



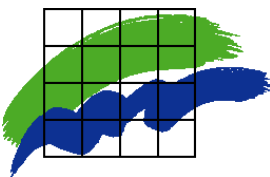
r/v Gunnar Thorson

Monitoring Cruise Report

Cruise no.: GT 247

Time: 15 - 19 September 2008

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



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Data sheet

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Monitoring Cruise Report - Cruise No. GT 247, 15-19 September 2008

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Participants:	Dorete W. Jensen Kjeld Sauerberg Gitte Jacobsen Barbara Thornberg
Vessel:	R/V Gunnar Thorson
Sampling region:	The Sound, the Arkona Sea, the Belt Sea and the Kattegat
Primary aim:	Monitoring of oxygen deficiency

This report is based on preliminary data, which might later be corrected. Citation permitted only when quoting is evident.

Summary

- The prevailing winds during the cruise were from the Northeast which resulted in generally lower surface water salinities in the region than expected.
- Bottom waters of the Belt Sea are generally oxygen depleted and the waters of the Southern Belt Sea in particular are severely oxygen depleted. Oxygen concentrations in the bottom waters of the Fehmarn Belt are the lowest they have been for September during the last six years.
- The oxygen depletion in the bottom waters of the Belt Sea is also influencing nutrient concentrations in these waters. Inorganic nitrogen concentrations were lower than expected, most likely due to denitrification and phosphorus concentrations were high due to release from sediments.
- Silicate concentrations in surface and bottom waters of the Belt Sea are higher than expected for this time of year.

Introduction

The cruise is part of the Danish national monitoring programme (NOVANA), the HELCOM monitoring programme (COMBINE) for the Baltic Sea area, and the OSPARCOM monitoring programme (JAMP) for the Greater North Sea (the Kattegat). The primary aim of the cruise is to provide measurements of hydrography, nutrient concentrations and oxygen concentrations. *Figure 1* shows the locations of the monitoring sampling stations.



Figure 1 Map showing the stations sampled by the monitoring cruise, regional sea names and the location of the transect plotted in the following figures.

Meteorology

Since December last year average air temperatures have been above normal. By September, the monthly average air temperature had returned to normal values (*Figure 2*). The month of August experienced more than twice the normal amount of precipitation. Whilst in September values were as expected.

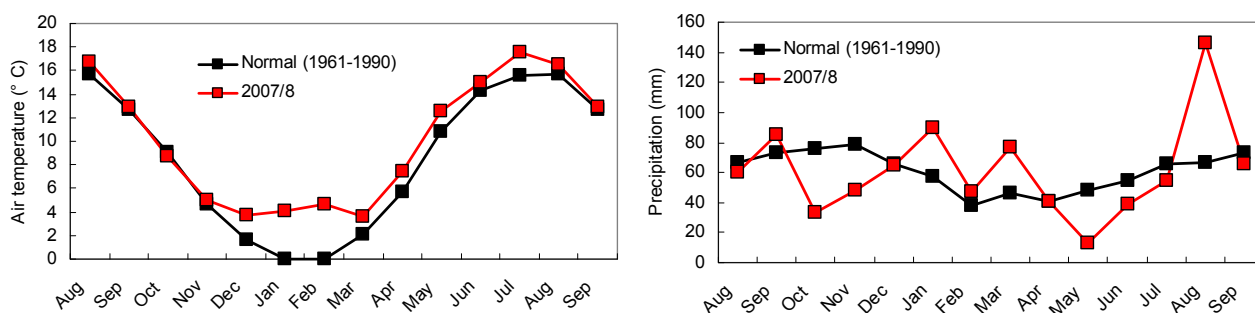


Figure 2 Monthly average air temperature and monthly total precipitation data for August 2007 to September 2008 compared with long-term averages (1961-1990). Data retrieved from the Danish Meteorological Institute (www.DMI.dk).

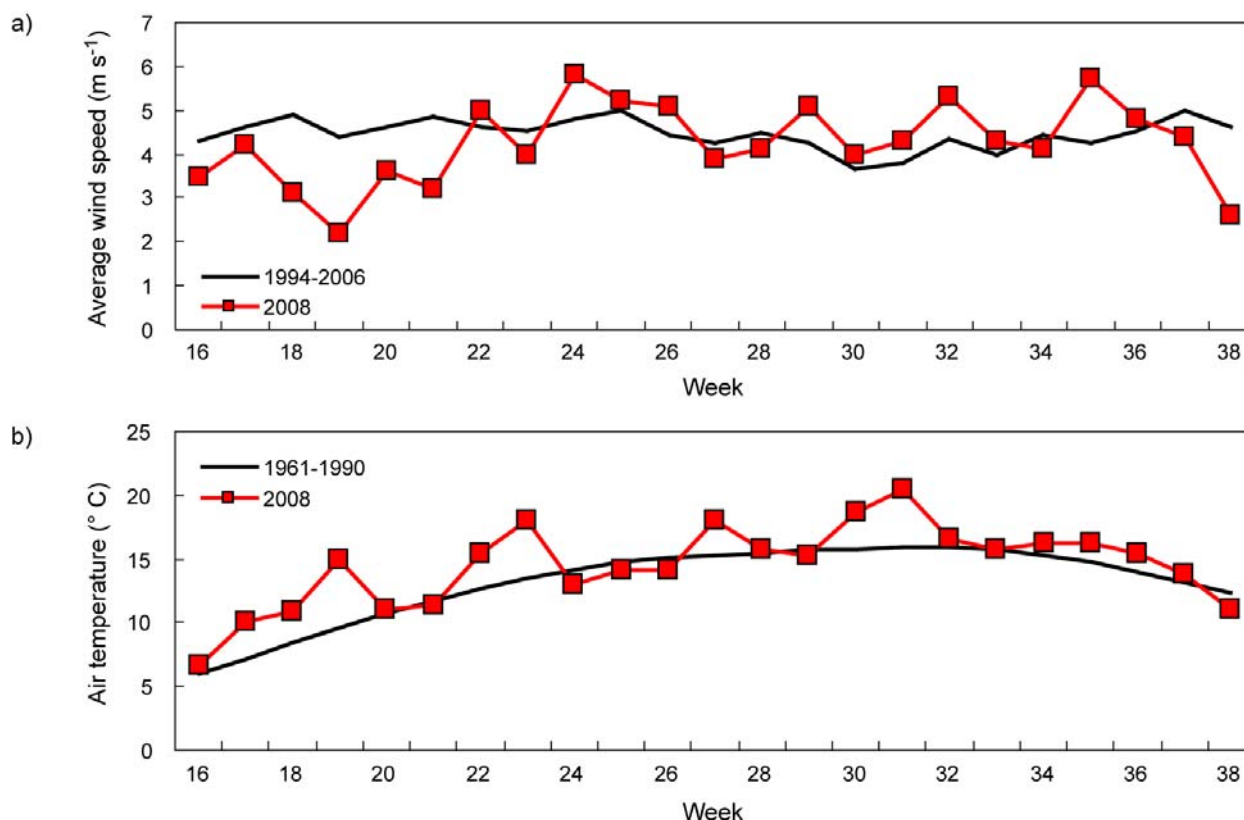


Figure 3 a) Weekly average wind speed from mid-April to the week of the cruise compared with average values from 1994-2006. b) Weekly air temperature from the same period compared to average values from 1961-1990. This cruise was in week 38.

This cruise was in week 38 and in *Figure 3* the average weekly temperatures and wind speeds for the preceding weeks are shown. As seen in the monthly average temperatures, it is clear that air temperatures are returning to normal values. Since the start of July (week 28) wind speeds have been slightly above average, however, the week of the cruise was characterised by low winds (*Figure 3a*) except for strong wind at the start of the cruise (approximately 10 m s^{-1} on the evening of the 15th whilst at station 449). For the length of the cruise the wind was predominantly from the Northeast.

Hydrography

A transect that summarises the horizontal gradients in the hydrographic and nutrient measurements is presented in *Figure 4* and the locations of the transect is marked on *Figure 1*.

Surface water temperatures were relatively constant varying between 14.5 to 16.25°C . In comparison to the last six years this is approximately 1°C cooler than expected. Bottom water temperatures were on average 13.7°C and not notably different from what is expected for this time of year. In the Northern Kattegat (station 1001) below 70 m a pocket of cold ($<8^{\circ}\text{C}$) and saline (>35) water was present.

Surface water salinities were on average 3.6 lower than expected for this time of year. This was most pronounced in the Great Belt and the Kattegat and can be seen in the profile plots in the Appendix. It is likely that

this is due to the dominating North-easterly winds during the sampling cruise and the large amount of precipitation in August. The water column at station 449 located south of Møn, was well mixed (*Figure 4*) and this is most likely a result of the higher winds at the time of sampling.

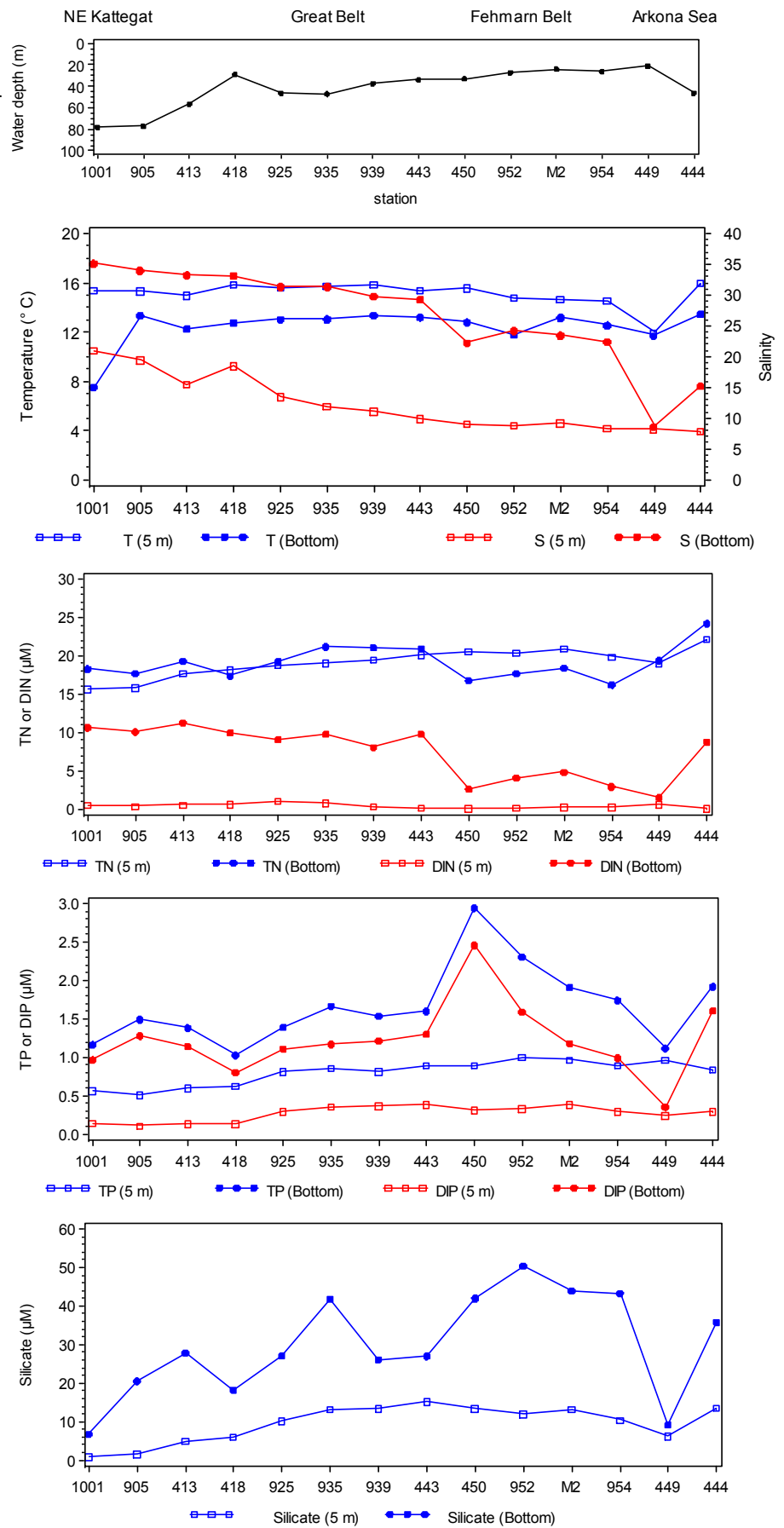
Nutrients

Total nitrogen (TN) concentrations in surface waters decreased from Arkona to the Northern Kattegat from 22 to 15 μM . In general bottom water TN concentrations were similar to that of surface waters except for i) the Northern Kattegat where TN concentrations were slightly higher, and ii) the Southern Belt Sea where TN concentrations were lower (*Figure 4*). Dissolved inorganic nitrogen (DIN) concentrations in surface waters were very low ($<1 \mu\text{M}$) and primarily consisted of ammonium. Bottom water DIN concentrations were approximately 10 μM , except for the Southern Belt Sea where concentrations were lower ($< 5 \mu\text{M}$).

Total phosphorus (TP) and dissolved inorganic phosphorus (DIP) concentrations in surface waters decreased from East to West along the transect from 0.84 and 0.30 μM to 0.56 and 0.14 μM respectively (*Figure 4*). A different trend was apparent for the bottom water concentrations. As with the surface waters, the bottom concentrations of TP and DIP varied in a similar fashion. Maximum concentrations were measured in the Southern Belt Sea at station 450, where TP was 2.9 and DIP was 2.5 μM (*Figure 4*).

Silicate concentrations in the surface waters were lowest in the Northern Kattegat ($< 1 \mu\text{M}$) and greatest in the Great Belt, Belt Sea region with concentrations ranging between 12-15 μM , which is greater than expected for this time of year (e.g. Appendix station 925). Bottom water concentrations were considerably higher (*Figure 4*) with maximum values of 50 μM at station 952 in the Fehmarn Belt.

Figure 4 Transects of surface and bottom water temperature, salinity and nutrient concentrations. Position of the transect is indicated in *Figure 1*.



Chlorophyll a

Chlorophyll concentrations in the upper 15 m ranged from 1.1 to 6.2 $\mu\text{g/l}$, which is within the range expected for this time of year. For the majority of the stations the chlorophyll concentrations in the surface 15 m were very similar. Exceptions were station 939 in the Great Belt where the chlorophyll maximum was at 15 m and station 450 in the Sothern Belt Sea where the maximum was at 20 m. Additionally, at station M2 in the Mecklenburg Bight maximum chlorophyll concentrations were in the surface 5 m.

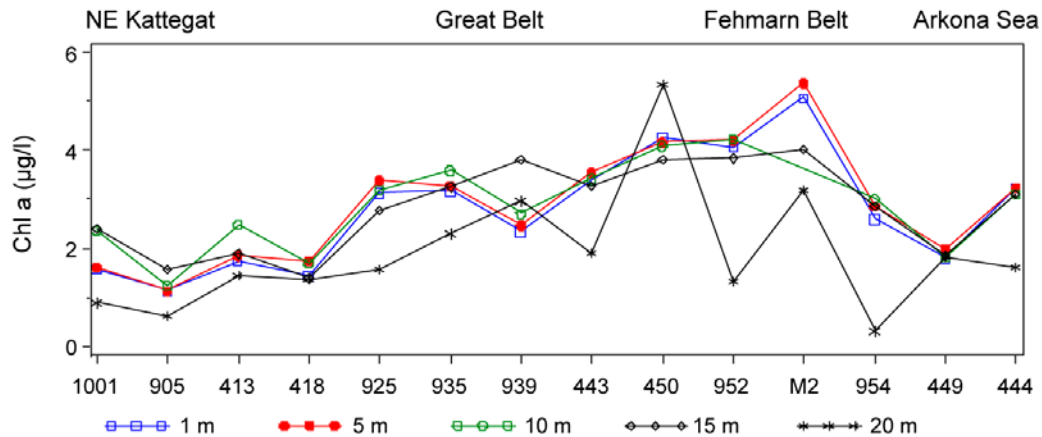


Figure 5 Chlorophyll a concentrations in surface waters along the transect shown in Figure 1.

Oxygen

Bottom water oxygen concentrations ranged between 0.34 and 6.3 ml/l, with lowest concentrations measured in the Fehmarn Belt and highest concentrations measured at the relatively shallow station 449 in the Arkona Sea where the water column was well mixed. For the majority of stations oxygen concentrations fell within the expected values for this time of year with much of the Belt Sea experiencing oxygen depletion and with severe oxygen depletion in the Southern Belt Sea.

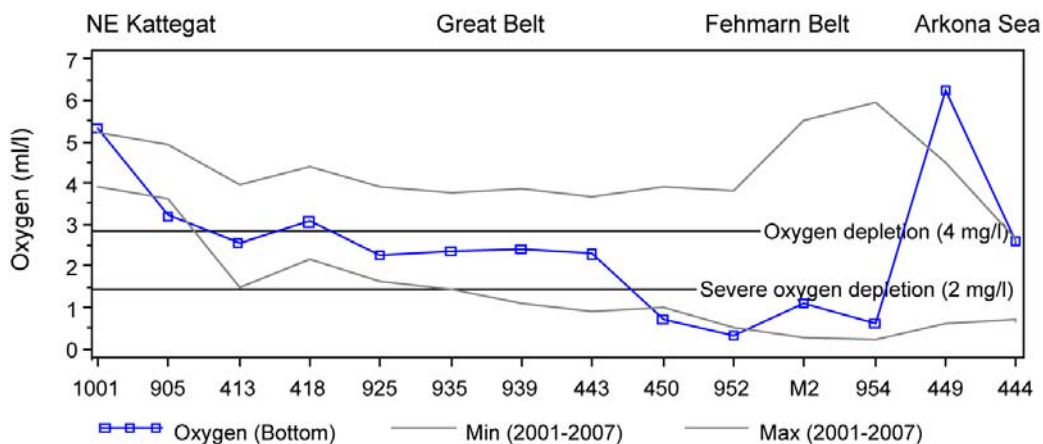
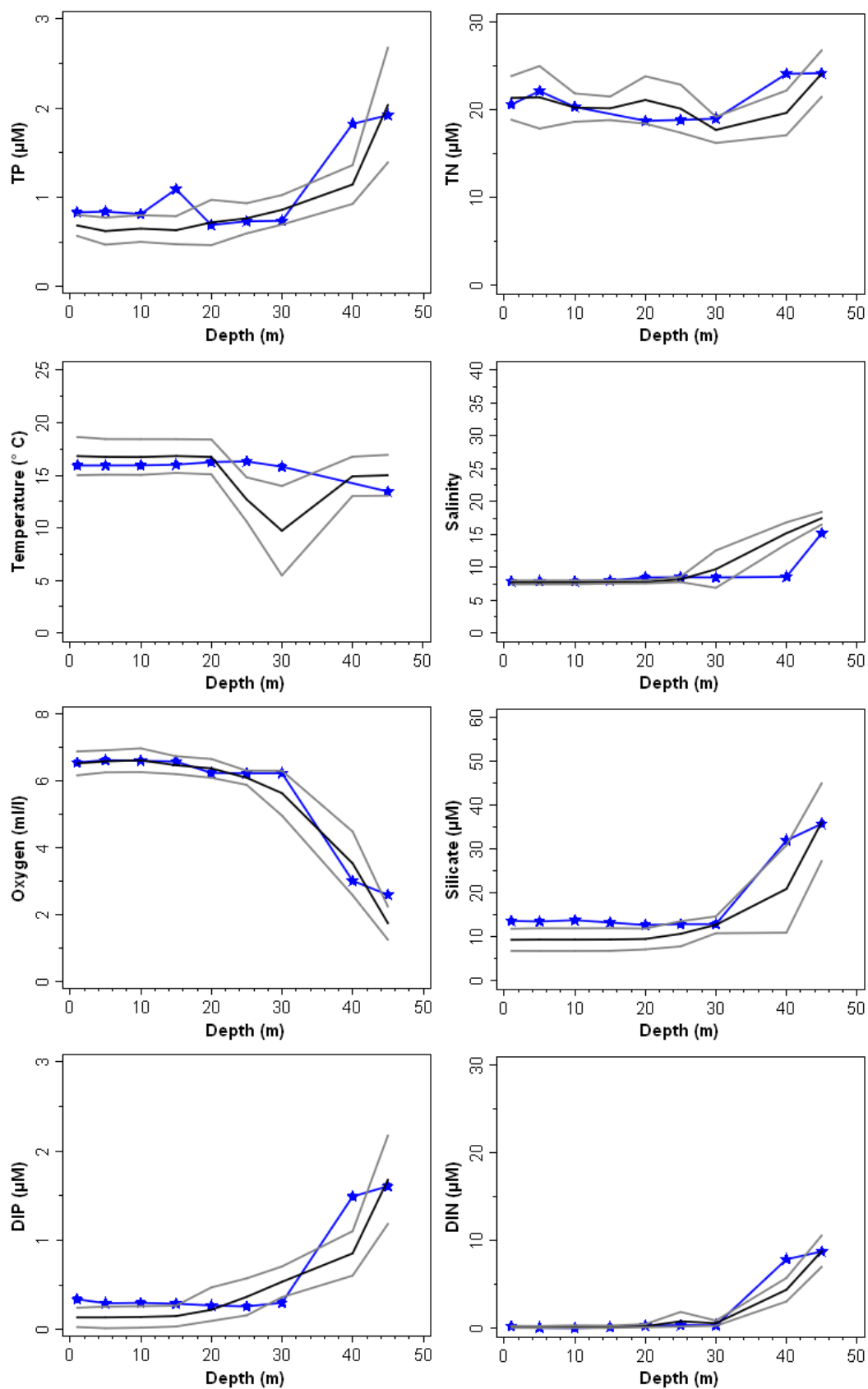


Figure 6 Bottom water oxygen concentrations along the transect shown in Figure 1. Also shown are the reference concentrations for oxygen depletion and severe oxygen depletion.

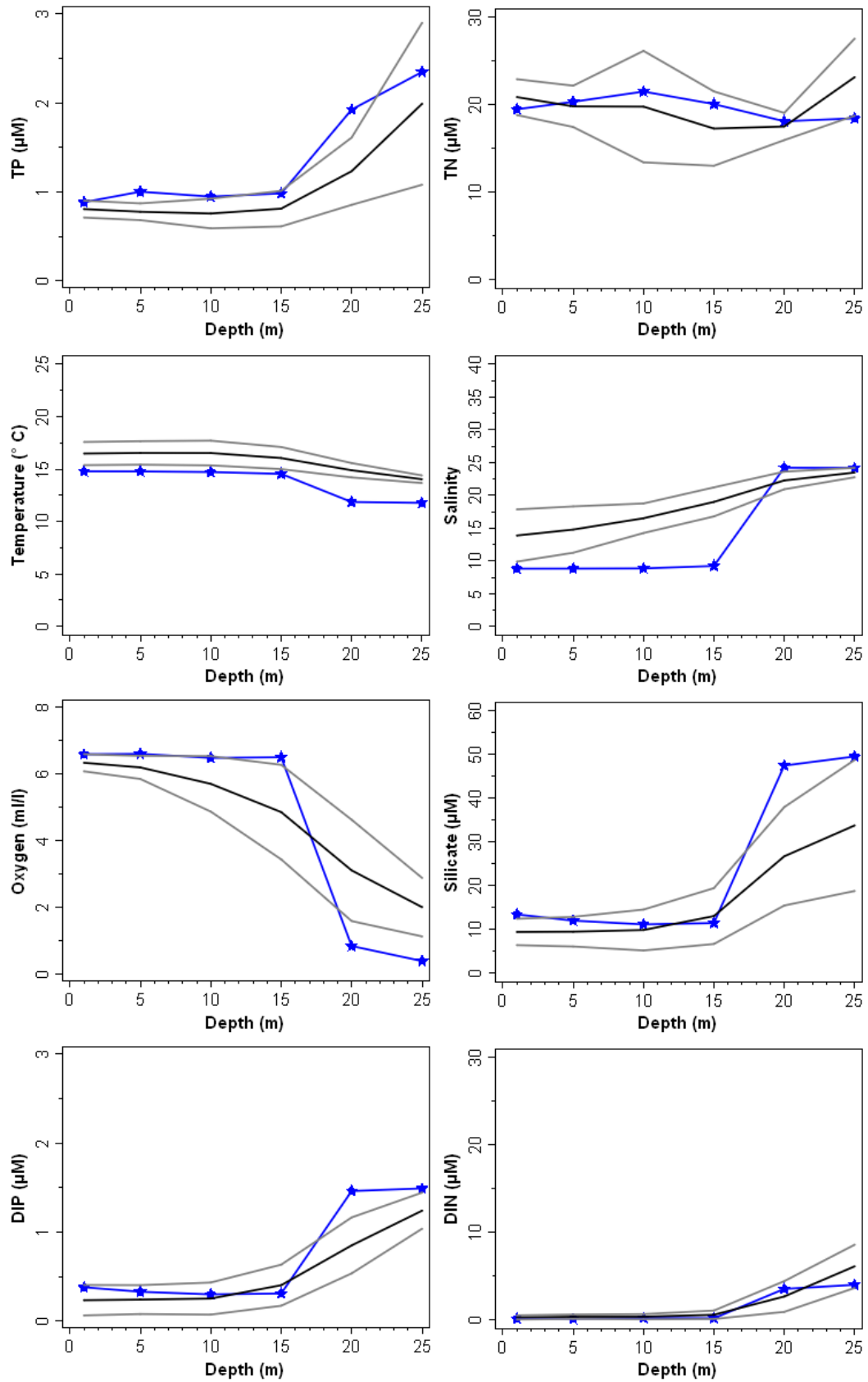
Appendix

The following graphs show profiles of the measured parameters at seven chosen stations (blue lines). The mean profiles are also plotted for the station from the same cruise during the period 2001-2007 (black). The grey lines are the upper and lower 95% confidence limits for the mean.

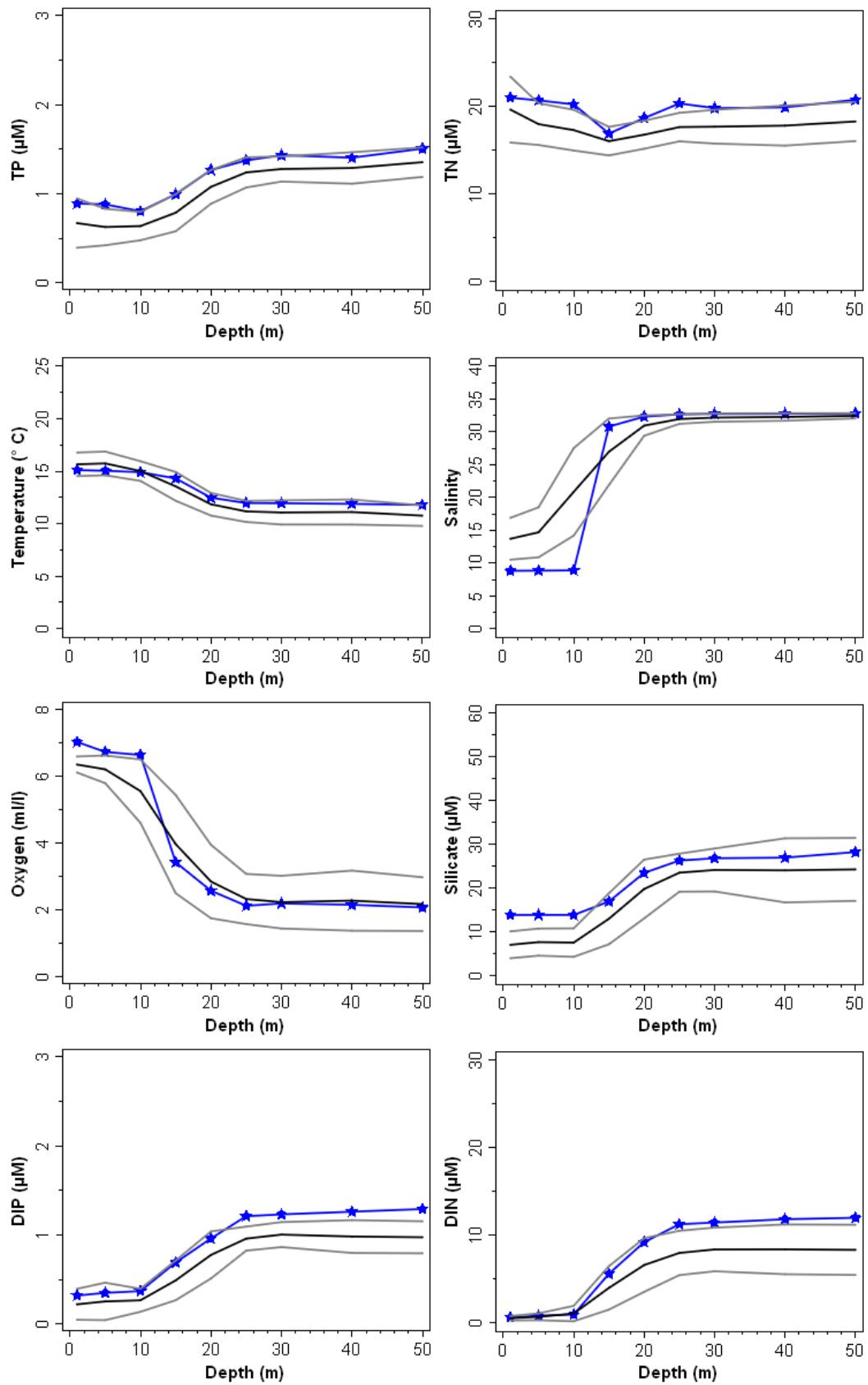
St. 444 - Arkona Sea



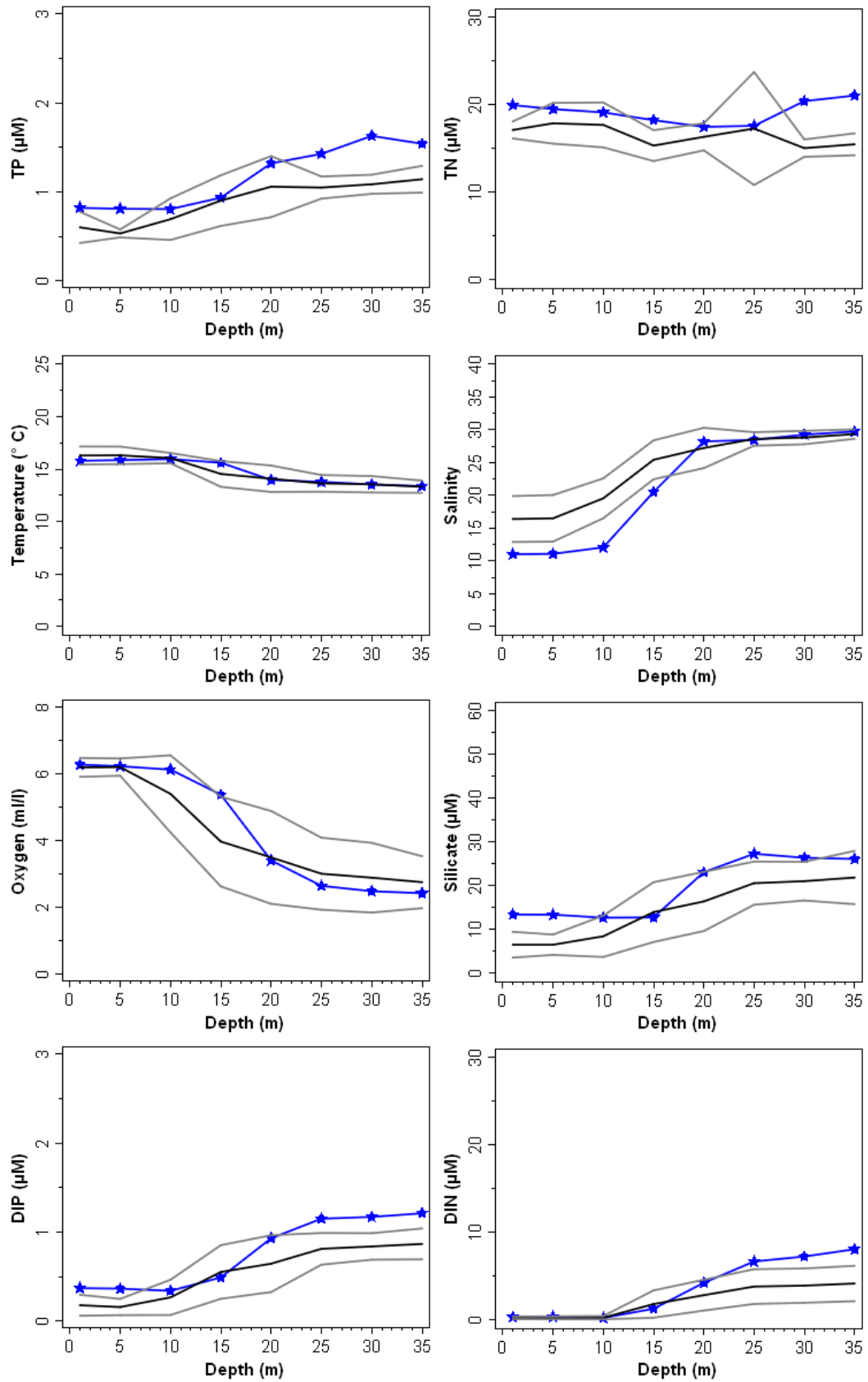
St. 952 - Fehmarn Belt



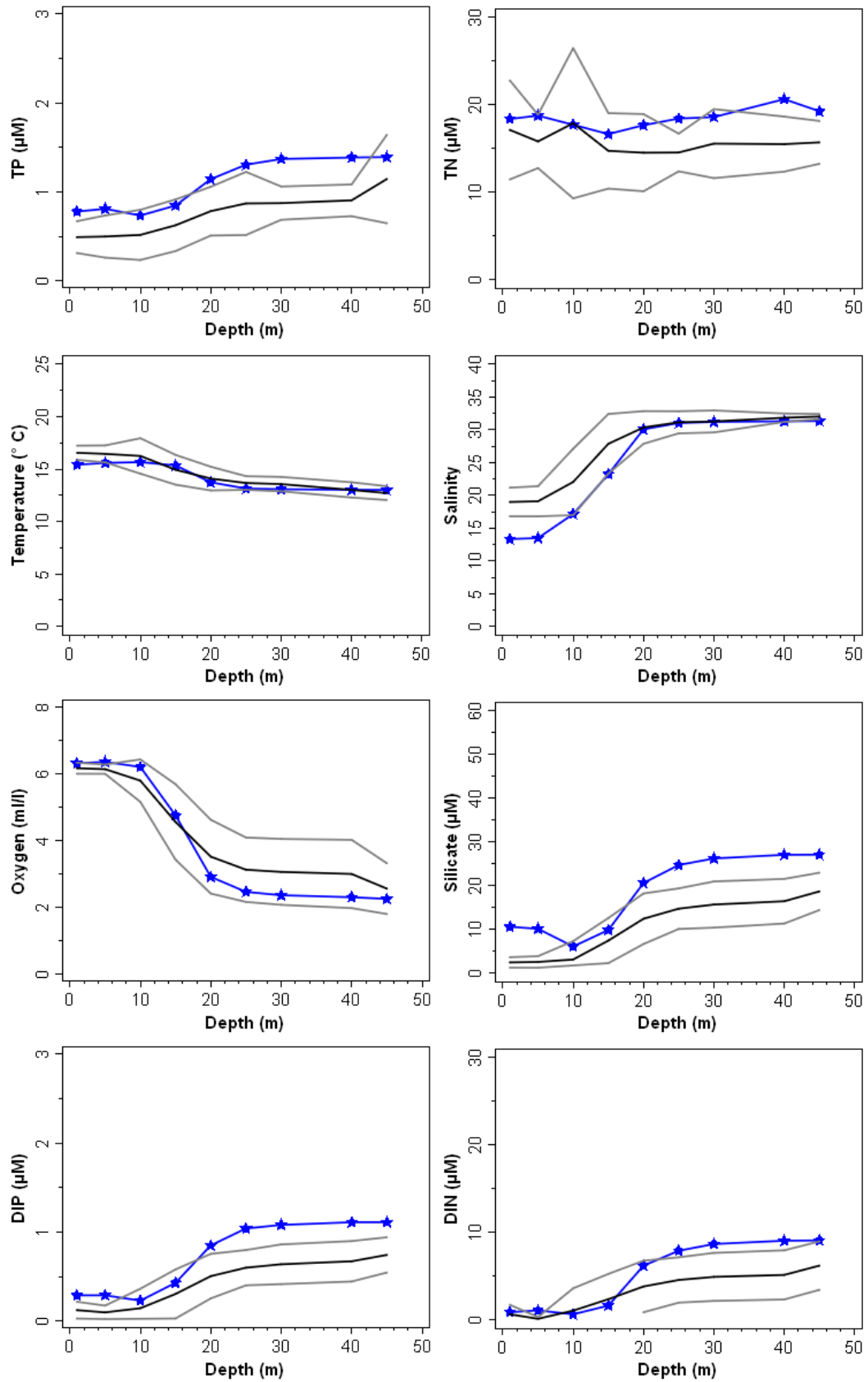
St. 431 - The Sound



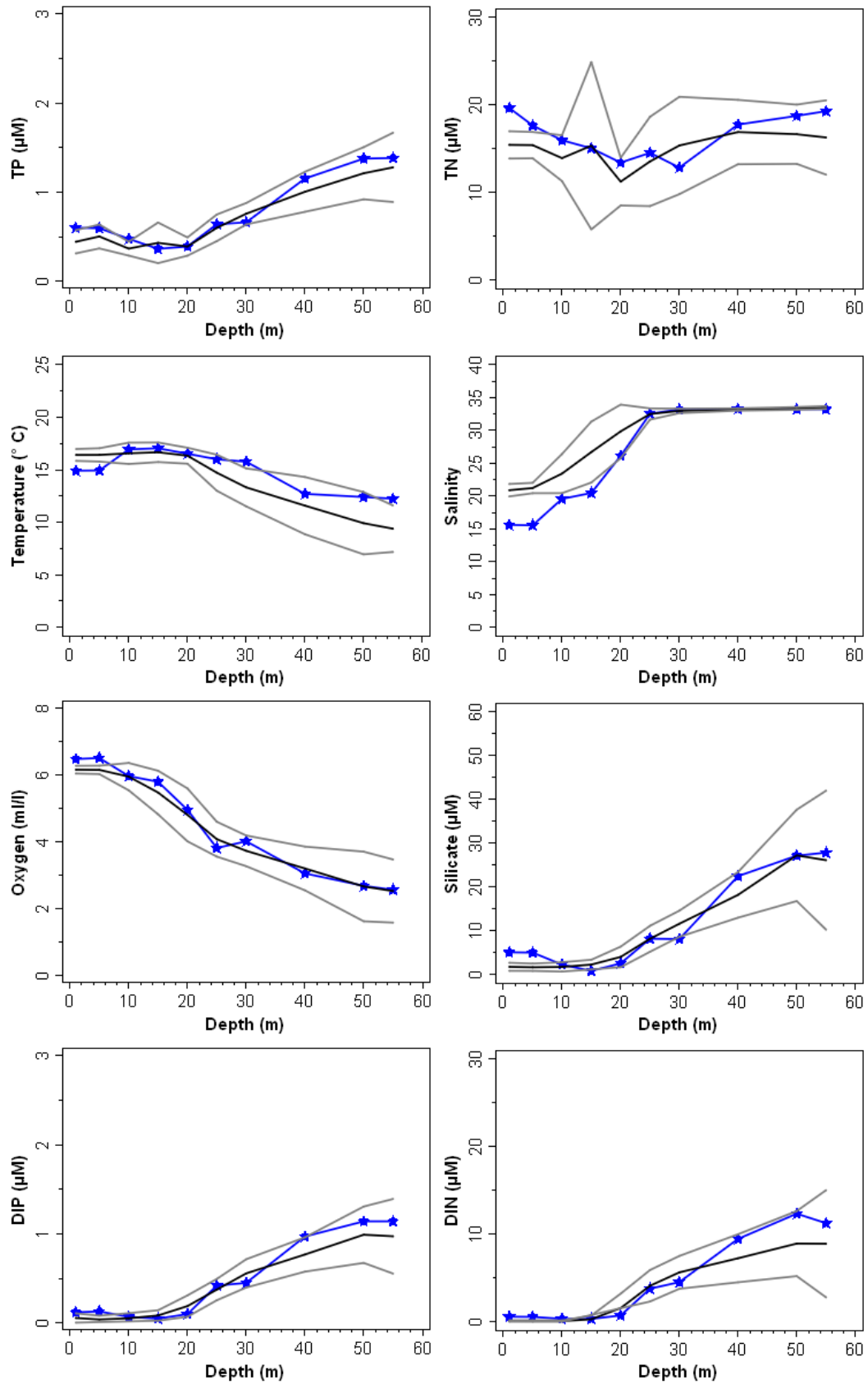
St. 939 - The Great Belt



St. 925 - Southern Kattegat



St. 413 - Central Kattegat



St. 1001 - Northern Kattegat

