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RIVO report

North Sea hydro acoustic herring survey
Survey report for FRV "TRIDENS"
28 June - 21 July 2004

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Ecosystem and Fisheries

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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 Herring AssessmentWorking Group (HAWG) om de omvang van de populatie vast te stellen.
Voor de survey wordt gebruik gemaakt van een Simrad 38kHz splitbeam transducer met een EK60 echolood. De toegepaste methode is echo-integratie. Door transecten te varen in het gebied wordt het totale akoestische oppervlak per oppervlakteeenheid bepaald. Door het uitvoeren van vistrekken wordt de soort-samenstelling bepaald. Van haring en sprot worden daarnaast biologische monsters genomen om leeftijd en rijpheid te bepalen. 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 992.000 ton, die van sprot op 1.950 ton. De paai-biomassa van haring wordt geschat op 558.000 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. The ICES Herring Assessment Working Group (HAWG) uses this estimation is as a “tuning index” to assess the North Sea herring stock. For this survey a Simrad 38kHz 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. Trawling identified species composition of localized schools. 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 992.000 tonnes from which 558.000 tonnes was mature fish. For sprat the total biomass was estimated to be 1.950 tonnes.

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

Bram Couperus (cruise leader 1st two weeks)
Kees Bakker (cruiseleader 2nd two weeks)
Sytse Ybema (2nd two weeks)
Henk Heessen (1st week)
Andre Dijkman Dulkes (1st two weeks)
Mario Stoker (2nd two weeks)
Kees Camphuysen (Ornithologist)
Hans Verdaat (Ornithologist 1st two weeks)
Sabine Wilhelm (Canadian Wildlife Service, ornithologist; 2nd two weeks)
Mohammed Ahmed Ould Taleb (IMROP, Mauritania)

2.2 Narrative

On Monday 28 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 Tuesday at 24.00 Dutch time. Next morning the calibration started (see paragraph "Calibration").
On Wednesday 30 June the survey started at the western end of the 58°10 transect (Moray Firth). The rest of the week, only few echo's assigned to herring were recorded and only 3 hauls were made. Sunday was spent in Aberdeen.
In the night from Sunday to Monday, Tridens set course for the 57º15, 56º55 and 56º40 transects. Again, only 3 hauls were made. On Wednesday a north-south transect was made at 2º50 up to the Doggersbank. Arrival at IJmuiden to spend the weekend was on Thursday 8 July at 12.00
On Monday morning 12 July the port was left at 11.30 local time. On 13 July the 56º25 transect was picked up. The rest of the trip developed without difficulties with a cruise break in Newcastle during the weekend. Only few schools of fish were detected and therefore only 10 hauls were made in this second part of the cruise. Tuesday 20 July many large schools were seen on the 55º10 transect and the catch consisted of sprat and immature herring. At the end of the 54º54 transect, a dense layer, close to the sea floor was found and appeared to be small transparant gobys. On Thursday 21 July the survey was terminated and course was set to Scheveningen. Arrival at 14.00.

2.3 Survey design

The survey was carried out from 28 June to 21 July 2004, covering an area east of Scotland from latitude 54°39 to 58°10 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. Acoustic data from transects running north-south close to the shore (that is parallel to the depth isolines) were excluded from the dataset.
The surveyed cruise track and trawl positions are presented in figure 1.

2.4 Calibration

Three calibrations were executed:

1. 38 kHz in the towed body: good results.
2. 200 kHz in the towed body: good results.
3. 38 kHz hull mounted: good results.

The three calibrations were successful. The transducers in the towed body were checked before the survey and some adjustments on the keel were made to perform a good calibration of the hull mounted transducer.
During the calibration of the 200 kHz transducer, it took a relative long time (several minutes), for each individual point in the beam to become detected. Also, the deviation from the expected beam-shape was high (RMS 0.4). We do not know the cause.

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

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 a pelagic trawl, the vessel turned and fished back on its track line. If the recordings showed schools, a 60 kHz 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. It was not possible to make near-surface hauls, because the necessary floating buoys were not available on board.
Fish samples were divided into species by weight. Length measurements were taken to the 0.5 cm below for sprat, herring and to the cm below for other species. For herring and sprat length stratified samples were taken for maturity, age (otolith extraction) and weight, five specimens per 0.5 cm class as a maximum. Three specimens of immature 4w-ring herring were found but were treated as “mature” during data analysis.

2.7 Hydrographical data

Hydrographical data have been collected in 37 CTD stations, all at fixed locations (Figure 2). 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", "pelagics" and "sand eel". 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. 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 5 strata for herring and 1 stratum for sprat, based on similar length distribution and geographical position (Figure 3). 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 4 shows the acoustic values (NASC's) per five nautical mile interval along the track lines for herring.

3.2 Biological data

In all, 16 trawl hauls have been conducted (figure 1). Herring was found in 14 hauls of which 13 samples were taken. Sprat was found in 3 hauls of which 1 sample was taken (see also 2.8 *Data analysis*). In 13 hauls herring was the most abundant species in weight. In none of the hauls sprat was the most abundant species. In haul 16 the meshes were stuck with small transparent gobys indicating that this species would have been an abundant species in the catch if the mesh size had been smaller. 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.
Table 3 shows the age/maturity length keys for herring (strata A-E) and sprat.

3.3 Biomass estimates

Table 4 summarizes numbers and biomass for stratum A-E 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 991.9 tonnes and for sprat 1.9 tonnes. Figure 5 shows the estimated numbers and biomass of herring by ICES rectangle.

4. Discussion

The herring was equally distributed over the survey area, whereas in the previous years the highest concentrations were found around the Devil holes.
For the first time in four years, when the 1998 yearclass appeared as matures in the catches, the estimated biomass of mature herring is lower than the year before: 558 thousand tons vs. 623 thousand tons in 2003. Also the amount of immature herring is lower than in the previous year: 434 thousand tons vs. 780 thousand tons in 2003, due to an apparently week 2002 yearclass. The results of this years survey show that the number of 2 winter-ringers is lower than the number of 3 winter-ringers. This is something that rarely happens and is explained by the strong 2000 yearclass, combined with a weak 2001 yearclass.
This year, the overall feeding condition of herring is found lower compared to 2003 (resp. 0.86 to 0.81). 0- and 1-ringers are excluded in this analysis.

Table 1. Simrad EK60 settings used on the June 2004 North Sea hydro acoustic survey for herring, FRV “Tridens”. **TB**=Towed Body **HM**=Hull Mounted.

Transceiver menu		
	TB	**HM**
Absorption coefficient	9.4 dB/km	9.4 dB/km
Pulse length	1.024 ms	1.024 ms
Bandwidth	2.43 kHz	2.43 kHz
Max Power	2000 W	2000 W
Two-way beam angle	-20.6 dB	-20.6 dB
3 dB Beam width	7.02 dg	7.02 dg
Calibration details		
	TB	**HM**
Calibration details		
TS of sphere	-33.6 dB	-33.6 dB
Range to sphere in calibration	13.00 m	18.50 m
Transducer gain	25.64 dB	25.50 dB
Calibration factor for NASC's	-	-
Log/Navigation Menu		
	TB	**HM**
Speed	Serial from ship's GPS	Serial from ship's GPS
Operation Menu		
	TB	**HM**
Ping interval	0.6 s	0.6 s
Display/Printer Menu		
	TB	**HM**
TVG	20 log R	20 log R
Integration line	N/A	N/A
TS colour min.	-50 dB	-50 dB
Sv colour min.	-70 dB	-70 dB

Table 2a. Details of the trawl hauls taken during the July 2004 North Sea hydro acoustic survey, FRV “Tridens”.

haul	date	position	ICES rectangle	Time UTC	haul duration (min)	depth	gear	sample id
1	01/07/2004	58 10N 01 20W	45E8	08:00	45	89	pelagic trawl	5400701
2	01/07/2004	58 10N 01 48E	45F1	20:04	45	80	pelagic trawl	5400702
3	03/07/2004	57 15N 00 10E	43F0	08:30	37	88	pelagic trawl	5400703
4	05/07/2004	57 15N 01 32E	43F1	09:00	30	90	pelagic trawl	5400704
5	05/07/2004	56 54N 00 10E	42F0	18:35	30	92	pelagic trawl	5400705
6	06/07/2004	56 55N 00 44W	42E9	06:20	48	68	pelagic trawl	5400706
7	13/07/2004	56 25N 02 09E	41F2	09:10	130	84	pelagic trawl	5400707
8	13/07/2004	56 25N 00 30W	41E9	20:25	20	69	pelagic trawl	5400708
9	14/07/2004	56 09N 01 09W	41E8	14:50	20	66	pelagic trawl	5400709
10	14/07/2004	56 10N 00 26W	41E9	18:45	20	50	pelagic trawl	5400710
11	15/07/2004	56 10N 00 43E	41F0	07:07	83	68	pelagic trawl	5400711
12	15/07/2004	55 55N 01 16E	40F1	19:13	53	67	pelagic trawl	5400712
13	16/07/2004	55 39N 00 43E	40F0	19:43	53	60	pelagic trawl	5400713
14	19/07/2004	55 26N 01 04E	39F1	06:46	53	73	pelagic trawl	5400714
15	20/07/2004	55 10N 01 13E	39F1	11:52	108	52	pelagic trawl	5400715
16	20/07/2004	54 54N 01 12E	38F1	17:31	30	40	pelagic trawl	5400716

Table 2b. Trawl catches during the July 2004 North Sea hydro acoustic survey, FRV "Tridens" in kg.

Haul	RIVO sample_id	Herring	Sprat	Norway pout	Grey gurnard	Haddock	Mackerel	Whiting	Cod	Saithe	Spurdog
1	5400701	1251.6			2.1	148.2	46.3	0.8			
2	5400702	2033.2		0.9	0.6	2.9		1.4			
3	5400703	5803.1			1.1	100.5	398.8	29.5			
4	5400704	4697.0		0.3	1.6		94.8				
5	5400705	21099.8									
6	5400706	1710.1			1.3	33.2	36.1	4.5	117.4		
7	5400707	5863.2			1.6	14.8		1.3	0.2	7.2	0.5
8	5400708	435.9			3.8	5.5		3.3			
9	5400709	716.7	21.2				11.2				
10	5400710	115.0	0.1		5.1	5.6	6.4	0.8			
11	5400711	1553.6			24.4	4.5	7.5	2.3			
12	5400712	428.2			12.3	5.5	5.5	0.3			
13	5400713					6.6	0.3	0.8			
14	5400714	2.8			2.0	3.8	6.0	0.1			
15	5400715	5204.2	1294.2		33.7	50.1	0.9	1			
16	5400716										

Table 2c. Length frequency proportions of herring by haul during the July 2004 North Sea hydro acoustic survey, FRV “Tridens”.

l.class/haul:	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
7																
7.5																
8																
8.5																
9																
9.5																
10																
10.5																
11																
11.5																
12																
12.5																
13																
13.5																
14																
14.5																
15									0.4					1.7	0.8	
15.5									0.4					1.7	7.9	
16														3.4	15.9	
16.5														13.6	19.0	
17									0.7					18.6	32.5	
17.5														16.9	17.5	
18														20.3	4.0	
18.5									0.4					13.6	1.6	
19										0.5				10.2	0.8	
19.5									0.4	0.5	0.3					
20									1.4	3.1	0.6	1.2				
20.5						1.0				0.5	0.6	0.3				
21						0.3		1.1		1.6	3.1	2.9				
21.5						2.1		2.4		1.6	4.6					
22	0.4			0.2		3.1		0.8		3.9	6.2	4.7				
22.5	6.2		1.8	1.6	1.5	9.4		1.6		5.2	6.2	15.2				
23	27.1	3.3	5.7	5.2	2.6	29.9	5.5	7.3	5.4	18.1	30.8	30.5				
23.5	27.1	6.8	17.0	16.1	11.7	22.9	5.5	22.7	24.5	17.8	13.8	21.1				
24	18.1	24.8	29.3	19.6	25.4	17.4	12.9	27.0	34.3	24.9	22.2	16.4				
24.5	10.7	21.7	14.1	21.0	19.2	8.3	11.1	20.5	21.7	8.4	6.5	1.8				
25	2.3	18.6	11.7	14.0	17.2	1.2	12.4	6.5	7.2	10.5		0.9				
25.5	3.0	9.3	8.8	8.4	13.0	1.4	19.4	4.3	2.9	2.1	2.8	1.8				
26	4.5	6.0	4.8	3.1	1.0	2.8	8.3	2.7		0.5	0.6	0.6				
26.5	0.4	1.9	3.5	2.8	4.8		3.7	0.8		0.5	0.6					
27	0.2	3.7	1.8	2.8	1.4		14.7		0.4		1.2	2.3				
27.5		3.1	1.5	4.4		0.2		0.3				0.3				
28					0.2		5.5	1.6								
28.5		0.9		0.5	2.1											
29				0.2			0.9	0.3								
29.5																
30				0.2												
30.5																
31																
31.5																
32																
32.5																
33																
total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**0**	**100**	**100**	**0**

Table 3a. Age/maturity-length key for herring – Stratum A,B,C,D,E and F. Tridens, North Sea acoustic survey 2004.

stratum	length class	1imm	1mat	2imm	2mat	3imm	3mat	4mat	5mat	6mat	7mat	8mat	9mat
A	15												
A	15.5												
A	16												
A	16.5												
A	17												
A	17.5												
A	18												
A	18.5												
A	19												
A	19.5												
A	20												
A	20.5	2		1									
A	21	2											
A	21.5	2		3									
A	22			1		5							
A	22.5			4	1	5							
A	23			1	2	6	1						
A	23.5				2	7	1						
A	24				4	2	3	1					
A	24.5				4	3	3						
A	25						9						
A	25.5				4		5						
A	26				2		5	1	1				
A	26.5						2						
A	27				1								
A	27.5											1	
A	28												
A	28.5												
A	29												
A	30												

stratum	length class	1imm	1mat	2imm	2mat	3imm	3mat	4mat	5mat	6mat	7mat	8mat	9mat
B	15												
B	15.5												
B	16												
B	16.5												
B	17												
B	17.5												
B	18												
B	18.5												
B	19												
B	19.5												
B	20												
B	20.5												
B	21												
B	21.5												
B	22			1									
B	22.5			2	1	7							
B	23			2	4	14							
B	23.5			1	3	14	2						
B	24			4	4	8	4						
B	24.5				5	5	9	1					
B	25				11	1	6	1	1				
B	25.5				5	1	11	3					
B	26				3		12	2					
B	26.5				2		8	3	4				
B	27				1		10	2	2				
B	27.5						4	4	3	1	1		
B	28						1						
B	28.5						2	1	1				
B	29									1			
B	30										1		

stratum	length class	1imm	1mat	2imm	2mat	3imm	3mat	4mat	5mat	6mat	7mat	8mat	9mat
C	15	1											
C	15.5	1											
C	16												
C	16.5												
C	17	2											
C	17.5												
C	18												
C	18.5	1											
C	19	2											
C	19.5	3											
C	20	5		1									
C	20.5	4											
C	21	6		1									
C	21.5	1		5		1							
C	22	1		6		1							
C	22.5			3		5							
C	23			2		11	2						
C	23.5			2	1	11		1					
C	24			1	1	10	2	1					
C	24.5				5	7	2	1					
C	25				2	1	11	1					
C	25.5				1		5	1	1				
C	26						4	2					
C	26.5						5						
C	27								1				
C	27.5							1					
C	28						1		2				
C	28.5												
C	29								1				
C	30												

stratum	length class	1imm	1mat	2imm	2mat	3imm	3mat	4mat	5mat	6mat	7mat	8mat	9mat
D	15												
D	15.5												
D	16												
D	16.5												
D	17												
D	17.5												
D	18												
D	18.5												
D	19												
D	19.5	1											
D	20	2		1									
D	20.5	3											
D	21	5		5									
D	21.5	1		6		1							
D	22			4		6							
D	22.5			3		8							
D	23			3	1	12	1						
D	23.5				1	7	1						
D	24			1	4	6	4						
D	24.5				2	3	7						
D	25				4		1	1					
D	25.5				4		5		1				
D	26				3		4						
D	26.5				2		3						
D	27						2	2	3	1			
D	27.5								1				
D	28								2		1		1
D	28.5												
D	29										2		
D	30												

stratum	length class	1imm	1mat	2imm	2mat	3imm	3mat	4mat	5mat	6mat	7mat	8mat	9mat
E	15	1											
E	15.5	5											
E	16	5											
E	16.5	5											
E	17	5											
E	17.5	5											
E	18	5											
E	18.5	2											
E	19	1											
E	19.5												
E	20												
E	20.5												
E	21												
E	21.5												
E	22												
E	22.5												
E	23												
E	23.5												
E	24												
E	24.5												
E	25												
E	25.5												
E	26												
E	26.5												
E	27												
E	27.5												
E	28												
E	28.5												
E	29												
E	30												

Table 3b. Age/maturity-length key for sprat - Total area.
Tridens, North Sea acoustic survey 2004.

length class	1imm	1mat	2imm	2mat	3imm	3mat	4mat	5mat	6mat	7mat	8mat	9mat
10.5			2		1							
11				4		1						
11.5				4		1						
12				1		3						
12.5				2		4						
13						5						
13.5						5						
14						3						

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 2004 North Sea hydro acoustic survey for herring, FRV "Tridens".

stratum	yearclass	age	mean weight (g)	mean length (cm)	numbers (millions)	biomass (thousand tonnes)	numbers (%)	biomass (%)
A	2002	1imm	66.25	21.03	32.15	2.38	1.83	1.27
A	2002	1mat	0.00	0.00	0.00	0.00	0.00	0.00
A	2001	2imm	89.41	22.40	129.45	11.65	7.36	6.23
A	2001	2mat	114.80	23.91	398.17	43.93	22.64	23.49
A	2000	3imm	102.15	23.27	778.37	78.78	44.27	42.12
A	2000	3mat	122.03	24.50	379.42	45.14	21.58	24.13
A	1999	4mat	121.07	24.37	30.20	3.53	1.72	1.89
A	1998	5mat	142.00	26.00	5.58	0.79	0.32	0.42
A	1997	6mat	0.00	0.00	0.00	0.00	0.00	0.00
A	1996	7mat	0.00	0.00	0.00	0.00	0.00	0.00
A	1995	8mat	163.00	27.50	5.02	0.85	0.29	0.45
A	1994	9mat	0.00	0.00	0.00	0.00	0.00	0.00
Immature					**939.97**	**92.81**	**53.46**	**49.62**
Mature					**818.39**	**94.24**	**46.54**	**50.38**
Total					**1758.36**	**187.05**	**100.00**	**100.00**

stratum	yearclass	age	mean weight (g)	mean length (cm)	numbers (millions)	biomass (thousand tonnes)	numbers (%)	biomass (%)
B	2002	1imm	0.00	0.00	0.00	0.00	0.00	0.00
B	2002	1mat	0.00	0.00	0.00	0.00	0.00	0.00
B	2001	2imm	104.01	23.75	304.66	32.80	6.66	5.93
B	2001	2mat	120.40	24.58	1074.01	128.91	23.48	23.32
B	2000	3imm	107.04	23.78	1362.51	147.50	29.79	26.68
B	2000	3mat	133.06	25.14	1452.70	187.39	31.76	33.89
B	1999	4mat	142.17	25.88	243.94	34.42	5.33	6.23
B	1998	5mat	159.31	26.59	108.61	16.66	2.37	3.01
B	1997	6mat	156.08	28.31	13.55	2.51	0.30	0.45
B	1996	7mat	187.83	28.85	13.55	2.68	0.30	0.48
B	1995	8mat	0.00	0.00	0.00	0.00	0.00	0.00
B	1994	9mat	0.00	0.00	0.00	0.00	0.00	0.00
Immature					**1667.17**	**180.31**	**36.45**	**32.61**
Mature					**2906.36**	**372.57**	**63.55**	**67.39**
Total					**4573.53**	**552.88**	**100.00**	**100.00**

stratum	yearclass	age	mean weight (g)	mean length (cm)	numbers (millions)	biomass (thousand tonnes)	numbers (%)	biomass (%)
C	2002	1imm	54.08	19.48	34.78	2.08	8.51	4.75
C	2002	1mat	0.00	0.00	0.00	0.00	0.00	0.00
C	2001	2imm	89.73	22.67	44.34	4.16	10.85	9.51
C	2001	2mat	119.24	24.37	36.08	4.21	8.83	9.63
C	2000	3imm	105.50	23.62	194.75	20.65	47.64	47.21
C	2000	3mat	129.71	24.93	69.32	8.71	16.96	19.92
C	1999	4mat	118.39	24.63	22.41	2.72	5.48	6.21
C	1998	5mat	164.60	27.50	7.12	1.21	1.74	2.77
C	1997	6mat	0.00	0.00	0.00	0.00	0.00	0.00
C	1996	7mat	0.00	0.00	0.00	0.00	0.00	0.00
C	1995	8mat	0.00	0.00	0.00	0.00	0.00	0.00
C	1994	9mat	0.00	0.00	0.00	0.00	0.00	0.00
Immature					**273.87**	**26.88**	**66.99**	**61.47**
Mature					**134.94**	**16.85**	**33.01**	**38.53**
Total					**408.81**	**43.73**	**100.00**	**100.00**

stratum	yearclass	age	mean weight (g)	mean length (cm)	numbers (millions)	biomass (thousand tonnes)	numbers (%)	biomass (%)
D	2002	1imm	66.25	20.60	59.39	4.12	3.98	2.55
D	2002	1mat	0.00	0.00	0.00	0.00	0.00	0.00
D	2001	2imm	86.32	22.28	198.73	17.62	13.32	10.90
D	2001	2mat	121.78	24.67	215.44	26.20	14.44	16.21
D	2000	3imm	98.61	23.11	659.15	65.29	44.18	40.39
D	2000	3mat	123.31	24.85	262.97	32.73	17.63	20.25
D	1999	4mat	146.46	26.25	22.56	3.32	1.51	2.05
D	1998	5mat	158.97	26.96	46.11	7.36	3.09	4.55
D	1997	6mat	156.00	27.00	7.02	1.12	0.47	0.69
D	1996	7mat	181.33	28.67	15.33	2.95	1.03	1.83
D	1995	8mat	0.00	0.00	0.00	0.00	0.00	0.00
D	1994	9mat	160.00	28.00	5.11	0.91	0.34	0.57
Immature					**917.27**	**87.04**	**61.49**	**53.85**
Mature					**574.55**	**73.68**	**38.51**	**46.15**
Total					**1491.82**	**160.72**	**100.00**	**100.00**

stratum	yearclass	age	mean weight (g)	mean length (cm)	numbers (millions)	biomass (thousand tonnes)	numbers (%)	biomass (%)
E	2002	1imm	38.34	17.02	1203.05	46.59	100.00	100.00
E	2002	1mat	0.00	0.00	0.00	0.00	0.00	0.00
E	2001	2imm	0.00	0.00	0.00	0.00	0.00	0.00
E	2001	2mat	0.00	0.00	0.00	0.00	0.00	0.00
E	2000	3imm	0.00	0.00	0.00	0.00	0.00	0.00
E	2000	3mat	0.00	0.00	0.00	0.00	0.00	0.00
E	1999	4mat	0.00	0.00	0.00	0.00	0.00	0.00
E	1998	5mat	0.00	0.00	0.00	0.00	0.00	0.00
E	1997	6mat	0.00	0.00	0.00	0.00	0.00	0.00
E	1996	7mat	0.00	0.00	0.00	0.00	0.00	0.00
E	1995	8mat	0.00	0.00	0.00	0.00	0.00	0.00
E	1994	9mat	0.00	0.00	0.00	0.00	0.00	0.00
Immature					**1203.05**	**46.59**	**100.00**	**100.00**
Mature					**0.00**	**0.00**	**0.00**	**0.00**
Total					**1203.05**	**46.59**	**100.00**	**100.00**

Table 5a. Herring. Mean length, mean weight, biomass (thousends of tonnes) and numbers (millions) breakdown by age and maturity obtained during the July 2004 North Sea hydro acoustic survey for herring, FRV “Tridens”.

yearclass	age	numbers (millions)	Biomass (thousand tonnes)	numbers (%)	biomass (%)	mean weight (g)	mean length (cm)
2002	1imm	1329.38	55.17	14.09	5.56	40.67	17.34
2002	1mat						
2001	2imm	677.17	66.24	7.18	6.68	95.09	22.99
2001	2mat	1723.70	203.26	18.27	20.49	119.25	24.43
2000	3imm	2994.79	312.23	31.74	31.48	103.81	23.49
2000	3mat	2164.41	273.97	22.94	27.62	129.84	24.99
1999	4mat	319.11	43.99	3.38	4.43	138.80	25.68
1998	5mat	167.42	26.03	1.77	2.62	158.86	26.71
1997	6mat	20.58	3.64	0.22	0.37	156.05	27.86
1996	7mat	28.88	5.63	0.31	0.57	184.38	28.75
1995	8mat	5.02	0.85	0.05	0.09	163.00	27.50
1994	9mat	5.11	0.91	0.05	0.09	160.00	28.00
Immature		**5001.33**	**433.63**	**53.01**	**43.72**		
Mature		**4434.23**	**558.28**	**46.99**	**56.28**		
Total		**9435.57**	**991.91**	**100.00**	**100.00**		

Table 5b. Sprat. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age and maturity obtained during the July 2004 North Sea hydro acoustic survey for herring, FRV “Tridens”.

yearclass	age	numbers (millions)	Biomass (thousand tonnes)	numbers (%)	biomass (%)	mean weight (g)	mean length (cm)
2002	1imm						
2002	1mat						
2001	2imm	1.80	0.01	1.18	0.69	9.50	10.50
2001	2mat	48.43	0.55	31.79	28.31	13.93	11.84
2000	3imm	0.90	0.01	0.59	0.34	10.00	10.50
2000	3mat	101.24	1.38	66.44	70.66	15.39	12.45
Immature		**2.71**	**0.02**	**1.78**	**1.03**		
Mature		**149.68**	**1.93**	**98.22**	**98.97**		
Total		**152.38**	**1.95**	**100.00**	**100.00**		

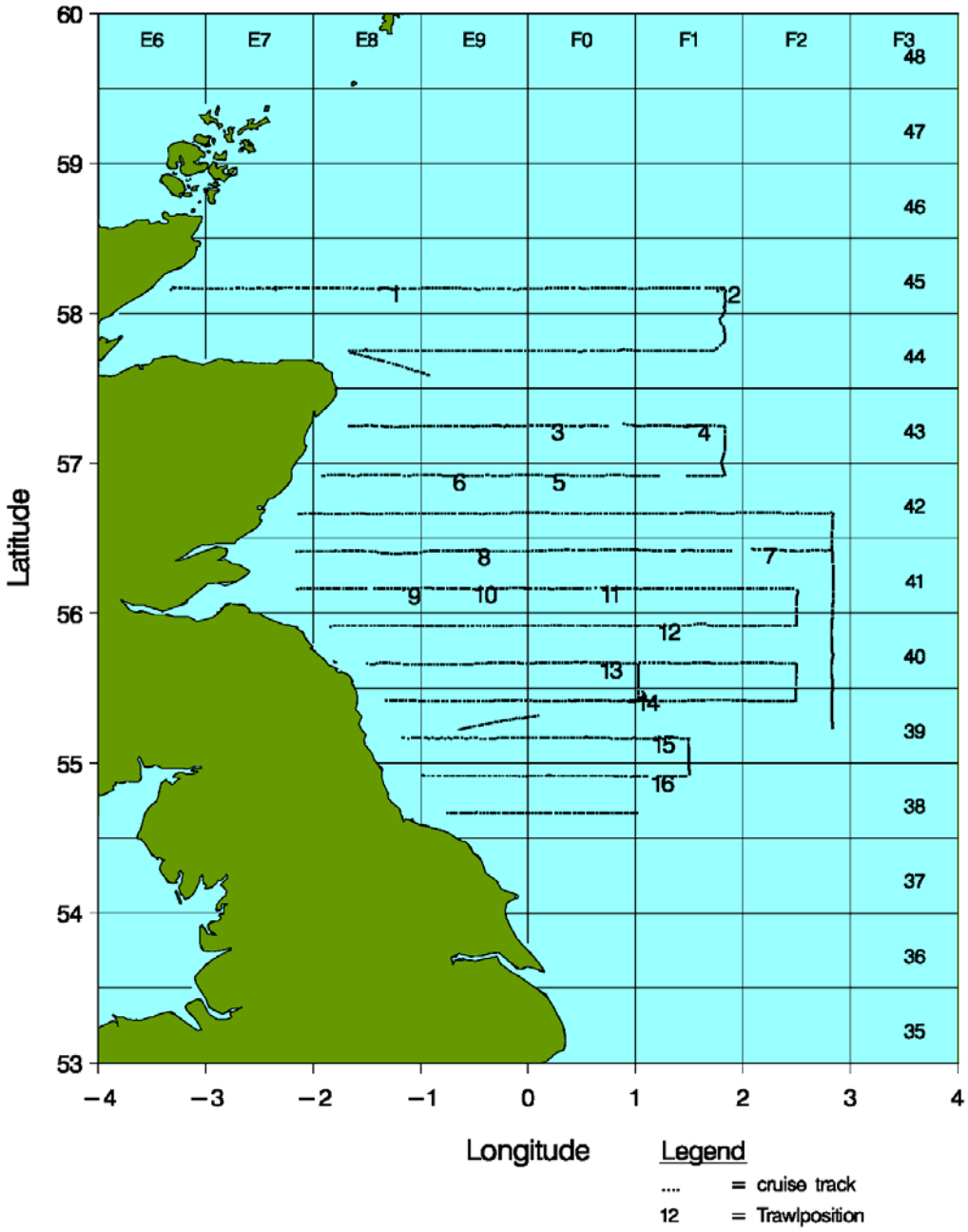

Figure 1. Cruise track and positions of fishing trawls undertaken during the July 2004 North Sea hydro acoustic survey for herring by RV Tridens. Sprat was caught in haul 9, 10 and 15.

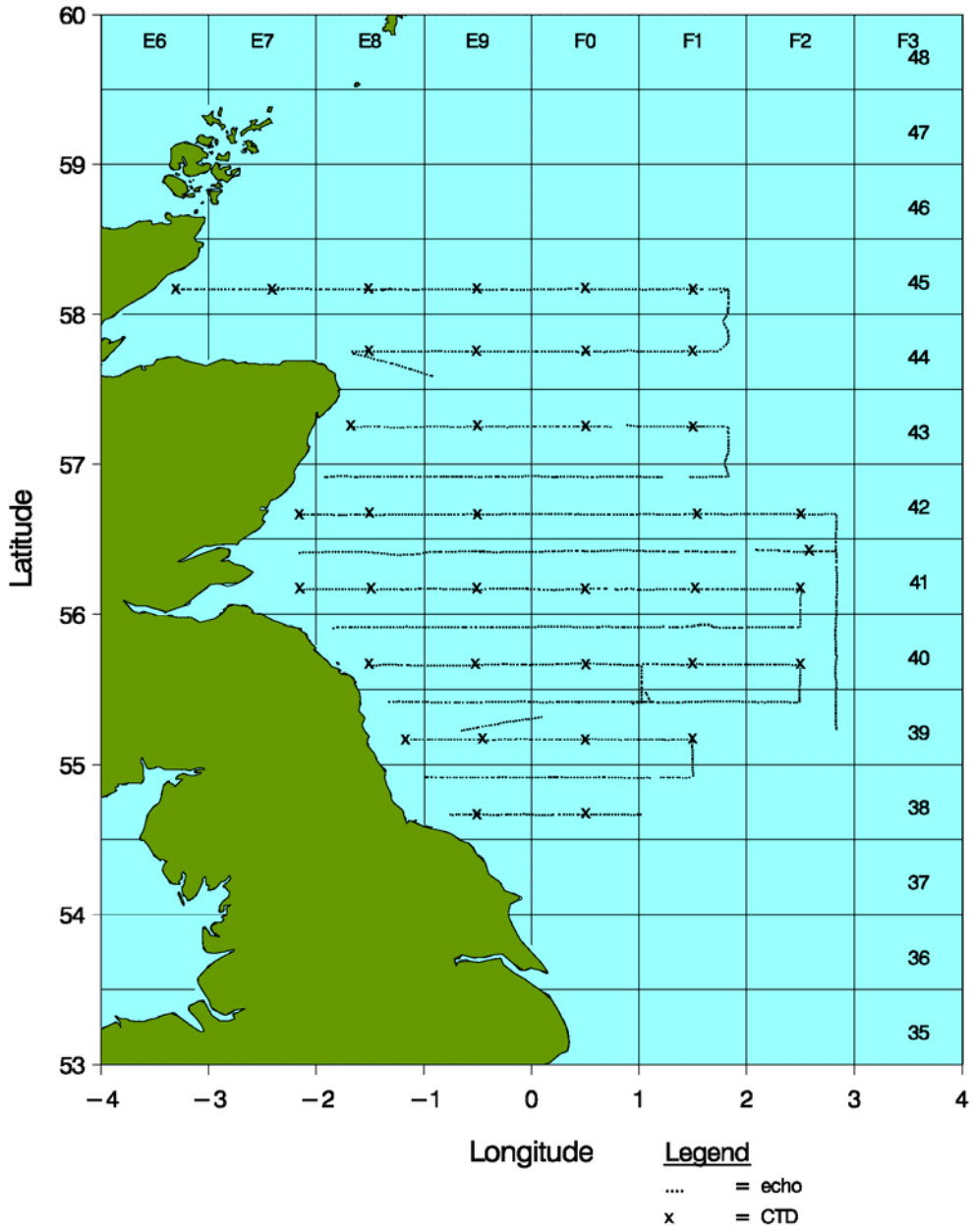

Figure 2. Positions of CTD stations during the July 2004 North Sea hydro acoustic survey for herring by FRV “Tridens”.

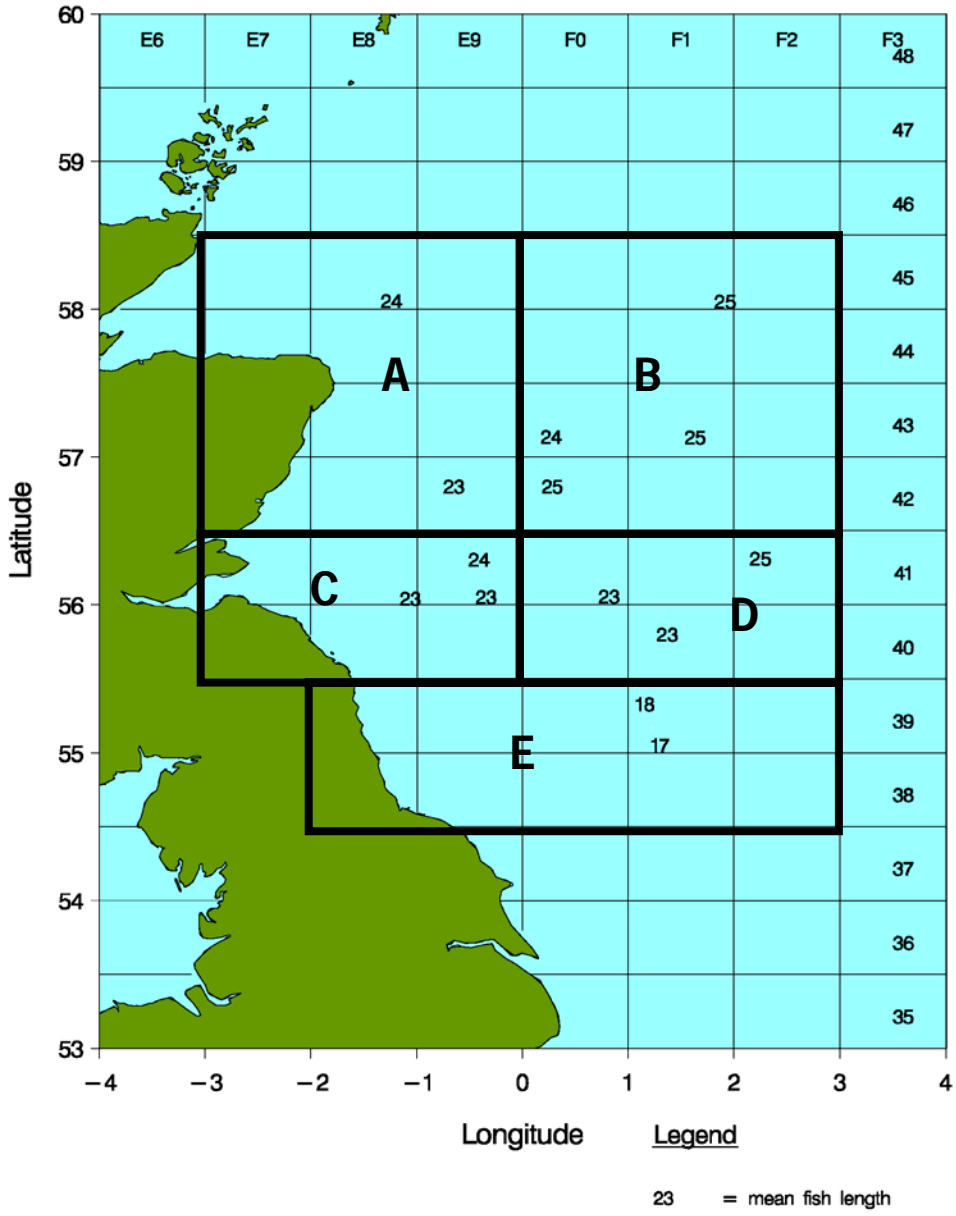

Figure 3. Post plot of herring mean length from FRV “Tridens”, observed during the July 2004 North Sea hydro acoustic survey for herring. Strata-areas A to E are indicated.

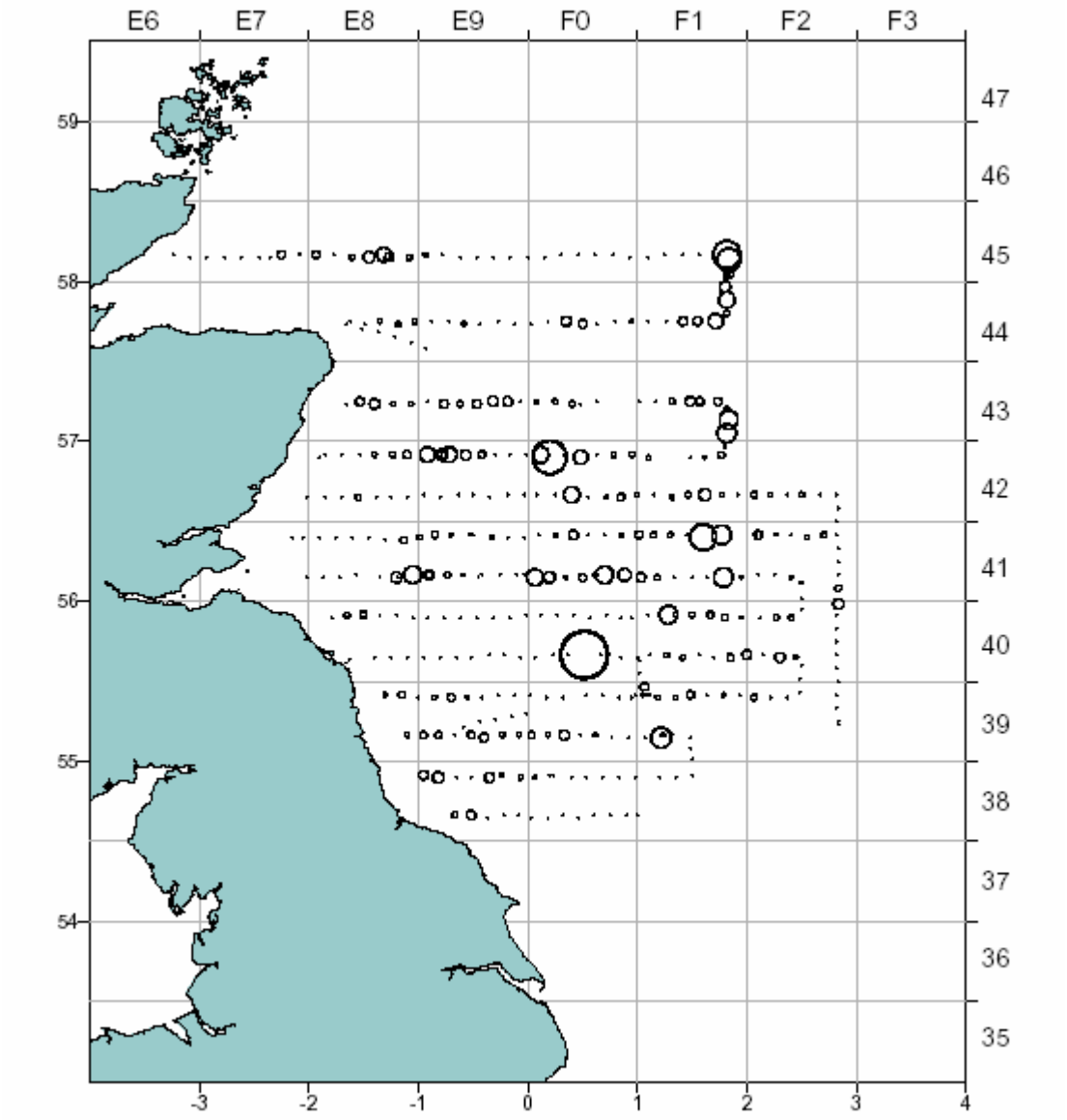

Figure 4. Post plot showing the distribution of total herring NASC values (on a proportional square root scale relative to the largest value of 4760,2) obtained during the July 2004 North Sea herring hydro acoustic survey on FRV "Tridens".

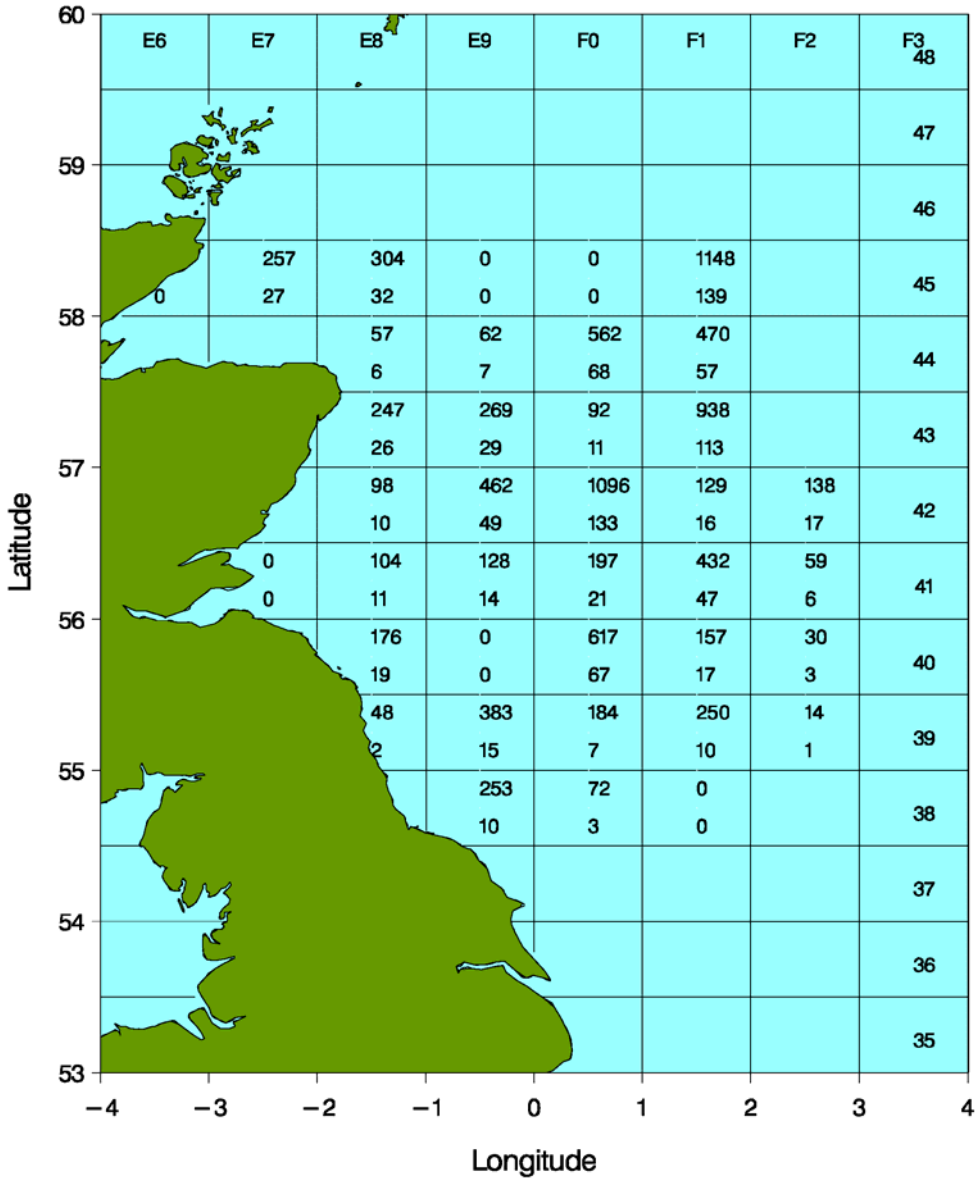

Figure 5. Estimated numbers of herring in millions (upper half square) and biomass in thousands of tonnes (lower half of square) by ICES rectangle. Results from the July 2004 North Sea hydro acoustic survey, FRV “Tridens”.