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2000 ICES COORDINATED ACOUSTIC SURVEY OF ICES DIVISIONS IIIa, IVa, IVb AND VIa (NORTH)

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ABSTRACT

Six surveys were carried out during late June and July covering most of the continental shelf north of 54°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 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.

INTRODUCTION

Six surveys were carried out during late June and July covering most of the continental shelf north of 54°N in the North Sea and 56°N to the west of Scotland to a northern limit of 62°N. The eastern edge of the survey area is bounded by the Norwegian, Danish and German coasts, and to the west by the shelf edge at approximately 200 m depth. The surveys are reported individually in appendices la-f of the report of the planning group for herring surveys (ICES, 2001). The vessels, areas and dates of cruises are given below and in Figure 1:

| | | |
|--------------------|-------------------|-----------------|
| <i>Scotia</i> | 4-24 July | 58-62N 4W-2E |
| <i>Kings Cross</i> | 7-26 July | 56- 60N 10-3W |
| <i>Tridens</i> | 19-14 July | 54 30-58N 4W-3E |
| <i>GO Sars</i> | 27 June -18 July | 57-62N 2W-8E |
| <i>Dana</i> | 26 June - 7 July | 56/57N 6E-12E |
| <i>W Herwig</i> | 23 June - 14 July | 54-57N 3E-8E |

The data has 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 survey track for each vessel that has covered each statistical rectangle. The data has been combined and estimates of North Sea autumn spawning herring, Western Baltic spring spawning herring, and West of Scotland (Vla_{north}) herring are shown in Tables 4.1.1a-c.

METHODS

The acoustic surveys were carried out using Simrad EK500 or EY500 38 kHz sounder echo-integrator with transducers mounted on the hull, drop keel and towed bodies. Further data analysis was carried out using BI500, Echoview and 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 of Orkney, east and west of Shetland, and in the Skaggearak where short additional transects were carried out at 7.5 nm spacing.

The following target strength values 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

The estimates of North Sea Spawning Stock Biomass (SSB) are 1.7 million tonnes and 8,750 millions herring (Table 1). The North Sea survey is consistent with previous years, giving a total adult mortality of about 0.4 over the last two years, which is similar to the estimates from the assessment (0.5). The SSB rose from 1999 to 2000. The survey also shows exceptional numbers of 1 ring herring (the 1998 year class) in the North Sea, which is consistent with the observation of an exceptionally large year class observed in the MIK and IBTS surveys (ICES, 2000). The acoustic survey indicates that the abundance of this year class is four times the preceding (1997) year class. The numbers and biomass of adult autumn spawning herring can be seen in Figure 2, the numbers at ages 1, 2 and 3+ rings in are given in Figure 3. The spatial distribution of mean weight at age 1 and 2 ring, and fraction mature at 2 and 3 ring, are given in Figure 4. These show considerable spatial trend which is observed each year, with larger more mature fish found in the North and smaller less mature fish found in the south and particularly the eastern North Sea. The relative spatial distributions of adult and juvenile autumn spawning herring can be seen in Figures 5 and 6 respectively. The contours on these figures have been set to contain 10% of the abundance within each contour.

The estimates of Western Baltic spring spawning herring SSB are 190,000 tonnes and 2,000 millions and show a similar pattern to previous years, with a slight increase in SSB over 1999 (Table 2). The numbers and biomass of adult autumn spawning herring can be seen in Figures 7 along with the numbers at ages 1, 2 and 3+ rings. The spatial distribution of mean weight at age 1 and 2 ring, and fraction mature at 2 and 3 ring are given in Figure 8. The relative spatial distributions of adult and juvenile autumn spawning herring can be seen in Figure 9. The contours on these figures have been set to contain 10% of the abundance within each contour.

The West of Scotland survey gives estimates of SSB of 440,000 tonnes and 2,400 million fish, and shows the high 1995 year class again this year. Total adult mortality shows low mortality (0.14) which is consistent with the 2000 assessment that the stock is lightly exploited (ICES, 2000). The spatial distributions can be seen in the same figures for the North Sea.

REFERENCES

ICES. 2000. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 2000/ACFM:10.

ICES. 2001. Report of the planning group for herring surveys. ICES CM 2001/G:02.

TABLE 1

Total numbers and biomass of North Sea autumn spawning herring in the area surveyed in the acoustic surveys July 2000, with mean weights and fraction mature by winter ring.

| North Sea | Numbers (millions) | Biomass Tonnes * 10 ⁶ | Maturity (fraction) | mean weight (g) |
|-----------|-----------------------|-------------------------------------|------------------------|--------------------|
| 0 | 7570.6 | 39.2 | 0.00 | 5 |
| 1 | 24514.1 | 1139.6 | 0.00 | 46 |
| 2 | 2773.3 | 326.1 | 0.66 | 118 |
| 3 | 1995.9 | 360.2 | 0.96 | 180 |
| 4 | 2871.0 | 626.6 | 1.00 | 218 |
| 5 | 923.5 | 214.4 | 1.00 | 232 |
| 6 | 442.8 | 115.4 | 1.00 | 261 |
| 7 | 243.9 | 71.9 | 1.00 | 295 |
| 8 | 111.5 | 33.5 | 1.00 | 300 |
| 9+ | 91.9 | 25.8 | 1.00 | 280 |
| Immature | 33127.0 | 1231.1 | | |
| Mature | 8411.5 | 1682.4 | | |
| Total | 41538.5 | 2952.8 | | |

TABLE 2

Total numbers and biomass of Western Baltic spring spawning herring in the area surveyed in the acoustic surveys July 2000, with mean weights and fraction mature by winter ring.

| Baltic | Numbers (millions) | Biomass Tonnes * 10 ⁶ | Maturity (fraction) | mean weight (g) |
|----------|-----------------------|-------------------------------------|------------------------|--------------------|
| 0 | 0.0 | 0.0 | 0.00 | |
| 1 | 1509.2 | 61.4 | 0.00 | 40.7 |
| 2 | 1891.1 | 138.1 | 0.42 | 73.1 |
| 3 | 673.6 | 68.8 | 0.80 | 102.2 |
| 4 | 363.9 | 45.3 | 1.00 | 124.4 |
| 5 | 185.7 | 25.1 | 1.00 | 135.4 |
| 6 | 55.6 | 10.0 | 1.00 | 179.2 |
| 7 | 6.9 | 1.4 | 1.00 | 208.8 |
| 8 | 9.6 | 1.3 | 1.00 | 135.2 |
| 9+ | 0.0 | 0.0 | 1.00 | 0 |
| Immature | 2736.0 | 155.2 | | |
| Mature | 1959.5 | 196.2 | | |
| Total | 4695.5 | 351.5 | | |

TABLE 3

Total numbers and biomass of autumn spawning of West of Scotland herring in the area surveyed in the acoustic surveys July 2000, with mean weights and fraction mature by winter ring.

| West Scot | Numbers (millions) | Biomass Tonnes * 10 ⁶ | Maturity (fraction) | mean weight (g) |
|-----------|-----------------------|-------------------------------------|------------------------|--------------------|
| 0 | 0.0 | 0.0 | 0.00 | |
| 1 | 447.6 | 27.8 | 0.00 | 62 |
| 2 | 316.2 | 44.6 | 0.45 | 141 |
| 3 | 337.1 | 58.3 | 0.92 | 173 |
| 4 | 899.5 | 164.6 | 1.00 | 183 |
| 5 | 393.4 | 76.4 | 1.00 | 194 |
| 6 | 247.6 | 50.5 | 1.00 | 204 |
| 7 | 199.5 | 42.2 | 1.00 | 211 |
| 8 | 95.0 | 21.1 | 1.00 | 222 |
| 9+ | 65.0 | 15.0 | 1.00 | 230 |
| Immature | 648.7 | 55.5 | | |
| Mature | 2352.0 | 444.9 | | |
| Total | 3000.8 | 500.5 | | |

TABLE 4

Estimates of North Sea autumn spawners (millions) at age from acoustic surveys, 1984-2000. 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 2000 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. The 1996 to 1999 surveys have been revised due to changes in methods for calculating mean weight and proportion adult.

| | Numbers (millions) | | | | | | | | | | | | | | | | |
|----------------------------|--------------------|-------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Year | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| Age (ring) | | | | | | | | | | | | | | | | | |
| 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 | 6,542 | 24,514 |
| 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 | 2,945 | 2,773 |
| 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 | 4,364 | 1,996 |
| 4 | 394 | 323 | 833 | 657 | 528 | 1,612 | 3,370 | 2,102 | 1,397 | 909 | 429 | 656 | 1,087 | 1,696 | 1,625 | 1,036 | 2,871 |
| 5 | 158 | 113 | 135 | 368 | 349 | 488 | 1,349 | 1,984 | 1,510 | 795 | 363 | 272 | 311.0 | 692.1 | 982.4 | 470.1 | 923.5 |
| 6 | 44 | 41 | 36 | 77 | 174 | 281 | 395 | 748 | 1,311 | 788 | 321 | 175 | 98.7 | 259.2 | 445.2 | 289.5 | 442.8 |
| 7 | 52 | 17 | 24 | 38 | 43 | 120 | 211 | 262 | 474 | 546 | 238 | 135 | 82.8 | 78.6 | 170.3 | 128.9 | 243.9 |
| 8 | 39 | 23 | 6 | 11 | 23 | 44 | 134 | 112 | 155 | 178 | 220 | 110 | 132.9 | 78.3 | 45.2 | 51.6 | 111.5 |
| 9+ | 41 | 19 | 8 | 20 | 14 | 22 | 43 | 56 | 163 | 116 | 132 | 84 | 206.0 | 158.3 | 121.4 | 82.7 | 91.9 |
| 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 | 15,910 | 35,521 |
| 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 | 0.60 | 0.34 |
| Smoothed Z(2+/3+) | | 0.78 | 0.70 | 0.82 | 0.46 | 0.13 | 0.32 | 0.44 | 0.53 | 0.92 | 0.91 | 0.57 | 0.45 | 0.50 | 0.91 | 0.46 | 0.22 |
| 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 | 1,501 | 1,682 |

TABLE 5

Numbers of Western Baltic Spring Spawning herring at age (winter rings) from acoustic surveys 1991 to 2000.

| AGE | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|-----|------|------|------|------|------|------|------|------|--------|-------|
| 2 | 1864 | 2092 | 2768 | 413 | 1887 | 1005 | 715 | 1682 | 1142.9 | 1121 |
| 3 | 1927 | 1799 | 1274 | 935 | 1022 | 247 | 787 | 901 | 522.7 | 765.5 |
| 4 | 866 | 1593 | 598 | 501 | 1270 | 141 | 166 | 282 | 134.8 | 183.2 |
| 5 | 350 | 556 | 434 | 239 | 255 | 119 | 67 | 111 | 28.3 | 39.8 |
| 6 | 88 | 197 | 154 | 186 | 174 | 37 | 69 | 51 | 2.8 | 30.3 |
| 7 | 72 | 122 | 63 | 62 | 39 | 20 | 80 | 31 | 1.5 | 2.1 |
| 8 | 10 | 20 | 13 | 34 | 21 | 13 | 77 | 53 | 0.7 | 9.6 |

TABLE 6

Numbers at age and SSB of West of Scotland Autumn Spawning herring at age (winter rings) from acoustic surveys 1987, 1991 to 2000.

| Age | 1987 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 [#] | 1998 | 1999 | 2000 |
|------|----------|---------|---------|---------|---------|----------|---------|-------------------|-----------|-----------|---------|
| 1 | 249 100 | 338 312 | 74 310 | 2 760 | 494 150 | 441 240 | 41 220 | 792 320 | 1 221 700 | 487 000 | 447600 |
| 2 | 578 400 | 294 484 | 503 430 | 750 270 | 542 080 | 1103 400 | 576 460 | 641 860 | 794 630 | 293 900 | 316200 |
| 3 | 551 100 | 327 902 | 210 980 | 681 170 | 607 720 | 473 220 | 802 530 | 286 170 | 666 780 | 1 265 800 | 337 100 |
| 4 | 353 100 | 367 830 | 258 090 | 653 050 | 285 610 | 450 270 | 329 110 | 167 040 | 471 070 | 393 800 | 899 500 |
| 5 | 752 600 | 488 288 | 414 750 | 544 000 | 306 760 | 152 970 | 95 360 | 66 100 | 179 050 | 280 700 | 393 400 |
| 6 | 111 600 | 176 348 | 240 110 | 865 150 | 268 130 | 187 100 | 60 600 | 49 520 | 79 270 | 126 400 | 247 600 |
| 7 | 48 100 | 98 741 | 105 670 | 284 110 | 406 840 | 169 080 | 77 380 | 16 280 | 28 050 | 78 900 | 199 500 |
| 8 | 15 900 | 89 830 | 56 710 | 151 730 | 173 740 | 236 540 | 78 190 | 28 990 | 13 850 | 25 200 | 95 000 |
| 9+ | 6 500 | 58 043 | 63 440 | 156 180 | 131 880 | 201 500 | 114 810 | 24 440 | 36 770 | 32 300 | 65 000 |
| SSB: | 273 000* | 452 000 | 351 460 | 866 190 | 533 740 | 452 120 | 370300 | 140 910 | 375 890 | 419 500 | 444 900 |

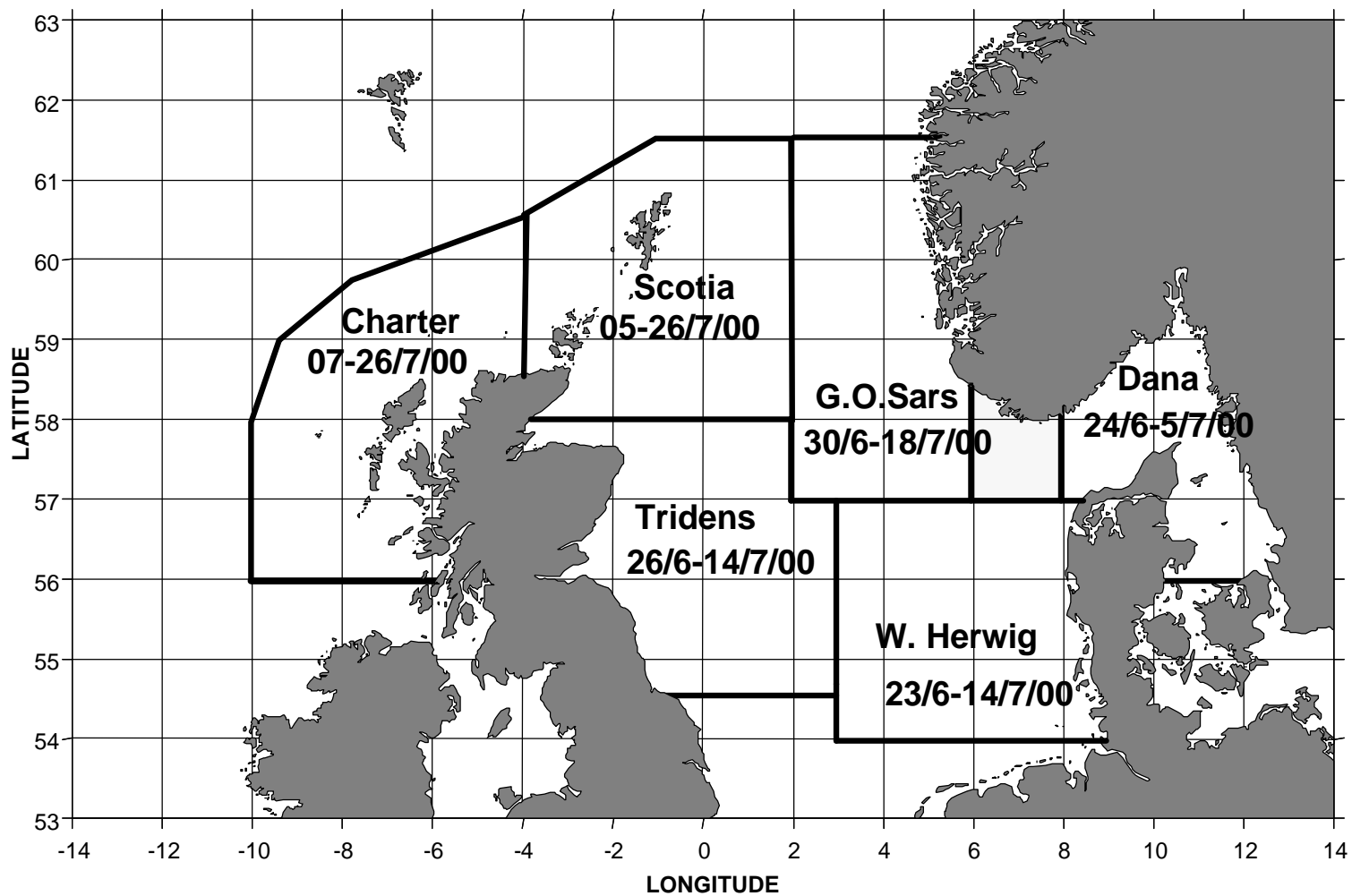


Figure 1. Survey area layouts and dates for all participating vessels in the 2000 North Sea and west of Scotland herring acoustic survey. Shaded areas indicate areas of overlap.

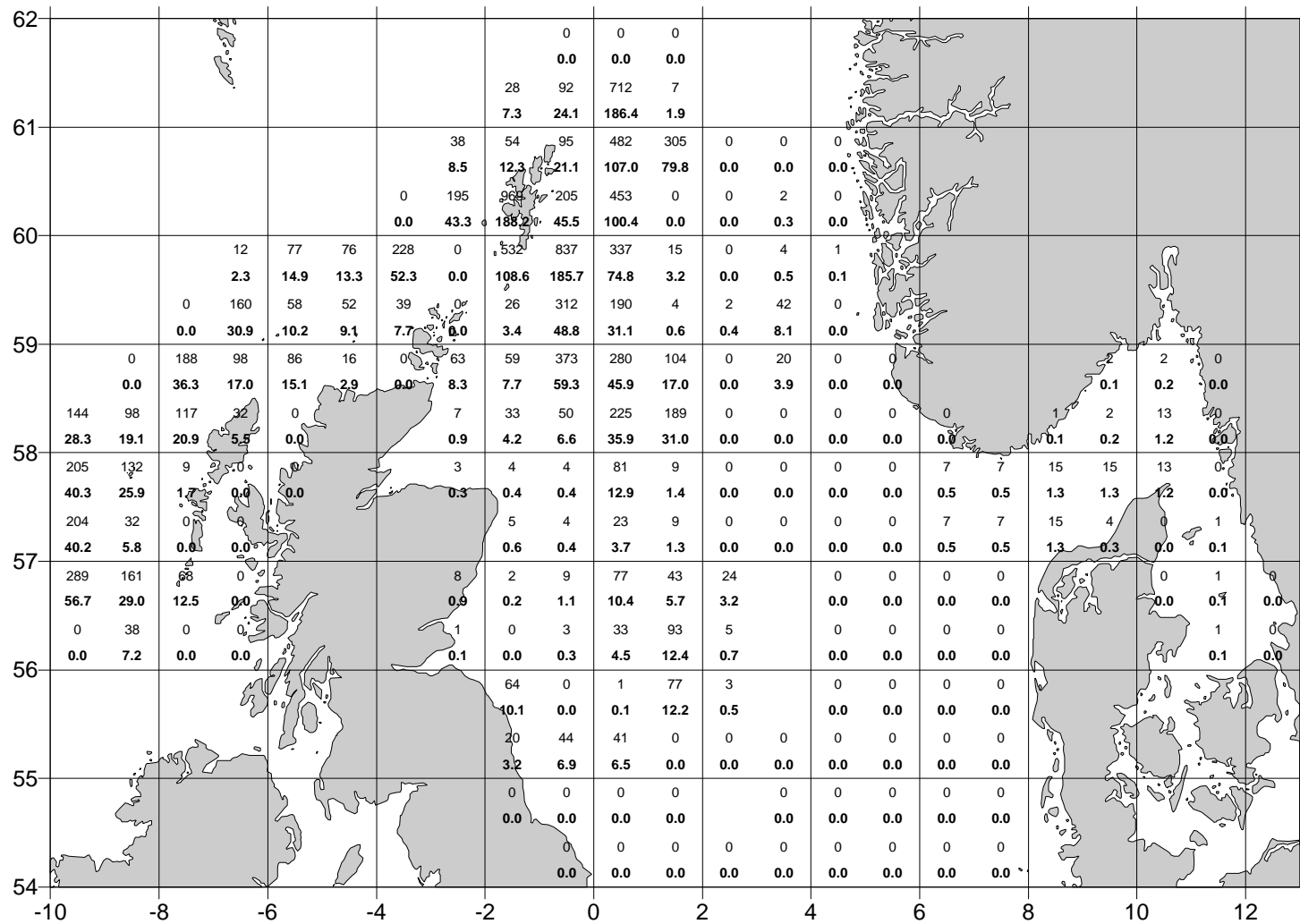


Figure 2. Numbers and biomass (upper and lower value) of mature autumn spawning herring from combined acoustic surveys in June July 2000.

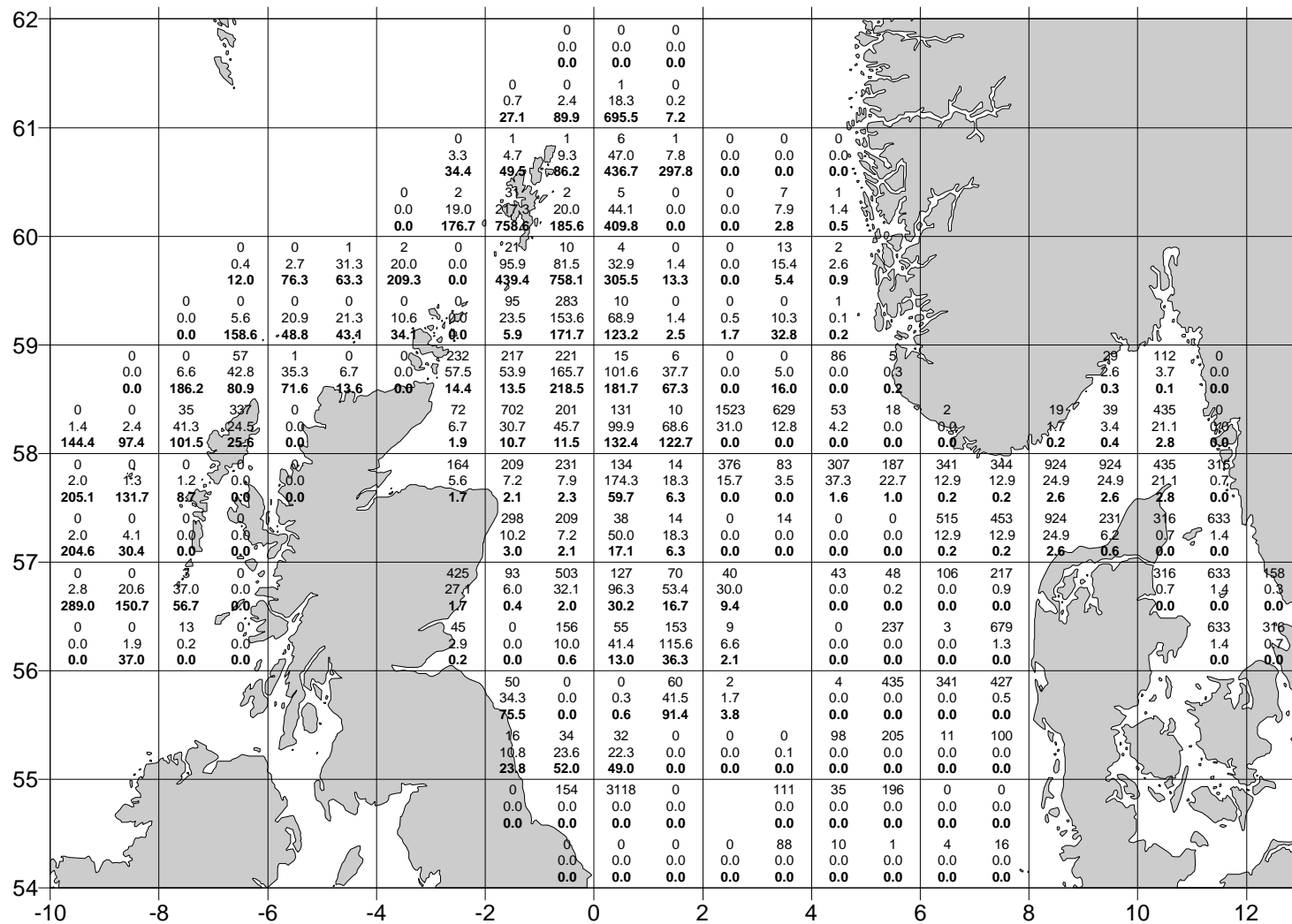


Figure 3. Numbers at ages 1, 2 3+ ring (upper middle and lower value) of autumn spawning herring from combined acoustic surveys in June July 2000.

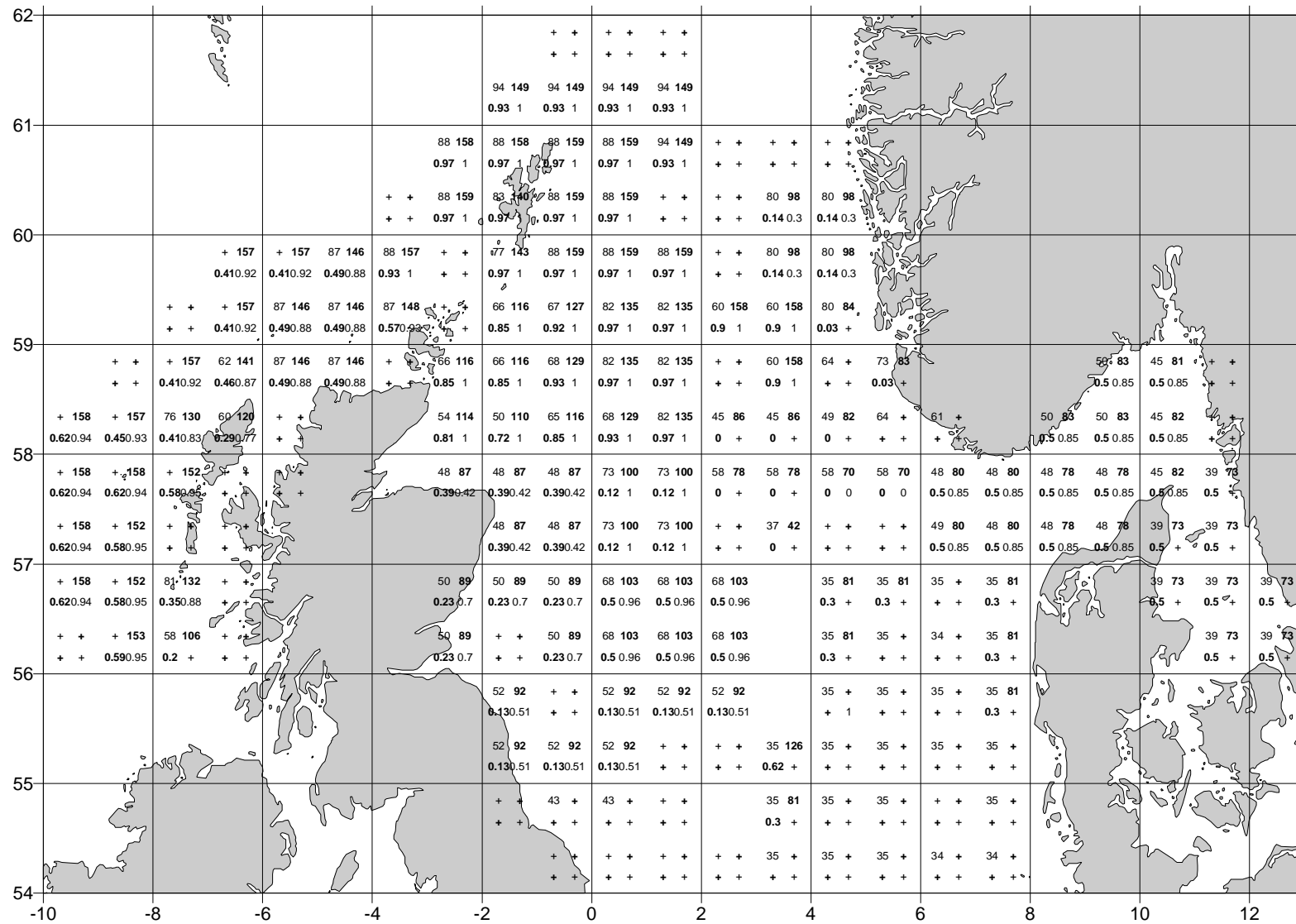


Figure 4. Mean weight at ages 1, 2 ring (upper left and right value) and fraction mature at ages 2, 3 ring (lower left and right values) of autumn spawning herring from combined acoustic surveys in June July 2000.

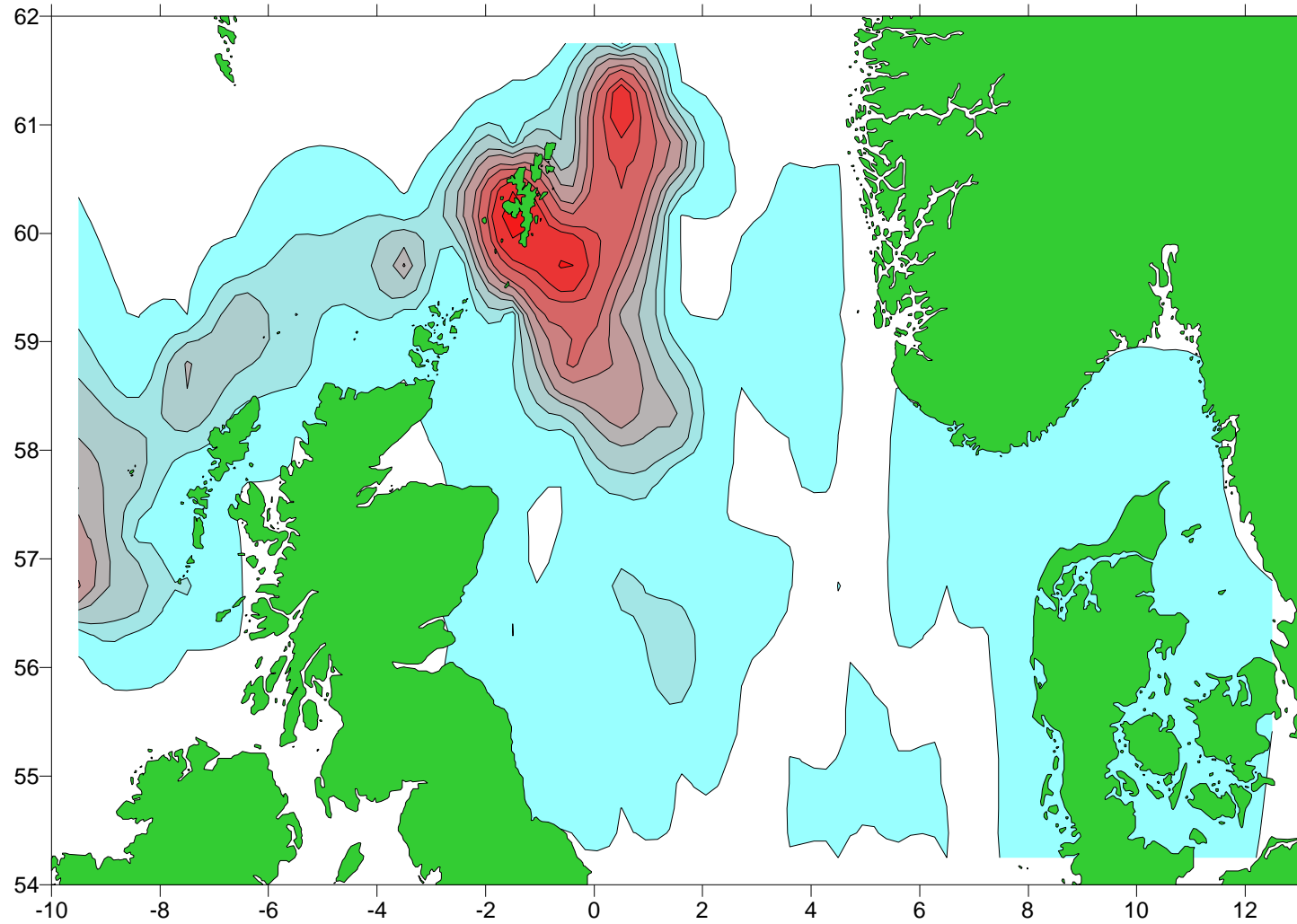


Figure 5. Relative spatial distribution of mature autumn spawning herring from combined acoustic surveys in June July 2000. 10% of the population is contained within each contour. Contour colour indicated density.

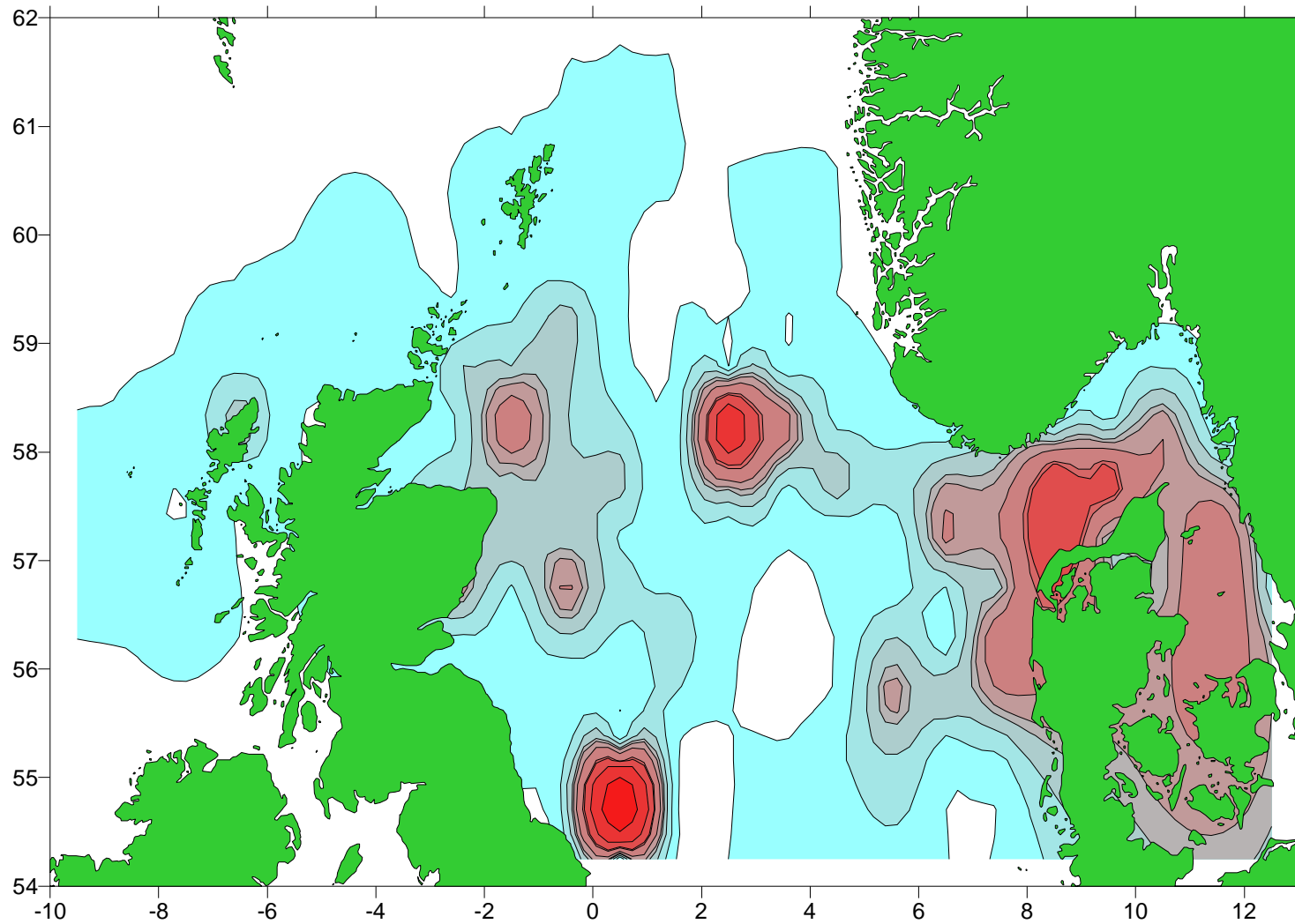


Figure 6. Relative spatial distribution of juvenile autumn spawning herring from combined acoustic surveys in June July 2000. 10% of the population is contained within each contour. Contour colour indicated density.

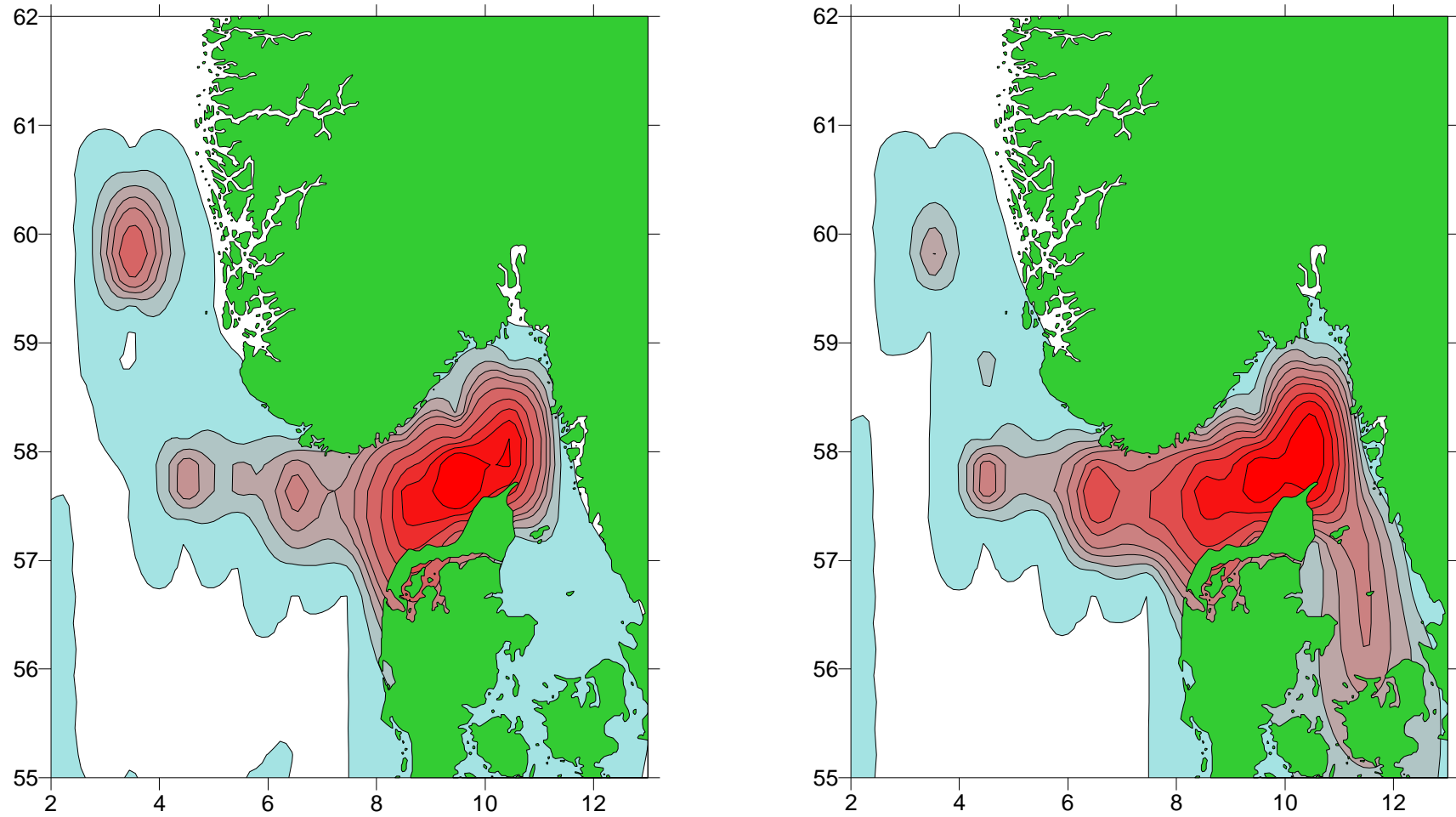


Figure 9. Relative distribution of numbers of mature (left panel) and juvenile (right panel) Western Baltic spring spawning herring, from combined acoustic surveys in June July 2000.