r/v Gunnar Thorson

Monitoring Cruise Report

Cruise no.: 206

Time: 5 - 8 November 2001

Area: The Sound, Kattegat, Belt Sea and Arkona Sea

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Data Sheet

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Monitoring cruise with r/v Gunnar Thorson in the Sound, Kattegat, Belt Sea and Arkona Sea, 5-8 November 2001. Cruise no. 206.

Report: Gunni Ærtebjerg

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Participants: Kjeld Sauerberg, Peter Kofoed, Dorete Jensen

Summary
Strong westerly winds had changed the hydrographic situation since the cruise in October. The salinity had increased in the surface water and decreased in the bottom water, and generally the salinity was higher than normal for the season, except for lower salinity in the Kattegat bottom water. A large water mass of 30-33 PSU, which might originate from the Jutland Coastal Current, was present in the northern Kattegat from the surface to about 50 m depth and further south in Kattegat as bottom water. The stratification had decreased, and a relatively strong halocline (10-13 PSU) was present only in the Sound, southernmost Kattegat, northern Great Belt and Arkona Sea. Inflow of salty oxygen rich water from the Sound and Belt Sea to the Arkona Sea was evident. The temperature was in the whole water column 9.7-12.0°C and higher than normal for the season.

Nitrate, phosphate and silicate were now present in the surface water, except for nitrate in the areas with the strongest stratification mentioned above. Relatively high concentrations of nitrite (0.5-0.8 µmol/l) and high concentrations of ammonium (1-3.5 µmol/l) were observed in the northern and eastern Kattegat in the 30-33 PSU water.

Relatively high concentrations of chlorophyll-*a* (3-6 µg/l) were observed in the central and southern Kattegat, Sound, Great Belt, Kiel Bight and central Arkona Sea. The lowest concentrations of 0.8-1.3 µg/l were observed in the northern Kattegat. The dominating species in eastern Kattegat were *Proboscia alata*, *Chaetoceros spp.*, *Pseudonitzschia spp.* and *Ceratium lineatum*, in the southern Belt Sea *Ceratium lineatum*, *C. tripos* and *C. fusus* and in Mecklenburg Bight also *Probiscia alata* and *Guinardia flacida*. In the Arkona Sea large centric diatoms dominated.

Since the cruise in October the minimum oxygen concentration had increased in all areas, except in the north-eastern Kattegat. The lowest oxygen concentration of 3.1-3.6 ml/l (49-56%) was observed in the Sound and south-eastern Kattegat. Oxygen depletion was no longer present in the investigated Danish open sea areas.

General
The objectives of the cruise were:

- to determine the actual situation in the open Danish waters
- to trace the influence of land based discharges of nutrients
- to establish reference data for the local monitoring in coastal areas
- to continue time series for trend monitoring

The cruise is part of the Danish nation wide monitoring programme NOVA 2003, the HELCOM monitoring programme for the Baltic Sea area (Arkona Sea, Sound, Belt Sea, Kattegat), and the OSPARCOM monitoring programme for the Greater North Sea (Kattegat). The main scope of the cruise was to monitor the oxygen situation, but also the hydrography and the concentrations of nutrients and chlorophyll-*a*. The stations of the cruise are shown in *figure 1*.

Meteorology
Mid-October was dominated by weak winds from east and south-east. At the end of the month the wind turned further south and increased. At the beginning of November and during the cruise strong western winds were prevailing.

Hydrography
The surface temperature (1 m depth) varied from 9.7°C in Aalborg Bight (St. 409) and 9.9-10.0°C in south-eastern Kattegat to 11.7-11.9°C in the northern Kattegat. The bottom water temperature ranged from 9.9°C in Aalborg Bight and at Kullen (St. 409, 921) to 12.0°C in the southern Kattegat (St. 413, 418, 925) (*figure 2*). The temperature stratification was thus generally less than 1.5°C.

The surface salinity ranged from 8.2 in the central Arkona Sea (St. 444) to 31.2-31.8 in the northern Kattegat (St. 403, 905, 1001, 1007, 1008, 1009). The bottom water salinity ranged from 18.0-21.2 in the Arkona Sea (St. 441, 444, 449, 954) to 34.1-34.2 in the south-eastern Kattegat (St. 921, 413) (*figure 3*). A large water mass of 30-33 PSU, which might originate from the Jutland Coastal Current, was present in the northern Kattegat from the surface to about 50 m depth and further south in Kattegat as bottom water. The salinity stratification was strong (10-13 PSU) only in the Sound, southernmost Kattegat, northern Great Belt and the Arkona Sea, and very weak in the northern Kattegat and southern Belt Sea.

Compared to long-term monthly means (Lightship observations 1931-1960) for November the temperature was in the whole water column higher than normal. Generally, also the salinity during the present cruise was higher than normal, except for lower bottom water salinity in most of Kattegat.

Nutrients
Nitrate was now present in the surface, except in the areas with the strongest stratification: the Sound, southern Kattegat, northern Great Belt and central Arkona Sea. In the bottom water nitrate concentrations above 5 µmol/l were present in the Kattegat, the Sound and the northern Great Belt (*figure 4*).

Relatively high concentrations of nitrite (0.5-0.8 µmol/l) and high concentrations of ammonium (1-3.5 µmol/l) were observed in the northern and eastern Kattegat in the 30-33 PSU water (*figure 5*).

Phosphate and silicate was present in the surface water in all areas with the lowest concentrations in the stratified southern Kattegat and highest in the well-mixed southern Belt Sea. In the bottom water the concentrations of phosphate and silicate were about normal for the season (*figure 6*).

Chlorophyll-*a* and phytoplankton

The mean chlorophyll concentration in the uppermost 10 m was highest in Kiel Bight (6.1 µg/l), Aalborg Bight (5.5 µg/l) and the central Arkona Sea (4.8 µg/l), and relatively high (3.0-3.7 µg/l) in the Sound, southern Kattegat and Great Belt. The lowest mean chlorophyll concentrations of 0.8-1.3 µg/l were observed in the northern Kattegat (*figure 7*).

Samples from Kattegat East (St. 413), Kiel Bight (St. N3), Mecklenburg Bight (St. M2) and Arkona Sea (St. 444) showed dominance by diatoms in Kattegat and Arkona Sea and by dinoflagellates in the southern Belt Sea. The dominating species in the eastern Kattegat were *Proboscia alata*, *Chaetoceros spp.*, *Pseudonitzschia spp.* and *Ceratium lineatum*, in the southern Belt Sea *Ceratium lineatum*, *C. tripos* and *C. fusus* and in Mecklenburg Bight also *Probiscia alata* and *Guinardia flacida*. In the Arkona Sea large centric diatoms dominated.

Oxygen

Since the cruise in October the minimum oxygen concentration had increased in all areas, except in the north-eastern Kattegat. The lowest oxygen concentration of 3.1-3.6 ml/l (49-56%) was found in the Sound and the south-eastern Kattegat (St. 431, 921, 413). In the eastern and southern Kattegat and the Great Belt 4.1-4.7 ml/l (54-73%) was observed (St. 1001, 905, 418, 922, 925, 935, 939, 443) (*figure 8*).

Compared to November last year and in the 1980s, the minimum oxygen concentrations this year are generally the same or higher, except for lower concentrations in the eastern Kattegat and Great Belt.

In Denmark oxygen depletion is defined as minimum oxygen concentrations below 2.8 ml/l (4 mg/l), and serious oxygen depletion as below 1.4 ml/l (2 mg/l). From these definitions oxygen depletion was no longer present in the investigated Danish open sea areas.

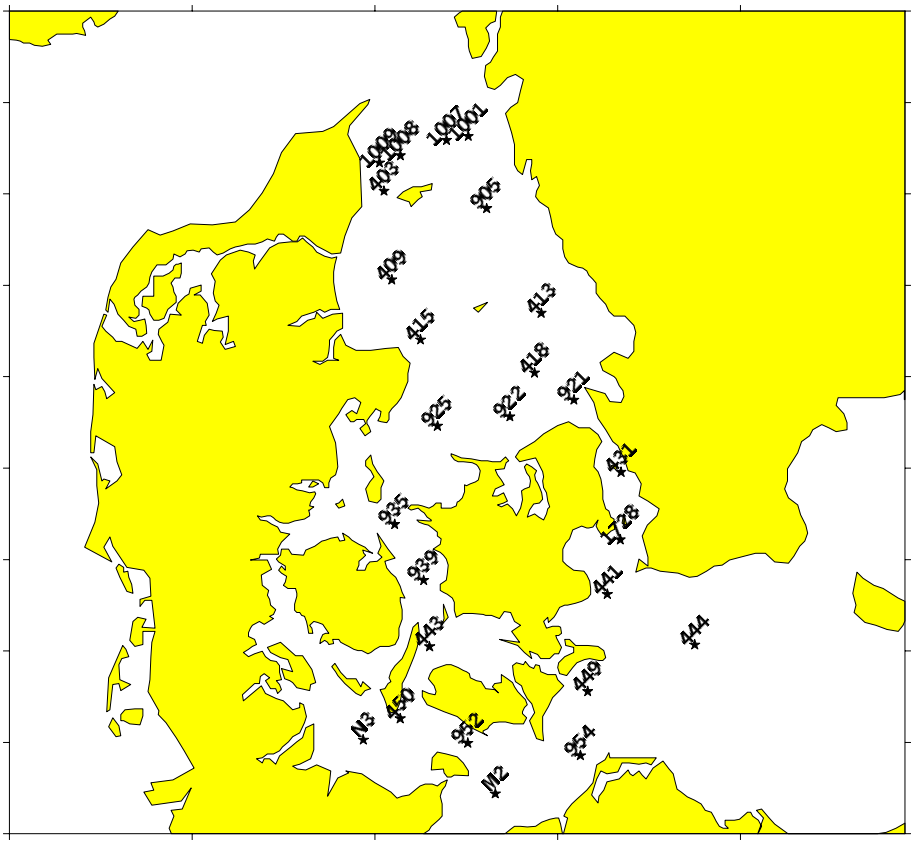

Figure 1 Stations of the monitoring cruise with r/v Gunnar Thorson 5-8 November 2001 in the Sound, Kattegat, Belt Sea and Arkona Sea. Gunnar Thorson cruise no. 206.

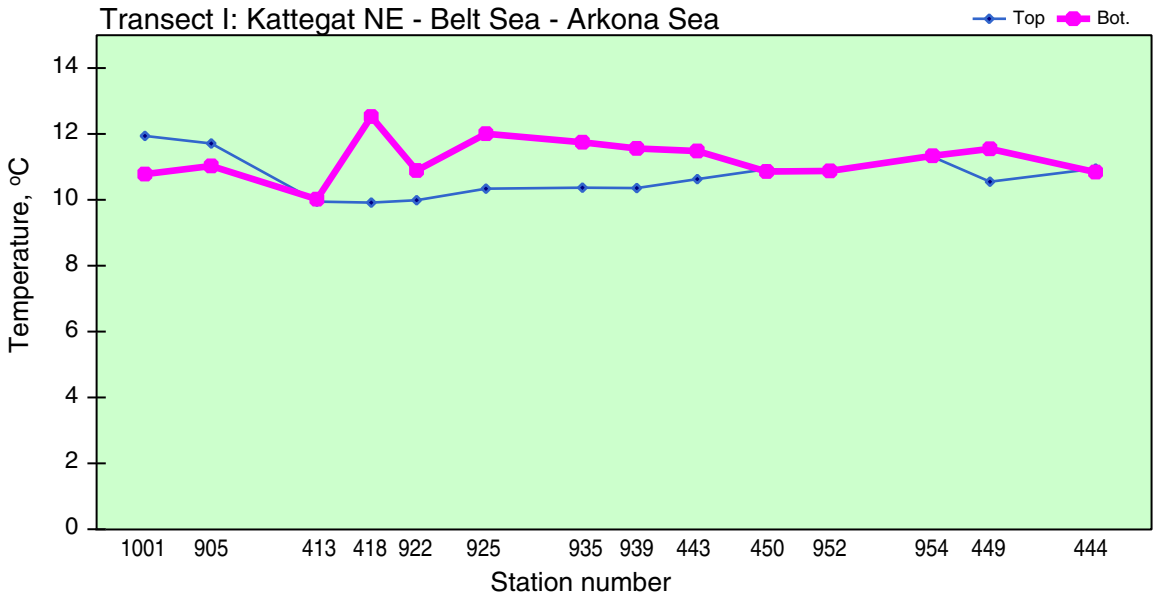

Figure 2 Surface and near bottom temperature along transect I from the north-eastern Kattegat through the Belt Sea to the Arkona Sea.

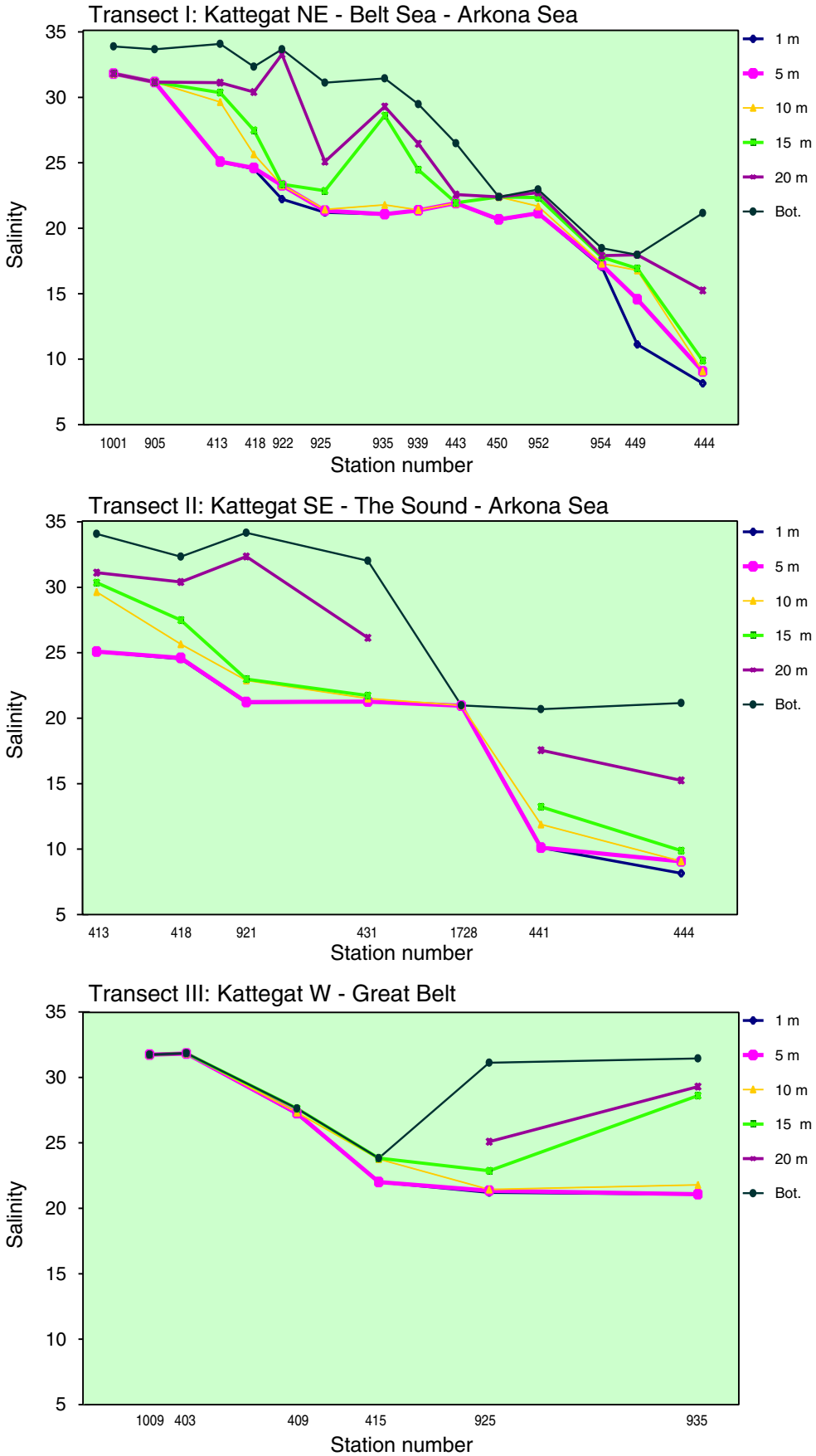

Figure 3 Salinity in 1 m, 5 m, 10 m, 15 m, 20 m depth and near bottom along transect I, II and III from the Kattegat through the Belt Sea and Sound to the Arkona Sea and in the western Kattegat to the Great Belt, respectively.

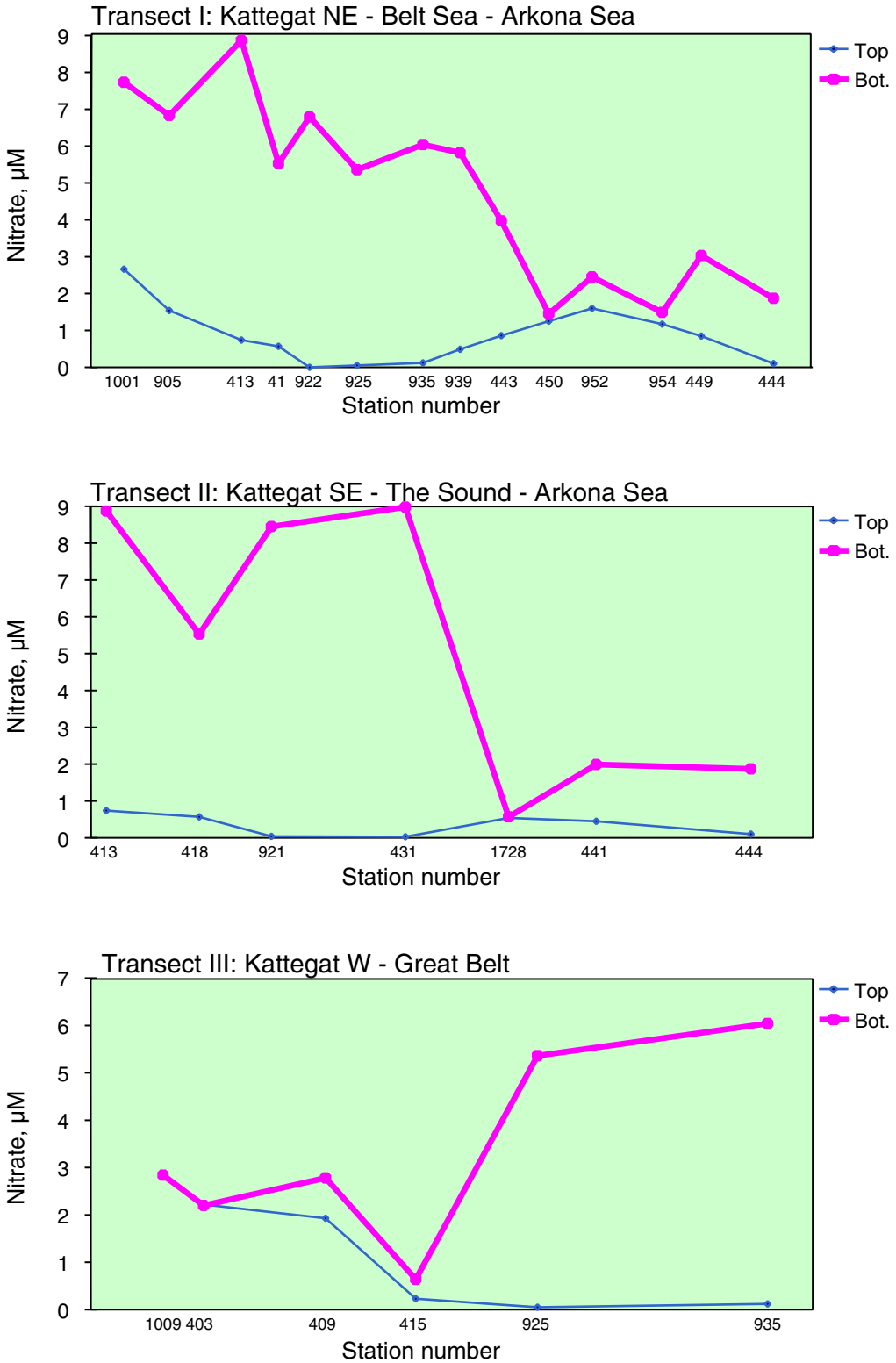

Figure 4 Surface and near bottom concentrations of nitrate along transect I, II and III.

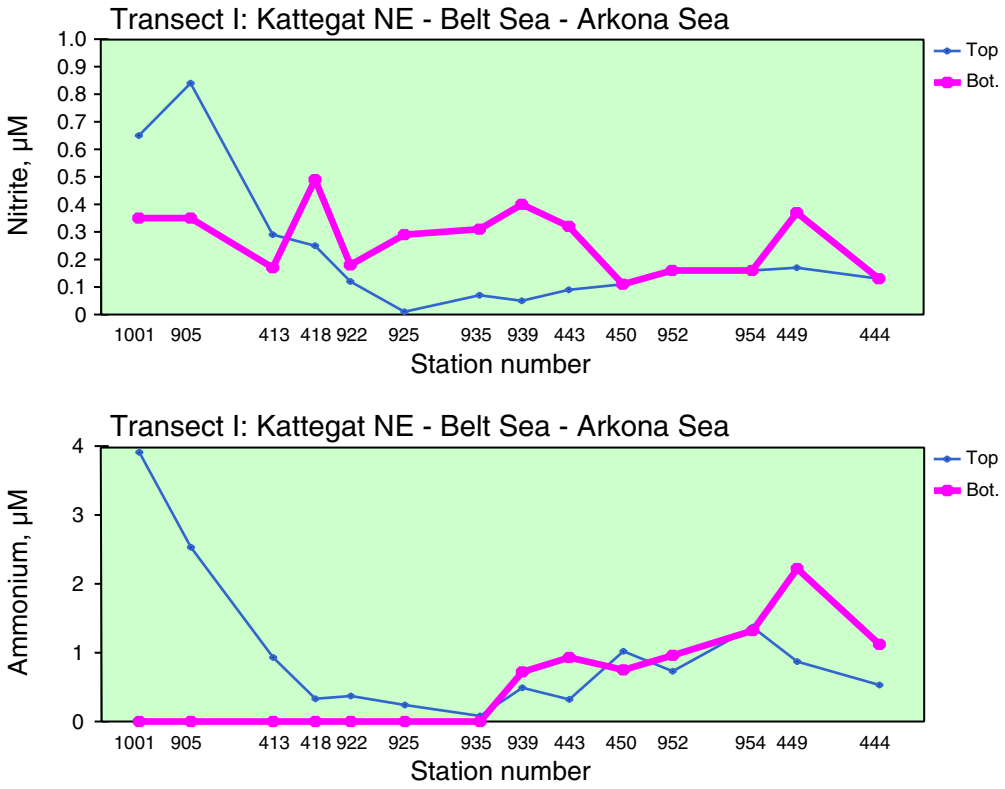

Figure 5 Surface and near bottom concentrations of nitrite and ammonium along transect I.

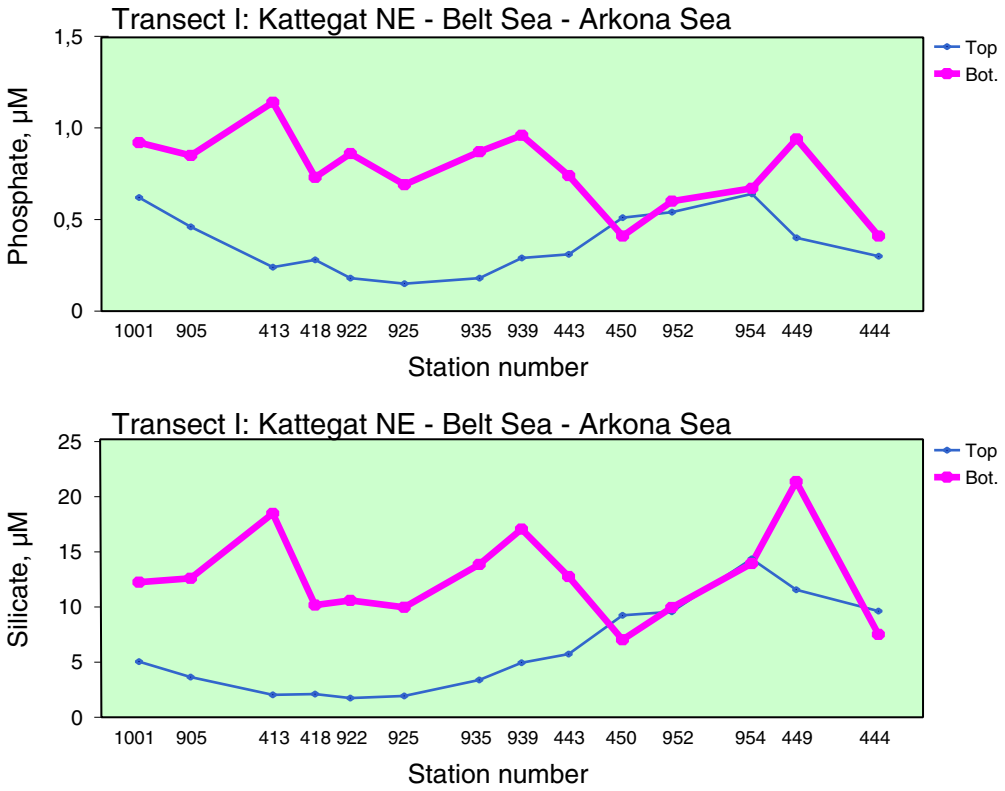

Figure 6 Surface and near bottom concentrations of phosphate and silicate along transect I.

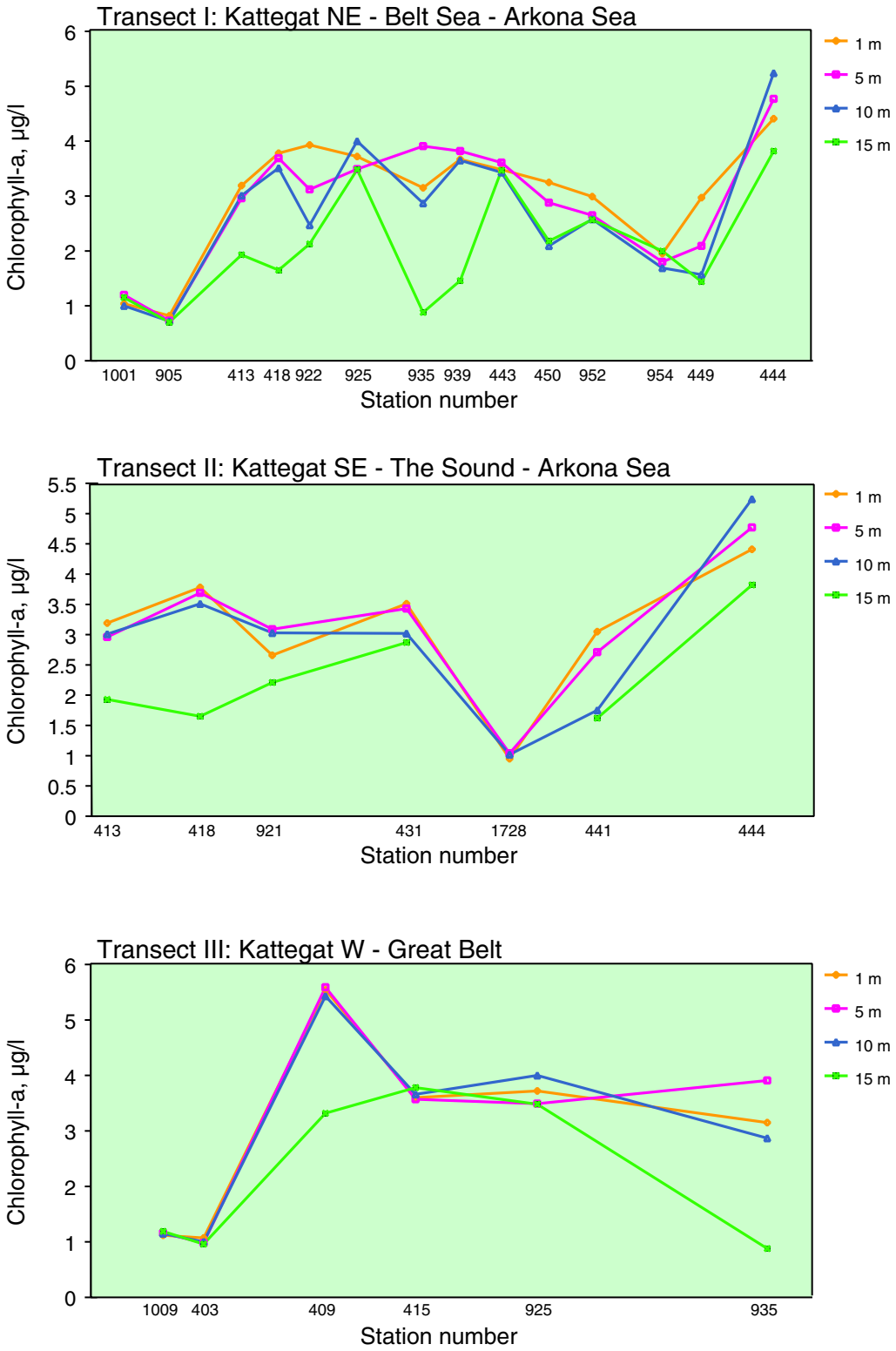

Figure 7 Chlorophyll-*a* concentrations in 1 m, 5 m, 10 m and 15 m depths along transect I, II and III.

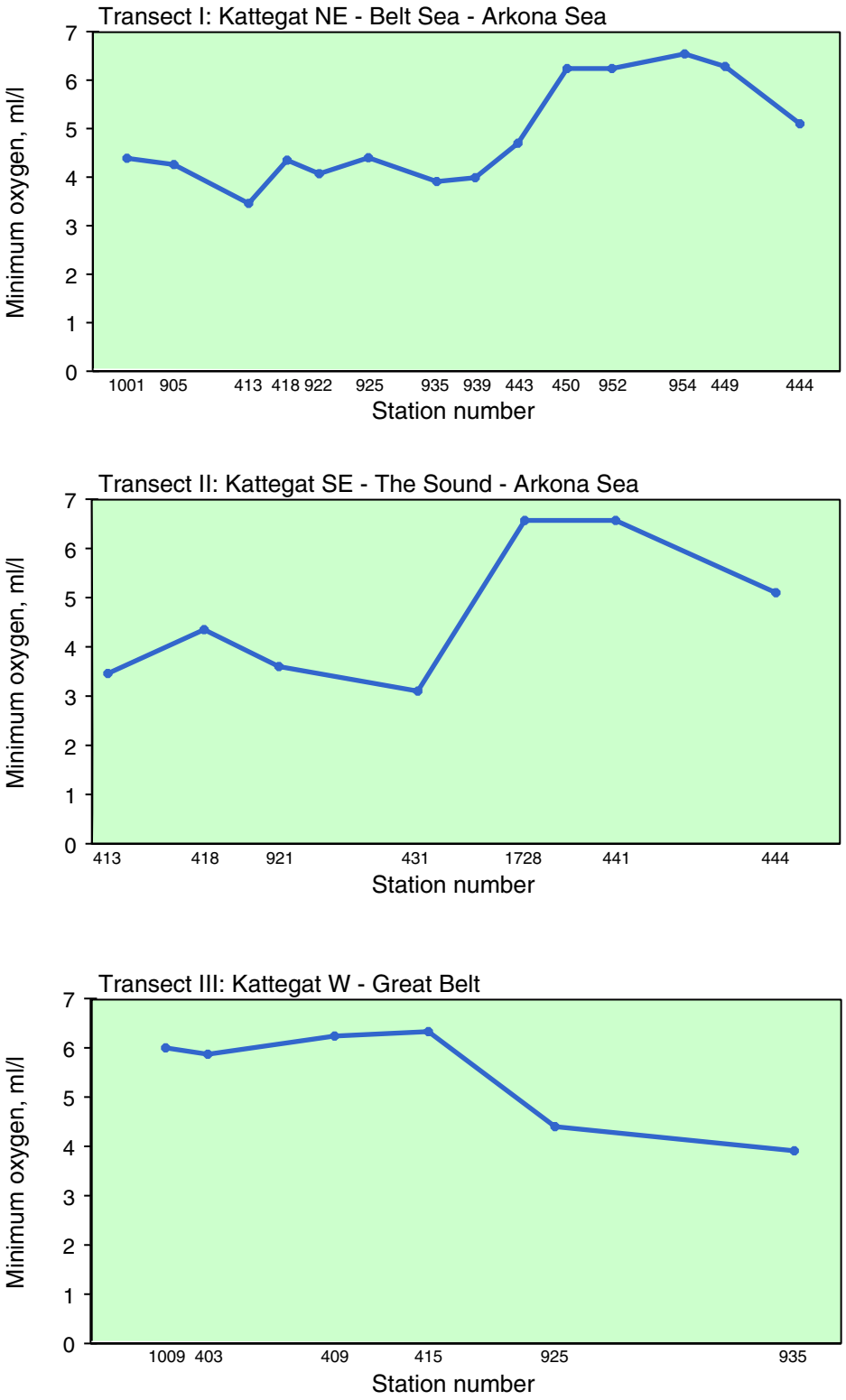

Figure 8 Minimum oxygen concentrations along transect I, II and III.