r/v Gunnar Thorson

Monitoring Cruise Report

Cruise no.: GT 246

Time: 18 - 22 August 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 246, 18-22 August 2008

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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

- Despite the warmer air temperatures during the last nine months, surface waters (depth <= 5m) were cooler and more saline than normal. This is thought to be due to the relatively strong winds in the weeks preceding the cruise which enhanced vertical mixing.
- Dissolved inorganic nitrogen (DIN) was absent from all surface waters and dissolved inorganic phosphorus (DIP) was absent in the surface waters of the Kattegat but at concentrations between 0.07-0.24 µM elsewhere.
- Oxygen depletion (<4 mg/l) was detected in the Fehmarn Belt, Mecklenburg Bight and Arkona Sea bottom waters. In general the levels and distribution of bottom water oxygen concentrations were as 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.

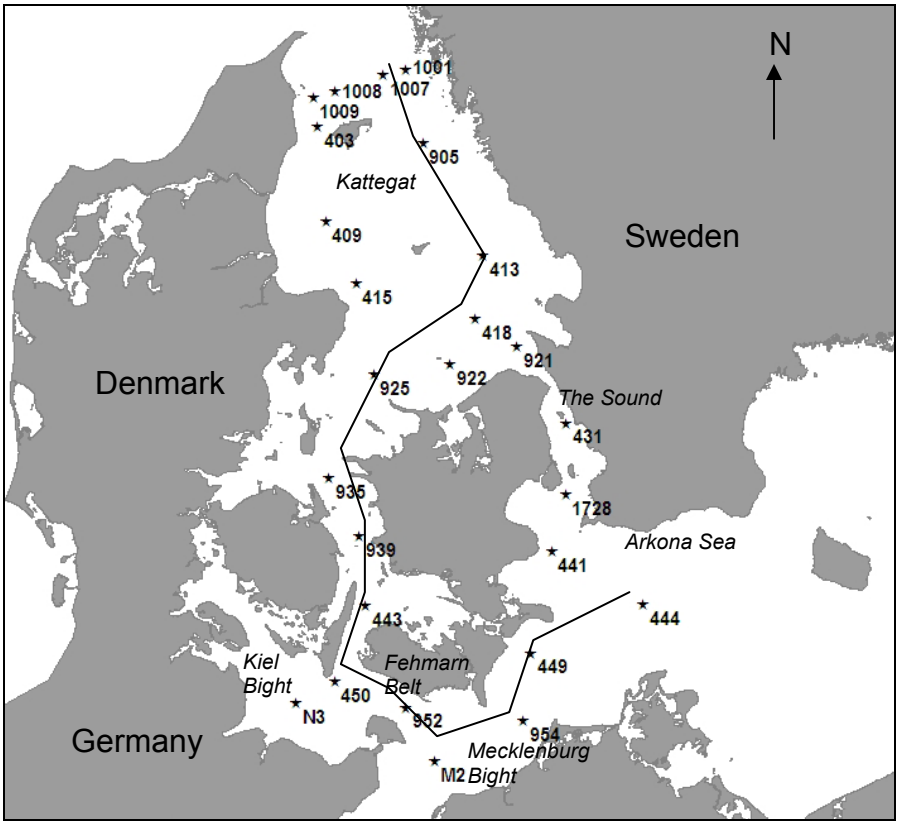


Figure 1 Map showing the stations sampled by the monitoring cruise, region sea names and the location of the transects plotted in the following figures.

Meteorology

Since December last year air temperatures have on average been warmer. January and February 2008 were over 4 degrees warmer than normal. From March to July temperatures have been 0.7 to 4 degrees warmer than normal (*Figure 2*). Additionally the winter of 2007/2008 was wetter than normal, however, during the months of May, June and July there has been little precipitation. During August, however, 146 mm of rain fell which is slightly more that twice the average for this month (*Figure 2*).

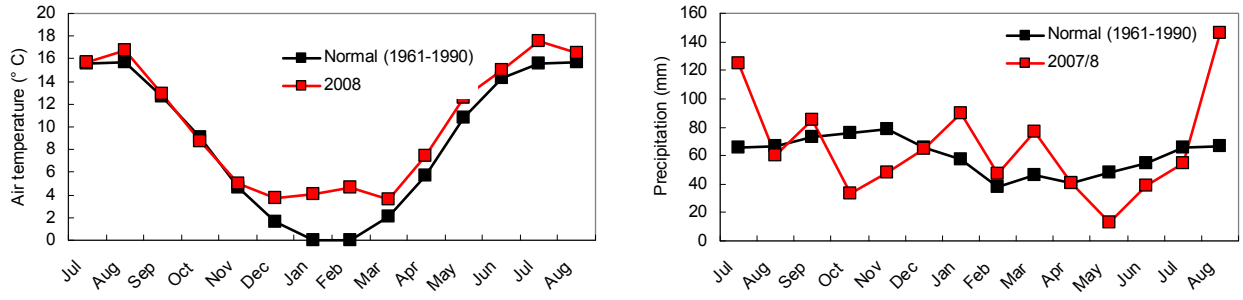


Figure 2 Monthly average air temperature and monthly total precipitation data for July 2007 to August 2008 compared with long term averages (1961-1990). Data retrieved from the Danish Meteorological Institute (www.DMI.dk).

From mid-March to mid-May average wind speeds were below normal, however from the beginning of June onwards wind speeds were often greater. The weeks preceding the cruise average wind speeds were above average (*Figure 3*). Also shown in *Figure 3* are the weekly average air temperatures. Here it is clear that since mid April half of the weeks have had notably warmer temperatures than normal.

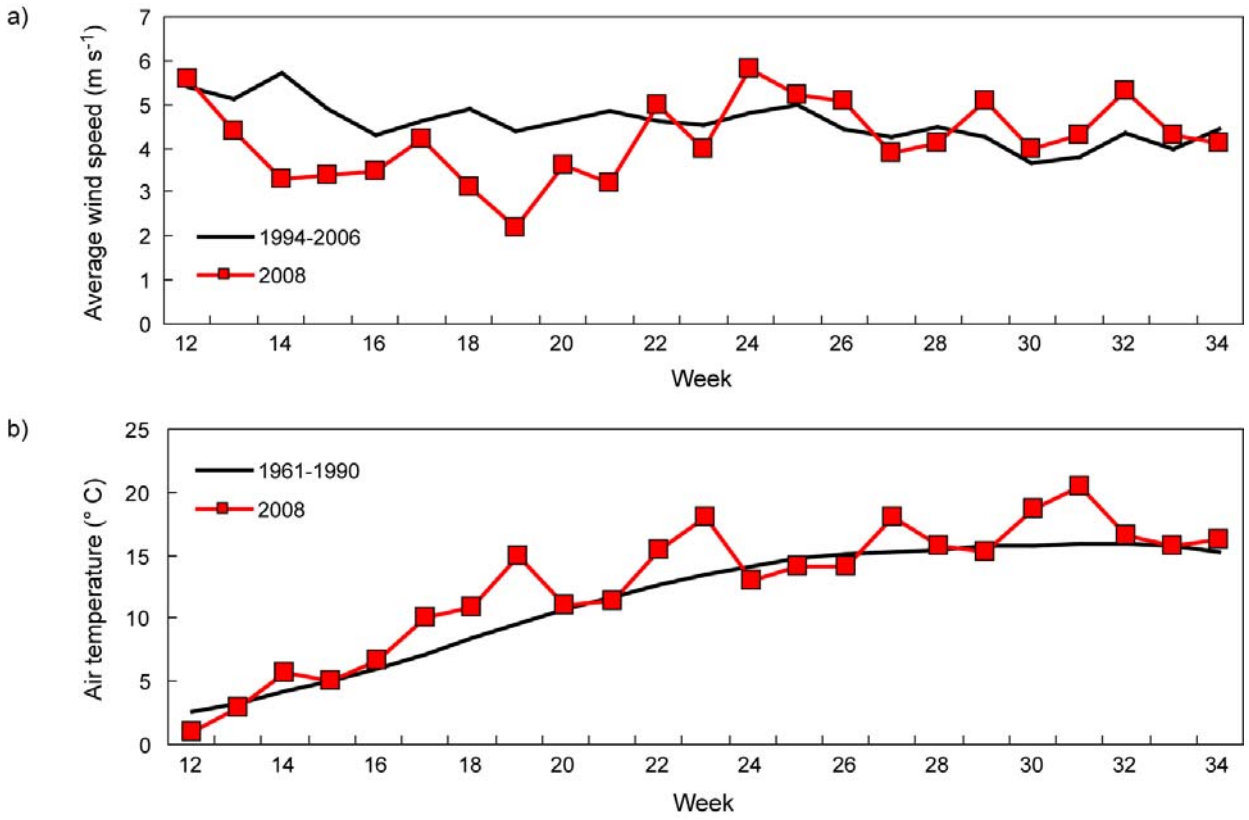


Figure 3 a) Weekly average wind speed from mid-March to the week of the cruise compared with average values from 1994-2006. b) Weekly air temperature from the same period compared to average values from 19961-1990. This cruise was in week 34.

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*.

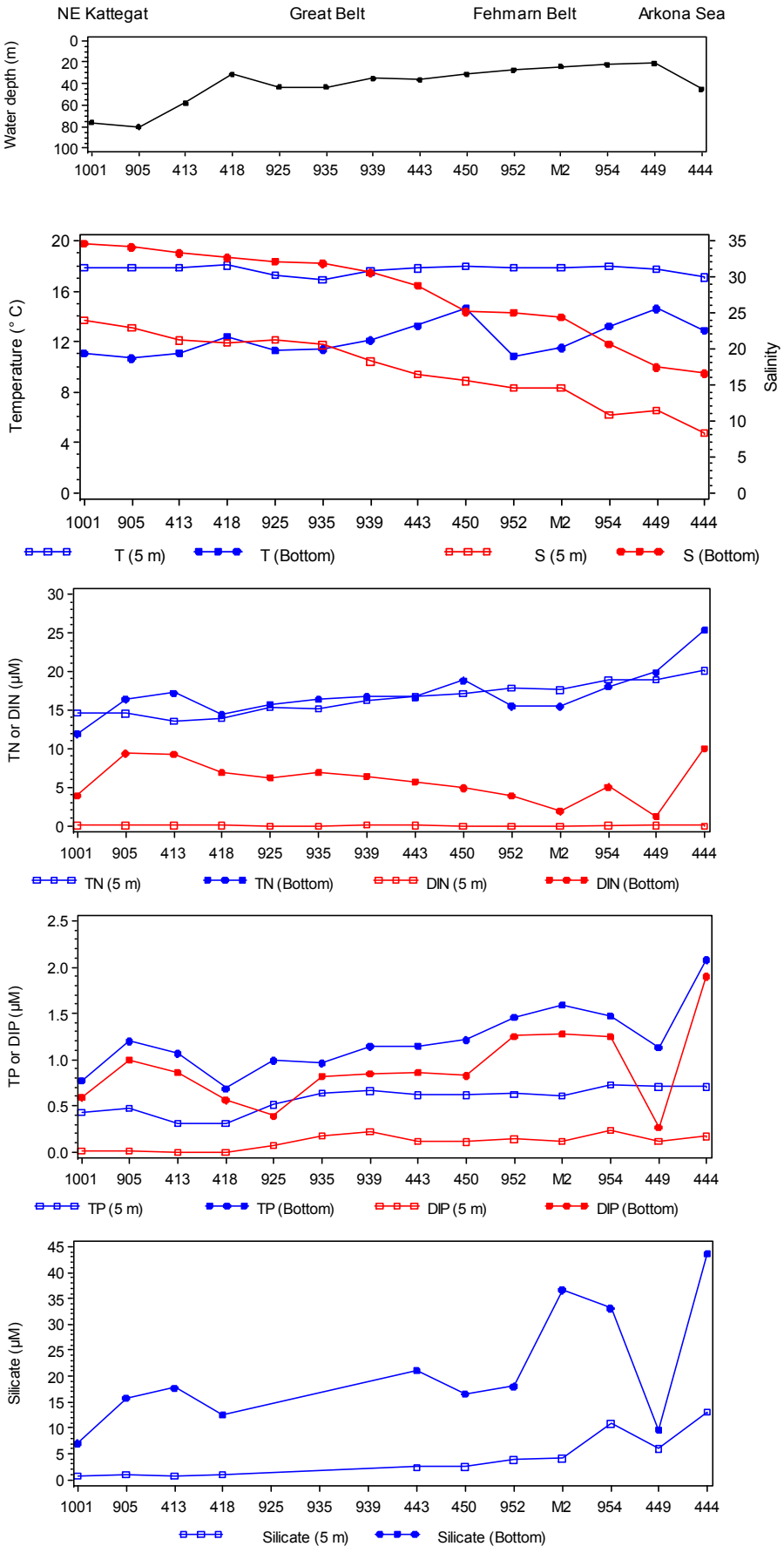
Surface water temperatures (5 m) along the transect were relatively constant, averaging 17.7° C (*Figure 4*). In comparison with the average values for this time of year the surface waters (depth <= 5 m) of the majority of the Kattegat stations were cooler than average by 1-1.7° C. Bottom water temperatures varied between 10.7-14.6° C. Half of the stations visited had bottom water temperatures between 1 and 4.3° C warmer than average for the last six years data for the month of August. Data from some stations are presented in the Appendix. The greatest deviations were observed in the Kattegat at stations 413 and 418 north of Zealand. Here bottom water temperatures were more than 4° C warmer. These trends in temperature are likely a result of generally warmer air temperatures since winter last year combined with above average wind speeds in the weeks preceding the cruise. Higher temperatures will result in the gradual warming of the surface water, whilst subsequent high wind speeds will cause greater vertical mixing, transferring heat to bottom waters and cooling surface waters.

Salinities in surface waters increased gradually along the transect from 8.3 in the Arkona Sea to 23.9 in the northern Kattegat. Bottom water salinities for the same transect ranged from 16.5 to 34.6 (*Figure 4*). In general surface water salinities were slightly higher than expected for this time of year, except in the Sound where conditions were normal (Appendix).

Nutrients

Total nitrogen (TN) concentrations in surface and bottom waters decreased from East to West along the transect (*Figure 4*). Surface water concentrations ranged between 13.5-20.1 µM and bottom water concentrations ranged between 11.9-25.4 µM. Dissolved inorganic nitrogen (DIN) was generally absent from surface waters whilst concentrations in the bottom waters varied between 1.3-10.1 µM along the transect shown in *Figure 4*. Total phosphorus (TP) concentrations in bottom waters ranged between 0.69-2.08 µM and generally increased from the northern Kattegat to the Arkona Sea. Surface TP concentrations followed a similar trend and were approximately half bottom water concentrations, ranging between 0.31-0.73 µM along the transect (*Figure 4*). Dissolved inorganic phosphorus (DIP) was generally absent from the surface waters of the Kattegat and at low concentrations in the Great Belt, the Belt Sea and the Arkona Sea (0.07-0.24 µM). DIP concentrations in the bottom waters were much higher ranging between 0.27-1.9 µM and followed the trend seen for TP. Silicate concentrations in the surface waters of the Kattegat were low ranging between 0.7 and 1.1 µM. In the Belt Sea and the Arkona Sea concentrations were higher ranging between 2.5-17.8 µM. Bottom water silicate concentrations along the transect ranged between 7.0-43.7 µM with the greatest concentrations measured in the Arkona Sea and Mecklenburg Bight.

Figure 4 Transects of surface and bottom water temperature, salinity and nutrient concentrations. Position of the transect is indicated in *Figure 1*. Note some silicate measurements are not shown as at the time of writing they were being re-analysed.



Chlorophyll *a*

Chlorophyll *a* concentrations in the surface 20 m varied between 0.4 and 5.1 µg/l, with highest concentrations measured in the Sound at 15 m (Station 431). In the Kattegat there was little difference between concentrations at the five depths measured. However, at some Great Belt and Belt Sea stations (St.935, St. 450 and M2) there was a chlorophyll maximum at 15-20 m depth.

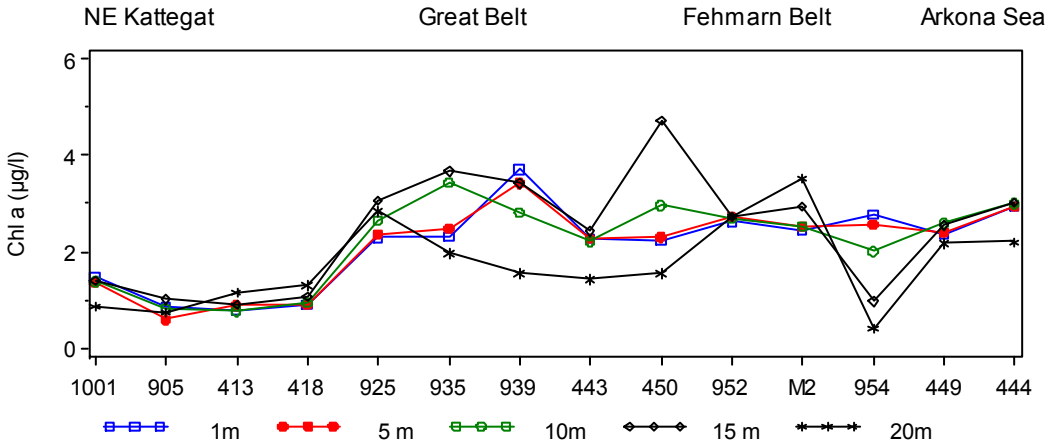


Figure 8 Chlorophyll *a* concentrations in surface waters along the transect shown in *Figure 1*.

Oxygen

Bottom water oxygen concentrations were typical for this time of year. *Figure 9* shows the values along the transect plotted together with the maximum and minimum values from the last six years. This year data follow the average trend. Oxygen depletion was present in the Fehmarn Belt, Mecklenburg Bight and the Arkona Sea.

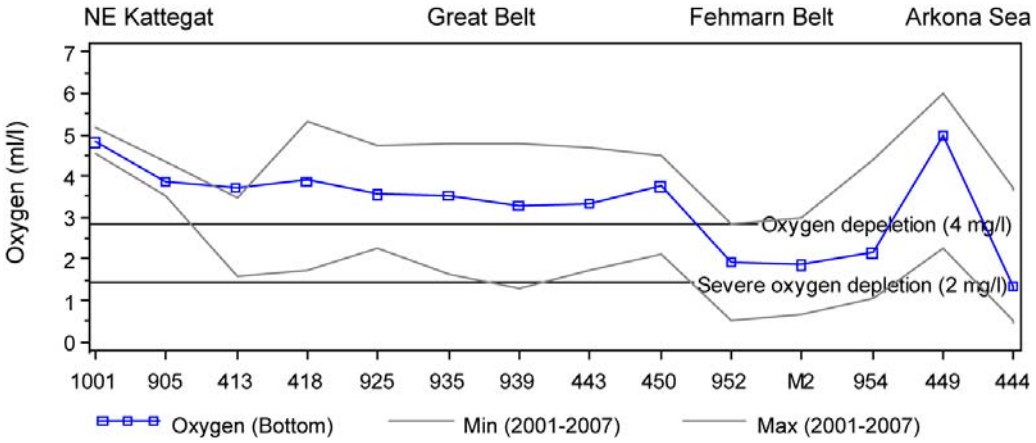
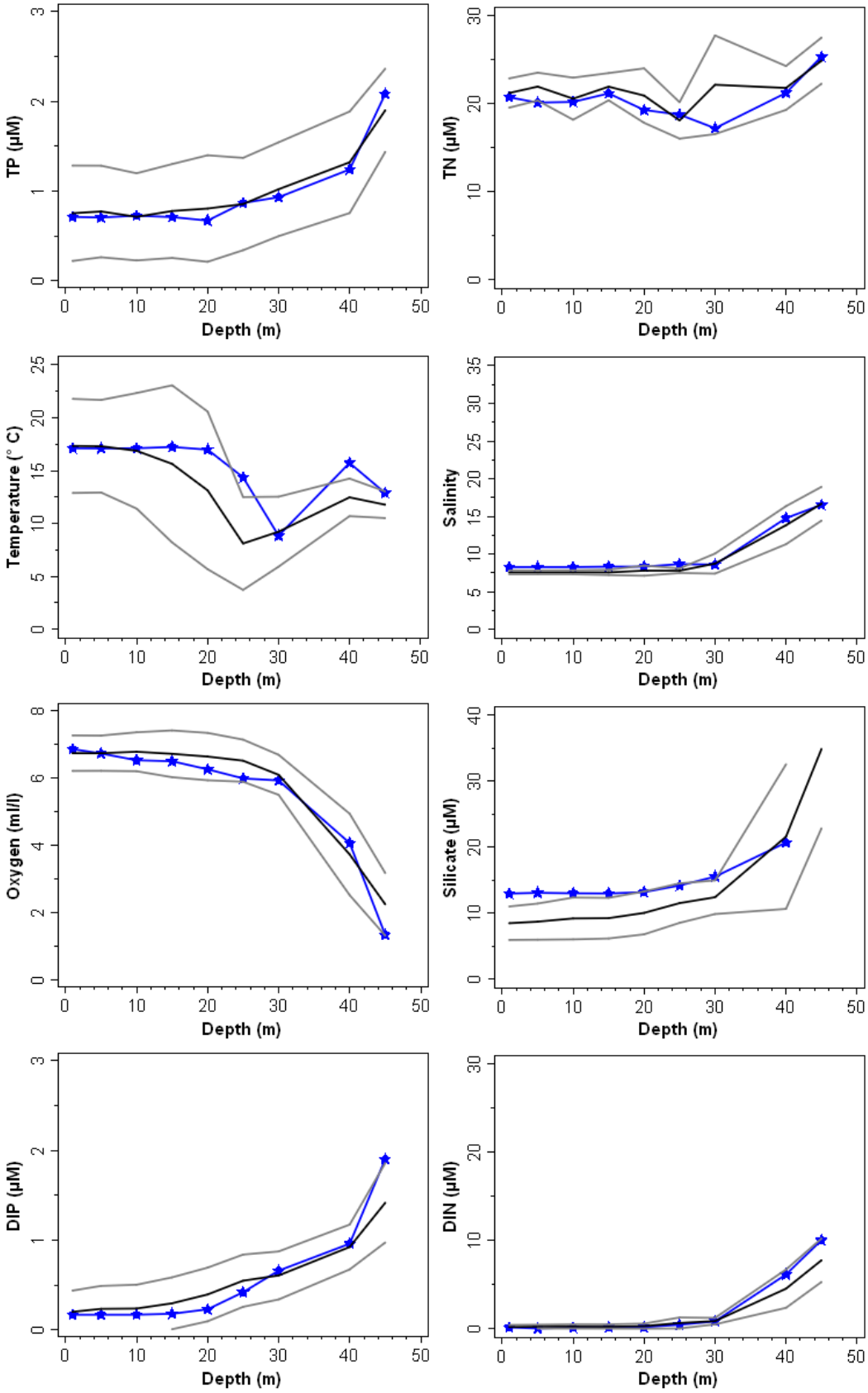


Figure 9 Bottom water oxygen concentrations along the transect shown in *Figure 1*. Also shown are the concentrations which define oxygen depletion and severe oxygen depletion.

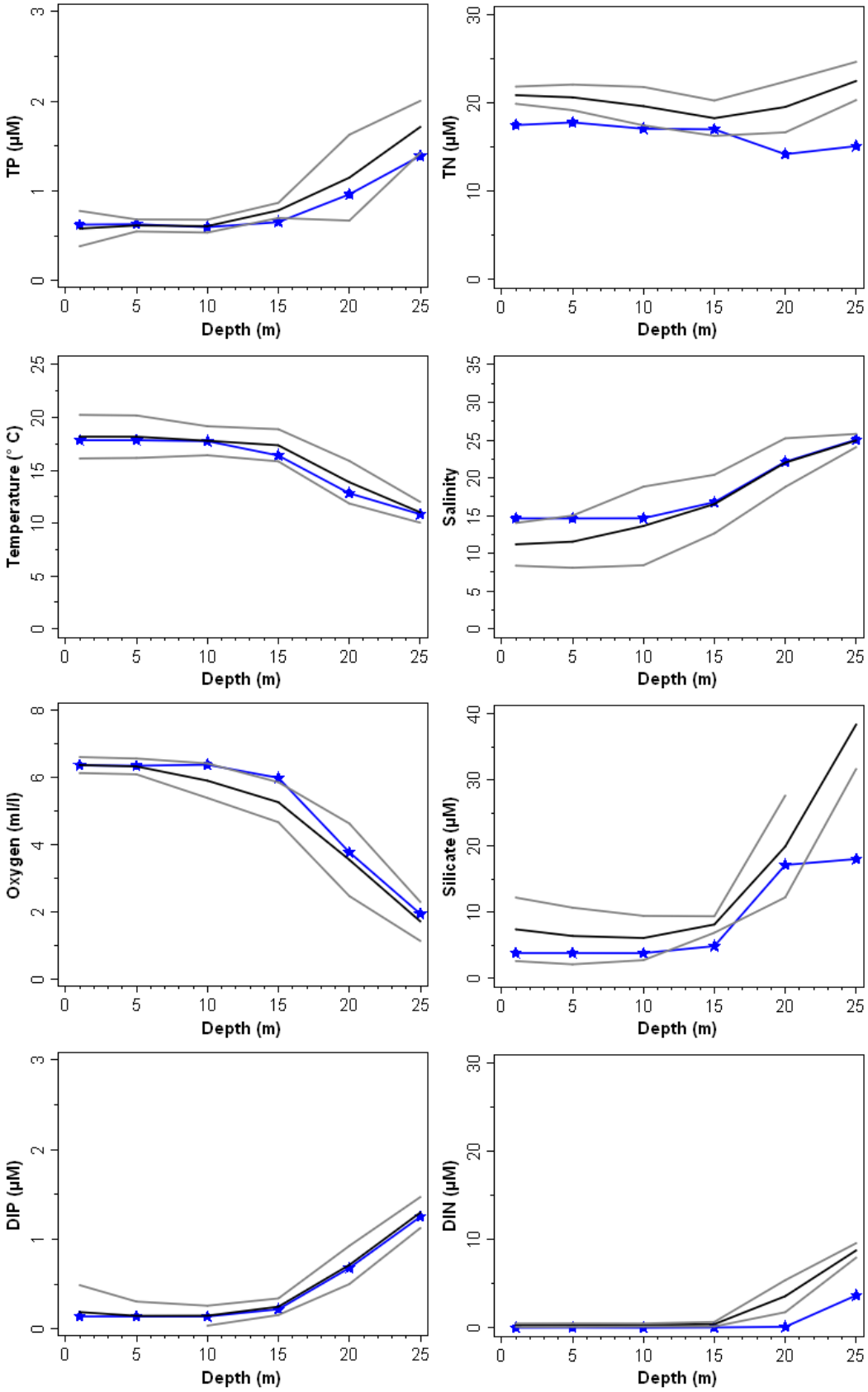
Appendix

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.

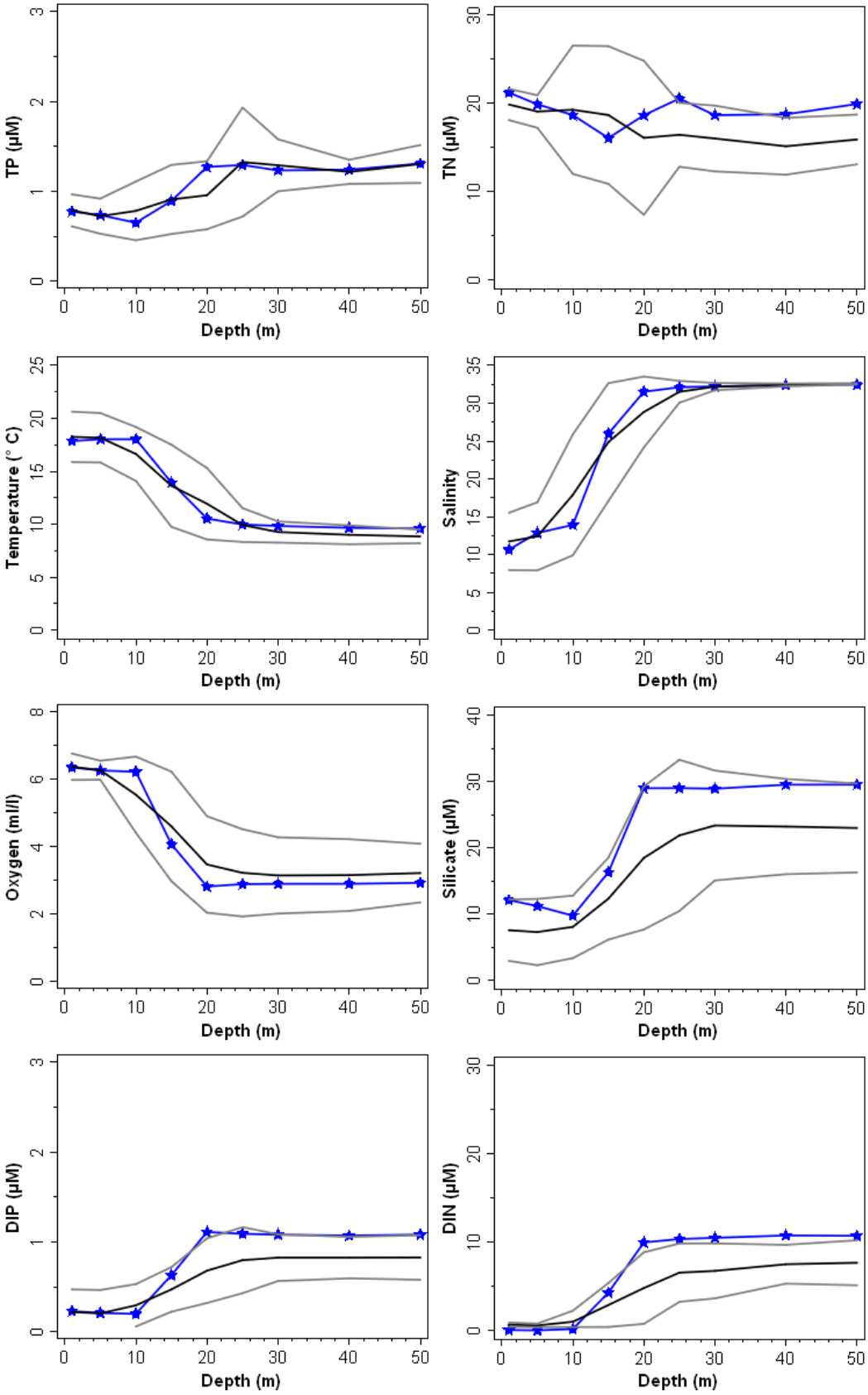
St. 444 - Arkona Sea



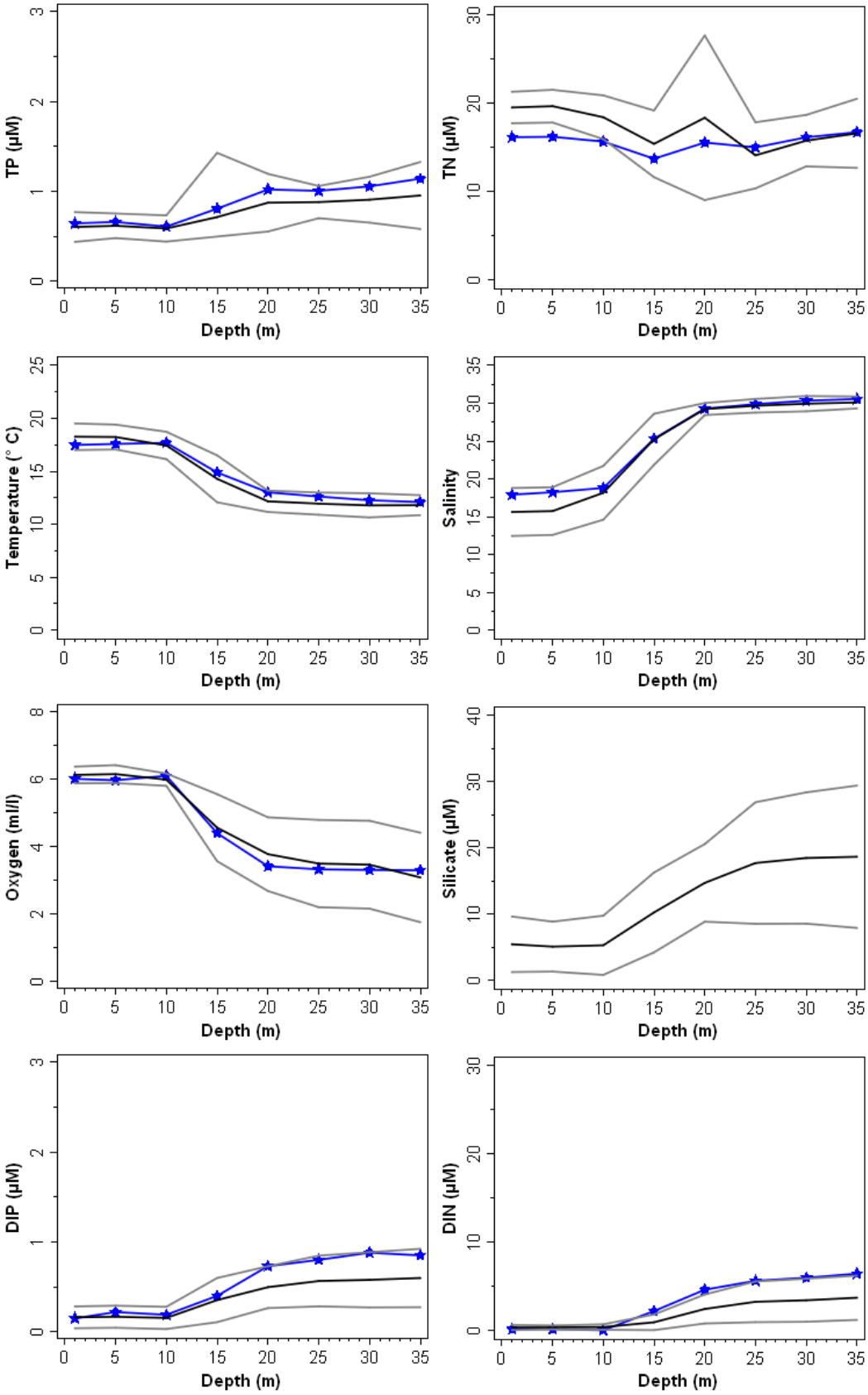
St. 952 - Fehmarn Belt



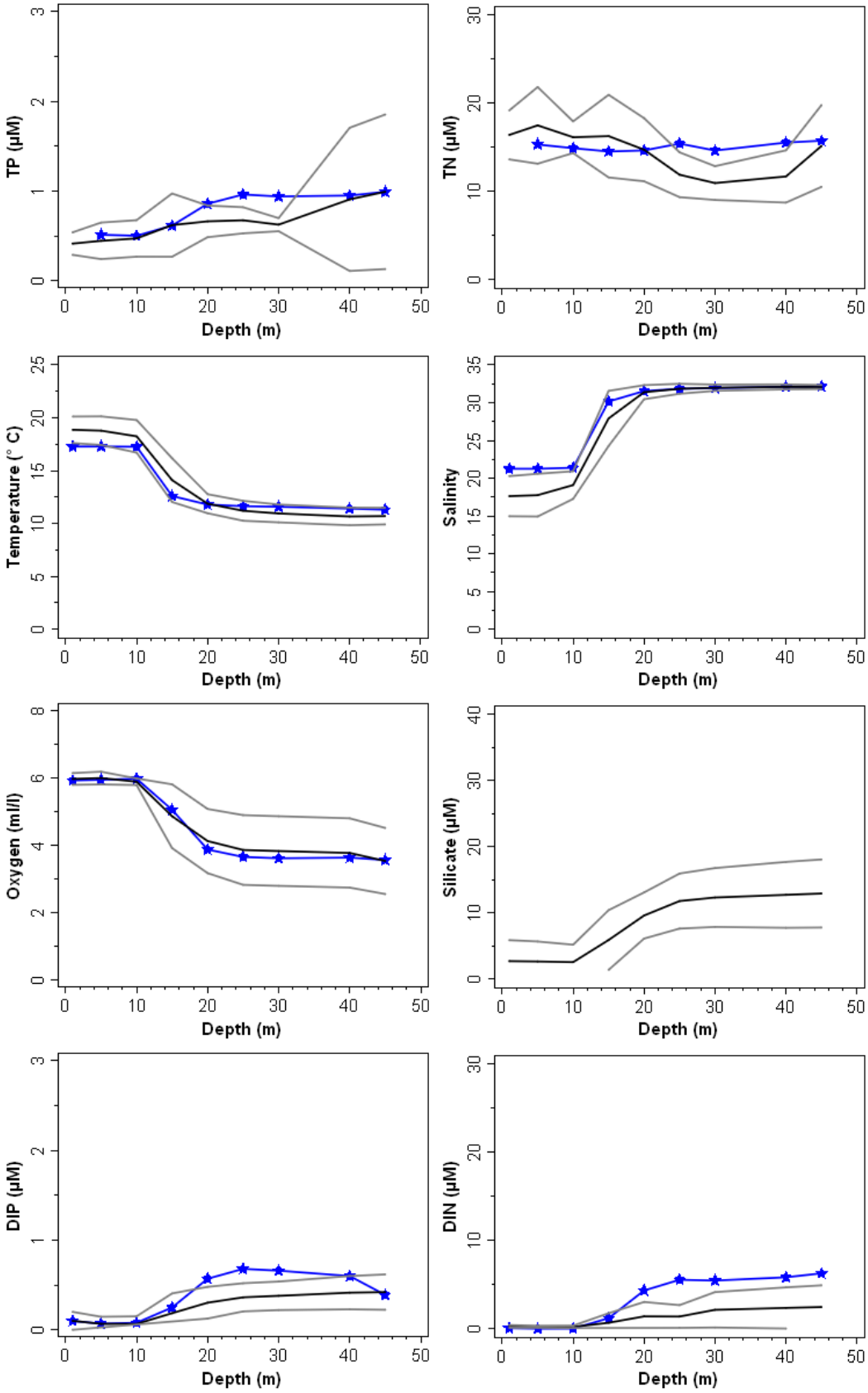
St. 431 - The Sound



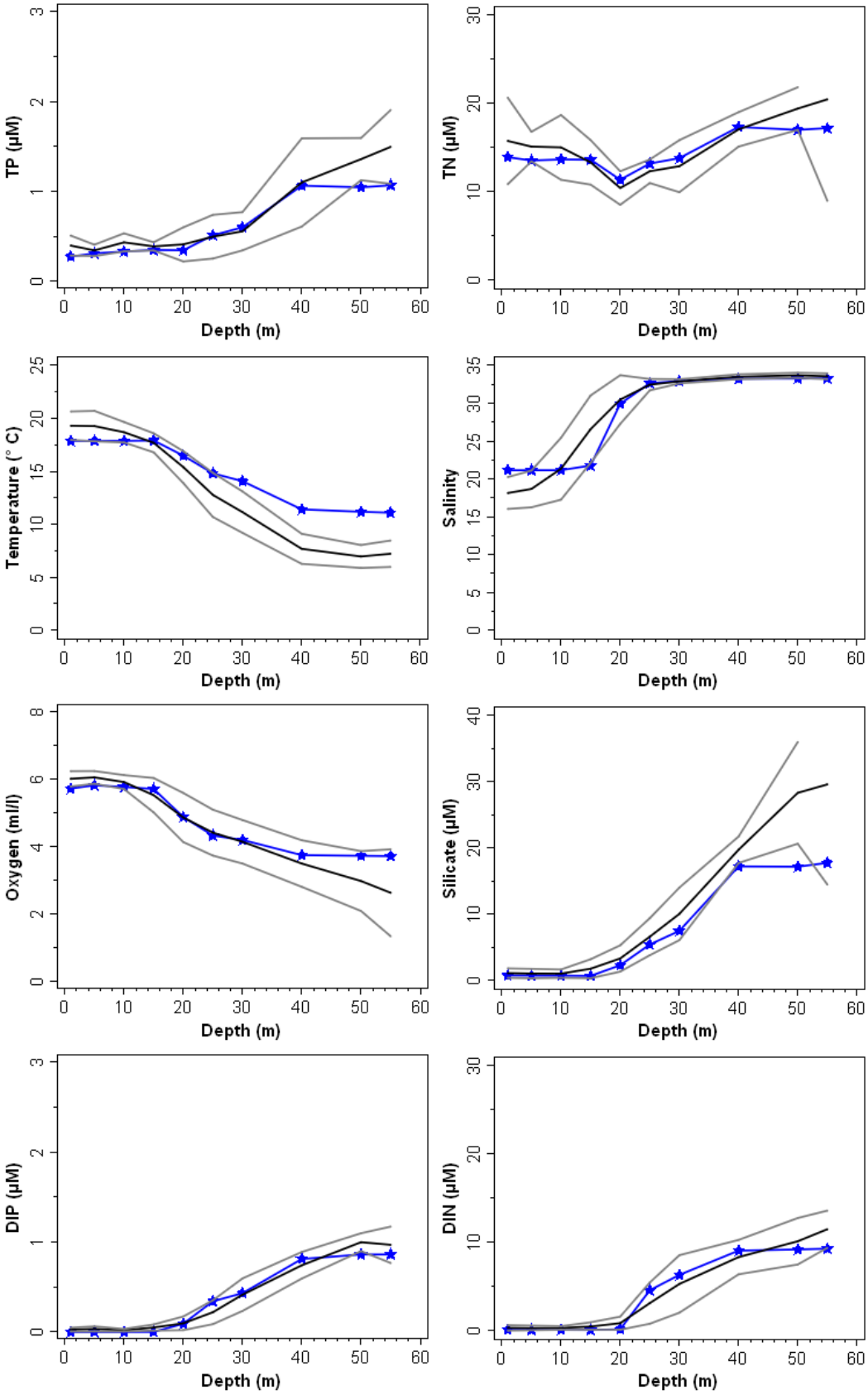
St. 939 - The Great Belt



St. 925 - Southern Kattegat



St. 413 - Central Kattegat



St. 1001 - Northern Kattegat