

## CRUISE REPORT FROM R/V ARGOS

**Survey period:** 2003-11-30 - 2003-12-12

**Survey area:** The Skagerrak, the Kattegat, the Sound, the Baltic proper and the Gulf of Bothnia.

**Principal:** SMHI

### SUMMARY

*The expedition took place within SMHI's regular marine monitoring programme and covered the Skagerrak, the Kattegat, the Sound, the Baltic Proper and the Gulf of Bothnia. Hydrographic measurements around several offshore banks were also completed. This report is based on preliminary, part-quality controlled data.*

*Surface phosphate levels in the southeastern Baltic Proper, East Gotland Basin and Northern Baltic Proper were 1 – 2 standard deviations above the 1990 – 1999 average. This is possibly related to the re-oxygenation of the deep water the previous winter and spring, and the release of phosphate from the bottom sediment. This is likely to impact on primary productivity next spring. Silicate levels remain above average throughout the Baltic Proper.*

*Oxygen concentrations below 2 ml/l were found in the Eastern, Western and Northern Gotland Basins at depths exceeding 60 to 80 metres. Hydrogen sulphide was found from 80-90 metres in the Western Gotland Basin and from 90 metres in the Northern Gotland Basin. Despite the low oxygen concentrations east of Gotland, these values are better than the average 1990 – 1999 conditions.*

*High surface salinity at Drogden East and West Landskrona, with a northward current, suggest that a saline inflow to the Baltic had just finished. The next expedition is planned for week 3, 2004*

## **PRELIMINARY RESULTS**

The cruise, part of the SMHI's ordinary monitoring programme, began in Karlskrona on November 30 and ended in Gothenburg on December 12.

The dominant weather during the beginning of the expedition consisted of weak winds and an air temperature of a few degrees above zero. During the first week the situation changed and southwesterly and later northwesterly winds with a speed of 20-25 m/s were experienced.

Tobias Larsson, from the Institute of Analytical Chemistry, Gothenburg University, took samples for the determination and characterization of humic substances (fluorescence spectroscopy), for TOC-analyses and for the determination of the dissolved fraction ( $<0.2\mu\text{m}$ ).

### **The Skagerrak**

Surface water temperatures varied between  $7.4^{\circ}\text{C}$  at P2 and  $8.9^{\circ}\text{C}$  at Å13. Surface temperature at all stations was about 1 standard deviation ( $\sigma$ ) higher than the December 1990 - 1999 mean. Surface salinity (at all stations) was also above the 1990 - 1999 mean value, and was high even in the Baltic Current - varying between 30.9 and 34.2 psu. The mixed layer was thin: less than 20 metres deep.

Surface phosphate levels at P2 and Å17 were below the seasonal 1990 - 1999 mean. Inshore, at Släggö, the concentration was  $1\sigma$  above the mean, while at Å13 the concentration was average for the time of year. Dissolved Inorganic Nitrogen (DIN) and Silicate were both below average concentrations. The high salinity values and the thin Baltic outflow may explain the low DIN and silicate values, on the assumption most DIN and silicate comes from the Baltic.

Oxygen concentration was significantly below the December average at P2 at Å13 (more than  $1\sigma$  below), though still above 5 ml/l.

### **The Kattegat and the Sound**

In addition to the standard stations at Anholt East and Fladen, transects were taken across the Stora Middelgrund, Lilla Middelgrund and Fladen Banks to collect data (temperature, salinity, oxygen and nutrients) as part of Naturvårdsverket's (Swedish Environmental Protection Agency) investigation into the environmental characteristic of Sweden's offshore banks.

Surface water temperatures were lowest ( $6.0^{\circ}\text{C}$ ) at Drogden East, in the Sound. The highest ( $7.5^{\circ}\text{C}$ ) were observed on the south side of the Fladen bank. Surface salinity increased from 10.4 psu at Drogden East, to 19.2 psu at West Landskrona - suggesting that an inflow event had occurred, but that the normal Baltic surface outflow had just resumed. Bottom water salinities were also high in the Sound - 20.2 psu at Drogden East, and 31.8 psu at West Landskrona. The highest salinities in the Kattegat were observed in the vicinity of the Fladen Bank. West of Fladen, 23.3 psu was

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found in the surface water, while 34 psu was measured south of the bank.

Surface phosphate levels were highest at West Landskrona (0.5  $\mu\text{mol/l}$ ) and lowest over the Fladen Bank (around 0.3  $\mu\text{mol/l}$ ). In deep water, the highest concentration (around 0.8  $\mu\text{mol/l}$ ) was found around Stora Middelbank (near Anholt East). The sum of nitrate + nitrite was highest at West Landskrona, in the Sound (3.3  $\mu\text{mol/l}$ ) and lowest in the vicinity of Lilla Middelbank (around 1.7  $\mu\text{mol/l}$ ). Below the surface layer, the highest concentration was 7.6  $\mu\text{mol/l}$  at Anholt East. Silicate values were lowest in the northern Kattegat (5.9  $\mu\text{mol/l}$  at the surface, 4.7  $\mu\text{mol/l}$  at the bottom, both around Fladen Bank). The highest surface value (~10  $\mu\text{mol/l}$ ) was found in the Baltic outflow at West Landskrona.

The lowest oxygen concentration observed was 4.5 ml/l, just above the sea floor at Anholt East.

### **The Baltic Proper**

Surface water temperatures were in the range 5.2 - 7.4°C, which is normal for the time of year. Surface salinity was between 5.7 and 8.0 psu, which is also close to the 1990 - 1999 mean. Thermocline and halocline were found at the same depth. They began at 30-40 metres in the Arkona Basin and in the Western Gotland Basin and in the remainder of the Baltic proper at approximately 50 to 60 metres.

Surface phosphate content was normal in the West Gotland Basin. In the Northern Baltic Proper it was up to 2 $\sigma$  above average for the time of year, at 0.47  $\mu\text{mol/l}$ . In the East Gotland Basin and south-eastern Baltic Proper it was about 1 $\sigma$  above average. Silicate concentrations at stations BY 38 and BY32 (West Gotland Basin) were about 1 $\sigma$  higher than the mean. The sum of nitrate + nitrite was lower than average for the time of year, at 0.3  $\mu\text{mol/l}$ .

In the Arkona Basin the oxygen conditions were close to average for the time of year, between 5 and 6 ml/l. In the remainder of the Baltic proper oxygen concentrations below 2 ml/l were found in the Bornholm, Eastern, Western and Northern Gotland Basins at depths exceeding 60 to 80 metres. Despite this, the values found in the East Gotland Basin were between 1 $\sigma$  and 2 $\sigma$  above the average concentration for the period 1990 - 1999.

Hydrogen sulphide was found from 80-90 metres in the Western Gotland Basin and from 90 metres in the Northern Gotland Basin. An oxygen minimum was present in the East Gotland Basin between 60 and 150 metres, however hydrogen sulphide was not found.

### **The Gulf of Bothnia**

Surface water temperatures in the Bothnian Bay varied between 2.5 and 3.8°C and in the Bothnian Sea between 2.7 and 5.0°C, highest at SR8. At Solovjeva, in the Åland Sea, the temperature was 4.8°C and at the Sill to the south of it, 5.2°C. Surface water salinity in the Bothnian Bay was about 3 psu and up to 5.5 psu was observed

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in the Åland Sea and the eastern Bothnian Sea (as far north as the Southern Quark). Stratification was very weak, which is normal in the winter time.

The surface water in the Bothnian Sea had a phosphate concentration of 0.1-0.3  $\mu\text{mol/l}$ , a nitrate concentration of 1.6-4.0  $\mu\text{mol/l}$  and a silicate concentration of 13-22  $\mu\text{mol/l}$ . The Bothnian Bay had lower phosphate concentration and higher nitrate concentration, 0.05 and 6-7  $\mu\text{mol/l}$  respectively. Silicate concentration was almost double (31-34  $\mu\text{mol/l}$ ) that found in the Bothnian Sea. These values are normal for this region.

Oxygen conditions were good. The lowest bottom oxygen concentration was 6.5 ml/l between Åland and Sweden, while 7.8 ml/l was found at 120 m in the Bothnian Bay. With the weak stratification allowing mixing throughout the water column, these values are typical for the area and time of year.

## **PARTICIPANTS**

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## **APPENDICES**

- Track chart
  - Table over stations, parameters and sampling depths
  - Map showing bottom oxygen concentrations
  - Monthly average plots for selected stations
  - Profiles for selected stations
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