

**North Sea hydro acoustic herring survey
Survey report for R/V "TRIDENS"
28 June – 23 July 2010**

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Summary

This report presents the results of the 2010 Dutch participation in the North Sea Hydro acoustic survey for Herring and Sprat. This Survey is carried out yearly and is coordinated by ICES. Other participating countries are Scotland, Norway, Germany and Denmark.

For the Netherlands, FRV Tridens covered the area east of Scotland.

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

Immature	100.7 thousand tonnes
Spawning stock	271.6 thousand tonnes

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

Immature	1.8 thousand tonnes
Spawning stock	76.1 thousand tonnes

The amount of herring in that area was considerably lower compared to last year, probably due to shift of the adult population northwards, meaning that this part of the stock was covered by the Scottish vessel which has been operating north of the Tridens area.

1. Introduction

The Dutch Institute for Marine Resources & Ecosystem Studies (IMARES) has been participating in the international North Sea hydro acoustic survey for herring since 1991. Participants in this survey are Scotland, Norway, Germany, Denmark, The Netherlands and Ireland. 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 R/V "Tridens" .

Cruise plan

The survey was split into two periods of 2 weeks. The executed 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		
Sascha Fässler (cruise leader 2nd half)	x	x	x	x
Kees Bakker (technician)	x	x		
Hendrik-Jan Westerink (fish lab)	x	x		
Martijn de Jongh (ICT)	x	x		
Dirk Burggraaf (technician)			x	x
Silja Tribuhl (acoustics, fish lab)			x	x
Marcel de Vries (fish lab)			x	x
Daniel van Denderen (student)	x	x		

2.2 Narrative

After departure on Monday 28th June from the port of Scheveningen, Tridens steamed north in the direction of Scapa Flow. On 29th June at 56°25N-0°35E a test haul was carried out. Due to the extremely good weather conditions, it was decided to try to calibrate at sea. The calibration was carried out close to the starting point of the survey (58°23N-2°44W) in the afternoon of 29th and the morning of 30th June. The actual survey started 8:51 UTC on the 30th of June 2010. During the remaining days up till the weekend stop in Peterhead, 6 hauls were carried out. A lot of small fish schools at the surface were seen in the area. Unfortunately, on two occasions the crew claimed that it was not possible to fish on the recordings due to technical problems (once because of a not working netsonde and once because the vessel had only one engine available). Hence important information on school species composition was lost. The survey was interrupted at 57°50N – 1°40W at 11:05 UTC for the stop at Peterhead. Departure from Peterhead was delayed by one hour in the morning of 5th July on instruction of the harbour authorities. The survey continued according to the planned transects till Thursday 8th July at 56°50N – 1°50E. Arrival in Scheveningen the next morning at 6:00 UTC.

Departure from Scheveningen on Monday 12th July was delayed by 6 hours due to technical problems concerning navigation lights of the ship. After these problems were solved, Tridens steamed up north-west to the start point of transect line 6 (56°20N-2°27W). The survey was started the following day, Tuesday 13th July at 16:20 UTC. During week 28 no hauls were carried out as major fish aggregations were absent on the echosounder records. The weather situation turned to the worse towards the end of the week and gale force winds (8 or even 9) were experienced. While there were fish seen at that time, no trawls could be done due to the bad weather conditions. Also, 2 CTD stations had to be abandoned for bad weather reasons. On Friday morning 16th July at 7:42 UTC, it was noted that the network connection to the acoustic room was lost. An investigation identified the cable socket in the network hub in the ships computer room to be faulty - most probably caused by increased movement during bad weather. To solve the problem, the cable was rewired to a connector and provisionally connected to the acoustic room. The fault caused that the echosounder data had no GPS position signal for over 4 hours. The lost position data was interpolated during data analysis. Additionally, a security steel cable going to the towed body was found to be cut apart due to increased grinding on the towed body itself during heavy winds. The survey was stopped on Friday 16th July at 15:45 UTC, after the end of transect 7 (55°05N-1°33W) was reached and Tridens steamed to Newcastle-upon-Tyne for the week end break.

Departure from Newcastle was on Monday morning, 19th July at 6:00 UTC. The survey continued on the same day at 9:50 UTC at the start of an additional transect (55°35N-1°18W), which was added at latitude 55°35N between 1°18W and 1°50E. This was done in an attempt to collect biological/hydrographic information in rectangles where no trawling/CTD could be performed due to the bad weather in the previous week. As enough time was available, this did not affect the original coverage. The remaining transects were covered as planned until Thursday 22nd July at 54°20N-0°8.8W. ETA in Scheveningen was on Friday 23rd July at 5:00 UTC.

2.3 Survey design

The actual survey was carried out from 30th June to 22nd 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 to 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 main (31010) and spare (30501) 38 kHz transducers mounted in the towed body was executed at sea in very calm conditions in the Morray Firth. Conditions allowed for an optimal and good calibration. Also, calibration of the 200 kHz transducer gave no problems, resulting in a RMS of 0.24. This was unusual, since calibration of the 200 kHz transducer in previous years usually gave worse results.

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 echo sounder and logged with Sonardata Echoview software in 1 nautical mile intervals. The EK60 received the vessel speed from the ship's GPS. An average survey 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 the depths of 50 - 150 m observed in most of the area covered.

NOTE: As in previous years, there were substantial sinusoid noise bands on the 200 kHz data caused by vessel noise. These noise bands mask recordings at 200 kHz up to depths of about 50 m and present significant problems for multi-frequency data analysis. At present, the noise bands are so severe, that the 200 kHz data CANNOT be used! A solution to this problem would be the use of an acoustic drop keel (presently unavailable on Tridens).

2.6 Biological data collection

Fishing

The acoustic recordings were verified by fishing with a 2000 mesh pelagic trawl with 20 mm meshes in the cod-end. Fishing was carried out to identify species-composition of major recordings observed on the echo sounder and to obtain biological samples of herring and sprat. In general, after it was decided to make a tow with a pelagic trawl, the vessel turned and fished back on its track line. If the recordings showed schools, a Simrad SD570 60kHz sonar was used to be able to track schools that were swimming away from the track line. In all hauls the footrope was very close to the ground with vertical net openings varying from 10 to 20 m (specifications are listed in the PGMERS manual).

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

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 were collected at 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.

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 backscattering cross-section "sigma" (σ_{bs}) was calculated according to the target strength-length relationships (TS) recommended by the ICES Planning Group for Herring Surveys.

The qualitative breakdown of sprat and herring marks 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 within each rectangle by the overall σ_{bs} in the corresponding rectangle.

The biological samples used for stock structure and biomass calculations were grouped in 2 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 north-eastern part of the Dutch survey area (Figure 3a). Sprat was found in the western Moray Firth and in the southern part of the survey area (rectangle with highest concentration: 37F1) (Figure 3b). There were considerable aggregations of Norway pout observed in the north-east part of the survey area (Figure 3c). Marks observed in rectangle 45F1, which has been dominated by herring in previous years, were found to consist exclusively of Norway pout.

3.2 Trawl data results

In all, 15 trawl hauls were conducted. Herring was found in 10 hauls of which 6 samples of more than 20 herring were taken. Sprat was found in 4 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 after they appeared in 2009 for the first time since about 10 years. The biological samples contained a total of 467 herring and 157 sprat that were collected and used for length, age and maturity keys.

3.3 Stock estimates

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

Immature	100.7 thousand tonnes
Spawning stock	271.6 thousand tonnes

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

Immature	1.8 thousand tonnes
Spawning stock	76.1 thousand tonnes

The amount of herring in that area was considerably lower compared to last year, probably due to shift of the adult population northwards, meaning that this part of the stock was covered by the Scottish vessel which has been operating north of the Tridens area.

Figure 4 shows the estimated numbers and biomass of herring by ICES rectangle in the area surveyed by R/V Tridens. Table 3 summarizes stock estimates per stratum and Tables 4 and 5 summarise the sub stock estimates for herring and sprat.

Table 1. Simrad EK60 calibration settings used on the June 2010 North Sea hydro acoustic survey for herring, R/V "Tridens".

```

# Calibration Version 2.1.0.12
#
# Date: 29-6-2010
#
# Comments:
#   Moray Firth 290610 38kHz 2nd
#
# Reference Target:
#   TS                -33.60 dB           Min. Distance      10.70 m
#   TS Deviation      5.0 dB             Max. Distance      14.80 m
#
# Transducer: ES38B Serial No. 31010
#   Frequency         38000 Hz           Beamtype           Split
#   Gain              24.15 dB           Two Way Beam Angle -20.5 dB
#   Athw. Angle Sens. 21.90             Along. Angle Sens. 21.90
#   Athw. Beam Angle  7.15 deg           Along. Beam Angle  6.99 deg
#   Athw. Offset Angle 0.02 deg         Along. Offset Angle -0.10 deg
#   SaCorrection      -0.63 dB           Depth              0.00 m
#
# Transceiver: GPT 38 kHz 009072017a3b 1-1 ES38B
#   Pulse Duration    1.024 ms           Sample Interval    0.192 m
#   Power             2000 W             Receiver Bandwidth 2.43 kHz
#
# Sounder Type:
#   EK60 Version 2.2.0
#
# 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. 9.5 dB/km           Sound Velocity     1498.7 m/s
#
# Beam Model results:
#   Transducer Gain   = 24.70 dB           SaCorrection       = -0.63 dB
#   Athw. Beam Angle  = 6.91 deg           Along. Beam Angle  = 6.87 deg
#   Athw. Offset Angle = 0.03 deg           Along. Offset Angle = -0.05 deg
#
# Data deviation from beam model:
#   RMS = 0.17 dB
#   Max = 0.50 dB No. = 155 Athw. = 2.6 deg Along = 3.1 deg
#   Min = -0.68 dB No. = 60 Athw. = -3.0 deg Along = 3.1 deg
#
# Data deviation from polynomial model:
#   RMS = 0.14 dB
#   Max = 0.42 dB No. = 121 Athw. = -0.4 deg Along = 4.7 deg
#   Min = -0.63 dB No. = 60 Athw. = -3.0 deg Along = 3.1 deg

```

Table 2a. Details of the trawl hauls taken. "Tridens", North Sea acoustic survey 2010.

haul	day	month	year	hour	minute	haul duration	lat	lon	depth	geardepth	wind direction	wind force	gear
1	30	6	2010	14	40	63	58.23	-1	94	15	359	1	pelagic trawl
2	30	6	2010	20	10	20	58.23	-0.09	128.9	na	359	4	pelagic trawl
3	1	7	2010	9	10	29	58.23	1.15	140	na	90	9	pelagic trawl
4	1	7	2010	12	14	33	58.23	1.38	96	na	90	9	pelagic trawl
5	2	7	2010	18	55	62	58.08	-2.48	36.5	na	90	2	pelagic trawl
6	3	7	2010	6	30	17	57.53	-2.49	82	na	90	2	pelagic trawl
7	5	7	2010	11	31	25	57.49	-0.49	97.5	10	158	2	pelagic trawl
8	5	7	2010	15	13	74	57.49	-0.08	93	na	158	2	pelagic trawl
9	5	7	2010	7	56	74	57.19	1.4	86	na	135	3	pelagic trawl
10	6	7	2010	15	39	83	57.19	0.35	84	10	203	4	pelagic trawl
11	19	7	2010	11	25	12	55.35	-1.04	104.9	103	113	1	pelagic trawl
12	19	7	2010	16	49	88	55.35	0.13	5	50	225	1	pelagic trawl
13	20	7	2010	14	40	128	55.2	-0.06	72.5	6	113		pelagic trawl
14	21	7	2010	7	56	81	54.49	0.15	79.59	52	270	1	pelagic trawl
15	21	7	2010	18	52	76	54.2	1.46	49.7	93	135	1	pelagic trawl

Table 2b. Trawl catches. "Tridens", North Sea acoustic survey 2010 in kg.

haul no	herring	N. pout	other gadoids	mackerel	sprat	others
1				35.4		
2	1875.078	106.742	2.1	12.8		
3	24.19	99.91	23.541	0.46		
4	0.1	1296.498	3.801	8.701		2.4
5				1.4		
6			4.8		386.755	
7	6037.199	1.7	3.4	3.1		0.7
8	34.8	817.804	36	10.32		3.1
9	4033.5		0.7	40		5
10	727.936	184.242	4.3	1654.564		39.738
11			0.37	11.9	573.847	
12		20.7	0.58	10.1		
13	0.184			29.6		
14	1		46.22	496.1	6.6	60.048
15	0.036			0.21	1441.8	64.852

Table 2c. Length frequency proportions of herring by haul. "Tridens", North Sea acoustic survey 2010.

length/haul-no proportion %	2	3	7	8	9	10
16	0	0	0	0	0	0
16.5	0	0	0	0	0	0
17	0	0.78125	0	0	0	0
17.5	0	0	0	0	0	0
18	0	0	0	0	0	0
18.5	0	0	0.970874	1.37931	0	0
19	0	0.78125	0.970874	1.37931	0	0
19.5	0	0.78125	1.941748	0	0.409836	0
20	0	0	4.854369	3.448276	2.459016	1.265823
20.5	0	0	15.53398	2.758621	2.868852	0
21	0.526316	0	15.53398	9.655172	2.459016	3.797468
21.5	0	0.78125	21.84466	17.93103	2.04918	4.43038
22	0.526316	0	10.19417	9.655172	4.098361	7.594937
22.5	0	0	8.252427	4.827586	5.737705	6.329114
23	0	0	2.427184	1.37931	5.327869	6.329114
23.5	3.684211	0	2.912621	4.137931	5.327869	5.696203
24	4.736842	0	2.912621	1.37931	6.967213	8.227848
24.5	6.842105	0	2.427184	4.137931	11.06557	13.29114
25	12.10526	2.34375	2.912621	2.068966	14.34426	6.962025
25.5	15.78947	2.34375	3.398058	10.34483	9.836066	8.860759
26	10	3.90625	1.456311	3.448276	10.2459	4.43038
26.5	7.894737	6.25	0.485437	5.517241	3.688525	3.164557
27	10	6.25	0.970874	4.137931	5.327869	5.063291
27.5	12.63158	10.9375	0	2.758621	4.098361	5.063291
28	4.736842	11.71875	0	3.448276	0.819672	2.531646
28.5	3.684211	10.9375	0	2.758621	1.639344	3.164557
29	5.263158	16.40625	0	1.37931	1.229508	0.632911
29.5	1.052632	11.71875	0	1.37931	0	1.898734
30	0	7.03125	0	0.689655	0	0.632911
30.5	0	1.5625	0	0	0	0.632911
31	0	3.125	0	0	0	0
31.5	0	1.5625	0	0	0	0
32	0	0.78125	0	0	0	0
32.5	0	0	0	0	0	0
33	0	0	0	0	0	0
33.5	0.526316	0	0	0	0	0
34	0	0	0	0	0	0
34.5	0	0	0	0	0	0
35	0	0	0	0	0	0
no in sample	190	128	206	145	244	158

Table 3. Age/maturity-length keys for herring –Stratum A - D. "Tridens", North Sea acoustic survey 2010.

		Stratum A					
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2009im			0	0.0	0.000	0.0
0M	2009ad			0	0.0	0.000	0.0
1I	2008im	21.6	82.7	229	11.5	18.917	6.4
1M	2008ad	22.5	94.0	7	0.3	0.627	0.2
2I	2007im	24.1	110.1	193	9.7	21.217	7.2
2M	2007ad	25.3	139.5	690	34.6	96.221	32.4
3I	2006im	26.4	145.3	69	3.5	10.059	3.4
3M	2006ad	26.8	159.0	388	19.5	61.612	20.8
4I	2005im	29.0	165.0	10	0.5	1.611	0.5
4M	2005ad	28.7	212.0	164	8.2	34.693	11.7
5I	2004im	28.5	182.5	21	1.0	3.808	1.3
5M	2004ad	30.4	240.4	35	1.8	8.403	2.8
6M	2003	28.9	196.0	57	2.8	11.085	3.7
7M	2002	30.0	222.8	27	1.4	6.092	2.1
8M	2001	29.4	233.0	59	2.9	13.652	4.6
9M	2000	28.8	197.2	40	2.0	7.930	2.7
10M	1999			0	0.0	0.000	0.0
11M	1998	28.5	175.0	5	0.2	0.806	0.3
12+	<1998			0	0.0	0.000	0.0
Mean		27.2	170.3				
Total				1991	100.0	296.734	100.0
Immature				521	26.2	55.612	18.7
Mature				1470	73.8	241.122	81.3

		Stratum B					
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2009im			0	0.0	0.000	0.0
0M	2009ad			0	0.0	0.000	0.0
1I	2008im	21.1	79.4	422	57.2	33.558	44.4
1M	2008ad	24.9	135.3	10	1.4	1.360	1.8
2I	2007im	22.4	95.3	101	13.7	9.607	12.7
2M	2007ad	25.5	146.2	86	11.7	12.591	16.7
3I	2006im	24.9	125.2	15	2.0	1.883	2.5
3M	2006ad	26.2	146.7	70	9.4	10.224	13.5
4I	2005im			0	0.0	0.000	0.0
4M	2005ad	28.1	188.2	19	2.6	3.567	4.7
5I	2004im			0	0.0	0.000	0.0
5M	2004ad	28.4	161.8	4	0.6	0.687	0.9
6M	2003	27.9	172.9	6	0.8	1.027	1.4
7M	2002	28.0	205.0	3	0.3	0.522	0.7
8M	2001			0	0.0	0.000	0.0
9M	2000	28.0	186.0	3	0.3	0.474	0.6
10M	1999			0	0.0	0.000	0.0
11M	1998			0	0.0	0.000	0.0
12+	<1998			0	0.0	0.000	0.0
Mean		26.0	149.3				
Total				738	100.0	75.500	100.0
Immature				538	72.9	45.049	59.7
Mature				200	27.1	30.451	40.3

Table 4. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) **herring** breakdown by age and maturity obtained during the July 2010 North Sea hydro acoustic survey, FRV "Tridens".

		Total area (all strata summarized)			
Age	Year	Number (millions)	%	Biomass (1000 tons)	%
0I	2009im	0	0.0	0.000	0.0
0M	2009ad	0	0.0	0.000	0.0
1I	2008im	651	23.9	52.475	14.1
1M	2008ad	17	0.6	1.987	0.5
2I	2007im	294	10.8	30.824	8.3
2M	2007ad	776	28.4	108.812	29.2
3I	2006im	84	3.1	11.942	3.2
3M	2006ad	457	16.8	71.836	19.3
4I	2005im	10	0.4	1.611	0.4
4M	2005ad	183	6.7	38.260	10.3
5I	2004im	21	0.8	3.808	1.0
5M	2004ad	39	1.4	9.089	2.4
6M	2003	63	2.3	12.111	3.3
7M	2002	30	1.1	6.614	1.8
8M	2001	59	2.1	13.652	3.7
9M	2000	43	1.6	8.404	2.3
10M	1999	0	0.0	0.000	0.0
11M	1998	5	0.2	0.806	0.2
12+	<1998	0	0.0	0.000	0.0
Total		2730	100.0	372.232	100.0
Immature		1060	38.8	100.660	27.0
Mature		1670	61.2	271.572	73.0

Table 5. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) **sprat** breakdown by age and maturity obtained during the June-July 2010 North Sea hydro acoustic survey for herring, FRV "Tridens".

		Total area (all strata summarized)			
Age	Year	Number (millions)	%	Biomass (1000 tons)	%
0I	2009im	166	2.8	1.398	1.8
0M	2009ad	1850	30.9	20.853	26.7
1I	2008im	41	0.7	0.449	0.6
1M	2008ad	3273	54.6	45.812	58.8
2I	2007im	0	0.0	0.000	0.0
2M	2007ad	395	6.6	6.620	8.5
3I	2006im	0	0.0	0.000	0.0
3M	2006ad	192	3.2	2.828	3.6
4I	2005im	0	0.0	0.000	0.0
4M	2005ad	0	0.0	0.000	0.0
5I	2004im	0	0.0	0.000	0.0
5M	2004ad	0	0.0	0.000	0.0
6M	2003	0	0.0	0.000	0.0
7M	2002	0	0.0	0.000	0.0
8M	2001	0	0.0	0.000	0.0
9M	2000	0	0.0	0.000	0.0
10M	1999	0	0.0	0.000	0.0
11M	1998	0	0.0	0.000	0.0
12+	<1998	73	1.2	0.000	0.0
Total		5990	100.0	77.960	100.0
Immature		207	3.4	1.847	2.4
Mature		5784	96.6	76.113	97.6

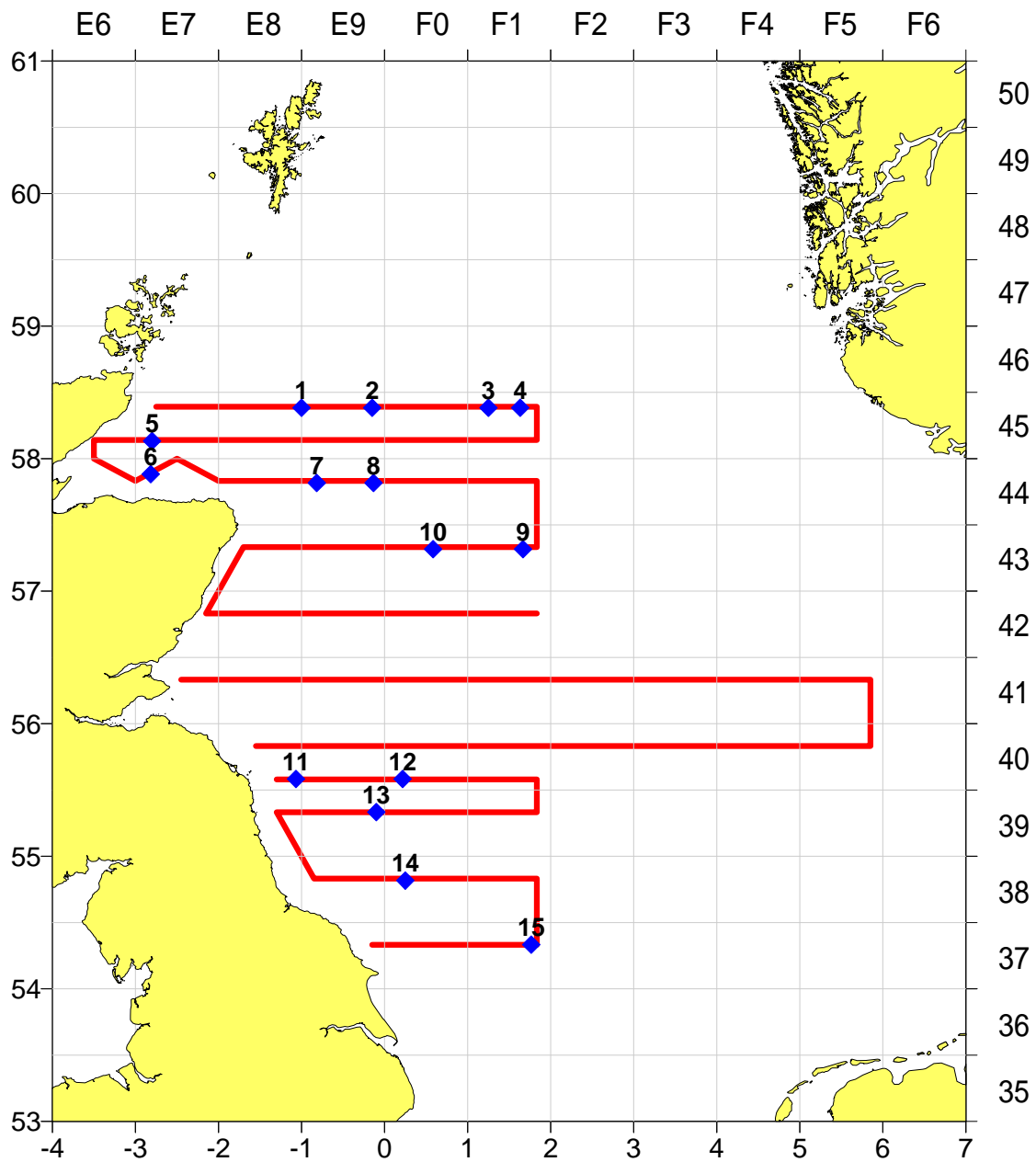


Figure 1a. Map of executed cruise track and positions of trawl stations (blue diamonds with numbers) during the June-July 2010 North Sea herring hydro acoustic survey on R/V "Tridens".

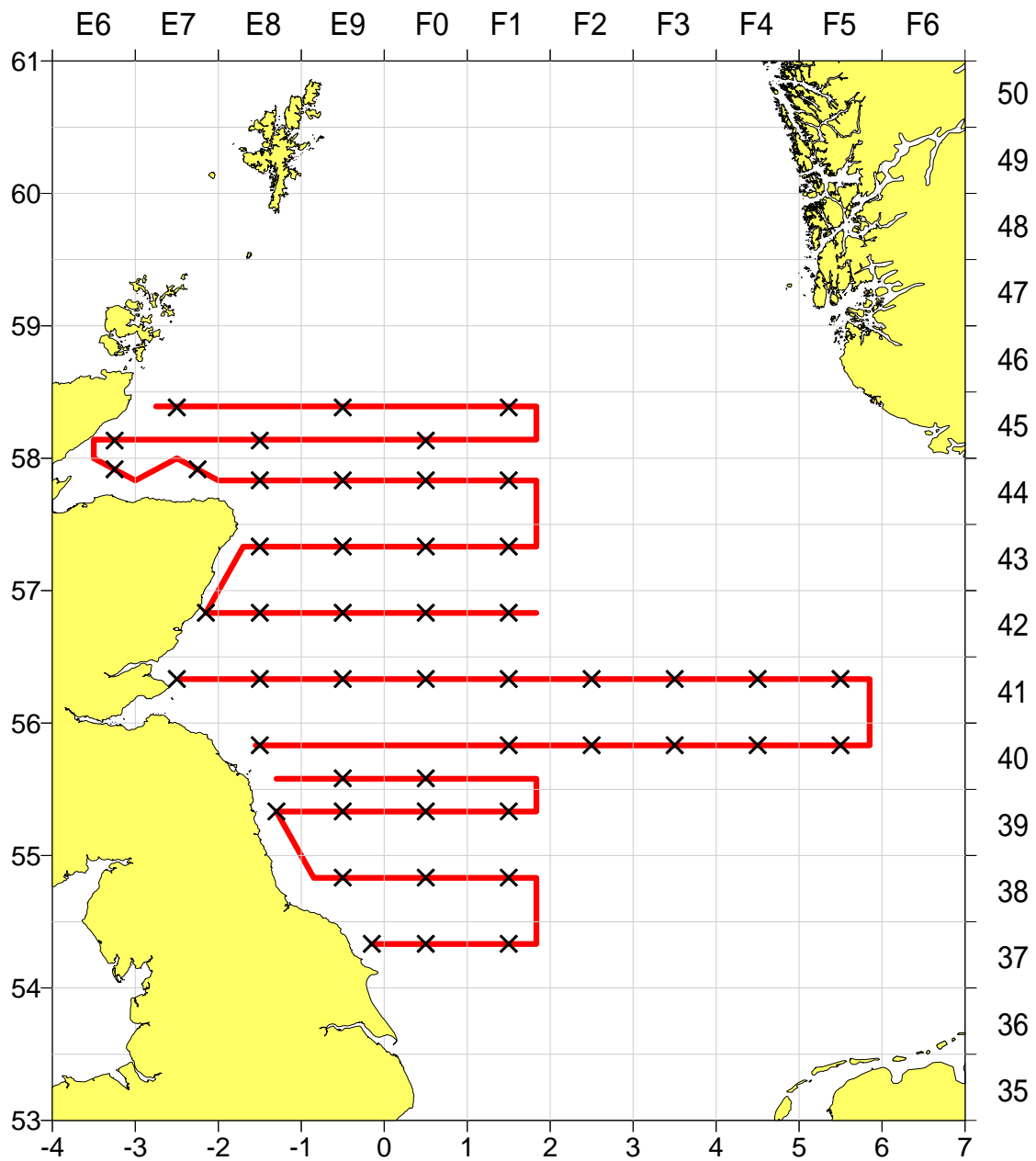


Figure 1b. Map of hydrographical stations (crosses) during the June-July 2010 North Sea herring hydro acoustic survey on R/V "Tridens".

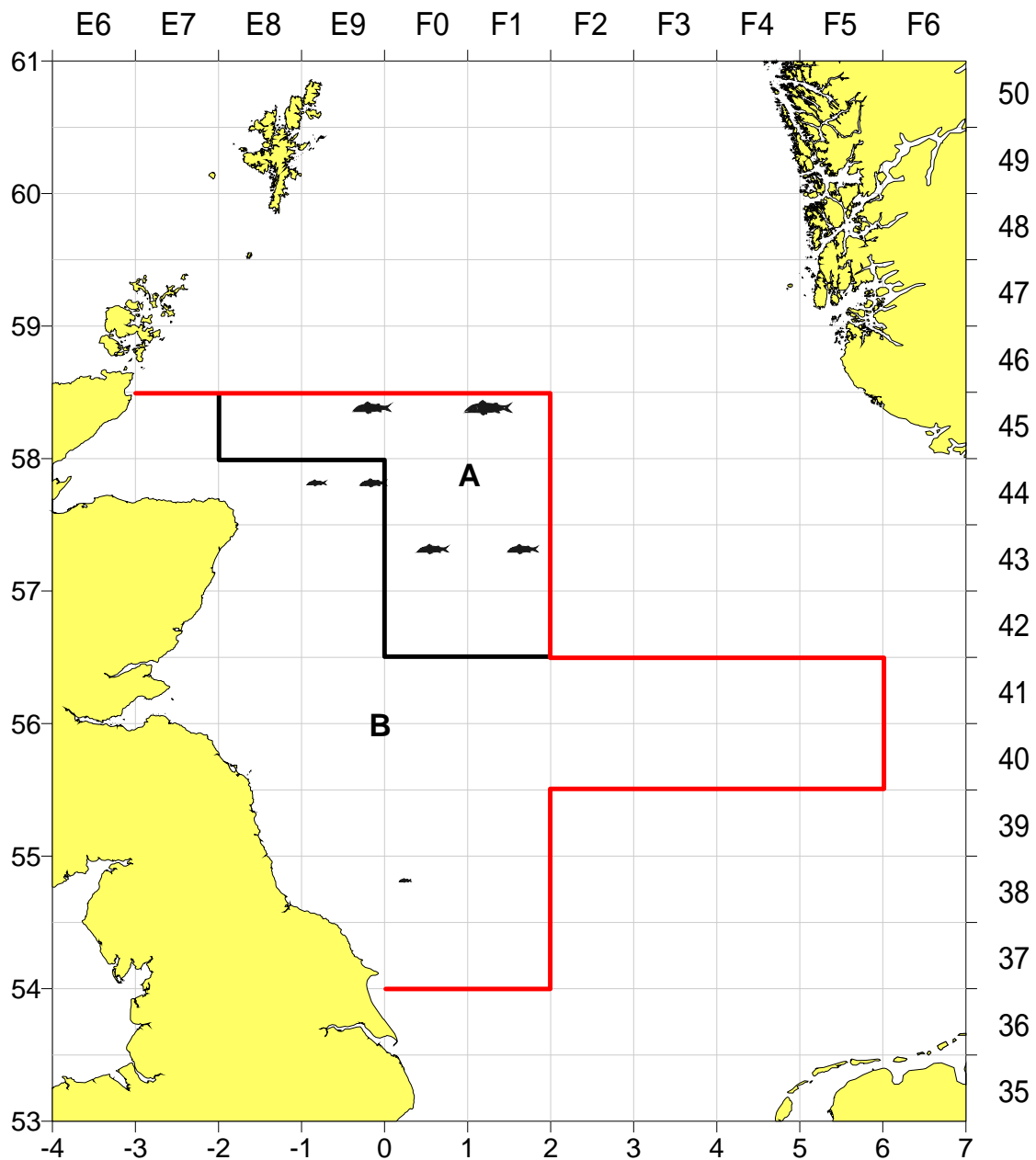


Figure 2. Geographical strata used to pool mean weights and relative mean lengths of herring in order to raise NASC's by rectangle to numbers and biomass during the June-July 2010 North Sea hydro acoustic survey for herring by R/V "Tridens". Size of fish symbols represent relative mean lengths of herring caught in the respective hauls. Note that the haul in rectangle 38F0 is shown for indicative purposes only. It only contained 5 herring and was therefore not included in the analysis.

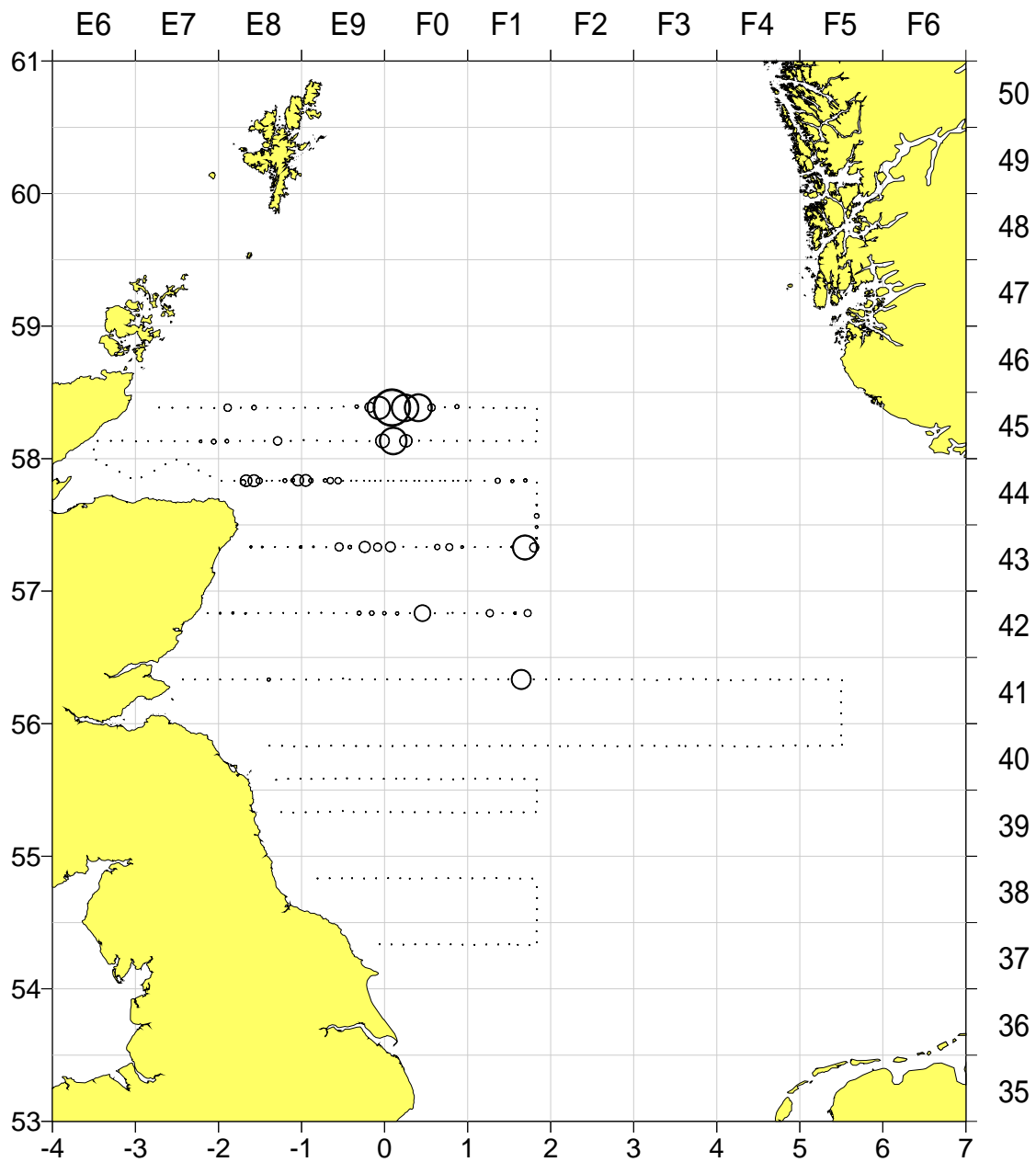


Figure 3a. Post plot showing the distribution of **total herring** NASC's of 5 nm intervals (on a proportional square root scale relative to the largest value of 3474.25) obtained during the June-July 2010 North Sea herring hydro acoustic survey on R/V "Tridens".

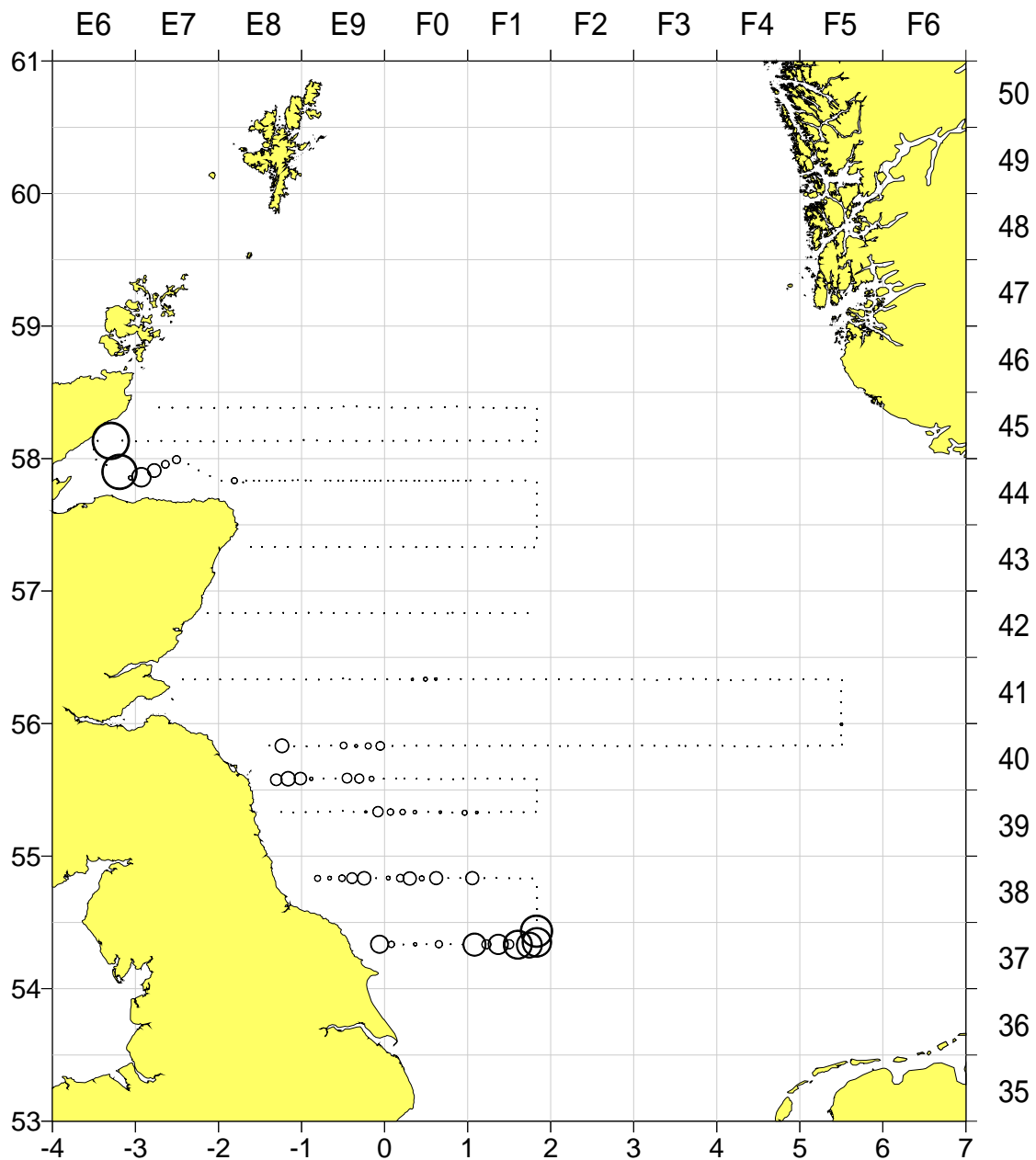


Figure 3b. Post plot showing the distribution of **total sprat** NASC's by 5 nm intervals (on a proportional square root scale relative to the largest value of 931.8). Obtained during the June-July 2009 North Sea herring hydro acoustic survey on R/V "Tridens".

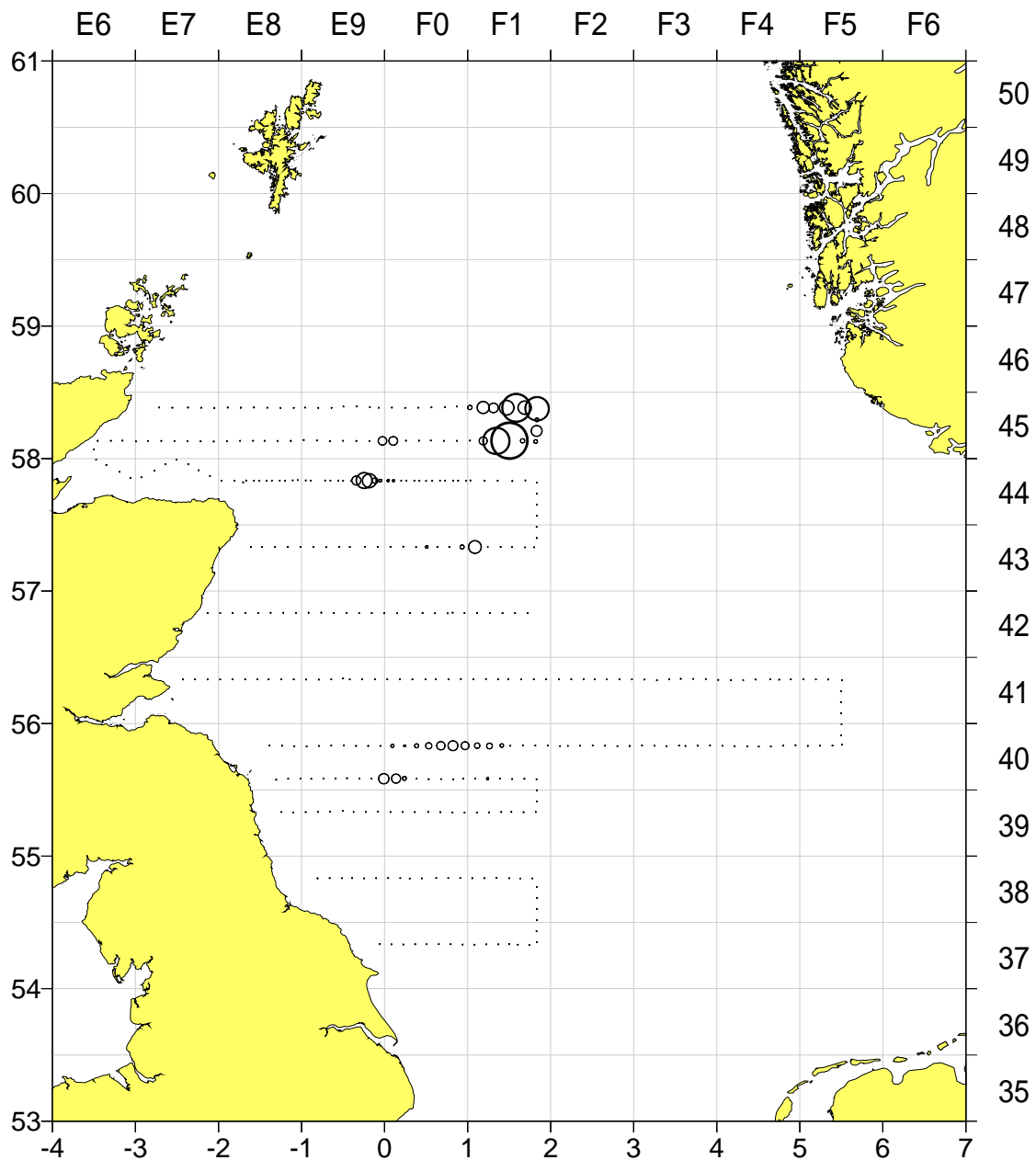


Figure 3c. Post plot showing the distribution of **total Norway pout** NASC's by 5 nm intervals (on a proportional square root scale relative to the largest value of 931.8). Obtained during the June-July 2009 North Sea herring hydro acoustic survey on R/V "Tridens".

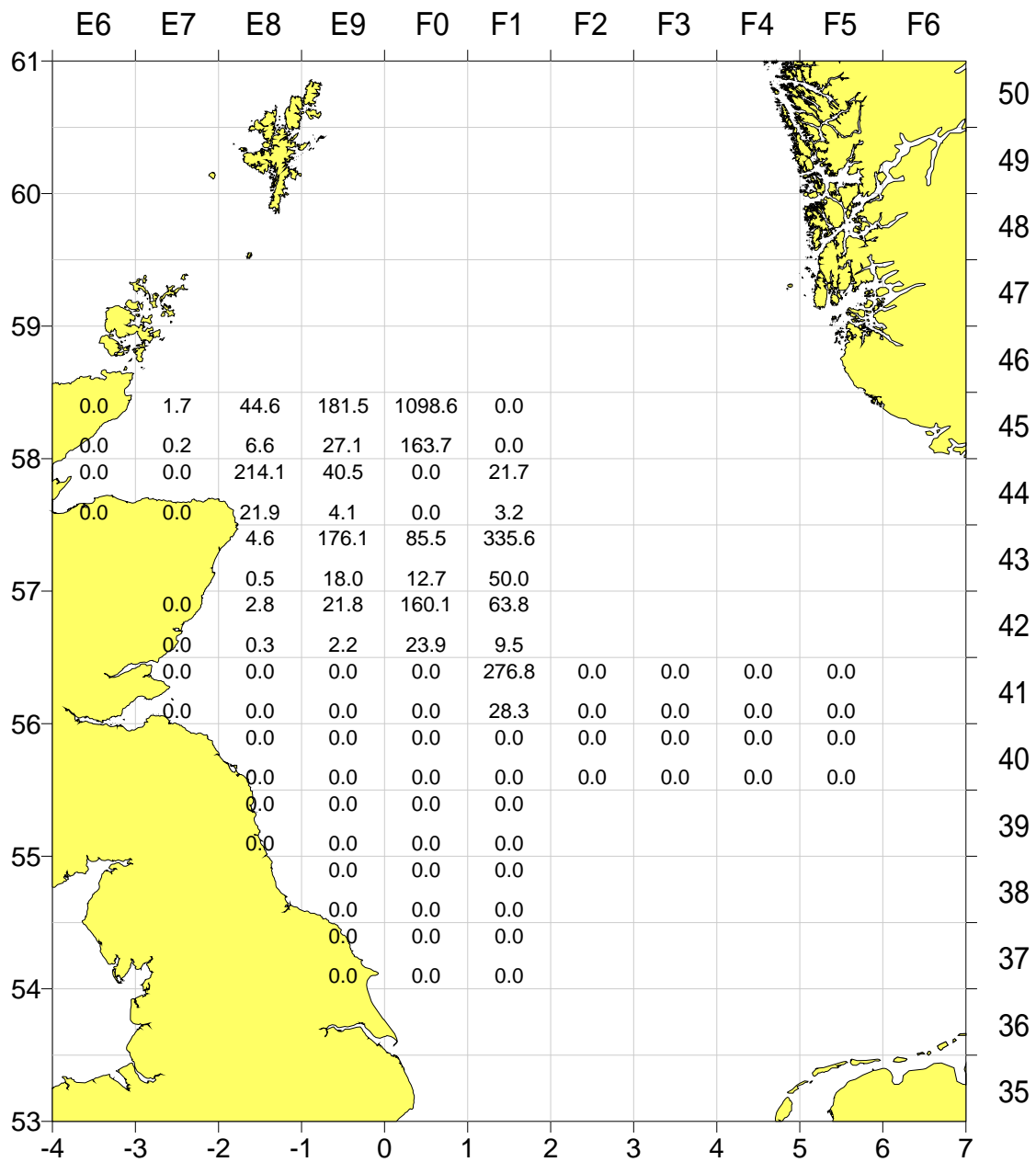


Figure 4. Estimated numbers of **herring** in millions (upper half square) and biomass in thousands of tonnes (lower half of square) by ICES rectangle. Results from the July 2010 North Sea hydro acoustic survey, R/V "Tridens".

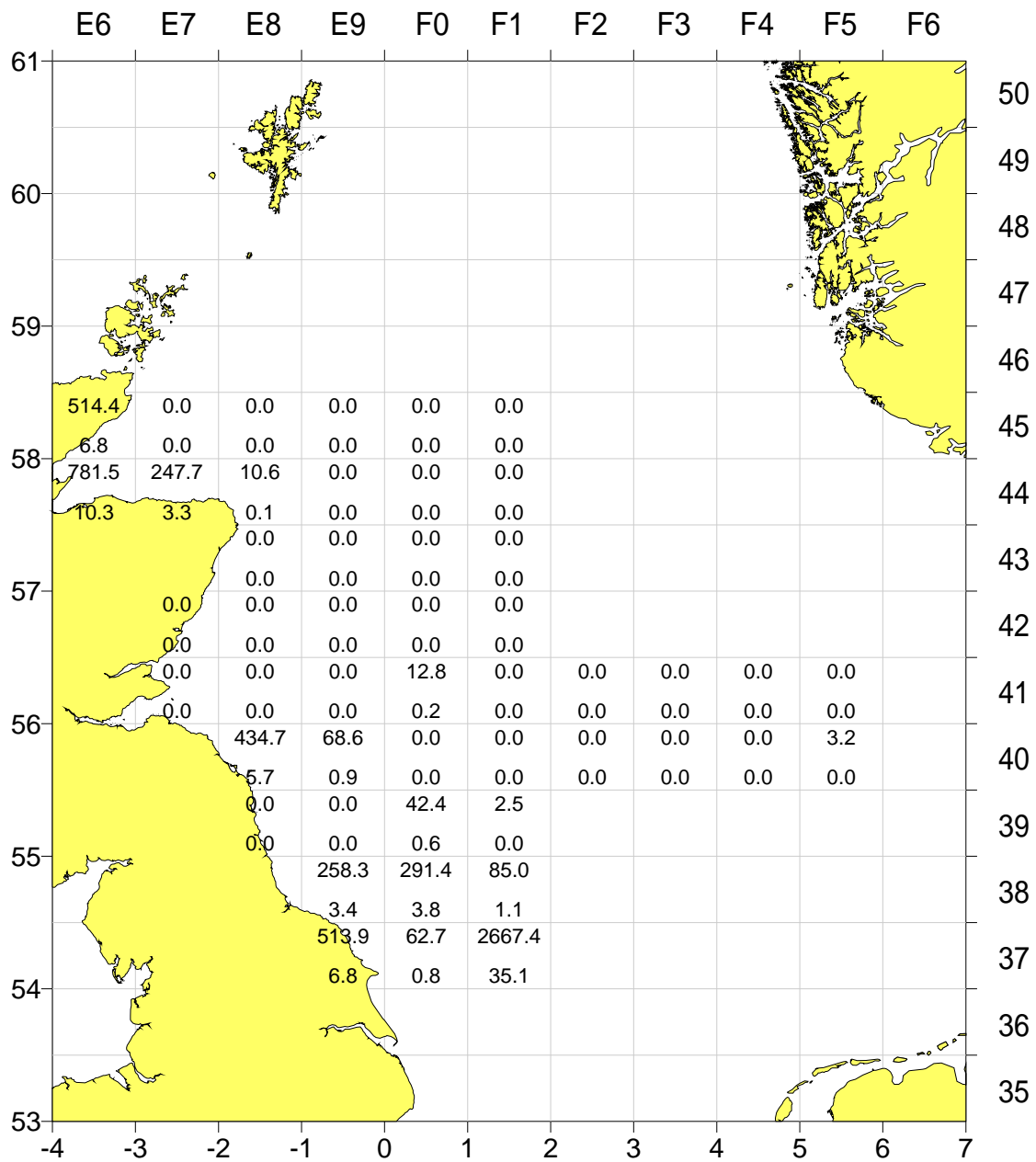


Figure 5. Estimated numbers of sprat in millions (upper half square) and biomass in thousands of tonnes (lower half of square) by ICES rectangle. Results from the July 2010 North Sea hydro acoustic survey, R/V "Tridens".

Justification

Rapport C004/11

Project Number: 4301211014

The scientific quality of this report has been peer reviewed by the a colleague scientist and the head of the department of IMARES.

Approved: Ingeborg de Boois
Researcher

Signature:

Date: 18 January 2011

Approved: Dr. Ir. T.P. Bult
Head Fisheries Department

Signature:

Date: 18 January 2011