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**NAFO/ICES *PANDALUS* ASSESSMENT GROUP MEETING**

# Results of the Norwegian Bottom Trawl Survey for Northern Shrimp (*Pandalus borealis*) in Skagerrak and the Norwegian Deep (ICES Divisions IIIa and IVa east) in 2006 and 2007

by

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## Abstract

The Norwegian shrimp survey in Skagerrak and the Norwegian Deep (ICES Divs. IIIa and IVa east) has gone through large changes in recent years. The result is a series of four different surveys, lasting from two to nineteen years. New series were initiated in both 2004 (May) and 2006 (February). Conducting the survey in the 1st quarter gives good estimates of recruitment and SSB. In 2007, the survey was conducted in February, and in 2008 it will be as well. Thus, a new time series at the most optimal time of year is established.

There was no trend in the annual survey biomass estimates from the mid 1990s to 2002 when this series was discontinued. The 2004 and 2005 mean values of a new biomass index series were not statistically different. The 2007 index is 77% higher than the 2006 value. This increase in biomass is probably mainly due to the very large 2005-year class.

The size distribution of the 2006 survey has a large mode of 1-year old shrimp, which appears as a very large mode of 2-year old shrimp dominating the catches in the 2007 survey. The 1-group in 2007 is of equal size as the 1-group in 2006, indicating good catches of both 2- and 3-year old shrimp in 2008.

An index of shrimp predator biomass was estimated to 60.8 kg/nm in 2007, compared with only 18.7 kg/nm in 2006.

## Introduction

A trawl survey for northern shrimp in Skagerrak and the North Sea (ICES Divs. IIIa and IVa east, and the far north-east corner of Div. IVb) has since 1984 been conducted annually by the Norwegian Institute of Marine Research with the objective of assessing the biomass and demographic composition of the shrimp stock, the size of the stocks of shrimp predators, as well as measuring hydrographical conditions in the distributional area of shrimp.

The survey data consist of: 1) one time series based on a survey conducted in October/November 1984-2002 using R/V *Michael Sars* and the Campelen-trawl; 2) a point estimate for 2003 as R/V *Michael Sars* was taken out of service and substituted with R/V *Håkon Mosby*, whose winches at that time were not powerful enough for the Campelen-trawl, resulting in the survey being conducted with the Shrimp trawl 1420; 3) a start of a potential new series as the survey in both 2004 and 2005 was conducted in May/June with R/V *Håkon Mosby* using the standard Campelen trawl; and 4) a start of yet a new series in February 2006 still using R/V *Håkon Mosby* and the Campelen trawl. Conducting the survey in the 1st quarter gives good estimates of the 1-group (recruitment) and SSB (berried females) and was strongly recommended by the *Pandalus* working group in 2004 (ICES 2005). In 2007, the survey was conducted in February, and in 2008 it will be as well. Thus, a new time series at the most optimal time of year is established.

This paper presents the results of the 2006 and 2007 surveys.

## Material and Methods

*Survey design*

The design of the new time series (2004-2005 and 2006- ) is similar to the old one (1984-2002) (ICES 2005).

The survey area covers depths of approximately 100 to 550 m in ICES Div. IIIa and IVa east. A couple of stations are located in the far north-east corner of Div. IVb. The survey is stratified by four depth zones (100-200 m, 200-300 m, 300-500 m, and >500 m), and area (Table 1, Fig. 1). In 2007 the strata division has been revised. The depth contours have been updated using GIS and the bathymetric database GEBCO, and the strata areas have been updated accordingly. The strata 1-4 have been extended north to 60º N in order to incorporate the two northernmost stations in the strata system, and the deep water area in the middle of Skagerrak (>500 m) has been included as a 17$^{th}$ stratum as 4 trawl stations are located in this area. Thus, the new survey area is divided into 17 strata covering 16 789 nm² (Table 1, Figs. 1, 2).

The survey has a fixed station design with 100 stations distributed over the survey area (Fig. 1). The deepest and shallowest stations have depths of respectively 540 and 111 m. Ideally, all 100 stations should be trawled every year, giving a coverage of one haul per 168 nm$^2$. However, this rarely happens due to time constraints. The stations will be revised before the 2008 survey, aiming to obtain a more equal coverage of the different strata, possibly by both deleting old stations and adding new ones.

The survey data are analysed using a programme written in SAS-code (SAS statistical software). Changes were made in the programme in 2007 due to detection of errors in how the programme allocated stations to strata. The revised programme imports a table with stations allocated to strata by GIS, substituting the old SAS-routine that previously performed this task. Data from the 2006 survey has thus been reanalysed this year.

In 2006 the survey was carried out 2-15 February, and in 2007, 7-22 February. The trawl used is a Campelen 1800/35 bottom trawl with rockhopper gear. In 2006 the rigging was changed with more float added in order to reduce the number of “mud hauls”. This worked out very well, and the new rigging was kept in 2007. Mesh size in the cod end is 22 mm with a 6 mm lining net. Strapping has previously not been used, but in 2007 it was tried out in the first haul. The remaining hauls were without strapping, however, the door spread was still quite stable with a mean of 52.42 m (SD = 1.67 m). Thus, a fixed trawl geometry was assumed. Tow duration was 1 hour until 1989 when it was reduced to 0.5 hour. Tow speed is roughly 3 knots. In 2007 the average tow speed was 3.01 knots (SD = 0.19). No compensation for diurnal vertical migration is made.

In all surveys CTD casts have been made at each station, but previously the data have not been analysed. To avoid damages on the equipment, the CTD is not lowered further than 10 m above the bottom. For the 2008 survey, a temperature sensor will be attached to the trawl itself in order to measure the temperature at the bottom proper.

*Calibration experiment*

Data exist from a small shrimp survey (16 fixed stations) conducted in March 1988-2003 using R/V *G. M. Dannevig* and the Shrimp trawl 1420. During the 2007 survey parallel hauls by R/V *Håkon Mosby* (trawling with Campelen 1800) and R/V *G. M. Dannevig* (trawling with the Shrimp trawl 1420) were carried out on two stations. This trawl calibration enables comparison between the new survey series (2006- ) and the old, smaller survey with regards to recruitment and SSB.

These data have not been analysed for this assessment.

*Stock size index*

The swept area was estimated by applying a wingspread of 11.7 m to tow length. Tow length was time towed multiplied by an average towing speed of 3 knots. The swept area is thus 0.019 nm$^2$/hour.

The catch in each tow divided by the swept area represents a sample of shrimp density in a stratum. From these samples the mean and standard error of the density in each stratum was calculated and multiplied by the area of the

stratum to give an estimate of stratum biomass and abundance. The biomass and abundance for the 17 strata were summed to give the overall values for the survey area.

A biomass index of shrimp predators was calculated as average catch/nm over all hauls of 22 fish species or species' groupings.

*Biological samples*

Samples of 250-300 shrimp specimens are taken from each trawl haul, sorted by sexual characteristics, and measured to the nearest mm below (carapace length (CL)). The length frequency distribution of the samples was weighted by stratum area to obtain estimates of the overall distribution, as well as distribution per area (Skagerrak and the Norwegian Deep). Length frequency distributions were partitioned into age groups by modal analysis using the method of Bhattacharya (1967) (software: FISAT).

## Results

*Area coverage*

Three out of the 16 days of the 2007 survey were reserved for hydrographical investigations. Due to weather and time constraints, only 66 out of the 100 fixed stations were covered (Fig. 3). There were two invalid tows, one tow was used for testing strapping, and two stations were towed several times as part of the calibration, thus only 60 tows were available for analysis. This is still an improvement from the 2006 survey, where only 43 tows were available for analysis.

*Temperature and salinity*

In 2007 the average temperature (10 m above the bottom) on the Norwegian Deep trawl stations was 7.9 ºC (SD: 0.5), and in Skagerrak 7.3 ºC (SD: 0.8) (Fig. 4). The salinity was 35.20 ‰ (SD: 0.07) and 35.17 ‰ (SD: 0.07) in the Norwegian Deep and Skagerrak respectively.

*Biomass indices*

The biomass index increased from the late 1980s to the early 1990s, remained at a stable level until the mid 1990s where after it started fluctuating at a slightly higher level (Table 2, Fig. 5). This series was discontinued in 2002. The very low 2003 biomass index could have resulted from the use of the Shrimp trawl 1420, which has mesh size in the cod end of 36 mm, and no lining. However, the trawl opening is taller compared with the Campelen trawl. The 2005 mean value is lower than that of 2004, but not statistically different. The 2007 index is 77% higher than the 2006 value, but is heavily influenced by the very high mean biomass in stratum 16 (Table 2), which could explain some of the difference. However, even if data from stratum 16 are removed, the 2007 index is still 34% higher than the 2006 index (24 500 vs. 18 254 t (tons)).

In both 2006 and 2007 shrimp catches per nm were higher in Skagerrak (Div. IIIa) compared with the Norwegian Deep (Div. IVa east) (Fig. 6). This is also shown by a higher biomass index in Skagerrak than in the Norwegian Deep, both in 2006 (10 890 vs. 9 805 t) and in 2007 (26 080 vs. 10 650 t). The survey results are supported by trends in the LPUE from the fishery (Søvik and Thangstad 2007), where the area specific LPUE is much higher in Skagerrak than in the Norwegian Deep both in 2006 and in 2007, and where the LPUE in both areas increases from 2006 to 2007.

*Size, age and sex distribution*

In Skagerrak, the size distribution of the 2006 survey shows a large mode (12.1 mm CL) of 1-year old shrimp (Table 3, Fig. 7a), which appears as a very large mode of 2-year old shrimp (16.5 mm CL) dominating the catches in the 2007 survey. The 1-group in 2007 is of equal size as the 1-group in 2006, indicating good catches of both 2- and 3-year old shrimp in 2008.

In contrast to the good recruitment in Skagerrak, there were almost no 1-group shrimp in the Norwegian Deep, neither in 2006 nor in 2007, and the survey catches were completely dominated by shrimp 2 years and older (Fig. 7b). The 2-group was larger in 2007 compared with 2006, contrary to what one would expect from the very low density of 1-year old shrimp in the 2006 survey. A weak 2005 year class in the Norwegian Deep was also

suggested by the length distributions of commercial catches in 2006 (SCR Doc. 07/82). A sudden increase in the 2005 year class in the Norwegian Deep in early 2007 suggests migration of shrimp from Skagerrak into the Norwegian Deep.

The total length distribution very much resembles the distribution in Skagerrak due to the much larger catches in this area (Fig. 7a). The very large 2005-year class probably makes up most of the increase in biomass from 2006 to 2007.

*Predator abundance*

Catch per trawl haul (kg/nm) in 2007 are given for various shrimp predators (Fig. 8). Saithe is the most numerous species, with an average catch of 39.3 kg/nm (Table 4). The total index of shrimp predator biomass was estimated to 60.8 kg/nm in 2007, compared with only 18.7 kg/nm in 2006 (Table 4). The increase is mainly due to an increase in the saithe index. Results from the first survey series (1984-2002) range from 28.6 to 63.1kg/nm (ICES 2004), while in 2004-2005 the indices were respectively 58.1 and 115.4 kg/nm (ICES 2006). This indicates that last year's index was very low, however, the results from the different surveys are not comparable.

## References

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**Table 1.** The estimated biomass available to the trawl (Ktons) and abundance (millions) from the Norwegian shrimp survey in Skagerrak and the Norwegian Deep (ICES Divs. IIIa and IVa east) in 2006 and 2007. Depth intervals are given in meter, and stratum area in $nm^2$. SE is the standard error.

2006

| Stratum | Depth (m) | Area (nm^2) | Hauls | Biomass | SE | Abund. | SE |
|---|---|---|---|---|---|---|---|
| 1 | 100-200 | 2,542 | - | - | - | - | - |
| 2 | 200-300 | 2,464 | 1 | 2.88 | - | 378 | - |
| 3 | 100-200 | 273 | - | - | - | - | - |
| 4 | 200-300 | 1,539 | 3 | 1.98 | 0.94 | 434 | 226 |
| 5 | 100-200 | 1,374 | - | - | - | - | - |
| 6 | 200-300 | 1,137 | 3 | 2.07 | 1 | 368 | 110 |
| 7 | 300-500 | 544 | - | - | - | - | - |
| 8 | 100-200 | 134 | - | - | - | - | - |
| 9 | 200-300 | 576 | 2 | 0.37 | 0.31 | 114 | 103 |
| 10 | 300-500 | 531 | 1 | 0.12 | - | 36 | - |
| 11 | 100-200 | 361 | 5 | 0.86 | 0.30 | 311 | 113 |
| 12 | 200-300 | 250 | 5 | 0.88 | 0.23 | 219 | 85 |
| 13 | 300-500 | 725 | 3 | 1.87 | 1.24 | 473 | 324 |
| 14 | 100-200 | 1,384 | 8 | 3.27 | 1.03 | 874 | 248 |
| 15 | 200-300 | 725 | 7 | 1.57 | 0.41 | 419 | 139 |
| 16 | 300-500 | 1,116 | 5 | 2.44 | 0.79 | 1079 | 469 |
| 17 | > 500 | 1,116 | - | - | - | - | - |
| Total | | 16,789 | 43 | 18.31 | 0.81 | 4,705 | 258 |

2007

| Stratum | Depth (m) | Area (nm^2) | Hauls | Biomass | SE | Abund. | SE |
|---|---|---|---|---|---|---|---|
| 1 | 100-200 | 2,542 | - | - | - | - | - |
| 2 | 200-300 | 2,464 | 6 | 3.65 | 0.44 | 585 | 97 |
| 3 | 100-200 | 273 | - | - | - | - | - |
| 4 | 200-300 | 1,539 | 5 | 1.00 | 0.38 | 154 | 62 |
| 5 | 100-200 | 1,374 | 2 | 0.11 | 0.11 | n.m. | n.m. |
| 6 | 200-300 | 1,137 | 5 | 2.92 | 0.84 | 573 | 177 |
| 7 | 300-500 | 544 | 1 | 0.72 | - | 173 | - |
| 8 | 100-200 | 134 | - | - | - | - | - |
| 9 | 200-300 | 576 | 4 | 1.22 | 0.69 | 178 | 95 |
| 10 | 300-500 | 531 | 2 | 1.03 | 0.07 | 247 | 31 |
| 11 | 100-200 | 361 | 3 | 2.01 | 0.69 | 548 | 205 |
| 12 | 200-300 | 250 | 6 | 1.30 | 0.50 | 483 | 171 |
| 13 | 300-500 | 725 | 3 | 6.74 | 0.65 | 2498 | 189 |
| 14 | 100-200 | 1,384 | 10 | 1.82 | 0.70 | 351 | 129 |
| 15 | 200-300 | 725 | 9 | 1.98 | 0.31 | 462 | 88 |
| 16 | 300-500 | 1,116 | 3 | 12.23 | 7.67 | 3721 | 2330 |
| 17 | > 500 | 1,116 | 1 | 0.00 | - | 0 | - |
| Total | | 16,789 | 60 | 36.73 | 2.14 | 9973 | 667 |

**Table 2.** Estimated biomass indices (t) from the Norwegian shrimp survey in Skagerrak and the Norwegian Deep (ICES Divs. IIIa and IVa east) by survey and stratum 1984-2007. Indices from the different surveys series are not comparable (see text). SE is the standard error.

| Survey | | Stratum | | | | | | | | | | | | | | | | | Total area | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Series | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | Index | SE |
| 1984 | 1 | 0 | 2441 | - | 2144 | 4048 | 3093 | 1313 | - | 336 | 346 | 316 | 1)556 | 605 | 1253 | 1305 | 1535 | | 19291 | |
| 1985 | 1 | 0 | 4768 | - | 1162 | 3288 | 2607 | 2016 | 0 | 815 | 475 | 1)1900 | 794 | 840 | 4921 | 2664 | 4066 | | 30316 | |
| 1986 | 1 | 0 | 2183 | - | 920 | 1)933 | 1940 | 663 | - | 389 | 177 | 1)857 | 540 | 618 | 1521 | 2073 | 733 | | 13547 | |
| 1987 | 1 | 88 | 3765 | - | 2482 | 4103 | 3294 | 1237 | 0 | 1370 | 254 | 1)1470 | 584 | 419 | 2168 | 1350 | 964 | | 23548 | |
| 1988 | 1 | 0 | 1126 | - | 720 | 373 | 1079 | 682 | 0 | 294 | 96 | 472 | 391 | 282 | 814 | 777 | 343 | | 7449 | |
| 1989 | 1 | - | 932 | - | 2347 | 1)898 | 1722 | 1159 | 0 | 560 | 263 | 579 | 556 | 498 | 1375 | 1443 | 918 | | 13248 | |
| 1990 | 1 | 0 | 705 | 187 | 3245 | 1)1067 | 2373 | 471 | 0 | 647 | 171 | 1044 | 559 | 564 | 2088 | 1895 | 907 | | 15920 | |
| 1991 | 1 | 0 | 1903 | 1008 | 2612 | 189 | 2851 | 1053 | 152 | 725 | 189 | 740 | 526 | 716 | 2163 | 2683 | 1312 | | 18821 | |
| 1992 | 1 | 0 | 615 | 717 | 585 | 136 | 5743 | 2299 | 0 | 568 | 527 | 2091 | 951 | 669 | 3567 | 2550 | 1211 | | 22229 | |
| 1993 | 1 | 0 | 1481 | 401 | 4063 | 1)1487 | 1437 | 688 | - | 621 | 281 | 2596 | 758 | 728 | 2735 | 3823 | 1237 | | 22336 | |
| 1994 | 1 | 0 | 1391 | 626 | 2321 | 345 | 2439 | 1992 | - | 461 | 255 | 1627 | 468 | 844 | 3004 | 2284 | 1320 | | 19377 | |
| 1995 | 1 | 0 | 2794 | - | 1420 | 202 | 4042 | 953 | - | 818 | 236 | 1836 | 513 | 665 | 2950 | 2076 | 1714 | | 20220 | |
| 1996 | 1 | 0 | 4901 | - | 1367 | 133 | 3576 | 1108 | - | 533 | 441 | 3590 | 616 | 921 | 4277 | 2456 | 1286 | | 25205 | |
| 1997 | 1 | 0 | 7882 | - | 1995 | 416 | 3393 | 2406 | - | 764 | 349 | 1969 | 1530 | 1487 | 3199 | 3584 | 3169 | | 32143 | |
| 1998 | 1 | - | 5069 | - | 3357 | 586 | 2223 | 1049 | - | 682 | 401 | 1105 | 451 | 529 | 3186 | 2439 | 1378 | | 22455 | |
| 1999 | 1 | 0 | 5180 | - | 5360 | 3158 | 3254 | 1051 | - | 235 | 243 | 475 | 266 | 311 | 4560 | 2228 | 1596 | | 27917 | |
| 2000 | 1 | - | 3436 | - | 2664 | 1121 | 2181 | 695 | - | 343 | 158 | 939 | 380 | 286 | 4159 | 2495 | 1497 | | 20354 | |
| 2001 | 1 | - | 5180 | 0 | 5360 | 3158 | 3254 | 1051 | - | 307 | 245 | 512 | 266 | 311 | 4560 | 2228 | 1596 | | 28028 | |
| 2002 | 1 | - | 1)3922 | - | 1)3104 | 459 | 3749 | 1847 | - | 1153 | 364 | 1403 | 496 | 411 | 5425 | 4470 | 3329 | | 30133 | |
| 2003 | 2 | - | - | - | 1410 | 750 | 2770 | 840 | 300 | 1240 | 430 | 480 | 770 | 960 | 2210 | 1950 | 850 | | 14960 | |
| 2004 | 3 | - | 3590 | - | 2830 | - | 3540 | 1530 | - | 690 | 400 | 120 | 1390 | 1230 | 11060 | 4650 | 2890 | | 33920 | 11600 |
| 2005 | 3 | 0 | 3790 | - | 5460 | 0 | 3160 | 1900 | - | 1130 | 580 | 1580 | 570 | 910 | 3370 | 3150 | 4500 | | 30100 | 11100 |
| 2006 | 4 | - | 2880 | - | 1980 | 2)1187 | 2070 | 2)1198 | - | 370 | 120 | 860 | 880 | 1870 | 3270 | 1570 | 2440 | - | 20694 | 810 |
| 2007 | 4 | - | 3650 | - | 1000 | 110 | 2920 | 720 | - | 1220 | 1030 | 2010 | 1300 | 6740 | 1820 | 1980 | 12230 | 0 | 36730 | 2140 |

1) Estimated as an average of the stratum estimates scaled by overall biomass of the year.

2) Estimated using strata specific mean biomasses (proportions) averaged over all years

**Table 3.** Mean carapace length (CL) with standard deviation (SD), abundance (millions) and proportions of age groups 1, 2 and 3+ from the 2006 and 2007 survey estimates of stock length frequency distribution in Skagerrak and the Norwegian Deep (ICES Divs. IIIa and IVa east). n.m. = "not measured" (very small catches were not length measured resulting in abundance not being calculated).

| | | Skagerrak | | | |
|---|---|---|---|---|---|
| year | age | CL (mm) | SD | abundance | proportion |
| 2006 | 1 | 12.06 | 1.45 | 1518 | 0.43 |
| | 2 | 17.72 | 1.37 | 1298 | 0.37 |
| | 3+ | 21.17 | 1.41 | 739 | 0.21 |
| 2007 | 1 | 11.38 | 1.17 | 1571 | 0.20 |
| | 2 | 16.50 | 1.41 | 5871 | 0.73 |
| | 3+ | 21.03 | 1.73 | 600 | 0.07 |

| | | Norwegian Deep | | | |
|---|---|---|---|---|---|
| year | age | CL (mm) | SD | abundance | proportion |
| 2006 | 1 | 10.80 | 0.97 | 21 | 0.01 |
| | 2 | 14.86 | 1.69 | 356 | 0.25 |
| | 3 | 19.35 | 1.48 | 700 | 0.49 |
| | 4+ | 23.65 | 1.28 | 347 | 0.24 |
| 2007 | 1 | 10.26 | 1.44 | 39 | 0.02 |
| | 2 | 16.56 | 1.83 | 1159 | 0.63 |
| | 3 | 22.56 | 1.79 | 649 | 0.35 |

| | | Total | | | |
|---|---|---|---|---|---|
| year | age | CL (mm) | SD | abundance | proportion |
| 2006 | 1 | 12.29 | 1.58 | 1728 | 0.36 |
| | 2 | 18.26 | 1.72 | 2190 | 0.45 |
| | 3 | 22.74 | 1.85 | 937 | 0.19 |
| 2007 | 1 | 11.45 | 1.23 | 1679 | 0.17 |
| | 2 | 16.51 | 1.47 | 6958 | 0.69 |
| | 3 | 21.74 | 1.91 | 1135 | 0.11 |
| | 4+ | 26.03 | 1.10 | 322 | 0.03 |

**Table 4.** Estimated indices of predator biomass based on catch per nm recorded from the Norwegian shrimp survey in Skagerrak and the Norwegian Deep (ICES Divs. IIIa and IVa east) in 2006 and 2007.

| | biomass index | |
|---|---|---|
| Species | 2006 | 2007 |
| Blue whiting | 0.13 | 0.14 |
| Saithe | 7.20 | 39.30 |
| Cod | 0.50 | 1.21 |
| Roundnosed Grenadier | 3.16 | 6.68 |
| Rabbit fish | 2.21 | 1.97 |
| Haddock | 0.96 | 3.79 |
| Redfishes | 0.18 | 0.39 |
| Velvet Belly | 1.28 | 2.53 |
| Skates, Rays | 0.40 | 0.01 |
| Long Rough Dab | 0.21 | 0.63 |
| Hake | 0.96 | 0.79 |
| Angler | 0.15 | 0.89 |
| Witch | 0.23 | 0.73 |
| Dogfish | 0.30 | 0.20 |
| Whiting | 0.34 | 0.97 |
| Blue Ling | 0 | 0 |
| Ling | 0.04 | 0.10 |
| Fourbearded Rockling | 0.06 | 0.14 |
| Cusk | 0.20 | 0 |
| Halibut | 0.08 | 0.08 |
| Pollack | 0.06 | 0.26 |
| Greater Fork-beard | 0 | 0 |
| Total | 18.65 | 60.81 |

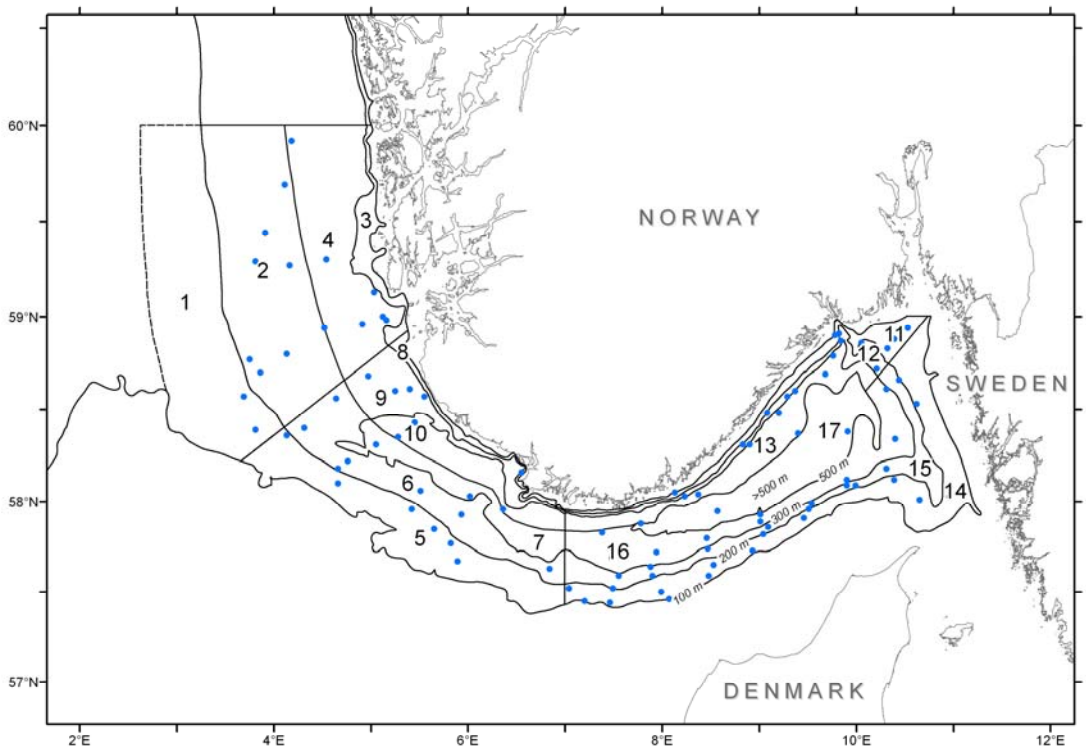


**Fig. 1.** Norwegian shrimp trawl survey in Skagerrak and the Norwegian Deep (ICES Divs. IIIa and IVa east): the revised strata system (introduced in 2007) with the 100 fixed trawl stations. Areas of the 17 strata are given in Table 1.

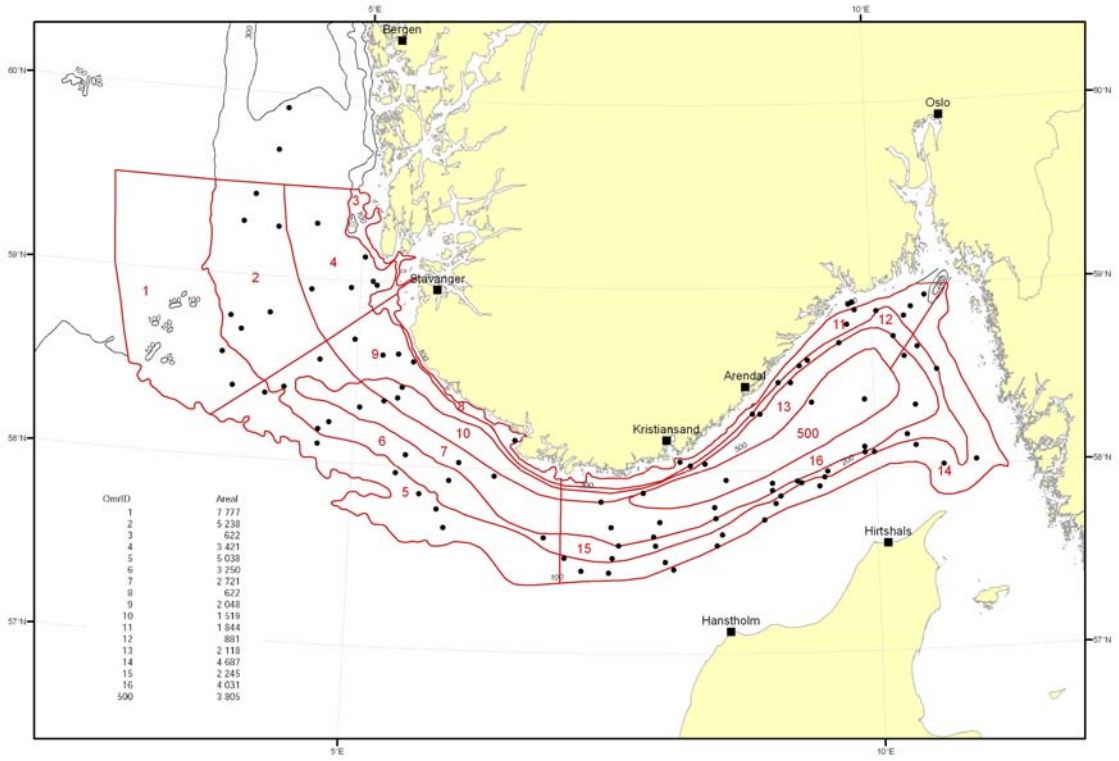


**Fig. 2.** Norwegian shrimp trawl survey in Skagerrak and the Norwegian Deep (ICES Divs. IIIa and IVa east): the old strata system (used until 2005) with the 100 fixed trawl stations. Areas ($nm^2$) of the 17 strata are given.

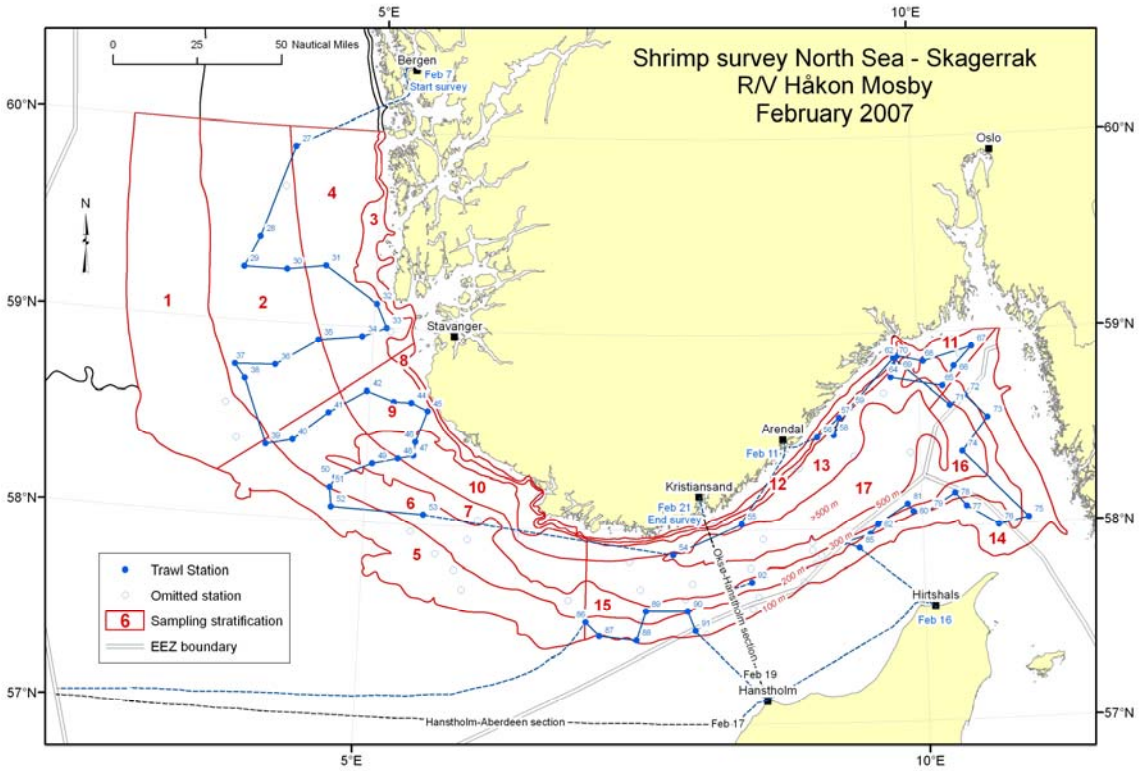


**Fig. 3.** The Norwegian shrimp survey in February 2007 with R/V *Håkon Mosby*: sailing route and trawled stations.

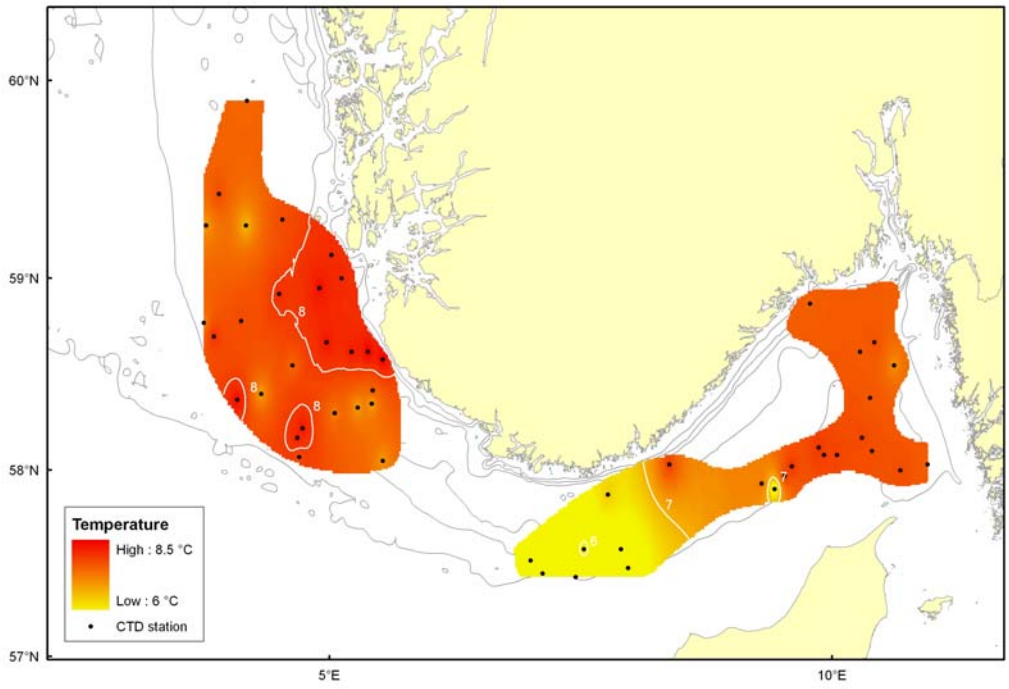


**Fig. 4.** Temperatures (ºC) measured with CTD on trawl stations during the February 2007 shrimp survey in Skagerrak and the Norwegian Deep (ICES Divs. IIIa and IVa east).

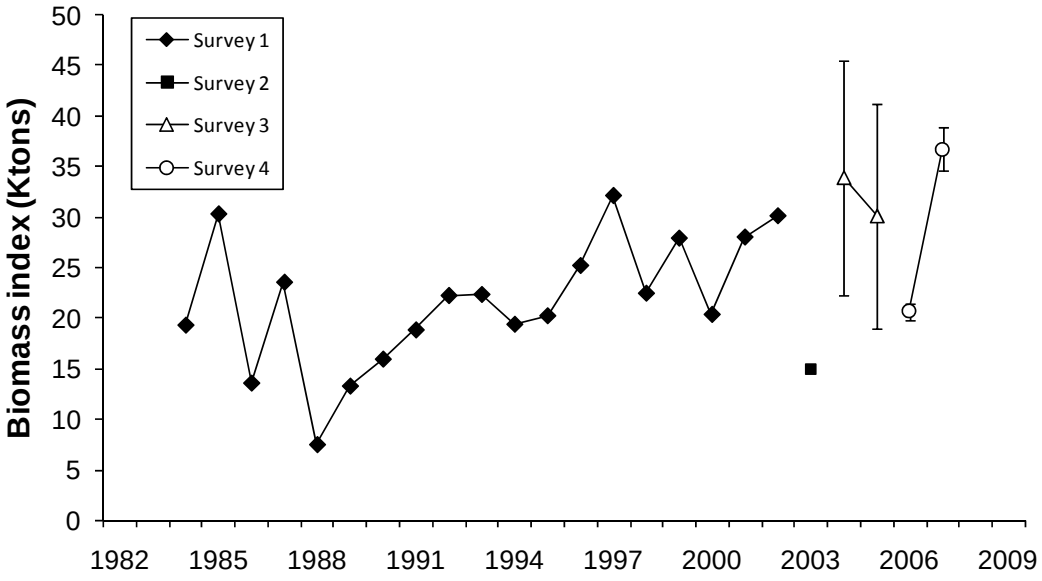


**Fig. 5.** Estimated survey biomass indices of shrimp (*Pandalus borealis*) in Skagerrak and the Norwegian Deep (ICES Divs. IIIa and IVa east), 1984-2007. The four surveys are not calibrated to a common scale. Standard errors have been calculated for the 2004-2007 surveys.

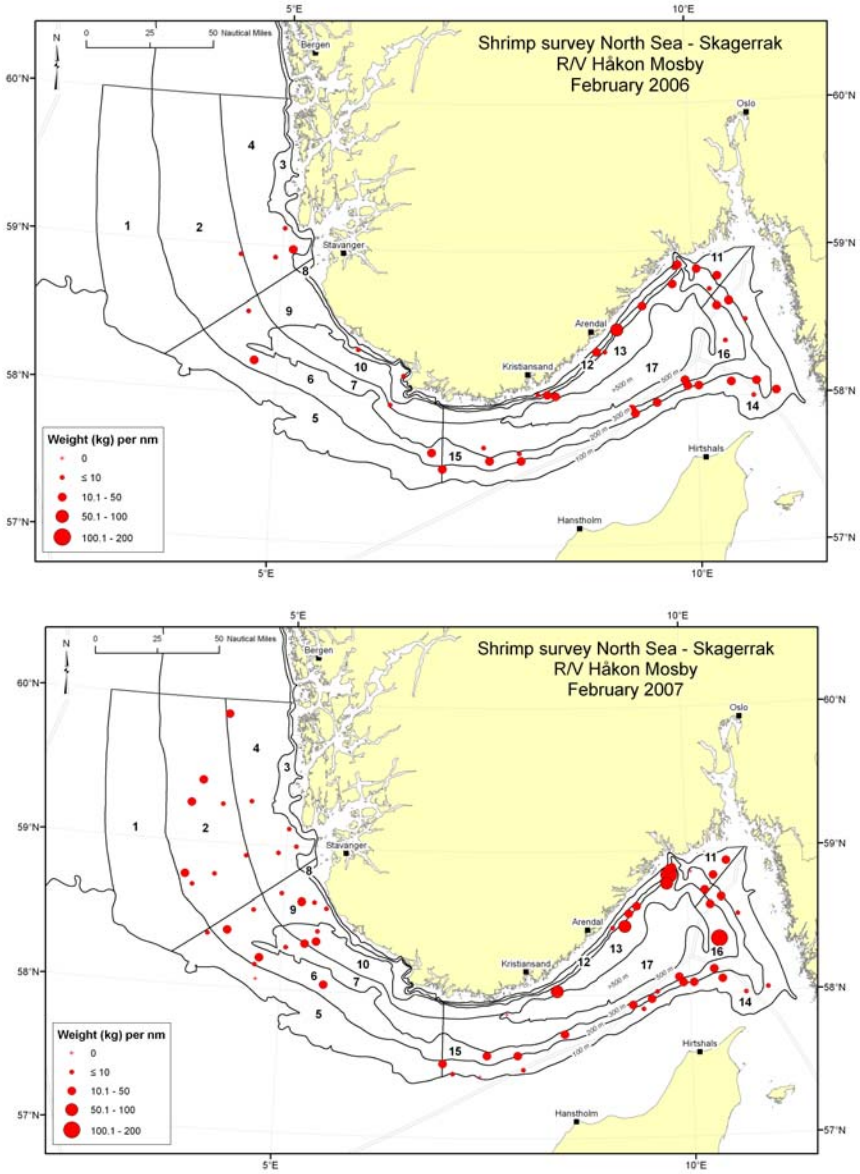


**Fig. 6.** Shrimp catches per trawl station (kg/nm) from the Norwegian shrimp survey in Skagerrak and the Norwegian Deep (ICES Divs. IIIa and IVa east) in February 2006 and 2007.

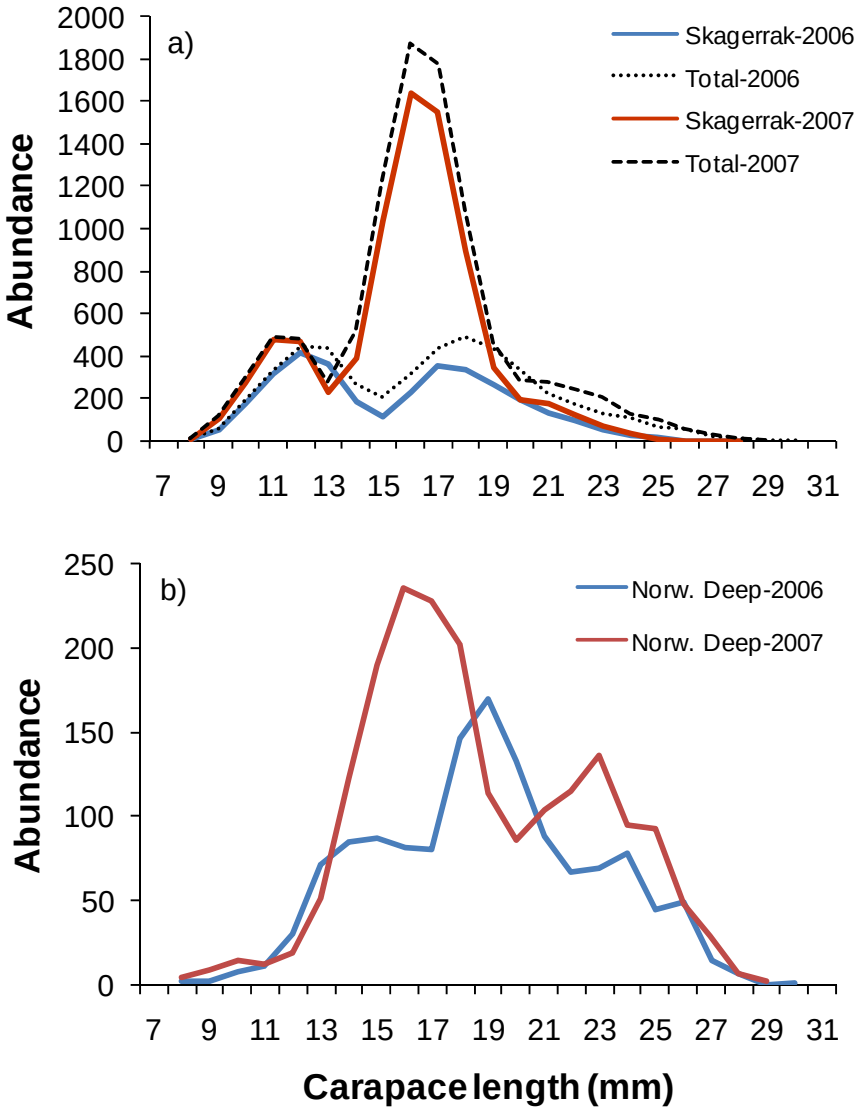


**Fig. 7.** Length frequency distributions for a) Skagerrak (ICES Div. IIIa) and b) the Norwegian Deep (ICES Div. IVa east) from the Norwegian shrimp survey in February 2006 and 2007. Total distributions are plotted in a). Note different scales on y-axes. Abundance in millions.

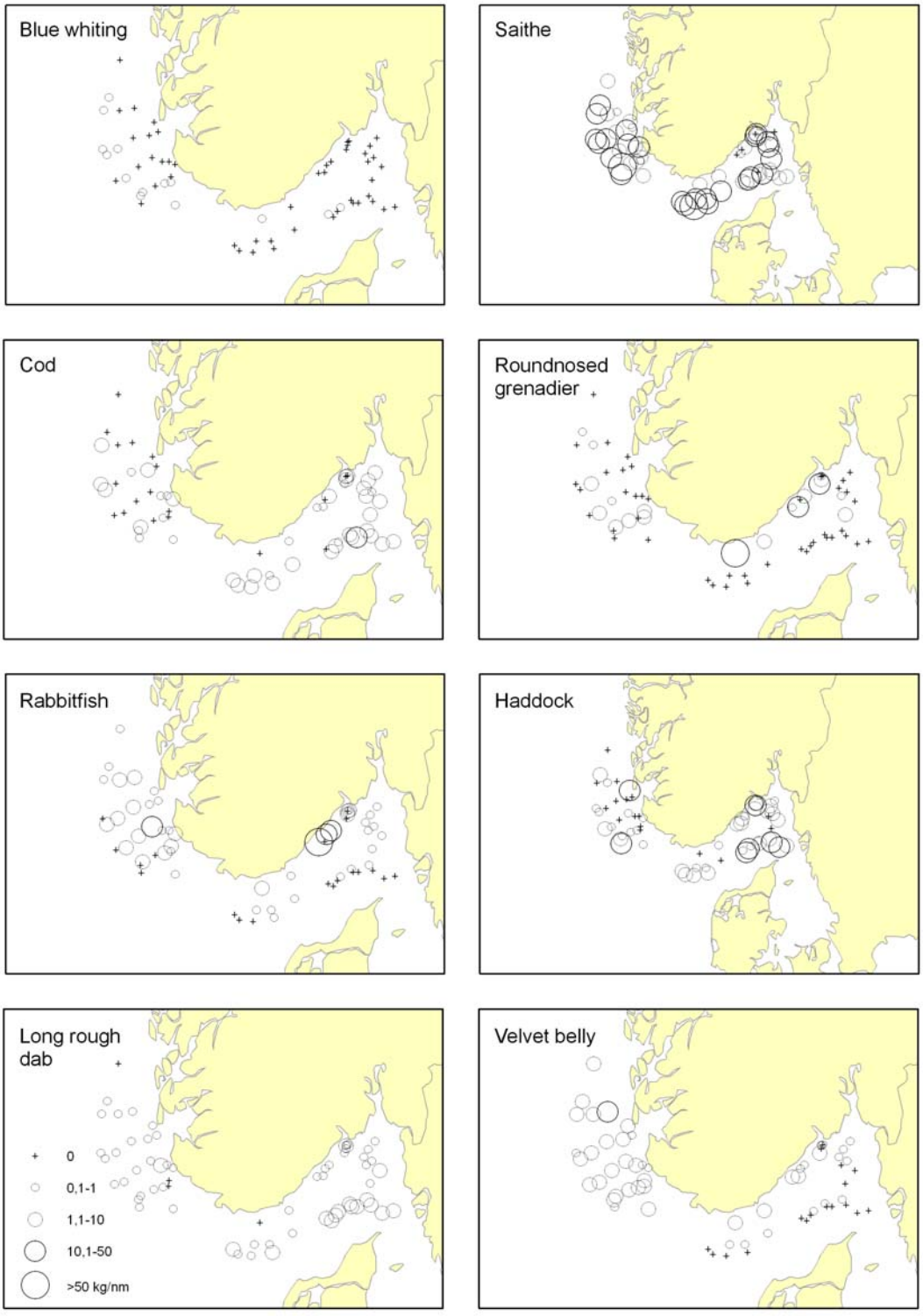


**Fig. 8.** Catches per trawl station (kg/nm) of shrimp predators from the Norwegian shrimp survey in Skagerrak and the Norwegian Deep (ICES Divs. IIIa and IVa east) in February 2007.

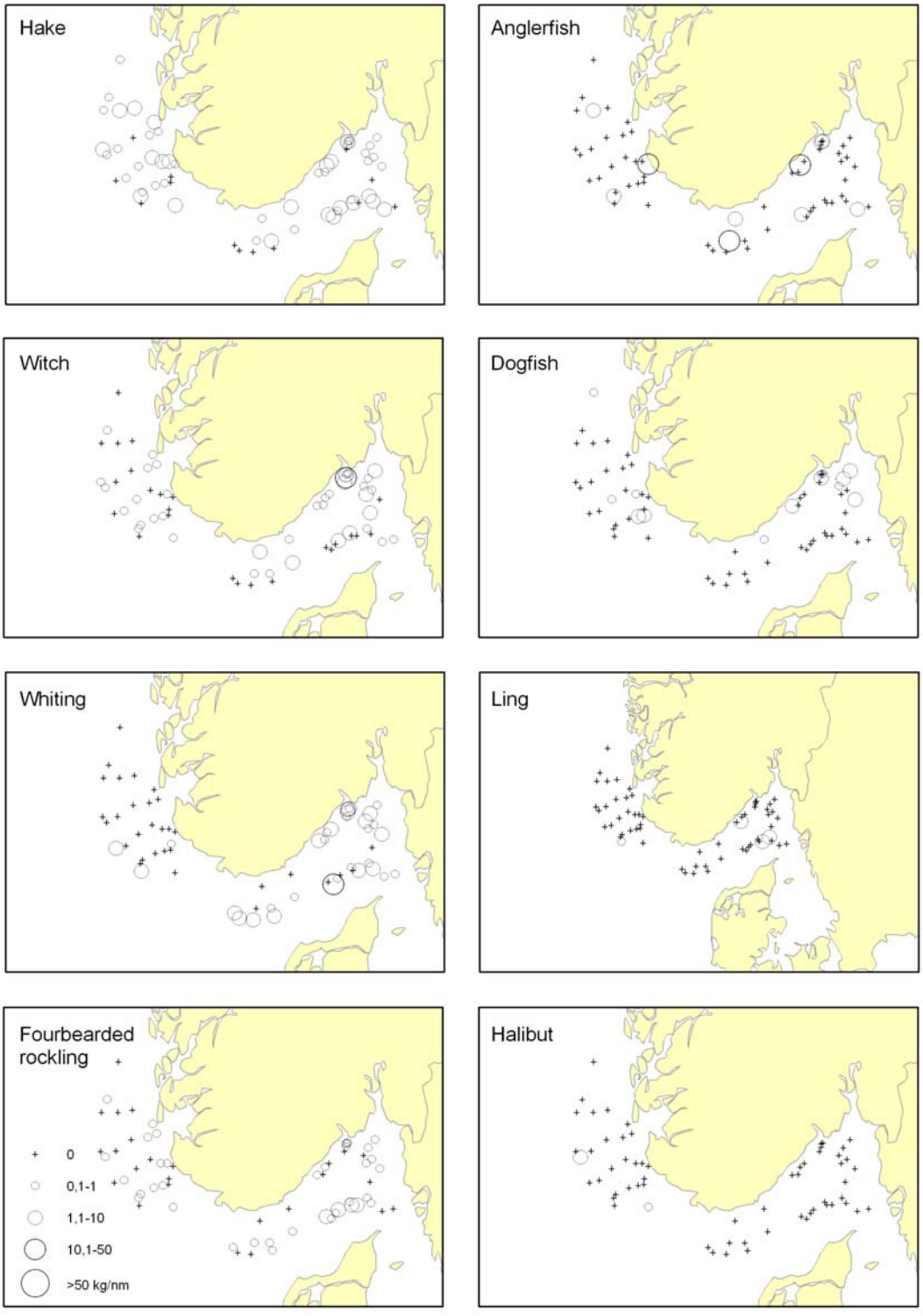


Fig 8. Continued


Fig. 8. continued