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North Sea hydro acoustic herring survey Survey report for FRV "TRIDENS" 23 June - 18 July 2003

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Samenvatting

Dit is het verslag van de Nederlandse deelname aan de Noordzee akoestische survey voor haring. Deze, door ICES gecoördineerde, survey wordt sinds 1991 jaarlijks uitgevoerd. Naast Nederland, nemen Schotland, Duitsland, Denemarken en Noorwegen deel aan de survey. Het doel van de survey is het maken van een schatting van de grootte van de Noordzee haring populatie. Deze schatting wordt gebruikt als een "tuning" index door de ICES Haring Assessment Working Group (HAWG) om de omvang van de populatie vast te stellen. Voor de survey wordt gebruik gemaakt van een Simrad 38 kHz splitbeam transducer met een EK60 echolood. De toegepaste methode is echo-integratie. Door transekten te varen in het gebied wordt het totale akoestische oppervlak per oppervlakte eenheid bepaald. Door het uitvoeren van vistrekken wordt de soort-samenstelling van de waargenomen vis-concentraties bepaald. Van alle soorten wordt de lengte-samenstelling bepaald. Van haring en sprot worden bovendien snij-monsters genomen voor het bepalen van leeftijd en rijpheid. Voor deze soorten kan aldus een schatting van de populatie, uitgesplitst naar leeftijd en rijpheid, gemaakt worden. De biomassa van de haring-populatie in het bemonsterde gebied wordt geschat op 1399.000 ton, die van sprot op 2.900 ton. De paai-biomassa van haring wordt geschat op 618.000 ton.

Summary

This is the report of the Dutch part of the international North Sea hydro acoustic survey for herring. The survey is coordinated by ICES and has been executed annually since 1991. Scotland, Germany, Denmark and Norway also participate in the survey.

The purpose of the survey is to estimate the herring stock of the North Sea. This estimation is used as a 'tuning index' by the ICES Herring Assessment Working Group (HAWG) to assess the North Sea herring stock.

For this survey a Simrad 38 kHz splitbeam transducer was used together with a Simrad EK60 echo sounder. The applied method was echo integration. By sailing transects over the survey area, the total acoustic cross section can be calculated by surface area sampled. Species composition of localised schools were identified by trawling. The length composition of each species was determined. Herring and sprat were examined on age and fecundity from which a split up stock structure was made.

The total biomass of the herring population in the surveyed area was estimated to be 1399,000 tonnes from which 618,000 tonnes was mature fish. For sprat the total biomass was estimated to be 2,9000 ton.

1. Introduction

The Netherlands Institute for Fisheries Research (RIVO) participates in the international North Sea hydro acoustic survey for herring since 1991. The survey is part of the EU data collection framework. 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) to determine the population size. In this report the results are presented of the survey in the central North Sea, carried out by FRV "Tridens".

2. Methods

2.1 Scientific Staff

Sytse Ybema

Bram Couperus (cruise leader 2nd two weeks)

Mario Stoker (2nd two weeks)

Kees Bakker (cruise leader 1st two weeks)

Marcel de Vries (2nd two weeks)

Kees Camphuysen (Ornithologist)

Steve Geelhoed (Ornithologist; 1st two weeks)

Marcel Laks (Ornithologist; 2nd two weeks)

Reinold Pasterkamp (guest scientist from De Vrije Universiteit, Amsterdam)

2.2 Narrative

On Monday 23 June Tridens left the port of IJmuiden and headed towards Scapa Flow. On its way the equipment for the calibration was prepared. Arrival at Scapa Flow was at 23.00 the next day (dutch time). Next morning a colleague from the Marine Laboratory Aberdeen was picked up in Scapa Flow. The calibration started (see paragraph "Calibration").

On Thursday 26 June the survey started at the western end of the 57.45 transect (Moray Firth). There was some trouble logging the data with the BI500, which meant that during the first 30 nautical miles only raw EK60 data were collected. These data are not included in this analysis. Next day the 57.15 transect was finished. The weekend was spent in Aberdeen.

In the night from Sunday to Monday, Tridens set course for Shetland in order to sample 4 ICES squares with double intensity together with FRV Scotia. After having surveyed this area, Tridens headed on 2 July for ICES square 41F2, to survey from there in southern direction. Thursday evening the survey was interrupted and course was set to IJmuiden.

On Monday morning 7 June the port was left at 11.30 local time. On 8 July the 56.55 transect was picked up slightly more to the west than planned because a derrick barge ship operated in the area. The rest of the trip developed without difficulties with a cruise break in Newcastle during the weekend. On Thursday 17 July the survey was terminated and course was set to IJmuiden.

2.3 Survey design

The survey was carried out from 2 June to 19 July 2003, covering an area east of Scotland from latitude 54°30' to 57°30' North and from longitude 3° West (or the Scottish/English coast) to 3° East. An adapted survey design was applied, partly based on the herring distribution from previous years. Parallel transects along latitudinal lines were used with spacing between the lines set at 15 or 30 nm depending on the expected distributions. South of Shetland an area between 59° N and 60° N and between 0° W and 2° W was surveyed at the same time together with FRV Scotia (Figure 1). Acoustic data from transects running north-south close to the shore (that is parallel to the depth isolines) were excluded from the dataset.

2.4 Calibration

Four calibrations were executed:

1. 38 kHz in the towed body.
2. 200 kHz in the towed body, 1.024 puls duration: poor results.
3. 38 kHz hull mounted: very poor results (probably defect hardware).
4. 200 kHz towed body 0.256 ms – poor results.

Three of four calibrations were unsuccessful. Fortunately the most important transducer, the 38 kHz in the towed body performed all right. The 200 kHz is only used as a help for species recognition during the survey. The poor performance of the 200 kHz and the 38 kHz transducer in the towed body is presently under investigation.

2.5 Acoustic 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. The data were logged with the Simrad BI500 integrator software under X Windows, simulated under Windows 2000. The EK60 received the vessel speed (approximately 10-12 knots) from the ship's GPS. A ping rate of 0.6 s was used. This ping rate has proven most suitable at depths of 50 - 150 m as they occur in most of the area.

The data were logged in 1 nm intervals. In total SA values of 1805 intervals have been collected.

2.6 Biological data

The acoustic recordings were verified by fishing with a 2000 mesh pelagic trawl with 20 mm meshes in the cod-end. Fishing was carried out when there was doubt about the species composition of recordings observed on the echo sounder and to obtain biological samples of herring and sprat. In general, after it was decided to make a tow with the pelagic trawl, the vessel turned and fished back on its track line. If the recordings showed schools, a 60kHz sonar was used to be able to hunt schools that were swimming away from the track line. In haul 11 four large floating buoys were attached to the headline of the trawl to keep the net as high as possible at the surface and to enlarge the vertical opening (25-30 m). In most other hauls the ground rope was very close to the bottom with vertical net openings varying from 10 to 20 m.

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

For herring and sprat length stratified samples were taken for maturity, age (otolith extraction) and weight, five specimens per 0.5 cm class as a maximum.

2.7 Hydrographical data

Hydrographical data have been collected in 21 CTD stations, mostly at the end of a haul. The CTD-data are used for other studies.

2.8 Data analysis

The acoustic values (NASC's) from each log interval were assigned to the following categories: "definitely herring", "probably herring", "possibly herring", "definitely sprat", "probably sprat", "possibly sprat", "gadoids", "mackerel", and "sandeel". The breakdown of sprat and herring in "definitely", "probably" and "possibly" serves merely as a relative indication of certainty within the subjective process of integral partitioning ("scrutinizing"). For the analysis "definitely –" and "possibly herring/sprat" integrator counts were summed to obtain a "best herring/sprat" estimate. The TS/length relationships used were those recommended by the ICES Planning Group for Herring Surveys (ICES 2000). The numbers of herring and sprat per ICES rectangle were calculated.

The biological samples were grouped in 6 strata for herring and 1 stratum for sprat, based on similar length distribution and geographical position (see 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

Figure 3 shows the acoustic values (NASC's) per five nautical mile intervals along the track lines for herring.

3.2 Biological data

In all, 22 trawl hauls have been conducted (figure 1). Herring was found in 21 hauls of which 21 samples were taken. Sprat was found in 5 hauls of which 5 samples were taken (see also 2.8 *Data analysis*). In 20 hauls herring was the most abundant species in weight. In none of the hauls sprat was the most abundant species. In haul 11 the meshes were stuck with small sandeel indicating that this species would have been an abundant species in the catch if the mesh size had been smaller. The catch weights per haul and species are presented in table 2. Table 3 shows the age/maturity length keys for herring (strata A-F) and sprat.

3.3 Biomass estimates

Table 4 summarizes numbers and biomass for stratum A-F for herring. Table 5a and 5b summarize numbers and biomass for the whole area for herring and sprat. The stock biomass estimate of herring is 1399.000 tonnes and for sprat 27,000 tonnes. Figure 4 shows the estimated numbers and biomass of herring by ICES rectangle.

4. Discussion

The coverage of the Dutch part of the 2003 hydro acoustic survey for herring in the North Sea is different from previous years. Therefore the results are not directly comparable. Nevertheless, some results and observations are striking:

Only 43% of the 2WR (year class 2000) is found mature. In the 2002 survey this percentage was 90%. If this is the case in the whole survey, it will certainly have an impact on the herring stock assessment.

In the 2002 survey a surprising high number (30%) of 1 ringers was found mature in the Dutch survey. Normally, this is less than 1%. This high number was not found during this year's survey.

Norway pout, a species that was very abundant in the survey hauls during the second half of the 90's, was absent in the 2003 catches, confirming the decreasing trend of the last three years.

In general the herring was more equally distributed over the surveyed area than in previous years. The main concentrations of herring were found below 56°30N, in particular south and southeast of the Devil's holes, east of Farn Deep and Dogger Bank.

Table 1. Simrad EK60 settings used on the June 2003 North Sea hydro acoustic survey for herring, FRV "Tridens".

Transceiver menu	
Absorption coefficient	9.4 dB/km
Pulse length	1.024 ms
Bandwidth	2.43 kHz
Max Power	2000 W
Two-way beam angle	-20.6 dB
3 dB Beam width	7.0 dg
Calibration details	
TS of sphere	-33.6 dB
Range to sphere in calibration	11.50 m
Transducer gain	25.57 dB
Calibration factor for NASC's	-
Log/Navigation Menu	
speed	serial from ship's GPS
Operation Menu	
Ping interval	0.6 s
Display/Printer Menu	
TVG	20 log R
Integration line	N/A
TS color min.	-50 dB
Sv color min.	-70 dB

Table 2a. Details of the trawl hauls taken during the July 2003 North Sea hydro acoustic survey, FRV "Tridens".

haul	date	position	Time UTC	Haul duration	depth	gear
1	27/06/2003	57 15N 01 48E	06:40		35 91	pelagic trawl
2	27/06/2003	57 15N 00 06E	14:02		58 80	pelagic trawl
3	30/06/2003	59 09N 01 50W	07:50		60 80	pelagic trawl
4	30/06/2003	59 10N 00 28W	12:32		23 140	pelagic trawl
5	01/07/2003	59 45N 01 19W	05:36		33 87	pelagic trawl
6	01/07/2003	59 51N 00 09W	11:07		26 142	pelagic trawl
7	01/07/2003	59 20N 00 44W	17:10		13 122	pelagic trawl
8	02/07/2003	59 25N 01 16W	07:35		15 100	pelagic trawl
9	03/07/2003	56 09N 02 10E	06:37		49 80	pelagic trawl
10	08/07/2003	56 54N 00 37E	09:26		16 89	pelagic trawl
11	08/07/2003	56 54N 01 21W	16:53		28 60	pelagic trawl
12	09/07/2003	56 39N 01 27E	06:20		35 91	pelagic trawl
13	09/07/2003	56 40N 00 19W	13:44		16 75	pelagic trawl
14	10/07/2003	56 23N 00 21E	12:33		16 88	pelagic trawl
15	10/07/2003	56 09N 00 35E	07:29		3 80	pelagic trawl
16	11/07/2003	56 09N 00 07W	13:53		9 85	pelagic trawl
17	14/07/2003	55 55N 00 37W	08:28		29 69	pelagic trawl
18	15/07/2003	55 40N 01 04E	06:17		18 95	pelagic trawl
19	16/07/2003	55 24N 00 50W	06:17		18 95	pelagic trawl
20	16/07/2003	55 09N 00 58E	18:26		14 73	pelagic trawl
21	17/07/2003	54 45N 00 04E	06:40		18 78	pelagic trawl
22	17/07/2003	54 44N 00 11E	08:51		18 68	pelagic trawl

Table 2b. Trawl catches during the July 2003 North Sea hydro acoustic survey, FRV "Tridens" in kg.

Haul	Herring	Haddock	Saithe	Whiting	Norway pout	Mackerel	Grey gurnard	Sprat	Cod
1	1159								
2	2325								
3	831.8								
4	1070	1.723	10.93	4.435					
5	1299								
6	1716				10.63				
7	871.7				2.152	23.31			
8	2872								
9	2245	0.572		0.483		63.58			
10	766.2					5.245			
11	0.78	0.914				1.65	0.34	1.229	
12	7135	2.195		0.619		0.899	0.118		
13	1432	44.82		14.68		0.57	2.824		
14	10003	8.587		1.295		0.242	0.17		
15	618.9								
16	3012	0.726		1.423			19.83		
17	3287	80.92		26.8		66.65	15.43	38.48	
18		34.57		1.53			1.952		
19	2.59	1.53	2.65	26.93			0.999	1.329	
20	1516	5.478		14.86			1.446	0.163	0.668
21	1.322	69.77	0.848	147.3			0.803	0.155	2.003
22	14205	5.709		119.9		20.95	1.692		

Table 3a. Age/maturity-length key for herring – Stratum A,B,C,D,E and F.
Tridens, North Sea acoustic survey 2003

stratum	lclass	0imm	1imm	1mat	2imm	2mat	3imm	3mat	4imm	4mat	5mat	6mat	7mat	8mat	9mat	11mat
A	17		1													
A	17.5		1													
A	18		1													
A	18.5		5													
A	19		5													
A	19.5		4													
A	20		3													
A	20.5		3													
A	21				6											
A	21.5				10											
A	22				13	2										
A	22.5				15											
A	23				7	8										
A	23.5				4	10		1								
A	24				5	10										
A	24.5					14	1									
A	25					11		2								
A	25.5					13		1	1							
A	26					8		2	1							
A	26.5					2		1	3		1					
A	27					1										
A	27.5							1	1							
A	28.5								1							
stratum	lclass	0imm	1imm	1mat	2imm	2mat	3imm	3mat	4imm	4mat	5mat	6mat	7mat	8mat	9mat	11mat
B	21				1											
B	21.5				3											
B	22				3											
B	22.5				3											
B	23				7											
B	23.5				5	7										
B	24				2	8		1								
B	24.5				3	6	1	1								
B	25					9		2								
B	25.5					9		1	1							
B	26					6		1	4							
B	26.5					6		3	2							
B	27					3		3	5							
B	27.5					1		4	4	1						
B	28					1		1	4	2						
B	28.5							3	3	1						
B	29								7				1			
B	29.5								2		2	1				
B	30								1		1				1	
B	30.5								1		1					
B	31									1					1	
B	31.5											1				

stratum	lclass	0imm	1imm	1mat	2imm	2mat	3imm	3mat	4imm	4mat	5mat	6mat	7mat	8mat	9mat	11mat
F	17		4													
F	17.5		3													
F	18		7													
F	18.5		7	4												
F	19		9	3												
F	19.5		9	4												
F	20		13	5												
F	20.5		6	10												
F	21		2	9												
F	21.5			9	1											
F	22			3	7											
F	22.5			4	6											
F	23				10											
F	23.5			1	9											
F	24				9	1										
F	24.5				10											
F	25				10	1										
F	25.5				5	1	1									
F	26				3			4								
F	26.5				2			1	2	1						
F	27						1		3	1	1					
F	27.5									2	2	1				
F	28								1	1		1				

Table 3g. Age/maturity-length key for sprat - Total area.
Tridens, North Sea acoustic survey 2003

lclass	0imm	1imm	1mat	2imm	2mat	3mat
8.5		5		1		
9		4	6			
9.5		2	9			
10		1	10			1
10.5		2	13	1		3
11			20			3
11.5			13			4
12			5			3
12.5					10	3
13					9	1
13.5					9	2
14					5	1
14.5					1	1

Table 4. Herring. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age and maturity per stratum obtained during the July 2003 North Sea hydro acoustic survey for herring, FRV "Tridens".

Stratum A						
age	mean weight (g)	mean length (cm)	Numbers (millions)	Biomass (1000 tonnes)	Millions %	Tonnes %
0imm	0.0	0.0	0.0	0.0	0.0	0.0
0mat	0.0	0.0	0.0	0.0	0.0	0.0
1imm	57.3	19.3	62.2	3.6	5.7	3.2
1mat	0.0	0.0	0.0	0.0	0.0	0.0
2imm	90.7	22.5	505.6	47.5	46.1	41.7
2mat	127.0	24.1	479.2	56.1	43.7	49.3
3imm	110.0	24.5	6.1	0.7	0.6	0.7
3mat	144.4	24.9	30.3	3.9	2.8	3.4
4imm	0.0	0.0	0.0	0.0	0.0	0.0
4mat	160.0	26.5	11.1	1.8	1.0	1.6
5mat	0.0	0.0	0.0	0.0	0.0	0.0
6mat	166.0	26.5	1.4	0.2	0.1	0.2
7mat	0.0	0.0	0.0	0.0	0.0	0.0
8mat	0.0	0.0	0.0	0.0	0.0	0.0
9mat	0.0	0.0	0.0	0.0	0.0	0.0
10mat	0.0	0.0	0.0	0.0	0.0	0.0
11mat	0.0	0.0	0.0	0.0	0.0	0.0
Total			1095.8	114.0	100.0	100.0
Immature			573.8	51.9	52.4	45.5
Mature			522.0	62.1	47.6	54.5

Stratum B						
age	mean weight (g)	mean length (cm)	Numbers (millions)	Biomass (1000 tonnes)	Millions %	Tonnes %
0imm	0.0	0.0	0.0	0.0	0.0	0.0
0mat	0.0	0.0	0.0	0.0	0.0	0.0
1imm	0.0	0.0	0.0	0.0	0.0	0.0
1mat	0.0	0.0	0.0	0.0	0.0	0.0
2imm	98.7	23.2	177.5	18.5	18.9	13.7
2mat	138.1	25.1	433.8	58.0	46.1	42.9
3imm	126.0	24.5	11.0	1.4	1.2	1.0
3mat	167.3	26.3	121.3	19.1	12.9	14.1
4imm	0.0	0.0	0.0	0.0	0.0	0.0
4mat	199.8	27.5	155.0	28.7	16.5	21.2
5mat	190.8	28.1	23.4	4.7	2.5	3.5
6mat	269.0	30.0	8.9	2.3	0.9	1.7
7mat	264.0	29.7	5.8	1.5	0.6	1.1
8mat	280.0	32.5	1.4	0.5	0.1	0.3
9mat	267.0	30.5	2.8	0.8	0.3	0.6
10mat	0.0	0.0	0.0	0.0	0.0	0.0
11mat	0.0	0.0	0.0	0.0	0.0	0.0
Total			941.0	135.4	100.0	100.0
Immature			188.5	19.9	20.0	14.7
Mature			752.5	115.5	80.0	85.3

Stratum C							
age	mean weight (g)	mean length (cm)	Numbers (millions)	Biomass (1000 tonnes)	Millions %	Tonnes %	
0imm	2.8	7.7	1077.3	3.0	100.0	100.0	
0mat	0.0	0.0	0.0	0.0	0.0	0.0	
1imm	0.0	0.0	0.0	0.0	0.0	0.0	
1mat	0.0	0.0	0.0	0.0	0.0	0.0	
2imm	0.0	0.0	0.0	0.0	0.0	0.0	
2mat	0.0	0.0	0.0	0.0	0.0	0.0	
3imm	0.0	0.0	0.0	0.0	0.0	0.0	
3mat	0.0	0.0	0.0	0.0	0.0	0.0	
4imm	0.0	0.0	0.0	0.0	0.0	0.0	
4mat	0.0	0.0	0.0	0.0	0.0	0.0	
5mat	0.0	0.0	0.0	0.0	0.0	0.0	
6mat	0.0	0.0	0.0	0.0	0.0	0.0	
7mat	0.0	0.0	0.0	0.0	0.0	0.0	
8mat	0.0	0.0	0.0	0.0	0.0	0.0	
9mat	0.0	0.0	0.0	0.0	0.0	0.0	
10mat	0.0	0.0	0.0	0.0	0.0	0.0	
11mat	0.0	0.0	0.0	0.0	0.0	0.0	
Total			1077.3	3.0	100.0	100.0	
Immature			0.0	0.0	0.0	0.0	
Mature			1077.3	3.0	100.0	100.0	

Stratum D							
age	mean weight (g)	mean length (cm)	Numbers (millions)	Biomass (1000 tonnes)	Millions %	Tonnes %	
0imm	0.0	0.0	0.0	0.0	0.0	0.0	
0mat	0.0	0.0	0.0	0.0	0.0	0.0	
1imm	53.3	19.6	1839.9	111.4	19.1	14.2	
1mat	0.0	0.0	0.0	0.0	0.0	0.0	
2imm	75.6	20.9	5588.8	418.1	58.2	53.2	
2mat	118.9	23.6	1774.7	197.9	18.5	25.2	
3imm	90.0	22.5	23.6	2.2	0.2	0.3	
3mat	132.7	24.8	176.3	23.2	1.8	3.0	
4imm	116.0	24.0	7.4	0.9	0.1	0.1	
4mat	158.2	26.3	163.9	25.6	1.7	3.3	
5mat	165.7	27.3	15.9	2.8	0.2	0.4	
6mat	163.6	27.8	12.6	2.3	0.1	0.3	
7mat	0.0	0.0	0.0	0.0	0.0	0.0	
8mat	194.0	28.0	4.9	0.9	0.1	0.1	
9mat	0.0	0.0	0.0	0.0	0.0	0.0	
10mat	0.0	0.0	0.0	0.0	0.0	0.0	
11mat	0.0	0.0	0.0	0.0	0.0	0.0	
Total			9607.9	785.3	100.0	100.0	
Immature			7459.7	532.6	77.6	67.8	
Mature			2148.2	252.7	22.4	32.2	

Stratum E						
age	mean weight (g)	mean length (cm)	Numbers (millions)	Biomass (1000 tonnes)	Millions %	Tonnes %
0imm	0.0	0.0	0.0	0.0	0.0	0.0
0mat	0.0	0.0	0.0	0.0	0.0	0.0
1imm	37.0	17.9	38.1	1.5	18.2	6.4
1mat	0.0	0.0	0.0	0.0	0.0	0.0
2imm	64.0	20.0	9.5	0.5	4.5	2.3
2mat	0.0	0.0	0.0	0.0	0.0	0.0
3imm	0.0	0.0	0.0	0.0	0.0	0.0
3mat	0.0	0.0	0.0	0.0	0.0	0.0
4imm	0.0	0.0	0.0	0.0	0.0	0.0
4mat	0.0	0.0	0.0	0.0	0.0	0.0
5mat	125.0	26.4	38.1	5.4	18.2	23.3
6mat	134.8	25.6	92.1	11.6	43.9	50.6
7mat	134.0	25.5	31.8	4.0	15.2	17.3
8mat	0.0	0.0	0.0	0.0	0.0	0.0
9mat	0.0	0.0	0.0	0.0	0.0	0.0
10mat	0.0	0.0	0.0	0.0	0.0	0.0
11mat	0.0	0.0	0.0	0.0	0.0	0.0
Total			209.7	23.0	100.0	100.0
Immature			47.7	2.0	22.7	8.8
Mature			162.1	21.0	77.3	91.2

Stratum F						
age	mean weight (g)	mean length (cm)	Numbers (millions)	Biomass (1000 tonnes)	Millions %	Tonnes %
0imm	0.0	0.0	0.0	0.0	0.0	0.0
0mat	0.0	0.0	0.0	0.0	0.0	0.0
1imm	57.3	19.7	998.2	64.0	27.5	18.9
1mat	0.0	0.0	0.0	0.0	0.0	0.0
2imm	79.5	20.9	1365.5	108.4	37.6	32.0
2mat	133.7	23.5	1070.9	130.5	29.5	38.5
3imm	0.0	0.0	0.0	0.0	0.0	0.0
3mat	152.0	25.2	38.3	5.9	1.1	1.7
4imm	0.0	0.0	0.0	0.0	0.0	0.0
4mat	173.0	26.3	90.5	16.0	2.5	4.7
5mat	176.7	27.1	36.0	7.0	1.0	2.1
6mat	175.5	27.1	23.4	4.6	0.6	1.4
7mat	185.0	27.8	10.8	2.2	0.3	0.7
8mat	0.0	0.0	0.0	0.0	0.0	0.0
9mat	0.0	0.0	0.0	0.0	0.0	0.0
10mat	0.0	0.0	0.0	0.0	0.0	0.0
11mat	0.0	0.0	0.0	0.0	0.0	0.0
Total			3633.6	338.5	100.0	100.0
Immature			2363.7	172.4	65.1	50.9
Mature			1269.9	166.2	34.9	49.1

Table 4. (continued)

Table 5a. Herring. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age and maturity obtained during the July 2003 North Sea hydro acoustic survey for herring, FRV "Tridens".

Year	age	Numbers (millions)	Biomass (1000 tonnes)	Numbers %	Biomass %
2002	0imm	1077.3	3.0	6.5	0.2
2002	0mat				
2001	1imm	2938.4	180.5	17.7	12.9
2001	1mat				
2000	2imm	7646.9	593.0	46.2	42.4
2000	2mat	3758.6	442.5	22.7	31.6
1999	3imm	40.6	4.3	0.2	0.3
1999	3mat	366.2	52.1	2.2	3.7
1998	4imm	7.4	0.9	0.0	0.1
1998	4mat	420.5	72.1	2.5	5.2
1997	5mat	113.4	19.8	0.7	1.4
1996	6mat	138.4	21.0	0.8	1.5
1995	7mat	48.4	7.7	0.3	0.5
1994	8mat	6.3	1.4	0.0	0.1
1993	9+mat	2.8	0.8	0.0	0.1
Total		16565.4	1399.1	100.0	100.0
Immature		11703.3	780.8	70.7	55.9
Mature		4862.1	618.3	29.3	44.1

Table 5b. Sprat. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age and maturity obtained during the July 2003 North Sea hydro acoustic survey for herring, FRV "Tridens".

Year	age	Numbers (millions)	Biomass (1000 tonnes)	Number s %	Biomass s %
2002	0imm				
2002	0mat				
2001	1imm	26.7	0.2	11.7	6.0
2001	1mat	71.6	0.6	31.4	20.7
2000	2imm	1.6	0.0	0.7	0.5
2000	2mat	104.0	1.7	45.6	58.5
1999	3imm				
1999	3mat	24.1	0.4	10.6	14.3
1998	4imm				
1998	4mat				
1997	5mat				
1996	6mat				
1995	7mat				
1994	8mat				
1993	9mat				
Total		228.0	2.9	100.0	100.0
Immature		28.3	0.2	12.4	6.5
Mature		199.6461	2.7	87.6	93.5

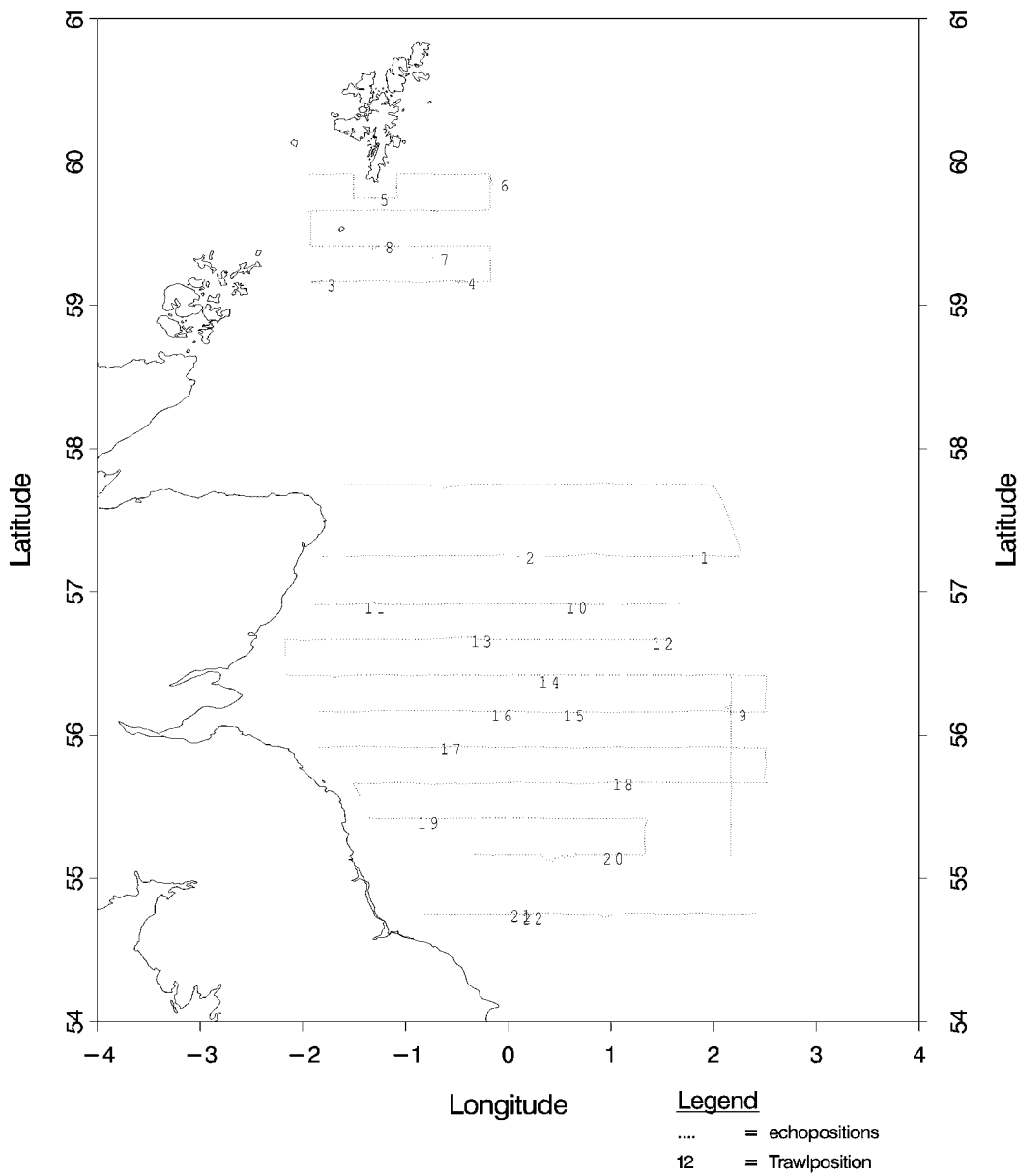


Figure 1. Cruise track and positions of fishing trawls undertaken during the July 2003 North Sea hydro acoustic survey for herring by RV Tridens. Sprat was caught in haul 3, 5, 8, 19, 27, 28 and 31.

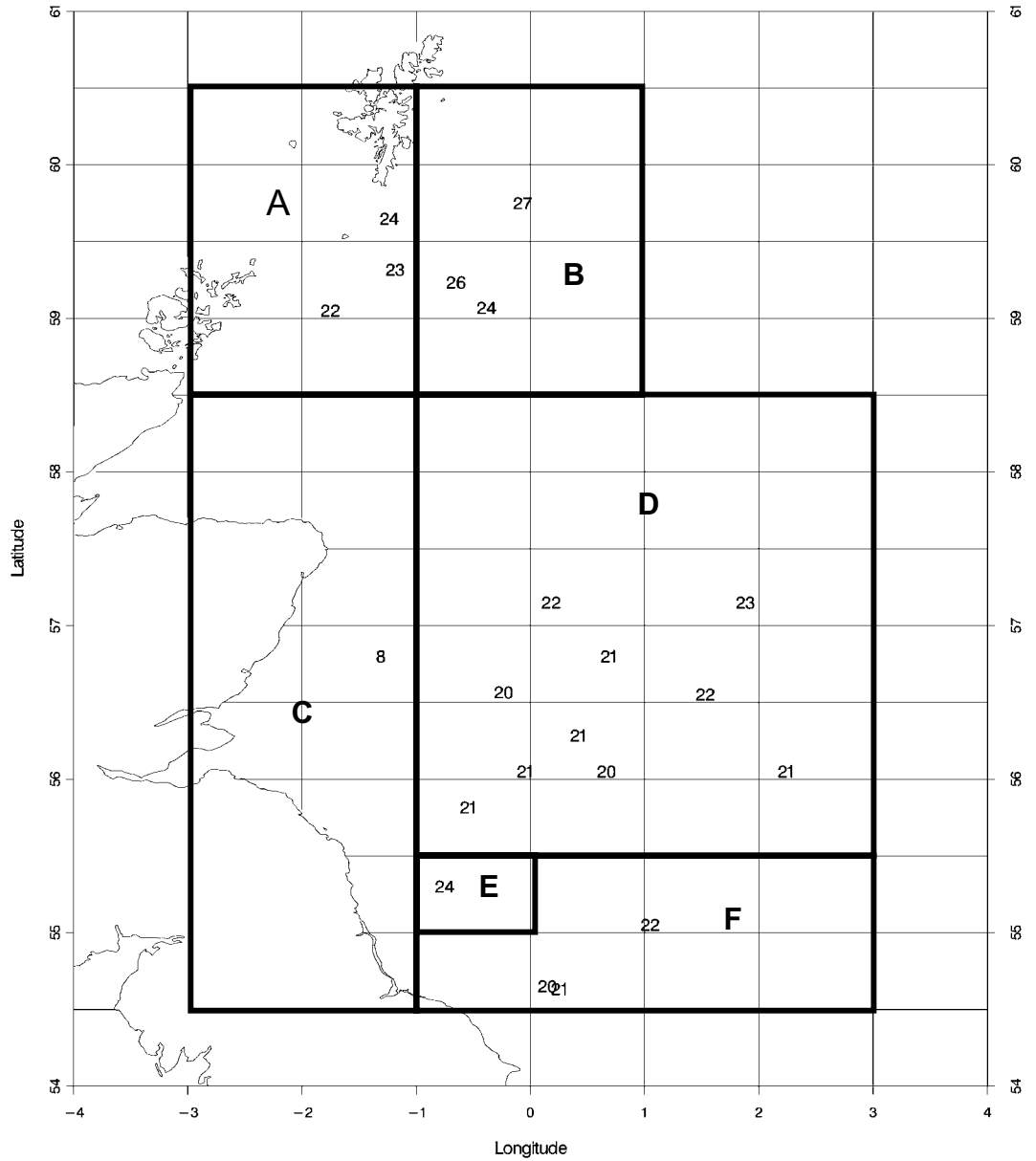


Figure 2. Post plot of herring mean length from FRV "Tridens", observed during the July 2003 North Sea hydro acoustic survey for herring. The numbers indicate the mean length in cm. Strata-areas A to F are indicated.

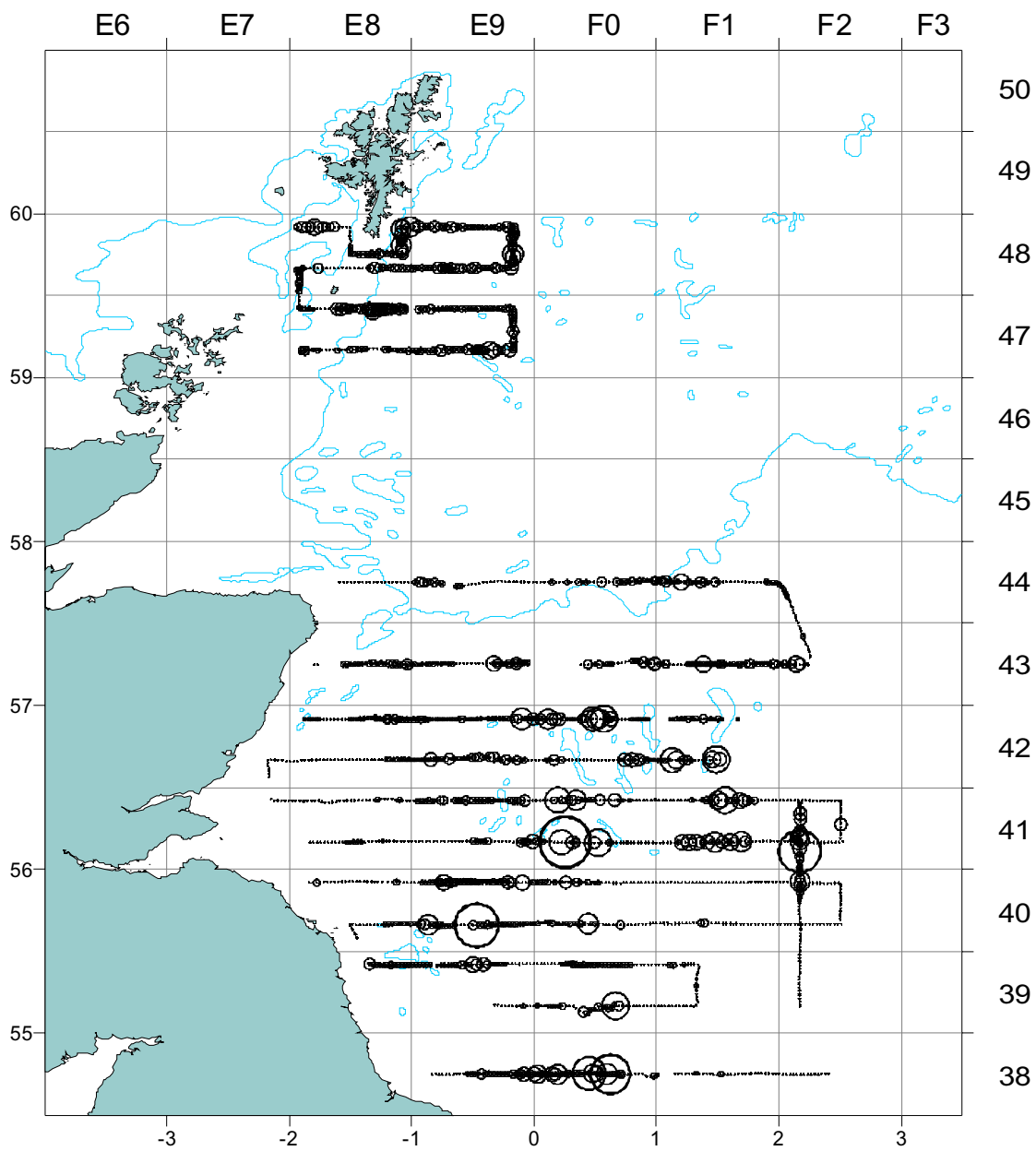


Figure 3. Post plot showing the distribution of total herring NASC values (on a proportional square root scale relative to the largest value of 3601,4) obtained during the July 2003 North Sea herring hydro acoustic survey on FRV "Tridens".

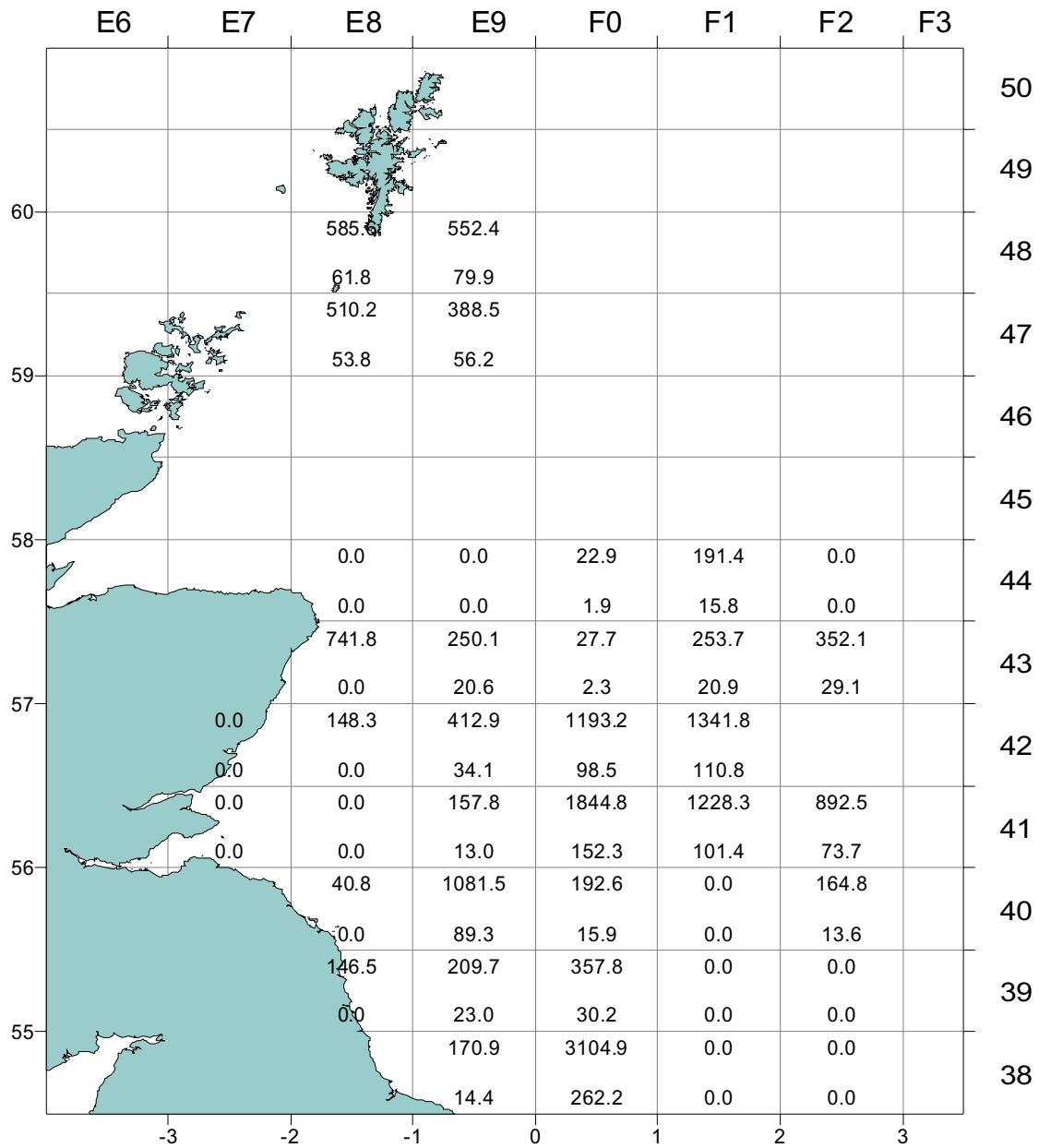


Figure 4. Estimated numbers of herring in millions (upper half square) and biomass in thousands of tonnes (lower half of square) by ICES rectangle. Results from the July 2003 North Sea hydro acoustic survey, FRV "Tridens".