Survey report FRV “Tridens”
North Sea hydro acoustic herring survey

24 June – 19 July 2002

1. Introduction

The Netherlands Institute for Fisheries Research (RIVO) participates in the international North Sea hydro acoustic survey 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 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)
Ronald Bol
Kees Bakker (1st two weeks)
Arie Kraayenoord (2nd two weeks)
Kees Camphuysen (Birdwatcher)
Martin Poot (Birdwatcher; 1st two weeks)
Jaap van der Meer (Birdwatcher; 2nd two weeks)

2.2 Narrative

“Tridens” left the port of IJmuiden on Monday 24 June heading for the scheduled calibration site at Scapa Flow, Orkneys.
In the morning of 26 June “Tridens” anchored in Scapa Flow (exact position: 58°55.70 N - 003°01.98 W). Due two a strong northwestern wind it appeared not to be possible to calibrate the hull mounted and the towed body transducers. Since the forecast was not very promising, it was decided to run the survey on calibration settings of a calibration conducted on 3 June at Europort.
The survey started in the Moray Firth at 57°55 N. Soon after the start the net was shoot for schools at the bottom, which resulted in a severe damaged net and no catch. The rest of the day it was not possible to fish. Therefore it was decided to stop early to avoid missing a lot of fish recordings. Also some repairs had to be made on the CTD sonde and the heel and pitch cable. During the first week the 57°40 N transect was finished. The weekend of 29 and 30 June was spent in Aberdeen.
In the second week the 56°55 N transect was finished. ICES rectangle 42F2 was also covered on the transect of 56°40 N. The eastern most rectangles south of 56°30 N

were covered by running on transect in southern direction on the way to IJmuiden, where the weekend of 6/7 July was spent.
The survey was resumed on 8 July at the 56°40 N transect in western direction. Relative large concentrations of herring in the whole area and in particular southwest of the Devils Hole were encountered. In the Wee Bankie area transects were adjusted to collect additional data on Sandeel for the IMPRESS project. The weekend of 13/14 July was spent in Leith. Due to lack of time, during the last week, large parts of the scheduled transects south of 55°30 N were cancelled. On 18 July "Tridens" was homeward bound. Arrival on 19th of July in IJmuiden.

2.3 Survey design

The survey was carried out from 24 June to 19 July 2002, covering an area east of Scotland from latitude 54° to 58° North and from longitude 3° West (or the Scottish/English coast) to 3° East. A stratified survey design was applied, based on the herring distribution from previous years. Parallel transects along the lines of latitude were used with spacing between the lines set at 15 nm. From 55° southwards ICES rectangles were covered less extensively (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.
In the 2002 survey the transects at Wee Bankie were slightly altered to collect acoustic data for the another sampling program (IMPRESS).

2.4 Calibration

Due to the strong northwestern wind, the sphere was moving too much, which made positioning almost impossible. There was a lot of air in the first meters below the surface. Also many pieces of debris or weed were floating at the site. Since there was no expected improvement of the weather conditions that day, it was decided to use the calibration settings of the last calibration (3 June, Europort, Europahaven; see table 1). For that calibration, the program implemented in the EK60 was used.

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. Acoustic data were collected with a Simrad EK60 scientific echo sounder. The data were logged with the Simrad BI500 integrator software runned under Windows X, 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 proved the most suitable with depths (50 - 150 m) in most of the area.
The data were logged in 1 nm intervals. In total SA values from 2002 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 fish, 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 hunt schools that were swimming away from the track line. In haul 4, 8, and 9 four large floating buoys were attached to the upper rope 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 bottom 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. 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 53 CTD stations spread over the survey area (Figure 2). The CTD-data are used for other studies.

2.8 Data analysis

The SA values 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 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.
Due to technical problem and human errors, length frequency samples of sprat from haul 27 en 28 were not available. For the analysis, the length frequency distribution of haul 31 was used. Due to the same kind of problems, the sprat sample of haul 31 was not used: for this report sprat length stratified age and maturity samples from haul 3, 5, 19 en 27 have been analysed

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 31 trawl hauls have been conducted (figure 1). Herring was found in 23 hauls of which 21 samples were taken. Sprat was found in 9 hauls of which 5 samples were taken (see also 2.8 *Data analysis*). In 16 hauls herring was the most abundant species in weight. Sprat was in none of the hauls most abundant. In 6 hauls the meshes were stuck with small sandeel (5) or small a mixture of Norway pout and sandeel (1) indicating the these species would have been the most abundant species in the catch if the mesh size would have been smaller. The catch weights per haul and species are presented in table 2.
Table 3a-g shows the age/maturity length keys for herring (strata A-F) and sprat.

3.3 Biomass estimates

Table 4a and 4b summarize 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 488.000 tonnes and for sprat 15.000 tonnes. Figure 5 shows the estimated numbers and biomass of herring by ICES rectangle.

4. Discussion

The numbers in the area south of 58° N (and west of 3° E) are higher than in 2001 when it was highest in five years. The estimation of the stock biomass in the area surveyed is 237.000 ton. However, this figure also includes one-ringers. According to the maturity readings, about 30 % of the one ringers is mature. Normally this percentage is much lower and in the stock assessment, all 1 ringers are considered immature. If all 1 ringers are considered immature, the spawning biomass is approximately 130.000 ton of which almost 50% is from the strong 98 yearclass. The high number of 1 ringers in the abundance estimate of all ages indicates a strong yearclass 2000, which is in line with the ICES larvae and MIK net surveys. The area covered by FRV "Tridens" is mainly important for immatures and for recruits (three ringers) in the herring spawning stock. The 2001-2002 situation is comparable with the years 87-89 when recruits from the strong 84, 85 and 86 year classes showed up in the area south of 58° N.
Compared to the late 90's the adult herring was less often mixed with Norway pout. Especially in the 1999 survey, when the abundance of herring was extremely low in

the area south of 58° N, mixed aggregations of herring and Norway pout caused severe problems in the scrutinizing process. Like in 2000 and 2001, most herring was found in the area of the Devil's Holes. Compared to 2001 the herring concentrations were slightly more distributed in southerly direction.

Table 1. Simrad EK60 settings used on the June 2002 North Sea hydro acoustic survey for herring, FRV “Tridens”.

Transceiver menu	
Absorption coefficient	10.3 dB/km
Pulse length	1.024 ms
Bandwith	2.43 kHz
Max Power	2000 W
Two-way beam angle	-20.6 dB
3 dB Beamwidth	7.1 dg
Calibration details	
TS of sphere	-33.6 dB
Range to sphere in calibration	11.50 m
Transducer gain	25.63 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	1000
TS clour min.	-50 dB
Sv colour min.	-70 dB

Table 2a. Details of the trawl hauls taken during the July 2002 North Sea hydro acoustic survey, FRV “Tridens”.

haul no	date	latitude(N)	longitude	E/W	time UTC	Geartype	depth meters	trawl depth	duration min.	Used (biol. Samples)
1	26-jun	57.55	2.42	W	15:35	pel. trawl	60	bottom	55	no samples
2	27-jun	57.55	0.43	E	13:00	pel. trawl	130	bottom	45	her
3	28-jun	57.55	0.05	W	12:45	pel. trawl	180	bottom	45	her & sprat
4	28-jun	57.4	0.46	W	17:01	pel. trawl	97	surface	28	no samples
5	1-jul	57.24	1.32	W	6:15	pel. trawl	63	bottom	45	her & sprat
6	1-jul	57.25	0.01	E	16:46	pel. trawl	91	bottom	19	her
7	1-jul	57.25	0.59	E	19:54	pel. trawl	95	bottom	36	her
8	2-jul	57.25	1.38	E	9:28	pel. trawl	86	surface	22	no samples
9	2-jul	57.2	1.49	W	12:25	pel. trawl	73	surface	19	no samples
10	2-jul	57.1	0.03	W	14:15	pel. trawl	74	bottom	15	no samples
11	3-jul	56.55	1.47	E	8:05	pel. trawl	92	bottom	27	her
12	3-jul	56.56	0.08	E	11:45	pel. trawl	85	bottom	45	her
13	3-jul	56.55	2.05	E	17:46	pel. trawl	70	bottom	44	her
14	4-jul	56.25	2.51	E	6:25	pel. trawl	80	bottom	55	her
15	9-jul	56.26	2.48	E	7:00	pel. trawl	85	bottom	45	her
16	9-jul	55.16	2.51	E	9:18	pel. trawl	90	bottom	32	her
17	9-jul	56.4	1.24	E	11:55	pel. trawl	86	bottom	20	her
18	9-jul	56.4	0.59	W	18:03	pel. trawl	68	midwater	35	no samples
19	10-jul	56.25	0.05	W	6:23	pel. trawl	75	bottom	17	her & sprat
20	10-jul	56.25	0.31	W	11:55	pel. trawl	72	sandeel	40	no samples
21	11-jul	56.25	1.14	E	6:02	pel. trawl	85	bottom	10	her
22	11-jul	56.1	1.11	E	9:35	pel. trawl	82	bottom	10	her
23	11-jul	56.1	0.29	W	16:05	pel. trawl	83	bottom	25	no samples
24	15-jul	56.1	1.01	W	12:02	pel. trawl	35	bottom	13	no samples
25	15-jul	56.1	1.54	W	6:46	pel. trawl	73	midwater	44	her
26	16-jul	55.55	0.43	E	14:45	pel. trawl	77	bottom	35	her
27	16-jul	55.55	0.26	W	7:05	pel. trawl	67	midwater	40	her & sprat
28	17-jul	55.55	2.19	E	15:04	pel. trawl	90	bottom	86	her
29	17-jul	55.35	0.09	E	11:04	pel. trawl	64	bottom	30	her
30	17-jul	55.28	0.5	W	18:05	pel. trawl	88	bottom	13	her
31	18-jul	54.54	1.1	W	6:55	pel. trawl	65	bottom	20	sprat

Table 2b. Trawl catches during the July 2002 North Sea hydro acoustic survey, FRV "Tridens" in kg.

haul	herring	N. pout	other gadoids	mackerel	Sprat	others	comments
1	0	0	0	0	0	0	
2	2000	11,3	3,6	0,5	0	0	
3	5,3	0	5,5	0,3	2,7	0	
4	0	0	0,02	0,98	0	0	surface haul; sandeel
5	27,5	64,2	0	33	0,93	0	sandeel
6	1200	0	2,205	0	0	0	
7	86	0,15	0,75	2,4	0	0	
8	0	0	0	14,3	0,6	0	surface haul; sandeel
9	0	0	0,613	44,4	0	0	surface haul; some sandeel
10	0	25,95	0	4,7	4,3	0	sandeel
11	14	0	19,3	10,32	0	0	
12	15000	0	0	50	0	0	
13	798,7	0	1,4	40,2	0	0	
14	1252	0	0,514	0,3	0	0	
15	36,8	0	0,5	9,5	0	0	
16	38	0	5,53	0	0	0	
17	5000	0	0	0	0	0	
18	0	0	0	0	0	0	midwater
19	256,4	0	0,12	0	2,4	0	
20	0	0	0	6,6	0	0	sandeel
21	2000	0	0,595	11,5	0	0	
22	315	0	0,62	0	0	0	
23	0	0	20,53	0,31	0	0	
24	0,016	0	0,01	0	0	0	sandeel
25	11,16	0	338,28	18	0,02	0	midwater
26	885	0	0	0	0	0	
27	2,9	0	13,48	8,48	0,067	0	midwater
28	1829	0	186	0	187,82	0	
29	30,6	0	0	0	0	0	
30	714,3	0	397,1	0	0	0	
31	0,065	0	97,6	0	0,995	0	

Table 3a. Age/maturity-length key for herring - Stratum A.
Tridens, North Sea acoustic survey 2002

Length	0		1		2		3		4	5	6	7	8	9+	Grand
(cm)	imm	mat	imm	mat	imm	mat	imm	mat	Total	Total	Total	Total	Total	Total	Total
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14,5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15,5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
16	0	0	6	0	0	0	0	0	0	0	0	0	0	0	6
16,5	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
17	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
17,5	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
18	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
18,5	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
19	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
19,5	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
20	0	0	8	1	0	0	0	0	0	0	0	0	0	0	9
20,5	0	0	5	2	0	0	0	0	0	0	0	0	0	0	7
21	0	0	4	1	0	0	0	0	0	0	0	0	0	0	5
21,5	0	0	3	1	1	1	0	0	0	0	0	0	0	0	6
22	0	0	0	5	0	1	0	0	0	0	0	0	0	0	6
22,5	0	0	0	2	0	4	0	0	0	0	0	0	0	0	6
23	0	0	0	1	0	4	0	0	0	0	0	0	0	0	5
23,5	0	0	0	0	0	5	0	0	0	0	0	0	0	0	5
24	0	0	0	0	0	5	0	0	0	0	0	0	0	0	5
24,5	0	0	0	0	0	4	0	0	0	0	0	0	0	0	4
25	0	0	0	0	0	2	0	2	1	0	0	0	0	0	5
25,5	0	0	0	0	0	3	0	1	1	0	0	0	0	0	5
26	0	0	0	0	0	2	0	0	1	0	0	0	0	0	3
26,5	0	0	0	0	0	3	0	1	0	0	0	0	0	0	4
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28,5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29,5	0	0	0	0	0	0	0	0	1	0	0	0	1	0	2
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	98	13	1	35	0	4	4	0	0	0	1	0	156

Table 3b. Age/maturity-length key for herring - Stratum B.
Tridens, North Sea acoustic survey 2002

Length	0		1		2		3		4	5	6	7	8	9+	Grand
(cm)	imm	mat	imm	mat	imm	mat	imm	mat	Total	Total	Total	Total	Total	Total	Total
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
19,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
20,5	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3
21	0	0	10	2	0	1	0	0	0	0	0	0	0	0	13
21,5	0	0	4	7	0	0	0	0	0	0	0	0	0	0	11
22	0	0	1	7	0	2	0	0	0	0	0	0	0	0	10
22,5	0	0	0	6	0	5	0	0	0	0	0	0	0	0	11
23	0	0	0	2	0	6	0	3	0	0	0	0	0	0	11
23,5	0	0	0	0	0	10	0	4	1	0	0	0	0	0	15
24	0	0	0	0	0	4	0	10	1	0	0	0	0	0	15
24,5	0	0	0	0	0	6	0	9	0	0	0	0	0	0	15
25	0	0	0	0	0	4	0	11	0	0	0	0	0	0	15
25,5	0	0	0	0	0	5	0	8	2	0	0	0	0	0	15
26	0	0	0	0	0	1	0	12	1	1	0	0	0	0	15
26,5	0	0	0	0	0	3	0	7	3	1	0	1	0	0	15
27	0	0	0	0	0	0	0	10	3	2	0	0	0	0	15
27,5	0	0	0	0	0	1	0	9	2	2	0	0	0	0	14
28	0	0	0	0	0	0	0	4	3	1	1	0	0	0	9
28,5	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3
29	0	0	0	0	0	0	0	0	1	0	1	1	0	0	3
29,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	20	24	0	48	0	87	20	7	2	2	0	0	210

Table 3c. Age/maturity-length key for herring - Stratum C.
Tridens, North Sea acoustic survey 2002

Length	0		1		2		3		4	5	6	7	8	9+	Grand
(cm)	imm	mat	imm	mat	imm	mat	imm	mat	Total	Total	Total	Total	Total	Total	Total
7	5	0	0	0	0	0	0	0	0	0	0	0	0	0	5
7,5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	5
8	5	0	0	0	0	0	0	0	0	0	0	0	0	0	5
8,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	15	0	0	0	0	0	0	0	0	0	0	0	0	0	15

Table 3d. Age/maturity-length key for herring - Stratum D.
Tridens, North Sea acoustic survey 2002

Length	0		1		2		3		4	5	6	7	8	9+	Grand
(cm)	imm	mat	imm	mat	imm	mat	imm	mat	Total	Total	Total	Total	Total	Total	Total
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
15,5	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
16	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10
16,5	0	0	12	0	0	0	0	0	0	0	0	0	0	0	12
17	0	0	20	0	0	0	0	0	0	0	0	0	0	0	20
17,5	0	0	22	0	0	0	0	0	0	0	0	0	0	0	22
18	0	0	26	0	0	0	0	0	0	0	0	0	0	0	26
18,5	0	0	19	2	0	0	0	0	0	0	0	0	0	0	21
19	0	0	24	0	0	0	0	0	0	0	0	0	0	0	24
19,5	0	0	27	2	0	0	0	0	0	0	0	0	0	0	29
20	0	0	25	4	1	0	0	0	0	0	0	0	0	0	30
20,5	0	0	12	19	0	0	0	0	0	0	0	0	0	0	31
21	0	0	7	23	0	1	0	0	0	0	0	0	0	0	31
21,5	0	0	9	17	2	5	0	0	0	0	0	0	0	0	33
22	0	0	1	26	0	6	0	1	0	0	0	0	0	0	34
22,5	0	0	0	19	2	7	0	0	0	0	0	0	0	0	28
23	0	0	0	4	0	17	0	3	0	0	0	0	0	0	24
23,5	0	0	0	0	0	16	0	5	0	0	0	0	0	0	21
24	0	0	0	0	0	13	0	8	0	0	0	0	0	0	21
24,5	0	0	0	0	0	3	0	14	0	0	0	0	0	0	17
25	0	0	0	0	0	8	0	13	0	0	0	0	0	0	21
25,5	0	0	0	0	0	5	0	14	2	0	0	0	0	0	21
26	0	0	0	0	0	4	0	14	2	0	0	0	0	0	20
26,5	0	0	0	0	0	1	0	7	4	1	0	0	0	0	13
27	0	0	0	0	0	1	0	7	4	0	0	0	0	0	12
27,5	0	0	0	0	0	0	0	5	1	2	2	0	0	0	10
28	0	0	0	0	0	0	0	0	1	4	0	1	0	0	6
28,5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	218	116	5	87	0	91	14	7	3	1	0	0	542

Table 3e. Age/maturity-length key for herring - Stratum E.
Tridens, North Sea acoustic survey 2002

Length	0		1		2		3		4	5	6	7	8	9+	Grand
(cm)	imm	mat	imm	mat	imm	mat	imm	mat	Total	Total	Total	Total	Total	Total	Total
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
17,5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
18	0	0	4	0	0	0	0	0	0	0	0	0	0	0	4
18,5	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
19	0	0	5	0	0	0	0	0	0	0	0	0	0	0	5
19,5	0	0	4	1	0	0	0	0	0	0	0	0	0	0	5
20	0	0	0	5	0	0	0	0	0	0	0	0	0	0	5
20,5	0	0	0	5	0	0	0	0	0	0	0	0	0	0	5
21	0	0	0	5	0	0	0	0	0	0	0	0	0	0	5
21,5	0	0	0	5	0	0	0	0	0	0	0	0	0	0	5
22	0	0	0	5	0	0	0	0	0	0	0	0	0	0	5
22,5	0	0	0	5	0	0	0	0	0	0	0	0	0	0	5
23	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
23,5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
24	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
24,5	0	0	0	0	0	1	0	2	0	0	0	0	0	0	3
25	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
25,5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26,5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27,5	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	17	33	0	1	0	7	0	1	0	0	0	0	59

Table 3f. Age/maturity-length key for herring - Stratum F.
Tridens, North Sea acoustic survey 2002

Length	0		1		2		3		4	5	6	7	8	9+	Grand
(cm)	imm	mat	imm	mat	imm	mat	imm	mat	Total	Total	Total	Total	Total	Total	Total
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
15,5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
16	0	0	19	0	0	0	0	0	0	0	0	0	0	0	19
16,5	0	0	24	0	0	0	0	0	0	0	0	0	0	0	24
17	0	0	24	0	0	0	0	0	0	0	0	0	0	0	24
17,5	0	0	29	0	0	0	0	0	0	0	0	0	0	0	29
18	0	0	32	0	0	0	0	0	0	0	0	0	0	0	32
18,5	0	0	34	0	0	0	0	0	0	0	0	0	0	0	34
19	0	0	35	0	1	0	0	0	0	0	0	0	0	0	36
19,5	0	0	31	4	0	0	0	0	0	0	0	0	0	0	35
20	0	0	30	6	0	0	0	0	0	0	0	0	0	0	36
20,5	0	0	21	14	0	0	0	0	0	0	0	0	0	0	35
21	0	0	12	14	1	1	0	0	0	0	0	0	0	0	28
21,5	0	0	8	17	0	0	0	0	0	0	0	0	0	0	25
22	0	0	2	12	0	6	0	0	0	0	0	0	0	0	20
22,5	0	0	0	9	0	4	0	1	0	0	0	0	0	0	14
23	0	0	0	1	0	8	0	1	0	0	0	0	0	0	10
23,5	0	0	0	0	0	2	0	1	0	0	0	0	0	0	3
24	0	0	0	0	0	3	0	2	0	0	0	0	0	0	5
24,5	0	0	0	0	0	1	0	6	1	0	0	0	0	0	8
25	0	0	0	0	0	0	0	3	2	1	1	0	0	0	7
25,5	0	0	0	0	0	0	0	2	1	2	0	0	0	0	5
26	0	0	0	0	0	0	0	6	1	1	2	0	0	0	10
26,5	0	0	0	0	0	0	0	0	1	3	2	0	0	0	6
27	0	0	0	0	0	0	0	1	0	0	2	0	0	0	3
27,5	0	0	0	0	0	0	0	0	0	0	1	1	0	1	3
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28,5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	304	77	2	25	0	23	6	7	9	1	0	1	455

Table 3g. Age/maturity-length key for sprat - Total area.
Tridens, North Sea acoustic survey 2002

Length	1		2		3		4		5	Grand
(cm)	imm	mat	imm	mat	imm	mat	imm	mat	Total	Total
7	2	0	0	0	0	0	0	0	0	2
7,5	1	0	0	0	0	0	0	0	0	1
8	3	1	7	0	0	0	0	0	0	11
8,5	2	6	10	0	0	0	0	0	0	18
9	0	5	3	10	0	0	0	0	0	18
9,5	0	5	0	13	0	0	0	0	0	18
10	0	2	0	15	0	0	0	0	0	17
10,5	0	0	0	15	0	1	0	0	0	16
11	0	0	0	10	0	2	0	0	0	12
11,5	0	0	0	1	0	3	0	0	0	4
12	0	0	0	1	0	4	0	0	0	5
12,5	0	0	0	0	0	4	0	1	0	5
13	0	0	0	0	0	2	0	3	0	5
13,5	0	0	0	0	0	1	0	4	0	5
14	0	0	0	0	0	3	0	2	0	5
Grand Total	8	19	20	65	0	20	0	11	1	144

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 2001 North Sea hydro acoustic survey for herring, FRV "Tridens".

Stratum A							
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2001im			0	0,0	0,000	0,0
0M	2001ad			0	0,0	0,000	0,0
1I	2000im	18,2	46,6	49	83,9	2,264	69,9
1M	2000ad	21,7	82,4	4	6,6	0,316	9,8
2I	1999im	21,5	82,0	0	0,7	0,032	1,0
2M	1999ad	23,7	116,5	4	7,8	0,524	16,2
3I	1998im			0	0,0	0,000	0,0
3M	1998ad	25,5	149,5	0	0,5	0,040	1,2
4A	1997	26,5	166,3	0	0,5	0,045	1,4
5A	1996			0	0,0	0,000	0,0
6A	1995			0	0,0	0,000	0,0
7A	1994			0	0,0	0,000	0,0
8A	1993	29,5	248,0	0	0,1	0,017	0,5
9+	<1993			0	0,0	0,000	0,0
Mean		23,8	127,3				
Total				58	100,0	3,238	100,0
Immature				49	84,6	2,297	70,9
Mature				9	15,4	0,941	29,1

Stratum B							
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2001im			0	0,0	0,000	0,0
0M	2001ad			0	0,0	0,000	0,0
1I	2000im	21,1	72,8	17	5,3	1,240	3,0
1M	2000ad	21,9	81,2	28	8,7	2,288	5,5
2I	1999im			0	0,0	0,000	0,0
2M	1999ad	24,5	124,6	76	23,6	9,496	22,7
3I	1998im			0	0,0	0,000	0,0
3M	1998ad	25,5	139,5	162	50,4	22,650	54,3
4A	1997	26,4	152,7	26	8,1	3,970	9,5
5A	1996	26,8	162,6	9	2,8	1,462	3,5
6A	1995	28,4	199,8	1	0,3	0,203	0,5
7A	1994	26,9	169,3	3	0,8	0,437	1,0
8A	1993			0	0,0	0,000	0,0
9+	<1993			0	0,0	0,000	0,0
Mean		25,2	137,8				
Total				322	100,0	41,745	100,0
Immature				17	5,3	1,240	3,0
Mature				305	94,7	40,505	97,0

Stratum C							
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2001im						
0M	2001ad						
1I	2000im						
1M	2000ad						
2I	1999im						
2M	1999ad						
3I	1998im						
3M	1998ad						
4A	1997						
5A	1996						
6A	1995						
7A	1994						
8A	1993						
9+	<1993						
Mean							
Total							
Immature							
Mature							

Stratum D							
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2001im			0	0,0	0,000	0,0
0M	2001ad			0	0,0	0,000	0,0
1I	2000im	18,8	51,2	725	45,7	37,108	29,3
1M	2000ad	21,3	76,8	378	23,8	28,992	22,9
2I	1999im	21,6	81,3	16	1,0	1,282	1,0
2M	1999ad	23,6	108,0	196	12,4	21,208	16,7
3I	1998im			0	0,0	0,000	0,0
3M	1998ad	25,3	135,4	226	14,3	30,661	24,2
4A	1997	26,5	154,4	32	2,0	4,878	3,8
5A	1996	27,4	179,1	10	0,6	1,810	1,4
6A	1995	27,7	175,9	4	0,3	0,715	0,6
7A	1994	28,0	165,0	1	0,1	0,167	0,1
8A	1993			0	0,0	0,000	0,0
9+	<1993			0	0,0	0,000	0,0
Mean		24,5	125,2				
Total				1588	100,0	126,823	100,0
Immature				741	46,7	38,390	30,3
Mature				847	53,3	88,433	69,7

Table 4. (continued)

Stratum E							
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2001im			0	0,0	0,000	0,0
0M	2001ad			0	0,0	0,000	0,0
1I	2000im	18,9	51,9	49	17,2	2,548	11,5
1M	2000ad	21,1	78,9	218	76,8	17,230	77,8
2I	1999im			0	0,0	0,000	0,0
2M	1999ad	24,5	112,0	2	0,6	0,191	0,9
3I	1998im			0	0,0	0,000	0,0
3M	1998ad	24,9	127,1	12	4,2	1,517	6,9
4A	1997			0	0,0	0,000	0,0
5A	1996	27,5	190,0	3	1,2	0,648	2,9
6A	1995			0	0,0	0,000	0,0
7A	1994			0	0,0	0,000	0,0
8A	1993			0	0,0	0,000	0,0
9+	<1993			0	0,0	0,000	0,0
Mean		23,4	112,0				
Total				285	100,0	22,133	100,0
Immature				49	17,2	2,548	11,5
Mature				236	82,8	19,585	88,5

Stratum F							
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2001im			0	0,0	0,000	0,0
0M	2001ad			0	0,0	0,000	0,0
1I	2000im	18,8	52,8	3729	78,4	196,981	69,0
1M	2000ad	20,9	75,4	766	16,1	57,748	20,2
2I	1999im	19,8	58,8	24	0,5	1,403	0,5
2M	1999ad	22,5	97,1	100	2,1	9,755	3,4
3I	1998im			0	0,0	0,000	0,0
3M	1998ad	24,8	126,1	68	1,4	8,520	3,0
4A	1997	25,4	147,3	19	0,4	2,836	1,0
5A	1996	26,0	156,1	23	0,5	3,620	1,3
6A	1995	26,5	167,9	25	0,5	4,198	1,5
7A	1994	27,5	195,0	2	0,0	0,319	0,1
8A	1993			0	0,0	0,000	0,0
9+	<1993	27,5	151,0	2	0,0	0,247	0,1
Mean		24,0	122,8				
Total				4757	100,0	285,626	100,0
Immature				3753	78,9	198,384	69,5
Mature				1004	21,1	87,242	30,5

Table 5a. Herring. Mean length, mean weight, biomass (thousends of tonnes) and numbers (millions) breakdown by age and maturity obtained during the July 2002 North Sea hydro acoustic survey for herring, FRV “Tridens”.

Total area (all strata summarized)					
Age	Year	Number (millions)	%	Biomass (1000 tons)	%
0I	2001im	3447	33,0	8,174	1,7
0M	2001ad	0	0,0	0,000	0,0
1I	2000im	4569	43,7	240,141	49,2
1M	2000ad	1394	13,3	106,573	21,9
2I	1999im	40	0,4	2,717	0,6
2M	1999ad	379	3,6	41,174	8,4
3I	1998im	0	0,0	0,000	0,0
3M	1998ad	469	4,5	63,388	13,0
4A	1997	77	0,7	11,729	2,4
5A	1996	46	0,4	7,539	1,5
6A	1995	30	0,3	5,117	1,0
7A	1994	5	0,0	0,923	0,2
8A	1993	0	0,0	0,017	0,0
9+	<1993	2	0,0	0,247	0,1
Total		10457	100,0	487,739	100,0
Immature		8056	77,0	251,033	51,5
Mature		2401	23,0	236,706	48,5

Table 5b. Sprat. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) breakdown by age and maturity obtained during the July 2002 North Sea hydro acoustic survey for herring, FRV “Tridens”.

Total area (all strata summarized)				
Age	Number (millions)	%	Biomass (1000 tons)	%
1I	80	3,6	0,264	1,7
1M	423	19,1	2,208	14,4
2I	363	16,4	1,623	10,6
2M	1113	50,3	7,562	49,3
3I	0	0,0	0,000	0,0
3M	139	6,3	1,918	12,5
4I	0	0,0	0,000	0,0
4M	90	4,1	1,713	11,2
5A	3	0,1	0,064	0,4
Total	2210	100,0	15,353	100,0
Immature	443	20,0	1,887	12,3
Mature	1767	80,0	13,465	87,7

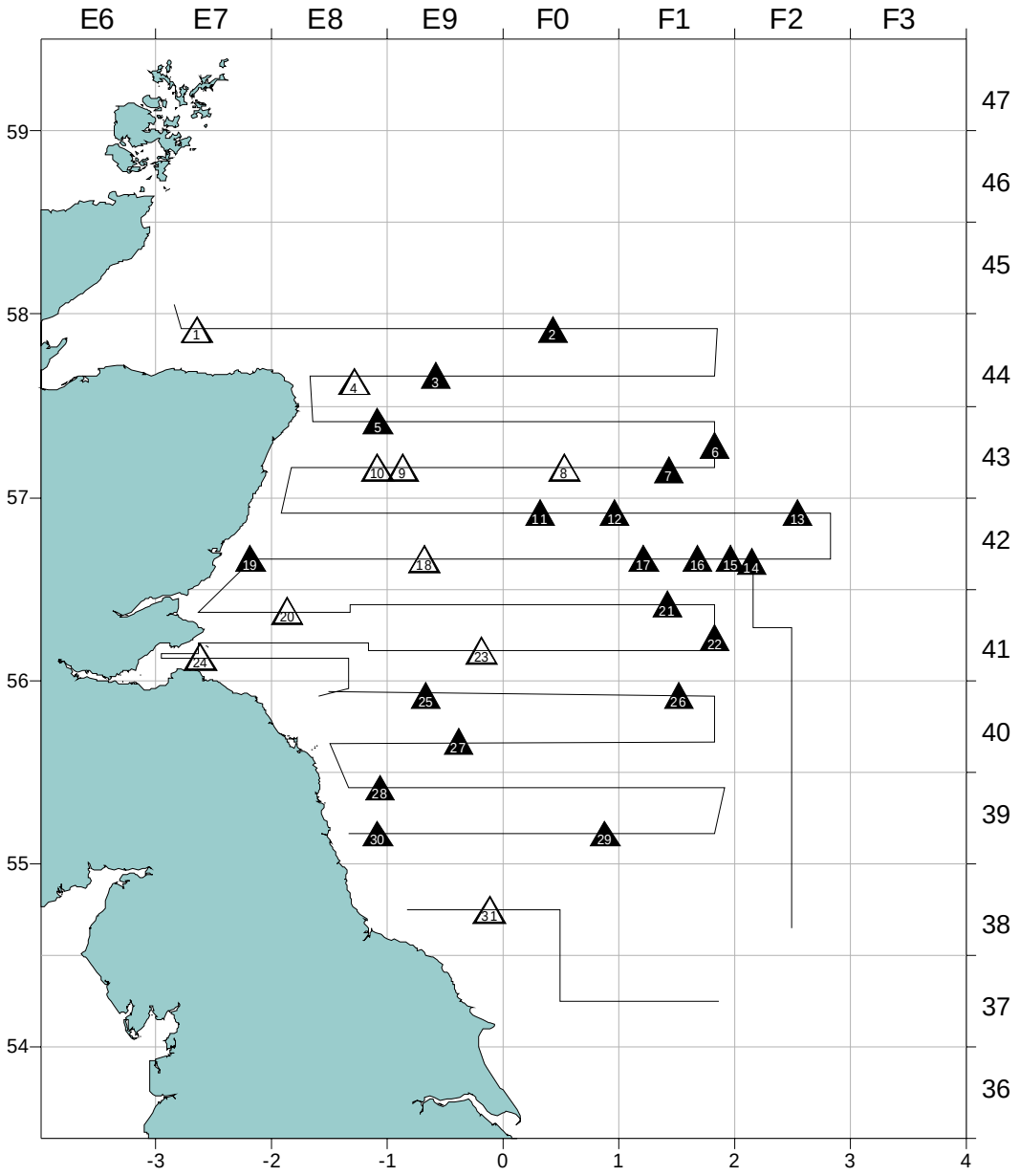

Figure 1. Map of east of Scotland showing cruise track and positions of fishing trawls undertaken during the July 2002 North Sea hydro acoustic survey for herring by RV Tridens. Filled triangles indicate pelagic trawls in which herring were caught. Open triangles indicate trawls with no herring. Sprat was caught in haul 3, 5, 8, 19, 27, 28 and 31.

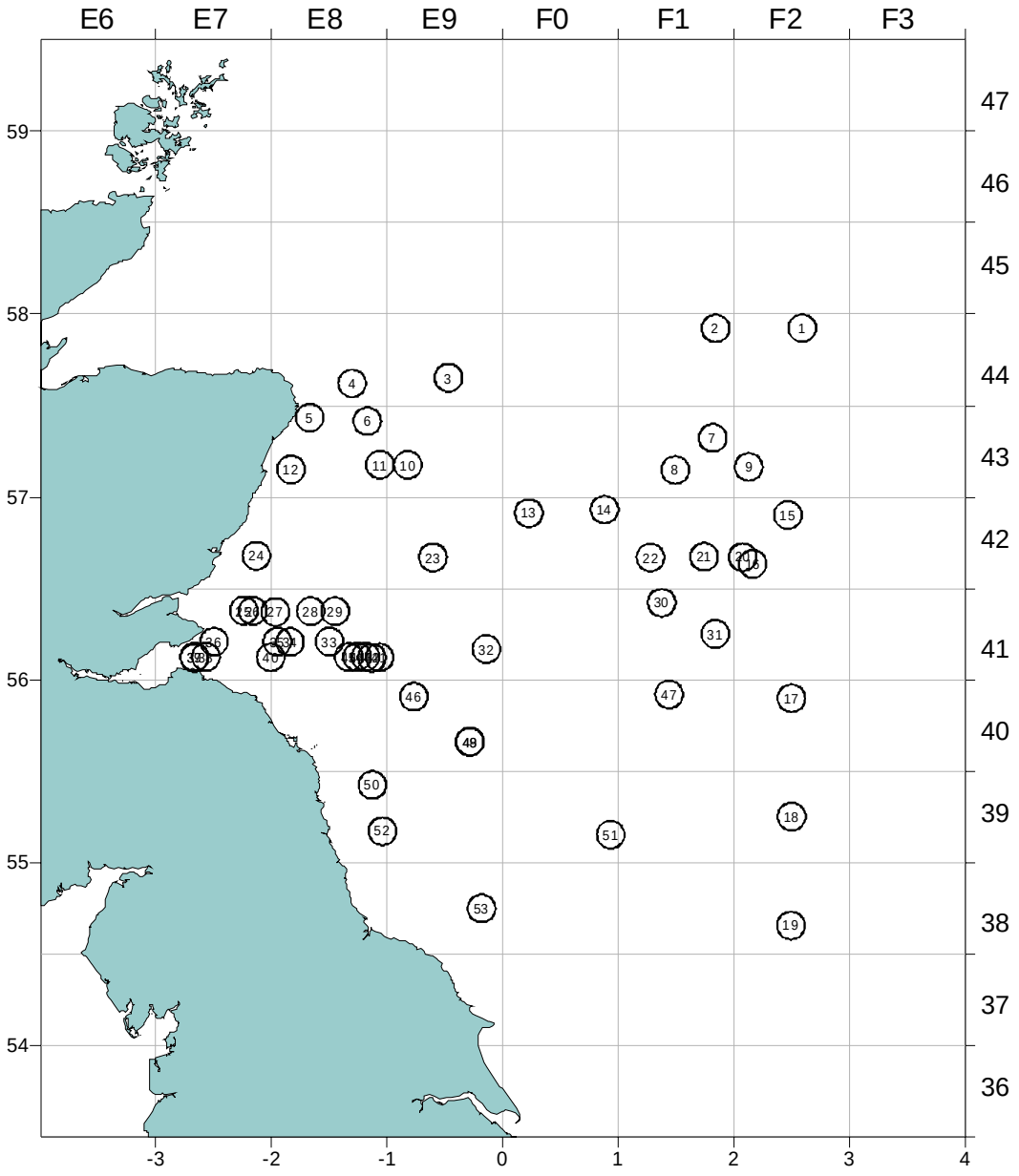

Figure 2. Positions of CTD stations undertaken during the July 2002 North Sea hydro acoustic survey for herring by FRV “Tridens”.

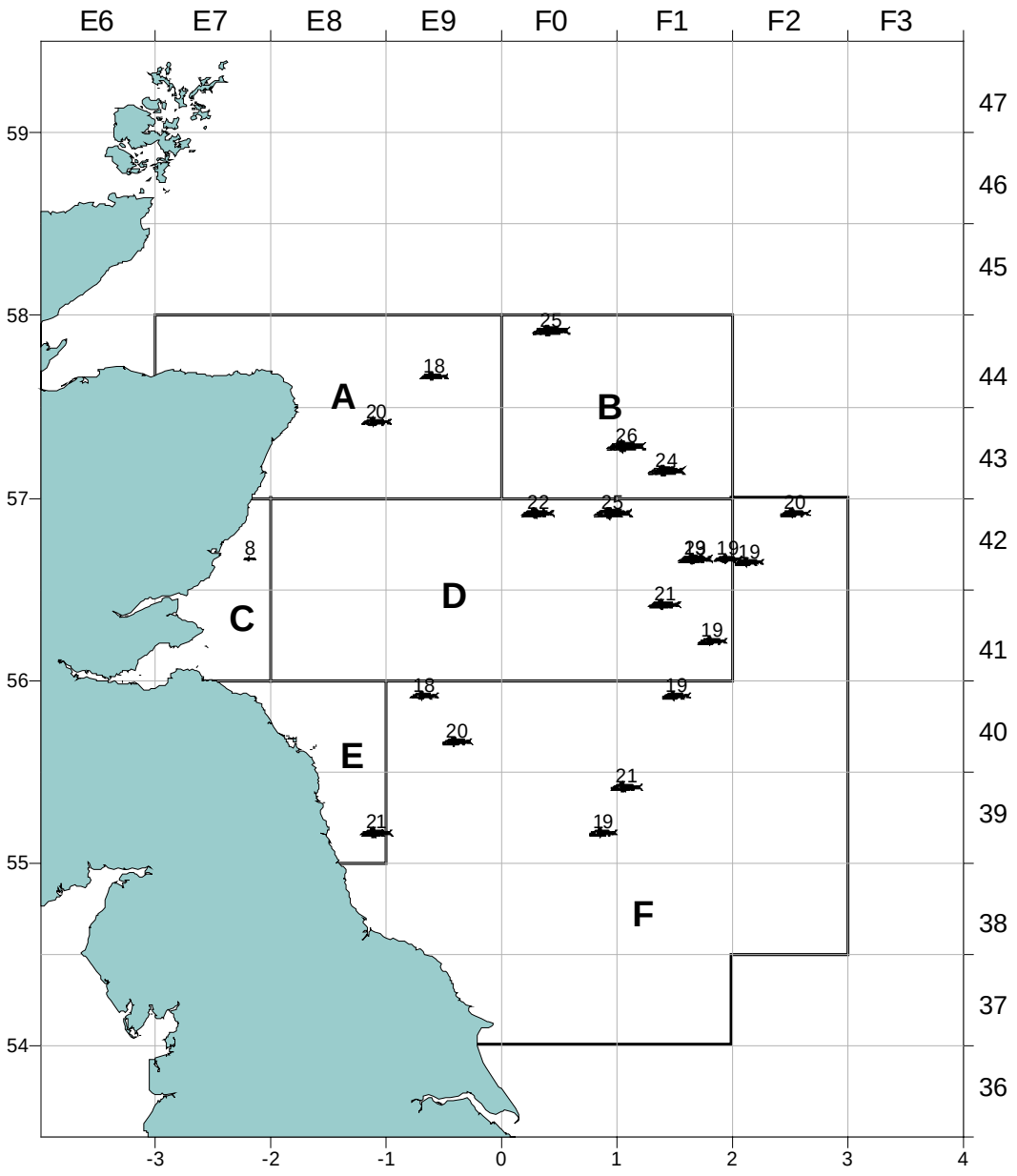

Figure 3. Post plot of herring mean length from FRV “Tridens”, observed during the July 2002 North Sea hydro acoustic survey for herring. Symbol size is proportional to the mean length from trawl hauls used to qualify the acoustic data. The number above the symbols indicates the mean length in cm. Strata-areas A to F are indicated.

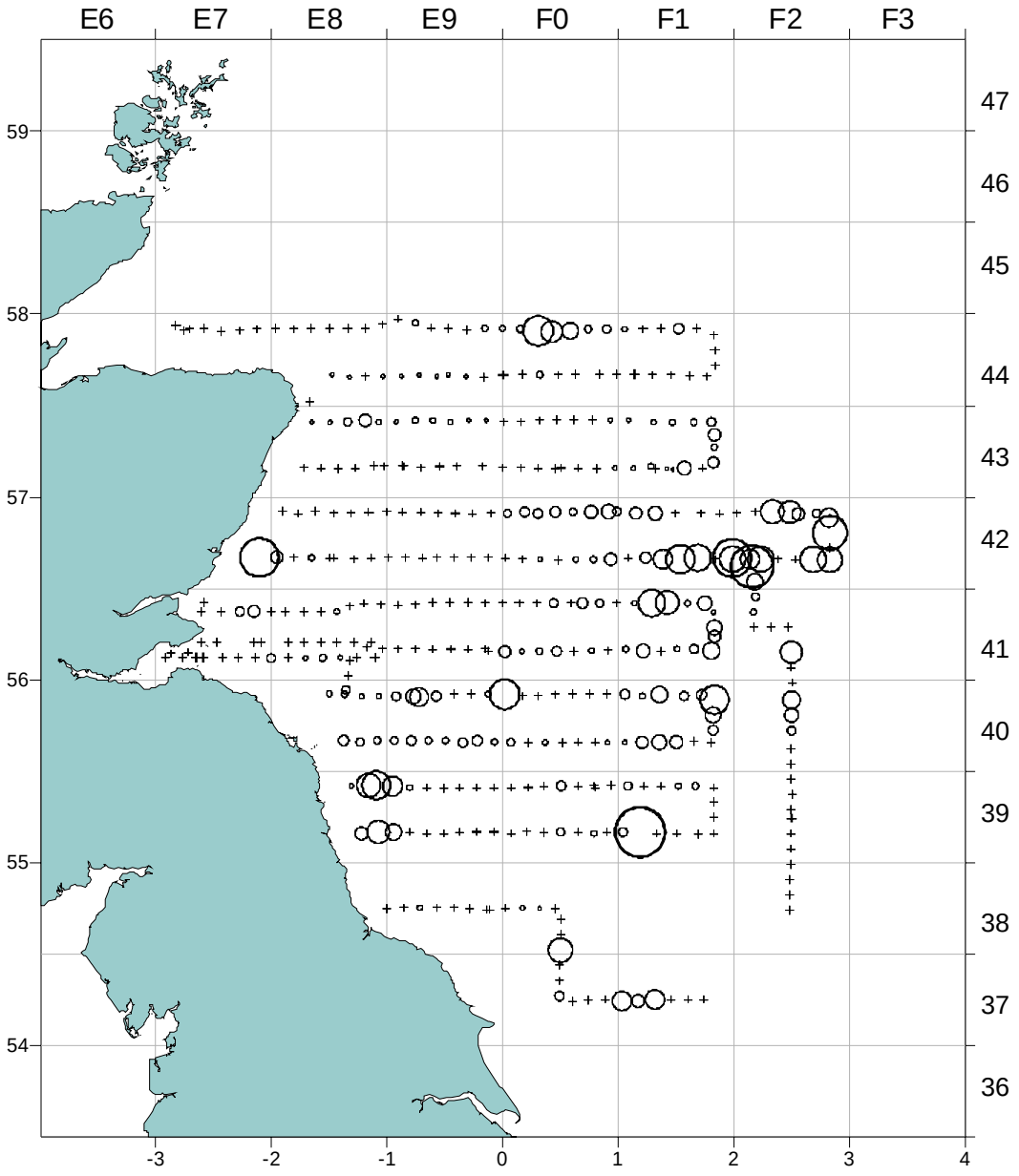

Figure 4. Post plot showing the distribution of total herring NASC values (on a proportional square root scale relative to the largest value of 3601,4) obtained during the July 2002 North Sea herring hydro acoustic survey on FRV “Tridens”. Crosses indicate zero values.

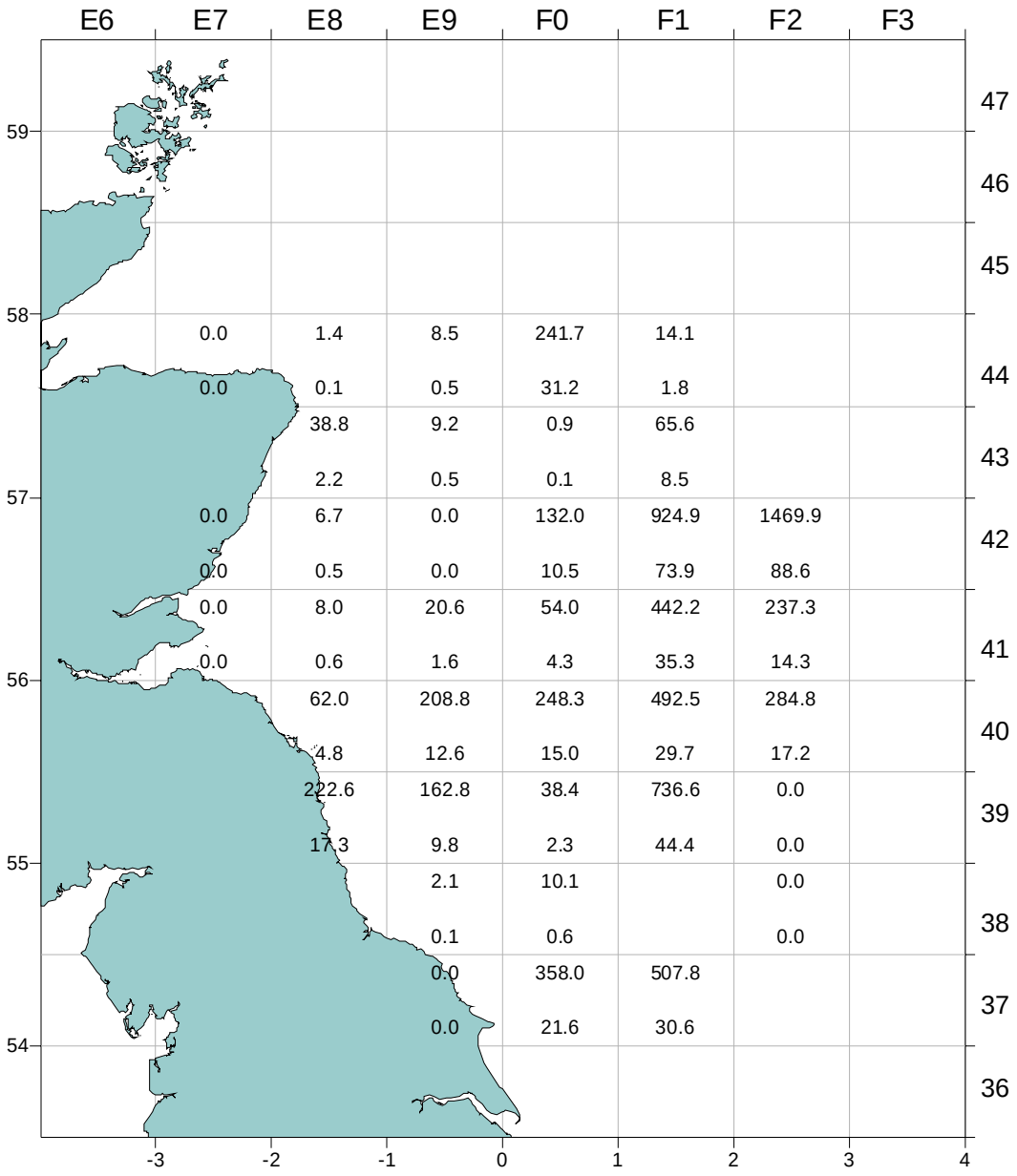

Figure 5. Map showing estimated numbers of herring in millions (upper half square) and biomass in thousands of tonnes (lower half of square) by ICES rectangle. Results from the July 2002 North Sea hydro acoustic survey, FRV “Tridens”.