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ICES COORDINATED ACOUSTIC SURVEY OF ICES DIVISIONS IIIa, IVa, IVb AND Via (NORTH) 2003 Results

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ABSTRACT

Six surveys were carried out during late June and July covering most of the continental shelf north of 52°N in the North Sea and to the west of Scotland to a northern limit of 62°N. The eastern edge of the survey area was bounded by the Norwegian and Danish, Swedish and German coasts, and to the west by the shelf edge between 200 and 400 m depth. The surveys are reported individually in the report of the planning group for herring surveys, and a combined report has been prepared from the data from all surveys. The combined survey results provide spatial distributions of herring abundance by number and biomass at age by statistical rectangle; and distributions of mean weight and fraction mature at age. The estimates of North Sea autumn spawning herring are consistent with previous years at 3.1 million tonnes and 18,400 million herring. The survey also shows two exceptional year classes of herring (the 1998 and 2000 year classes) in the North Sea, which is consistent with the observation of exceptionally large year classes observed in the MIK and IBTS surveys. The estimates of Western Baltic spring spawning herring SSB are 106,000 tonnes and 823,000 herring and show a substantial decrease compared with the previous year. The Western Baltic survey produces a rather noisy signal but the indications are of a stock that is slightly higher than during the period 1996 to 2000. The West of Scotland survey estimates of 739,000 tonnes and 4,000 million herring and shows the high 1995 year class again this year. The 1998 year class now (4 ring) is now confirmed also a large one. Indications are that the 2000 yearclass is also good. Total adult mortality shows low mortality again (0.1) but the mean mortality over the last 4 years has been around 0.3: this is consistent with the 2003 assessment that the stock is lightly exploited.

INTRODUCTION

Six surveys were carried out during late June and July covering most of the continental shelf north of 52°N in the North Sea and to the west of Scotland to a northern limit of 62°N. The eastern edge of the survey area was bounded by the Norwegian and Danish, Swedish and German coasts, and to the west by the shelf edge between 200 and 400 m depth. The surveys are reported individually in appendices IIa-f of the report of the planning group for herring

surveys (ICES, 2003). The vessels, areas and dates of cruises are given below and in Figure 1:

Vessel	Period	Area
FV Enterprise	01 July – 21 July	56°- 60°N, 3° - 7° W
R.V Sarsen	1 – 22 July	56°30'- 61° N, 2° - 6° E
Scotia	27 June – 20 July	58°- 62° N, 4° W - 2° E
Tridens	23 June – 18 July	54°30 – 58° N, west of 3° E
Walther Herwig III	26 June – 13 July	52° - 57° N, east England / 3° E
Dana	27 June – 8 July	North of 57°NS & 56° N, Kattegat east of 6° E

The data have been combined to provide an overall estimate. Estimates of numbers at age, maturity stage and mean weights at age are calculated as weighted means of individual survey estimates by ICES statistical rectangle. The weighting applied is proportional to the length of survey track for each vessel that has covered each statistical rectangle. The data have been combined and estimates of North Sea autumn spawning herring, Western Baltic spring spawning herring, and West of Scotland (VIa_{north}) herring are shown in Tables 1-3.

METHODS

The acoustic surveys were carried out using Simrad EK60, EK500 and EY500 38 kHz sounder echo-integrator with transducers mounted on the hull, drop keel and towed bodies. Further data analysis was carried out using either BI500, Echoview or Echoann software. The survey track was selected to cover the area giving a basic sampling intensity over the whole area based on the limits of herring densities found in previous years. A transect spacing of 15 nautical miles was used in most parts of the area with the exception of some relatively high density sections, east and west of Shetland, and in the Skagerrak where short additional transects were carried out at 7.5 nmi spacing.

The following target strength to fish length relationships have been used to analyse the data:

herring	TS = 20 log L - 71.2 dB
sprat	TS = 20 log L -71.2 dB
gadoids	TS = 20 log L - 67.5 dB
mackerel	TS = 21.7 log L - 84.9 dB

Combined Acoustic Survey Results for 2003

The estimates of North Sea autumn spawning herring SSB are 3.1 million tonnes and 17,300 millions herring (Table 1). The North Sea survey is consistent with previous years, giving a total adult mortality of about 0.45 over the last 3 years, which is similar to the estimates from the assessment. The SSB rose from 2.4 million tonnes in 2001 (Table 4) to 2.9 million tonnes in 2002 and again to 3.1 million tonnes in 2003. The survey shows again two exceptional year classes of herring (the 1998 and 2000 year classes) in the North Sea, which is consistent with the observation of exceptionally large year classes observed in the MIK and IBTS surveys (ICES 2001a). The 2003 estimate of the 2000 yearclass suggests it is higher than the 1998 yearclass at 1.5 times at age 2wr. Growth of the 2000 yearclass seems to be slower than previously at 1.5 cm smaller, and 20g lighter than the 1998 yearclass at the same age. In addition only 43% are mature compared to 77% and 86% for 1998 and 1999 yearclasses.

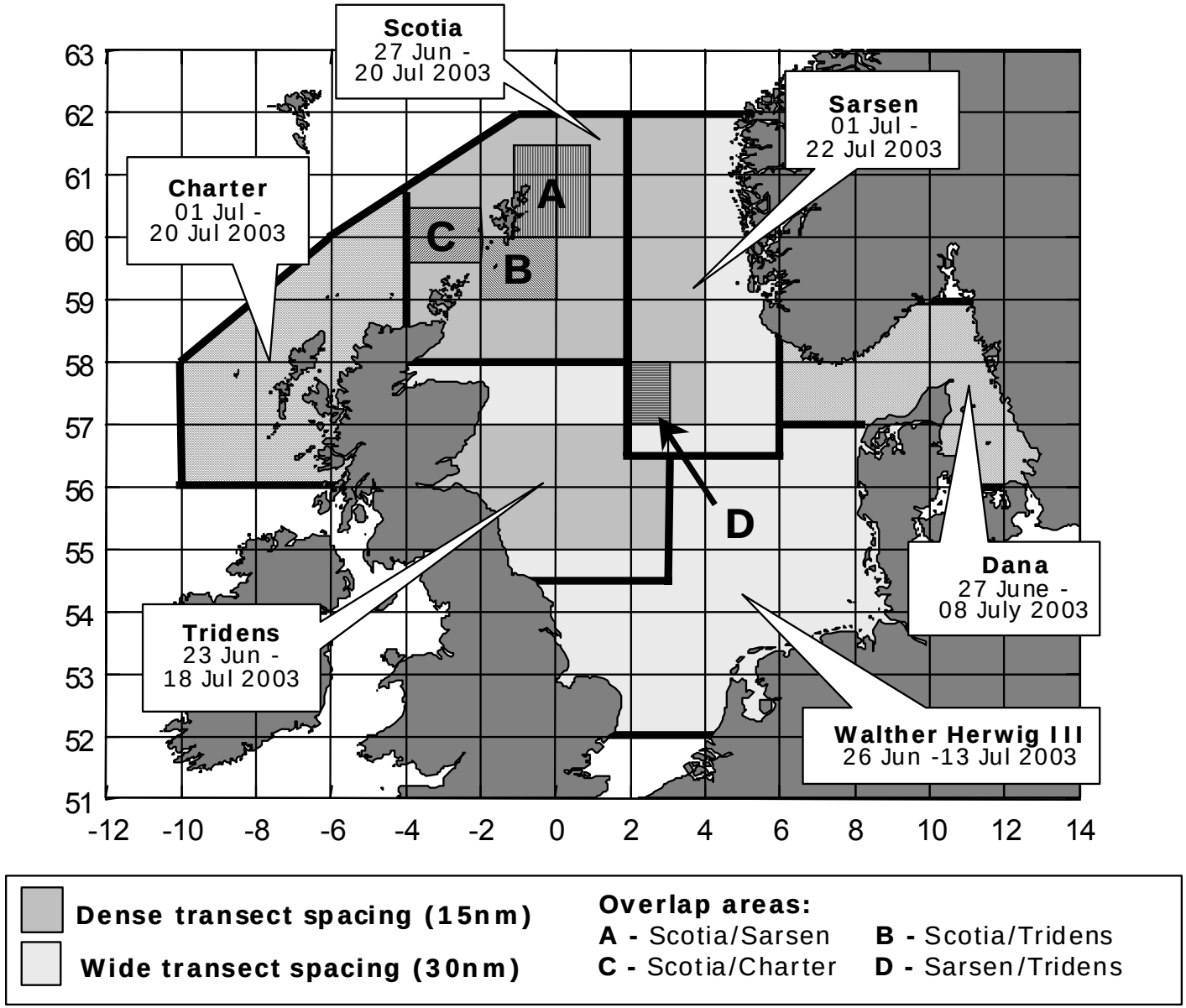

Figure 1 Survey area layouts and dates for all participating vessels in the 2003 acoustic survey of the North Sea and adjacent areas. Heavily shaded areas indicate areas of overlap.

Table 1 Total numbers (millions of fish) and biomass (thousands of tonnes) of North Sea autumn spawning herring in the area surveyed in the acoustic surveys July 2003, with mean weights, mean lengths and fraction mature by age ring.

Age (ring)	Numbers	Biomass	Maturity	weight(g)	Length (cm)
0	2589.9	15.7	0.00	6	9.3
1	9829.4	453.1	0.00	46	18.0
2	18949.4	1967.5	0.43	104	22.5
3	3081.0	568.7	0.93	185	26.3
4	4188.9	876.3	1.00	209	27.5
5	675.1	144.2	1.00	214	28.0
6	494.8	120.2	1.00	243	28.9
7	568.3	159.7	1.00	281	30.0
8	145.5	42.2	1.00	290	30.3
9+	177.7	54.6	1.00	307	31.0
Immature	23420.9	1403.3			
Mature	17279.2	2998.9			
Total	40700.1	4402.1			

Table 2 Total numbers (millions of fish) and biomass (thousands of tonnes) of Western Baltic spring spawning herring in the area surveyed in the acoustic surveys July 2003, with mean weights, mean length and fraction mature by age ring.

Age (ring)	Numbers	Biomass	Maturity	weight(g)	length (cm)
0	0.0	0.0	0.00		
1	1833.1	79.0	0.00	43	17.7
2	1110.0	91.5	0.19	82	21.6
3	394.6	41.4	0.36	104.9	21.7
4	323.4	41.7	1.00	128.8	25.3
5	103.4	13.9	1.00	134.2	25.7
6	25.2	4.2	1.00	165.4	27.0
7	12.0	2.0	1.00	167.2	27.7
8	5.2	0.9	1.00	170.2	27.5
9+	0.2	0.0	1.00	173.5	28.5
Immature	2975.1	168.2			
Mature	832.0	106.4			
Total	3807.1	274.6			

Table 3 Total numbers (millions of fish) and biomass (thousands of tonnes) of autumn spawning of West of Scotland herring in the area surveyed in the acoustic surveys July 2003, with mean weights, mean lengths and fraction mature by age ring.

Age (ring)	Numbers	Biomass	Maturity	weight(g)	Length (cm)
0	0.0	0.0	0.00		
1	438.8	28.3	0.00	64	19.1
2	1039.4	143.3	0.76	138	24.5
3	932.5	164.2	1.00	176	26.5
4	1471.8	280.3	1.00	190	27.2
5	181.3	37.0	1.00	204	27.8
6	129.2	27.5	1.00	213	28.2
7	346.7	75.3	1.00	217	28.4
8.00	114.3	25.5	1.00	223	28.6
9+	75.2	17.2	1.00	228	28.8
Immature	693.9	59.3			
Mature	4035.2	739.2			
Total	4729.1	798.6			

The estimates of Western Baltic spring spawning herring SSB are 106,000 tonnes and 830,000 herring (Table 2) and show a large reduction compared with previous years. This survey produces a rather noisy signal but the indications are still that of a stock that is slightly higher now than between 1996 to 2000. Last years estimate was high, as some year classes were seen to increase from 2001 to 2002, Results this year are more comparable with 2001.

Table 4 Estimates of North Sea autumn spawners (millions) at age from acoustic surveys, 1984-2003. For 1984-1986 the estimates are the sum of those from the Division IVa summer survey, the Division IVb autumn survey, and the Divisions IVc, VIId winter survey. The 1987 to 2003 estimates are from the summer survey in Divisions IVa,b and IIIa excluding estimates of Division IIIa/Baltic spring spawners. For 1999 and 2000 the Kattegat was excluded from the results because it was not surveyed. Smoothed Z are those estimated over 2 years providing an estimate of mortality that is less noisy.

Year/age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	551	726	1,639	13,736	6,431	6,333	6,249	3,182	6,351	10,399	3,646	4,202	6,198	9,416	4,449	5,087	24,735	6,837	23,055	9,829
2	3,194	2,789	3,206	4,303	4,202	3,726	2,971	2,834	4,179	3,710	3,280	3,799	4,557	6,363	5,747	3,078	2,922	12,290	4,875	18,949
3	1,005	1,433	1,637	955	1,732	3,751	3,530	1,501	1,633	1,855	957	2,056	2,824	3,287	2,520	4,725	2,156	3,083	8,220	3,081
4	394	323	833	657	528	1,612	3,370	2,102	1,397	909	429	656	1,087	1,696	1,625	1,116	3,139	1,462	1,390	4,189
5	158	113	135	368	349	488	1,349	1,984	1,510	795	363	272	311	692.1	982.4	506.4	1,006	1,676	794.6	675.1
6	44	41	36	77	174	281	395	748	1,311	788	321	175	98.7	259.2	445.2	313.6	482.5	449.6	1,031	494.8
7	52	17	24	38	43	120	211	262	474	546	238	135	82.8	78.6	170.3	138.6	266.4	169.6	244.4	568.3
8	39	23	6	11	23	44	134	112	155	178	220	110	132.9	78.3	45.2	54.3	120.4	97.7	121	145.5
9+	41	19	8	20	14	22	43	56	163	116	132	84	206	158.3	121.4	87.2	97.2	58.9	149.5	177.7
Total	5,478	5,484	7,542	20,165	13,496	16,377	18,262	12,781	17,173	19,326	13,003	11,220	18,786	22,028	16,104	15,107	34,928	26,124	39,881	38,110
$Z_{2+/3+}$	.	0.92	0.57	1.02	0.81	0.11	0.11	0.57	0.37	0.74	1.21	0.53	0.43	0.40	0.76	0.52	0.32	0.38	0.47	0.59
Smooth $Z_{2+/3+}$	.	.	0.73	0.76	0.91	0.30	0.11	0.25	0.46	0.52	0.94	0.80	0.48	0.41	0.55	0.63	0.41	0.35	0.425	0.53
SSB ('000 t)	807	697	942	817	897	1,637	2,174	1,874	1,545	1,216	1,035	1,082	1446.2	1,780	1,792	1,534	1,833	2,622	2,948	2,999

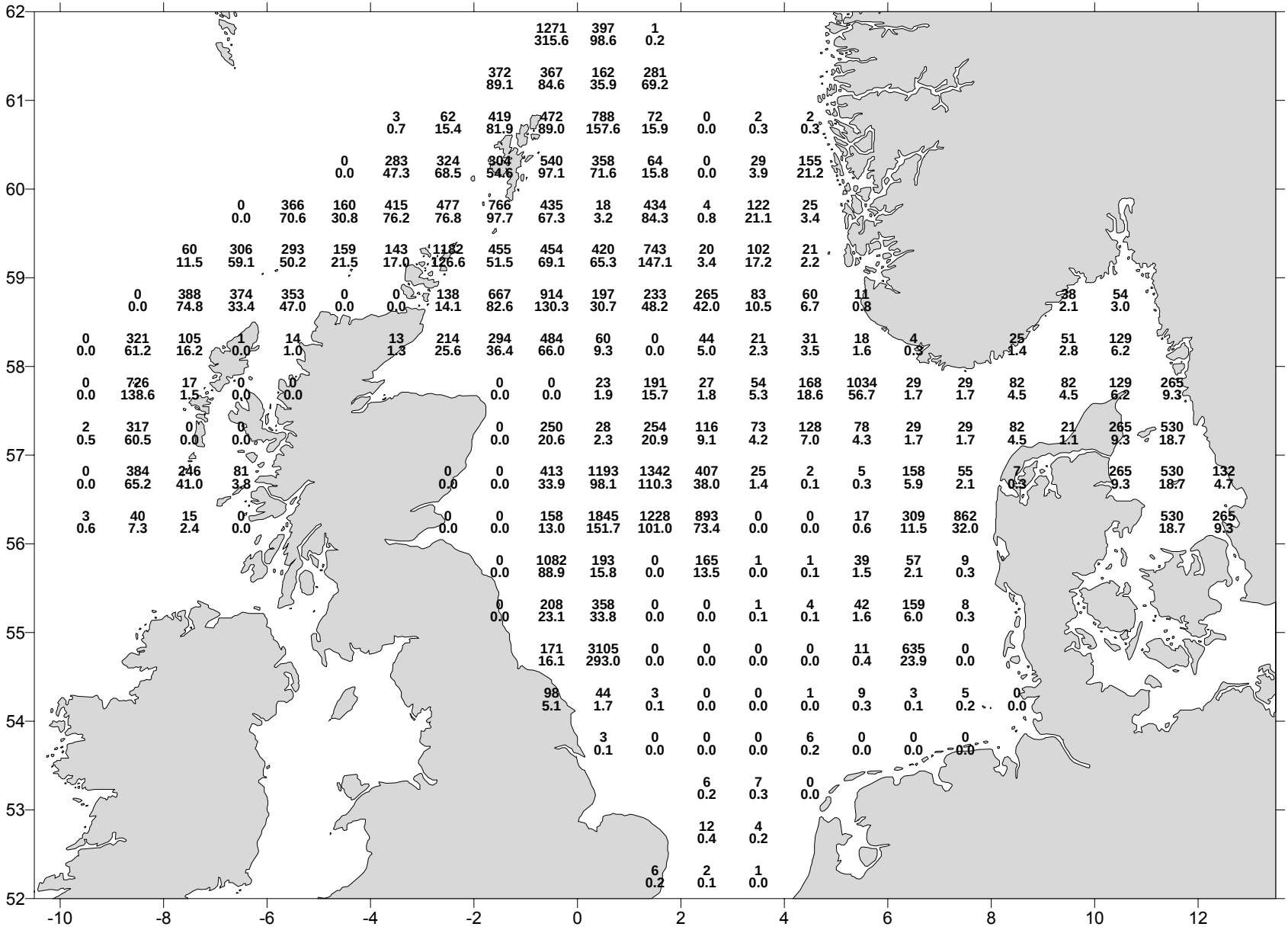

Figure 2 Abundance of Autumn spawning herring from combined acoustic survey July 2003. Numbers (millions) (upper figure) and biomass (thousands of tonnes) (lower figure).

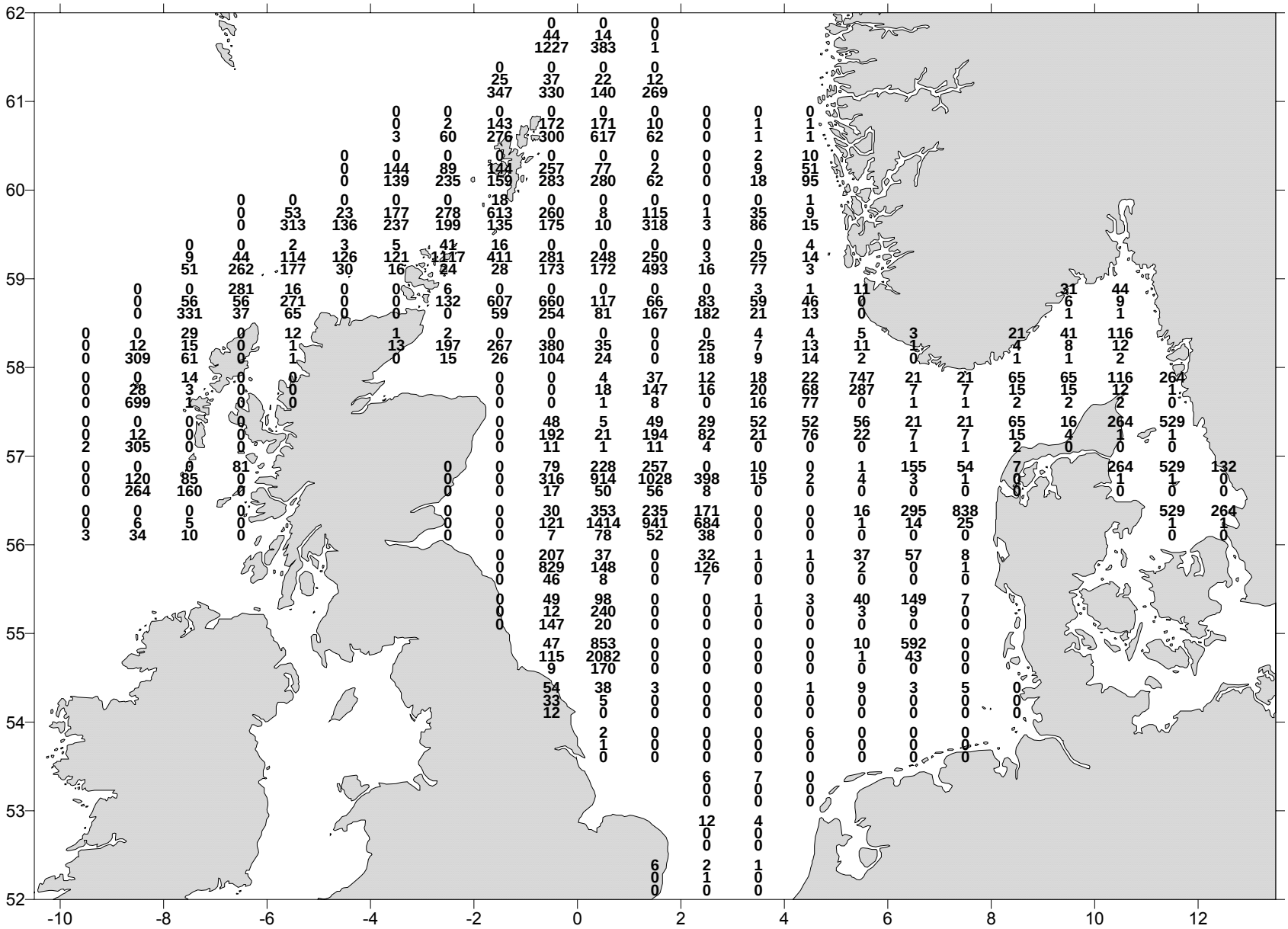

Figure 3 Numbers (millions) of Autumn spawning herring from combined acoustic survey June - July 2003. 1 ring (upper figure), 2 ring (centre figure), 3+ (lower figure).

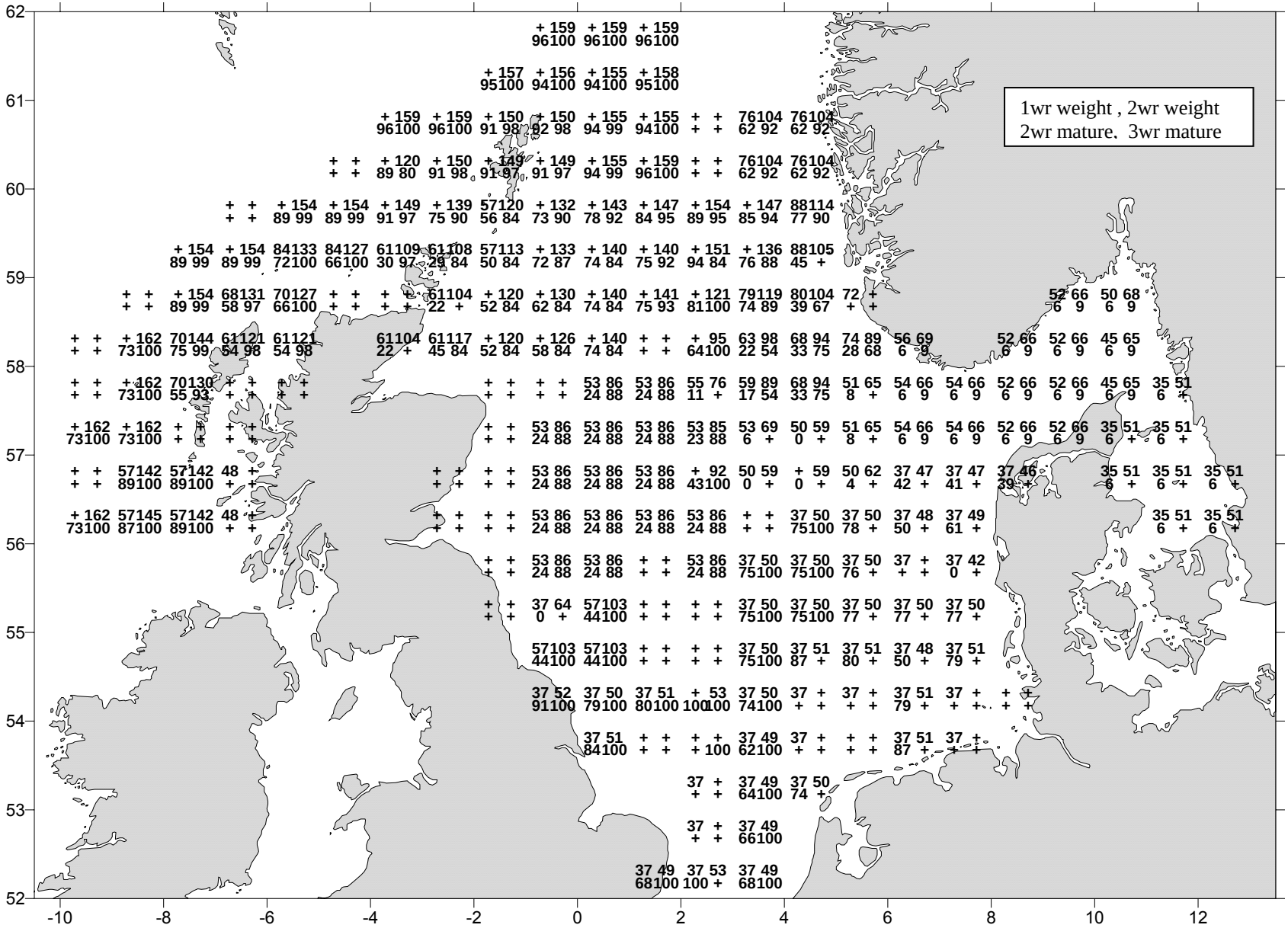

Figure 4 Mean weight & maturity of Autumn spawning herring from combined acoustic survey June - July 2003. Four values per ICES rectangle, percentage mature (lower),2 ring (left), 3 ring (right), mean weights gram (upper),1 ring (left) ,2 ring (right) ,0 indicates measured percentage mature, + indicates surveyed with zero abundance blank indicates an unsurveyed rectangle

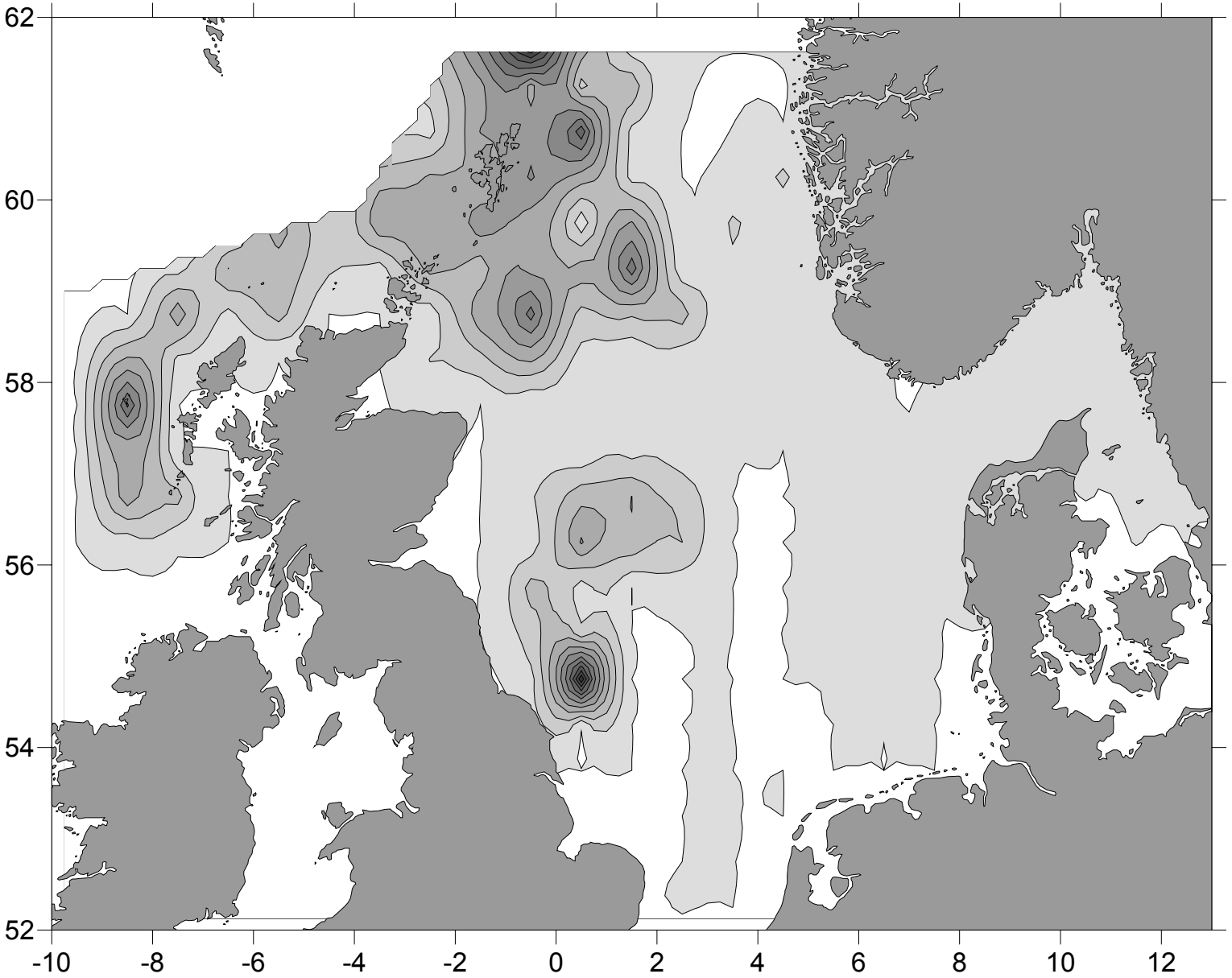

Figure 5 Numbers of mature autumn spawning herring from combined acoustic survey June -July 2003.

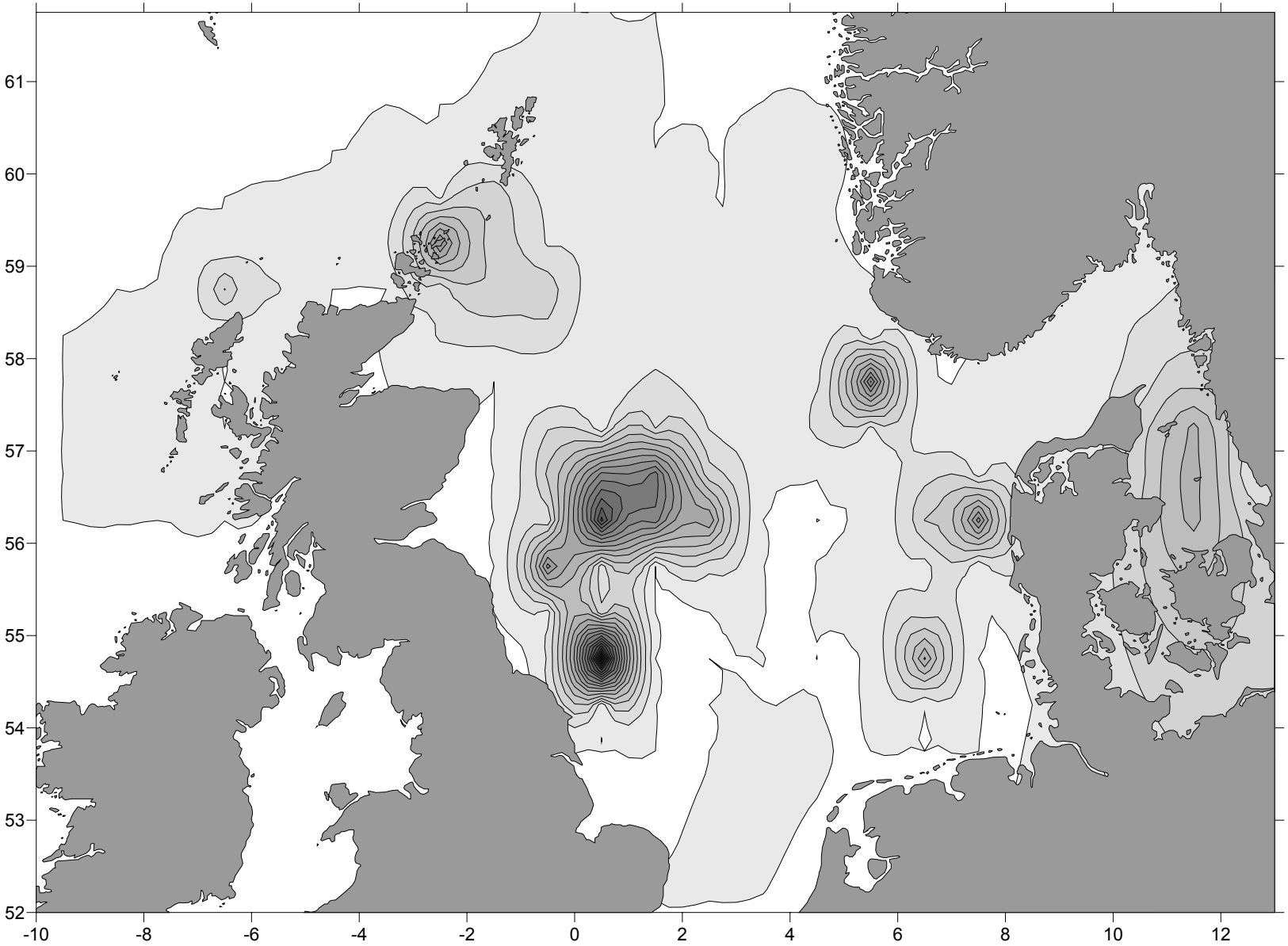

Figure 6 Biomass of immature autumn spawning herring from combined acoustic survey June -July 2002.

Table 5 Numbers (millions) of Western Baltic Spring Spawning herring at age (rings) from acoustic surveys 1989 to 2003. The 1999 survey was incomplete due to the lack of participation by RV DANA.

Year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0		31		3,853	372	964									
1		135		277	103	5	2,199	1,091	128	138	1367	1509	66	3346	1833
2	1,105	1,497	1,864	2,092	2,768	413	1,887	1,005	715	1,682	1143	1891	641	1576	1110
3	714	549	1,927	1,799	1,274	935	1,022	247	787	901	523	674	452	1392	394.6
4	317	319	866	1,593	598	501	1,270	141	166	282	135	364	153	524	323.4
5	81	110	350	556	434	239	255	119	67	111	28	186	96	88	103.4
6	51	24	88	197	154	186	174	37	69	51	3	56	38	40	25.2
7	16	10	72	122	63	62	39	20	80	31	2	7	23	18	12.0
8+	4	5	10	20	13	34	21	13	77	53	1	10	12	19	5.4
Total	2,288	2,680	5,177	10,509	5,779	3,339	6,867	2,673	2,088	3,248	3,201	4,696	1,481	7,002	3,807
3+ group	1,183	1,017	3,313	4,287	2,536	1,957	2,781	577	1,245	1,428	691	1,295	774	2,081	864

Table 6 Numbers at age (millions) and SSB of West of Scotland Autumn Spawning herring at age (rings) from acoustic surveys 1987, 1991 to 2003. #In 1997 the survey was carried out one month early in June as opposed to July when all the other surveys were carried out

Age	**1987**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997#**	**1998**
1	249.1	338.3	74.3	2.8	494.2	441.2	41.2	792.3	1,221.7
2	578.4	294.5	503.4	750.3	542.1	1,103.4	576.5	641.9	794.6
3	551.1	327.9	211.0	681.2	607.7	473.2	802.5	286.2	666.8
4	353.1	367.8	258.1	653.1	285.6	450.3	329.1	167.0	471.1
5	752.6	488.3	414.8	544.0	306.8	153.0	95.4	66.1	179.1
6	111.6	176.3	240.1	865.2	268.1	187.1	60.6	49.5	79.3
7	48.1	98.7	105.7	284.1	406.8	169.1	77.4	16.3	28.1
8	15.9	89.8	56.7	151.7	173.7	236.5	78.2	29.0	13.9
9+	6.5	58.0	63.4	156.2	131.9	201.5	114.8	24.4	36.8
SSB:	273.0	452.0	351.5	866.2	533.7	452.1	370.3	140.9	375.9

Age	**1999**	**2000**	**2001**	**2002**	**2003**
1	534.2	447.6	313.1	424.7	438.8
2	322.4	316.2	1,062.0	436.0	1039.4
3	1,388.8	337.1	217.7	1,436.9	932.5
4	432.0	899.5	172.8	199.8	1471.8
5	308.0	393.4	437.5	161.7	181.3
6	138.7	247.6	132.6	424.3	129.2
7	86.5	199.5	102.8	152.3	346.7
8	27.6	95.0	52.4	67.5	114.3
9+	35.4	65.0	34.7	59.5	75.2
SSB:	460.2	500.5	359.2	548.8	739.2

The West of Scotland estimates of SSB are 740,000 tonnes and 4,000 million heering (Table 3), and show the high 1995 year class again this year (Table 6). The 1998 year class now 4 ring is now confirmed as large and the early indications are that the magnitude of the 2000 yearclass is also a large. Total adult mortality shows rather low mortality similar to last year (0.1) but the mean mortality over the last 4 years has been approximately 0.3: this is consistent with the 2003 assessment that the stock is lightly exploited (ICES 2003). The survey still indicates a slightly rising stock over the last 4 years.

The spatial distributions of the abundance (numbers and biomass) of autumn spawning herring are shown in Figure 2. The distribution of numbers by age are shown in Figure 3 for 1 ring, 2 ring and 3+ ring autumn spawning herring. The survey provides estimates of maturity and weight at age: the mean weight at age for 1 and 2 ring herring along with the proportion mature for 2 and 3 ring herring are shown in Figure 4. The spatial distribution of mature and immature autumn spawning herring is shown in Figures 5 & 6 respectively. The spatial distributions of the abundance (numbers and biomass) of Western Baltic spring spawning herring are shown in Figure 7. The distribution of numbers by age are shown in Figure 8 for 1 ring, 2 ring and 3+ ring. The mean weight at age for 1 and 2 ring herring along with the proportion mature for 2 and 3 ring herring are shown in Figure 9. The spatial distribution of mature and immature Western Baltic spring spawning herring is shown in Figures 10 & 11 respectively.

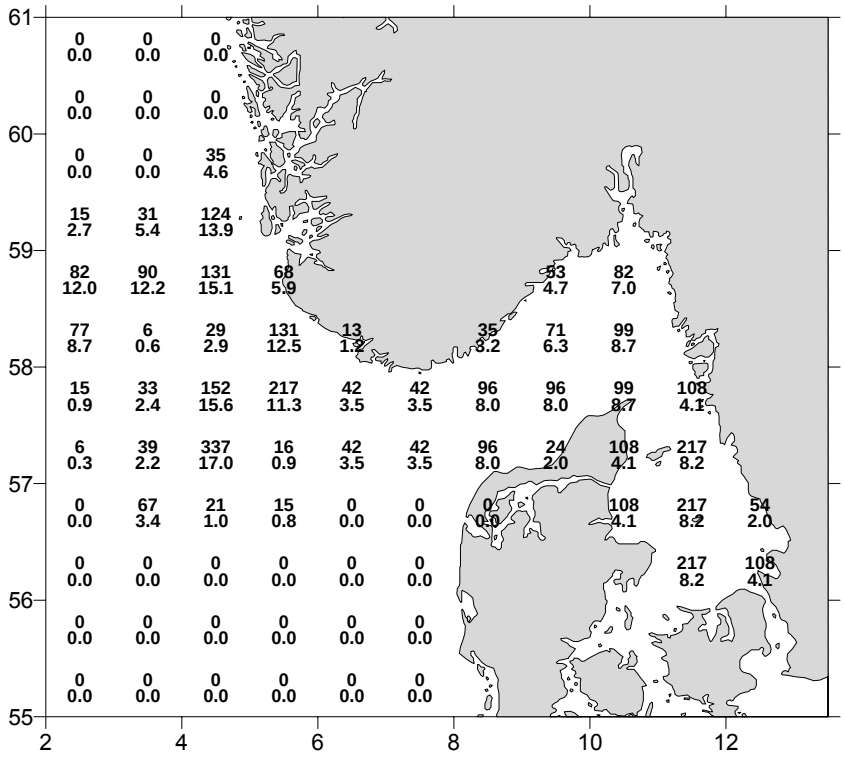

Figure 7 Numbers (millions) (upper) and biomass (thousands of tonnes) (lower) of Western Baltic spring spawning herring from combined acoustic survey June - July 2003.

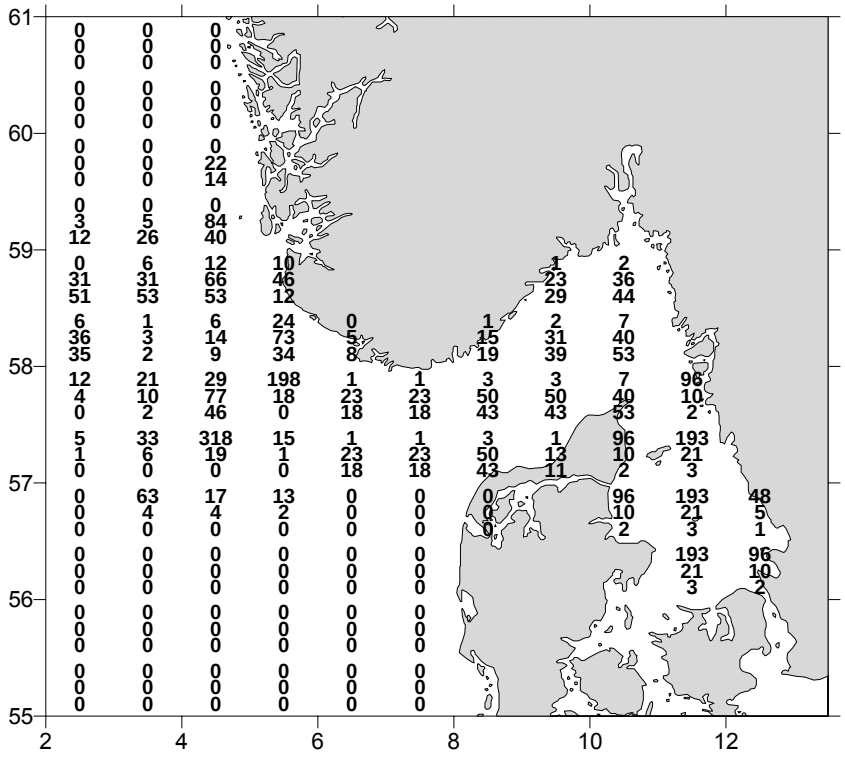

Figure 8 Numbers (millions) of Western Baltic spring spawning herring from combined acoustic survey June - July 2003. 1 ring (upper figure), 2 ring (centre figure), 3+ (lower figure).

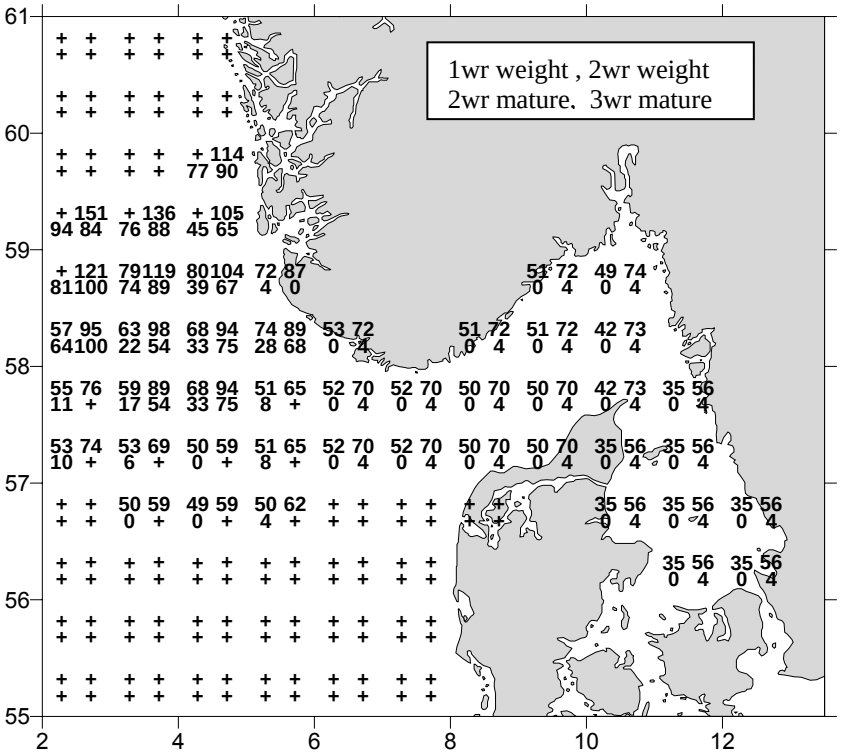

Figure 9 Mean weight & maturity of Western Baltic spring spawning herring from combined acoustic survey June - July 2003. Four values per ICES rectangle, percentage mature (lower),2 ring (left), 3 ring (right), mean weights gram (upper),1 ring (left) ,2 ring (right) ,0 indicates measured percentage mature, + indicates surveyed with zero abundance blank indicates an unsurveyed rectangle.

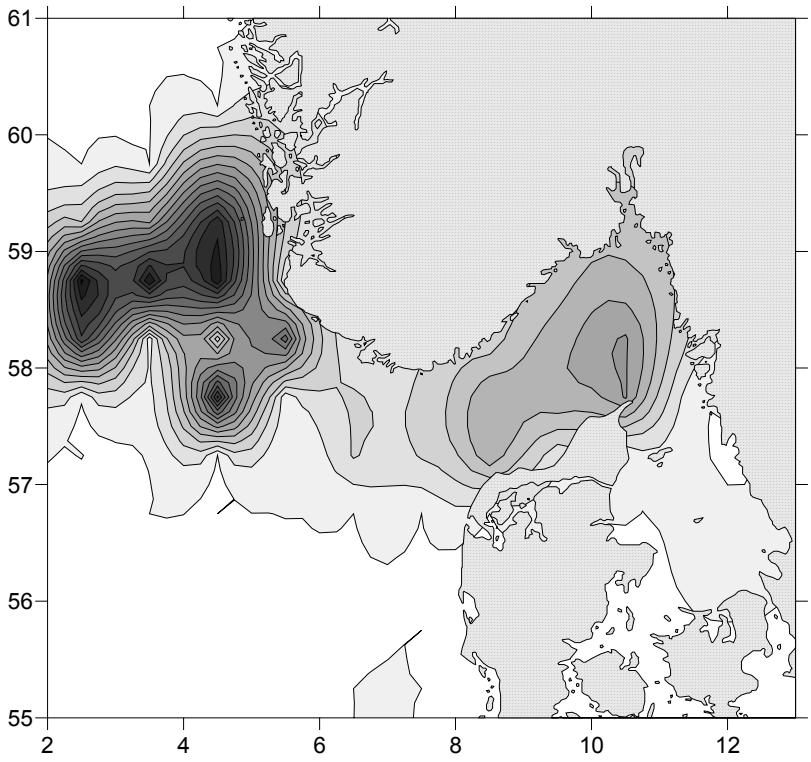

Figure 10 Abundance of mature Western Baltic spring spawning herring from combined acoustic survey July 2003. Numbers of herring .

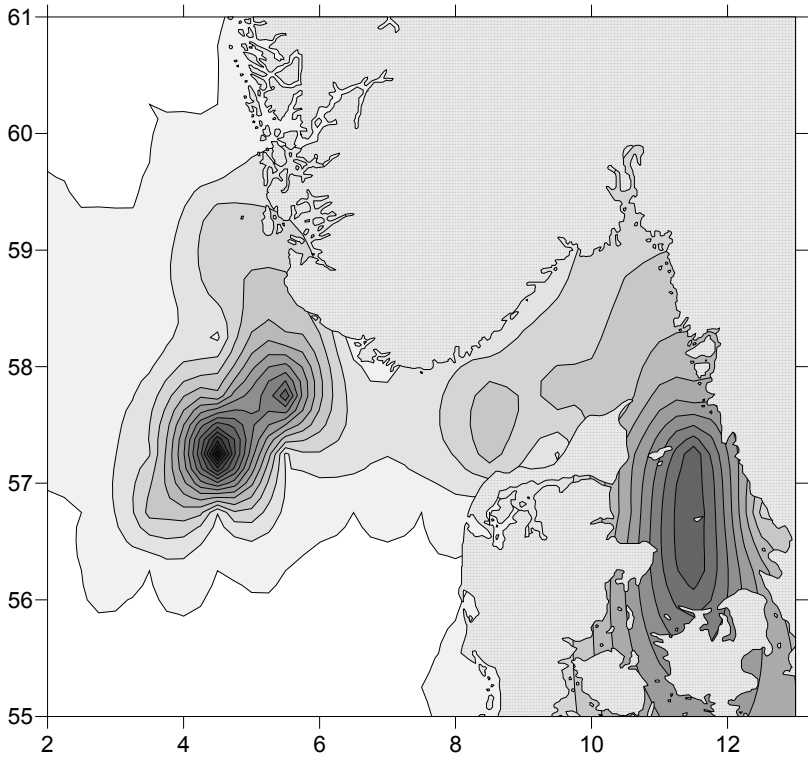

Figure 11 Abundance of immature Western Baltic spring spawning herring from combined acoustic survey July 2003. Numbers of herring .

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