r/v Gunnar Thorson

# Monitoring Cruise Report

**Cruise no.: GT 244**

**Time: 4 - 8 February 2008**

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

National Environmental Research Institute
University of Aarhus
Frederiksborgvej 399
DK-4000 Roskilde
Denmark
Tel.: +45 4630 1200 ◇ Fax: +45 4630 1114
www.neri.dk

# Data sheet


| | |
|---|---|
| Title: | Monitoring cruise report - Cruise no. GT 244, 4-8 February 2008 |
| Author: | Colin A. Stedmon |
| Department: | Department of Marine Ecology |
| Serial title: | Monitoring Cruise Report |
| Publisher: | National Environmental Research Institute © |
| | University of Aarhus |
| URL: | http://www.neri.dk |
| Week/year of publication: | 15/2008 |
| Please cite as: | Stedmon, C.A. 2008: Monitoring cruise report - Cruise no. GT 244, 4-8 February 2008. National Environmental Research Institute, University of Aarhus, Denmark. 17 pp. – Monitoring cruise report. |





| | |
|---|---|
| Keywords: | Marine, monitoring, hydrography, eutrophication |
| Layout: | Anne van Acker |
| Drawings: | Colin A. Stedmon |
| ISSN (electronic): | 1600-1656 |
| Number of pages: | 17 |
| Remark: | The numbers of the monitoring cruises may not be successive, as the numbers also include other types of cruises. |
| Internet-version: | The report is available in electronic format at NERI's website http://www.dmu.dk/Vand/Havmiljoe/Togtrapporter/ |
| Published by: | National Environmental Research Institute<br>University of Aarhus<br>Frederiksborgvej 399<br>P.O. Box 358<br>DK-4000 Roskilde<br>Denmark<br>Tel. +45 4630 1200<br>E-mail: dmu@dmu.dk<br>www.neri.dk |

# Monitoring Cruise Report - Cruise No. GT 244, 4 - 8 February 2008


Report author: Colin A. Stedmon

Cruise leader: Kjeld Sauerberg

Participants: Jan Damgaard Nielsen
Dorete W. Jensen
Kjeld Sauerberg
Peter Kofoed
Gitte Jacobsen
Colin A. Stedmon (Copenhagen to Rødvig)
Martin Larsen (Copenhagen to Rødvig)
Pia Lassen (Copenhagen to Rødvig)


Vessel: R/V Gunnar Thorson

Sampling region: The Sound, the Arkona Sea, the Belt Sea and the Kattegat

Primary aim: Monitoring of winter nutrient concentrations



## Summary


- The exceptionally warm weather during December 2007 and January 2008 has resulted in warmer surface waters in the region than normally expected for this time of year.
- Total nitrogen, dissolved inorganic nitrogen and total phosphorus concentrations were similar to the average conditions for this time of year (compared to six year average).
- Dissolved inorganic phosphorus concentrations in the Fehmarn Belt were significantly greater than average for this time of year.
- Silicate concentrations in the Belt Sea and Kattegat waters were also greater than normal.
- There was clear evidence for local sources of N, P and Si in the Belt Sea region (Kiel Bight, Great Belt, Fehmarn Belt and Mecklenburg Bight), where concentrations were greater than values at lower and higher salinities (Arkona and Kattegat respectively).


## 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 and nutrient concentrations. In addition samples were taken for a research project on the biogeochemistry of dissolved organic matter in these waters. *Figure 1* shows the locations of the monitoring sampling stations.

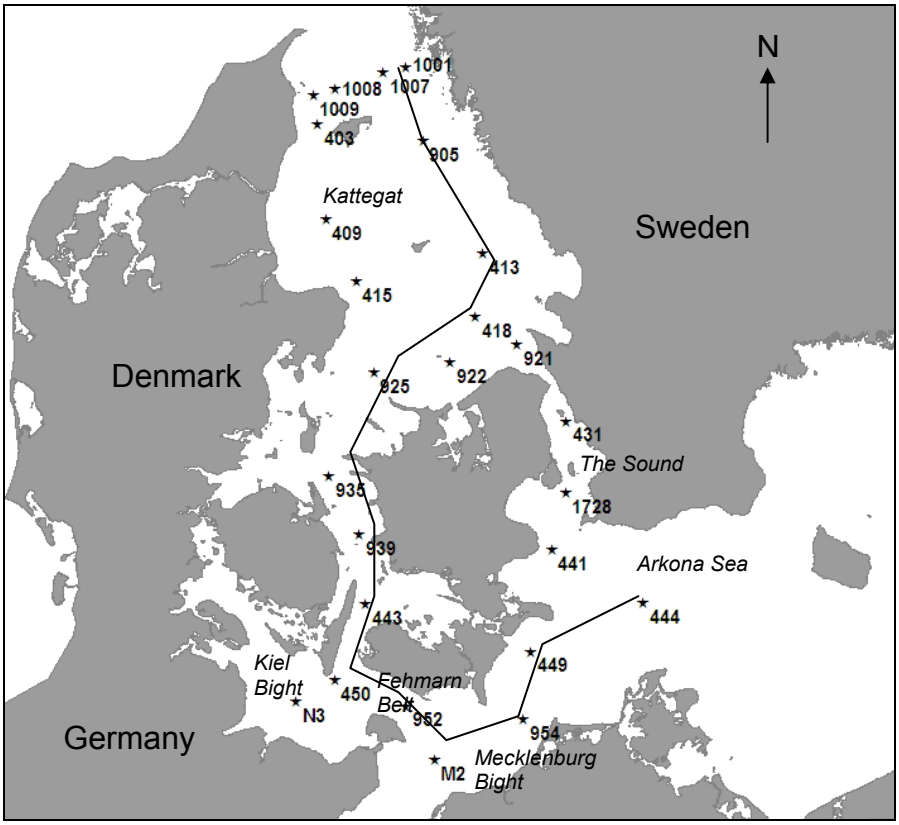



**Figure 1** Map showing the stations sampled by the monitoring cruise, region sea names and the location of the transects plotted in the following figures.

## Meteorology

The months of December and January were notably warmer than the long term average (*Figure 2*). Monthly averages are normally 1.6 and 0° C for December and January respectively, however this year monthly averages were 3.7 and 4.1° C. Monthly precipitation was average in December but 50% greater than average in January 2008.

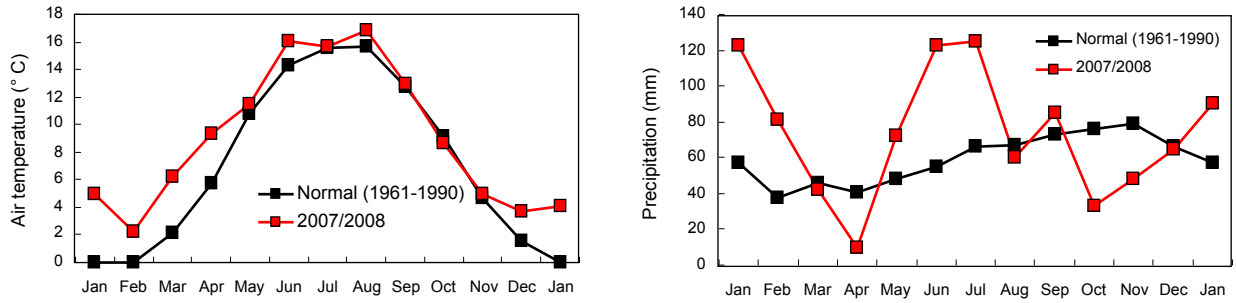



**Figure 2** Monthly average air temperature and monthly total precipitation data for 2007 and January 2008 compared with long term averages (1961-1990). Data retrieved from Danish Meteorological Institute (www.DMI.dk).

The average wind speeds and air temperatures for the weeks preceding the cruise are shown in *Figure 3*. For the six weeks preceding the cruise wind speeds were on average 1.5 m $s^{-1}$ above the normal. Additionally from week 2 to 6 air temperatures were between 4-5.7° C warmer than average.

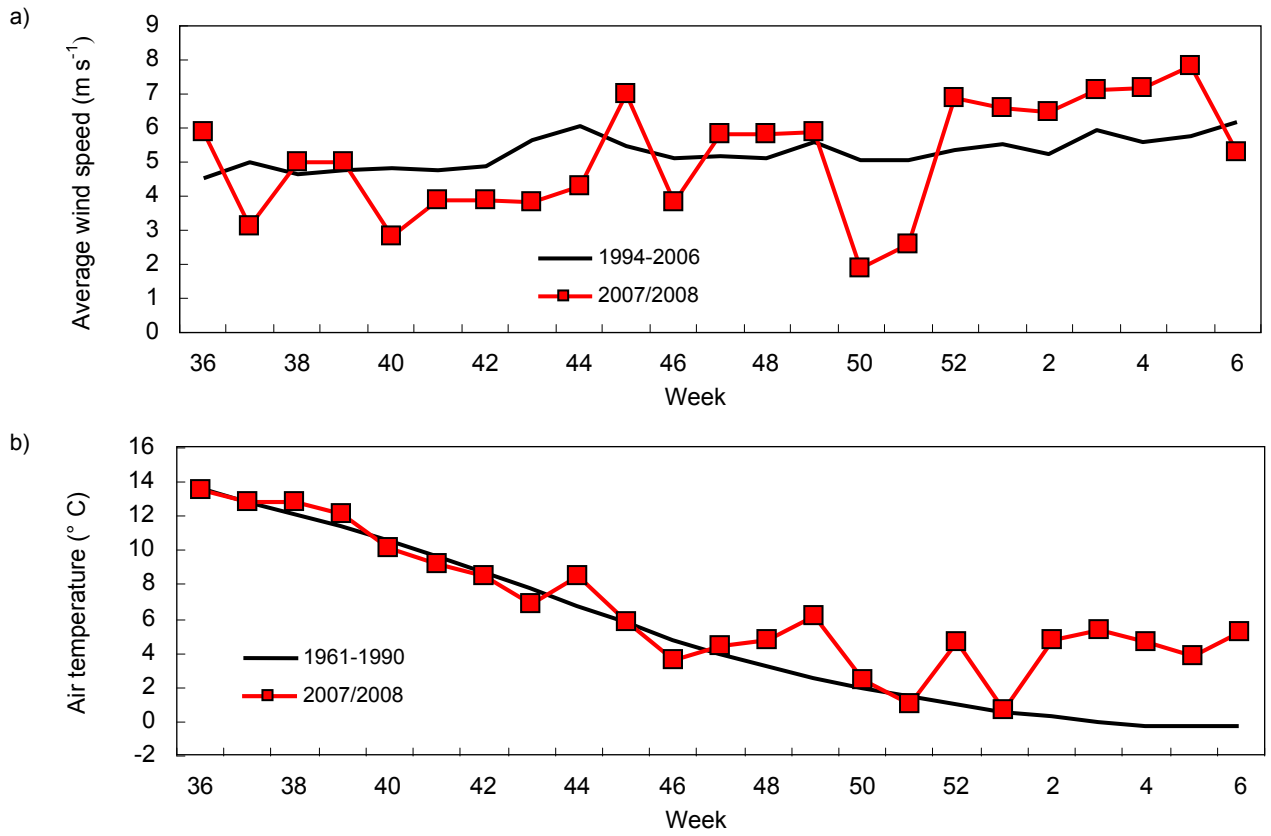



**Figure 3** a) Weekly average wind speed for the end of 2007 and start of 2008 compared with average values from 1994-2006. b) Weekly air temperature compared to average values from 19961-1990. This cruise was in week 6.

## 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) were relatively constant along the transect ranging between 3.7-4.6° C. In the Fehmarn Belt and Arkona Sea bottom water temperatures were very similar to surface values whilst in the Kattegat bottom waters were on average 1.8° C warmer than surface waters, ranging between 4.8 and 7.1° C (*Figure 4*). In general surface water temperatures were higher than they have been for the last 6 years (see Appendix).

Surface and bottom water salinities increased from southeast to northwest reflecting the brackish surface outflow from the Baltic Sea and the saline inflow from the North Sea. The shallow stations in the Mecklenburg Bight (M2, 954, 449) were well mixed with similar salinities and temperatures in surface and bottom waters (*Figure 4*). For the rest of the stations on the transect, bottom water salinities were greater than surface waters by 2.4-6.8. *Figure 5* shows a T-S plot for the data collected. From this one can clearly see the mixing of the cold brackish surface Baltic waters (T~4° C, S~10) with warmer saline North Sea waters (T~5° C, S~30), and the presence of pockets of warm saline deep water (T>5° C, S>30).

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

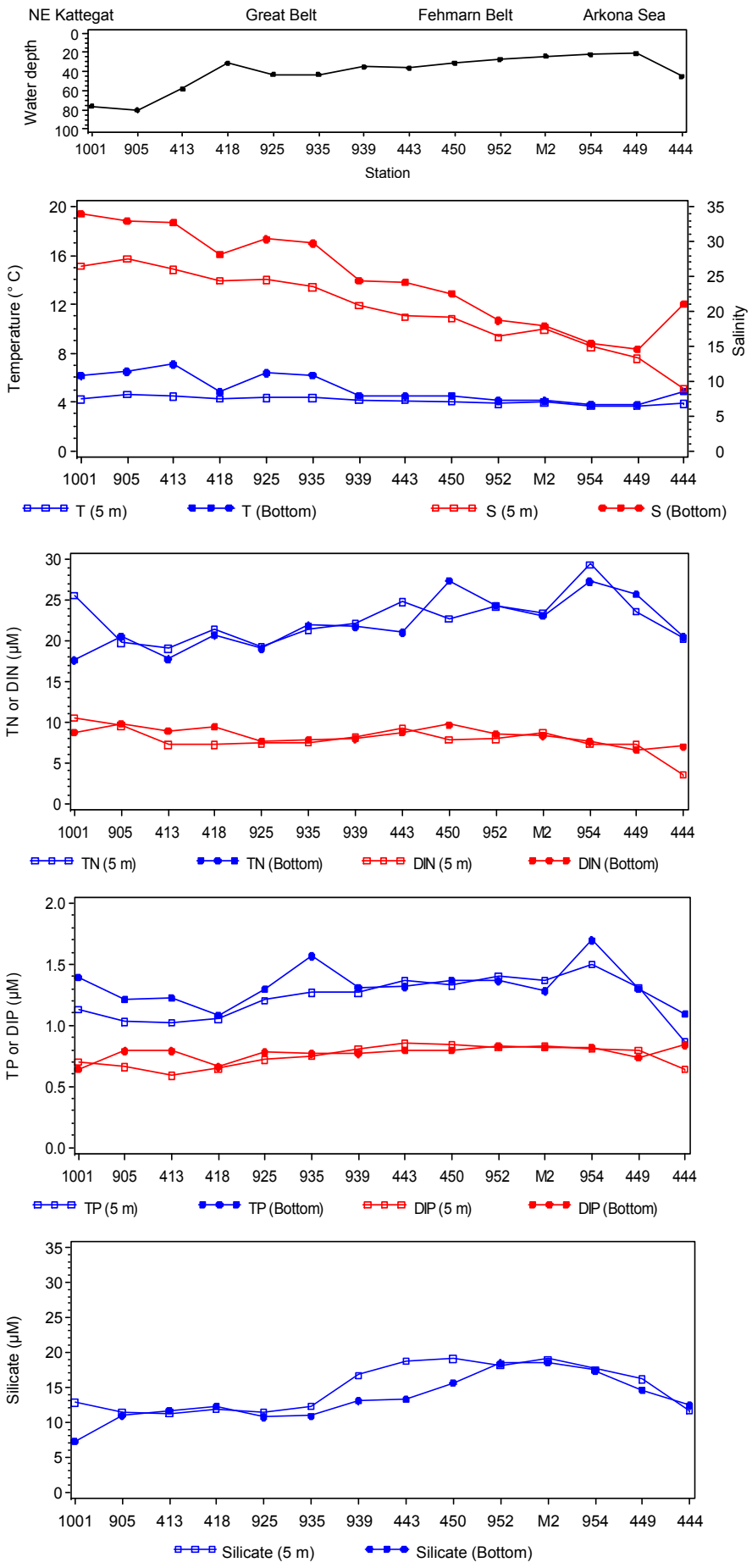
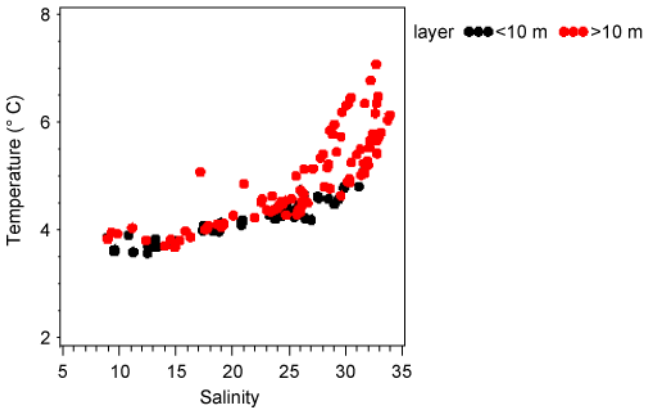


**Figure 5** Temperature-Salinity diagram for samples collected.




## Nutrients

Total nitrogen (TN) concentrations in surface and bottom waters were generally very similar. Concentrations generally decreased from a maximum in the Mecklenburg Bight (29.4 µM, St. 959) to a minimum in the northwest Kattegat bottom waters (17.6 µM, St. 1001) (*Figure 4*). TN concentrations in the Arkona Sea were 20.4 µM. Dissolved inorganic nitrogen (DIN) concentrations generally increased from southeast to northwest along the transect with surface waters concentrations increasing from 3.5 to 10.5 µM. *Figure 6* shows TN, DIN and organic N (ON = TN-DIN) concentrations plotted against salinity and it is clear that as the Baltic surface waters flows from the Arkona Sea to the Kattegat TN concentrations increase by 5-8 µM due to local inputs. The majority of this additional TN at a salinity of approximately 15 appears to be as ON (*Figure 6*).

Total phosphorus (TP) and dissolved inorganic phosphorus (DIP) in surface waters generally decreased along the transect from southeast to northwest. Surface water TP concentrations varied between 0.86-1.50 µM and DIP concentrations between 0.59-0.85 µM. Bottom water TP concentrations in the Kattegat were in general greater than surface water concentrations. DIP concentrations in the Fehmarn Belt were greater than the average values from the last six years (see Appendix, St. 952). As seen for N, the mixing plots in *Figure 6* also show that there is a local input of P in the Belt Sea and Great Belt region. TP concentrations are approximately 0.4 µM greater than would be expected from conservative mixing of Arkona Sea and S. Kattegat water. Much of this increase appears to be due to organic phosphorus (OP) input at a salinity of 15 in the Mecklenburg Bight, Kiel Bight, Fehmarn Belt and Great Belt waters.

Silicate concentrations in surface waters ranged between 11.2 and 19.1 µM with maximum values in Kiel Bight and Fehmarn Belt region. Bottom water concentration varied over a similar range, however, maximum concentrations were in the Mecklenburg Bight. Comparison of the profiles from this cruise with the averages for the same cruise during the last six years shows that silicate concentrations are significantly higher than average in the Belt Sea and Kattegat waters. From the salinity plot in *Figure 7* it is clear that there is a local source of silicate in the Belt Sea region resulting concentrations approximately 5 µM higher than expected from mixing of the Baltic outflow and North Sea inflow alone. Interestingly the highest concentrations were measured at a salinity between 18

and 19, whereas the local inputs for TN and TP were most pronounced at a salinity of 15.

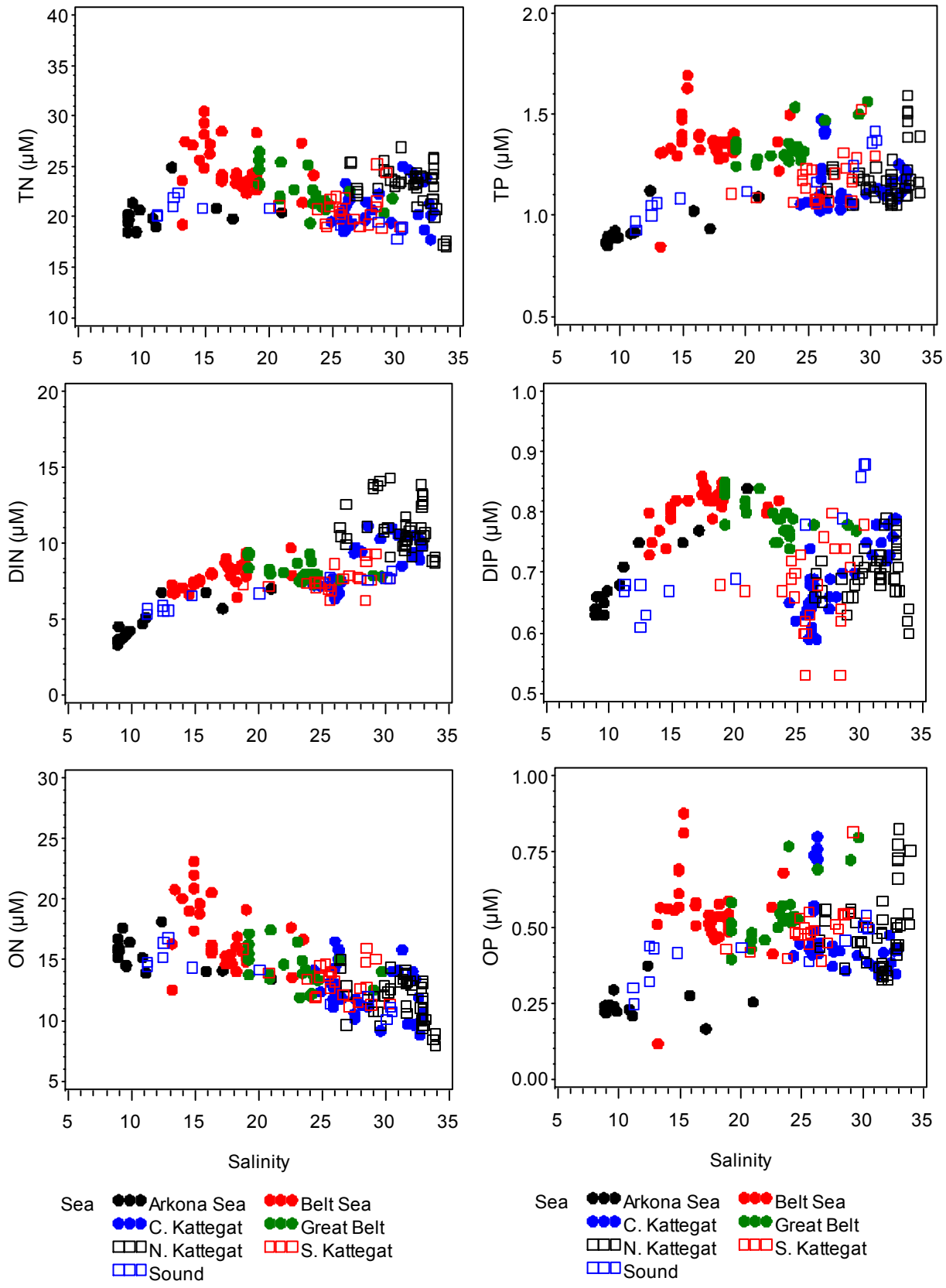



**Figure 6** Salinity mixing plots for total, dissolved inorganic, and organic N and P.

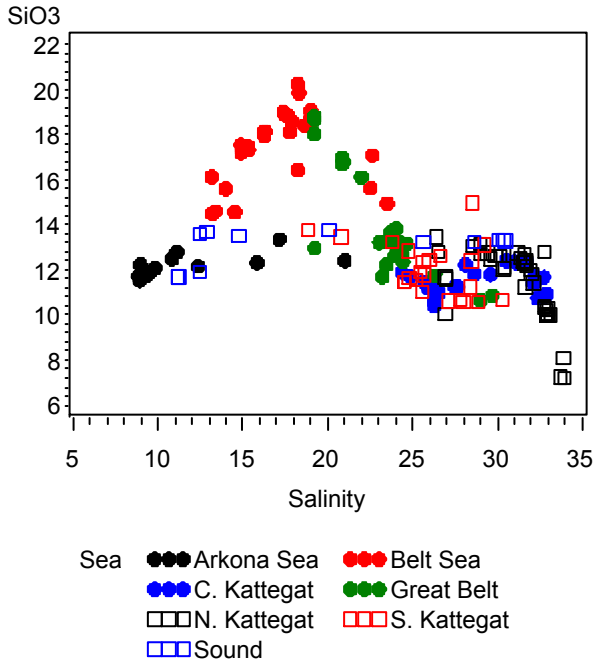



**Figure 7** Mixing plot for silicate.

## Chlorophyll a

Chlorophyll a concentrations were low and varied between 0.37 to 1.9 µg/l with the highest concentrations measured in the Fehmarn Belt and Northern Kattegat (*Figure 8*). No clear trends with respect to depth were apparent.

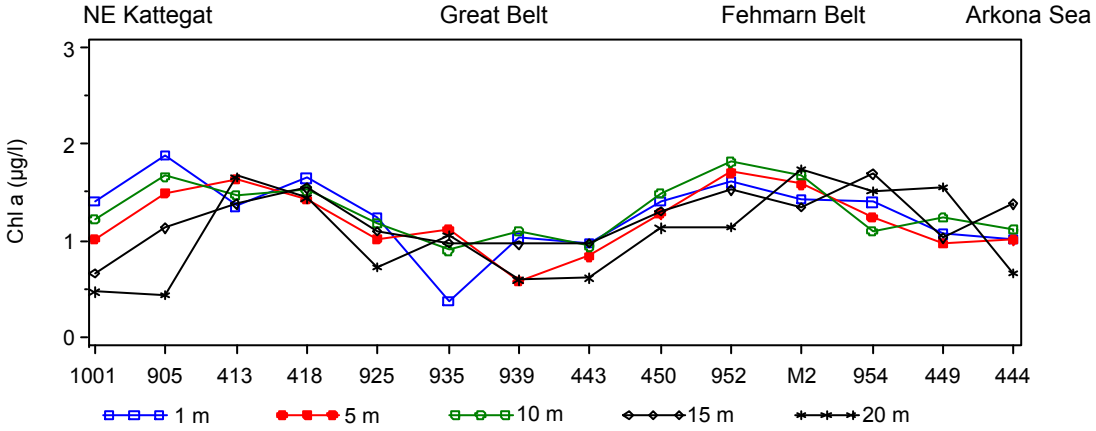
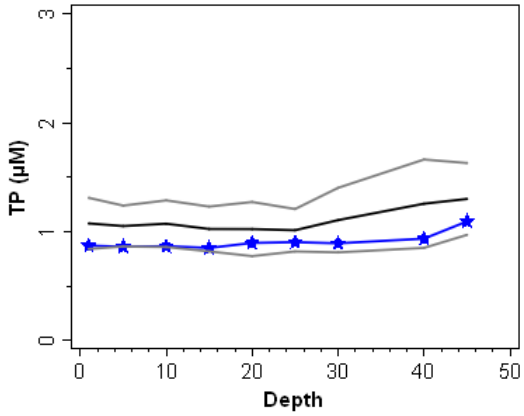


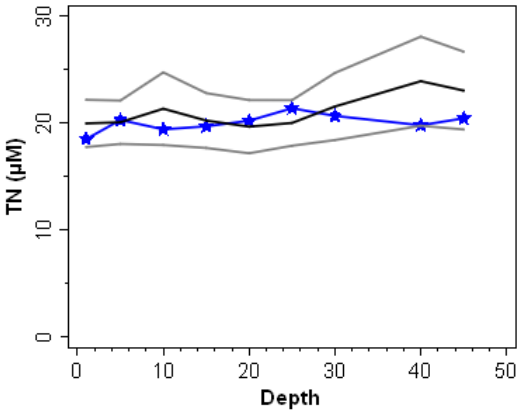

**Figure 8** Chlorophyll a concentrations in surface waters along the two transects shown in *Figure 1*.

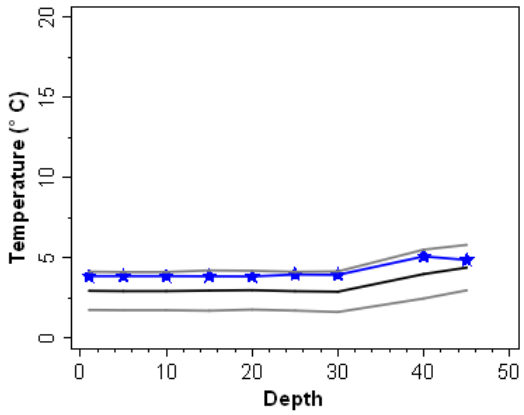
# Appendix

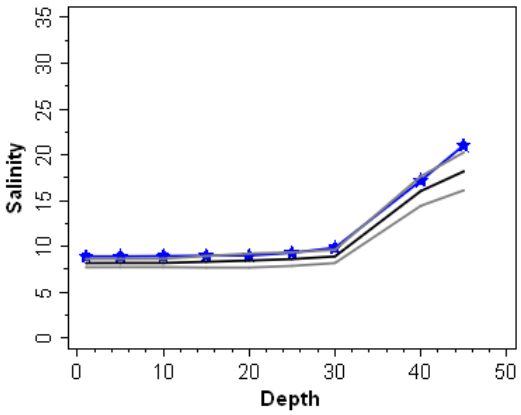
The following graphs show profiles of the measured parameters at seven chosen stations (blue lines). The mean profiles are also plotted for the station from the same cruise during the period 2000-2006 (black). The grey lines are the upper and lower 95% confidence limits for the mean.

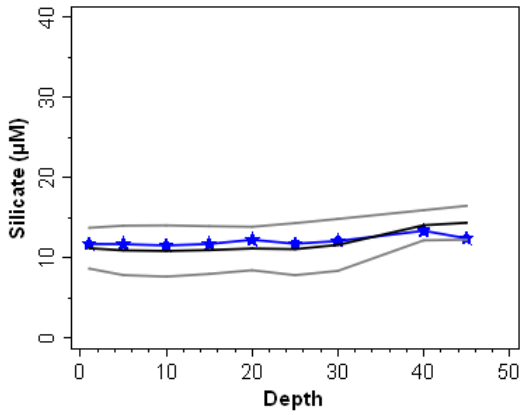
**St. 444 - Arkona Sea**

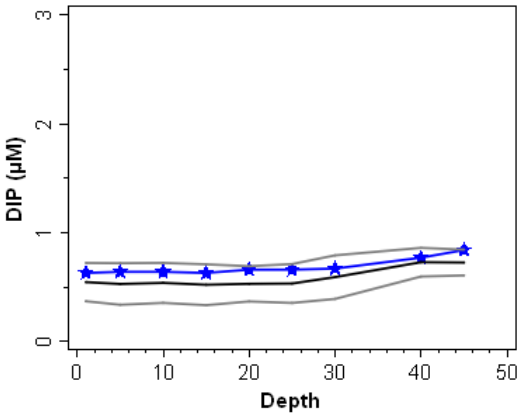


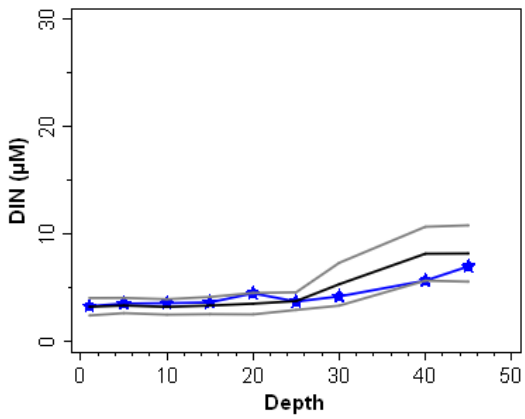



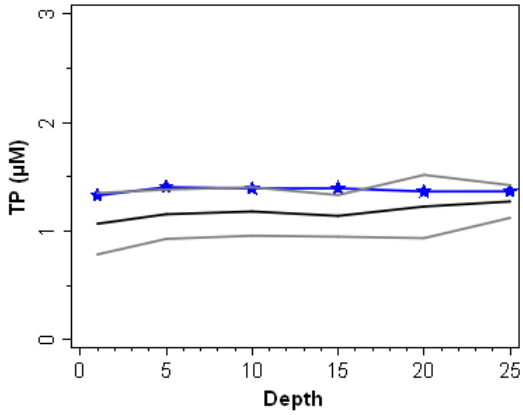



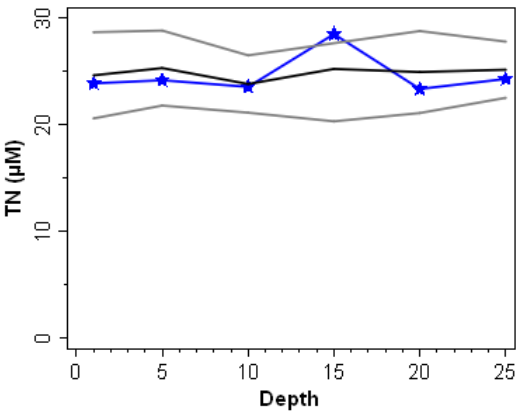



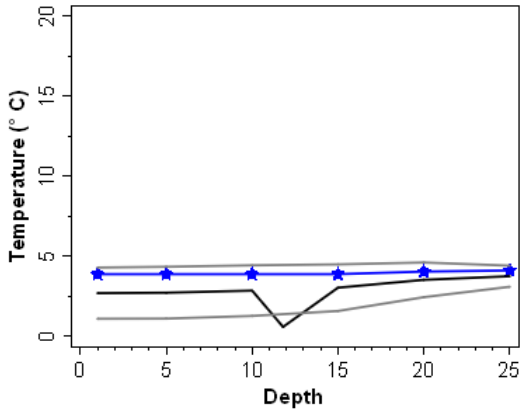



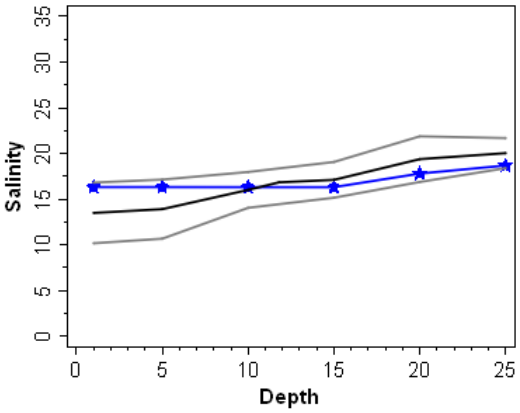



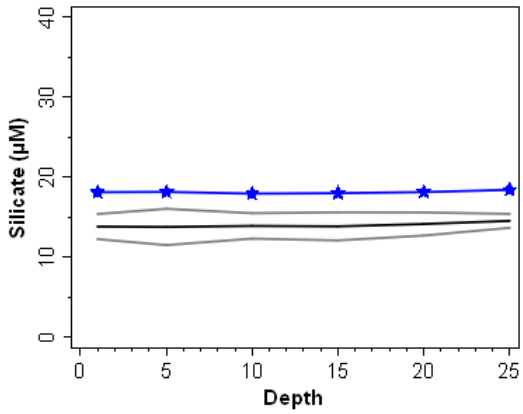
**St. 952 - Fehmarn Belt**

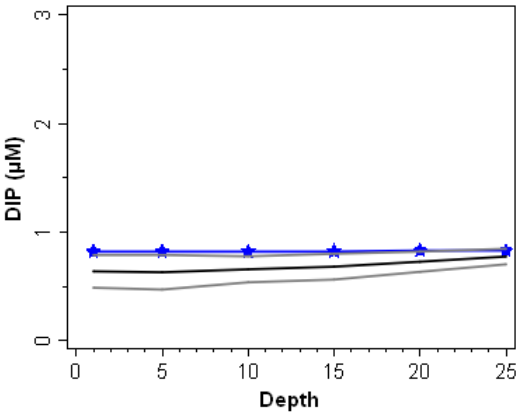


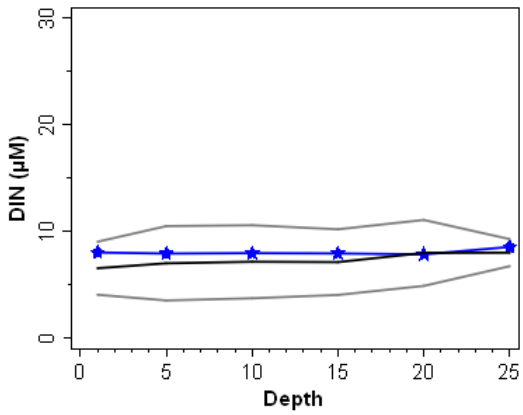



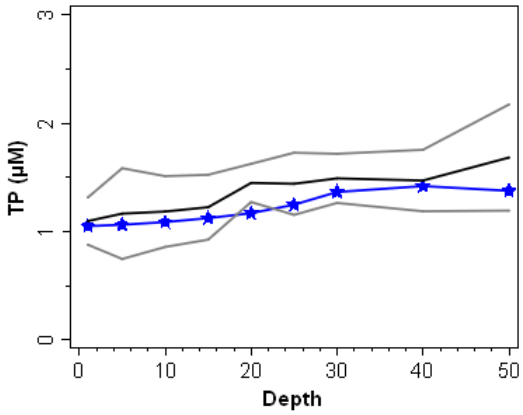



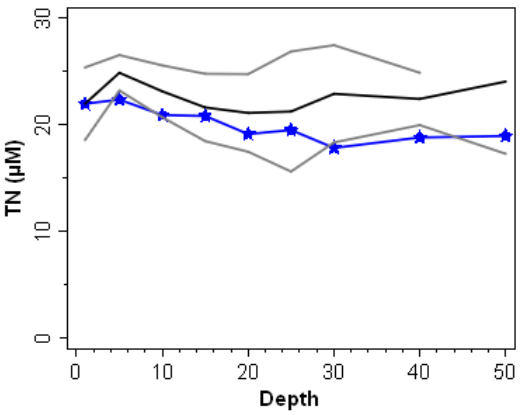



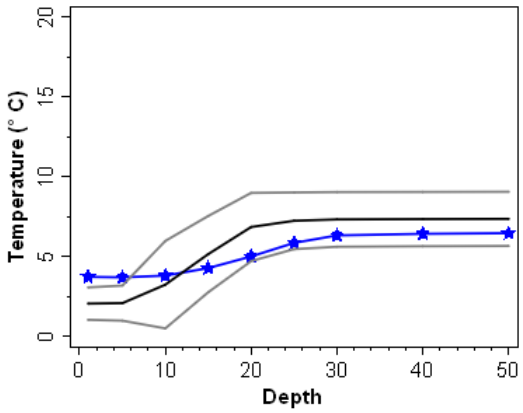



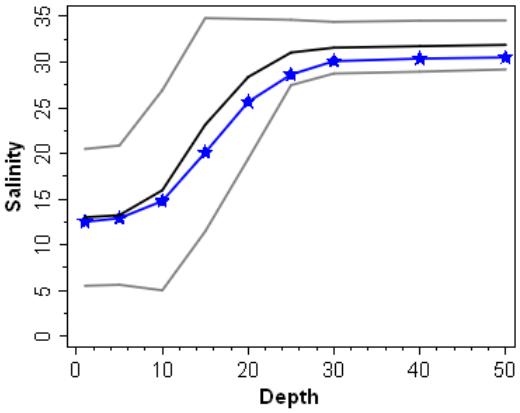



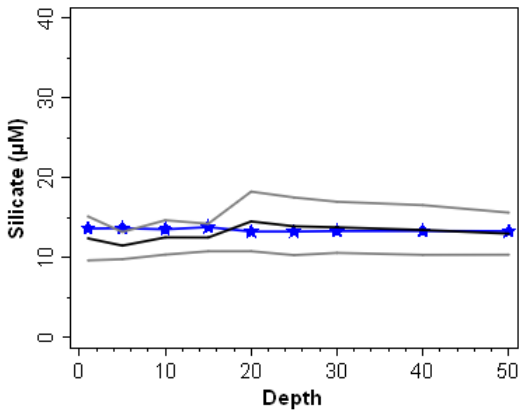
**St. 431 - The Sound**

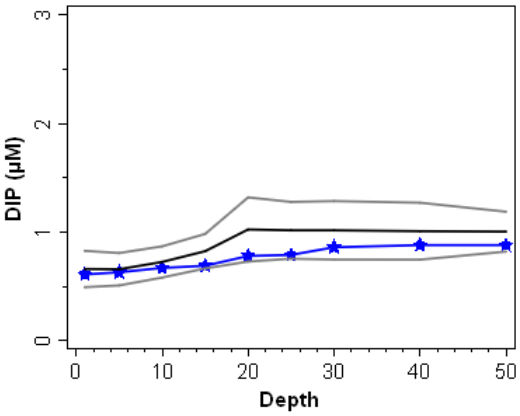


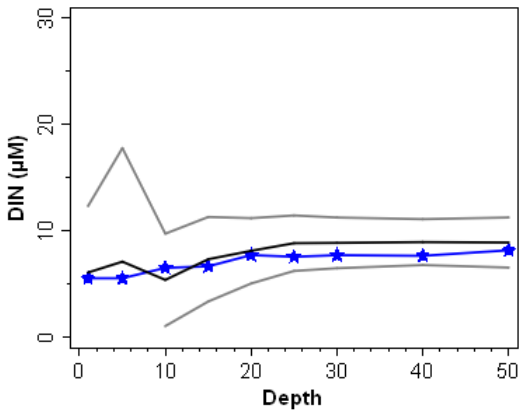



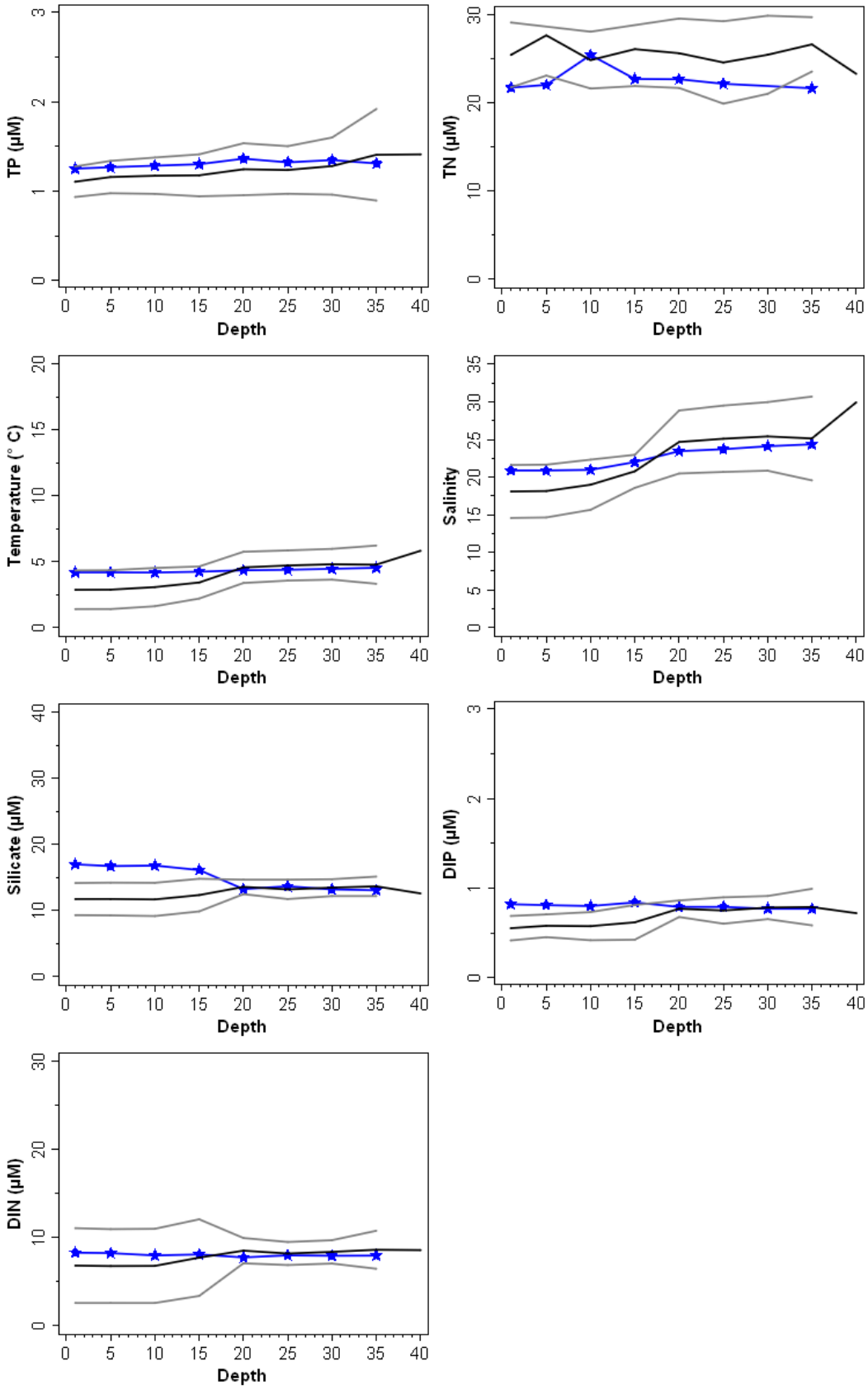



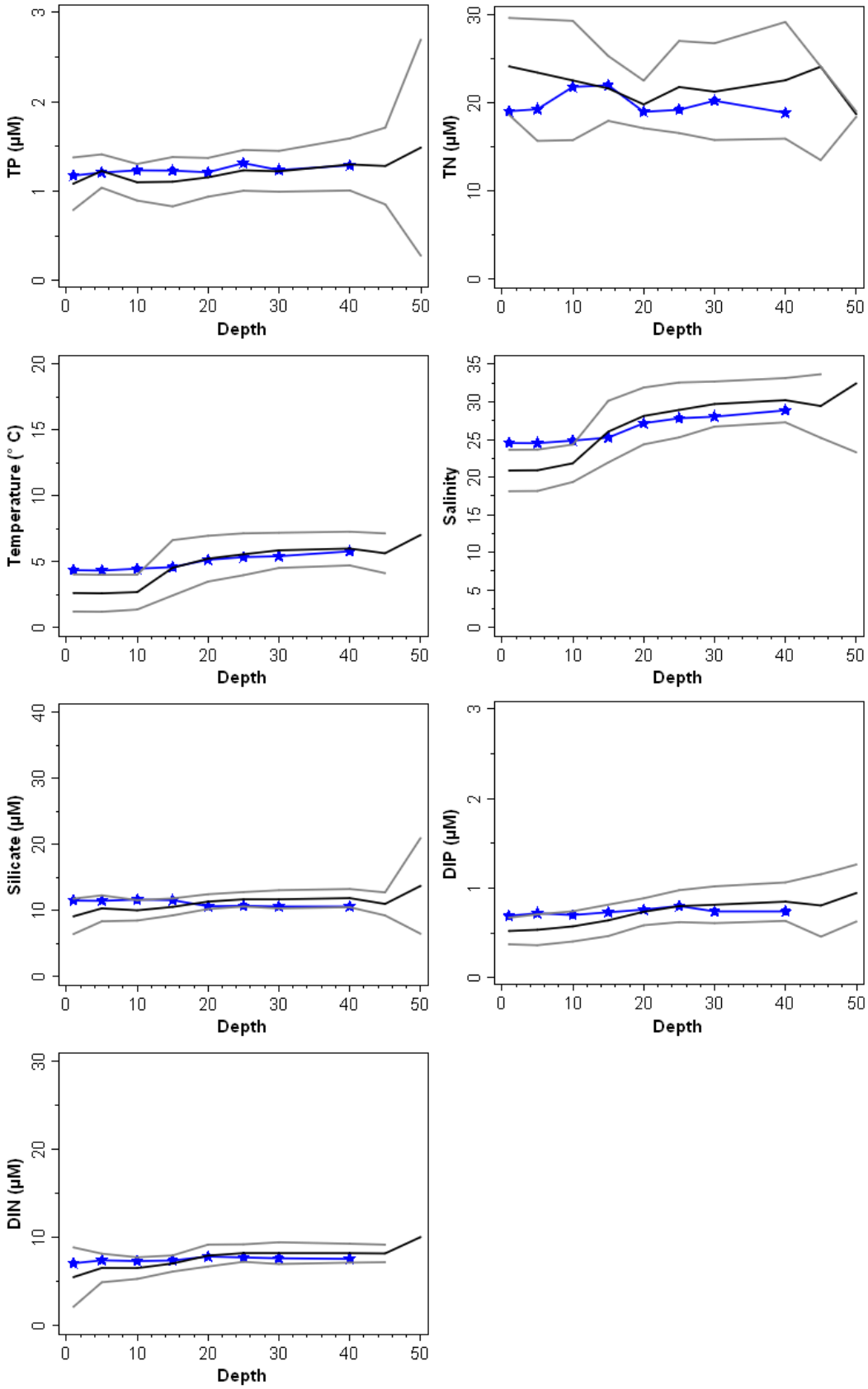



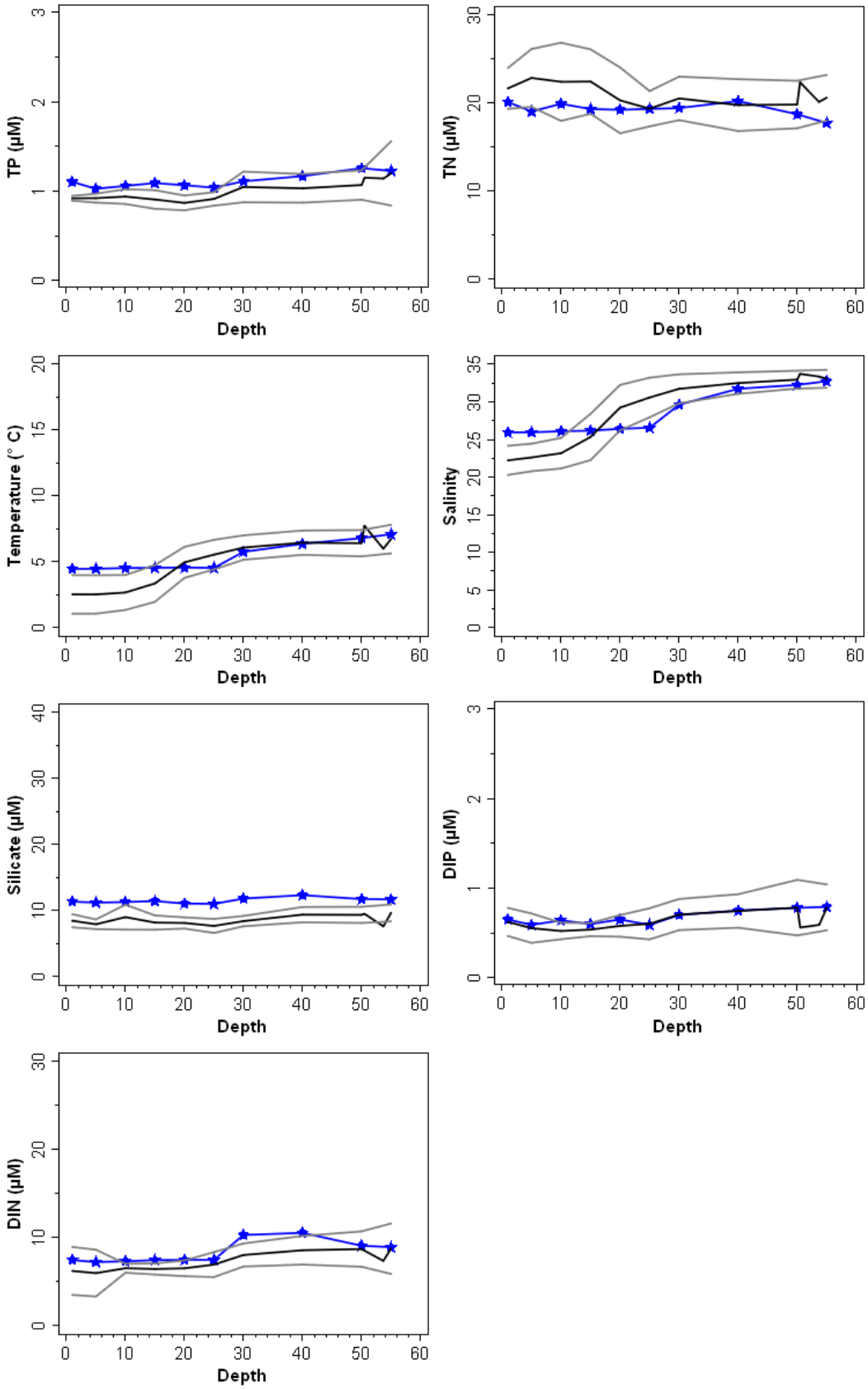
**St. 939 - the Great Belt**



**St. 925 - Southern Kattegat**



**St. 413 - Central Kattegat**



**St. 1001 - Northern Kattegat**