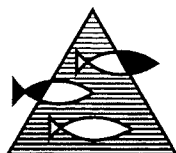


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Rapport:

FISKEN OG HAVET

NR. 12 - 1999

Tittel:

DISTRIBUTION AND ABUNDANCE OF NORWEGIAN SPRING
SPAWNING HERRING DURING THE SPAWNING SEASON IN 1999

Senter:

Marine ressurser

Seksjon:

Pelagisk

Forfatter(e):

Aril Slotte & Are Dommasnes

Antall sider, vedlegg inkl.:

27

Dato:

09.09.99

Sammendrag:

During the period 15.02-21.03.99 the maturing and spawning herring (*Clupea harengus* L.) were distributed along the Norwegian coast from 57°N to 69°N. Between 61°N and 69°N the biomass and abundance estimates were 7.1 million tonnes and 27.6 billion individuals respectively, whereas between 57°N and 60°N the respective estimates were 90 thousand tonnes and 323 million individuals at the highest. The 1992 and 1991 year classes predominated the spawning stock with 42.7 % and 27.3 % respectively, but the proportion of 1991 year class tended to increase northwards from 62°N. The average overall body length, condition factor, somatic condition factor and gonad condition factor tended to increase southwards. This tendency was also recorded within year classes. The temperature and salinity increased with depth. In addition these parameters tended to decrease northwards and southwards from 62°N at all depths, and they tended to decrease at bank areas (depth < 200 m), i.e. spawning areas. North of 61°N the herring mainly spawned at depths between 100-200 m with ambient temperatures at 6-8°C and a salinity of 33.5-35 ‰. South of 61°N the majority of the herring spawned at depths below 75 m with temperatures at 3.5-6°C and a salinity at 32.5-34 ‰.

Emneord:

1. Abundance
2. distribution
3. herring
4. migration
5. spawning

.....
Prosjektleder

.....
Seksjonsleder

«Cruise report»

RV *Michael Sars* 15.02.-21.03.99

**Distribution and abundance of Norwegian spring spawning
herring during the spawning season in 1999**

by

Aril Slotte and Are Dommasnes

Institute of Marine Research, P. O. Box 1870, Nordnes, N-5817 Bergen, Norway

Participants

Dommasnes, Are	15.02 - 01.03, cruise leader
Gill, Helga	05.03 - 21.03
Haugsdal, Annlaug	15.02 - 05.03
Hermansen, Eilert	15.02 - 05.03
Hestenes, Knut	05.03 - 21.03
Johnsen, Anne-Liv	15.02 - 05.03
Kvinge, Bjarte	05.03 - 21.03
Meland, Elna	05.03 - 21.03
Mjanger, Magnar	15.02 - 05.03
Nilsen, Leiv	15.02 - 16.02
Nilsen, Tore	05.03 - 21.03
Patel, Ruben	15.02 - 17.02
Slotte, Aril	01.03 - 21.03, cruise leader from 01.03
Strømsnes, Kjell	16.02 - 05.03

Methods

Acoustical data were registered with a 38 kHz SIMRAD EK 500 echo sounder and echo integrator. In addition BEI, Bergen echo integrator system, was also applied in the interpretation the data. Integrator values were divided into herring and «other categories» based on the density and appearance of the registrations, target strength (TS) distribution and data from trawl catches. Based on the acoustic observations and age composition in the trawl catches the distribution area was divided into sub areas. Conversion of integrator readings (S_A) to number of herring was achieved by the following relation between target strength (TS) and total fish length (L):

$$TS(\text{db}) = 20.0 \cdot \log L - 71.9$$

The number of individuals (N) within a certain area (A) was given by:

$$N = 1/\sigma \cdot S_A \cdot A \text{ where } 1/\sigma = 10^6 \cdot 1.23 \cdot L^{-2}$$

The area A with positive integrator values was delimited after plotting the 1 n.m. integrator values attributed to herring along the survey lines. The mean integrator value (S_A) was the arithmetic mean of all positive values within the area A.

Results

Abundance and distribution

The spawning grounds from 61°N to 69°N were surveyed during 17 February to 4 March (**Fig. 1**). As in previous years (Slotte, 1998a) the herring were mostly distributed in layers; close to the surface at night time and closer to bottom at day time. The total spawning stock within this area was estimated to 7.083 million tonnes and 27.605 billion individuals, of which about 50 % was distributed at the spawning grounds north of Møre (north of 64°N) (**Fig. 2**). The recruitment to the spawning stock in 1999 was low, and at the same time the stock was reduced with more than 1 million tonnes due to natural mortality and fishery mortality. Despite these circumstances the 1999 estimate was comparatively higher than the 1998 estimate of 5.3 million tonnes and 22.5 billion individuals (Slotte and Dommasnes, 1998). However, the estimate was more in accordance with estimates at the wintering grounds and in the feeding area than in previous years. Nevertheless, the reasons for the increased estimate remains to be explained.

During 6-7 March a local herring stock was surveyed in Åsenfjorden, but the results from these investigations are not given in the present paper. During 8-10 March coastal areas from 62°N to 59°N were surveyed (**Figs. 3-4**). Except for some registrations of spawning herring off Bremanger, no herring schools were observed along the cruise track. The traditional spawning grounds south of 59°N were surveyed during 10-12 March, and repeated during 16-18 March (**Fig. 5**). The first period 70 thousand tonnes of herring were estimated in the area (**Fig. 6**), whereas the next period the biomass was reduced to 21 thousand tonnes (**Fig. 7**).

Likewise the traditional spawning grounds to the west and south of the island of Karmøy was surveyed two times; during 14-16 March and 20-21 March (**Fig. 8**). The first period only 6 thousand tonnes was estimated in this area (**Fig. 9**), whereas the next period the biomass had increased to 19 thousand tonnes (**Fig. 10**). Due to the historical importance of the spawning grounds to the south of 60°N, these areas has been closely investigated in the past years. It seems that the herring in these areas are generally in a spawning stage. In other words they arrive in the area, spawn and leave again within a short period. Thus, the biomass in this area is probably underestimated.

Age and size distribution

The 1992 and 1991 year class (7 and 8 year olds) predominated in the spawning stock with 42.7 % and 27.3 % respectively, but the proportion of 1991 year class tended to increase northwards from Møre (**Fig. 11**). The proportion of young herring at age 3-5 also increased at the northernmost grounds. The composition off Karmøy and farther south were similar to that observed in the southern part of Møre, except for some increase in the young 3-5 year olds (**Fig. 12**). As in previous years (Slotte, 1998a), the herring were distributed close to bottom at the southern grounds. In addition gill nets for gadoids were very common within the spawning grounds. Therefore sampling with trawl was difficult, and the number of samples limited. It should be mentioned that one sample taken at Siragrunnen during the second survey, comprised mainly local herring which are characteristically smaller as first time spawners (**Fig. 13**).

In addition there were some clear latitudinal trends in the size of the herring. First, the average overall age groups body length, condition factor, somatic condition factor and gonad condition factor tended to increase southwards (**Fig. 14**). Second, also within age groups these parameters tended to increase southwards (**Figs. 15-18**). This size dependent distribution pattern is in accordance with the observations in recent years, which has been thoroughly discussed in Slotte and Dommasnes, 1997, 1998; Slotte, 1998b; Slotte, 1999a). The main hypothesis is that this could be due to the high energetic costs of migration, which is relatively higher in small compared to larger fish (Slotte, 1999b). Thus, large fish and fish in better condition will have a higher migration potential and more energy to invest in gonad production.

Temperature and salinity

The temperature (Figs. 19-20) and salinity (Figs. 21-22) increased with depth. In addition these parameters tended to decrease northwards and southwards from 62°N at all depths, and they tended to decrease at bank areas (depth < 200 m), i.e. spawning areas. The majority of the herring off Møre and northwards, spawned at depths between 100-200 m with ambient temperatures at 6-8°C and a salinity of 33.5-35 ‰. At the southernmost grounds (south of 61°N) the majority of the herring spawned at depths below 75 m, i.e. at temperatures of 3.5-6°C and a salinity of 32.5-34.

Acknowledgement

All the participants and the rest of the crew on board RV Michael Sars are thanked for their valuable work during the cruise.

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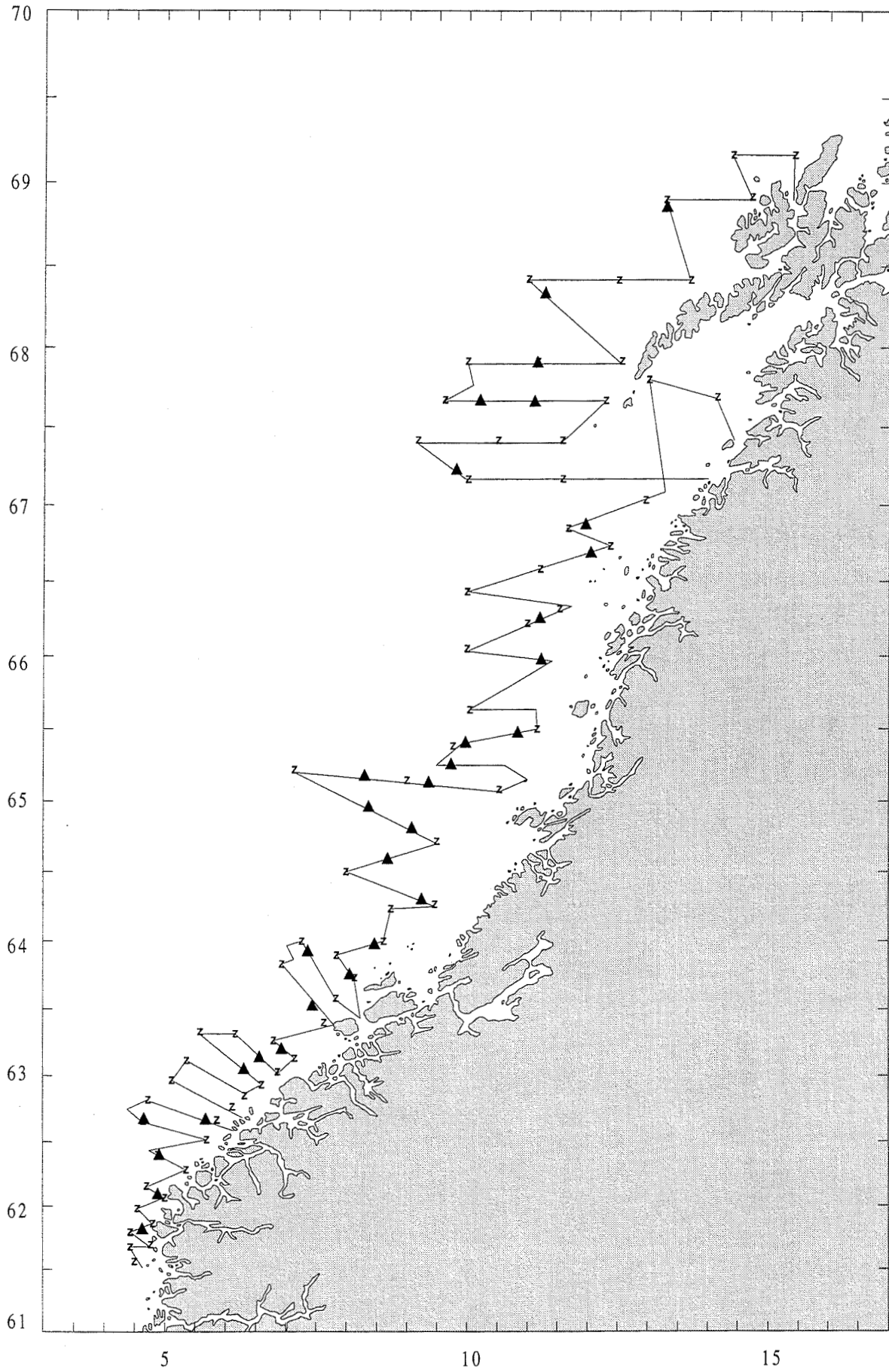


Fig. 1. Cruise tracks, CTD-stations (z) and pelagic trawl stations (filled triangles) during an acoustical survey with RV Michael Sars 17.02 - 04.03.99.

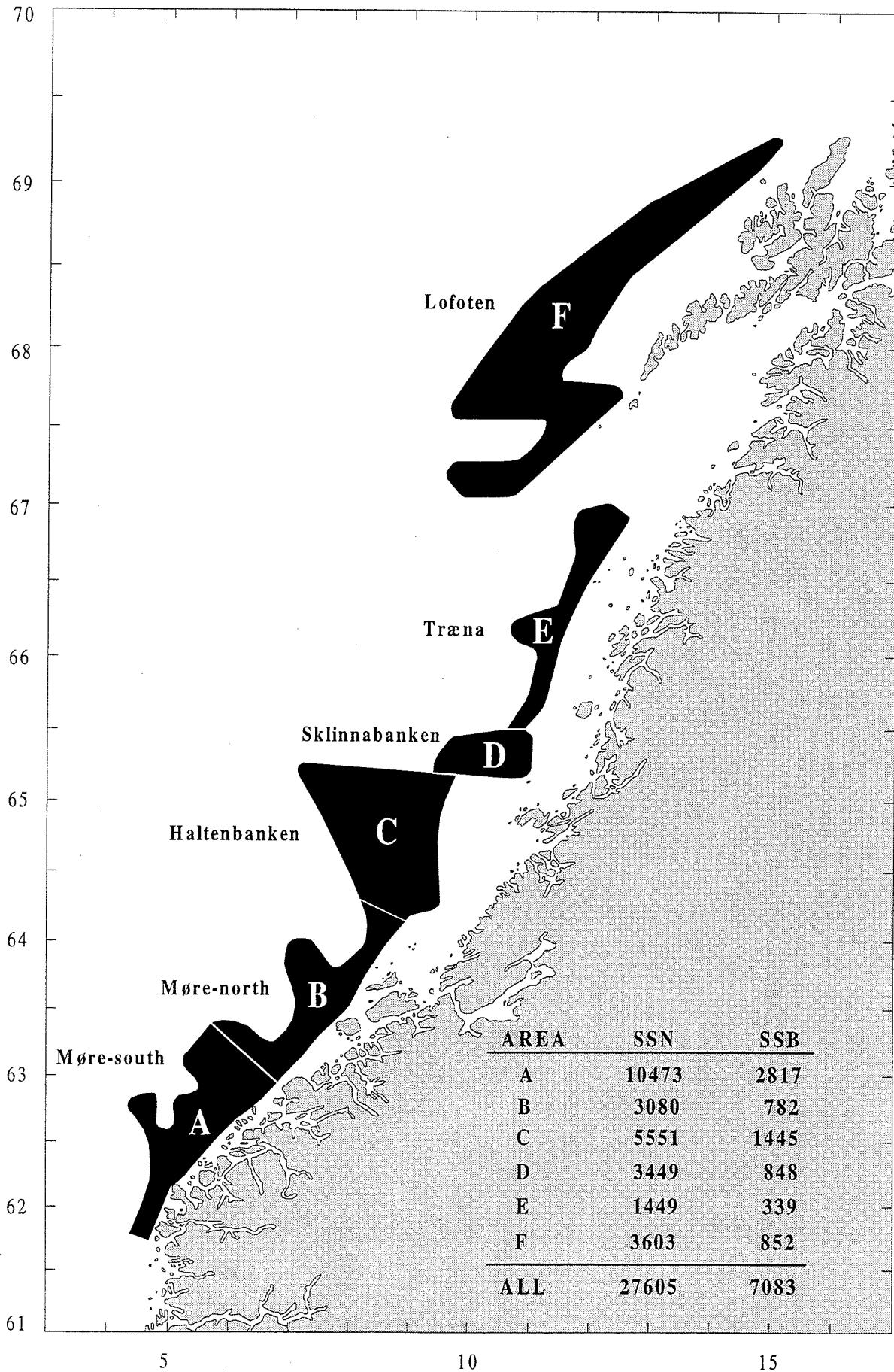


Fig. 2. Distribution areas, abundance (SSN) in millions and biomass (SSB) in thousand tonnes of mature Norwegian spring spawning herring as estimated during an acoustical survey with RV Michael Sars 17.02-04.03.99.

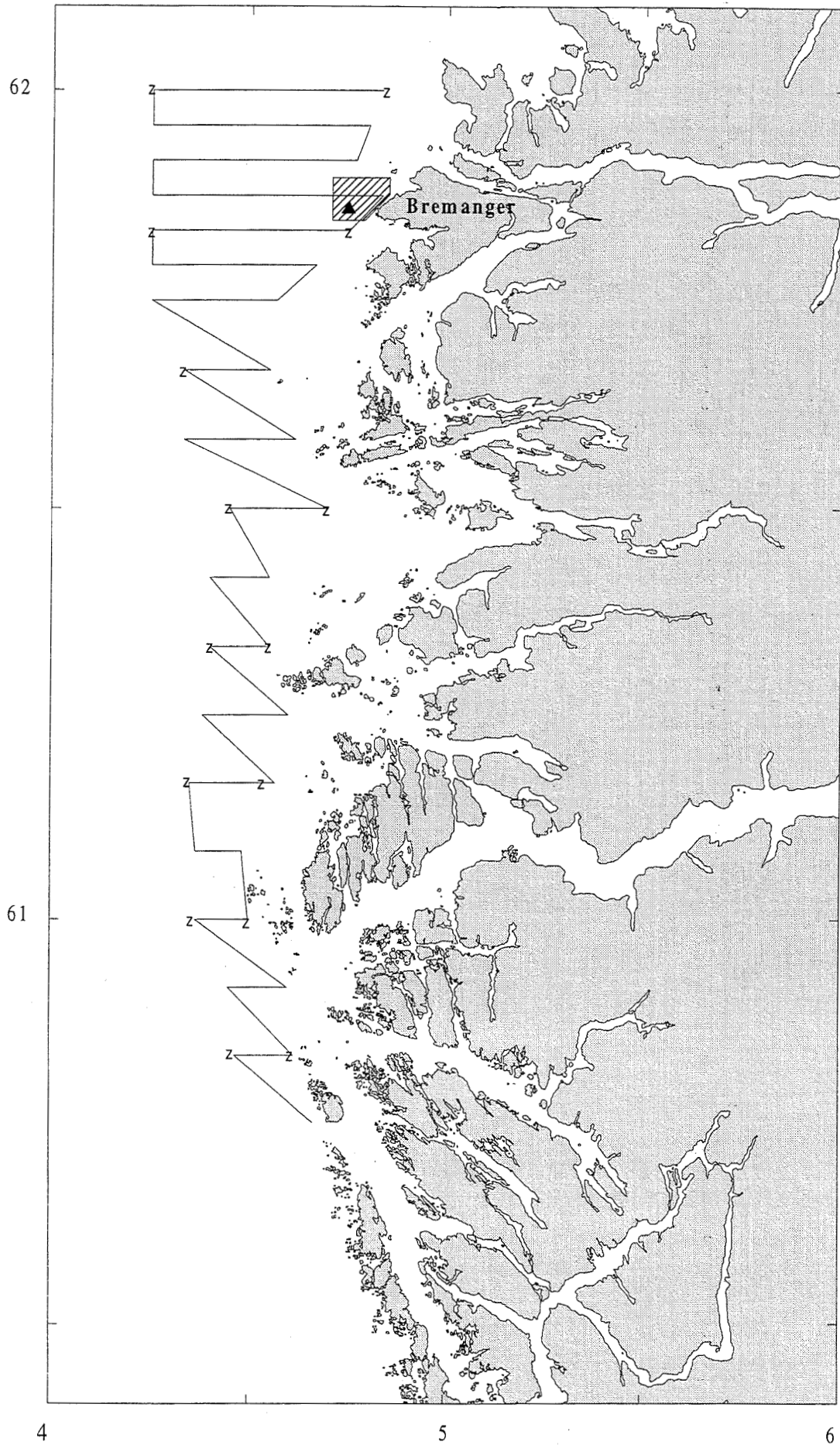


Fig. 3. Cruise tracks, CTD-stations (z), pelagic trawl station (filled triangle) and distribution area (hatched) of Norwegian spring spawning herring observed during an acoustical survey with RV Michael Sars 08.- 09.03.99.

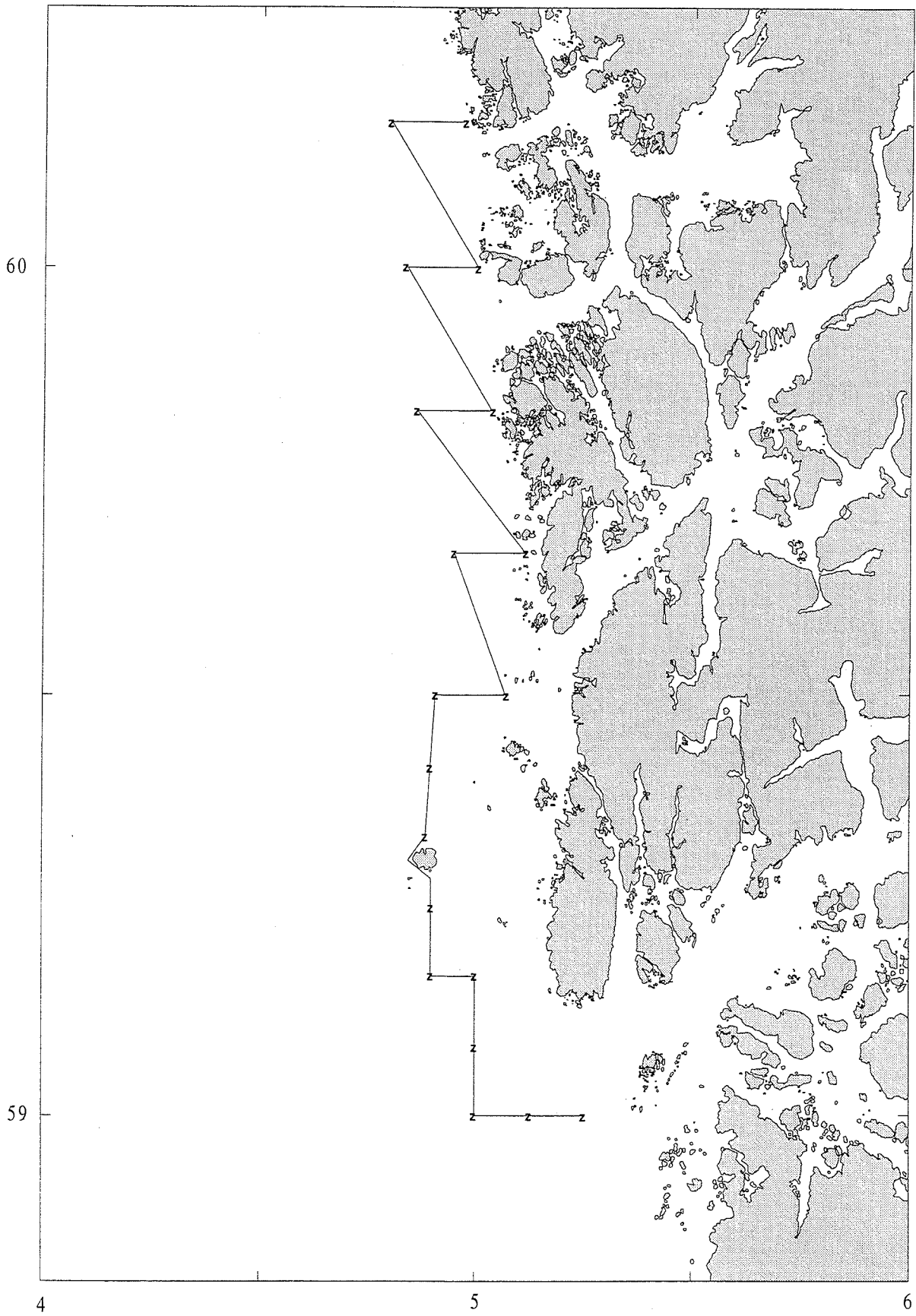


Fig. 4. Cruise tracks and CTD-stations (z) during an acoustical survey with RV Michael Sars 9.-10.03.99. Herring schools were not observed along the cruise track.

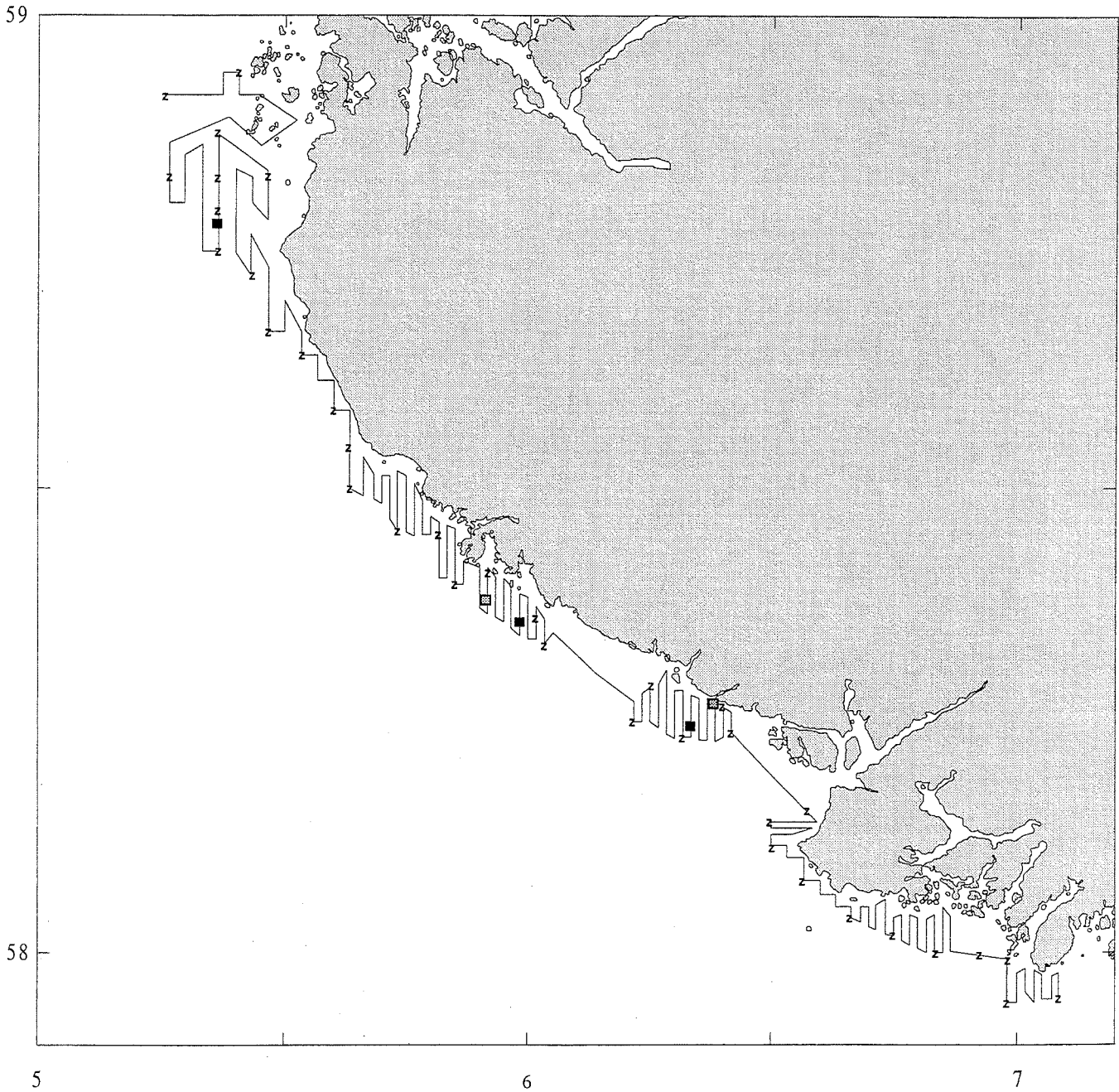


Fig. 5. Cruise tracks, CTD-stations (z) and bottom trawl stations (filled rectangles) during an acoustical survey with RV Michael Sars 10.-12.03.99. The cruise track was repeated during 16.-18-03.99, and grey rectangles denote trawl stations taken during this period.

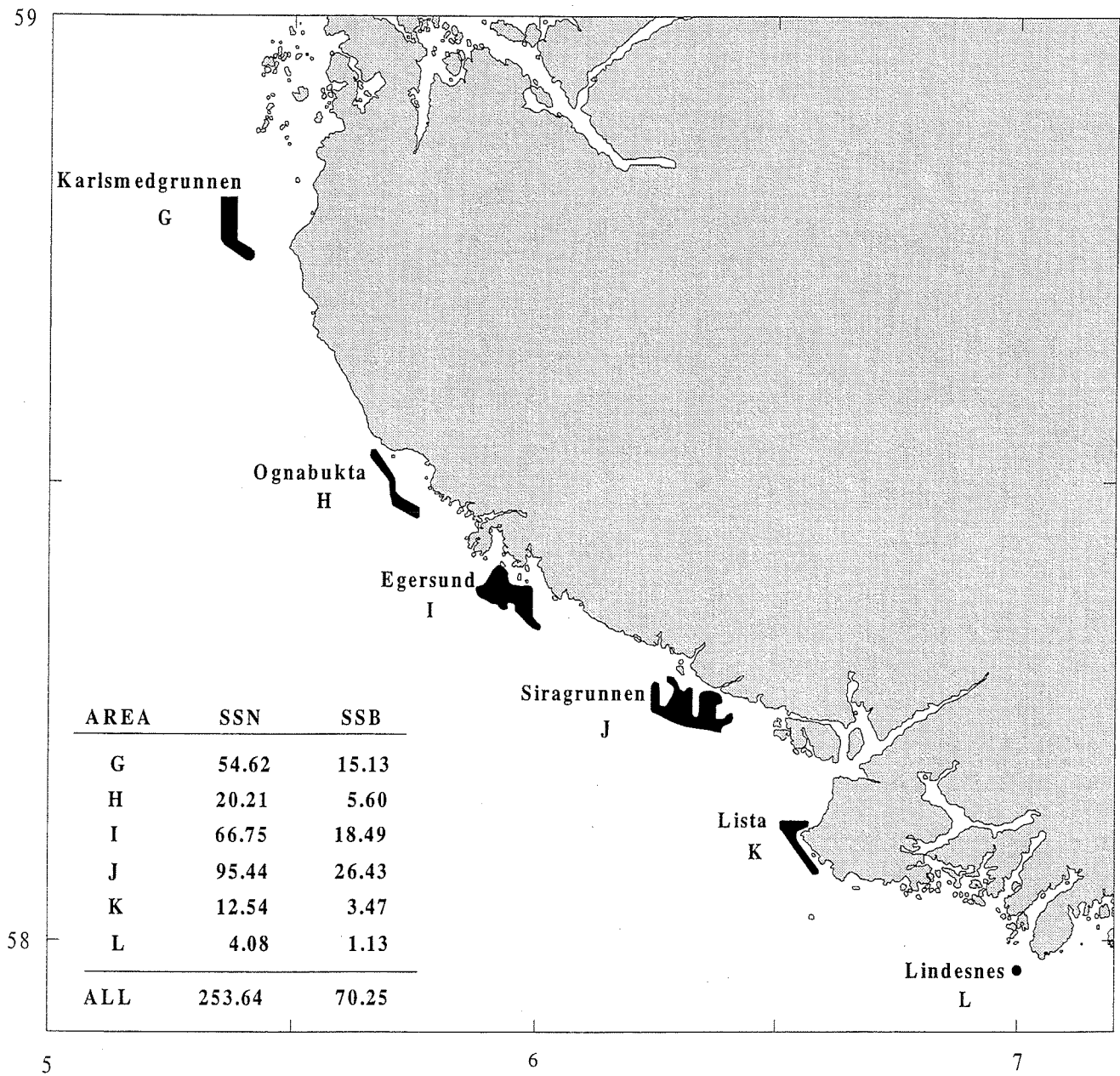


Fig. 6. Distribution areas, abundance (SSN) in millions and biomass (SSB) in thousand tonnes of mature Norwegian spring spawning herring during an acoustical survey with RV Michael Sars 10.03-12.03.99

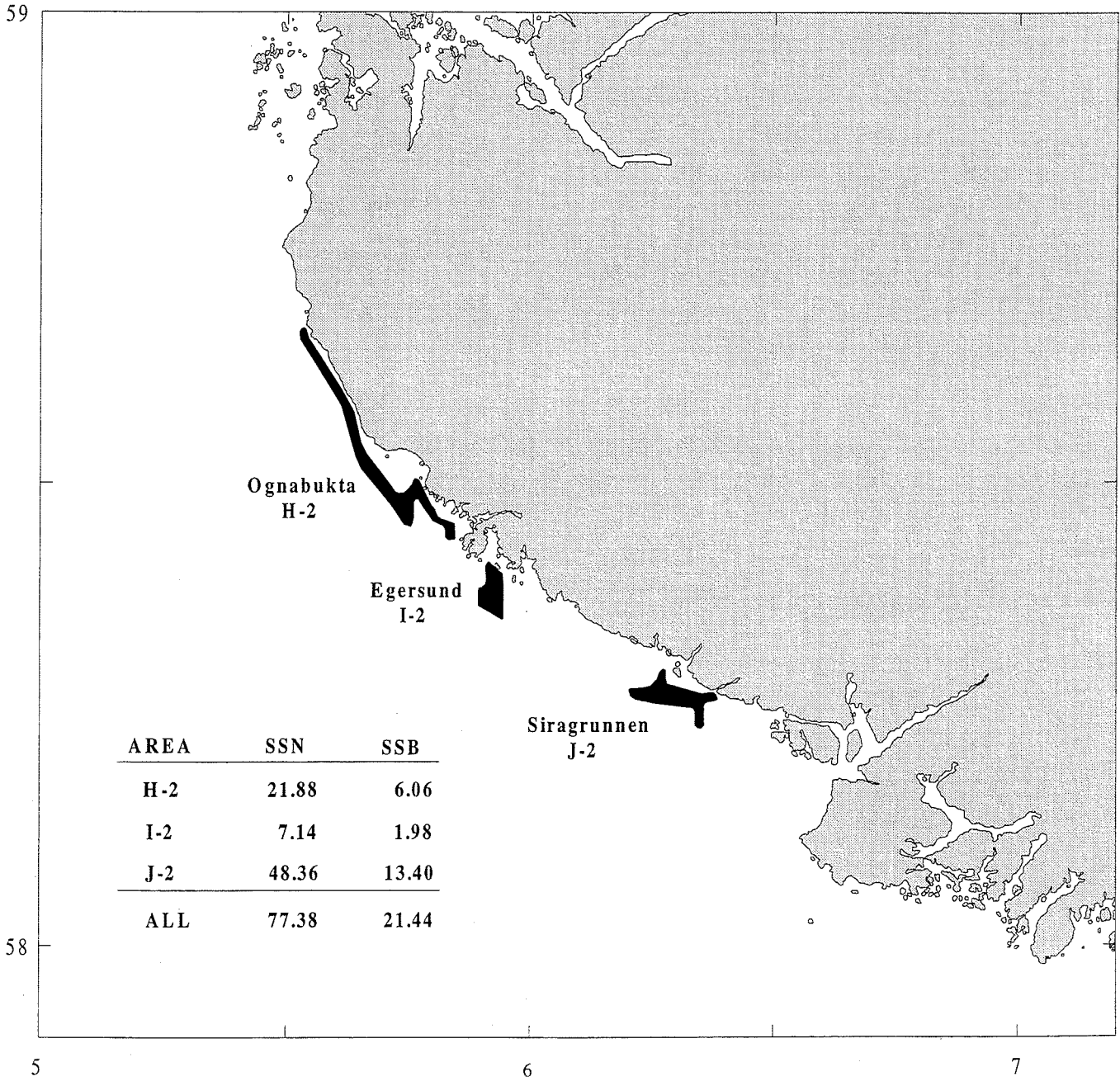


Fig. 7. Distribution areas, abundance (SSN) in millions and biomass (SSB) in thousand tonnes of mature Norwegian spring spawning herring during an acoustical survey with RV Michael Sars 16.03-18.03.99

59°30'

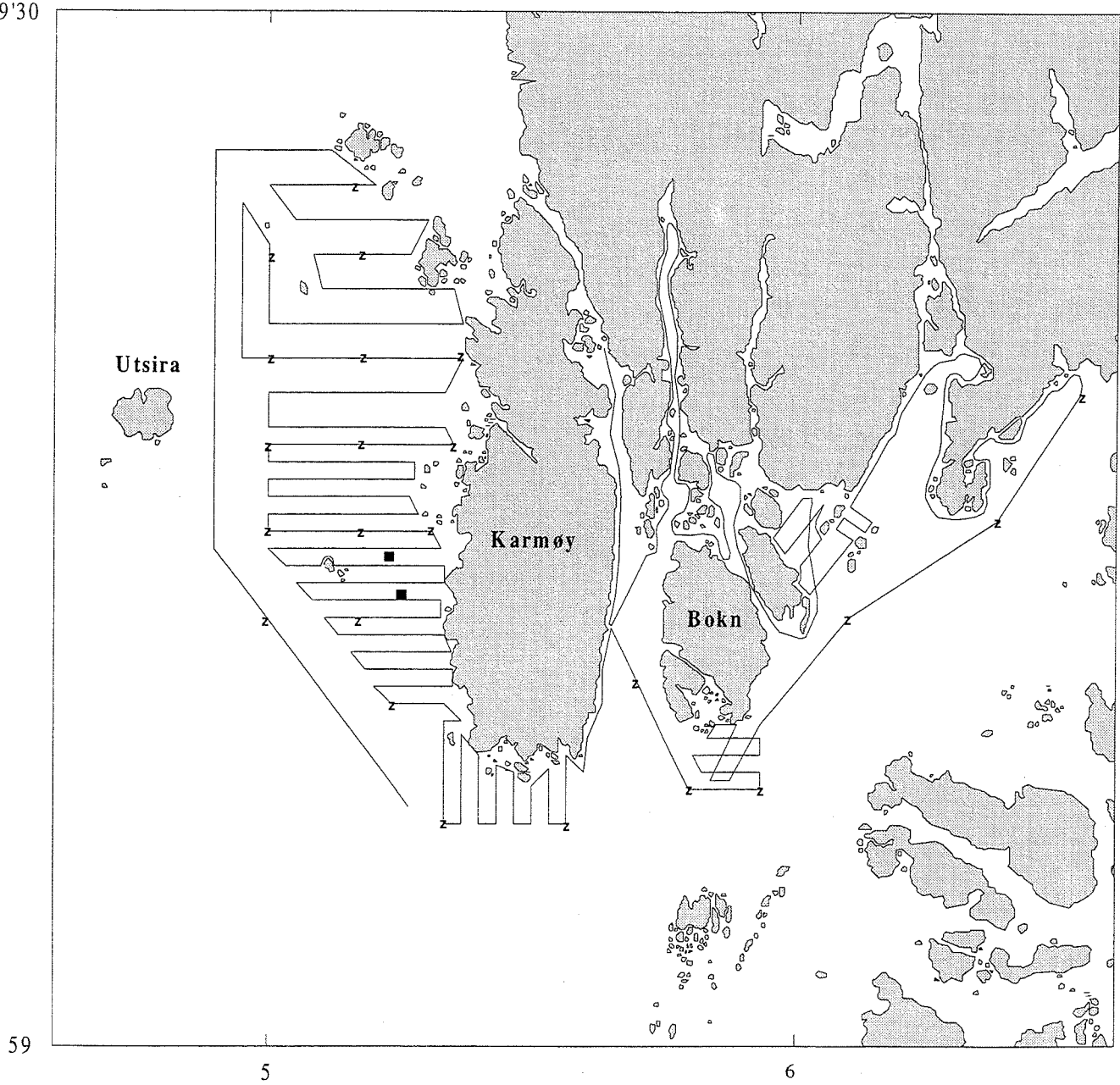


Fig. 8. Cruise tracks, CTD-stations (z) and bottom trawl stations (filled rectangles) during an acoustical survey with RV Michael Sars 14.-16.03.99. The cruise track was repeated 20.-21.03.99.

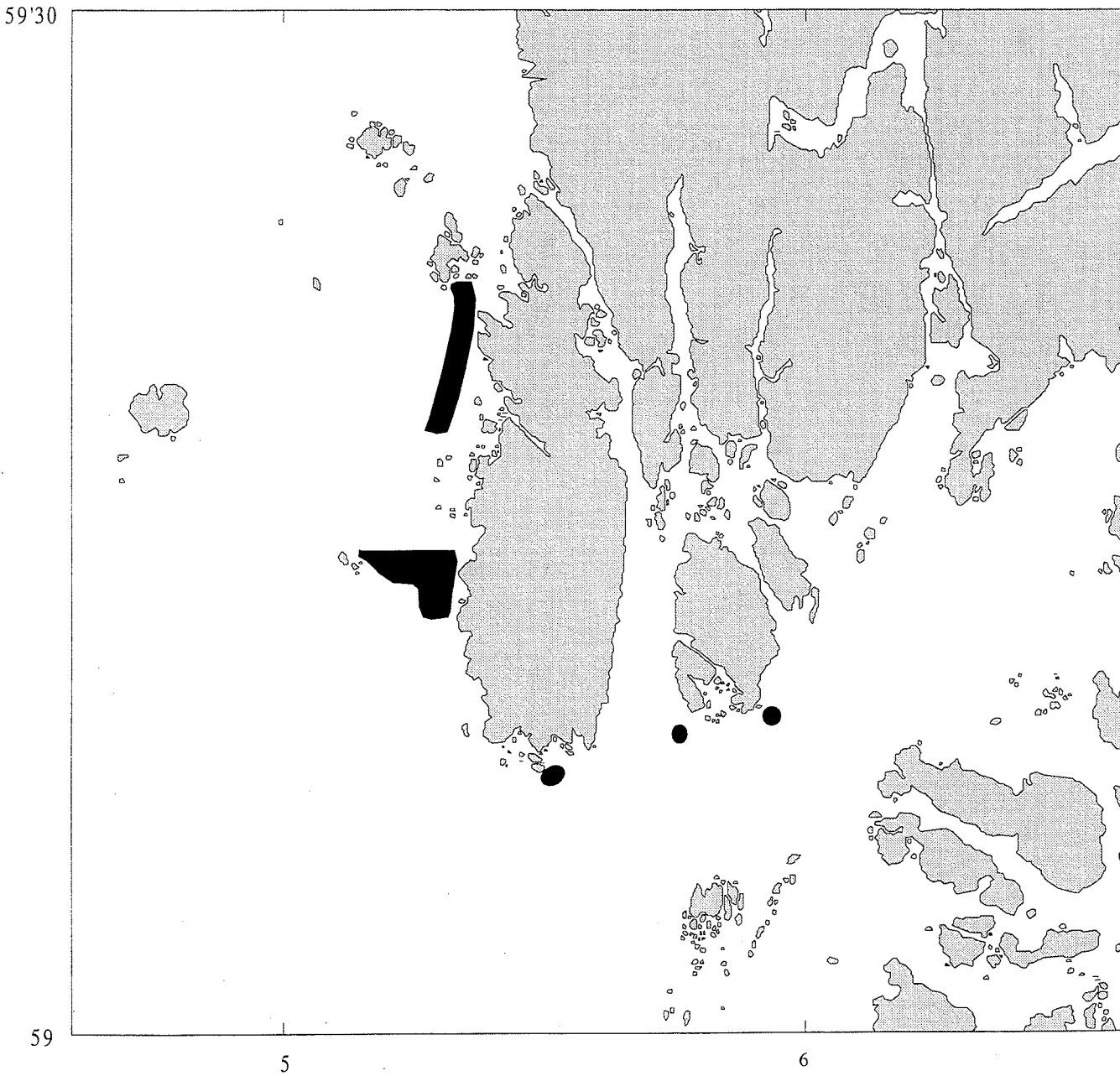


Fig. 9. Distribution areas of mature Norwegian spring spawning herring during an acoustical survey with RV Michael Sars off Karmøy 14.03-16.03.99. The estimated abundance in the Karmøy area was 22.72 millions, and the corresponding biomass was 6.46 thousand tonnes.

59'30

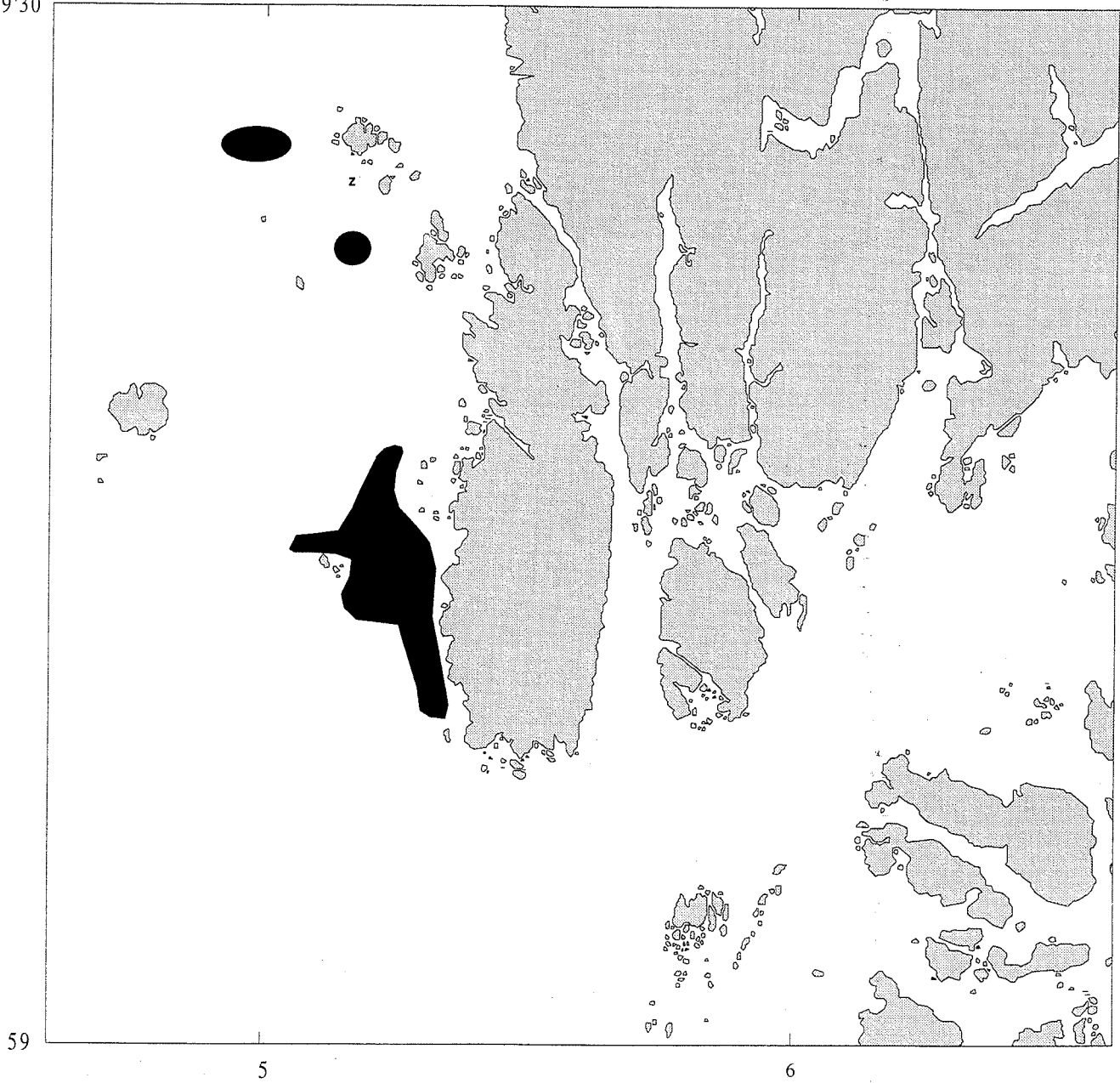


Fig. 10. Distribution areas of mature Norwegian spring spawning herring during an acoustical survey with RV Michael Sars off Karmøy 20.03-21.03.99. The estimated abundance in the Karmøy area was 68.75 millions, and the corresponding biomass was 19.54 thousand tonnes.

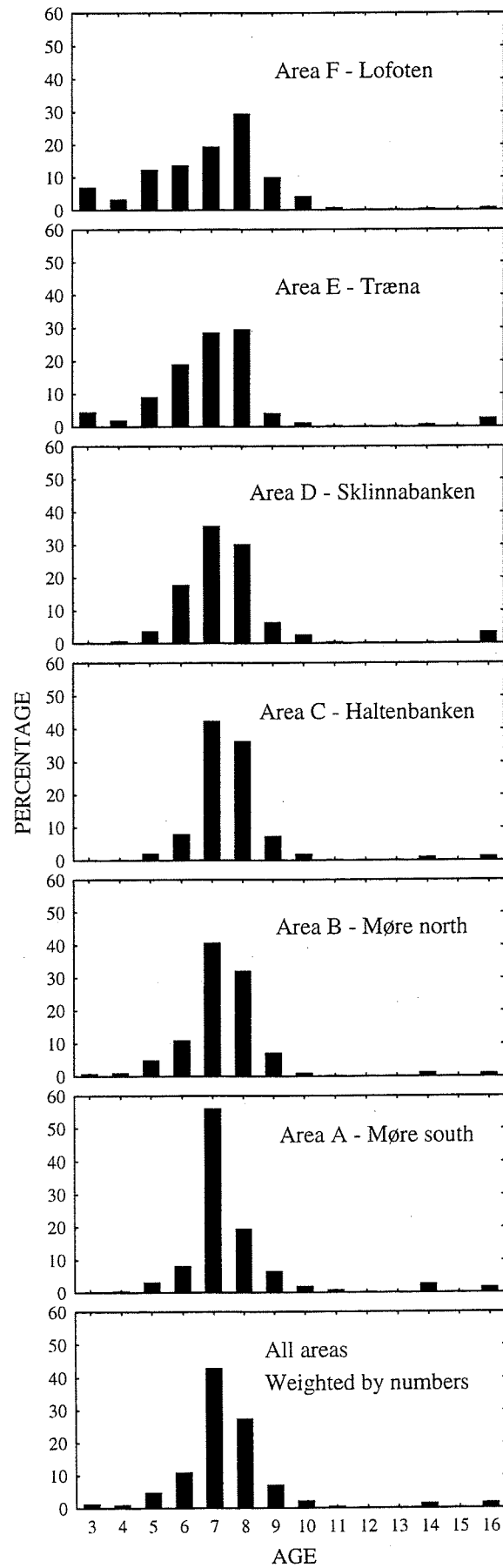


Fig. 11. Age composition of Norwegian spring spawning herring by distribution area (see Fig. 2) during the spawning season in 1999.

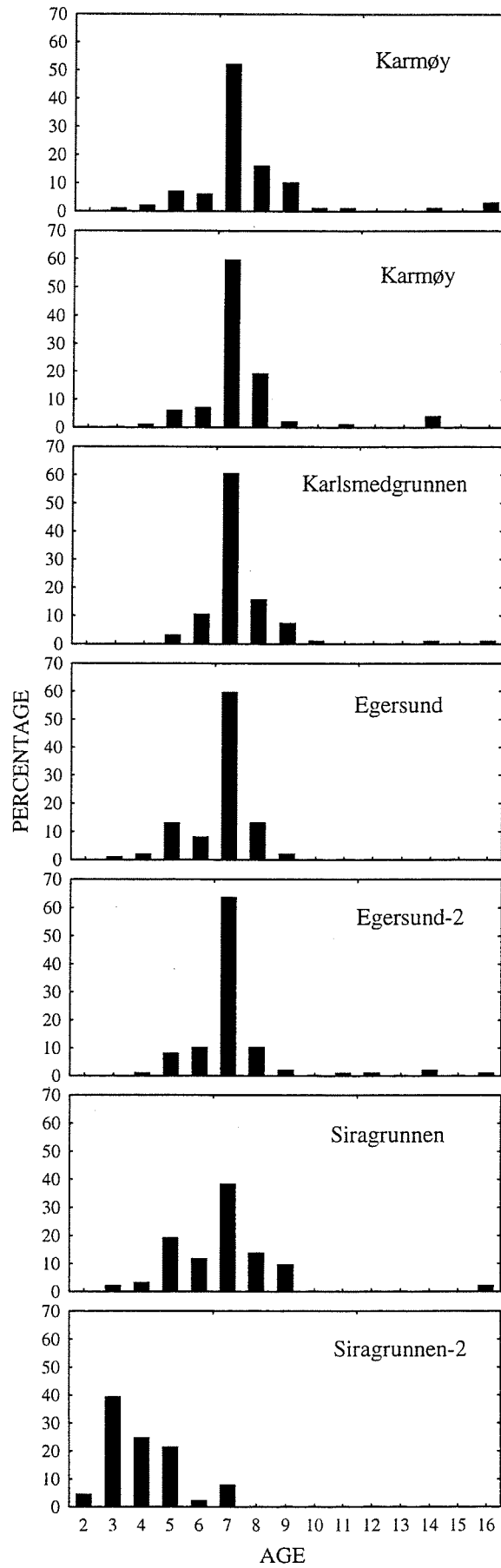


Fig. 12. Age composition of Norwegian spring spawning herring by distribution area at the southernmost grounds (see Fig. 5-10) during the spawning season in 1999 (-2 denotes that the samples were taken when the cruise track was repeated a second time).

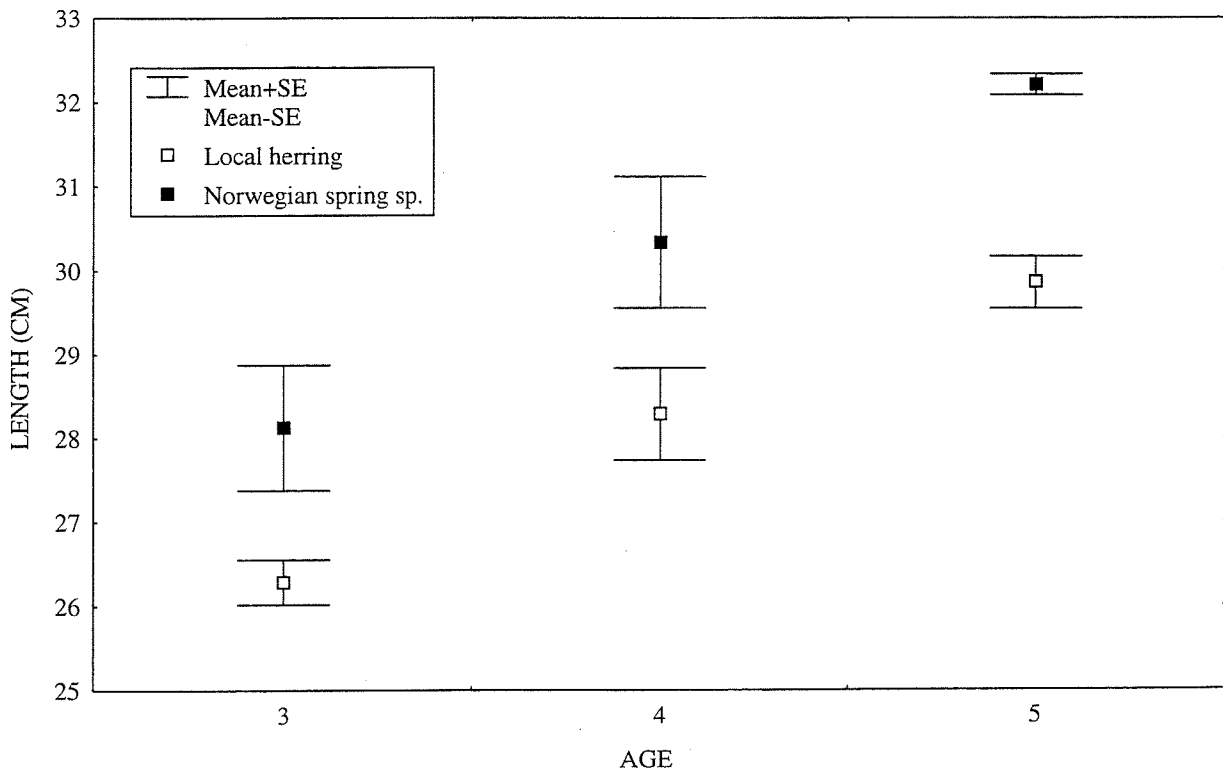


Fig. 13. Comparison of length at age between a sample from Siragrunnen predominated by local herring and samples from Karmøy-Siragrunnen comprising Norwegian spring spawning herring.

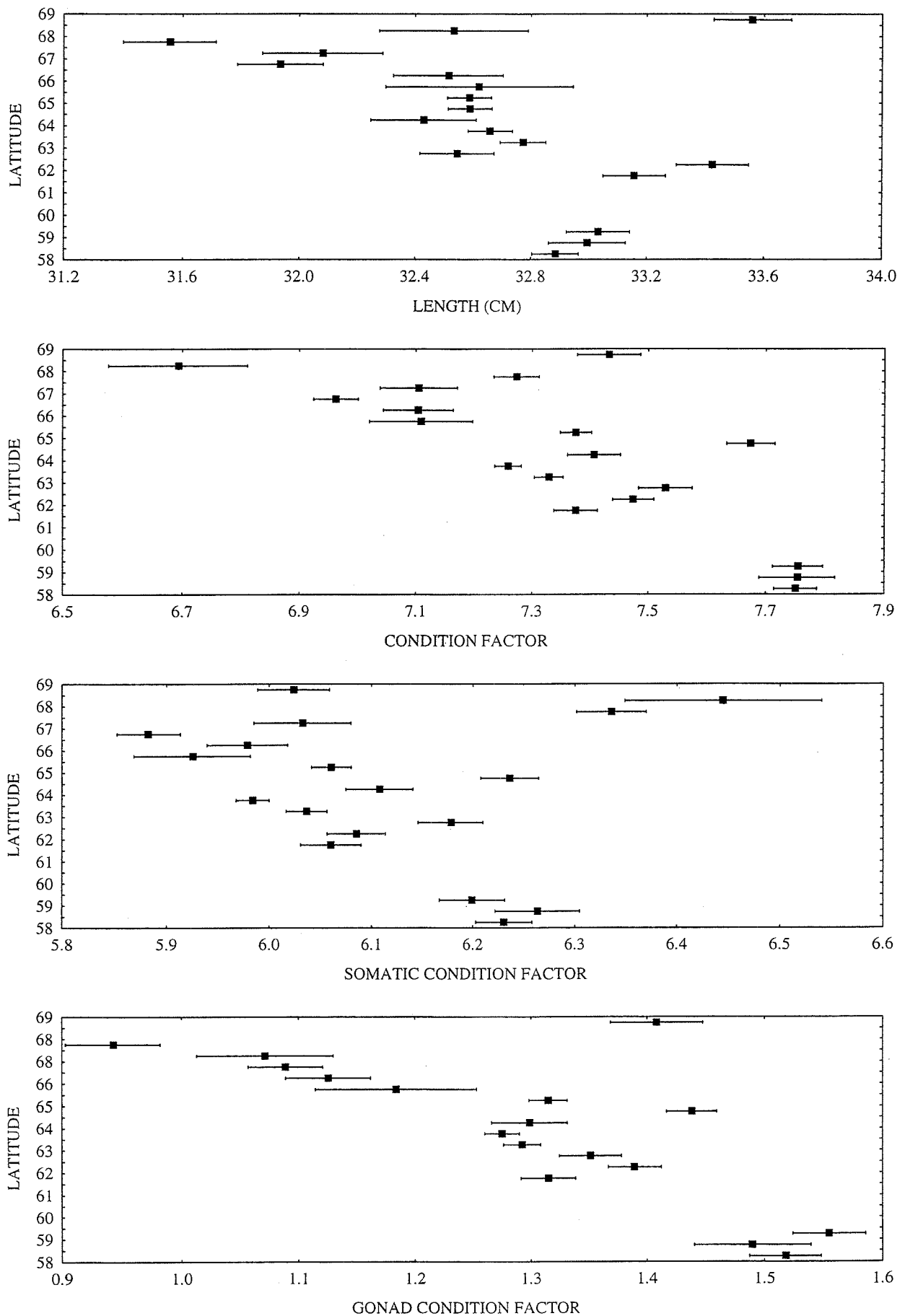


Fig. 14. Body length, condition factor, somatic condition factor and gonad condition factor in relation to latitude. Mean values \pm SE are given.

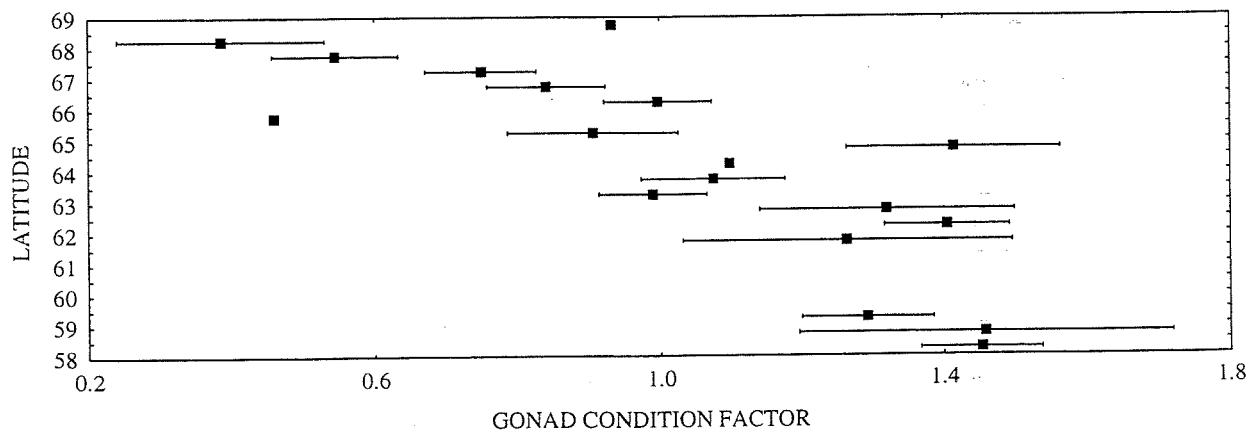
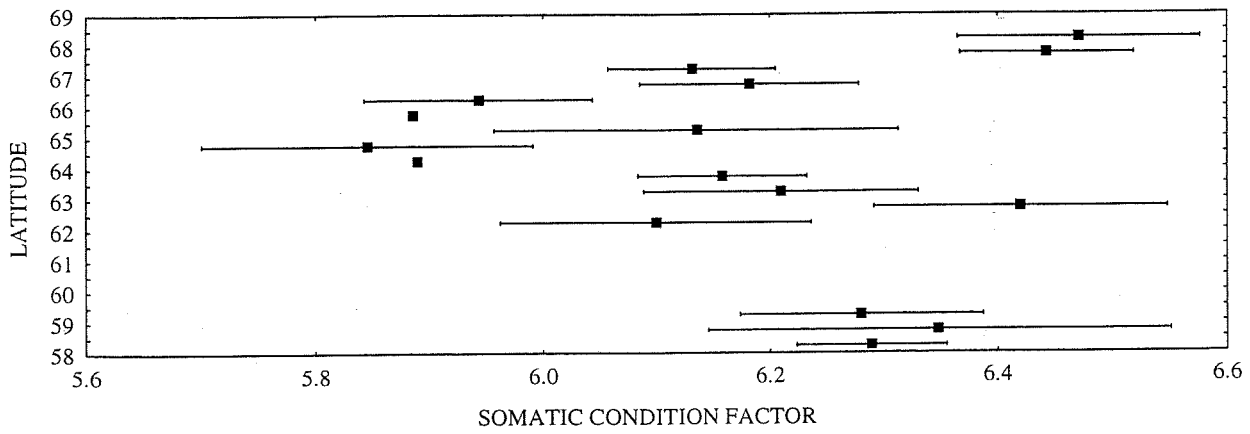
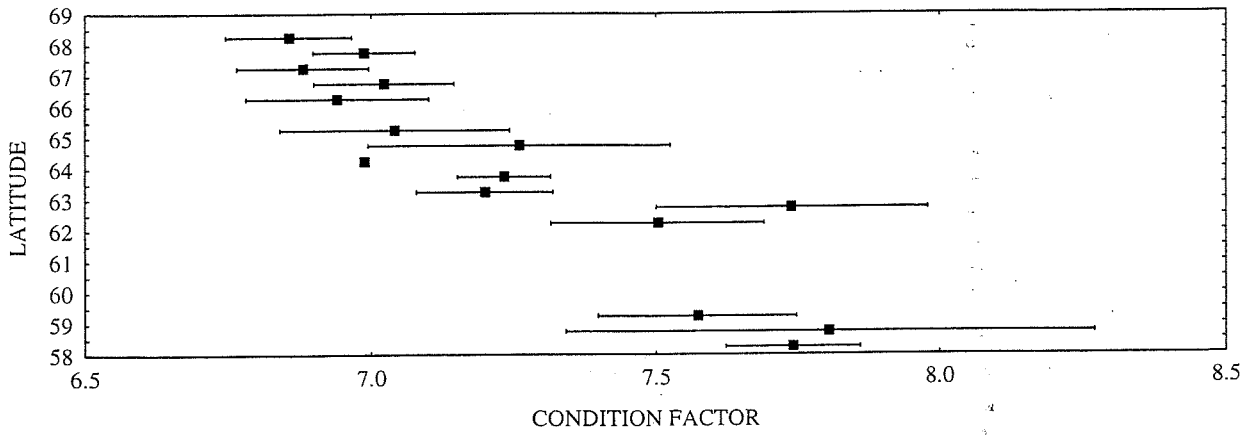
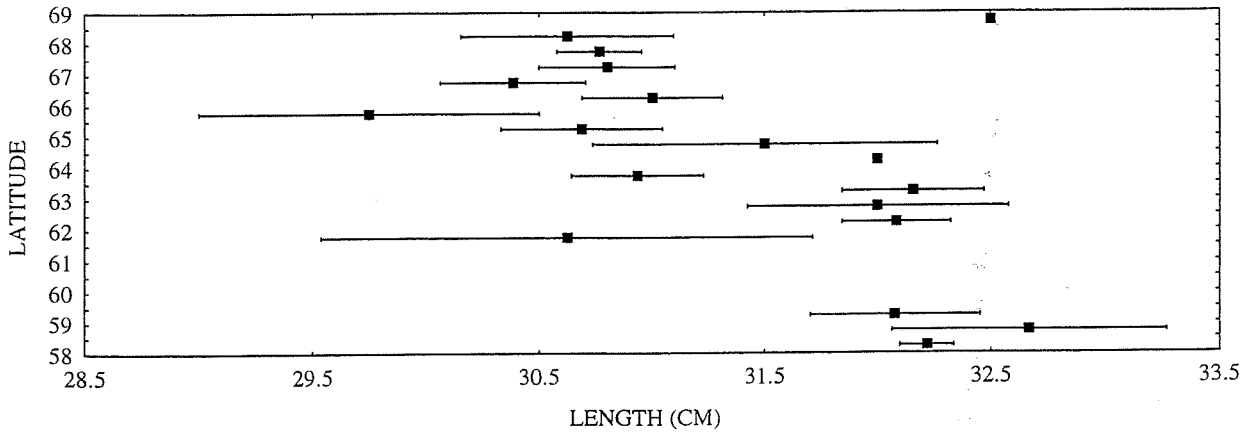


Fig. 15. Body length, condition factor, somatic condition factor and gonad condition factor of 5 year olds in relation to latitude. Mean values \pm SE are given.

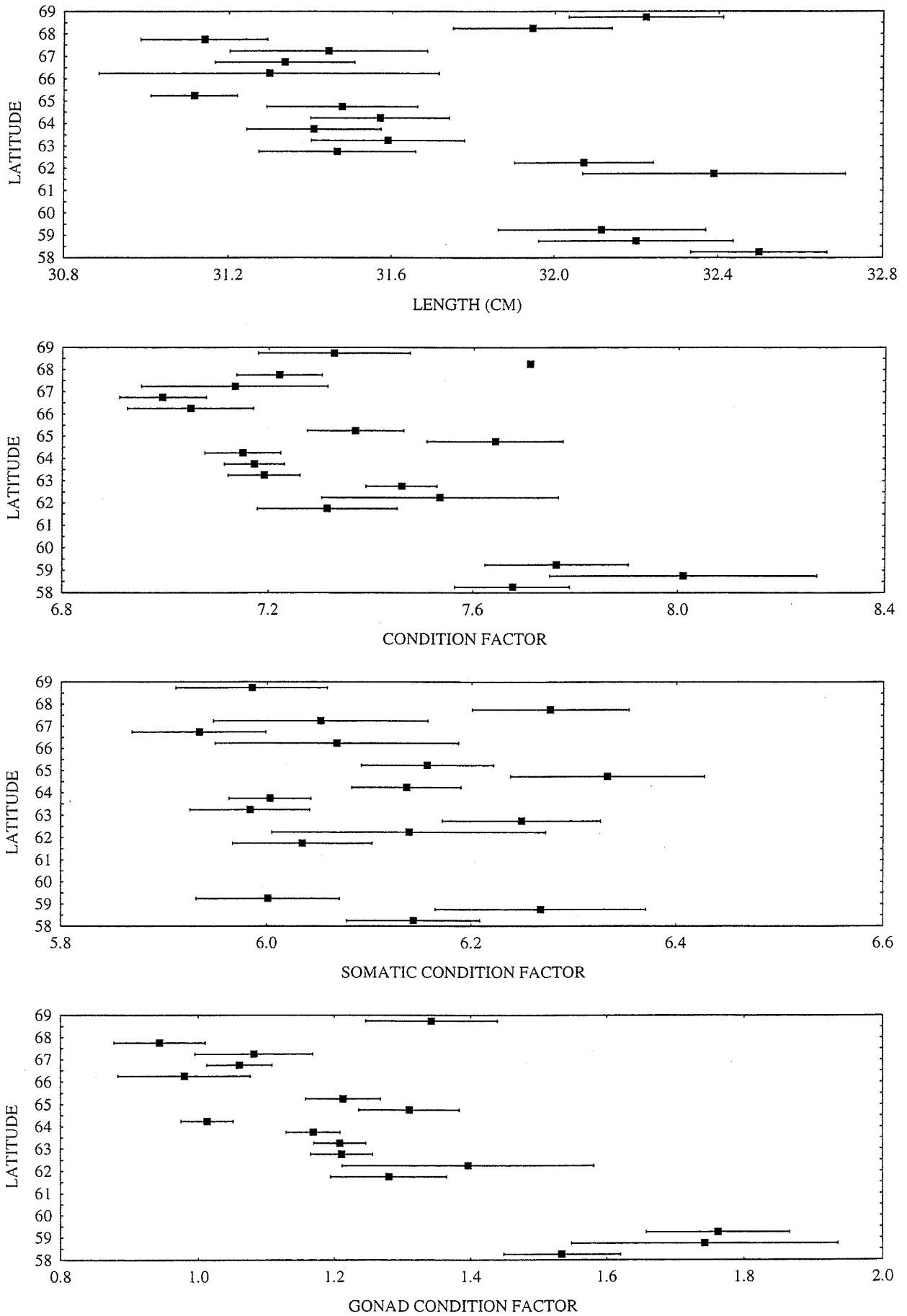


Fig. 16. Body length, condition factor, somatic condition factor and gonad condition factor of 6 year olds in relation to latitude. Mean values \pm SE are given.

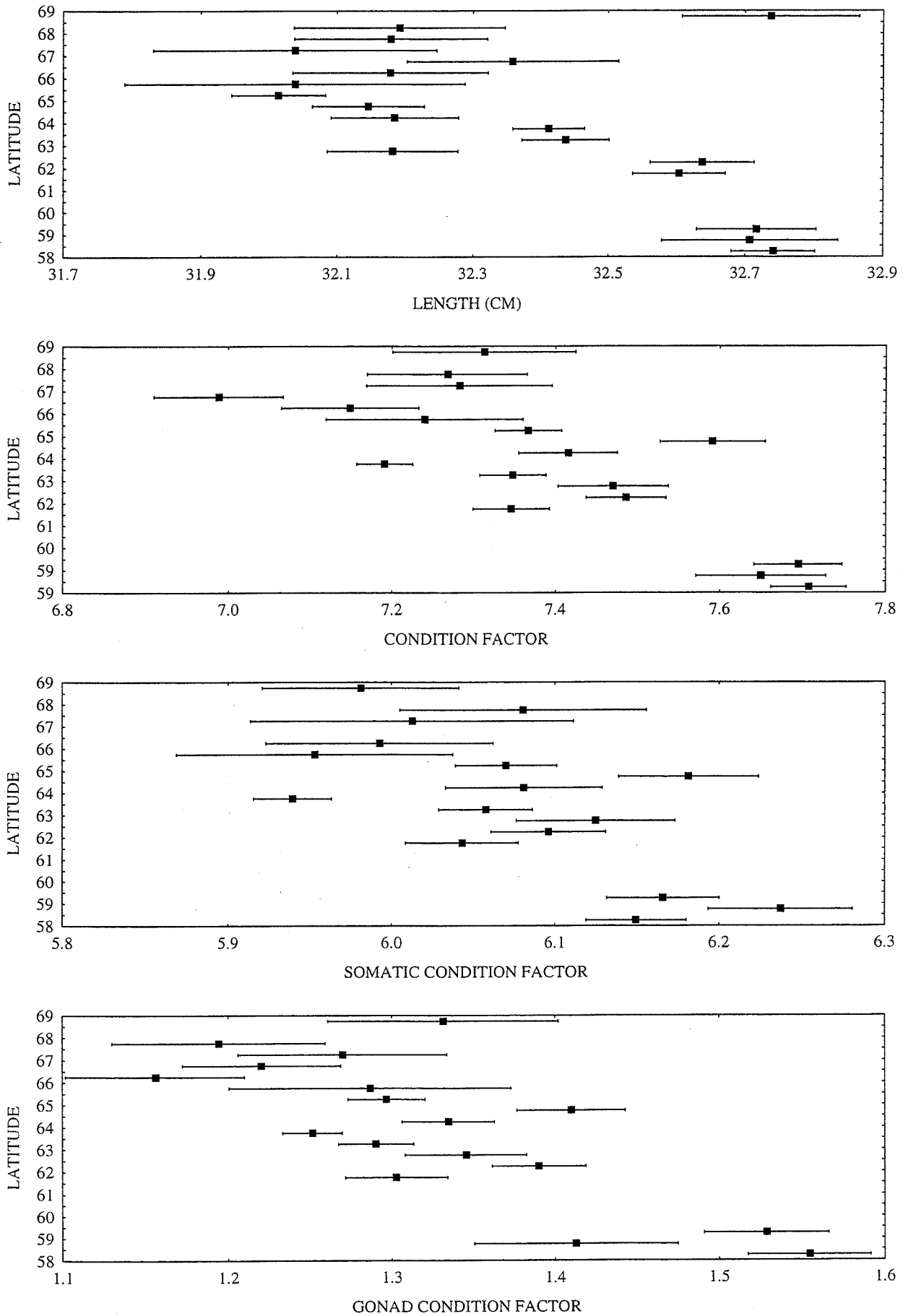


Fig. 17. Body length, condition factor, somatic condition factor and gonad condition factor of 7 year olds in relation to latitude. Mean values \pm SE are given.

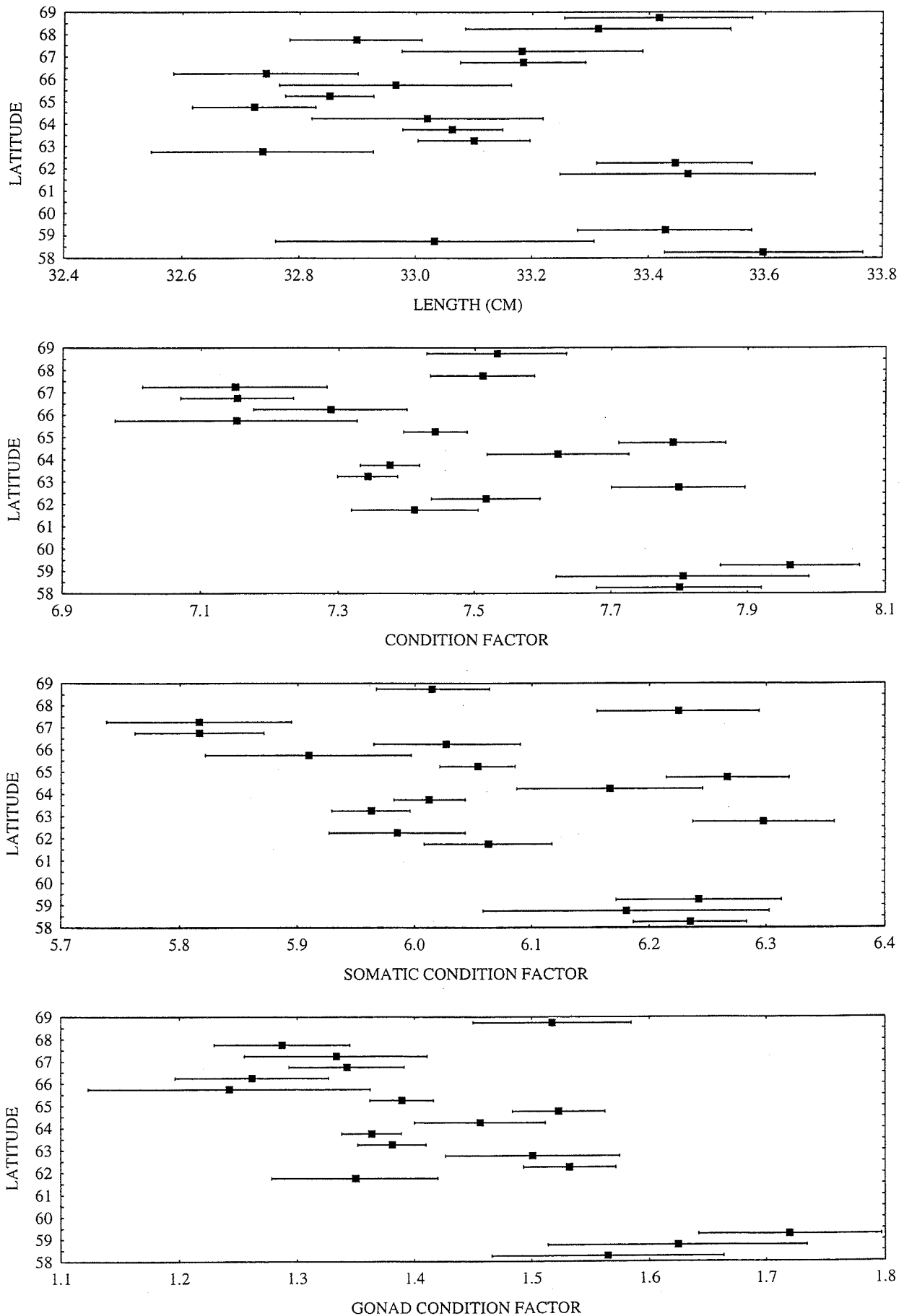


Fig. 18. Body length, condition factor, somatic condition factor and gonad condition factor of 8 year olds in relation to latitude. Mean values \pm SE are given.

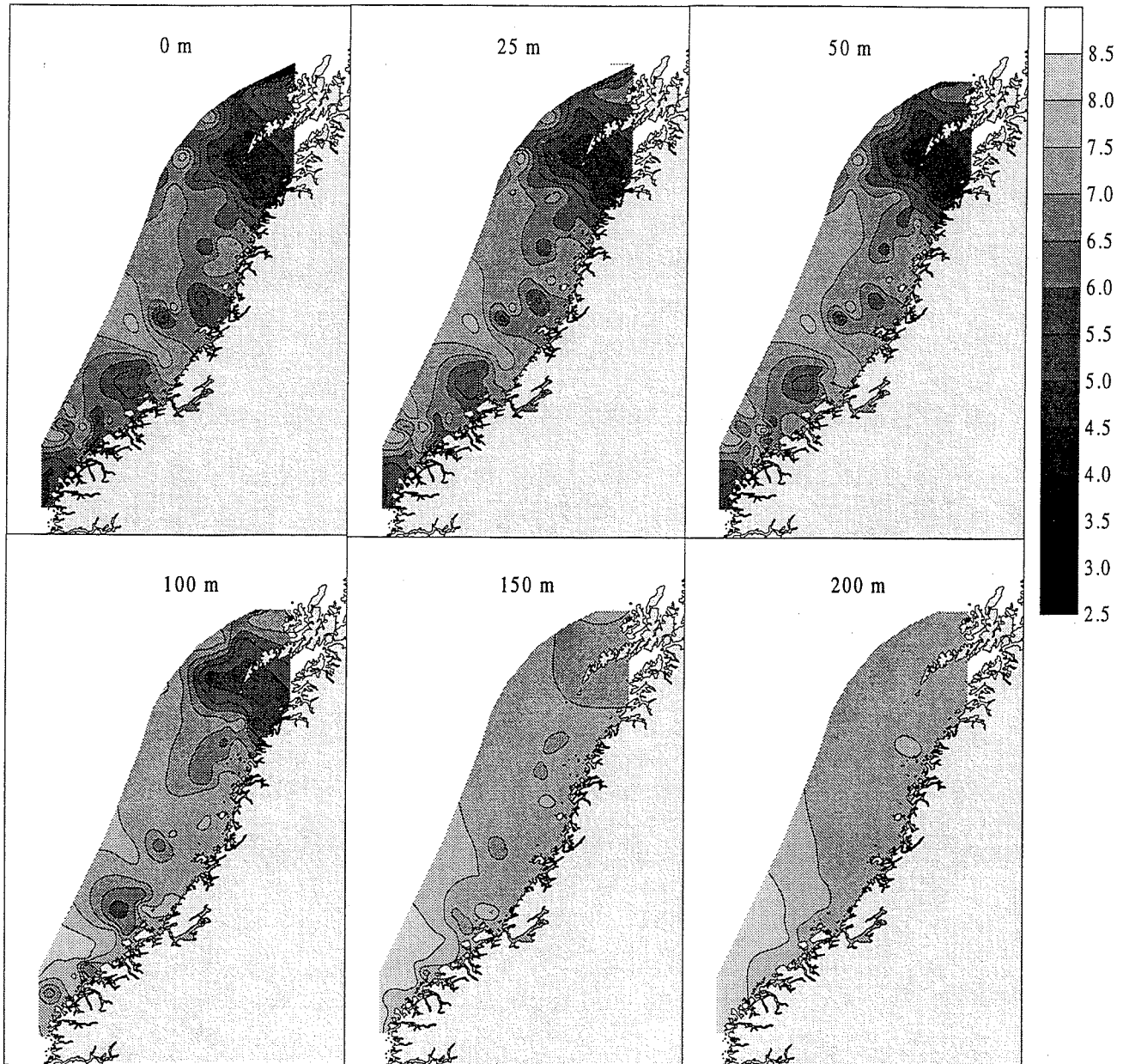


Fig. 19. Spatial temperature distribution at different depths as recorded at CTD-stations during an acoustical survey with RV Michael Sars 17. 02 - 04.03.99.

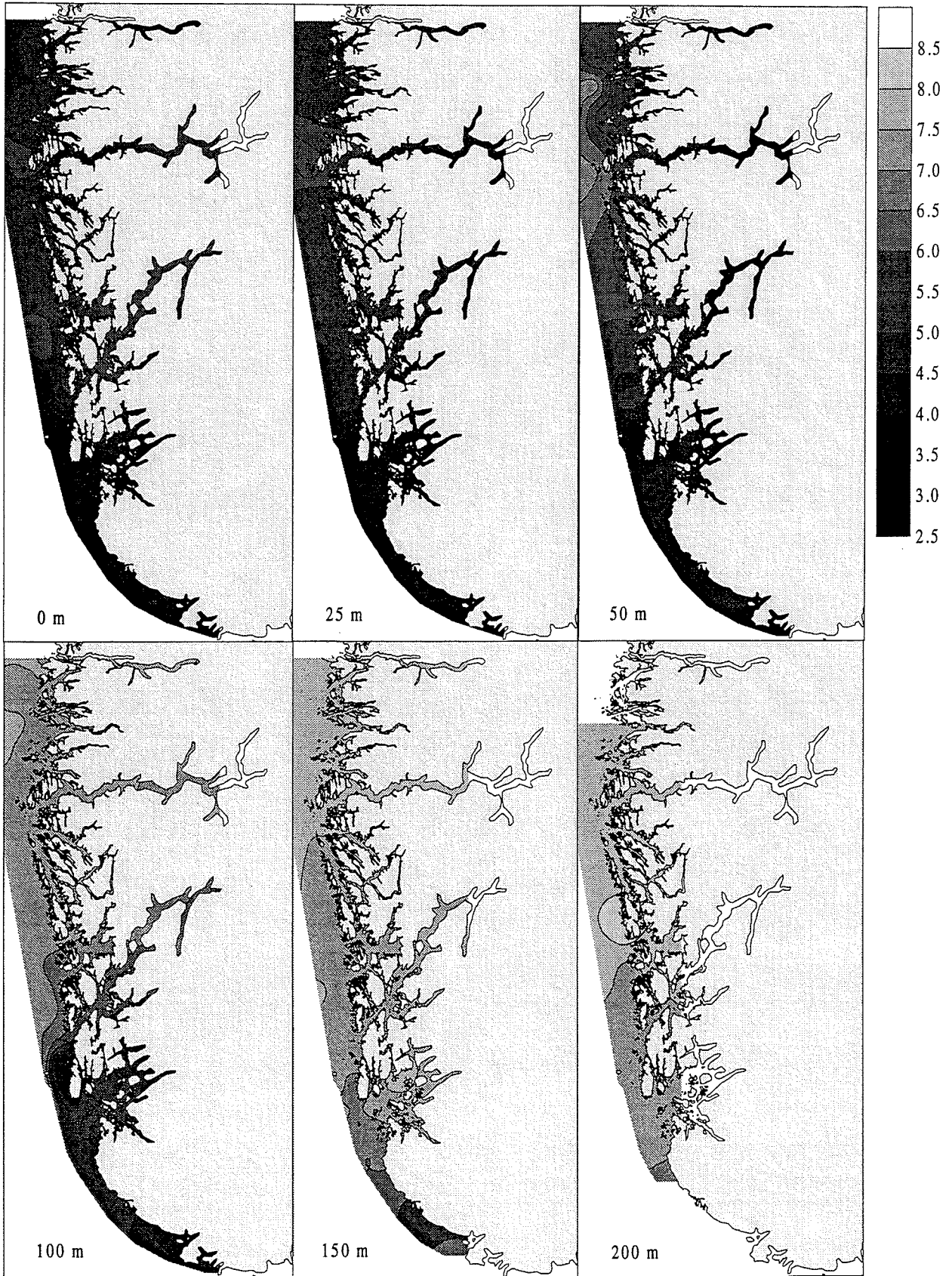


Fig. 20. Spatial temperature distribution at different depths as recorded at CTD-stations during an acoustical survey with RV Michael Sars 05.03 - 21.03.99.

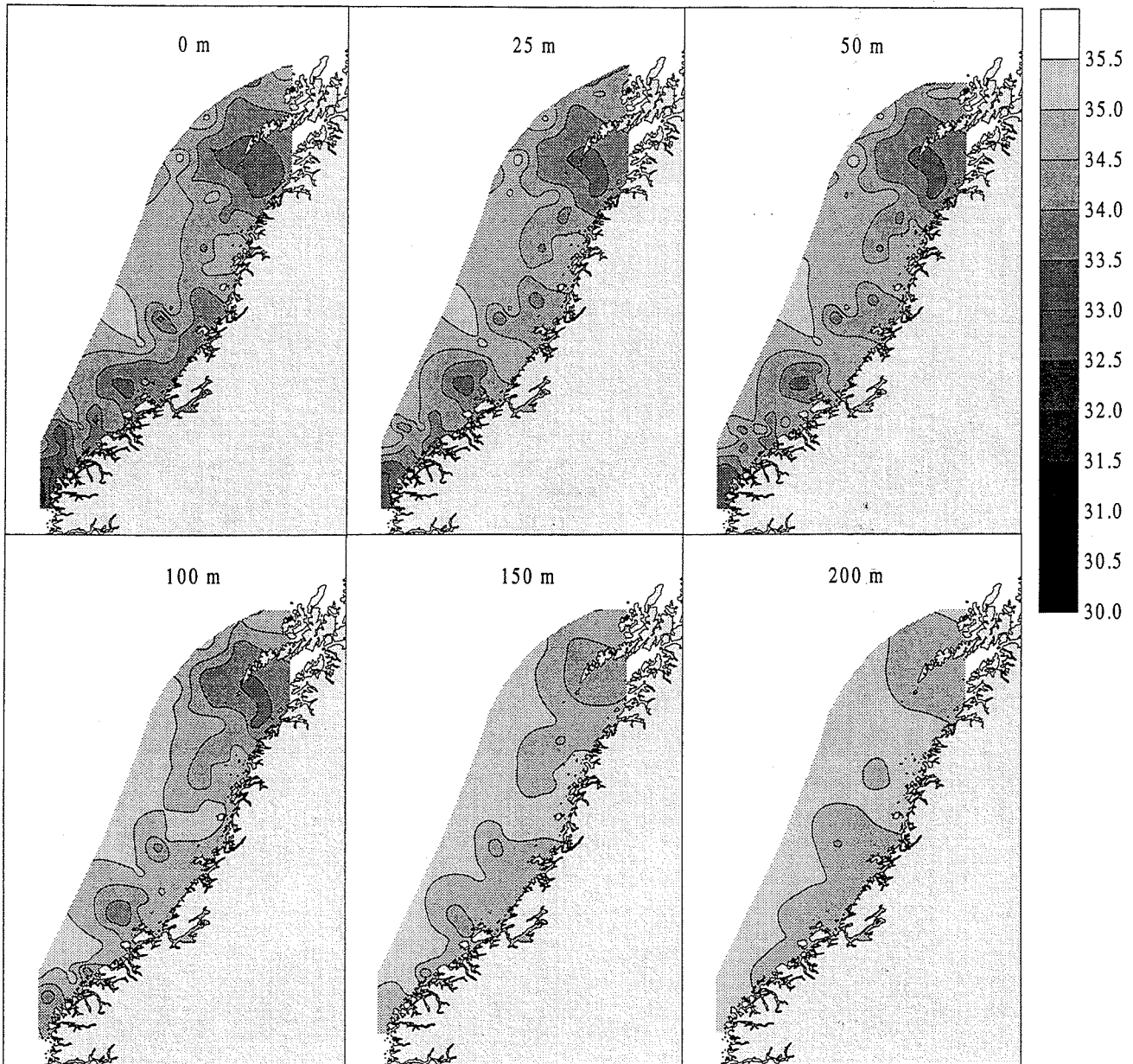


Fig. 21. Spatial salinity distribution at different depths as recorded at CTD-stations during an acoustical survey with RV Michael Sars 17. 02 - 04.03.99.

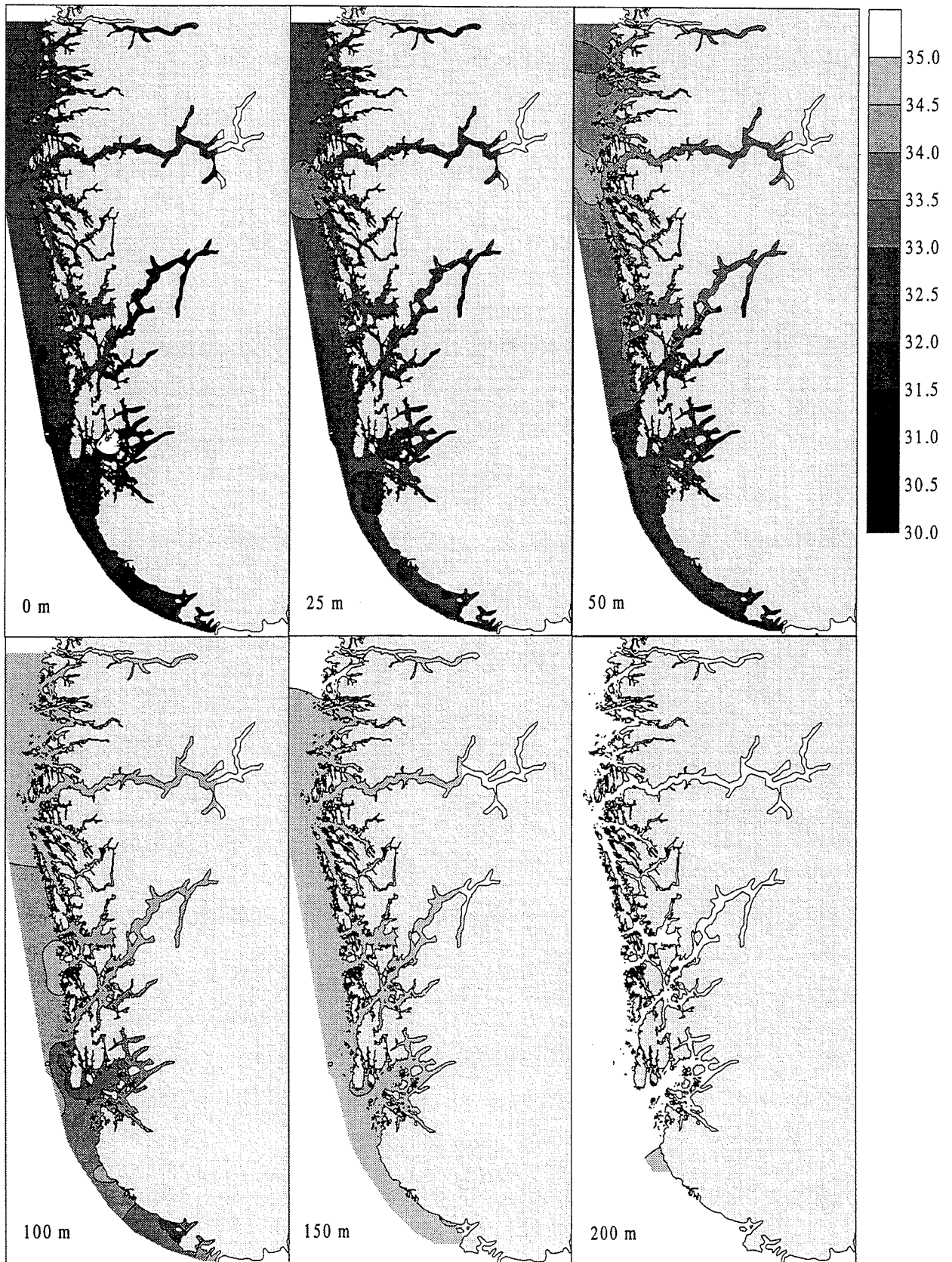


Fig. 22. Spatial salinity distribution at different depths as recorded at CTD-stations during an acoustical survey with RV Michael Sars 05.03 - 21.03.99.