	0	0	0	1
6.75	1	0	0	0	0	0	1
7.25	14	0	0	0	0	0	14
7.75	44	0	0	0	0	0	44
8.25	79	0	3	0	0	0	82
8.75	100	17	12	0	0	0	129
9.25	83	60	7	6	0	0	156
9.75	48	141	6	20	0	0	215
10.25	19	167	5	37	0	0	228
10.75	10	161	0	66	2	0	239
11.25	1	133	0	70	2	0	206
11.75	0	101	0	92	3	0	196
12.25	0	44	0	104	5	0	153
12.75	0	12	0	91	20	0	123
13.25	0	1	0	81	19	0	101
13.75	0	0	0	45	24	0	69
14.25	0	0	0	12	14	0	26
14.75	0	1	0	1	9	2	13
15.25	0	0	0	1	1	0	2
total	400	838	33	626	99	2	1998

ANNEX 5G: Ireland

Survey report for RV "Celtic Explorer"

3–22 July 2009

Ciaran O'Donnell, Marine Institute, Galway, Ireland.

1. INTRODUCTION

The northwest and west coast (ICES Divisions VIaS and VIIb, c) herring acoustic survey programme was first established in 1994. Prior to acoustic estimation a larval survey programme was conducted between 1981 and 1986. In the early 1990s, the ICES herring working group (HAWG) identified the need for a dedicated herring acoustic survey in this area (Anon, 1994). From 1994 to 1996 surveys were carried out on this stock during summer feeding phase. In 1997 a two-survey spawning survey was established covering both autumn and winter components. In 2004, a single spawning stock survey was carried out early in quarter 1 and continued until 2007. In 2008, it was decided that this survey should be incorporated into the larger coordinated Malin shelf survey as recommended by SGHERWAY and WGHAWG.

This survey was the second in a new time-series and a step away from the traditional spawning stock surveys. The Irish survey was carried out concurrently with the West of Scotland (MarLab) and Irish Sea surveys (AFBI) and was coordinated through the ICES Planning Group of International Pelagic Surveys (PGIPS). Combined survey data on herring distribution, abundance and age will be used to provide a measure of the relative abundance of herring within the Malin shelf stock complex. Survey data on stock numbers at-age are submitted to the ICES Herring Assessment Working Group (HAWG) and used in the annual stock assessment process.

The northwest and west coast (ICES Divisions VIaS and VIIb, c) herring stock is composed of 2 of spawning components, autumn and winter spawners. Spawning covers a large geographical area and extends over a 4-month period from late September through to late March (Molloy *et al.,* 2000). Traditionally fishing effort has been concentrated on spawning and prespawning aggregations. The autumn spawning component, which mostly occurs within VIIb, feeds along the shelf break area to the west of the spawning grounds. In VIaS, summertime distribution extends from close inshore to the shelf break. A component of this winter spawning fish is known to undertake northward feeding migration into VIaN before returning in winter to spawn along the Irish coast.

Up to 40 vessels commonly participate in the fishery, many of which are based in the Co. Donegal port of Killybegs. The fleet is made up of 20 RSW (Refrigerated Seawater) vessels of 40–70m in length; 20 polyvalent trawlers 10 of which are vessels of 22–40m and 10 of less than 25m.

Objectives

The primary survey objectives of the survey are listed below:

- Carry out a predetermined survey cruise track based on the known summer herring distribution
- Collect biological samples from directed trawling on fish echotraces to determine age structure and maturity state of survey stock

- Determine an age stratified estimate of relative abundance and biomass of herring within the survey area (ICES Divisions VIIb-c and VIaS) using acoustic survey techniques
- Collect physical oceanography data via a deployed sensor array.

2. SURVEY DESCRIPTION AND METHODS

2.1 Personnel

Organisation	Name	Capacity
FSS	Ciaran O'Donnell	Acoustics (SIC)
FSS	Ryan Saunders	Acoustics
FSS	Eugene Mullins	Acoustics
FSS	Robert Bunn	Acoustics
FSS	Mairead O'Sullivan	Biologist
FSS	Clementine Harma	Biologist
FSS	Marcin Blaszkowski	Biologist (Deck Sci)
FSS	Deirdre Hoare	Biologist
IWDG	Laura Kavanagh	Marine Mammal Obs.

2.2 Survey design

The survey was focused on the northwest and west coast of Ireland (ICES Divisions VIaS and VIIb-c) as shown in Figure 1. The survey track commenced in the north and worked southwards in continuity.

To keep in line with existing survey methodology (MarLab West of Scotland survey) acoustic surveying was only undertaken between 04:00 and 23:00 (daylight hours).

A systematic parallel transect design was adopted with a randomized start point. Transects were positioned running perpendicular to the lines of bathymetry where possible. Offshore, transects extended to the 250m depth contour and inshore to approximately the 30m depth contour. Transect spacing was set at 3.5 nautical mile (nautical miles) in the main body of the survey and at 15nmi where transects were interlaced with the MarLab charter vessel.

In total, the survey accounted for 2,440nmi, with 2,252nmi of data available for acoustic integration. Survey design and methodology adheres to the methods laid out in the PGHERS acoustic survey manual.

2.3 Calibration

The ER60 was calibrated in Killary Harbour on the July 18 mid way through the survey. Beam model results were not updated until after the survey. The results of the calibration are presented in Table 1. Prior to this the ER60 was last calibrated in March 2009 (O'Donnell *et al.*, 2009).

2.4 Acoustic data collection

Equipment settings for the acoustic equipment were determined before the start of the survey program and were based on established settings employed by FSS on previous surveys (O'Donnell *et al.*, 2004). Equipment settings of the *Celtic Explorer* acoustic array are shown in Table 1.

Acoustic data were collected using the Simrad ER60 scientific echosounder. A Simrad ES-38B (38 KHz) split-beam transducer is mounted within the vessels drop keel and lowered to the working depth of 3.3m below the vessels hull or 8.8m below the sea surface. Three additional operating frequencies were used during the survey (18, 120 and 200kHz) for trace recognition purposes, with the 38KHz data used solely to generate the abundance estimate.

Whilst on survey track the vessel is normally propelled using DC twin electric motor propulsion system with power supplied from 1 main diesel engine, so in effect providing "silent cruising" as compared to normal operations (Anon, 2002). Cruising speed is maintained at a maximum of 10 Kts (knots) where possible. During fishing operations normal 2 engine operations were employed to provide sufficient power to tow the net.

Acoustic data were observed and recorded onto the hard-drive of the processing unit using the equipment settings from previous surveys (Table 1). The "RAW files" were logged via a continuous Ethernet connection as "EK5" files to the vessels server and the ER60 hard drive as a backup in the event of data loss. In addition, as a further back up a hard copy was stored on an external HDD and copied to DVD. Sonar Data's Echoview® Echolog (Version 4.2) live viewer was used to display the echogram during data collection to allow the scientists to scroll through echograms noting the locations and depths of fish shoals. A member of the scientific crew monitored the equipment continually. Time and location (GPS position) data were recorded for each transect within each survey strata. This log was used to monitor the time spent off track during fishing operations and hydrographic stations plus any other important observations.

2.5 Biological data - fishing trawls

A single pelagic midwater trawl with the dimensions of 19m in length (LOA) and 6m at the wing ends and a fishing circle of 330m was employed during the survey (Figure 11). Mesh size in the wings was 1.6m through to 2cm in the codend. The net was fished with a vertical mouth opening of approximately 8m, which was observed using a cable linked "BEL Reeson" netsonde (50 kHz). The net was also fitted with a SCANMAR depth sensor. Spread between the trawl doors was monitored using SCANMAR distance sensors, all sensors being configured and viewed through a SCANMAR Scanbas system.

All components of the catch from the trawl hauls were sorted and weighed; fish and other taxa were identified to species level. Fish samples were divided into species composition by weight. Species other than the herring were weighed as a component of the catch and length and weight measurements were taken for 100 individuals in addition to a 300 fish length frequency sample. Age, length, weight, sex and maturity data were recorded for individual herring within a random 100 fish sample from each trawl haul with a further 100 random length and weight measurements were also taken in addition to a 300 fish length frequency sample. All herring were aged on-board. The appropriate raising factors were calculated and applied to provide length frequency compositions for the bulk of each haul.

Decisions to fish on particular echotraces were largely subjective and an attempt was made to target marks in all areas of concentration not just high density shoals. No bottom-trawl gear was used during this survey.

2.6 Hydrographic data

Oceanographic stations were carried out during the survey at predetermined locations along the track. Data on temperature, depth and salinity were collected using a Seabird 911 sampler from 1m subsurface to full depth (with a 2m safety offset).

2.7 Data analysis

Echogram scrutinisation

Acoustic data were backed up every 24 hrs and scrutinised using Sonar data's Echoview® (V 4.2) post-processing software. Partitioning of data into the above categories was largely subjective and was viewed by a scientist experienced in viewing echograms.

The NASC (Nautical Area Scattering Coefficient) values from each herring region were allocated to one of 4 categories after inspection of the echograms. Categories identified on the basis of trace recognition were as follows:

1. "Definitely herring" echotraces or traces were identified on the basis of captures of herring from the fishing trawls which had sampled the echotraces directly, and on large marks which had the characteristics of "definite" herring traces (i.e. very high intensity (red), narrow inverted tear-shaped marks either directly on the bottom or in midwater and in the case of spawning shoals very dense aggregations in proximity to the seabed).

2. "Probably herring" were attributed to smaller echotraces that had not been fished but which had the characteristic of "definite" herring traces.

3. "Herring in a mixture" were attributed to NASC values arising from all fish traces in which herring were thought to be contained, owing to the presence of a proportion of herring within the nearest trawl haul or within a haul which had been carried out on similar echotraces in similar water depths.

4. "Possibly herring" were attributed to small echotraces outside areas where fishing was carried out, but which had the characteristics of definite herring traces.

The "EK5" files were imported into Echoview for echo post-processing. The echograms were divided into transects. Echo integration was performed on a region which were defined by enclosing selecting marks or scatter that belonged to one of the four categories above. The echograms were analysed at a threshold of -70 dB and where necessary plankton was filtered out by thresholding at –65 dB.

The allocated echo integrator counts (NASC values) from these categories were used to estimate the herring numbers according to the method of Dalen and Nakken (1983).

The following TS/length relationships used were those recommended by the acoustic survey planning group (Anon, 1994):

Herring	TS = 20logL – 71.2 dB per individual (L = length in cm)
Sprat	TS = 20logL – 71.2 dB per individual (L = length in cm)
Mackerel	TS = 20logL – 84.9 dB per individual (L = length in cm)
Horse mackerel	TS = 20logL – 67.5 dB per individual (L = length in cm)

The TS length relationship used for gadoids was a general physoclist relationship (Foote, 1987):

Gadoids TS = 20logL – 67.5 dB per individual (L = length in cm)

The same categories were applied to other target pelagic species encountered during the survey. Selection criteria are based primarily upon the species composition of trawl samples as well as target strength (TS) information.

2.8 Abundance estimates

Total abundance, N_T, is given by $\sum_{m}^{Mark-types} N_{T,m}$, the sum over the total abundance by mark-types.

$$N_{T,m} = \sum_{s}^{strata} N_{m,s}$$

Suppressing the mark-type index, m, the stratum abundance is

$$N_s = area_s \sum_{l}^{transects} \bar{n}_{s,t} l_{s,t} \Big/ \sum_{j} l_{s,j}$$

,where l is the transect length and $\bar{n}$ is the transect mean abundance n.mi^{-2} which is given by

$$\sum_{j}^{track\cdot fragments} n_{s,t,j} d_{s,t,j} \Big/ l_{s,t}$$

, where d is the distance of the track fragment and $n_{s,t,j}$ is the mean abundance n.mi^{-2} for the jth track fragment.

Because hauls are assigned with their own stratification that will not necessarily coincide with the acoustic strata, the conversion of NASC into mean density is done at the track fragment level, usually a 1 n.mi segment, but these could be just for the schools themselves. The haul assigned, $h_{m,s,t,j}$, depends strongly on the mark-type (m) and because more than one school can be in a track fragment it needs to be specified. Because age and maturity length-keys are to be applied, the basic estimation is mean density by length bins. The $n_{s,t,j}$ is found by summing over the $n_{s,t,j}$.

$$n_{t,j,i} = \frac{NASC_{t,j}}{\bar{\sigma}_{h_{m,t,j}}} p_{i,h_{m,t,j}}$$

, where i indexes length bins, p_i is the proportion of herring in the i^{th} length bin, and is given by $\sum_{spe}^{species} \sum_i p_{spe,i} 10^{(a+b\log10(L_{spe,i}))/10}$

, where $p_{spe,i}$ applies over all species considered in the haul, $L_{spe,i}$ is the length to use for the i^{th} length bin and the data comes from the haul (of combination of hauls) assigned, $h_{m,t,j}$. For non-mix mark-types, the later simplifies to

$$\sum_i p_{herring,i} 10^{(073+20\log10(L_{herring,i}))/10}.$$

For biomass, a mean weight is also applied to the $n_{t,j,i}$ using the estimated regression relationship, a L_i^b.

For abundance by age and maturity, the abundance by length bin, $n_{t,j,i}$, is averaged over track fragments then transects to give a strata (and mark-type) mean. The age and maturity keys are applied to the results.

$V_s = area_s^2 s_s^2 W_s$, where $W_s = \sum_l^{transects} l^2_{s,t} / (\sum_j l_{s,j})^2$ and s^2 is the sample variance.

The variance for the total is the sum of strata variances.

The total biomass can be obtained directly from the track fragment mean biomass by

$B_T = \sum_k^{track\cdot fragment} \bar{n}_k w_k$, where w_k is a factor that takes into account the factors for transect and strata averaging, i.e. $w_k = \frac{1n.mi}{l_{t_k}} \frac{l_{t_k}}{\sum_t^{stratum.s_k} l_{s_k,t}} area_{s_k} = \frac{1}{\sum_t^{stratum.s_k} l_{s_k,t}} area_{s_k}$

, where the 1 n.mi is the length of the track fragment. This ignores the mark-type because that is already accounted for in the $\bar{n}_k$. The $\bar{n}_k w_k$ is the biomass from a track fragment and they can then be used to map the biomass at a fine spatial scale.

Estimates are made for SSB, total abundance and biomass, abundance by age (ring counts), and abundance by age x length bins. A cv (based on strata standard error divided by the strata mean) is estimated for SSB, total abundance and biomass, and abundance by age.

3. RESULTS

Thirty one hauls were carried out over the course of the survey of which 13 contained herring (Figure 2, Table 2). Herring schools close to the surface proved very difficult to catch and as a result only a few successful trawls were made. As a result the number of valid herring samples (n=>100) was low (3). Over 900 length measurements of herring were taken and 347 individual were aged during the survey.

3.1 Herring biomass and abundance

A full breakdown of the survey stock structure is presented by distribution, age, length, biomass, abundance and area in Tables 4, 5 and 6 and Figures 3 and 4.

Herring	Millions	Biomass (t)	% contribution
Total estimate			
Definitely	328	24,760	53.3
Mixture	26	6,126	13.2
Probably	194	15,574	33.5
Total estimate	**548**	**46,460**	100
Possibly	-	-	
Possible estimate			
SSB Estimate			
Definitely	68	8,717	41.7
Mixture	26	6,126	29.3
Probably	44	6,063	29.0
SSB estimate	**138**	**20,906**	100

3.2 Herring distribution

A full breakdown of school categorization, number and biomass and abundance by strata is provided in Table 9.

In VIaS, herring were found distributed on the shelf between 55–56ºN. Schools in this area were observed mainly as single midwater/surface spikes in the mid-shelf area (Figure 6c). Single schools that were successfully targeted were found to be composed mainly of small juvenile fish and a small proportion of mature individuals from 16.5–27.5cm (Figures 2 and 3, Table 3). Due to the difficulties in successfully catching herring samples in this area the accuracy length profile data should be considered and may not be a true representation of the school composition.

Towards the shelf break in VIaS herring were observed as mixed schools often occurring over a very wide area (Figure 6a). The pattern of school type and distribution is similar to 2008. However, in the northern reaches along the shelf break area some very large high density scattering layers containing small amounts of herring were observed. One of which was in excess of 14nmi long stretching from the 120–250m depth contours. Trawl samples from these layers yielded very small amounts of herring (2 individuals per sample) and a much greater contribution of mackerel. Due to the high density of this scattering layer, the high density of plankton and the mix of fish and non-fish species it was impossible to accurately determine the proportion of herring contained within these layers. As a result it was decided that no allocations should be made to herring.

In VIIb, herring were found distributed along the shelf break around the 54ºN within a localized area (Figure 3). Herring on the shelf break were found mixed with mackerel that were in various stages of spawning (Figure 6a). Samples from VIIb ranged from 25–31cm overall and were distinctly different from those further north. The age profile of herring in VIIb showed a similar profile to the expected age composition as observed in 2008.

In 2008, the highest density registrations were also encountered along the shelf break area in VIIb. However, in 2008 a relatively large number of small herring schools were also found distributed in shallow waters on-shelf close to autumn spawning grounds. In 2009, these small on-shelf schools were absent and it is thought that migration westward to the shelf edge feeding grounds had already taken place.

3.3 Stock structure

Age analysis of biological samples showed herring within the survey area to be composed of age from 1–9 years (winter rings), as shown in Figure 4 and Table 4. Over 86% of the total-stock biomass was located in VIaS in the regions associated with mainly winter spawners. The remaining 14% of the total biomass was located in VIIb a region more associated with autumn spawners.

Areas combined, the stock appears dominated by 1 winter ring fish which contribute 55.7% of the biomass and 76% of the abundance estimate. Combined these two year classes represent over 78% of the total biomass observed during the survey. The next most dominate year class is the 2 winter ring which make up over 22% of the biomass and 15% of total abundance. The 4, 7, and 5 winter ring fish make up the remaining ranked year classes. However, the large proportion of total biomass in VIaS and the associated low age profile distorts the overall profile of the estimate.

The dominant year classes from the 2008 survey were the 2 and 3 winter ring fish and contributed 25% and 24% of the total biomass respectively. In 2009 these year classes are largely under represented as the now 3 and 4 winter ring fish. Weak signs of the 4 winter ring fish are visible but not in the numbers that would be expected. The age profile of herring within VIIb are as would be expected based on the 2008 survey results and from commercial catch data.

Maturity analysis indicates over 55% of the total biomass to be immature, which represents over 74% of the abundance estimate. Of the remaining biomass 45% of which was mature 27% is accounted for by the stage 3 (maturing) fish which were mostly located within VIIb in the region associated with autumn spawners and 15% of stage 8 (spent) fish that were located further north in winter spawning region.

3.4 Secondary species

Boarfish

Boarfish (Capros aper) were encountered almost exclusively along the shelf break from 120–250m depth between the 53–54ºN line of latitude as clean single high density schools (Figure 5 and 6d). Boarfish schools once positively identified were easily discernible from other species. Over 720 individual length measurements and 303 length/weight measurements were recorded. Length ranged between 10.5–17.5cm, with a mean length and weight of 12.7cm and 47g respectively.

A full breakdown of school number and biomass and abundance by strata is provided in Table 10.

Boarfish	Millions	Biomass (t)	% contribution
Total estimate			
Definitely	2000.0	21,697	100.0
Mixture	0	0	0
Probably	0	0	0
Total estimate	2000	21,697	100

Mackerel

Mackerel were the most commonly observed species on the survey and were found in 94% of hauls. Mackerel were distributed over the entire survey area as single species schools and also in mixed layers. On the shelf, schools of mixed size classes were encountered which tended to be composed of smaller individuals. These on-shelf schools ranged from low to high density. Further offshore towards the shelf break, larger fish in various spawning stages were encountered as both single and mixed schools. These schools were generally of high density. Mixed species aggregations of very high density were observed in the northern reaches of the survey. The fish component of these aggregations was composed mainly of mackerel and aggregations of over 14 nautical mile were observed (Figure 6b). In total 4,125 individual length measurements were taken for mackerel. Lengths ranged from 20–42cm with a mean length of 26.9cm relating to a mean weight of 176g.

Horse mackerel

Horse mackerel were found distributed over both the shelf break and shelf areas. Between 54–55ºN schools were found on the shelf around the Donegal Bay area as small medium to high density single species schools over patches of rough ground. The 2001 year class was well represented in trawl samples. In total 1,105 individuals were measured and 688 length/weight measurements were taken.

3.5 Oceanography

In total 27 CTD casts were made during the survey (Figure 7). All data were compiled to produce horizontal plots of temperature and salinity at the following depths; 5m subsurface, 20m, 40m and 60m (Figures 8–11 respectively).

Overall, surface waters appear warmer and fresher than last year and the water column is more stratified with regards to temperature with a defined strong thermocline. A warm freshwater lens is a prominent feature varies from data recorded at the 20m around Donegal Bay area (Figure 9). In deeper waters the West Irish Shelf Front is visible through the tightening of the isohalines off Mayo and provides a good indication of that position of this front is similar to 2008 (Figure 11).

The Islay Front in the northern survey area is the most noticeable feature in surface waters north of Malin Head (Figure 8). This is a well-documented front that separates Atlantic water from the Irish Sea.

4. DISCUSSION AND CONCLUSIONS

4.1 Discussion

Overall, the survey was a success with no time losses due to poor weather or mechanical failure. Survey aims were not achieved as planned due to the vessel not being permitted to enter UK waters. This resulted in the planned transect interlacing with the Scottish (FV *Quantus*) and Northern Ireland (RV "Corystes") vessels being dropped. The cruise plan was adjusted and survey effort was reallocated back into Irish waters.

The biomass of herring observed was overall higher than in 2008 by over 4% but distribution showed a similar pattern. The bulk of the stock was located in VIaS and thought to be composed of winter spawners. However, the age structure of the stock was markedly different from 2008 due to the high abundance of 1-ringer fish. Trawling success was considered low with only 3 valid herring samples over the survey. Only two samples used to generate the biomass for area VIaS, which represented over 86% of the total biomass. Both samples contained a large proportion of juveniles and thus were weighted heavily during the analysis. A third valid trawl sample containing a very similar length profile from VIaS was omitted from the analysis due to the small number of fish (n=31) but followed a similar length profile. The issue of catchability should be considered in terms of whether the length profile of the samples was representative or that larger individual's evaded the gear. The age structure of herring located in VIIb (autumn spawners) can be considered more robust and shows a similar pattern to the 2008 survey and also commercial catch data.

Signals of a potentially strong year class in VIaS were picked up from commercial samples taken in quarter one but not in the proportions observed from the survey data. The 2008 Scottish west coast MIK net survey indicated a higher than normal abundance of herring larvae in VIaS/VIaN border region which could explain the high abundance of 1-ringer fish observed during the survey. However, due to the small number of samples taken during the survey it is difficult to validate with any degree of certainty. As a result the estimate should be treated with a degree of caution. If a strong recruiting year class is developing then this will be picked up in both the fishery and the survey in 2010.

The high density large aggregations of mixed species observed in the northern shelf area (VIaS), although found to contain very small numbers of herring, were not allocated any herring biomass during the analysis. This was decided as the proportion of herring within these schools could not be determined with a degree of accuracy from trawl samples or through acoustic thresholding. To include allocations of these aggregations would have led to a gross overestimate of the stock. As a result biomass of herring within the VIaS region may be an underestimate.

The distribution of small on-shelf herring schools observed in the northern area of VIIb in 2008 were absent in 2009. Although of low acoustic density individually, combined these small schools contributed significantly to the overall stock biomass. Reports from fishers indicated that herring had been in Donegal Bay in June but had since left. The absence of these schools may be attributed to the difference in water temperature noted in 2008–2009 which may have prompted an earlier migration to feeding grounds either to the west or north of the Bay. Overall, SST was over 1.5ºC higher in 2009 than at the same time in 2008. Horse mackerel were found distributed over the shelf areas in and around the Donegal Bay area and historically would aggregated in August in this area. The early migration of herring and the early appearance of horse mackerel may also be an indicator of the warmer SST observed in 2009.

4.2 Conclusions

The 2009 herring estimate is similar to that observed in 2008 in terms of biomass. The biomass itself could be an underestimate due to the omission of an unquantifiable component of herring in the northern area contained within mixed layers.

The age structure of the stock as determined purely from survey data cannot be determined with any degree of certainty due to the small number of valid samples and the large proportion of 1-ringer fish. The results from the 2008 survey show good alignment with the commercial catch data. The results of the 2009 survey also show good alignment with the exception of the very strong 1-ringer fish.

As a result the estimate for herring in VIIb can be considered relatively robust in terms of biomass and abundance, although only a single sample was used to determine the age profile. The VIaS estimate should be treated with a degree of caution especially in relation to the disaggregated age data until more evidence of this year class strength becomes available.

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Table 5G.1. Survey settings and calibration report (38KHz) for the Simrad ER60 echosounder. Northwest herring survey, July 2009.

Vessel :	R/V Celtic Explorer	Date :	17/07/2009
Echo sounder :	ER60 PC	Locality :	Killary Harbour
Type of Sphere : CU-60	TS_{Sphere}: -33.50 dB (Corrected for soundvelocity or t,S)	Depth(Sea floor) :	34 m

Calibration Version 2.1.0.11

Comments:
Killary Harbour, Flat Calm @ 08:30am

Reference Target:

TS	-33.50 dB	Min. Distance	15.00 m
TS Deviation	5.0	Max. Distance	25.00 m

Transducer: ES38B Serial No. 30227

Frequency	38000 Hz	Beamtype	Split
Gain	25.73 dB	Two Way Beam Angle	-20.6 dB
Athw. Angle Sens.	21.90	Along. Angle Sens.	21.90
Athw. Beam Angle	7.05 deg	Along. Beam Angle	6.96 deg
Athw. Offset Angle	-0.01 deg	Along. Offset Angl	-0.07 deg
SaCorrection	-0.73 dB	Depth	8.80 m

Transceiver: GPT 38 kHz 009072033933 2 ES38B

Pulse Duration	1.024 ms	Sample Interval	0.193 m
Power	2000 W	Receiver Bandwidth	2.43 kHz

Sounder Type:
EK60 Version 2.2.0

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.	8.9 dB/km	Sound Velocity	1507.9 m/s

Beam Model results:

Transducer Gain =	25.71 dB	SaCorrection =	-0.63 dB
Athw. Beam Angle =	7.00 deg	Along. Beam Angle =	6.97 deg
Athw. Offset Angle =	-0.02 deg	Along. Offset Angle=	-0.06 deg

Data deviation from beam model:
RMS = 0.14 dB
Max = 0.40 dB No. = 133 Athw. = 3.2 deg Along = -3.4 deg
Min = -1.46 dB No. = 18 Athw. = -4.1 deg Along = -0.9 deg

Data deviation from polynomial model:
RMS = 0.11 dB
Max = 0.39 dB No. = 133 Athw. = 3.2 deg Along = -3.4 deg
Min = -1.45 dB No. = 18 Athw. = -4.1 deg Along = -0.9 deg

Comments :
Flat Calm, good overall conditions
Wind Force : 2 kn. **Wind Direction :** NW
Raw Data File: F:\Northwest Herring 2009\Calibration files\NWHAS_09-D20080620-T084011.raw
Calibration File: H:\ER-60\Calibrations 2009\38Khz Killary 17.07.09

Calibration: Ciaran O'Donnell

Table 5G.2. Catch composition and position of hauls undertaken by the RV "Celtic Explorer". Northwest herring survey, July 2009.

No.	Date	Lat. N	Lon. W	Time	Bottom (m)	Target (m)	Bulk Catch (Kg)	Herring %	Mackerel %	Scad %	Sprat %	Others* %
1	04.07.09	55 49.04	008 52.20	08:48	122	0-20	164.0	0.1	99.6			0.3
2	04.07.09	55 49.05	008 23.29	12:15	135	0-20	9.2	2.4	96.9			0.7
3*	04.07.09	55.49.07	007 45.48	16:24	132	0-11	1.5		100.0			
4*	04.07.09	55 51.01	007 31.16	21:41	82	0-12	183.4	0.1	99.9			
5*	05.07.09	55 45.13	009 08.21	10:54	124	30	5.0		94.0			6.0
6	05.07.09	55 48.10	007 25.50	18:00	59	34	1000.0	31.8	68.2			
7*	06.07.09	55 29.44	009 14.67	11:48	134	14	2.0		100.0			
8	06.07.09	55 29.35	008 12.35	16:34	83	55-68	700.0	75.7	24.3			
9	07.07.09	55 24.66	008 37.00	08:50	95	25	21.0	1.0	98.0			1.0
10*	07.07.09	55 22.39	009 27.11	16:30	150	0-20	1.5					100.0
11	08.07.09	55 18.90	008 36.10	10:52	96	85	450.0	1.0	99.0			
12	08.07.09	55 15.31	009 43.07	18:00	132	35	20.9		98.1	1.9		
13*	08.07.09	55.08.52	009.48.07	14:20	123	0-15	15.0	3.3	96.7			
14*	09.07.09	55 05.07	008 55.14	23:00	86	60	20.6	1.6	92.5	4.9		1.0
15*	10.07.09	55 05.00	009 07.48	05:04	101	45	250.0		100.0			
16*	10.07.09	55.01.37	009.07.04	14:19	83	0-9	0.8	93.1			6.9	
17	11.07.09	55.50.91	009.15.87	14:46	88	0-14	250.0		99.7	0.3	0.1	
18	12.07.09	54 47.39	008 44.42	08:10	65	8	300.0		100.0			
19	12.07.09	54.43.81	010 14.18	19:00	123	25-35	450.0		70.9	29.1		
20	13.07.09	54 33.39	010 20.16	19:44	120	90	270.0		80.8	19.2		
21	14.07.09	54.30.13	010.41.44	14:00	233	16-35	112.6		97.4	2.6		
22	14.07.09	54 26.63	010 21.06	22:00	82	0-10	62.4	0.3	84.6	0.8	0.1	14.2
23	15.07.09	54 26.49	009 00.53	04:53	63	0-10	900.0		98.2	1.3		0.6
24	15.07.09	54.19.59	010.28.74	16:00	144	0-15	19.9		74.6	17.5		7.9
25	16.07.09	54 05.57	010 40.14	10:21	185	0-12	188.0	11.3	49.7	15.9		23.1
26	16.07.09	54.02.05	010.52.17	16:15	185	0-20	107.0	0.3	35.0	18.5		46.2
27	16.07.09	53 58.57	010 41.55	21:10	128	100	391.6		52.6	40.1		7.3
28	17.07.09	53 55.02	011 13.57	08:25	230	170	200.0		14.0	5.0		81.0
29	18.07.09	53 37.37	011 20.97	20:16	198	0-15	400.0		21.98	65.4		12.61
30	19.07.09	53 33.71	011 21.32	10:32	178	80	47.1		24			76
31*	20.07.09	53 19.73	010 14.00	12:10	101	70	5.5		8		50	42

Note: "Others" was used to represent fish and non-fish species occurring in the catch. * Indicates target mark not caught.

Table 5G.3. Length frequency (%) of herring hauls used for calculating 'definitely' and 'probably' abundance. Northwest herring survey, July 2009.

Haul # Length	6	8	25	Totals
16.5	1.0			1
17	3.2	1.5		5
17.5	8.7	2.4		11
18	14.9	11.8		27
18.5	19.4	16.6		36
19	10.7	17.8		28
19.5	10.0	13.0		23
20	5.5	6.8		12
20.5	2.3	3.8		6
21	3.6	3.6		7
21.5	1.3	2.7		4
22	1.3	2.1		3
22.5	1.6	3.0		5
23	1.0	4.4		5
23.5	4.5	4.1		9
24	2.6	1.8		4
24.5	2.9	2.1		5
25	1.3	0.6	0.5	2
25.5	1.9		0.5	2
26	1.3	1.2	0.5	3
26.5	1.0		1.9	3
27		0.3	6.2	6
27.5		0.6	3.8	4
28			19.0	19
28.5			19.9	20
29			24.6	25
29.5			13.7	14
30			7.1	7
30.5			1.9	2
31			0.5	0
Totals	100	100	100	

Table 5G.4. Herring length at-age (winter rings) as abundance (millions) and biomass (000's tonnes). Northwest herring survey, July 2009.

Length	Age (Rings)											Abundance	Biomass	Mn wt
(cm)	0	1	2	3	4	5	6	7	8	9	10	(millions)	000's t	(g)
16.5	-	2.51	-	-	-	-	-	-	-	-	-	2.51	0.1	39.5
17	-	12.2	-	-	-	-	-	-	-	-	-	12.19	0.53	43.5
17.5	-	28.7	-	-	-	-	-	-	-	-	-	28.69	1.37	47.8
18	-	69.1	-	-	-	-	-	-	-	-	-	69.08	3.62	52.3
18.5	-	93	-	-	-	-	-	-	-	-	-	93.03	5.32	57.2
19	-	73.5	-	-	-	-	-	-	-	-	-	73.53	4.59	62.4
19.5	-	59.6	-	-	-	-	-	-	-	-	-	59.61	4.04	67.9
20	-	31.8	-	-	-	-	-	-	-	-	-	31.82	2.34	73.7
20.5	-	14.4	1.44	-	-	-	-	-	-	-	-	15.81	1.26	79.8
21	-	18.4	-	-	-	-	-	-	-	-	-	18.38	1.59	86.3
21.5	-	10.2	-	-	-	-	-	-	-	-	-	10.24	0.95	93.2
22	-	2.9	5.81	-	-	-	-	-	-	-	-	8.7	0.87	100.4
22.5	-	-	11.8	-	-	-	-	-	-	-	-	11.84	1.28	108
23	-	-	14	-	-	-	-	-	-	-	-	14	1.62	116
23.5	-	-	12.5	7.47	2.49	-	-	-	-	-	-	22.42	2.79	124.4
24	-	-	11.3	-	-	-	-	-	-	-	-	11.28	1.5	133.2
24.5	-	-	12.9	-	-	-	-	-	-	-	-	12.88	1.84	142.5
25	-	-	3.66	1.22	-	-	-	-	-	-	-	4.87	0.74	152.2
25.5	-	-	3.44	-	1.72	-	-	-	-	-	-	5.16	0.84	162.3
26	-	-	3.28	-	3.28	-	-	-	-	-	-	6.55	1.13	172.9
26.5	-	-	0.74	1.47	0.74	-	-	-	-	-	-	2.94	0.54	184
27	-	-	0.44	-	1.33	0.44	-	0.44	-	-	-	2.66	0.52	195.5
27.5	-	-	-	0.16	1.11	0.95	0.48	-	-	-	-	2.7	0.56	207.5
28	-	-	-	0.79	2.39	1.33	1.33	-	-	-	-	5.83	1.28	220.1
28.5	-	-	-	0.31	1.53	1.84	0.61	1.84	-	-	-	6.13	1.43	233.2
29	-	-	-	-	0.47	1.43	2.85	2.37	-	0.47	-	7.59	1.87	246.8
29.5	-	-	-	-	-	1.51	1.21	1.51	-	-	-	4.23	1.1	260.9
30	-	-	-	-	-	-	0.37	1.09	0.37	0.37	-	2.19	0.6	275.6
30.5	-	-	-	-	-	0.19	0.19	0.19	-	-	-	0.58	0.17	290.8
31	-	-	-	-	-	0.05	0.05	0.05	-	-	-	0.15	0.04	306.7
SSN	-	17.6	70.3	11.4	15.1	7.74	7.08	7.5	0.37	0.84	-	**137.92**	-	-
SSB	-	1.46	9.27	1.67	2.78	1.82	1.72	1.87	0.1	0.22	-	-	**20.9**	-
Mn wt (g)	-	62.2	128	146	185	235	244	249	276	259	-	-	-	-
Mn L (cm)	-	19.2	23.9	24.8	26.7	28.8	29.1	29.3	30.2	29.7	-	-	-	-

Table 5G.5. Total biomass (000's tonnes) of herring at-age (winter rings), by strata as derived from acoustic estimate of abundance. Northwest herring survey, July 2009.

Strata	0	1	2	3	4	5	6	7	8	9	10	Total
40 D9	0	2.3	0.9	0.1	0.1	0	0	0	0	0	0	3.5
40 E0	0	0.3	0.1	0	0	0	0	0	0	0	0	0.4
40 E1	0	12.6	5.1	0.8	0.8	0	0	0	0	0	0	19.4
39 D9	0	8.2	3.2	0.3	0.4	0.1	0	0	0	0	0	12.2
39 E0	0	2.5	1	0.1	0.1	0	0	0	0	0	0	3.7
39 E1	0	0.1	0	0	0	0	0	0	0	0	0	0.1
38 E0	0	0	0	0	0	0	0	0	0	0	0	0
38 D9	0	0	0	0	0	0	0	0	0	0	0	0
38 D8	0	0	0	0	0.2	0.3	0.3	0.3	0	0	0	1.1
37 E0	0	0	0	0	0	0	0	0	0	0	0	0
37 D9	0	0	0	0	0	0	0	0	0	0	0	0
37 D8	0	0	0.1	0.2	1.1	1.4	1.4	1.5	0.1	0.2	0	6
36 D8	0	0	0	0	0	0	0	0	0	0	0	0.1
36 D7	0	0	0	0	0	0	0	0	0	0	0	0
35 D8	0	0	0	0	0	0	0	0	0	0	0	0
35 D7	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	25.90	10.40	1.70	2.80	1.80	1.70	1.90	0.10	0.20	0.00	46.50
%	0	55.70	22.40	3.60	6.00	3.90	3.70	4.00	0.20	0.50	0.00	100.00

sTable 5G.6. Herring abundance (millions) at-age (winter rings), by strata as derived from acoustic estimate of abundance. Northwest herring survey, June 2008.

Strata	0	1	2	3	4	5	6	7	8	9	10	Total
40 D9	0	36.36	7.42	0.71	0.65	0.12	0.05	0.02	0	0	0	45.32
40 E0	0	4.04	0.82	0.08	0.07	0.01	0.01	0.00	0	0	0	5.03
40 E1	0	209.36	38.47	5.99	5.27	0.01	0.00	0.00	0	0	0	259.1
39 D9	0	127.36	25.98	2.48	2.29	0.41	0.17	0.08	0	0	0	158.755
39 E0	0	38.24	7.80	0.75	0.69	0.12	0.05	0.02	0	0	0	47.7
39 E1	0	0.99	0.18	0.03	0.03	0	0	0	0	0	0	1.2
38 E0	0	0	0	0	0	0	0	0	0	0	0	0
38 D9	0	0	0	0	0	0	0	0	0	0	0	0
38 D8	0	0	0.09	0.22	0.94	1.10	1.05	1.14	0.06	0.13	0	4.7
37 E0	0	0	0	0	0	0	0	0	0	0	0	0
37 D9	0	0	0	0	0	0	0	0	0	0	0	0
37 D8	0	0	0.50	1.15	5.02	5.87	5.65	6.12	0.30	0.69	0	25.3
36 D8	0	0	0.01	0.02	0.09	0.11	0.10	0.11	0.01	0.01	0	0.5
36 D7	0	0	0	0	0	0	0	0	0	0	0	0
35 D8	0	0	0	0	0	0	0	0	0	0	0	0
35 D7	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	416.3	81.26	11.42	15.05	7.74	7.08	7.50	0.37	0.84	0.00	547.591
%	0	76.03	14.84	2.09	2.75	1.41	1.29	1.37	0.07	0.15	0.00	100
Cv (%)	NA	39.6	39.4	35.6	32.8	51.2	53.7	54.8	55.8	55.7	NA	NA

Table 5G.7. Herring biomass (000's tonnes) at maturity by strata. Northwest herring survey, July 2009.

Strata	Imm	Mature	Total
40 D9	2.3	1.2	3.5
40 E0	0.3	0.1	0.4
40 E1	12.4	7	19.4
39 D9	8.1	4.1	12.2
39 E0	2.4	1.2	3.7
39 E1	0.1	0	0.1
38 E0	0	0	0
38 D9	0	0	0
38 D8	0	1.1	1.1
37 E0	0	0	0
37 D9	0	0	0
37 D8	0	6	6
36 D8	0	0.1	0.1
36 D7	0	0	0
35 D8	0	0	0
35 D7	0	0	0
Total	25.6	20.9	46.5
%	55	45	100

Table 5G.8. Herring abundance (millions) at maturity by strata. Northwest herring survey, July 2009.

Strata	Imm	Mature	Total
40 D9	35.75	9.57	45.32
40 E0	3.97	1.06	5.03
40 E1	206.12	52.98	259.10
39 D9	125.24	33.51	158.76
39 E0	37.61	10.06	47.67
39 E1	0.98	0.25	1.23
38 E0	0	0	0
38 D9	0	0	0
38 D8	0	4.72	4.72
37 E0	0	0	0
37 D9	0	0	0
37 D8	0	25.31	25.31
36 D8	0	0.45	0.45
36 D7	0	0	0
35 D8	0	0	0
35 D7	0	0	0
Total	409.67	137.92	547.59
%	74.81	25.19	100

Table 5G.9. Herring biomass and abundance by survey strata. Northwest herring survey, July 2009.

Category Stratum	No. transects	No. schools	Def schools	Mix schools	Prob schools	% zeros	Def Biomass	Mix Biomass	Prob Biomass	Biomass (t)	SSB (t)	Abundance millions
40 D9	4	1	1	0	0	75	3.5	0	0	3.5	1.2	45.32
40 E0	4	2	0	0	2	50	0	0	0.4	0.4	0.1	5.03
40 E1	4	29	22	0	7	0	16.2	0	3.3	19.4	7	259.1
39 D9	9	9	5	0	4	56	1.7	0	10.4	12.2	4.1	158.755
39 E0	9	12	10	0	2	56	3.3	0	0.4	3.7	1.2	47.67
39 E1	4	1	1	0	0	75	0.1	0	0	0.1	0	1.226
38 E0	8	0	0	0	0	100	0	0	0	0	0	0
38 D9	8	0	0	0	0	100	0	0	0	0	0	0.00
38 D8	8	2	0	0	2	88	0	0	1.1	1.1	1.1	4.72
37 E0	3	0	0	0	0	100	0	0	0	0	0	0.00
37 D9	3	0	0	0	0	100	0	0	0	0	0	0.00
37 D8	9	43	0	43	0	78	0	6	0	6	6	25.31
36 D8	9	5	0	5	0	89	0	0.1	0	0.1	0.1	0.45
36 D7	9	0	0	0	0	100	0	0	0	0	0	0.00
35 D8	6	0	0	0	0	100	0	0	0	0	0	0.00
35 D7	6	0	0	0	0	100	0	0	0	0	0	0.00
Total	103	104	39	48	17	81	24.8	6.1	15.6	46.5	20.9	547.59
Cv (%)	-	-	-	-	-	-	-	-	-	34.2	32.2	37.5

Table 5G.10. Borefish biomass and abundance by survey strata. Northwest herring survey, July 2009.

Category Stratum	No. transects	No. schools	Def schools	Mix schools	Prob schools	% zeros	Def Biomass	Mix Biomass	Prob Biomass	Biomass (t)	Abundance millions
40 D9	4	6	6	0	0	75	0.2	0	0	0.2	20.17
40 E0	4	1	1	0	0	75	0	0	0	0	0.49
40 E1	4	0	0	0	0	100	0	0	0	0	0
39 D9	9	0	0	0	0	100	0	0	0	0	0
39 E0	9	0	0	0	0	100	0	0	0	0	0
39 E1	4	0	0	0	0	100	0	0	0	0	0
38 E0	8	0	0	0	0	100	0	0	0	0	0
38 D9	8	0	0	0	0	100	0	0	0	0	0
38 D8	8	0	0	0	0	100	0	0	0	0	0
37 E0	3	0	0	0	0	100	0	0	0	0	0
37 D9	3	0	0	0	0	100	0	0	0	0	0
37 D8	9	0	0	0	0	100	0	0	0	0	0
36 D8	9	5	5	0	0	78	0.1	0	0	0.1	4.40
36 D7	9	149	149	0	0	11	9.3	0	0	9.3	826.83
35 D8	6	1	1	0	0	83	0.1	0	0	0.1	5.43
35 D7	6	131	131	0	0	17	12.1	0	0	12.1	1142.80
Total	103	293	293	0	0	83	21.7	0	0	21.7	2000.11
Cv (%)	-	-	-	-	-	-	-	-	-	15	16

Table 5G.11. Historical spawning stock survey time-series. Abundance (millions), TSB and SSB (000's tonnes). Age in winter rings. Northwest herring survey, July 2009.

	Spawning Stock survey									*Summer Survey*	
Winter rings	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
0	-	-	5	19.36	-	0.09	1.28	-	-	-	-
1	18.99	10.71	22.69	51.65	10.28	-	7.83	1.6	0.3	6.1	416.35
2	104.77	60.88	52.33	102.93	26.26	3.9	56.91	6.9	3.5	75.9	81.28
3	32.53	48.96	6.41	48.15	30.02	62.35	93.51	86.7	59.8	64.7	11.42
4	11.34	25.57	6.47	10.87	11.08	54.93	109.87	57.5	21.9	38.4	15.06
5	1.65	9.43	2.63	9.17	2.94	80.07	100.8	27.9	11.7	22.3	7.74
6	0.94	2.35	1.94	5.54	0.64	47.14	56.54	16	6.35	26.2	7.09
7	0.3	1.28	0.12	3.95	0.94	13.81	21.16	4.8	1.86	9.1	7.49
8	0.17	0.43	0.24	1.68	0.3	11.77	24.64	4.8	-	5.0	0.4
9	0.11	0.75	0.07	2.06	0.14	-	12.74	1.3	-	3.7	0.9
10+	-	-	-	-	-	-	-	-	-	-	-
TSN (mil)	170.8	160.4	97.9	111.3	82.6	274.1	485.3	202.9	105.4	251.4	547.7
TSB (t)	23,762	21,048	11,062	8,867	10,300	41,700	71,253	27,770	14,222	44,611	46,460
SSB (t)	22,788	20,500	9,800	6,978	9,500	41,300	66,138	27,200	13,974	43,006	20,906

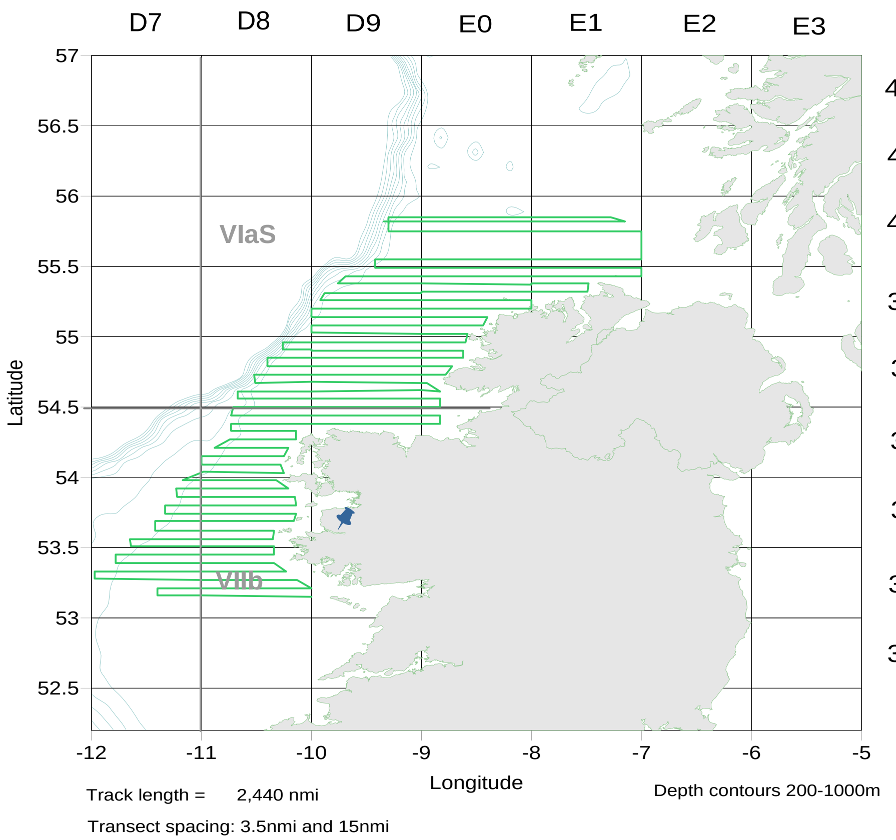


Figure 5G.1. RV "Celtic Explorer" cruise track (red line) Northwest herring survey, July 2009.

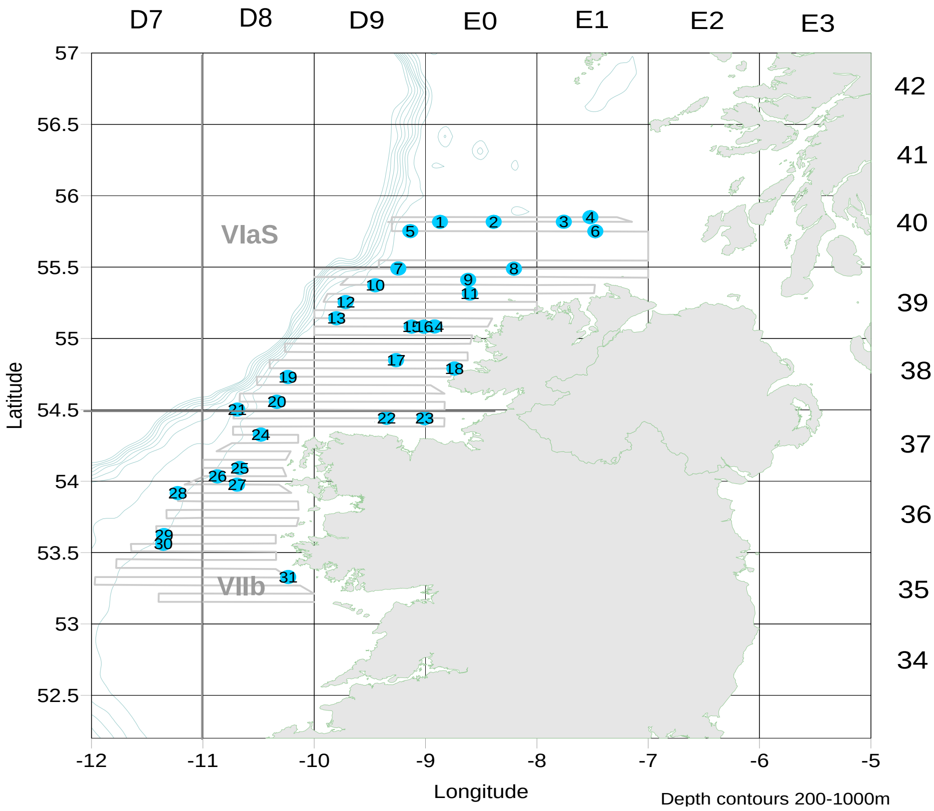


Figure 5G.2. RV "Celtic Explorer" cruise trawl stations and those carried out by the commercial vessels Northwest herring survey, July 2009.

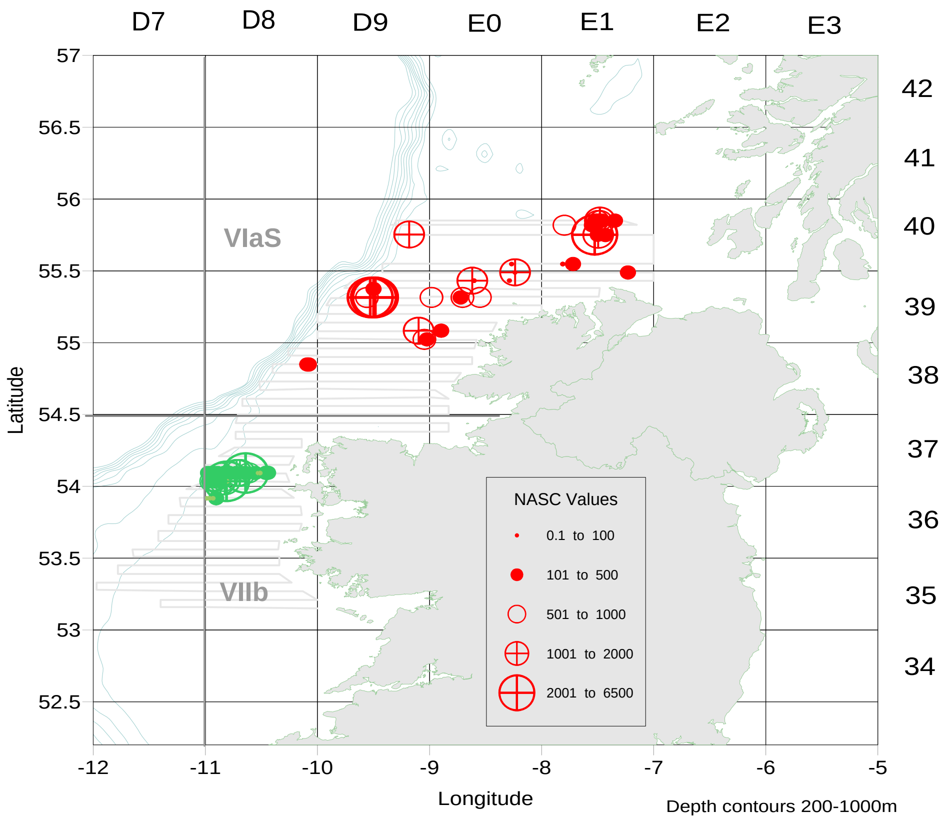


Figure 5G.3. NASC distribution plot of herring occurrence, red circles represent single herring marks, green circles represent herring occurring in mixed schools. Circle size relative to NASC value. Northwest herring survey, July 2009.

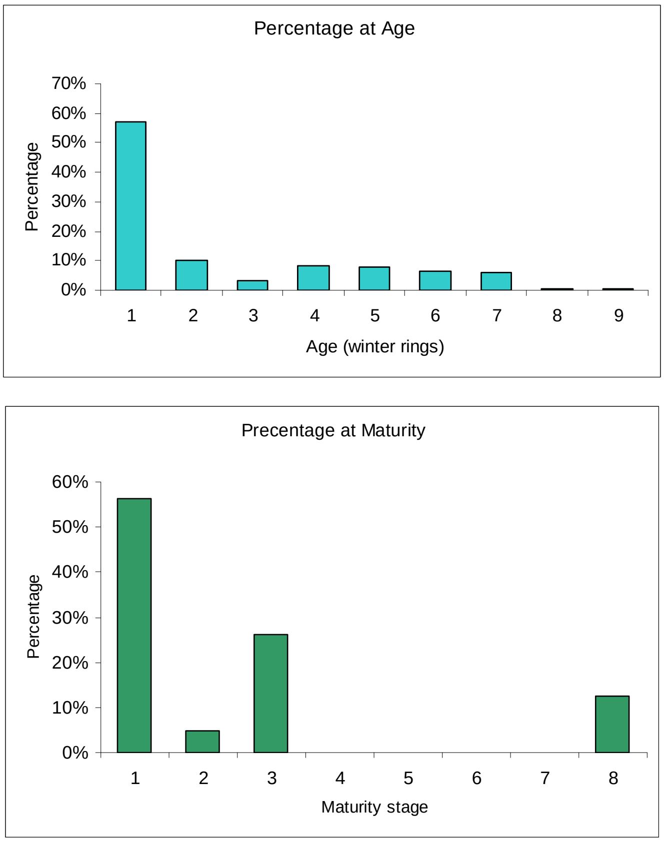


Figure 5G.4. Percentage composition of age (top panel) and maturity (bottom panel) of "Celtic Explorer" herring samples within the survey area. Northwest herring survey, July 2009.

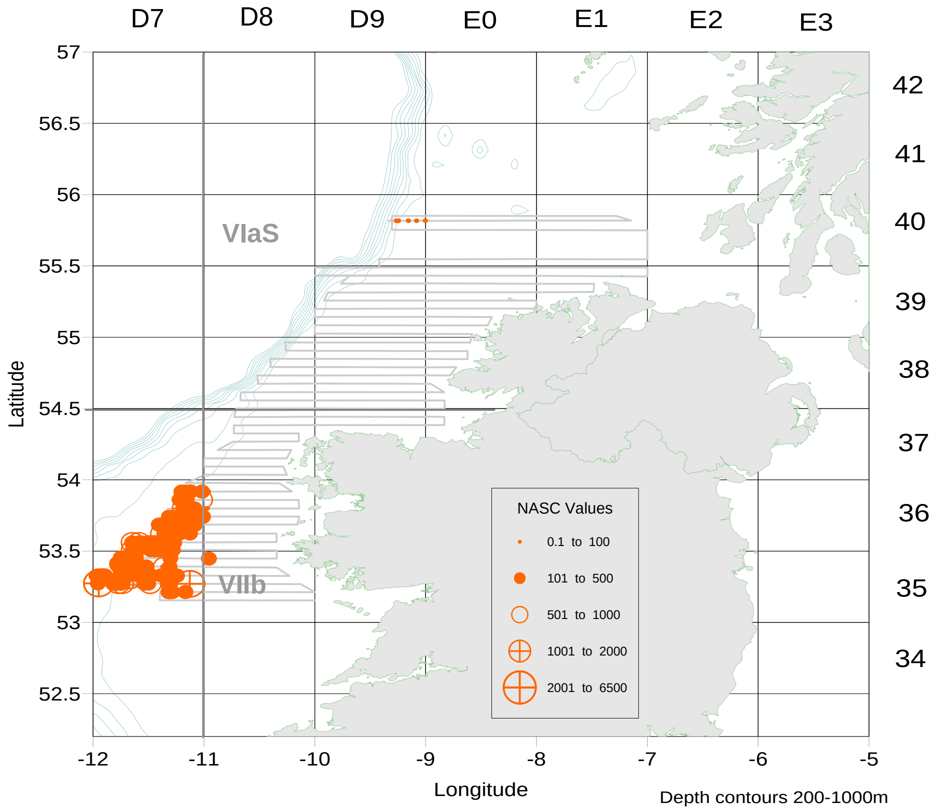
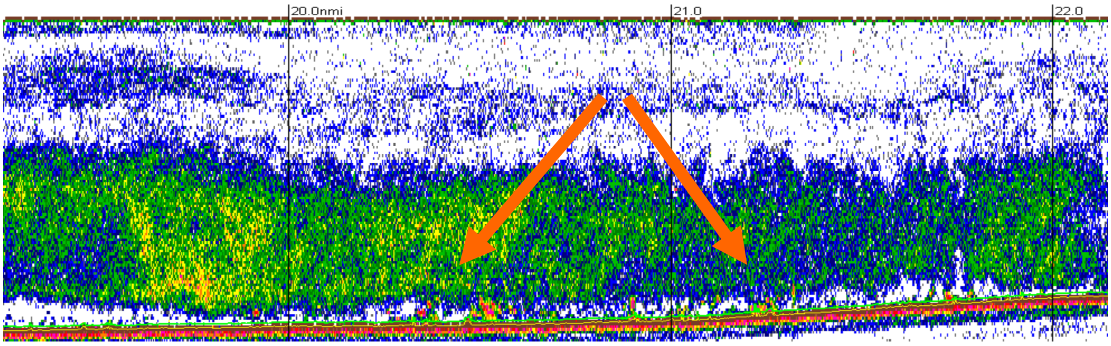
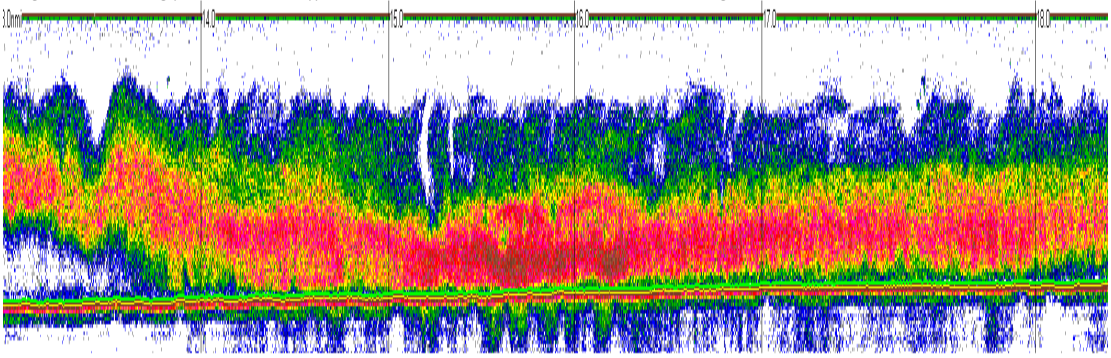


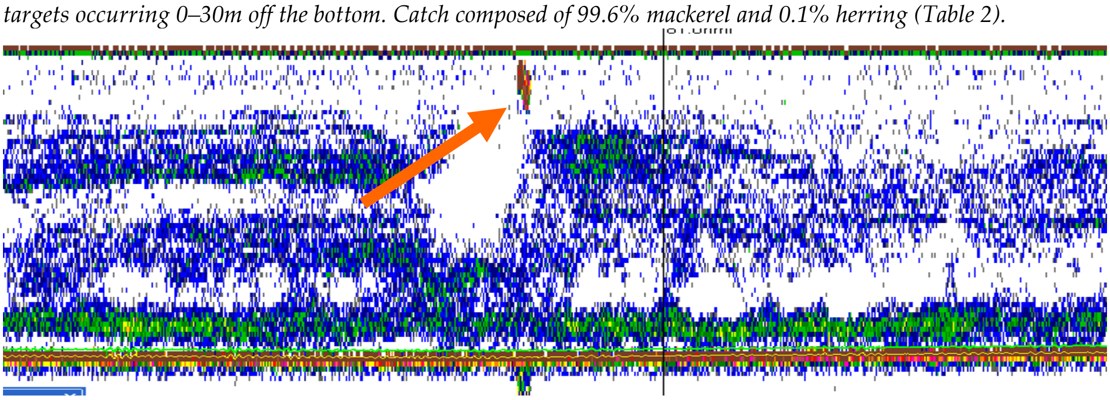
Figure 5G.5. NASC plot of boarfish (*Capros aper*) distribution. Circle size proportional to NASC value. Northwest herring survey, July 2009.



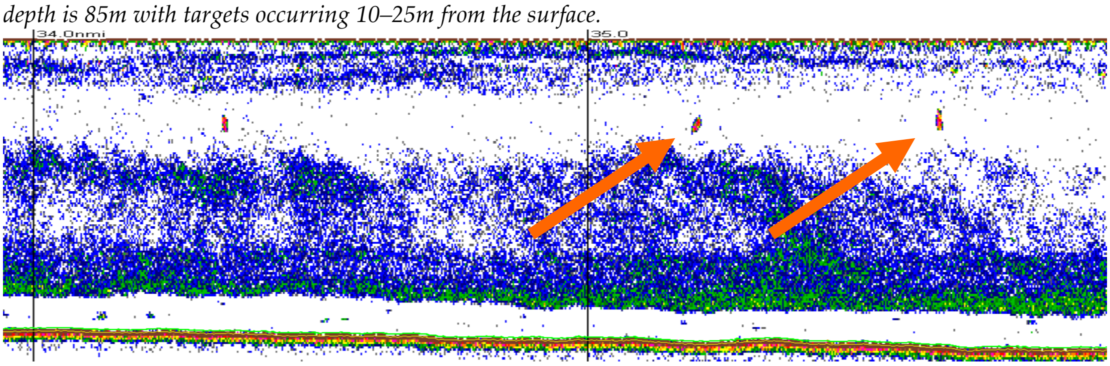
a). *Shelf edge mixed herring schools recorded prior to* ***Haul 25*** *at 10:21. Bottom depth is 185m with targets extending from 0–12m off the bottom. Catch contained 11% herring (See Table 2).*



b). *Very high density scattering layer recorded prior to* ***Haul 01*** *at 08:40. Bottom depth is 122m with targets occurring 0–30m off the bottom. Catch composed of 99.6% mackerel and 0.1% herring (Table 2).*



c). *High-density surface school of herring typical of those encountered along the north coast. Bottom depth is 85m with targets occurring 10–25m from the surface.*



d). *High-density schools of borefish schools typical of those encountered along the shelf slopes from 53–54ºN. Recorded prior to* ***Haul 28*** *a t08:25. Bottom depth is 220m with targets occurring 60m from the surface.*

Figures 5G.6a-d. Echotraces recorded prior to directed trawls. Northwest herring survey, July 2009.

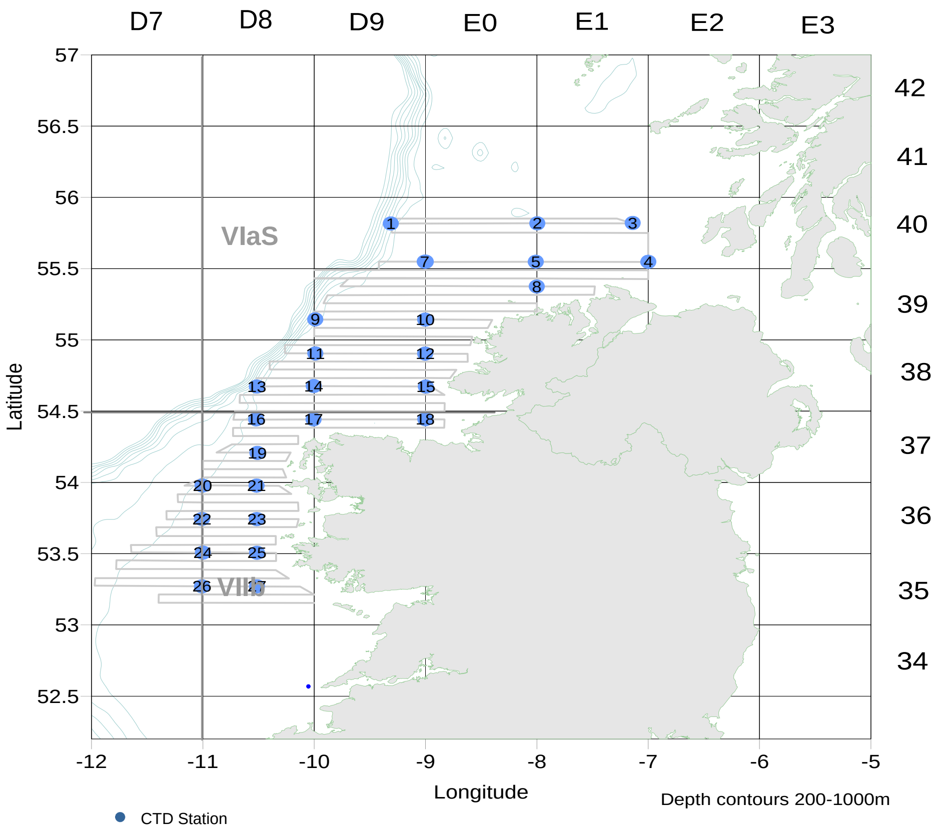


Figure 5G.7. Position of CTD casts. Northwest herring survey, July 2009.

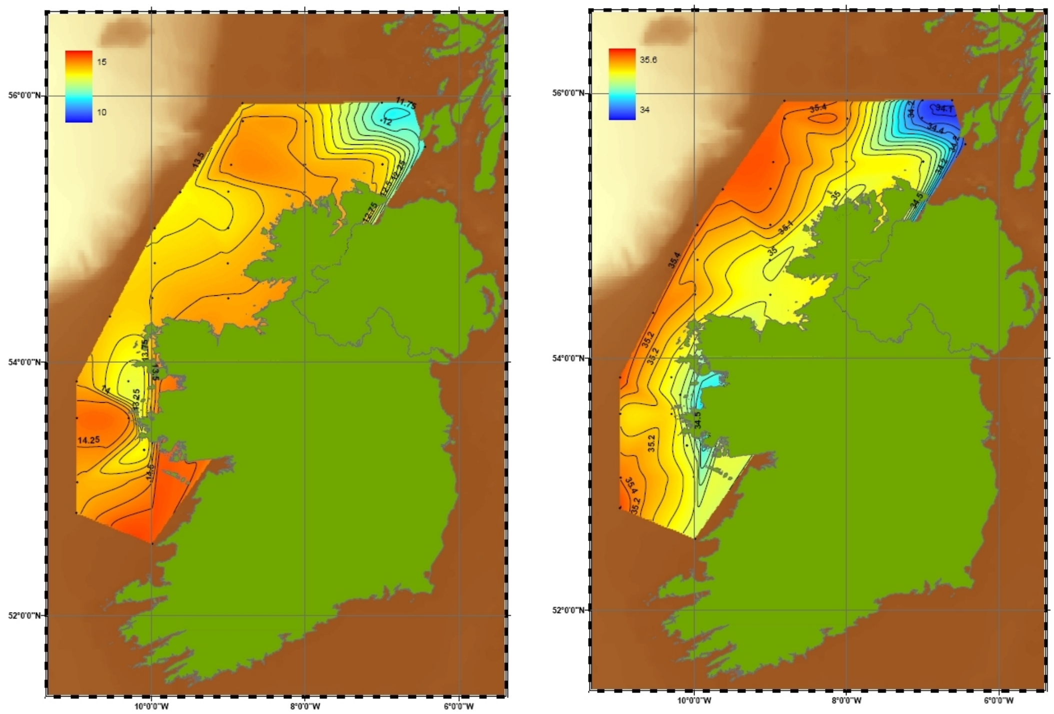


Figure 5G.8. Horizontal temperature (left panel) and salinity (right panel) at 5m subsurface as derived from vertical CTD cast data. Northwest herring survey, July 2009.

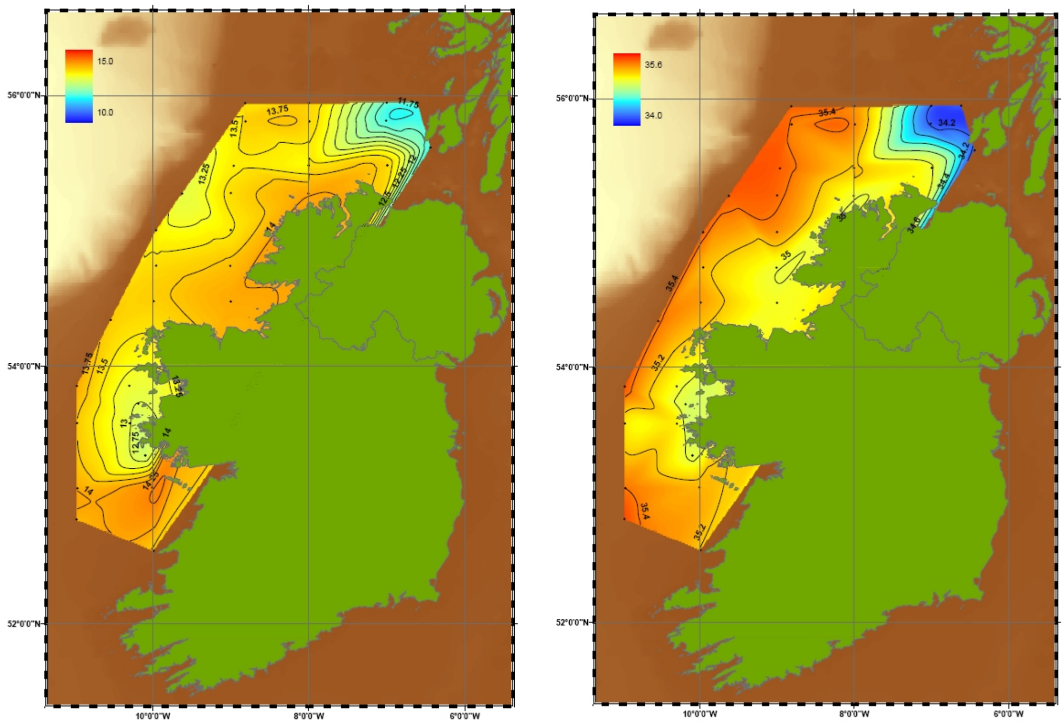


Figure 5G.9. Horizontal temperature (left panel) and salinity (right panel) at 20m subsurface as derived from vertical CTD cast data. Northwest herring survey, July 2009.

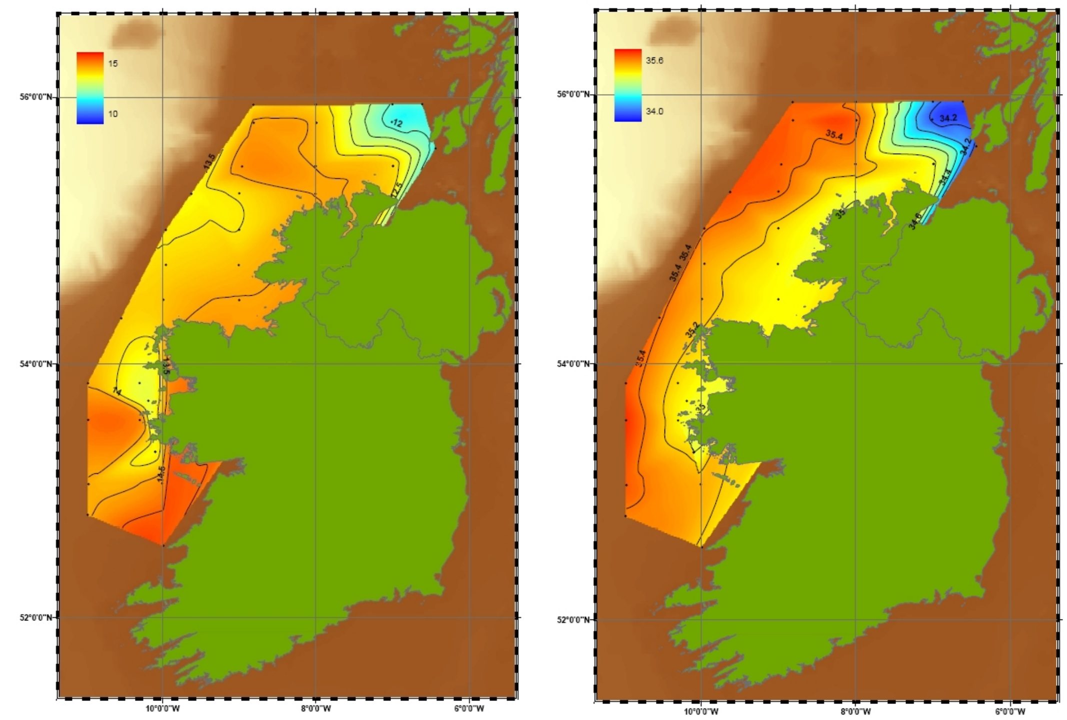


Figure 5G.10. Horizontal distribution of temperature (top) and salinity (bottom) at 40m subsurface as derived from vertical CTD cast data. Northwest herring survey, July 2009.

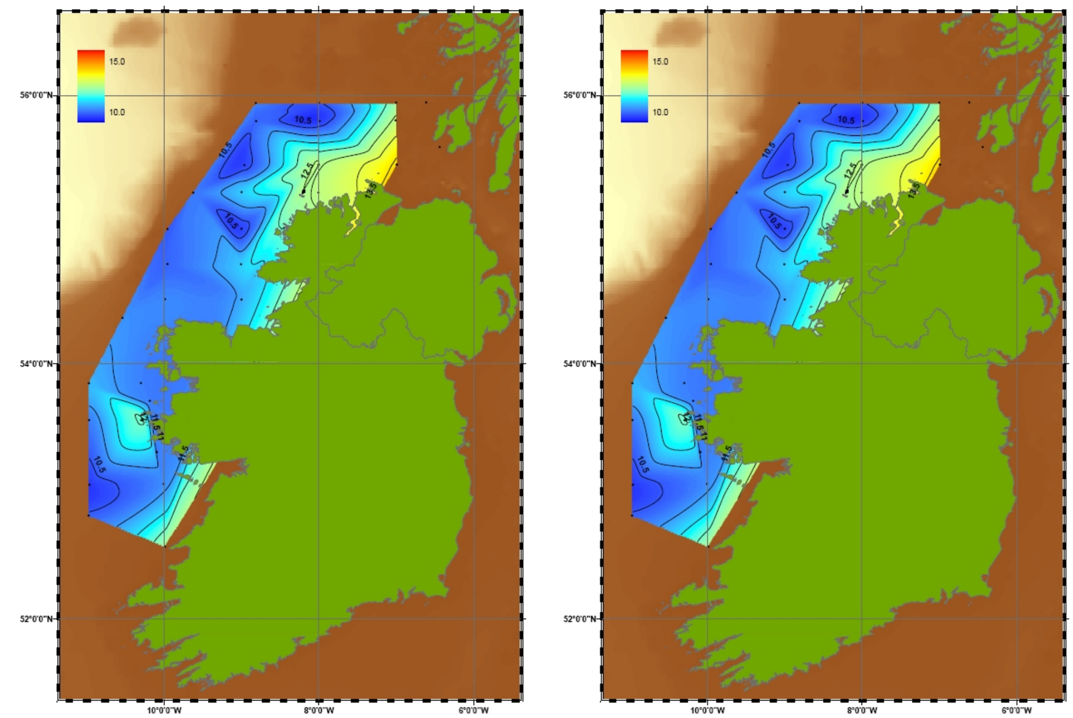


Figure 5G.11. Horizontal distribution of temperature (top) and salinity (bottom) at 60m depth. 100 m depth contour shaded. Northwest herring survey, July 2009.

HERRING MIDWATER TRAWL

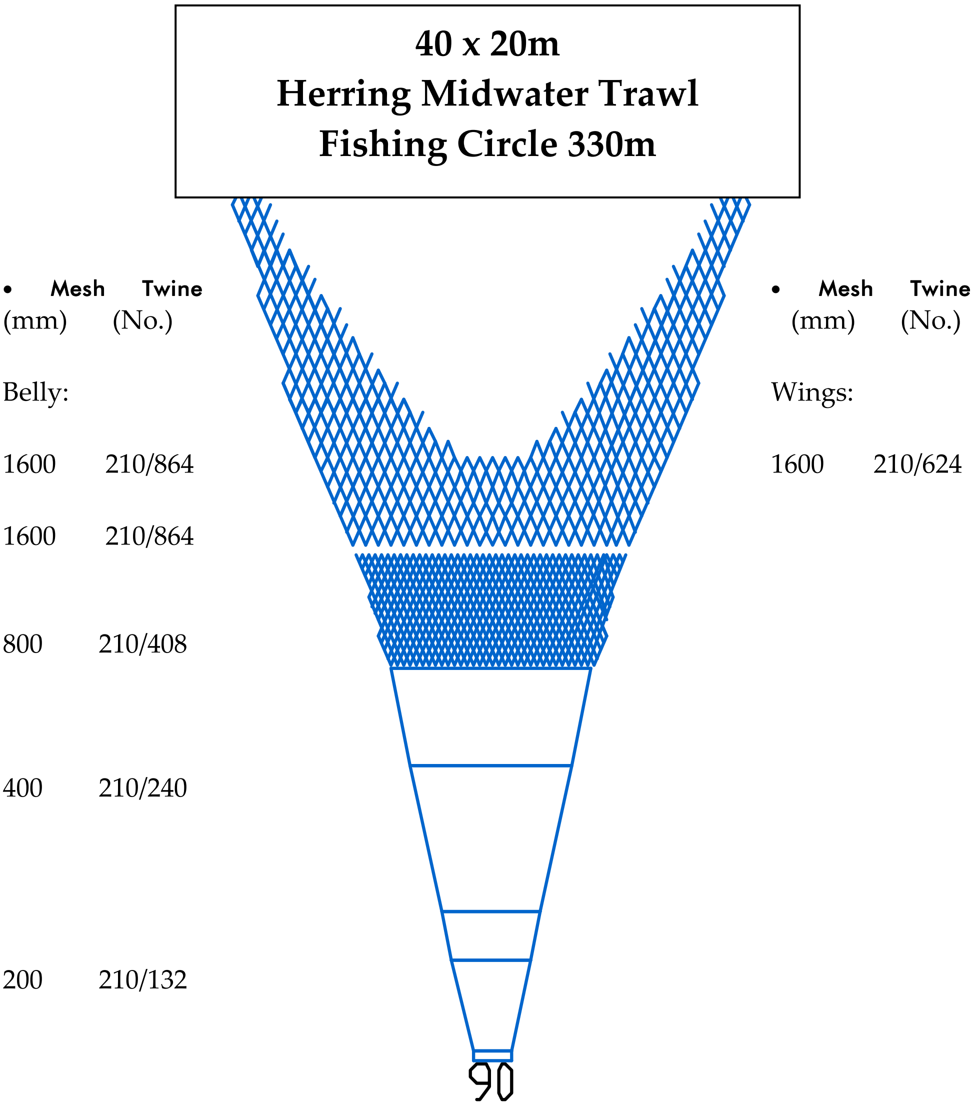


Figure 5G.12. "Celtic Explorer" herring midwater trawl employed during the Northwest herring acoustic survey, June 2009.

ANNEX 5H: German/Danish Western Baltic Autumn Survey

Survey report for RV "Solea"

02 - 21 October 2009

Tomas Gröhsler, vTI-OSF Rostock, Germany, and
Eberhard Götze, vTI-SF Hamburg, Germany

1 INTRODUCTION

The joint German/Danish survey is part of the **Baltic International Acoustic Survey,** which is coordinated within the scope of ICES and has the main objective to annually assess the clupeoid resources of herring and sprat in the Baltic Sea in autumn. 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 (Kattegat/Subdivisions 21 and Subdivisions 22, 23 and 24).

2 METHODS

2.1 Personnel

Participants/Calibration of acoustic equipment/02.–04.10.2009:	
This calibration could not be conducted due to stormy weather	
M. Drenckow	Institute of Sea Fisheries (SF), Hamburg
D. Gloe	Institute for Hydrobiology and Fisheries Science (IHF), Hamburg
E. Götze	Institute of Sea Fisheries (SF), Hamburg, Cr. Leader
S.-E. Levinsky	DTU Aqua, Charlottenlund, Denmark
Participants/Acoustic survey/05.– 21.10.2009:	
E. Götze	Institute of Sea Fisheries (SF), Hamburg,
D. Gloe	Institute for Hydrobiology and Fisheries Science (IHF), Hamburg
Dr T. Gröhsler	Institute of Baltic Sea Fisheries (OSF), Rostock, Cr. Leader
M. Koth	Institute of Baltic Sea Fisheries (OSF), Rostock
S.-E. Levinsky	DTU Aqua, Charlottenlund, Denmark
C. Schuster	Institute of Baltic Sea Fisheries (OSF), Rostock

2.2 Narrative

The 611th cruise of RV "SOLEA" represents the 22nd subsequent survey. Due to stormy weather RV "SOLEA" left the port of Rostock/Marienehe not earlier than on 5 October 2009. The acoustic survey covered the southern part of Subdivision 21 and the whole area of Subdivisions 22, 23 and 24. The northern part of Subdivision 21 could not be covered due a shortage in survey working time caused by stormy weather. The survey ended on 21 October 2009 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 characterized 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 area was 12,400 n.mi.^{2}. The cruise track (Figure 1) totally reached a length of 1,245 nautical miles.

2.4 Calibration

The hull mounted transducer was calibrated on 7 October 2009 east of the Isle of Als at a water depth of 23 m. The calibration procedure was carried out as described in the 'Manual for the Baltic International Acoustic Surveys (BIAS)' (ICES, 2003).

During neat weather conditions it was possible to calibrate the 38 kHz transducer twice. The difference between the two measurements was below 0.1 dB, which corresponds to the mandatory accuracy. Due to technical problems the 120 kHz transducer could not be calibrated.

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 echo signals was done with EchoView 4.70. The mean volume backscattering values (s_v) were integrated over 1 n.mi. intervals from 8 m below the surface to the bottom. Interferences 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 30 minutes. From each haul subsamples 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 CTD-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 distributions 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:

	TS	References
Clupeoids	= 20 log L (cm) - 71.2	ICES, 1983
Gadoids	= 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:
CLUPEA HARENGUS
ENGRAULIS ENCRASICOLUS
GADUS MORHUA
GASTEROSTEUS ACULEATUS
MERLANGIUS MERLANGUS
POMATOSCHISTUS MINUTUS
SPRATTUS SPRATTUS
TRACHURUS TRACHURUS

Exclusion of trawl hauls with low catch level:

Haul No.	Rectangle	Subdivision (SD)
1	37G1	22
10	40G0	22
11	40G0	22
15	38G2	24
23	38G3	24
47	42G2	21

Usage of neighboring trawl information for rectangles, which contain only acoustic investigations:

Rectangle/SD to be filled	with Haul No.	of Rectangle/SD
38G1/22	2 and 3	37G1/22 and 37G0/22
40F9/22	9	40G0/22
40G1/22	9	40G0/22
41G0/22	9	40G0/22
39G2/23	26, 33	39G2/24
37G3/24	19 and 18	out of 38G4/24 and 38G3/24
37G4/24	18, 20, 21, 22	38G4/24

3 RESULTS

3.1 Biological data

In total 49 trawl hauls were carried out:

Subdivision	No. of Hauls
21	12
22	13
23	4
24	20

1,503 herring and 775 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. The mean catch by Subdivision reached a record low level in all areas (Subdivisions 21–24). The highest concentrations of adult herring were found - as in the years before - in the Sound (Subdivision 23). However, the overall mean catch of herring in Subdivision 23 was on a record low level. Jon Dory (*Zeus faber*), which is normally distributed further north, was caught for the first time in one haul in the Belt Sea.

The length distributions of herring and sprat of the years 2008 and 2009 are presented by Subdivision in Figures 2 and 3. The herring length distributions by Subdivision are characterized in the following way:

- Juvenile herring (<15 cm) dominates in 2009 in all areas, now also including Subdivision 23.
- The contribution of older and larger herring decreased in 2009. This is most obvious in Subdivision 23, where the high fraction of very large herring (>25 cm) disappeared in 2009.

The length distributions of sprat in 2008 and 2009 show overall little differences in all areas (Figure 3). The contribution of the new incoming year-class (<10 cm) decreased compared to 2008. Catches are now more dominated by older and larger sprat. This is in contrast to the findings in Subdivision 22 and 24. In these areas the share of the new incoming year-class increased, whereas the contribution of older and larger sprat decreased. The length distribution in Subdivision 23 again contains mainly older sprat (> 10 cm). The fraction of the larger sprat <13 cm) increased compared to 2008.

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.

As in last year the horizontal distribution of the mean s_A values showed the usual main pattern (Figure 4). The highest values were found in Subdivision 23, followed by second high fish densities in the Arkona Sea (Subdivision 24) and general poor fish concentrations in the Belt Sea (Subdivision 22) and in the Kattegat (Subdivision 21). However, the mean s_A values this year were extremely low and reached only almost half of the long-term average in all areas. The largest and most important reduction was found in the southern part of the Sound (Subdivision 23). Last year's already lower echo readings in this area even further decreased this year. The catches around the island of Ven, which were formerly characterized by high amounts of larger adult herring, this year only showed poor concentrations of this type of herring. This year higher concentrations of larger adult herring were only found south of the island of Ven.

The echo readings in the Arkona Sea (SD 24) were in most areas even lower than last year's already low ones. High and above average concentrations were only recorded east of the island of Rügen.

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 summarized in Table 8 and Table 11.

The herring stock in Subdivisions 21–24 was estimated to be 4.1×10^9 fish or about 90.1×10^3 tonnes. For the included area of Subdivisions 22–24 the number of herring was calculated to be 3.5 x 10^9 fish or about 81.2 x 10^3 tonnes. The abundance estimate was dominated by young herring as in former years (Figure 2 and Table 6). However, compared to the results of the years 1993–2007 the last two years estimates are low in numbers and in biomass.

The estimated sprat stock in Subdivisions 21–24 was 6.1 x 10^9 fish or 44.3 x 10^3 tonnes. For the included area of Subdivisions 22–24 the number of sprat was calculated to be 6.0 x 10^9 fish or 43.4 x 10^3 tonnes. The present record low estimates of sprat in numbers and biomass are caused by a (Figure 3 and Table 9):

- comparatively weak new year-class,
- further diminishing importance of the last strong 2006 year-class.

4 DISCUSSION

Compared to last year's results, the present estimates of **herring** equal the same level in numbers but at the same time show sharp decline in biomass:

	Difference compared to 2008	
Area	Numbers (%)	Biomass (%)
Subdivisions 22–24	+2	-34
Subdivisions 21–24	-11	-39

The smaller numbers in the total area of Subdivisions 21–24 were mainly caused by a larger decrease in Subdivision 21, particularly in the fraction of the 0-group (2009/2008 in SD 21: -50%). The increase in numbers in Subdivisions 22–24 is a result of larger numbers in Subdivisions 22 and 23, especially in the fraction of the 0-group (2009/2008 in Subdivision 22: +27%; in Subdivision 23: +34% and in Subdivision 24: -9%).

The sharp decline in biomass is mainly caused by lower:

- numbers in Subdivision 21,
- share of older herring (3+ ringer) in Subdivisions 23 and 24.

The present herring biomass is the lowest recorded estimate in the whole time-series since 1993.

The overall low herring numbers in the last two years, which at the same time are showing a further sharp decline in biomass in 2009, could have been caused by following overlapping effects:

- lower recruitment during the last years, which is bringing down the stock size,
- different migration/distribution patterns, whereby only few individuals of the adult Western Baltic herring stock - normally overwintering on his way from the Skagerrak to the spawning areas in Subdivision 24 and in Subdivision 23 (The Sound) - have reached this area during the survey time,
- occurrence of more Central Baltic herring in Subdivision 24, which are characterized by lower mean weights at-age.

As in the years before, the abundance of the age-groups 0–1 are the main contributors in Subdivisions 22–24 (2009: 82%, 2008: 70%, 2007: 81% and 2006: 77%). The abundance of the age-groups 2–4 constitute 14% in 2009 (2008: 19%, 2007: 10% and 2006: 15%). The present contribution of the age-group 0 in Subdivisions 22–24 is 72% in numbers and 31% in biomass (2008: 60% in numbers and 19% in biomass, 2007: 68% in numbers and 22% in biomass, 2006: 64% in numbers and 17% in biomass).

The abundance of **sprat,** which already decreased significantly in 2007 compared to the high level in 2006 (2007/2006: Subdivisions 21–24: -68%; Subdivisions 22–24: -70%) and continued this downward trend in 2008 (2008/2007: Subdivisions 21–24: -30%; Subdivisions 22–24: -25%), shows no further decrease in 2009 (2009/2008: Subdivisions 21–24: +1.3%; Subdivisions 22–24: +0.1%). The rather stable abundance estimates in 2008/2009 are characterized by rather diverging results in the different areas:

- Subdivision 21: -45%,
- Subdivision 22: +70%,
- Subdivision 23: +136%,
- Subdivision 24: -12%.

This diverging picture is mainly caused by:

- lower and larger numbers of the new incoming year-class in Subdivisions 21 and 22, respectively,
- higher and smaller numbers of older sprat (ages 1+) in Subdivisions 23 and 24, respectively. The smaller numbers of older sprat in Subdivision 24 are to a larger extent caused by the diminishing importance of the last strong year-class 2006.

The contribution of the new year-class abundance Subdivisions 21–24, as well as, in Subdivisions 22–24 was 83% in 2006, 10% in 2007, ca. 52% in 2008 and 72% in 2009. Compared to 2008 this year's 0-group abundance was only higher in Subdivisions 22 and 24 (2009/2008 in Subdivision 21: -77%, in Subdivision 22: +88%, in Subdivision 23: -10% and in Subdivision 24: +28%). The contribution of the 0-group to the total biomass was 2009 about two times higher than 2008 (in Subdivisions 21–24, as well as, in Subdivisions 22–24: 2009 ca. 42%, 2008 ca. 24%).

5 REFERENCES

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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.

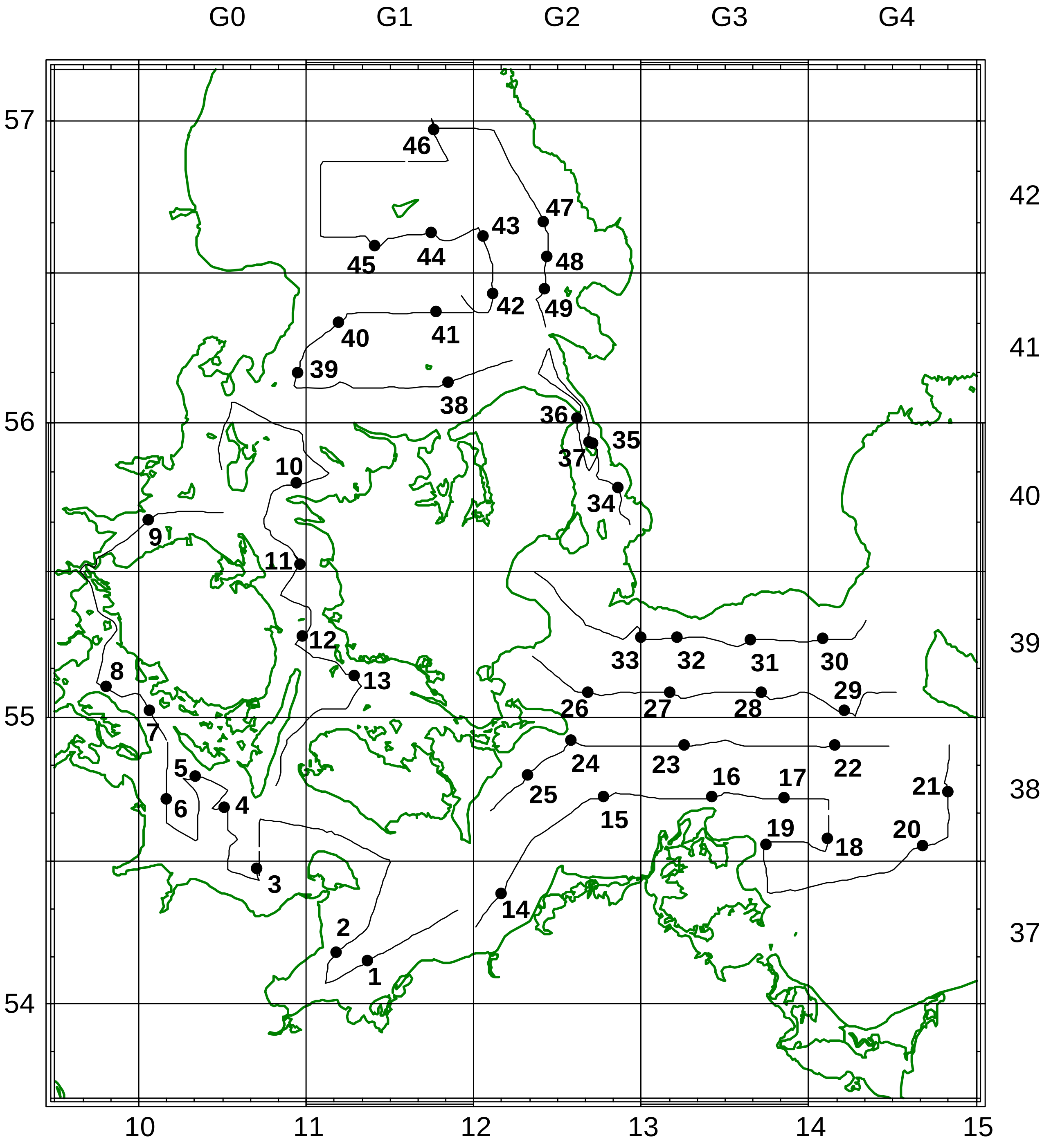

Figure 5H.1. Cruise track and trawl positions of RV "SOLEA" in October 2009.

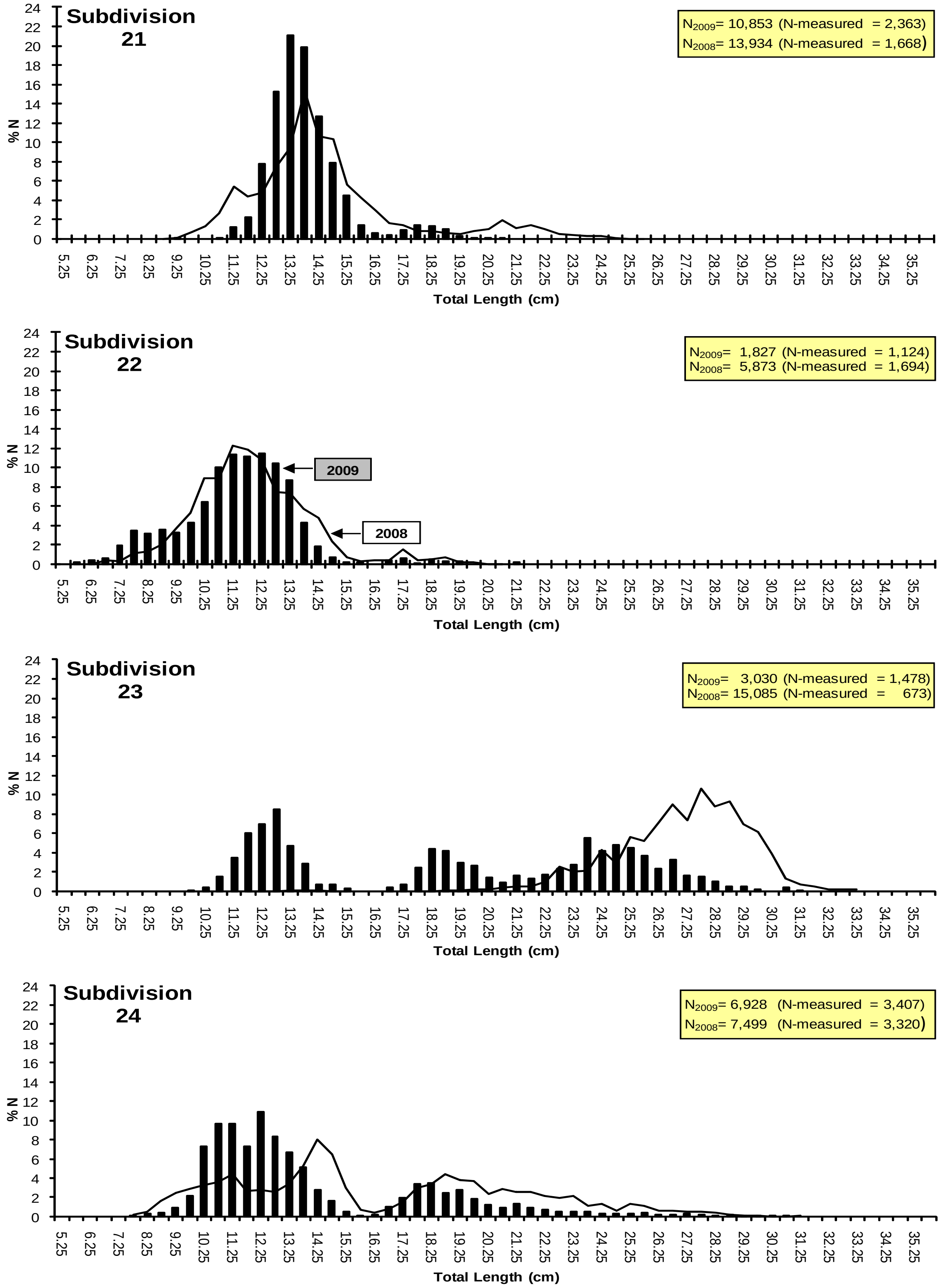

Figure 5H.2. Length distribution of herring in Subdivisions 21, 22, 23 and 24 in 2008 (=line) and in 2009 (=bar).

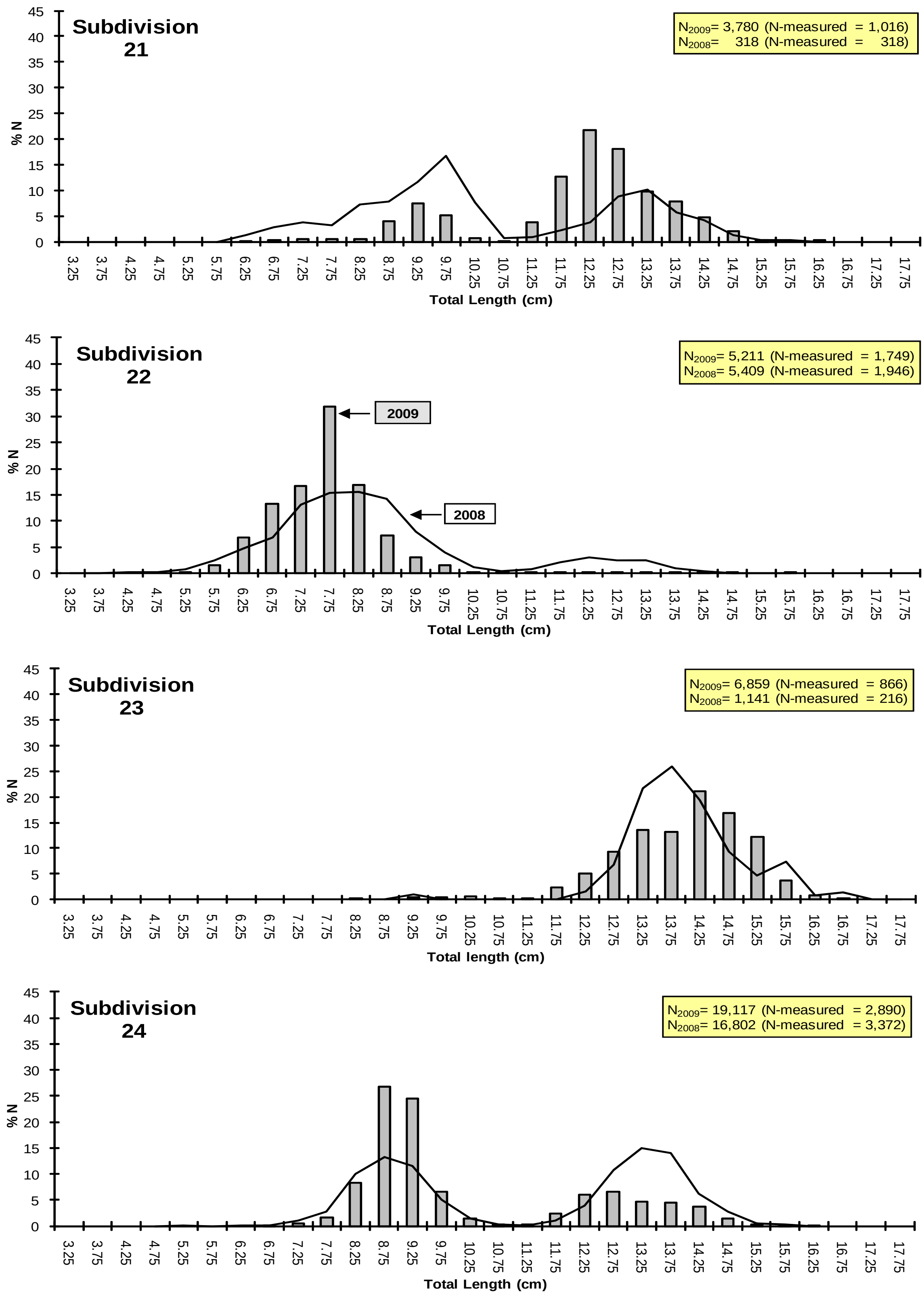

Figure 5H.3. Length distribution of sprat in Subdivisions 21, 22, 23 and 24 in 2008 (=line) and in 2009 (=bar).

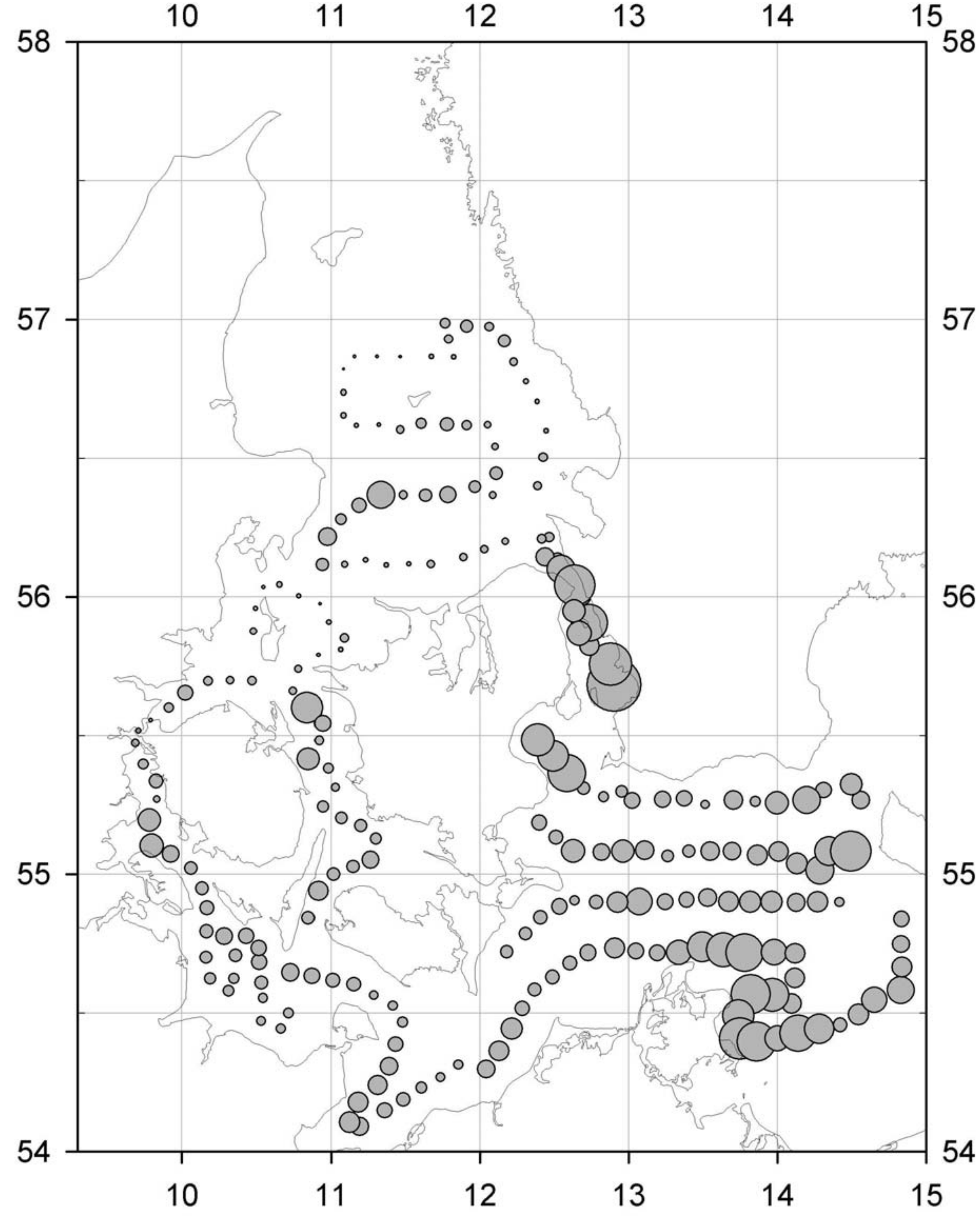

Figure 5H.4. Distribution of sA-values obtained during the acoustic survey of RV "SOLEA" in October 2009.

Table 1 Catch composition (kg/0.5 h) by trawl haul in Subdivision 21 (RV 'SOLEA' October 2009)

Haul No.	38	39	40	41	42	43	44	45	46
Species/ICES Rectangle	41G1	41G0	41G1	41G1	41G2	42G2	42G1	42G1	42G1
CALLIONYMUS LYRA			0.04						
CARCINUS									0.02
CLUPEA HARENGUS	10.31	6.70	29.68	18.20	41.24	1.92	18.22	3.09	18.35
CRANGON CRANGON						+			
CRYSTALLOGOBIUS LINEARIS	+	+		+		+	+		+
CTENOLABRUS RUPESTRIS	+		0.01						
CYCLOPTERUS LUMPUS	0.94								
ELEDONE					0.01		0.03	0.01	0.01
ENGRAULIS ENCRASICOLUS	0.14	0.28	1.09	0.21	2.16	0.46	11.34	1.67	2.93
EUTRIGLA GURNARDUS			0.02					+	0.04
GADUS MORHUA		0.01							
GASTEROSTEUS ACULEATUS		+							
GOBIUS NIGER								0.00	
LIMANDA LIMANDA		0.04	0.14	0.16	0.15		0.03	0.15	0.22
LOLIGO FORBESI	0.01	0.01	+	0.01	+	0.01	0.31	0.12	0.10
MERLANGIUS MERLANGUS		0.02	0.10	+	0.13	0.17	0.47		0.01
MYSIDACEA									+
PLATICHTHYS FLESUS	0.19				0.34				
PLEURONECTES PLATESSA			0.38	0.04					
POMATOSCHISTUS MINUTUS									
PSETTA MAXIMA									0.65
SARDINA PILCHARDUS					0.03		0.01		
SCOMBER SCOMBRUS					0.34		0.18		
SOLEA VULGARIS						+			
SPRATTUS SPRATTUS	1.24	0.13	5.86	0.50	39.30				
SYMPHODUS MELOPS	+								
TRACHINUS DRACO	0.35	0.15	0.49	10.37	3.00	0.05	0.26		0.82
TRACHURUS TRACHURUS	0.10	0.01	0.13	0.01	0.04	0.02	0.47	0.02	0.20
TRISOPTERUS MINUTUS		+							0.02
Total	**13.28**	**7.35**	**37.94**	**29.50**	**86.74**	**2.63**	**31.32**	**5.06**	**23.37**
Medusae	34.80	11.48	10.02	12.88	3.51	5.20	6.34	5.59	4.72

Haul No.	47	48	49	Total
Species/ICES Rectangle	42G2	42G2	41G2	
CALLIONYMUS LYRA				**0.04**
CARCINUS				**0.02**
CLUPEA HARENGUS	0.05	11.28	13.96	**173.00**
CRANGON CRANGON		+	+	**+**
CRYSTALLOGOBIUS LINEARIS		0.01	+	**0.01**
CTENOLABRUS RUPESTRIS				**0.01**
CYCLOPTERUS LUMPUS				**0.94**
ELEDONE		0.01		**0.07**
ENGRAULIS ENCRASICOLUS				**20.28**
EUTRIGLA GURNARDUS				**0.06**
GADUS MORHUA				**0.01**
GASTEROSTEUS ACULEATUS			+	**+**
GOBIUS NIGER				**+**
LIMANDA LIMANDA		0.09	0.04	**1.02**
LOLIGO FORBESI		0.02	0.01	**0.60**
MERLANGIUS MERLANGUS	0.02	0.03	0.11	**1.06**
MYSIDACEA				**+**
PLATICHTHYS FLESUS				**0.53**
PLEURONECTES PLATESSA			0.30	**0.72**
POMATOSCHISTUS MINUTUS			+	**+**
PSETTA MAXIMA				**0.65**
SARDINA PILCHARDUS		0.01	+	**0.05**
SCOMBER SCOMBRUS			0.63	**1.15**
SOLEA VULGARIS				**+**
SPRATTUS SPRATTUS		3.20	0.66	**50.89**
SYMPHODUS MELOPS				**+**
TRACHINUS DRACO		0.34	0.08	**15.91**
TRACHURUS TRACHURUS		0.04	0.01	**1.05**
TRISOPTERUS MINUTUS				**0.02**
Total	**0.07**	**15.03**	**15.80**	**268.09**
Medusae	9.33	6.97	1.78	**112.62**

+ = < 0,01 kg

Table 2 Catch composition (kg/0.5 h) by trawl haul in Subdivision 22 (RV 'SOLEA' October 2009)

Haul No.	1	2	3	4	5	6	7	8	9
Species/ICES Rectangle	37G1	37G1	37G0	38G0	38G0	38G0	39G0	39F9	40G0
ANGUILLA ANGUILLA				0.07					
CLUPEA HARENGUS	0.33	10.44	0.97	0.52	1.67	0.74	0.35	0.40	0.07
CRYSTALLOGOBIUS LINEARIS			+	+			+		+
CTENOLABRUS RUPESTRIS									
CYCLOPTERUS LUMPUS		0.35							
ENGRAULIS ENCRASICOLUS	0.02	0.13	1.94	0.02	0.09	0.66	0.07	0.98	2.81
GADUS MORHUA				+	0.02		0.05		
GASTEROSTEUS ACULEATUS	0.01	0.03	0.01	+	0.36	0.05	0.84	0.30	0.10
GOBIUS NIGER							0.05	0.01	
LIMANDA LIMANDA				0.80	0.15	0.88			
LOLIGO FORBESI				0.01	+			0.01	0.02
MERLANGIUS MERLANGUS		0.01	0.01	0.01	0.01	0.02		0.07	+
MULLUS SURMULETUS									
PLATICHTHYS FLESUS									0.07
POMATOSCHISTUS MINUTUS		+	0.01	+	0.02	0.01		0.06	+
SOLEA VULGARIS									+
SPRATTUS SPRATTUS	0.05	0.46	0.94	1.34	0.40	0.92	0.51	2.71	6.72
SYNGNATHUS ROSTELLATUS									+
TRACHINUS DRACO									
TRACHURUS TRACHURUS	0.14	1.01	0.40	0.63	0.13	0.48	0.01	0.22	0.08
ZEUS FABER									0.17
Total	**0.55**	**12.43**	**4.28**	**3.40**	**2.85**	**3.76**	**1.88**	**4.76**	**10.04**
Medusae	0.9	8.5	11.5	8.7	14.1	17.1	26.6	11.3	8.5

Haul No.	10	11	12	13	Total
Species/ICES Rectangle	40G0	40G0	39G0	39G1	
ANGUILLA ANGUILLA					**0.07**
CLUPEA HARENGUS		0.08	2.14	0.03	**17.74**
CRYSTALLOGOBIUS LINEARIS		+		+	**+**
CTENOLABRUS RUPESTRIS		0.01			**0.01**
CYCLOPTERUS LUMPUS					**0.35**
ENGRAULIS ENCRASICOLUS	0.09	0.93	4.39	0.03	**12.16**
GADUS MORHUA			0.03		**0.10**
GASTEROSTEUS ACULEATUS			+	0.36	**2.06**
GOBIUS NIGER				+	**0.06**
LIMANDA LIMANDA		0.07	0.01	+	**1.91**
LOLIGO FORBESI		0.03	0.01	0.03	**0.11**
MERLANGIUS MERLANGUS				0.13	**0.26**
MULLUS SURMULETUS			0.02		**0.02**
PLATICHTHYS FLESUS					**0.07**
POMATOSCHISTUS MINUTUS		0.01	+	+	**0.11**
SOLEA VULGARIS					**+**
SPRATTUS SPRATTUS		0.02	1.67	0.03	**15.77**
SYNGNATHUS ROSTELLATUS					**+**
TRACHINUS DRACO		0.19	0.16		**0.35**
TRACHURUS TRACHURUS	0.03	0.06	0.08	0.06	**3.33**
ZEUS FABER					**0.17**
Total	**0.12**	**1.40**	**8.51**	**0.67**	**54.65**
Medusae	10.3	3.5	9.8	3.9	**134.6**

+ = < 0,01 kg

Table 3 Catch composition (kg/0.5 h) by trawl haul in Subdivision 23 (RV 'SOLEA' October 2009)

Haul No. Species/ICES Rectangle	Hol 34 40G2	Hol 35 40G2	Hol 36 41G2	Hol 37 40G2	Total
ANGUILLA ANGUILLA	0.39		0.57		**0.96**
CLUPEA HARENGUS	159.26	12.12	10.48	13.71	**195.57**
CRANGON CRANGON		0.01			**0.01**
CRYSTALLOGOBIUS LINEARIS	+	+	+	+	**+**
CTENOLABRUS RUPESTRIS	0.02	0.06	+	+	**0.08**
ELEDONE		+			**+**
ENGRAULIS ENCRASICOLUS			0.01		**0.01**
EUTRIGLA GURNARDUS		+		0.02	**0.02**
GADUS MORHUA	17.50	23.93	3.74	2.93	**48.10**
GASTEROSTEUS ACULEATUS		+	+	0.01	**0.01**
LIMANDA LIMANDA		0.51	0.23	0.08	**0.82**
LOLIGO FORBESI		+	+	+	**+**
MELANOGRAMMUS AEGLEFINUS		1.94			**1.94**
MERLANGIUS MERLANGUS	4.52	6.23	3.44	0.51	**14.70**
MULLUS SURMULETUS		0.02			**0.02**
POMATOSCHISTUS MINUTUS	+	0.10	0.02	0.01	**0.13**
SCOMBER SCOMBRUS		0.25			**0.25**
SPRATTUS SPRATTUS	54.97	38.52	23.14	8.00	**124.63**
SYMPHODUS MELOPS		+			**+**
TRACHINUS DRACO		0.10	0.02		**0.12**
TRACHURUS TRACHURUS		0.42	0.03	0.02	**0.47**
Total	**236.66**	**84.21**	**41.68**	**25.29**	**387.84**
Medusae	2.3	0.5	2.0	15.0	**19.9**

+ = < 0,01 kg

Table 4 Catch composition (kg/0.5 h) by trawl haul in Subdivision 24 (RV 'SOLEA' October 2009)

Haul No. Species/ICES Rectangle	Hol 14 37G2	Hol 15 38G2	Hol 16 38G3	Hol 17 38G3	Hol 18 38G4	Hol 19 38G3	Hol 20 38G4	Hol 21 38G4	Hol 22 38G4	Hol 23 38G3	Hol 24 38G2
ANGUILLA ANGUILLA						1.04					
BELONE BELONE		0.40									
CLUPEA HARENGUS	10.04	0.74	1.48	4.25	5.82	3.42	3.80	26.20	1.75	0.75	2.74
CRANGON CRANGON		+	+				+		+	+	+
CRYSTALLOGOBIUS LINEARIS	0.01	0.00									+
CYCLOPTERUS LUMPUS											
ENGRAULIS ENCRASICOLUS	0.48	0.37	0.02	0.09		0.00			0.17	0.1	0.01
GADUS MORHUA			1.50	0.71		0.74		0.85			
GASTEROSTEUS ACULEATUS	0.09	1.33	0.34	0.01		0.02	+			0.04	0.02
GOBIUS NIGER	0.01								+		
LIMANDA LIMANDA	1.02									+	
MERLANGIUS MERLANGUS		0.01	2.96	28.81		9.83			5.98		0.21
MULLUS SURMULETUS											
MYOXOCEPHALUS SCORPIUS											
PLATICHTHYS FLESUS		0.28			0.18	0.20					0.2
PLEURONECTES PLATESSA											
POMATOSCHISTUS MINUTUS	0.04	0.02	0.09	0.01		0.02		+	0.16	0.04	0.03
SCOMBER SCOMBRUS				0.03							
SOLEA VULGARIS	0.06						+				
SPRATTUS SPRATTUS	0.60		24.73	35.53	4.47	5.38	0.11	3.61	8.44	0.04	2.49
TRACHURUS TRACHURUS	1.21		0.02	0.16		0.02	+		0.15		0.05
Total	**17.79**	**2.31**	**11.27**	**53.77**	**4.94**	**10.84**	**10.14**	**54.35**	**11.55**	**26.10**	**3.37**
Medusae	9.3	20.0	6.4	15.1	62.9	12.8	45.0	9.0	8.4	12.3	12.2

Haul No. Species/ICES Rectangle	Hol 25 38G2	Hol 26 39G2	Hol 27 39G3	Hol 28 39G3	Hol 29 39G4	Hol 30 39G4	Hol 31 39G3	Hol 32 39G3	Hol 33 39G2	Total
ANGUILLA ANGUILLA										**1.04**
BELONE BELONE										**0.40**
CLUPEA HARENGUS	1.36	10.41	7.90	3.49	8.37	32.6	7.81	3.49	16.3	**152.72**
CRANGON CRANGON		+	+							**+**
CRYSTALLOGOBIUS LINEARIS	+									**0.01**
CYCLOPTERUS LUMPUS		0.24								**0.24**
ENGRAULIS ENCRASICOLUS	0.01		+	0.29	0.52					**2.06**
GADUS MORHUA		0.14		0.46	+	12.5	0.89	0.4	5.95	**24.14**
GASTEROSTEUS ACULEATUS	0.05	0.01	0.03	0.01			+			**1.95**
GOBIUS NIGER										**0.01**
LIMANDA LIMANDA								0.21		**1.23**
MERLANGIUS MERLANGUS				1.51	9.84	13.6	3.65	0.78		**77.18**
MULLUS SURMULETUS					0.02					**0.02**
MYOXOCEPHALUS SCORPIUS	0.01									**0.01**
PLATICHTHYS FLESUS					0.54	0.64	0.38		0.25	**2.67**
PLEURONECTES PLATESSA						0.42				**0.42**
POMATOSCHISTUS MINUTUS	0.01	0.01	0.02	0.06	0.05	+	+	0.01	0.01	**0.58**
SCOMBER SCOMBRUS			0.70		0.16				0.62	**1.51**
SOLEA VULGARIS										**0.06**
SPRATTUS SPRATTUS	0.14	0.04	0.62	5.62	21.90	14.07	10.55	7.39	0.8	**146.53**
TRACHURUS TRACHURUS	0.01	0.02	0.00	0.03	0.05		0.01			**1.73**
Total	**1.59**	**10.87**	**9.27**	**11.47**	**41.45**	**73.83**	**23.29**	**12.28**	**23.93**	**414.51**
Medusae	33.4	24.2	5.2	13.5	5.3	5.8	45.3	3.1	12.7	**361.9**

+ = < 0,01 kg

Table 5 Survey statistics by area (RV "SOLEA" October 2009)

Sub-division	ICES Rectangle	Area (nm²)	Sa (m²/NM²)	Sigma (cm²)	N total (million)	Herring (%)	Sprat (%)	NHerring (million)	NSprat (million)
21	41G0	108.1	116.7	1.634	77.20	90.91	2.91	70.18	2.25
21	41G1	946.8	64.2	1.772	343.03	85.40	10.27	292.94	35.23
21	41G2	432.3	36.3	1.544	101.62	68.38	27.18	69.48	27.62
21	42G1	884.2	24.5	1.767	122.61	53.30	0.00	65.35	0.00
21	42G2	606.8	25.8	1.510	103.66	62.97	19.66	65.27	20.38
21	Total	2,978.2			748.12			563.22	85.48
22	37G0	209.9	43.3	1.112	81.72	20.34	28.36	16.62	23.17
22	37G1	723.3	113.3	1.307	627.16	79.29	6.26	497.27	39.23
22	38G0	735.3	71.8	0.712	741.19	22.92	47.72	169.89	353.73
22	38G1	173.2	30.4	1.149	45.82	49.81	17.31	22.83	7.93
22	39F9	159.3	107.0	0.573	297.31	4.29	73.54	12.76	218.63
22	39G0	201.7	87.5	0.784	225.23	12.15	33.18	27.37	74.74
22	39G1	250.0	65.5	0.350	467.93	0.30	1.81	1.41	8.48
22	40F9	51.3	19.8	0.638	15.93	0.30	87.26	0.05	13.90
22	40G0	538.1	65.0	0.638	548.49	0.30	87.26	1.64	478.59
22	40G1	174.5	22.2	0.638	60.75	0.30	87.26	0.18	53.01
22	41G0	173.1	10.6	0.638	28.77	0.30	87.26	0.09	25.11
22	Total	3,389.7			3,140.30			750.11	1,296.52
23	39G2	130.9	488.3	1.627	392.76	92.81	4.87	364.53	19.11
23	40G2	164.0	503.0	2.742	300.85	33.04	63.32	99.39	190.50
23	41G2	72.3	193.8	1.976	70.92	33.64	63.35	23.86	44.93
23	Total	367.2			764.53			487.78	254.54
24	37G2	192.4	162.7	1.160	269.77	72.04	3.67	194.34	9.91
24	37G3	167.7	562.3	1.302	724.30	11.60	85.09	84.01	616.32
24	37G4	875.1	302.5	2.252	1,175.53	45.20	46.60	531.40	547.84
24	38G2	832.9	98.1	0.937	872.48	48.44	30.63	422.66	267.27
24	38G3	865.7	292.8	1.155	2,193.88	4.64	90.25	101.86	1,980.05
24	38G4	1,034.8	174.3	2.252	800.95	45.20	46.60	362.07	373.27
24	39G2	406.1	117.1	1.627	292.21	92.81	4.87	271.21	14.22
24	39G3	765.0	110.1	1.831	459.93	36.33	56.99	167.11	262.11
24	39G4	524.8	274.5	2.639	545.86	26.44	68.21	144.35	372.31
24	Total	5,664.5			7,334.91			2,279.01	4,443.30
22-24	Total	9,421.4			11,239.74			3,516.90	5,994.36
21-24	Total	12,399.6			11,987.86			4,080.12	6,079.84

Table 6 Numbers (millions) of herring by age and area (RV "SOLEA" October 2009)

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total
21	41G0	68.56	1.62								70.18
21	41G1	271.95	20.84			0.15					292.94
21	41G2	67.79	1.69								69.48
21	42G1	54.38	10.59		0.28	0.09					65.34
21	42G2	61.37	3.90								65.27
21	Total	524.05	38.64	0.00	0.28	0.24	0.00	0.00	0.00	0.00	563.21
22	37G0	16.43	0.18								16.61
22	37G1	479.50	12.13	2.12	1.06	2.47					497.28
22	38G0	166.26	3.41		0.14	0.09					169.90
22	38G1	22.29	0.40	0.05	0.02	0.06					22.82
22	39F9	12.76									12.76
22	39G0	27.29	0.08								27.37
22	39G1		1.41								1.41
22	40F9	0.05									0.05
22	40G0	1.64									1.64
22	40G1	0.18									0.18
22	41G0	0.09									0.09
22	Total	726.49	17.61	2.17	1.22	2.62	0.00	0.00	0.00	0.00	750.11
23	39G2	337.84	12.70	4.19	3.28	2.78	1.43	1.42	0.86	0.03	364.53
23	40G2	31.09	39.31	16.65	7.59	2.73	1.14	0.43	0.22	0.23	99.39
23	41G2	21.44	2.06	0.24	0.12						23.86
23	Total	390.37	54.07	21.08	10.99	5.51	2.57	1.85	1.08	0.26	487.78
24	37G2	186.68	4.57	0.91	1.00	0.68	0.20	0.16	0.13		194.33
24	37G3	49.18	8.50	8.50	6.68	4.29	2.89	2.28	1.17	0.51	84.00
24	37G4	191.09	99.98	83.18	57.61	38.67	25.10	22.06	11.08	2.62	531.39
24	38G2	393.29	14.14	5.35	4.65	2.29	0.79	1.68	0.35	0.12	422.66
24	38G3	67.75	12.45	7.66	5.33	3.83	1.69	2.14	0.82	0.19	101.86
24	38G4	130.20	68.12	56.67	39.25	26.35	17.10	15.03	7.55	1.78	362.05
24	39G2	251.34	9.45	3.12	2.44	2.07	1.06	1.05	0.64	0.02	271.19
24	39G3	98.33	28.46	13.90	10.24	6.65	3.06	4.26	2.07	0.13	167.10
24	39G4	52.52	23.42	23.81	16.87	10.46	5.55	7.34	3.07	1.29	144.33
24	Total	1,420.38	269.09	203.10	144.07	95.29	57.44	56.00	26.88	6.66	2,278.91
22-24	Total	2,537.24	340.77	226.35	156.28	103.42	60.01	57.85	27.96	6.92	3,516.80
21-24	Total	3,061.29	379.41	226.35	156.56	103.66	60.01	57.85	27.96	6.92	4,080.01

Table 7 Mean weight (g) of herring by age and area (RV "SOLEA" October 2009)

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total
21	41G0	13.18	33.85								13.66
21	41G1	14.53	34.77			43.44					15.99
21	41G2	13.67	35.12								14.19
21	42G1	17.40	35.92		54.67	43.44					20.60
21	42G2	13.86	34.81								15.12
21	Total	14.46	35.07		54.67	43.44					15.91
22	37G0	8.70	31.08								8.94
22	37G1	10.10	32.36	60.00	39.50	38.12					11.06
22	38G0	7.19	28.89		39.50	36.33					7.67
22	38G1	9.39	31.96	60.00	39.50	38.12					10.00
22	39F9	6.27									6.27
22	39G0	8.60	26.92								8.65
22	39G1		33.50								33.50
22	40F9	9.43									9.43
22	40G0	9.43									9.43
22	40G1	9.43									9.43
22	41G0	9.43									9.43
22	Total	9.26	31.73	60.00	39.50	38.09					10.08
23	39G2	11.14	35.47	38.36	36.04	38.29	41.46	40.94	41.35	80.37	13.05
23	40G2	10.84	47.38	103.02	127.90	152.29	193.21	167.92	248.06	205.31	57.31
23	41G2	11.33	41.19	57.53	34.34						14.49
23	Total	11.13	44.35	89.65	99.46	94.77	108.79	70.43	83.52	190.77	22.13
24	37G2	8.92	32.88	33.03	32.60	32.36	37.70	35.43	37.03		9.87
24	37G3	9.77	38.03	67.51	89.70	77.40	106.68	83.22	109.15	131.73	35.74
24	37G4	11.35	38.28	58.61	70.04	62.72	81.18	72.69	70.86	120.64	41.54
24	38G2	7.49	34.47	49.32	40.45	38.33	57.09	48.00	57.74	80.37	9.76
24	38G3	8.26	36.45	54.79	49.48	46.63	56.35	53.79	53.31	83.15	21.06
24	38G4	11.35	38.28	58.61	70.04	62.72	81.18	72.69	70.86	120.64	41.54
24	39G2	11.14	35.47	38.36	36.04	38.29	41.46	40.94	41.35	80.37	13.05
24	39G3	12.56	37.16	48.58	43.74	43.71	44.97	46.34	44.42	92.43	24.81
24	39G4	14.01	39.25	65.07	81.54	80.43	85.61	74.98	68.17	120.13	47.19
24	Total	9.90	37.76	58.24	67.88	62.02	79.01	69.25	68.61	118.92	27.56
22-24	Total	9.91	38.50	61.18	69.88	63.16	80.29	69.29	69.18	121.62	23.08
21-24	Total	10.69	38.15	61.18	69.85	63.11	80.29	69.29	69.18	121.62	22.09

Table 8 Total biomass (t) of herring by age and area (RV "SOLEA" October 2009)

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total
21	41G0	903.6	54.8								958.4
21	41G1	3,951.4	724.6			6.5					4,682.5
21	41G2	926.7	59.4								986.1
21	42G1	946.2	380.4		15.3	3.9					1,345.8
21	42G2	850.6	135.8								986.4
21	Total	7,578.5	1,355.0	0.0	15.3	10.4	0.0	0.0	0.0	0.0	8,959.2
22	37G0	142.9	5.6								148.5
22	37G1	4,842.9	392.5	127.2	41.9	94.2					5,498.7
22	38G0	1,195.4	98.5		5.5	3.3					1,302.7
22	38G1	209.3	12.8	3.0	0.8	2.3					228.2
22	39F9	80.0									80.0
22	39G0	234.7	2.2								236.9
22	39G1		47.2								47.2
22	40F9	0.5									0.5
22	40G0	15.5									15.5
22	40G1	1.7									1.7
22	41G0	0.8									0.8
22	Total	6,723.7	558.8	130.2	48.20	99.8	0.0	0.00	0.00	0.0	7,560.7
23	39G2	3,763.5	450.5	160.7	118.20	106.4	59.3	58.10	35.60	2.4	4,754.7
23	40G2	337.0	1,862.5	1,715.3	970.8	415.8	220.3	72.2	54.6	47.2	5,695.7
23	41G2	242.9	84.9	13.8	4.1						345.7
23	Total	4,343.4	2,397.9	1,889.8	1,093.1	522.2	279.6	130.3	90.2	49.6	10,796.1
24	37G2	1,665.2	150.3	30.1	32.6	22.0	7.5	5.7	4.8		1,918.2
24	37G3	480.5	323.3	573.8	599.2	332.0	308.3	189.7	127.7	67.2	3,001.7
24	37G4	2,168.9	3,827.2	4,875.2	4,035.0	2,425.4	2,037.6	1,603.5	785.1	316.1	22,074.0
24	38G2	2,945.7	487.4	263.9	188.1	87.8	45.1	80.6	20.2	9.6	4,128.4
24	38G3	559.6	453.8	419.7	263.7	178.6	95.2	115.1	43.7	15.8	2,145.2
24	38G4	1,477.8	2,607.6	3,321.4	2,749.1	1,652.7	1,388.2	1,092.5	535.0	214.7	15,039.0
24	39G2	2,799.9	335.2	119.7	87.9	79.3	43.9	43.0	26.5	1.6	3,537.0
24	39G3	1,235.0	1,057.6	675.3	447.9	290.7	137.6	197.4	91.9	12.0	4,145.4
24	39G4	735.8	919.2	1,549.3	1,375.6	841.3	475.1	550.4	209.3	155.0	6,811.0
24	Total	14,068.4	10,161.6	11,828.4	9,779.1	5,909.8	4,538.5	3,877.9	1,844.2	792.0	62,799.9
22-24	Total	25,135.5	13,118.3	13,848.4	10,920.4	6,531.8	4,818.1	4,008.2	1,934.4	841.6	81,156.7
21-24	Total	32,714.0	14,473.3	13,848.4	10,935.7	6,542.2	4,818.1	4,008.2	1,934.4	841.6	90,115.9

Table 9 Numbers (millions) of sprat by age and area (RV "SOLEA" October 2009)

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	41G0	1.24	0.63	0.25	0.12	0.01					2.25
21	41G1	0.27	21.18	7.89	5.45	0.43	0.01	0.01			35.24
21	41G2	12.58	8.12	3.57	2.97	0.25	0.09	0.04			27.62
21	42G1										0.00
21	42G2	18.53	1.85								20.38
21	Total	32.62	31.78	11.71	8.54	0.69	0.10	0.05	0.00	0.00	85.49
22	37G0	20.28	1.26	0.42	0.46	0.28	0.47				23.17
22	37G1	33.40	2.50	1.51	0.97	0.21	0.64				39.23
22	38G0	347.58	2.04	0.71	1.39	0.67	1.33				353.72
22	38G1	6.85	0.47	0.23	0.18	0.07	0.15				7.95
22	39F9	218.63									218.63
22	39G0	74.55	0.06	0.06	0.06						74.73
22	39G1	8.48									8.48
22	40F9	13.90									13.90
22	40G0	478.59									478.59
22	40G1	53.01									53.01
22	41G0	25.11									25.11
22	Total	1,280.38	6.33	2.93	3.06	1.23	2.59	0.00	0.00	0.00	1,296.52
23	39G2	16.43	1.25	0.71	0.63	0.04	0.04				19.10
23	40G2	1.97	28.96	43.91	80.24	21.67	11.51	1.93	0.30		190.49
23	41G2	2.52	8.99	10.60	16.82	3.43	2.14	0.43			44.93
23	Total	20.92	39.20	55.22	97.69	25.14	13.69	2.36	0.30	0.00	254.52
24	37G2	3.03	3.70	1.49	1.47	0.11	0.08	0.01		0.01	9.90
24	37G3	598.88	12.71	1.82	2.69	0.22					616.32
24	37G4	142.27	172.04	116.81	100.32	6.78	8.10	0.69	0.14	0.69	547.84
24	38G2	244.94	20.42	1.01	0.82	0.04	0.04				267.27
24	38G3	1,864.19	92.44	11.70	10.11	0.72	0.67	0.11		0.11	1,980.05
24	38G4	96.94	117.22	79.59	68.35	4.62	5.52	0.47	0.10	0.47	373.28
24	39G2	12.22	0.93	0.53	0.47	0.03	0.03				14.21
24	39G3	75.35	105.80	40.53	34.36	2.54	2.87	0.29	0.07	0.29	262.10
24	39G4	3.06	129.34	118.74	97.60	8.31	12.09	1.31	0.54	1.31	372.30
24	Total	3,040.88	654.60	372.22	316.19	23.37	29.40	2.88	0.85	2.88	4,443.27
22-24	Total	4,342.18	700.13	430.37	416.94	49.74	45.68	5.24	1.15	2.88	5,994.31
21-24	Total	4,374.80	731.91	442.08	425.48	50.43	45.78	5.29	1.15	2.88	6,079.80

Table 10 Mean weight (g) of sprat by age and area (RV "SOLEA" October 2009)

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	41G0	3.66	13.60	15.44	15.85	16.85					8.47
21	41G1	3.78	13.64	15.56	16.77	17.58	21.89	21.89			14.53
21	41G2	5.93	13.06	16.21	17.77	20.55	21.89	21.89			10.83
21	42G1										
21	42G2	5.37	5.81								5.41
21	Total	5.51	13.03	15.76	17.11	18.70	21.89	21.89			11.00
22	37G0	4.69	11.06	17.19	16.42	16.55	17.57				5.90
22	37G1	4.90	12.25	14.29	14.62	15.80	20.97				6.29
22	38G0	2.89	11.50	14.78	15.73	16.73	17.68				3.10
22	38G1	4.79	11.70	15.22	15.42	16.32	19.08				6.10
22	39F9	2.56									2.56
22	39G0	3.17	12.67	12.67	12.67						3.20
22	39G1	4.76									4.76
22	40F9	2.86									2.86
22	40G0	2.86									2.86
22	40G1	2.86									2.86
22	41G0	2.86									2.86
22	Total	2.94	11.74	14.88	15.46	16.42	18.57				3.08
23	39G2	5.44	13.57	16.13	16.00	16.12	17.88	19.36			6.78
23	40G2	6.27	14.16	17.82	18.99	21.14	21.70	18.72	26.60		18.27
23	41G2	6.21	14.18	17.38	18.44	20.45	21.80	18.72			16.97
23	Total	5.61	14.15	17.71	18.88	21.03	21.71	18.69	26.67		17.18
24	37G2	4.31	12.87	15.86	15.85	15.96	18.13	19.36		19.36	11.23
24	37G3	4.77	11.80	14.82	14.98	15.02					5.00
24	37G4	5.77	12.58	16.35	16.32	16.52	17.93	19.36	20.84	19.36	12.45
24	38G2	5.10	11.86	15.77	15.51	15.02	16.50				5.69
24	38G3	4.44	12.49	15.11	15.82	16.17	18.68	19.36		19.36	4.95
24	38G4	5.77	12.58	16.35	16.32	16.52	17.93	19.36	20.84	19.36	12.45
24	39G2	5.44	13.57	16.13	16.00	16.12	17.88	19.36		19.36	6.78
24	39G3	5.78	12.96	16.15	16.32	17.04	18.18	19.36	20.84	19.36	11.94
24	39G4	5.34	13.20	16.74	17.14	18.37	18.42	19.36	20.84	19.36	15.64
24	Total	4.70	12.72	16.40	16.54	17.21	18.17	19.38	20.84	19.36	7.88
22-24	Total	4.19	12.79	16.56	17.08	19.12	19.26	19.06	22.43	19.36	7.24
21-24	Total	4.20	12.80	16.54	17.08	19.12	19.26	19.09	22.43	19.36	7.29

Table 11 Total biomass (t) of sprat by age and area (RV "SOLEA" October 2009)

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	41G0	4.5	8.6	3.9	1.9	0.2					19.1
21	41G1	1.0	288.9	122.8	91.4	7.6	0.2	0.2			512.1
21	41G2	74.6	106.0	57.9	52.8	5.1	2.0	0.9			299.3
21	42G1										0.0
21	42G2	99.5	10.7								110.2
21	Total	179.6	414.2	184.6	146.1	12.9	2.2	1.1	0.0	0.0	940.7
22	37G0	95.1	13.9	7.2	7.6	4.6	8.3				136.7
22	37G1	163.7	30.6	21.6	14.2	3.3	13.4				246.8
22	38G0	1,004.5	23.5	10.5	21.9	11.2	23.5				1,095.1
22	38G1	32.8	5.5	3.5	2.8	1.1	2.9				48.6
22	39F9	559.7									559.7
22	39G0	236.3	0.8	0.8	0.8						238.7
22	39G1	40.4									40.4
22	40F9	39.8									39.8
22	40G0	1,368.8									1,368.8
22	40G1	151.6									151.6
22	41G0	71.8									71.8
22	Total	3,764.5	74.3	43.6	47.3	20.2	48.1	0.0	0.0	0.0	3,998.0
23	39G2	89.4	17.0	11.5	10.1	0.6	0.7				129.3
23	40G2	12.4	410.1	782.5	1,523.8	458.1	249.8	36.1	8.0		3,480.8
23	41G2	15.6	127.5	184.2	310.2	70.1	46.7	8.0			762.3
23	Total	117.4	554.6	978.2	1,844.1	528.8	297.2	44.1	8.0	0.0	4,372.4
24	37G2	13.1	47.6	23.6	23.3	1.8	1.5	0.2	0.0	0.2	111.3
24	37G3	2,856.7	150.0	27.0	40.3	3.3	0.0	0.0	0.0	0.0	3,077.3
24	37G4	820.9	2,164.3	1,909.8	1,637.2	112.0	145.2	13.4	2.9	13.4	6,819.1
24	38G2	1,249.2	242.2	15.9	12.7	0.6	0.7	0.0	0.0	0.0	1,521.3
24	38G3	8,277.0	1,154.6	176.8	159.9	11.6	12.5	2.1	0.0	2.1	9,796.6
24	38G4	559.3	1,474.6	1,301.3	1,115.5	76.3	99.0	9.1	2.1	9.1	4,646.3
24	39G2	66.5	12.6	8.5	7.5	0.5	0.5	0.0	0.0	0.0	96.1
24	39G3	435.5	1,371.2	654.6	560.8	43.3	52.2	5.6	1.5	5.6	3,130.3
24	39G4	16.3	1,707.3	1,987.7	1,672.9	152.7	222.7	25.4	11.3	25.4	5,821.7
24	Total	14,294.5	8,324.4	6,105.2	5,230.1	402.1	534.3	55.8	17.8	55.8	35,020.0
22-24	Total	18,176.4	8,953.3	7,127.0	7,121.5	951.1	879.6	99.9	25.8	55.8	43,390.4
21-24	Total	18,356.0	9,367.5	7,311.6	7,267.6	964.0	881.8	101.0	25.8	55.8	44,331.1

ANNEX 5I: Northern Ireland (Clyde, North Channel)

Survey report for RV “Corystes”

6 –10 July 2009 and 27 August-13 September 2009,

Pieter-Jan Schön, Agri-Food and Biosciences Institute (AFBI), Belfast, Northern Ireland

1. INTRODUCTION

The WESTHER project recommended that the survey effort along the Malin shelf area (including ICES Divisions VIaN, VIaS, VIIb,c, Clyde and Irish Sea) should be increased or diverted to a combined survey on non-spawning herring. The utility of such a survey in a combined assessment of the three currently assessed stocks (VIaN, VIaS and VIIaN) was identified as necessary to move towards an integrated management plan for the area.

Acoustic surveys of the northern Irish Sea (ICES Area VIIaN) have been carried by the Agri-Food and Biosciences Institute (AFBI), formerly the Department of Agriculture and Rural Development for Northern Ireland (DARD), since 1991. This report covers primarily the additional survey effort to the routine Irish Sea survey in autumn, which is an increase in survey effort and the second of a new time-series that covers the Clyde and North Channel. The survey forms part of synoptic summer surveys on the Malin shelf. Concurrent surveys are conducted by Ireland (ICES Div VIaS, VIIb,c) and Scotland (ICES Div VIaN).

2. SURVEY DESCRIPTION and METHODS

2.1 Personnel

Steven Beggs (SIC)
Peter McCorriston
Ian McCausland
Enda O’Callaghan
John Peel

2.2 Narrative

The vessel departed Belfast at 2200 on the 5 July and started the survey off the north coast at 0300 on the 7 July after a day of calibration. Sea conditions were good throughout the survey, except during the first day of transecting off the north coast. The survey was completed at 1745 on the 10 July.

2.3 Survey design

The survey design of systematic, parallel transects covers approximately 635 nm (Figure 5I.1), which is substantially more than the 540 nm in 2008. Transect spacing is 4 nm in the Clyde and increased to 7.5 nm off the north coast and channel, in accordance with perceived herring abundance. Data collected on connecting transects were not included in the estimates. The area to the west of the Isle of Arran was surveyed using a zigzag pattern to maximize coverage considering proximity to the coast. Survey design and methodology adheres to the methods laid out in the PGHERS acoustic survey manual.

2.4 Calibration

The hull mounted transducer ES38B was calibrated on the 6 July off Brodick on the east coast of Isle of Arran in the Clyde. Conditions were good and the calibration results satisfactory. All procedures were according to those defined in the survey manual. Summary of calibration results are presented in Table 5I.1.

2.5 Acoustic data collection

Similar to the other surveys on the Malin shelf, acoustic data were only collected during daylight hours (0400–2300). Acoustic data at 38 kHz are collected in 15-minute elementary distance sampling units (EDSU's) with the vessel steaming at 10 knots. A Simrad EK-60 echosounder with hull-mounted split-beam transducer is employed, and data are logged and analysed using SonarData Echoview software. The system settings are given in Table 5I.1.

2.6 Biological data – fishing stations

Targets are identified where possible by aimed midwater trawling fitted with a sprat brailer. The net was fished with a vertical mouth opening of approximately 15m, which was observed using a SCANMAR "Trawleye" netsounder. To facilitate determining the position of the net in the water column, a SCANMAR depth sensor is also fitted to the headline.

Trawl catches are sorted to species level then weighted. Depending on the number of fish, the sorted catch is normally subsampled for length measurements. Length frequencies are recorded in 0.5 cm length classes. Individual length-weight data are collected for all fish species contributing to the catches. Random samples of 50 herring (1+ gp) are taken from each catch for recording of biological parameters (length, weight, sex and maturity) and removal of otoliths for age determination. Random samples of 25 sprats and 25 0-gp herring per haul are collected and frozen for extraction of otoliths on shore.

2.7 Hydrographic data

Surface temperature and salinity were recorded using the through-flow thermosalinograph, and logged together with DGPS position at 1-minute intervals.

2.8 Data analysis

EDSUs were defined by 15 minute intervals which represented 2.5 nm per EDSU, assuming a survey speed of 10 knots. The surface-area backscattering (NASC) estimates are calculated for schools, school groups and scattering layers using a threshold of -60 dB. Targets in each 15-minute interval were allocated to species or species mixes by scrutinizing the echo charts together with acoustic records during trawling and maps of NASC values indicating location of trawls relative to school groups. In some cases, trawls with similar species and size composition are combined to give a more robust estimate of population length composition. Data were analysed using quarter rectangles of 15' by 30'.

The single-species or mixed-species mean target strength (*TS*) is calculated from trawl data for each interval as $10 \log \{(\Sigma_{s,l} N_{s,l}.10^{0.1.TS_{s,l}}) / \Sigma_{s,l} N_{s,l}\}$ where $N_{s,l}$ is the number of fish of species *s* in length class *l*. The values recommended by ICES for the parameters *a* and *b* of the length -*TS* relationship $TS = a \log (l) + b$ are used: $a = 20$ (all species); $b = -71.2$ (herring, sprat, horse mackerel), -84.9 (mackerel) and -67.5 (gadoids). The weighted mean *TS* is applied to the NASC value to give numbers per square nautical mile. For herring, this is further decomposed into densities by age class according to the length frequencies in the relevant target-identification trawls and the survey age–length key. Mean weights-at-age, calculated from length-weight parameters for the survey, is used to calculate biomass of herring from the estimated numbers-at-age. The weighted mean fish density is estimated for each survey stratum (ICES rectangle) using distance covered in each 15-minute EDSU as weighting factors, and raised by stratum surface area. Approximate standard errors are computed for the biomass estimates based on the variation between EDSUs within strata.

3. RESULTS

3.1 Biological data

In total 9 trawl hauls were carried out. Table 5I.2 gives the positions, catch composition and mean length by species for these trawl hauls. Six hauls contained herring to be used in the analysis, but only 3 hauls contained large numbers/proportions of herring. The length frequency distributions of these hauls are illustrated in Figure 5I.2. All distributions are unimodal and indicate relatively small herring of similar size within the sampling area. It was not possible to get a sample of herring off the north coast.

The resulting weight-length relationship for herring was calculated from the sampling information as $W = 0.00638*L^{3.062}$ (length measured in cm). The age length key (Table 5I.3) used in the analysis indicate that the population is composed of juveniles and young, immature fish (age 1).

3.2 Acoustic data

The distribution of the NASC values assigned to herring and to clupeoid mixes (juvenile herring and sprat) are presented in Figure 5I.3. The highest abundance of herring was around the Isle of Aran and further south towards the North Channel.

3.3 Biomass estimates

The estimated biomass and number of herring and sprat by subrectangle are given in Table 5I.4. Only 0-gp and 1-gp herring were found in the area and the total number estimate comprises of 99% age 0 and 1% age 1.

4 DISCUSSION

The stock estimate in the survey area (Clyde/North Channel) was estimated to be 24,256 t or 5.9×10^9 individuals. The majority of the fish were below 10 cm and the major contribution of ages to the total estimates is from ages 0 fish. No mature fish were found in any of the hauls. Similar to the perception from last year’s survey, the surveyed area appears to be a juvenile nursery area rather than an adult feeding ground, but this perception might change with subsequent survey information.

The herring were fairly widely distributed within mixed schools at low abundance, with a few distinct high abundance areas. The largest herring aggregations were found in to the south of the Isle of Arran.

5 TABLES AND FIGURES

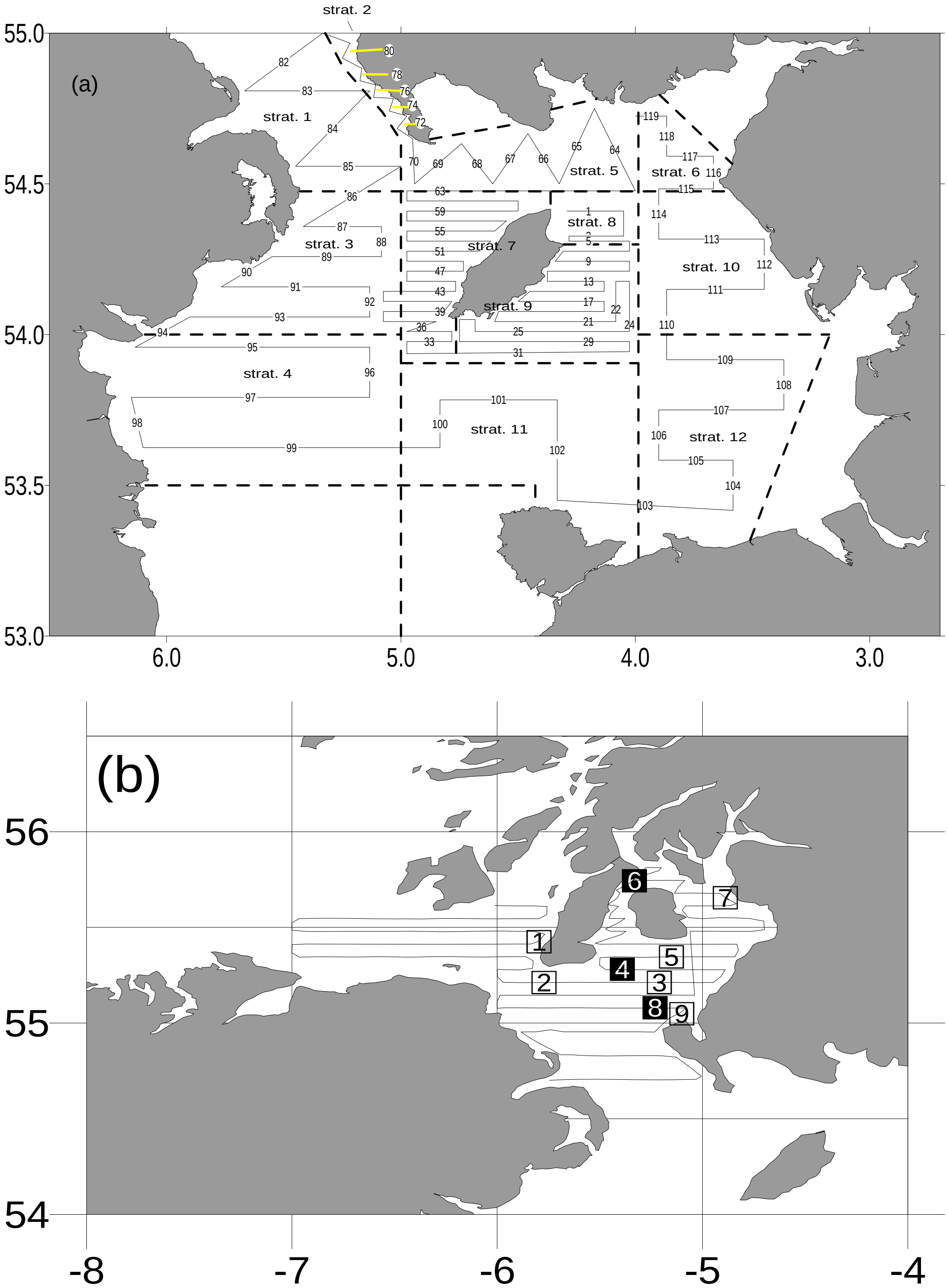

Figure 5I.1. Acoustic survey tracks of the Irish Sea, Clyde and North Channel surveys. (a) Survey grid of the main autumn herring acoustic survey in the Irish Sea in 2009. (b) Cruise track and trawl positions during the July 2009 Clyde and North Channel acoustic survey on RV "Corystes". Filled squares indicate trawls in which significant numbers of herring were caught or trawls with a large proportion of herring, while open squares indicate trawls with few or no herring.

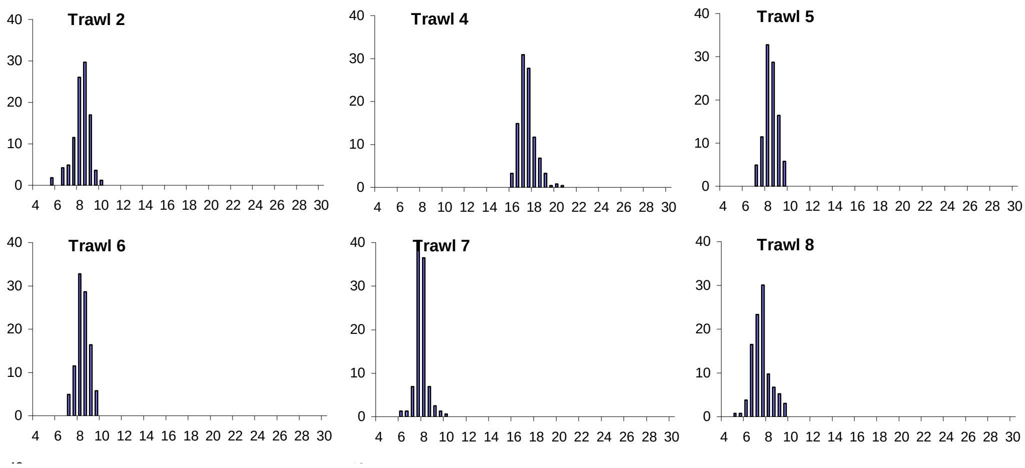

Figure 5I.2. Percentage length compositions of herring in each trawl sample in the July 2009 Clyde and North Channel acoustic survey on RV "Corystes".

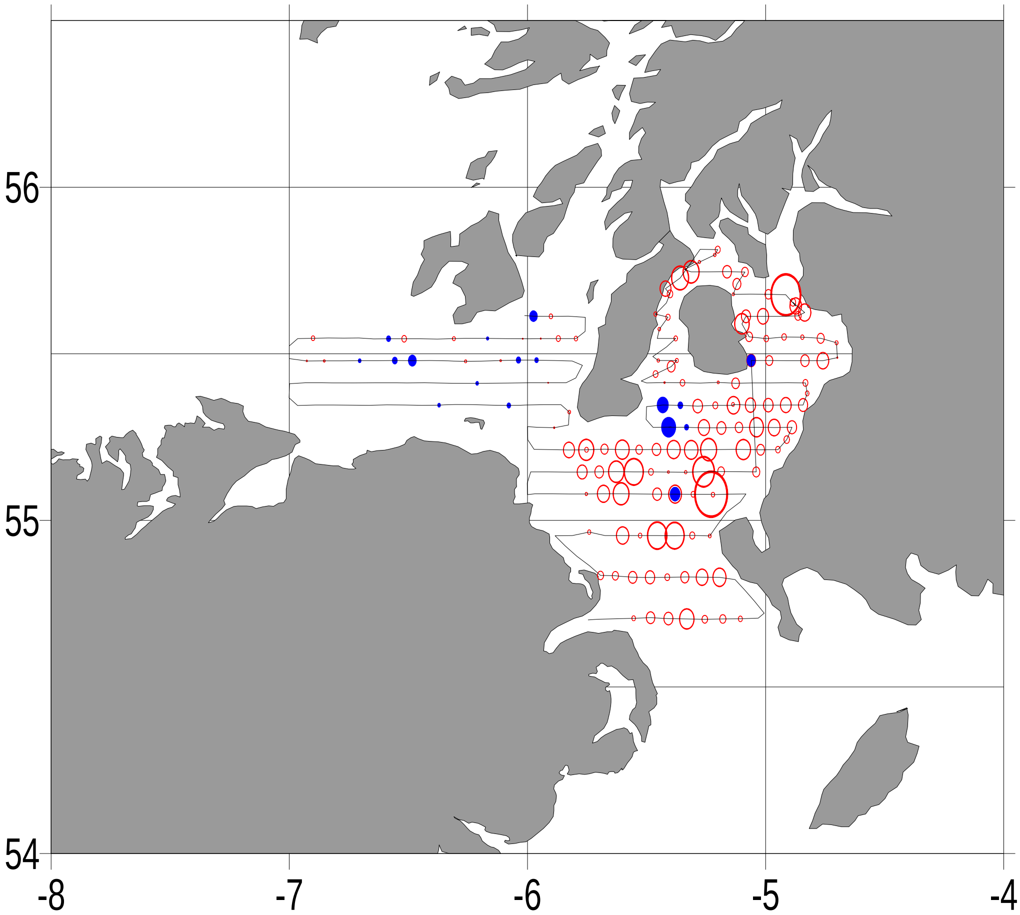

Figure 5I.3. Map of the Clyde and North Channel with a post plot showing the distribution of NASC values (size of elipses is proportional to square root of the NASC value per 15-minute interval) obtained during the July 2009 acoustic survey on RV "Corystes". (a) Solid circles are for herring NASC values (maximum value was 960) and (b) open circles are for clupeoid mix NASC, which include juvenile herring and sprat (maximum value was 5250).

Table 5I.1. Simrad EK60 and analysis settings used on the July 2009 Clyde and North Channel herring acoustic survey on RV "Corystes".

TRANSCEIVER MENU	
Frequency	38 kHz
Sound speed	1508 $m.s^{-1}$
Max. Power	2000 W
Equivalent two-way beam angle	-20.6 dB
Default Transducer Sv gain	24.84 dB
3 dB Beam width	6.9°
Calibration details	
TS of sphere	-33.6 dB
Range to sphere in calibration	12.5 m
Log Menu	
Integration performed in Echoview post-processing based on 15 minute EDSUs	
Operation Menu	
Ping interval	0.75 s 1 s at 250 m range
Analysis settings	
Bottom margin (backstep)	0.5 m
Integration start (absolute) depth	8 m
Sv gain threshold	-60 dB

Table 5I.2. Catch composition and position of hauls undertaken by the RV "Corystes" during the Clyde/North Channel survey, July 2009.

		SHOOTING DETAILS				TOTAL FISH	PERCENTAGE COMPOSITION OF FISH BY WEIGHT							MEAN LENGTH (CM)		INVERTEBRATE CATCH (KG)
TOW	DATE	TIME	LAT	LONG	DEPTH (M)	CATCH (KG)	SPRAT	HERRING	MACKEREL	SCAD	ANCHOVY	WHITING	OTHER FISH	SPRAT	HERRING	
1	07/07	1406	55 25.5	6 47.8	25	0	98.3	0.0	0.1	0.1	0.1	0.1	1.2	4.5		0.0
2	08/07	0620	55 12.7	4 46.3	38	52	1.1	3.3	91.9	0.0	0.0	6.0	1.0	9.2	8.4	0.0
3	08/07	1020	55 12.8	5 12.6	19	35	0	0.0	0.2	0.0	0.0	0.0	0.0		18.0	0.0
4	08/07	1500	55 16.9	4 23.4	38	280	0	0.0	100.0	0.0	0.0	0.0	0.0		17.6	0.0
5	08/07	1906	55 20.8	5 9.1	25	47	75.5	0.03	24.4	0.0	0.0	0.1	0.0	8.4	8.5	0.0
6	09/07	0716	55 44.6	5 19.9	39	40	13.4	99.99	86.6	0.0	0.0	0.0	0.0	8.8	8.0	0.0
7	09/07	1222	55 39.3	4 53.3	24	49		75.6	24.4	0.0	0.0	0.0	0.0	6.0	7.2	0.0
8	10/07	0652	55 4.8	5 13.9	32	46		35.8	62.9	0.0	0.0	1.3	0.0	8.1	7.6	0.0
9	10/07	0756	55 2.9	5 6.1	40	248	6.8	96.9	0.0	0.0	0.0	0.0	0.0	12.0		0.0

Table 5I.3. Age-length key for herring from which otoliths were removed at sea during the July 2009 Clyde/North Channel survey. Data are numbers of fish at-age in each length class in samples collected from each trawl.

	AGE CLASS (RINGS, OR AGES ASSUMING 1 JANUARY BIRTHDATE)				
LENGTH (CM)	0	1	2	3	TOTAL
5	2				2
6	4				4
7	8				8
8	8				8
9	7				7
10	1				1
11					
12		1			1
13					
14					
15					
16		4			4
17		6			6
18		8			8
19		5			5
20		3			3
21					
TOTAL	30	27			57

Table 5I.4. Acoustic survey estimates of biomass ('000t) and numbers ('000) of herring and sprat by survey stratum from the AFBI acoustic surveys in July 2008.

STRATUM	NO. SPRAT	BIOMASS SPRAT	NO. HER	BIOMASS HER
40E5C	349564	579	77517	212
40E4D	33509	170	379389	1439
40E4C	662	4	103753	466
40E4B	0	0	0	0
40E3D	1416	1	21911	98
40E3C	544	3	85183	382
39E5A	433347	1873	104731	482
39E4D	1909537	8252	607317	2796
39E4C	9601	56	1504335	6750
39E4B	503310	2175	163882	1598
39E4A	18	0	2755	12
39E3B	55	0	25509	748
39E3A	38	0	7688	101
38E4D	19459	89	74919	250
38E4C	86857	397	334402	1118
38E4B	503098	2299	1936929	6476
38E4A	103052	471	396752	1327
Total	3954067	16368	5826969	24256

Annex 6: The 2009 ICES Coordinated Acoustic Survey in the Skagerrak, Kattegat, the North Sea, west of Scotland and Malin Shelf area

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Abstract

Seven surveys were carried out during late June and July covering most of the continental shelf in the North Sea, West of Scotland and the Malin Shelf. An additional survey carried out by AFBI (Belfast, Northern Ireland) in the Irish Sea could not be included in this report due to late submission of the data. The surveys are reported individually in the report of the ICES Working Group for International Pelagic Surveys: the global estimate of herring from all of these surveys is reported here. The global 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 estimate of North Sea, autumn spawning herring, spawning stock is about a third higher compared to the previous year, at 2.6 million tonnes and 12 888 million herring. The survey continues to show the particularly strong 2000 year class of herring. Growth of this 2000 year class seems still to be slower than average: individuals of this year class were of a smaller mean length and mean weight than the younger 2001 year class.

The estimates of Western Baltic spring-spawning herring SSB were 205 000 tonnes and 1 602 million herring, which is lower than last year's estimate. The stock is dominated by 1 and 2 ring fish, however this year's estimated abundance of 1 and 2 ringers is considerably less compared to previous years since 2002.

The West of Scotland estimates of SSB are 579 000 tonnes and 2 560 million herring. These are lower compared to the estimates from the previous year, which were the second highest in the time-series. Once again the survey did not detect many immature fish this year. The youngest year class observed in the survey represents the strongest since the past four years. To ensure that the west of Scotland results were consistent with the time-series, they were derived from squares above 56°N only.

The synoptic survey covering what is currently considered the Malin Shelf population of herring was carried out for the second year. This provided an estimate comprising four stocks to the west of the British Isles: the West of Scotland herring stock in Division VIaN; the Clyde stock; the stock in Division VIaS and VIIb, c and the Irish Sea stock. Due to aforementioned problems, results from the survey covering the Clyde stock and the Irish Sea are not reported here. The Malin Shelf estimate of SSB reported here therefore covers the West of Scotland herring stock in Division VIaN and the stock in Division VIaS and VIIb, c. The SSB estimate was 593 000 tonnes and 2 647 million fish and is largely dominated by the West of Scotland estimate.

Introduction

Seven surveys were carried out during late June and July covering most of the continental shelf north of 52°N in the North Sea and to the west of Scotland and Ireland to a northern limit of 62°N. The eastern edge of the survey area was bounded by the Norwegian and Danish, Swedish and German coastline and to the west by the shelf edge between 200 and 400 m depth. The surveys are reported individually in appendices 2A-I of the report of the planning group for international pelagic surveys. The vessels, areas and dates of cruises are given in Table 6.1 and in Figure 6.1. The Norwegian part of the survey had a cut in survey time, resulting in an inadequate coverage of the survey area, as only 16 of a total of 39 squares (41%) were covered. The covered cells were the cells recommended by PGIPS 2009 to be covered with the highest effort (ICES, 2009).

Table 6.1. Vessels, areas and cruise dates during the 2009 herring acoustic surveys.

Vessel	Period	Area	Rectangles
Celtic Explorer (IR)	3 July – 22 July	53°-56°N ,12°-7°W	35D8-D9, 36D8-D9, 37D9-E1, 38D9-E1, 39E0-E2, 40E0-E2
Charter west Sco (SCO)	29 June – 18 July	55°30′-60°30′N, 4°-10°W	41E0-E3, 42E0-E3, 43E0-E3, 44E0-E3, 45E0-E4, 46E2-E5, 47E2-E5, 48E4-E5, 49E5
Johan Hjort (NOR)	13 July – 21 July	57°-62°N, 2°-5°E	43F2, 44F3-F4, 45F2-F4, 46F2, 47F2-F3, 48F2, 49F3, 50F2, 51F2-F3, 52F2-F3
Scotia (SCO)	28 June – 16 July	58°30′-62°N, 4°W-2°E	46E6-F1, 47E6-F1, 48E6-F1, 49E6-F1, 50E7-F1, 51E6-F1
Tridens (NED)	29 June – 24 July	54°– 58°30′N, 4° W–2°/ 6°E	37E9-F1, 38E8-F1, 39E8-F1, 40E8-F5, 41E7-F5, 42E7-F2, 43E7-F1, 44E6-F1, 45E6-F1
Solea (GER) DBFH	26 June – 15 July	52°-56°N, Eng to Den/Ger coasts	33F1-F4, 34F2-F4, 35F2-F4, 36F0-F7, 37F2-F8, 38F2-F7, 39F2-F7, 40F6-F7
Dana (DEN) OXBH	30 June – 13 July	Kattegat and North of 56°N, east of 6°E	41 F6-F7, 41G1-G2, 42F6-F7, 42G0-G2, 43F6-G1, 44F6-G1, 45F8-G1, 46F9-G0

The data were combined to provide an overall global estimate. Estimates of numbers at-age, maturity stage and mean weights at-age were calculated as weighted means of individual survey estimates by ICES statistical rectangle. The weighting applied was proportional to the length of survey track for each vessel in each ICES statistical rectangle. The data were combined to provide estimates of the North Sea autumn spawning herring, Western Baltic spring-spawning herring, West of Scotland (VIa north) herring and Malin Shelf stocks (VI and VII).

Methods

The acoustic surveys were carried out using Simrad EK60 38 kHz echosounders with transducers mounted either on the hull, drop keel or in towed bodies. Echo integration and further data analyses were carried out using either LSSS (Large Scale Survey System), Sonardata Echoview or Echoann software. The survey track was selected to cover the whole area with sampling intensities based on the herring densities of previous years. Transect spacing of 4, 7.5, 15 and 30 nautical miles were used in various parts of the area according to perceived abundance and variance from previous years' surveys.

The following target strength to fish length relationships were 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

Combined Acoustic Survey Results for 2009

The estimate of the North Sea autumn spawning herring spawning stock is about a third higher than in the previous year, at 2.6 million tonnes and 12 888 million herring (Table 6.2). The survey indicates that the strong 2000 year class of herring still persists in the population. The abundance of the 2006 year class (age 2 this year) is now higher than the number of fish at-age 1 last year, indicating that the 2007 estimate of age 0 fish might have been more precise than previously assumed. Growth of the 2000 year class is still slower than average, with individuals of this year class having a lower mean size and mean weight than those fish which are one year younger (the 2001 year class).

The estimates of Western Baltic spring-spawning herring SSB are 205 000 tonnes and 1 602 million herring (Table 6.3), which are both lower than last years' estimates. The stock is once again dominated by 1 and 2 ring fish, however abundances of 1 and 2 ringers are considerably less than those of previous years since 2002.

The West of Scotland estimates of SSB are 579 000 tonnes and 2 560 million herring (Table 6.4). This is lower than last year's estimate. The abundance is not dominated by immature fish; however, the present year class is the highest for the past four years. The abundance by year class is consistent with previous years and also with results from the adjacent North Sea area. The 2000 year class is still very large.

The synoptic survey covering what is currently considered the Malin Shelf population of herring was running for the second year. The provided estimate comprises four stocks to the west of the British Isles: the West of Scotland herring stock in Division VIaN (identified in Fishframe as her-vian); the Clyde stock (her-clyd); the stock in Division VIaS and VIIb,c (her-irlw) and the Irish Sea stock (her-nirs). Due to late submission of data from the survey covering the Clyde stock and the Irish Sea, those results were not included in this report. The remaining estimates were combined in the same manner as the surveys in the North Sea, with weighting applied to individual survey estimates at ICES statistical rectangle according to the amount of survey effort in the rectangle measured in nautical miles. The Malin Shelf estimate of SSB, excluding the Clyde stock and the Irish Sea, was 593 000 tonnes and 2 647 million fish (Table 6.5). This is largely dominated by the West of Scotland estimate.

The area covered during the individual acoustic surveys is given in Figure 6.1. The spatial distributions of the abundance (numbers and biomass) of autumn spawning herring are shown in Figure 6.2. The distribution of numbers by age is shown in Figure 6.3 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 proportions mature for 2 and 3 ring herring are shown in Figure 6.4. The spatial distribution of mature and immature autumn spawning herring is shown in Figures 6.5 and 6.6 respectively. The spatial distributions of the abundance (numbers and biomass) of Western Baltic spring-spawning herring are shown in Figure 6.7. The distribution of numbers by age is shown in Figure 6.8 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 6.9. The spatial distribution of mature and immature Western Baltic spring-spawning herring is shown in Figures 6.10 and 6.11 respectively.

The distribution of adult herring in the North Sea is still concentrated in the areas close to the Fladen grounds.

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 6.6 – 6.8, illustrated in Figures 6.12 -6.14 respectively. In each, a 3 year running mean is included to show the general trend more clearly.

Tables and Figures

Table 6.2. Total numbers (millions) and biomass (thousands of tonnes) of North Sea autumn spawning herring in the area surveyed in the acoustic surveys July 2009, with mean weights and mean lengths by age ring.

Age (ring)	Numbers	Biomass	Maturity	weight(g)	Length (cm)
0	13,554	95	0.00	7.0	10.0
1	4,655	260	0.04	55.9	18.3
2	5,632	832	0.89	147.7	24.8
3	2,553	532	1.00	208.3	27.4
4	1,023	242	1.00	236.3	28.4
5	1,077	249	1.00	231.5	28.3
6	674	162	1.00	239.6	28.5
7	638	169	1.00	265.5	29.4
8	1,142	285	1.00	249.2	28.8
9+	578	174	1.00	262.7	29.5
Immature	18,639	407		21.8	12.4
Mature	12,888	2,591		201.1	27.0
Total	31,526	2,998	0.41	95.1	18.4

Table 6.3. Total numbers (millions) and biomass (thousands of tonnes) of Western Baltic spring-spawning herring in the area surveyed in the acoustic surveys July 2009, with mean weights, mean length and fraction mature by age ring.

Age (ring)	Numbers	Biomass	Maturity	weight(g)	Length (cm)
0					
1	565	27	0.32	47.5	17.7
2	398	49	0.77	122.7	23.4
3	205	30	0.95	149.1	25.4
4	161	30	0.99	182.9	27.0
5	82	17	1.00	213.3	28.3
6	86	21	1.00	248.3	29.1
7	39	10	1.00	272.1	29.8
8+	65	20	1.00	304.7	30.3
Immature	490	31		63.5	19.0
Mature	1,113	174		156.2	24.7
Total	1,602	205	0.69	127.9	23.0

Table 6.4. Total numbers (millions) and biomass (thousands of tonnes) of autumn spawning West of Scotland herring in the area surveyed in the acoustic surveys July 2009, with mean weights, mean lengths and fraction mature by age ring.

Age (ring)	Numbers	Biomass	Maturity	weight(g)	Length (cm)
0					
1	346	20	0.00	59.0	18.5
2	187	28	0.70	151.5	24.8
3	264	55	1.00	206.4	27.5
4	430	96	1.00	223.3	28.3
5	374	87	1.00	233.1	28.6
6	219	51	1.00	231.2	28.6
7	187	43	1.00	231.8	28.6
8	500	116	1.00	232.3	28.6
9+	456	109	1.00	238.2	28.8
Immature	403	26		64.9	19.0
Mature	2,560	579		226.2	28.4
Total	2,962	605	0.86	204.2	27.1

Table 6.5. Total numbers (millions) and biomass (thousands of tonnes) of Malin Shelf herring in the area surveyed in the acoustic surveys July 2009, with mean weights, mean lengths and fraction mature by age ring.

Age (ring)	Numbers	Biomass	Maturity	weight(g)	Length (cm)
0					
1	773	45	0.00	58.9	18.6
2	265	38	0.67	143.3	24.5
3	274	56	0.99	204.1	27.4
4	444	98	1.00	222.1	28.2
5	380	89	1.00	233.0	28.6
6	225	52	1.00	231.5	28.6
7	193	45	1.00	232.4	28.6
8	500	116	1.00	232.3	28.6
9+	456	109	1.00	238.2	28.8
Immature	863	55		63.8	19.0
Mature	2,647	593		224.1	28.3
Total	3,510	648	0.75	184.7	26.0

Table 6.6. Estimates of North Sea autumn spawners (millions) at-age from acoustic surveys, 1985–2009. For 1985–1986 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 2009 estimates are from 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.

Years / Age (rings)	1	2	3	4	5	6	7	8	9+	Total	SSB ('000t)
1985	726	2,789	1,433	323	113	41	17	23	19	5,484	697
1986	1,639	3,206	1,637	833	135	36	24	6	8	7,542	942
1987	13,736	4,303	955	657	368	77	38	11	20	20,165	817
1988	6,431	4,202	1,732	528	349	174	43	23	14	13,496	897
1989	6,333	3,726	3,751	1,612	488	281	120	44	22	16,377	1,637
1990	6,249	2,971	3,530	3,370	1,349	395	211	134	43	18,262	2,174
1991	3,182	2,834	1,501	2,102	1,984	748	262	112	56	12,781	1,874
1992	6,351	4,179	1,633	1,397	1,510	1,311	474	155	163	17,173	1,545
1993	10,399	3,710	1,855	909	795	788	546	178	116	19,326	1,216
1994	3,646	3,280	957	429	363	321	238	220	132	13,003	1,035
1995	4,202	3,799	2,056	656	272	175	135	110	84	11,220	1,082
1996	6,198	4,557	2,824	1,087	311	99	83	133	206	18,786	1,446
1997	9,416	6,363	3,287	1,696	692	259	79	78	158	22,028	1,780
1998	4,449	5,747	2,520	1,625	982	445	170	45	121	16,104	1,792
1999	5,087	3,078	4,725	1,116	506	314	139	54	87	15,107	1,534
2000	24,735	2,922	2,156	3,139	1,006	483	266	120	97	34,928	1,833
2001	6,837	12,290	3,083	1,462	1,676	450	170	98	59	26,124	2,622
2002	23,055	4,875	8,220	1,390	795	1,031	244	121	150	39,881	2,948
2003	9,829	18,949	3,081	4,189	675	495	568	146	178	38,110	2,999
2004	5,183	3,415	9,191	2,167	2,590	317	328	342	186	23,722	2,584
2005	3,113	1,890	3,436	5,609	1,211	1,172	140	127	107	16,805	1,868
2006	6,823	3,772	1,997	2,098	4,175	618	562	84	70	20,199	2,130
2007	6,261	2,750	1,848	898	806	1,323	243	152	65	14,346	1,203
2008	3,714	2,853	1,709	1,485	809	712	1,749	185	270	20,355	1,784
2009	4,655	5,632	2,553	1,023	1,077	674	638	1,142	578	31,526	2,591

Table 6.7. Numbers at-age (millions) of Western Baltic Spring-spawning herring at-age (rings) from acoustic surveys 1991 to 2009. The 1999 survey was incomplete due to the lack of participation by RV "DANA".

Year/Age	1	2	3	4	5	6	7	8+	Total	3+ group
1991		1,864	1,927	866	350	88	72	10	5,177	3,313
1992	277	2,092	1,799	1,593	556	197	122	20	10,509	4,287
1993	103	2,768	1,274	598	434	154	63	13	5,779	2,536
1994	5	413	935	501	239	186	62	34	3,339	1,957
1995	2,199	1,887	1,022	1,270	255	174	39	21	6,867	2,781
1996	1,091	1,005	247	141	119	37	20	13	2,673	577
1997	128	715	787	166	67	69	80	77	2,088	1,245
1998	138	1,682	901	282	111	51	31	53	3,248	1,428
1999	1,367	1,143	523	135	28	3	2	1	3,201	691
2000	1,509	1,891	674	364	186	56	7	10	4,696	1,295
2001	66	641	452	153	96	38	23	12	1,481	774
2002	3,346	1,576	1,392	524	88	40	18	19	7,002	2,081
2003	1,833	1,110	395	323	103	25	12	5	3,807	864
2004	1,668	930	726	307	184	72	22	18	3,926	1,328
2005	2,687	1,342	464	201	103	84	37	21	4,939	910
2006	2,081	2,217	1,780	490	180	27	10	0.1	6,791	2,487
2007	3,918	3,621	933	499	154	34	26	14	9,200	1,661
2008	5,852	1,160	843	333	274	176	45	44	8,839	1,715
2009	565	398	205	161	82	85	39	65	1,602	638

Table 6.8. Numbers at-age (millions) and SSB of West of Scotland Autumn Spawning herring at-age (rings) from acoustic surveys 1992 to 2009. In 1997 the survey was carried out one month early in June as opposed to July when all the other surveys were carried out.

Year/Age	1	2	3	4	5	6	7	8	9+	SSB:
1992	74	503	211	258	415	240	106	57	64	352
1993	3	750	681	653	544	865	284	152	156	866
1994	494	542	608	286	307	268	407	174	132	534
1995	441	1,103	473	450	153	187	169	237	202	452
1996	41	577	803	329	95	61	77	78	115	370
1997	792	642	286	167	66	50	16	29	24	141
1998	1,221	795	667	471	179	79	28	14	37	376
1999	534	322	1,389	432	308	139	87	28	35	460
2000	448	316	337	900	393	248	200	95	65	500
2001	313	1,062	218	173	438	133	103	52	35	359
2002	425	436	1,437	200	162	424	152	68	60	549
2003	439	1,039	933	1,472	181	129	347	114	75	739
2004	564	275	760	442	577	56	62	82	76	396
2005	50	243	230	423	245	153	13	39	27	168
2006	112	835	388	285	582	415	227	22	59	472
2007	0	126	294	202	145	347	243	163	32	299
2008	48	233	912	669	340	272	721	366	264	788
2009	346	187	264	430	374	219	187	500	456	579

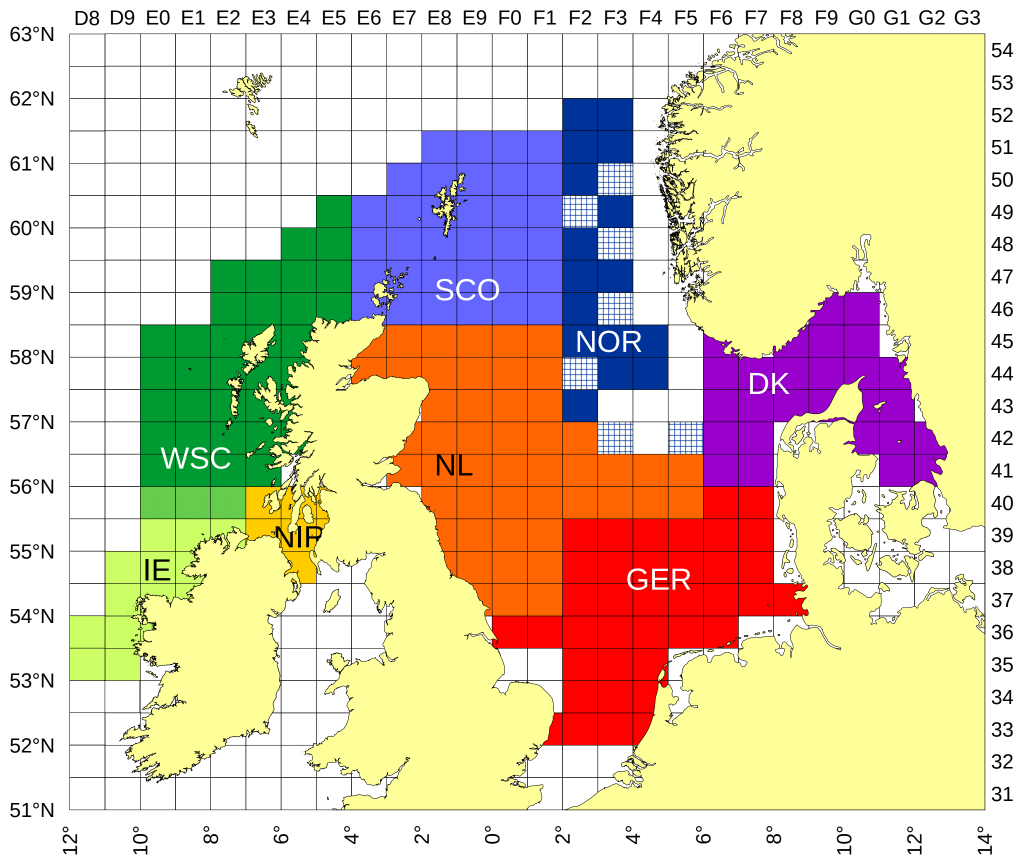

Figure 6.1. Survey area coverage in the pelagic acoustic surveys in 2009, by rectangle and nation (IR = Celtic Explorer; NIR = Corystes; WSC = West of Scotland charter vessel; SCO = Scotia; NOR = Johan Hjort; DK = Dana; NL = Tridens; GER = Solea). Multi-coloured rectangles indicate overlapping coverage by two or more nations (e.g. 40E1–40E3). Checked rectangles were interpolated from surrounding ones. Blank rectangles are not surveyed.

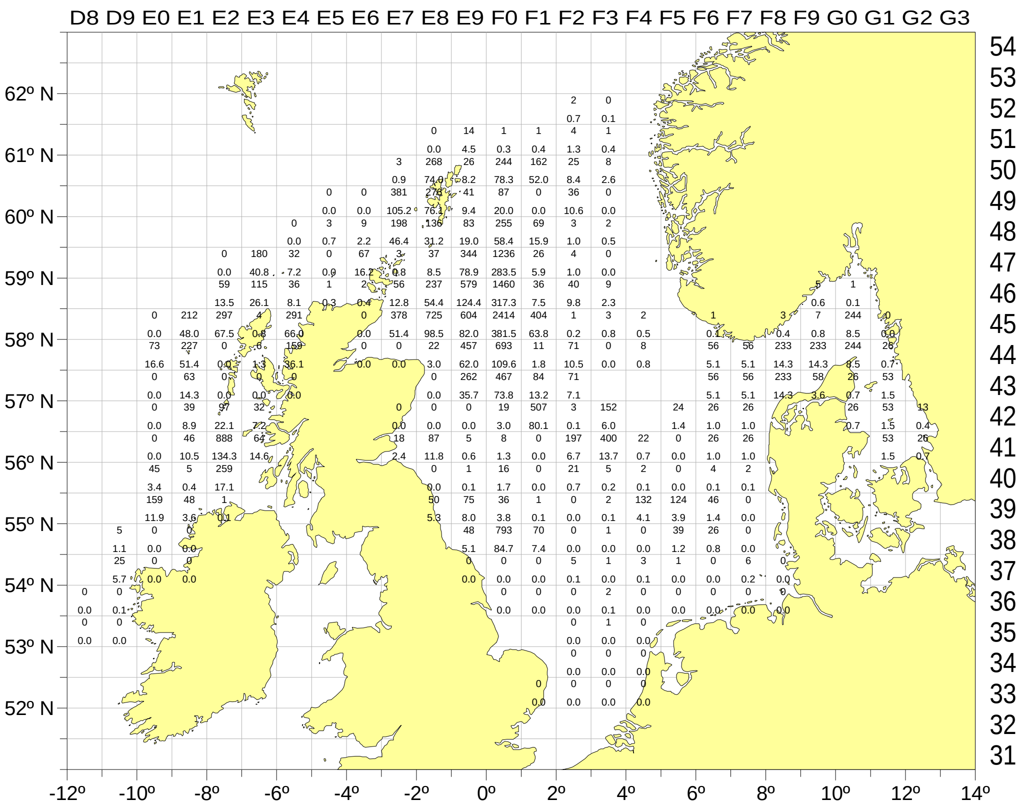

Figure 6.2. Abundance of autumn spawning herring (winter ring 1–9+) from the combined acoustic survey in June-July 2009. Numbers (millions, upper figure) and biomass (thousands of tonnes, lower figure). Blank and inturpolated rectangles are not surveyed. Interpolated rectangles are mark in Figure 6.1

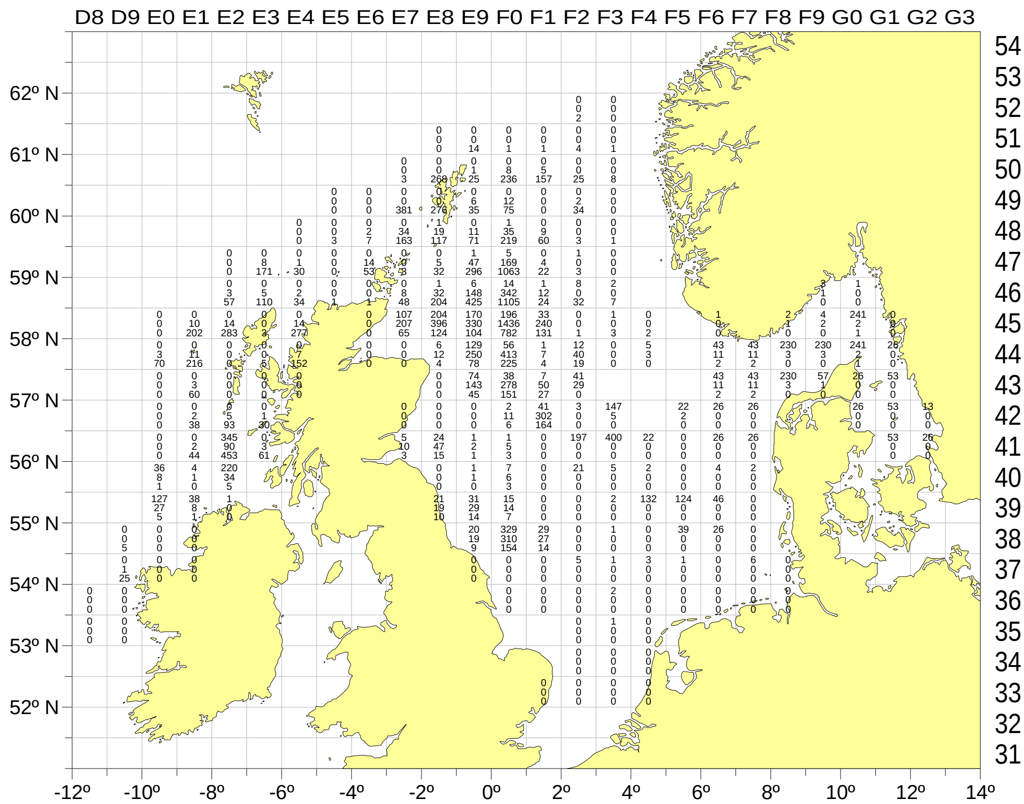

Figure 6.3. Numbers (millions) of autumn spawning herring from combined acoustic survey June – July 2009. 1 winter ring (upper figure), 2 ring (centre figure), 3+ (lower figure). Blank and interpolated rectangles are not surveyed. Interpolated rectangles are mark in Figure 6.1

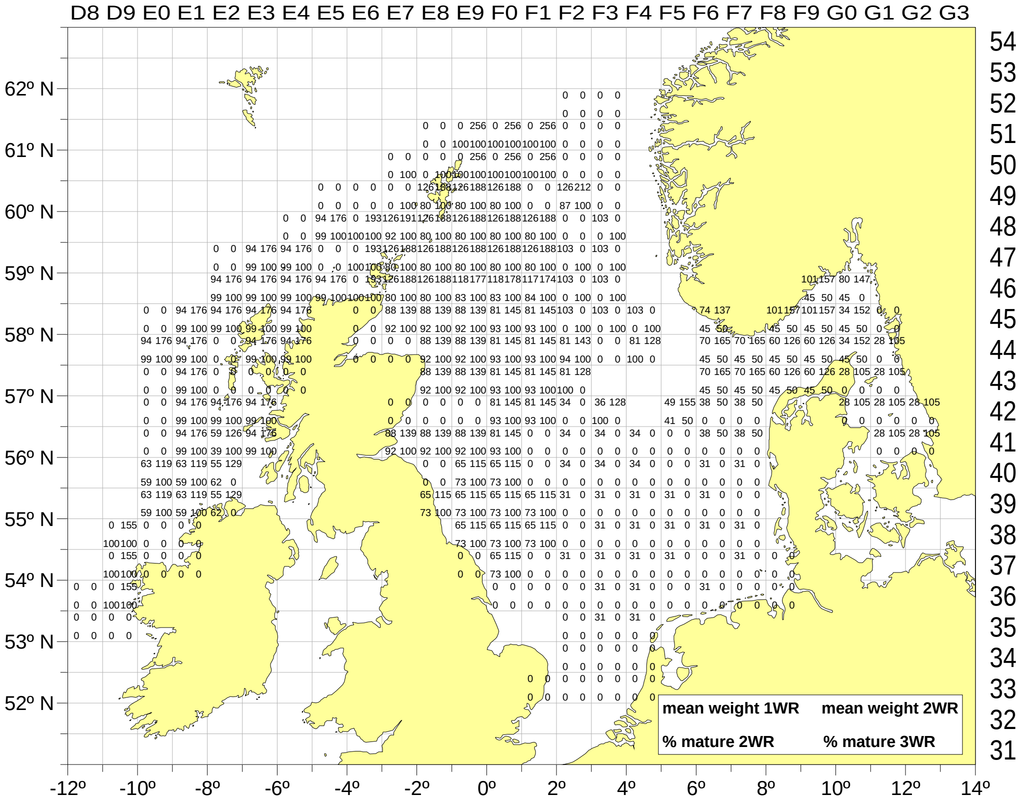

Figure 6.4. Mean weight and maturity of autumn spawning herring from combined acoustic survey June – July 2009. Four values per ICES rectangle, percentage mature of 2 ring (lower left) and 3 ring fish (lower right), mean weights (grammes) of 1 ring (upper left) and 2 ring fish (upper right), 0 indicates surveyed with zero abundance. Blank and interpolated rectangles are not surveyed. Interpolated rectangles are mark in Figure 6.1.

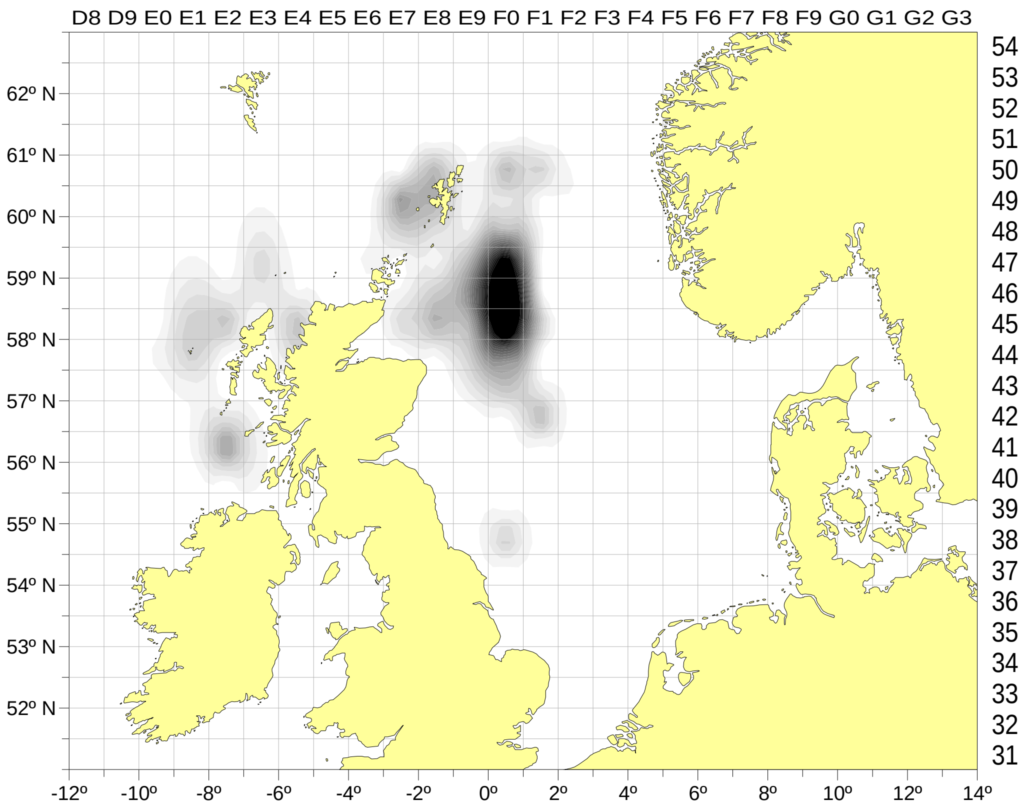

Figure 6.5. Biomass of mature autumn spawning herring from the combined acoustic survey in June – July 2009 (maximum value = 220 000).

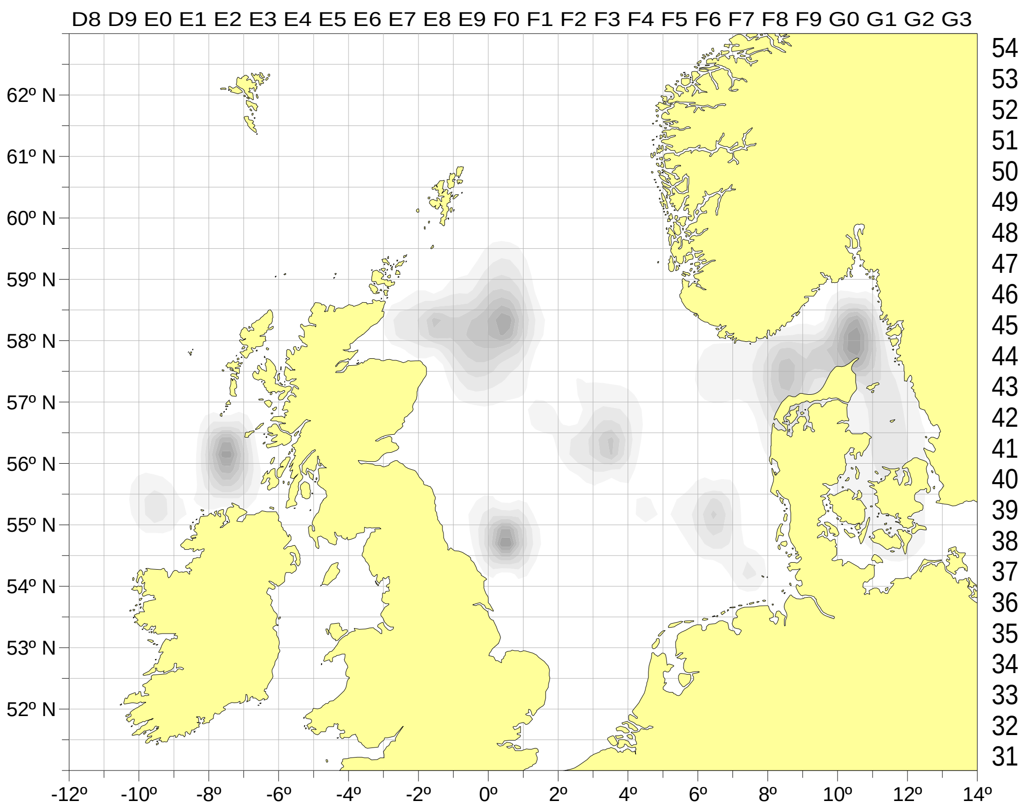

Figure 6.6. Biomass of immature autumn spawning herring from the combined acoustic survey in June – July 2009 (maximum value = 57 500).

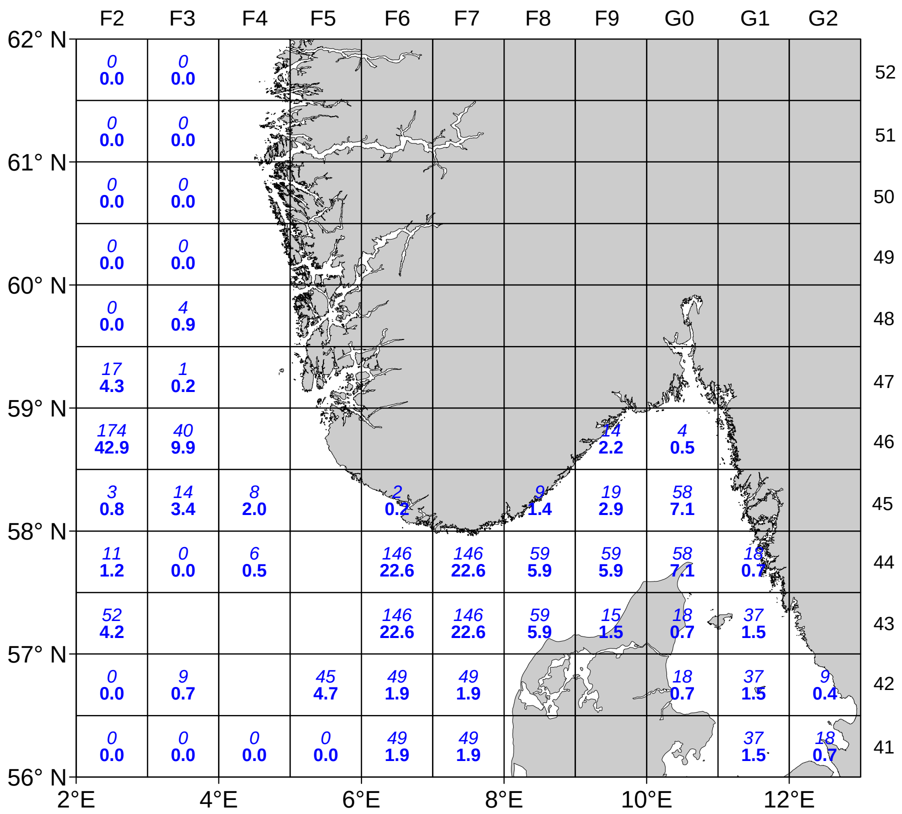

Figure 6.7. Abundance of western Baltic spring-spawning herring 1–9+ from combined acoustic survey July 2009. Numbers (millions, upper figure) and biomass (thousands of tonnes, lower figure). Blank and interpolated rectangles are not surveyed. Interpolated rectangles are mark in Figure 6.1.

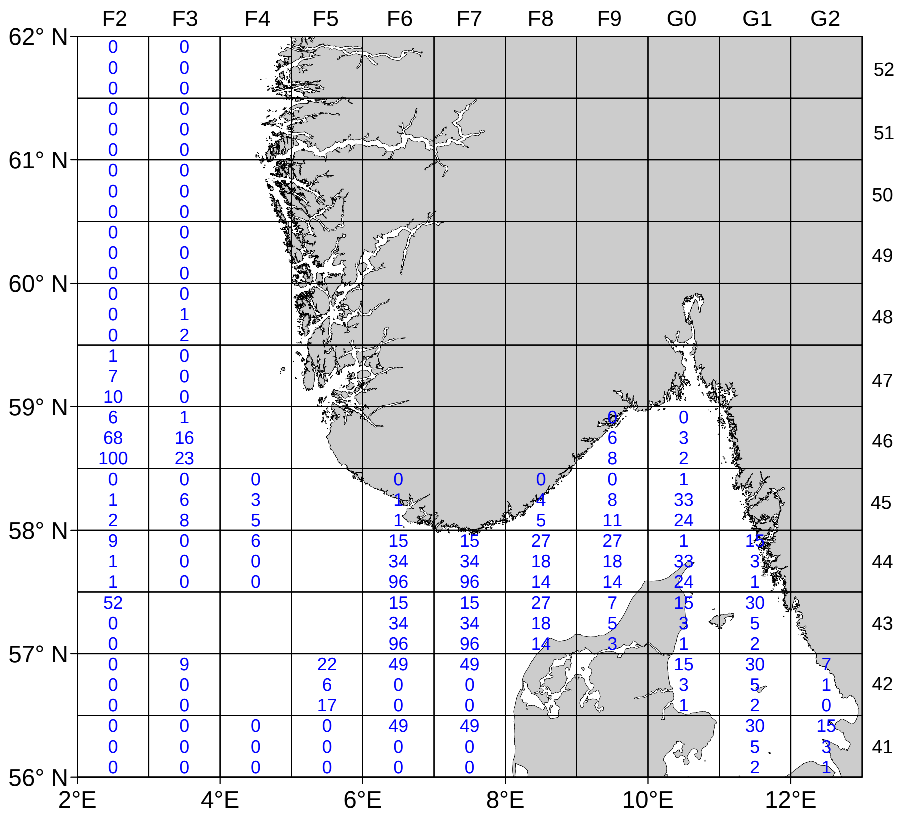

Figure 6.8. Numbers (millions) of western Baltic spring-spawning herring from combined acoustic survey June – July 2009. 1 ring (upper figure), 2 ring (centre figure), 3+ (lower figure). Blank and interpolated rectangles are not surveyed. Interpolated rectangles are mark in Figure 6.1.

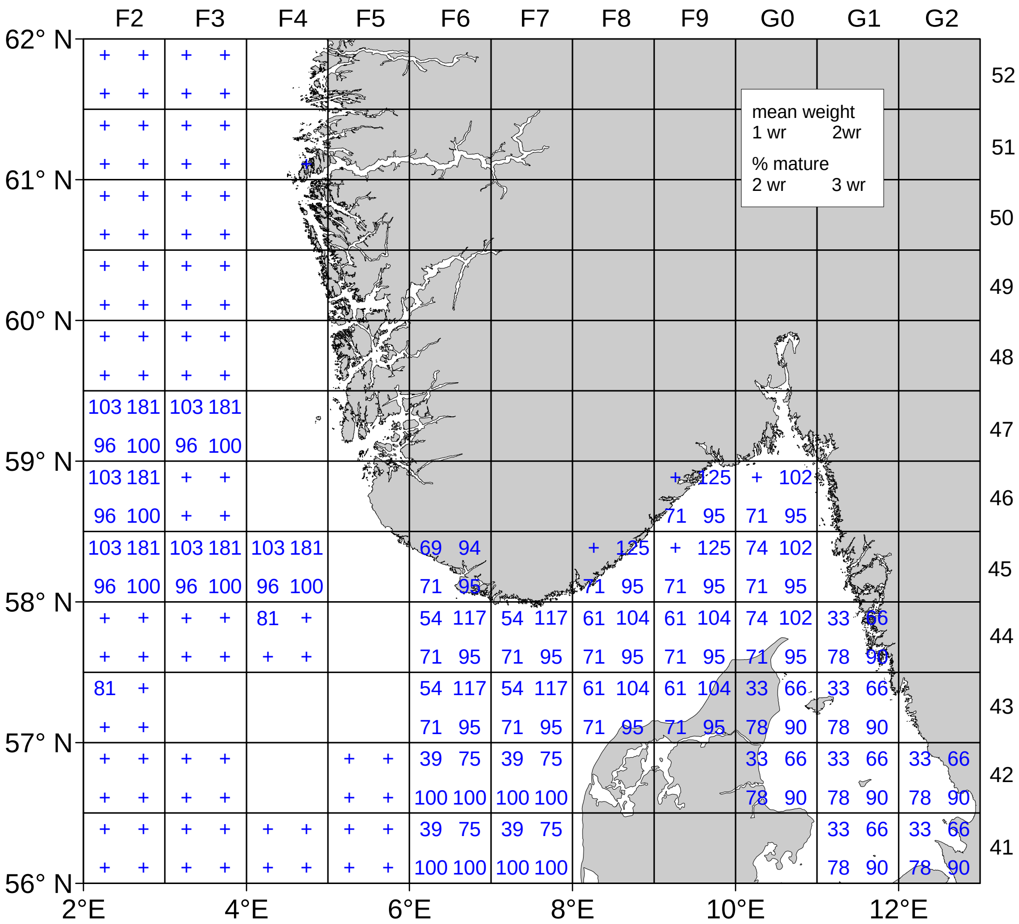

Figure 6.9. Mean weight and maturity of western Baltic spring-spawning herring from combined acoustic survey June – July 2009. Four values per ICES rectangle, percentage mature of 2 ring (lower left) and 3 ring fish (lower right), mean weights gram of 1 ring (upper left) and 2 ring fish (upper right), + indicates surveyed with zero abundance. Blank and interpolated rectangles are not surveyed. Interpolated rectangles are mark in Figure 6.1.

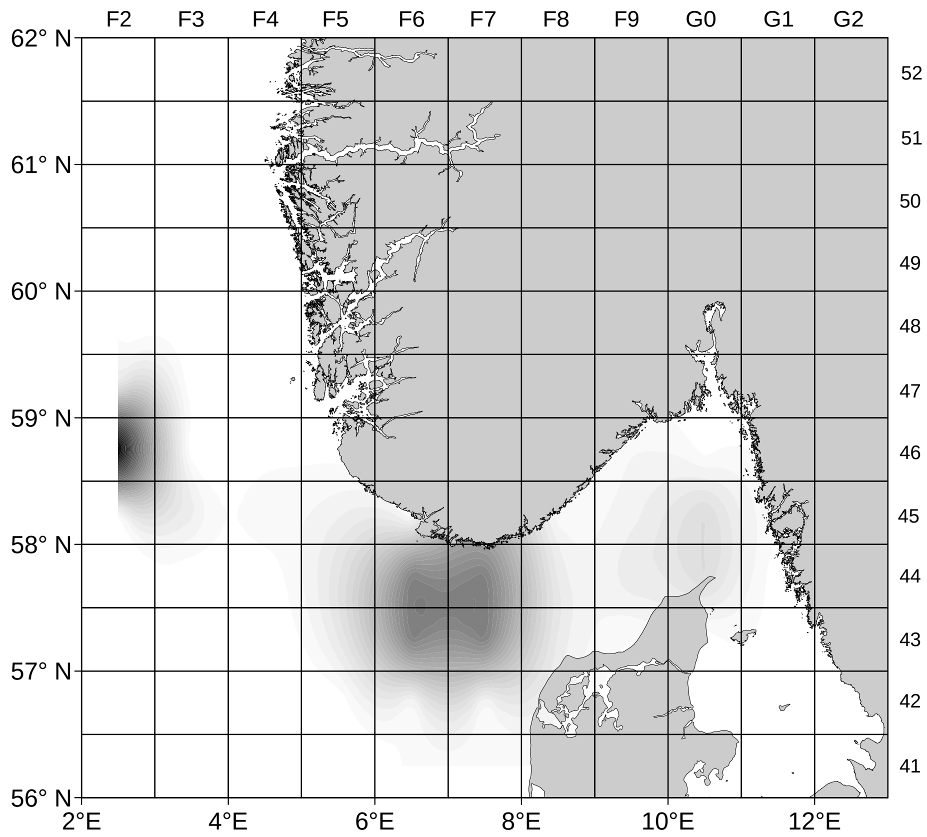

Figure 6.10. Biomass of mature western Baltic spring-spawning herring from combined acoustic survey in June – July 2009 (maximum = 40 000).

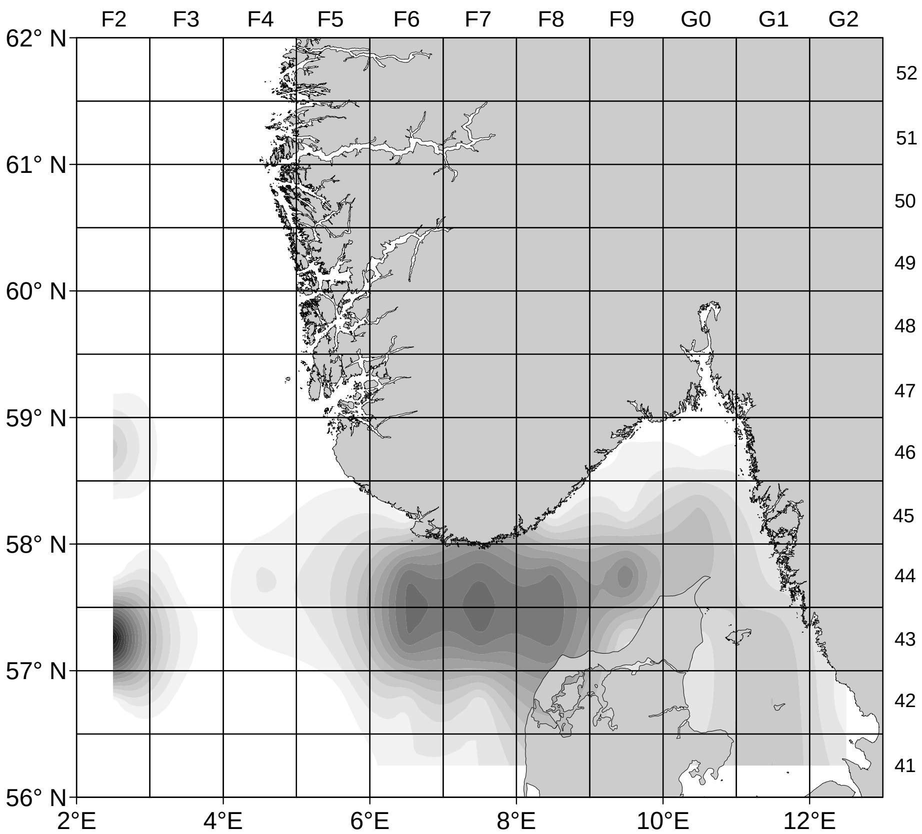

Figure 6.11. Biomass of immature western Baltic spring-spawning herring from combined acoustic survey in June – July 2009 (maximum = 3 800).

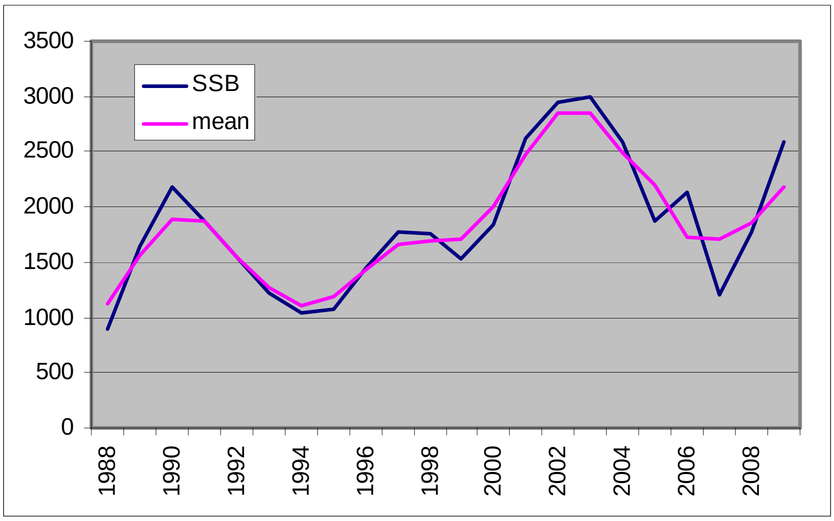

Figure 6.12. Time series of SSB of North Sea autumn spawning herring with three year running mean.

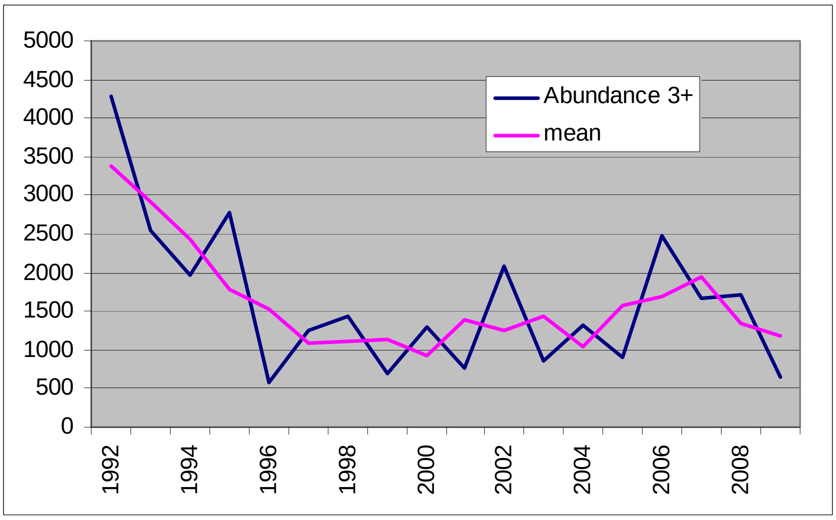

Figure 6.13. Time series of 3+ abundance of Western Baltic spring-spawning herring with three year running mean.

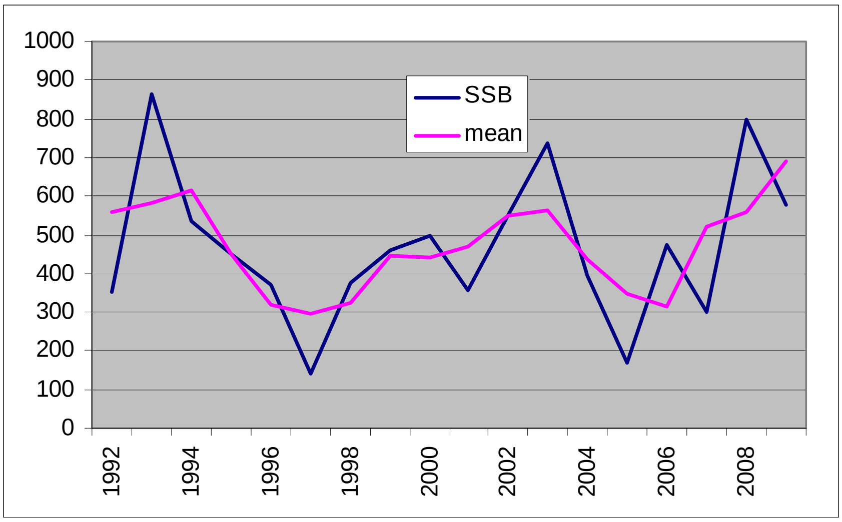

Figure 6.14. Time series of SSB of West of Scotland herring with three year running mean.

Annex 7: Working Documents to WGIPS

Version 3.1: 20.01.10

MANUAL

for

THE INTERNATIONAL HERRING LARVAE SURVEYS SOUTH OF 62° NORTH

Nackthai (GULF III) GULF VII

January 2010

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 periods and areas, following 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) survey participants should try to take at least two extra samples 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 which 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 2.2.1. The positions of the stations for each specific sampling area are described in the Annex of this manual.

All other locations, e.g. IVa North and IVa South and VIIb, which were part of the surveys up to the 1990s, 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 (Tables 7.1.1–7.4.3)

Participants in the surveys should notify the Chair 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. Trials showed no difference in catches of larvae between Gulf III and Gulf VII.

Samplers should be fitted with a 280 or 300 μ mesh size net. They should be equipped with depth recorder and two flowmeters, 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 on 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 for any drift in the flowmeters. The flowmeters will be fitted together on a pole and put underwater 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 this result 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 townet 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 recognized 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.

When available, a sub sample of at least 200 larvae per station should be measured. However due to time constraints, with regards to the timing of the assessment group (HAWG) in March, practical purposes may allow only a 100 larvae per sample to 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.

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 7.5.

5.1.1 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:

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

5.1.2 Data exchange

The International Herring Larvae Database is held at the "Johann-Heinrich von Thünen Institute", Institute of Sea Fisheries, Hamburg, 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).

5.1.3 Database

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

f) 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

g) 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

h) the length distributions of the measured larvae

i) larvae abundance estimates for the relevant length classes at each station (n/m^2)

5.1.4 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 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) 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 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.

6. References

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7. Appendices

7.1. Surveys in the Orkney/Shetland area

Table .7.1.1. 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

Tab .7.1.1 continued					
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 7.1.2. 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

Tab 7.1.2. continued					
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

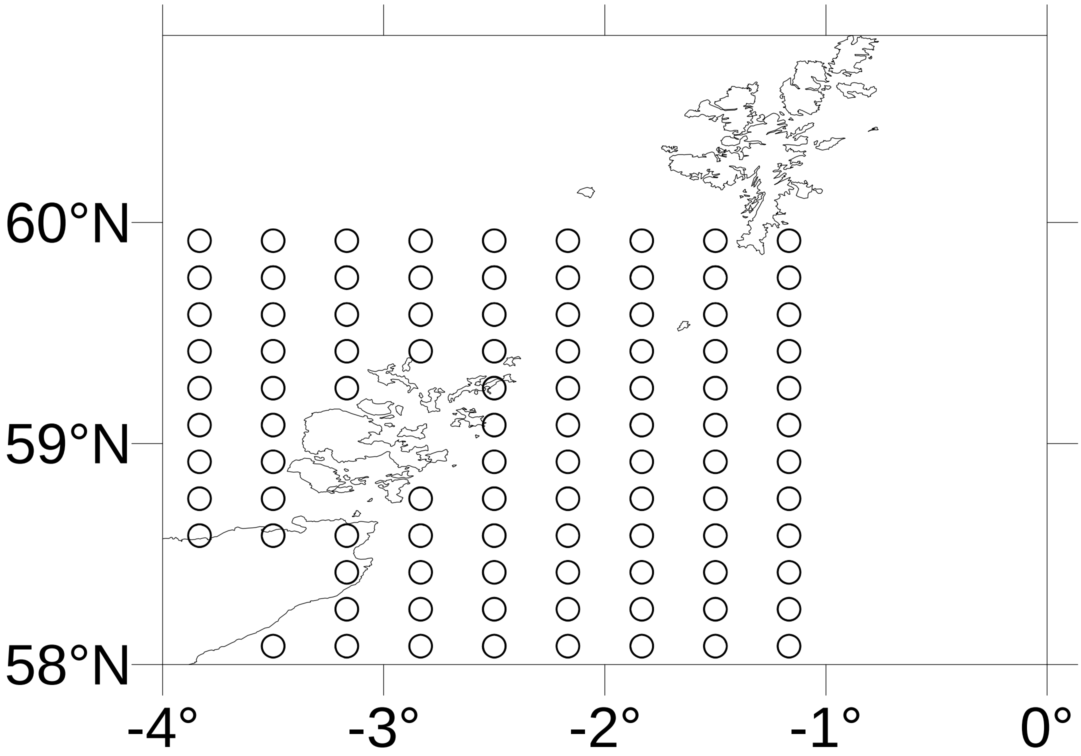

Figure 7.1.1. Station grid in Orkney/Shetlands, 01.09. – 15.09.

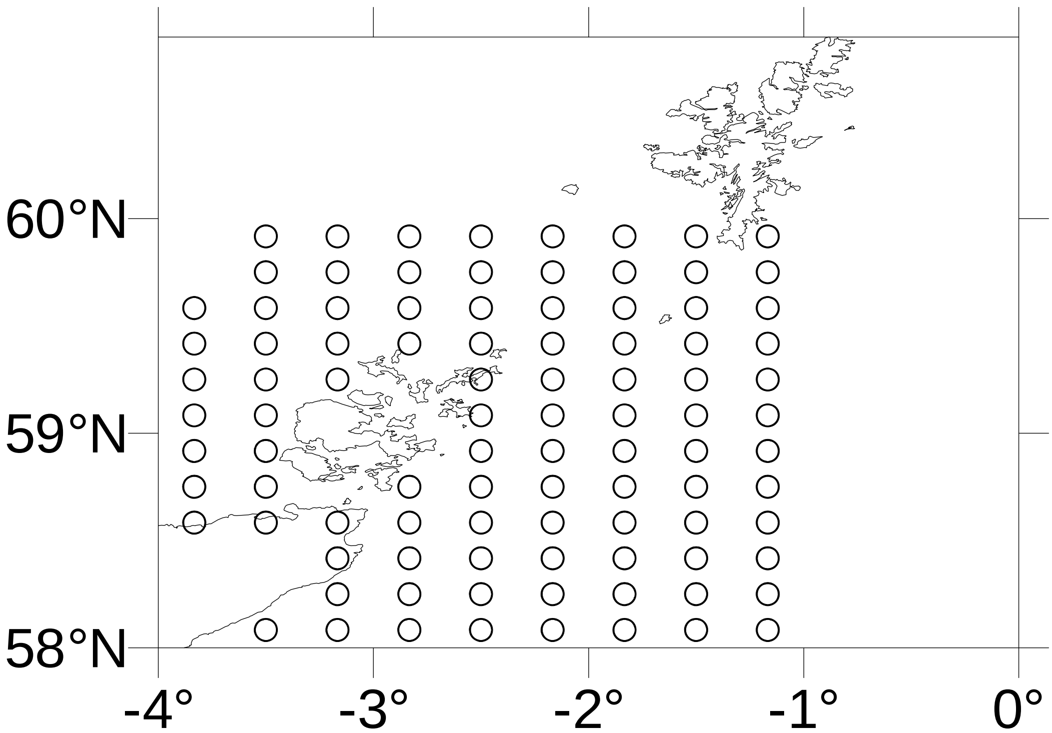

Figure7.1.2. Station grid in Orkney/Shetlands, 15.09. – 30.09.

7.2 Surveys in the Buchan area

Table 7.2.1. 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 7.2.2. Positions in the Buchan-Area, 16.09. – 30.09. (Area code C2)

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

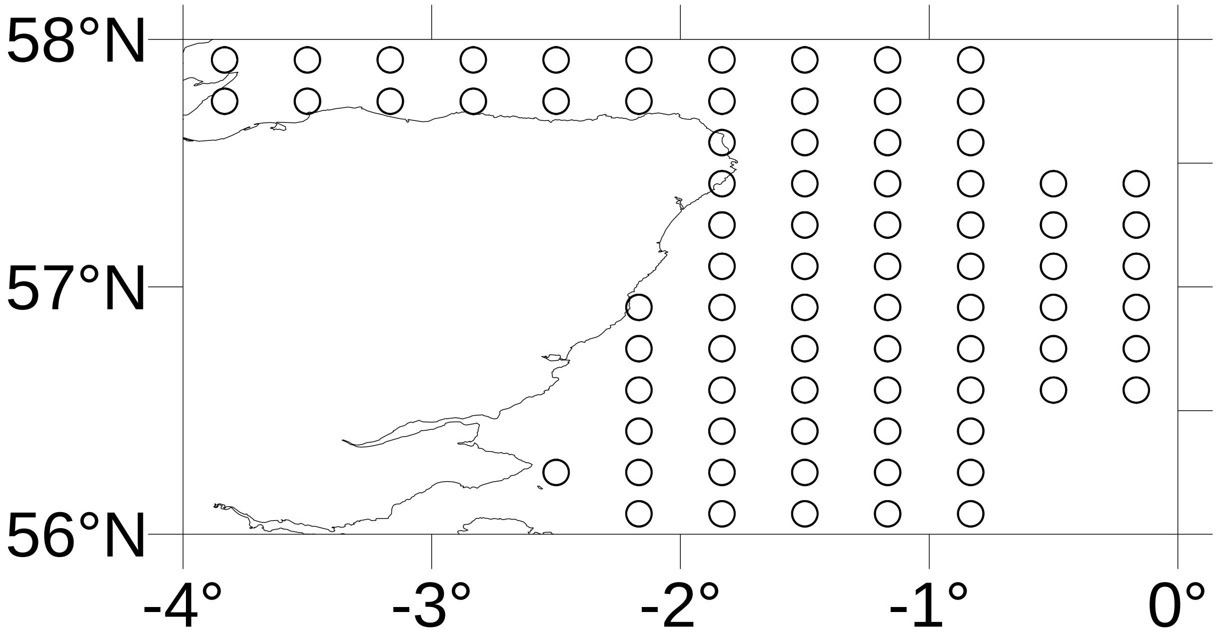

Figure 7.2.1. Station grid in the Buchan-Area, 01.09. – 15.09.

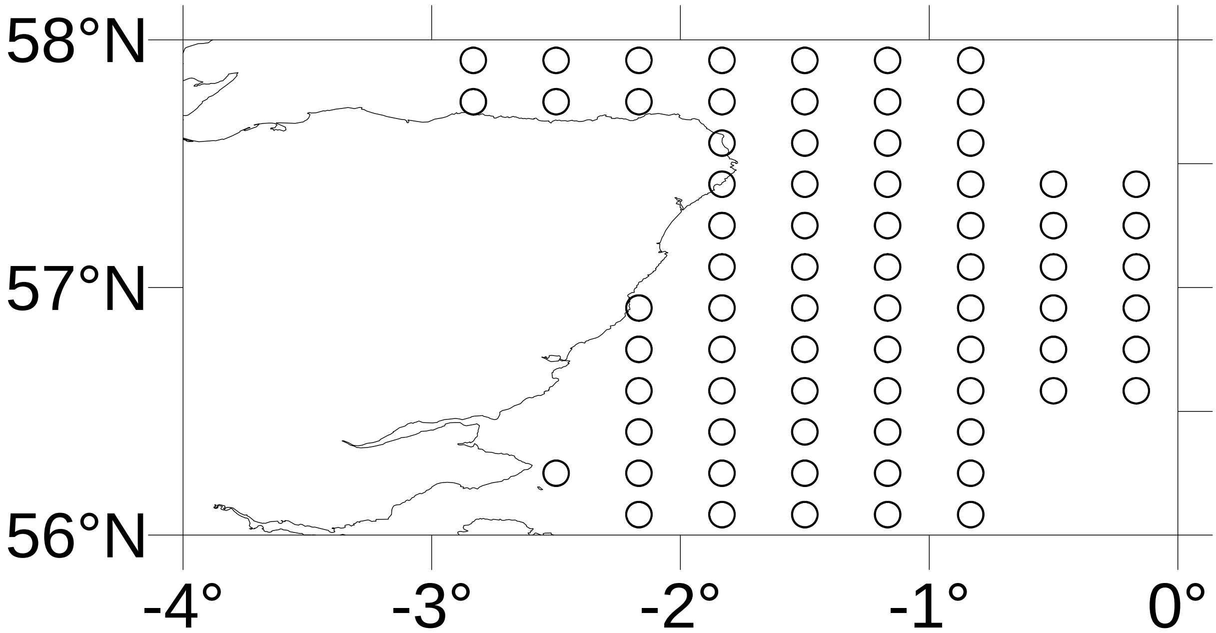

Figure 7.2.2. Station grid in the Buchan-Area, 15.09. – 30.09.

7.3 Surveys in the central North Sea

Table 7.3.1. 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 7.3.2. Positions in the central North Sea, 16.09. – 30.09. (Area code D2).

LATITUDE	LONGITUDE	ICES-CODE	LATITUDE	LONGITUDE	ICES-CODE
55°55N	01°50W	40E8a	54°35N	00°30E	38F0h
55°55N	01°30W	40E8b	54°35N	00°50E	38F0i
55°55N	01°10W	40E8c	54°35N	01°10E	38F1g
55°55N	00°50W	40E9a	54°25N	00°10W	37E9c
55°45N	01°50W	40E8d	54°25N	00°10E	37F0a
55°45N	01°30W	40E8e	54°25N	00°30E	37F0b
55°45N	01°10W	40E8f	54°25N	00°50E	37F0c
55°45N	00°50W	40E9d	54°25N	01°10E	37F1a
55°35N	01°30W	40E8h	54°25N	01°30E	37F1b
55°35N	01°10W	40E8i	54°15N	00°10W	37E9f
55°35N	00°50W	40E9g	54°15N	00°10E	37F0d
55°25N	01°30W	39E8b	54°15N	00°30E	37F0e
55°25N	01°10W	39E8c	54°15N	00°50E	37F0f
55°25N	00°50W	39E9a	54°15N	01°10E	37F1d
55°15N	01°30W	39E8e	54°15N	01°30E	37F1e
55°15N	01°10W	39E8f	54°05N	00°10E	37F0g
55°15N	00°50W	39E9d	54°05N	00°30E	37F0h
55°05N	01°10W	39E8i	54°05N	00°50E	37F0i
55°05N	00°50W	39E9g	54°05N	01°10E	37F1g
55°05N	00°30W	39E9h	54°05N	01°30E	37F1h
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°55N	01°30E	36F1b
54°45N	00°50W	38E9d	53°45N	00°10E	36F0d
54°45N	00°30W	38E9e	53°45N	00°30E	36F0e
54°45N	00°10W	38E9f	53°45N	00°50E	36F0f
54°45N	00°10E	38F0d	53°45N	01°10E	36F1d
54°35N	00°50W	38E9g	53°45N	01°30E	36F1e
54°35N	00°30W	38E9h	53°35N	00°30E	36F0h
54°35N	00°10W	38E9i	53°35N	00°50E	36F0i
54°35N	00°10E	38F0g	53°35N	01°10E	36F1g
			53°35N	01°30E	36F1h

Table 7.3.3. Positions in the central North Sea, 01.10. – 15.10. (Area code D3)

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

Table 7.3.3 continued					
54°45N	00°30W	38E9e	53°45N	01°30E	36F1e
54°45N	00°10W	38E9f	53°45N	01°50E	36F1f
54°45N	00°10E	38F0d	53°45N	02°10E	36F2d
54°45N	00°30E	38F0e	53°45N	02°30E	36F2e
54°45N	00°50E	38F0f	53°45N	02°50E	36F2f
54°45N	01°10E	38F1d	53°35N	00°30E	36F0h
54°45N	01°30E	38F1e	53°35N	00°50E	36F0i
54°45N	01°50E	38F1f	53°35N	01°10E	36F1g
54°35N	00°30W	38E9h	53°35N	01°30E	36F1h
54°35N	00°10W	38E9i	53°35N	01°50E	36F1i
54°35N	00°10E	38F0g	53°35N	02°10E	36F2g
54°35N	00°30E	38F0h	53°35N	02°30E	36F2h
			53°35N	02°50E	36F2i

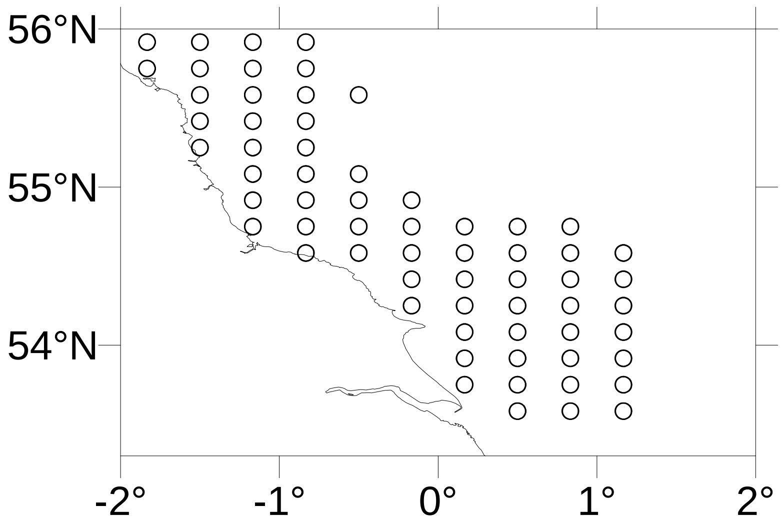

Figure 7.3.1. Station grid in the central North Sea, 01.09. – 15.09.

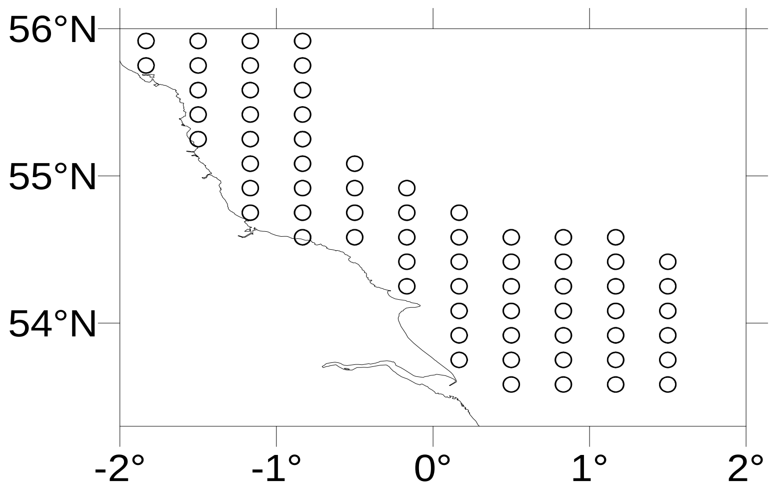

Figure 7.3.2. Station grid in the central North Sea, 16.09. – 30.09.

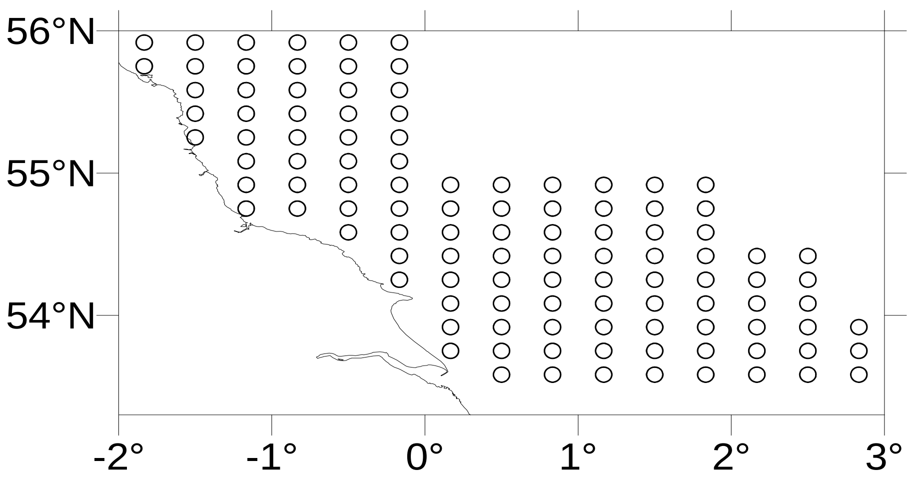

Figure 7.3.3. Station grid in the central North Sea, 01.10. – 15.10.

7.4 Surveys in the southern North Sea

Table 7.4.1. Positions in the southern North Sea, 16.12. – 31.12. (Area code E1)

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

Table7.4.2. Positions in the southern North Sea, 01.01. – 15.01. (Area code E2)

Latitude	Longitude	ICES-Code	Latitude	Longitude	ICES-Code
52°25N	02°50E	33F2c	50°55N	01°10E	30F1a
52°25N	03°10E	33F3a	50°55N	01°30E	30F1b
52°25N	03°30E	33F3b	50°45N	00°50E	30F0f
52°15N	02°30E	33F2e	50°45N	01°10E	30F1d
52°15N	02°50E	33F2f	50°45N	01°30E	30F1e
52°15N	03°10E	33F3d	50°35N	00°30E	30F0h
52°15N	03°30E	33F3e	50°35N	00°50E	30F0i
52°15N	03°50E	33F3f	50°35N	01°10E	30F1g
52°15N	04°10E	33F4d	50°35N	01°30E	30F1h
52°05N	02°30E	33F2h	50°25N	00°10E	29F0a
52°05N	02°50E	33F2i	50°25N	00°30E	29F0b
52°05N	03°10E	33F3g	50°25N	00°50E	29F0c
52°05N	03°30E	33F3h	50°25N	01°10E	29F1a
52°05N	03°50E	33F3i	50°25N	01°30E	29F1b
51°55N	02°30E	32F2b	50°15N	00°10W	29E9f
51°55N	02°50E	32F2c	50°15N	00°10E	29F0d
51°55N	03°10E	32F3a	50°15N	00°30E	29F0e
51°55N	03°30E	32F3b	50°15N	00°50E	29F0f
51°45N	02°10E	32F2d	50°15N	01°10E	29F1d
51°45N	02°30E	32F2e	50°05N	00°30W	29E9h
51°45N	02°50E	32F2f	50°05N	00°10W	29E9i
51°45N	03°10E	32F3d	50°05N	00°10E	29F0g
51°45N	03°30E	32F3e	50°05N	00°30E	29F0h
51°35N	01°50E	32F1i	50°05N	00°50E	29F0i
51°35N	02°10E	32F2g	50°05N	01°10E	29F1g
51°35N	02°30E	32F2h	49°55N	00°30W	28E9b
51°35N	02°50E	32F2i	49°55N	00°10W	28E9c
51°35N	03°10E	32F3g	49°55N	00°10E	28F0a
51°25N	01°50E	31F1c	49°55N	00°30E	28F0b
51°25N	02°10E	31F2a	49°55N	00°50E	28F0c
51°25N	02°30E	31F2b	49°45N	00°30W	28E9e
51°25N	02°50E	31F2c	49°45N	00°10W	28E9f
51°15N	01°50E	31F1f	49°45N	00°10E	28F0d
51°15N	02°10E	31F2d	49°35N	00°30W	28E9h
51°15N	02°30E	31F2e	49°35N	00°10W	28E9i
51°05N	01°30E	31F1h	49°25N	00°30W	27E9b
51°05N	01°50E	31F1i	49°25N	00°10W	27E9c

Table 7.4.3. Positions in the southern North Sea, 15.01. – 31.01. (Area code E3)

Latitude	Longitude	ICES-Code	Latitude	Longitude	ICES-Code
52°25N	02°10E	33F2a	51°15N	02°30E	31F2e
52°25N	02°30E	33F2b	51°05N	01°30E	31F1h
52°25N	02°50E	33F2c	51°05N	01°50E	31F1i
52°25N	03°10E	33F3a	50°55N	01°10E	30F1a
52°25N	03°30E	33F3b	50°55N	01°30E	30F1b
52°25N	03°50E	33F3c	50°45N	00°50E	30F0f
52°25N	04°10E	33F4a	50°45N	01°10E	30F1d
52°15N	02°10E	33F2d	50°45N	01°30E	30F1e
52°15N	02°30E	33F2e	50°35N	00°30E	30F0h
52°15N	02°50E	33F2f	50°35N	00°50E	30F0i
52°15N	03°10E	33F3d	50°35N	01°10E	30F1g
52°15N	03°30E	33F3e	50°35N	01°30E	30F1h
52°15N	03°50E	33F3f	50°25N	00°10E	29F0a
52°15N	04°10E	33F4d	50°25N	00°30E	29F0b
52°05N	02°10E	33F2g	50°25N	00°50E	29F0c
52°05N	02°30E	33F2h	50°25N	01°10E	29F1a
52°05N	02°50E	33F2i	50°25N	01°30E	29F1b
52°05N	03°10E	33F3g	50°15N	00°30W	29E9e
52°05N	03°30E	33F3h	50°15N	00°10W	29E9f
52°05N	03°50E	33F3i	50°15N	00°10E	29F0d
51°55N	02°10E	32F2a	50°15N	00°30E	29F0e
51°55N	02°30E	32F2b	50°15N	00°50E	29F0f
51°55N	02°50E	32F2c	50°15N	01°10E	29F1d
51°55N	03°10E	32F3a	50°05N	00°30W	29E9h
51°55N	03°30E	32F3b	50°05N	00°10W	29E9i
51°45N	01°50E	32F1f	50°05N	00°10E	29F0g
51°45N	02°10E	32F2d	50°05N	00°30E	29F0h
51°45N	02°30E	32F2e	50°05N	00°50E	29F0i
51°45N	02°50E	32F2f	50°05N	01°10E	29F1g
51°45N	03°10E	32F3d	49°55N	00°30W	28E9b
51°45N	03°30E	32F3e	49°55N	00°10W	28E9c
51°35N	01°50E	32F1i	49°55N	00°10E	28F0a
51°35N	02°10E	32F2g	49°55N	00°30E	28F0b
51°35N	02°30E	32F2h	49°55N	00°50E	28F0c
51°35N	02°50E	32F2i	49°45N	00°30W	28E9e
51°35N	03°10E	32F3g	49°45N	00°10W	28E9f
51°25N	01°50E	31F1c	49°45N	00°10E	28F0d
51°25N	02°10E	31F2a	49°35N	00°30W	28E9h
51°25N	02°30E	31F2b	49°35N	00°10W	28E9i
51°25N	02°50E	31F2c	49°35N	00°10E	28F0g
51°15N	01°50E	31F1f	49°25N	00°30W	27E9b
51°15N	02°10E	31F2d	49°25N	00°10W	27E9c

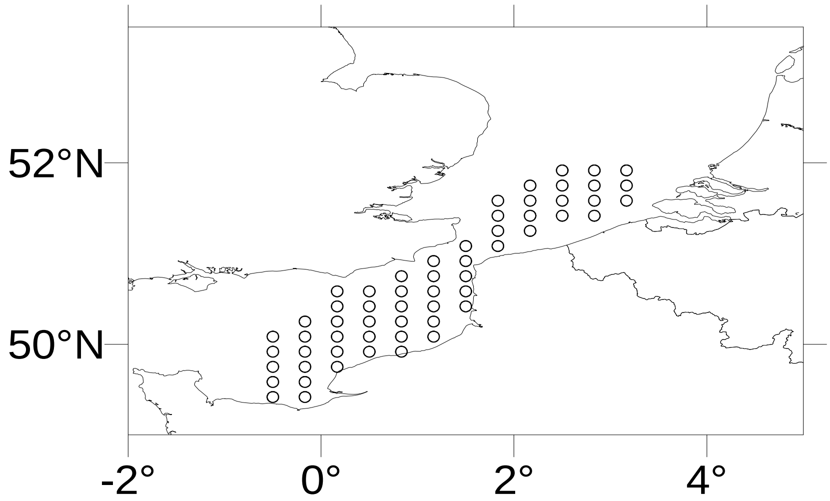

Figure 7.4.1. Station grid in the southern North Sea, 16.12. – 31.12.

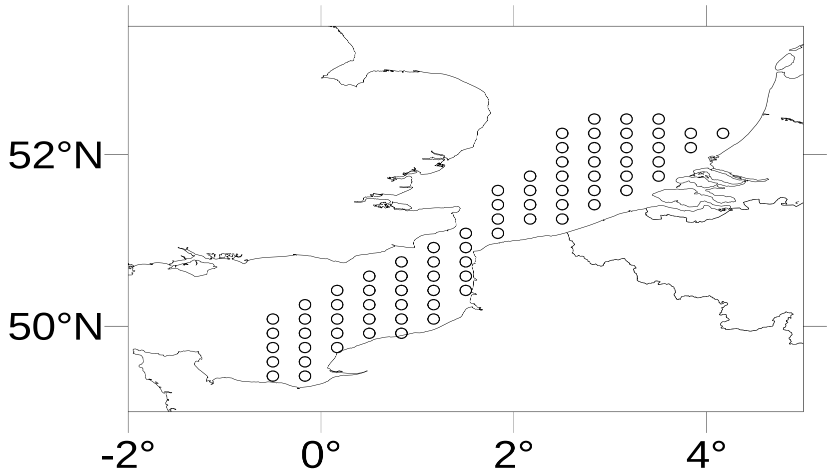

Figure 7.4.2. Station grid in the southern North Sea, 01.01. – 15.01.

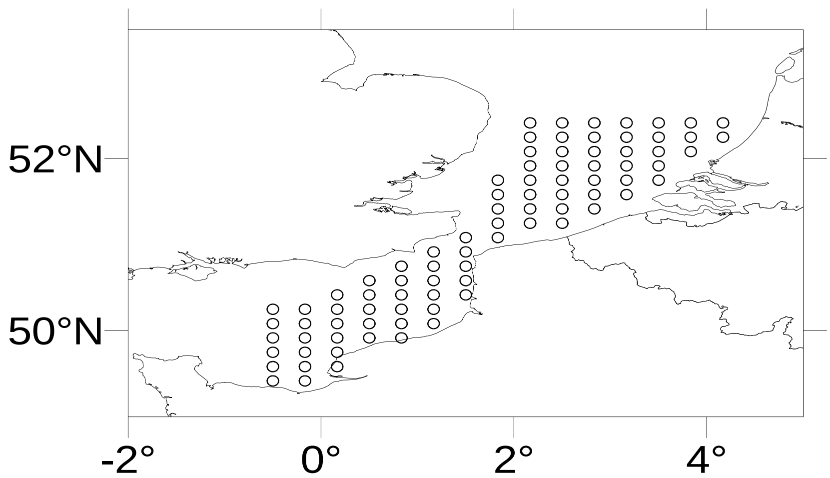

Figure 7.4.3. Station grid in the southern North Sea, 16.01. – 31.01.

7.5 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

7.6 Version history

The manual for the international herring larvae surveys is regularly updated and changes in the recent version of the manual compared to the previous version can be found in Table 7.6.1.

Table 7.6.1. Changes in the manual compared to the previous version.

Version 3	Version 3.1 2010
2.1 In areas with high densities at least two extra samples should be taken in the same 10*10 rectangle	In practise this has not always been proven to be possible. Therefore, the text has been changed to 'survey participants should try to take two extra samples'.
4.4 At least 200 larvae should be measured from the sample	Due to time constraints because of the timing of the assessment group meeting this is not possible and participants should try to measure at least 100 larvae.