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Swedish Meteorological and Hydrological Institute Oceanographic Laboratory 2016-01-16 Dnr: S/Gbg-2016-008

Report from the SMHI monitoring cruise with R/V Aranda



Survey period:2016-01-07 - 2016-01-15Survey area:Skagerrak, Kattegat, the Sound and the Baltic ProperPrincipal:SMHI and the Swedish Agency for Marine and Water Management

SUMMARY

The expedition was part of the Swedish marine monitoring programme and covered the Skagerrak, the Kattegat, the Sound and the Baltic Proper. In Kattegat the winter pool of nutrients were mapped. Data presented in this report has been subject to preliminary quality control procedures only.

The temperature in the surface water was above normal in the Baltic Proper. The concentrations of nutrients were generally normal for the season in Skagerrak and Kattegat. In the Baltic Proper the concentration of phosphate was elevated in the western parts while the silicate concentration was well below normal in the southern parts.

The effect of the inflow in December 2014 could not be detected further north than the station BY20 in the northern part of the Eastern Gotland Basin. At the station Gotland Deep BY15, hydrogen sulphide was again present in the bottom water. In the Western and Northern Gotland Basins the oxygen situation remains very serious as anoxic conditions occurred at depths exceeding 70-100 meters. Hypoxia in the bottom water was detected in the Hanö Bight, the Bornholm Basin and in the south eastern Baltic Proper.

The next monitoring cruise is scheduled to start on 15 February.



PRELIMINARY RESULTS

The cruise was operated aboard the Finnish research vessel Aranda. It commenced in Helsinki on January 7 and ended in the same port on January 15. The winds during the expedition were predominantly southeast to northern, and varied in strength from brisk to gale force. Air temperatures ranged between -14 and +4 $^{\circ}$ C. In the Kattegat and the Sound the winter pool of nutrients was mapped. Beyond the ordinary 4 stations, 12 extra mapping stations were visited.

The Skagerrak

The temperature of the surface water was normal for the season and varied between 2.6 and 4.6°C, lowest near the coast and high in the offshore areas. The salinity in the surface layer was also normal for the season and varied between 26.2 and 30.8 psu. The stratification, both the thermocline and the halocline, was weakly developed.

The nutrients in the surface showed typical values for the season, except for silicate which showed concentrations above normal in the central parts. In the surface water the concentration of phosphate ranged between 0.52 and 0.66 μ mol/, inorganic nitrogen (nitrite + nitrate) between 5.7 and 6.8 μ mol/l, while silicate varied from 7.1 to 14.5 μ mol/l.

The lowest oxygen concentrations, 4.5 ml/l, were found in the bottom water at Släggö in the mouth of the Gullmarn Fjord. Fluorescence measurements showed low biological activity in the surface layer. For more details on species composition see the separate algal report, AlgaAware.

The Kattegat and the Sound

The temperature in the surface water was normal for the season and varied between 2.7 and 4.6 °C. The surface salinity was generally lower than normal and ranged in the southern parts from 15.3 to 18.8 psu and in the northern parts from 20.2 to 23.2 psu. In the Sound the salinity was around 9 psu, which is lower than normal. A weak stratification was found at 10 - 20 meters depth.

The mapping of the winter pool of nutrients in Kattegat showed that the concentrations in the surface water were normal or lower than normal. The only exception was the station Fladen, which showed elevated concentrations of phosphate and silicate. Generally, the amount of all nutrients had increased since the last visit in December and the highest concentration were found in the western parts of Kattegat. The phosphate concentration now ranged from $0.6 - 0.8 \mu mol/l$, inorganic nitrogen from $3.2 - 6.2 \mu mol/l$ and silicate varied between 7.8 to $12.7 \mu mol/l$.

As a result of the weak stratification the oxygen situation in the deep water was good. The oxygen concentration in the bottom water was > 6 ml/l at all stations in Kattegat. The plankton activity was low in the whole investigated area.

SMHI

The Baltic Proper

The temperature of the surface layer was above normal in the whole Baltic Proper and varied from 3.7° C to 6.1° C. Surface salinity was elevated in the Bornholm Basin, the Hanö Bight and in the Western Gotland Basin. The halocline and thermocline coincided and were found a 50 - 70 meters depth in the Western Gotland Basin, at 60 - 80 meters depth in the Eastern and Northern Gotland Basin, while found at shallower depth in the southern parts.

Phosphate concentrations in the surface water had risen even further since the previous cruise and in the Western Gotland Basin the concentration were high above normal, $0.8 - 1.0 \mu mol/l$. In the remaining parts the concentration ranged from 0.6-0.7 $\mu mol/l$. The concentrations of inorganic nitrogen (nitrite + nitrate) were normal and varied between 2.3 and 3.2 $\mu mol/l$. The silicate concentration was still below normal in the southern parts, while elevated above normal in the remaining parts of the Baltic Proper. The concentrations ranged from 7.4 to 16.8 $\mu mol/l$.

In the Eastern Gotland Basin, acute hypoxia (<2 ml/l) occurred at depths exceeding 70-80 metres. Similar to the previous cruise in December, completely oxygen-free conditions (anoxia) with hydrogen sulphide present were observed in the northern parts (BY20 and BY21) from 125 metres depth. At BY15, hydrogen sulphide was again present in the bottom water and from 150 - 225 meters depth the oxygen concentrations were low, < 0.7 ml/l. Hence, the effects of the inflow in December 2014 could not be detected further north than BY20 in the Eastern Gotland Basin. In the Western and Northern Gotland Basin the oxygen situation continues to be extremely bad. In the Western Gotland Basin anoxic conditions were found from depth exceeding 70 – 90 meters, while hypoxia was found from 50 - 70 meters depth. The Northern Gotland Basin had anoxic conditions from 100 meters depth and hypoxia from 80 - 90 meters depth. Oxygen levels in the bottom water in the Bornholm Basin, Hanö Bight and the south eastern Baltic Proper were still low and acute hypoxia prevailed.

Fluorescence measurements showed low biological activity.



Oxygen, SBE 43, 2 [ml/l]







Figure 1. Transect showing the oxygen and salinity from the Sound to the Gulf of Finland.



PARTICIPANTS

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APPENDICES

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

TRACKCHART Country: Sweden Ship: R/V ARANDA Date: 20160107-20160115 Series: 0001-0040



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0032 KAEX29BAS ANHOLT E	N5640.0	E1207.0	20160112	1100	63	7	11	6 3	.7 992	2820 x	-xxxx	10 :	x x -	·x	- x :	ххх	(X)	(x x			·x
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0037 BPWX45BAS BY38 KARLSÖDJ	N5707	E1740	20160114	0030	110		00	0 - 3	.9 1005	9990 x	x	14 :	кх-	- x	ххх	ххх	(X)	c - x			·x
0038 BPWX38BAS BY32 NORRKÖPINGSDJ	N5801	E1759	20160114	0940	201		00	0 - 5	.7 1007	2850 x	x	17 3	кх-	- x '	ххз	ххх	(X)	c - x			·x
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Bottom water oxygen concentration (ml/l)

Country:	Finland
Ship :	Aranda
Date :	20160107-20160114
Series :	0001-0040



STATION BY20 SURFACE WATER





Vertical profiles BY20 January

STATION BY15 SURFACE WATER





Vertical profiles BY15 January

STATION BY10 SURFACE WATER





Vertical profiles BY10 January

STATION BCS III-10 SURFACE WATER





Vertical profiles BCS III-10 January

STATION BY5 SURFACE WATER

Vertical profiles BY5 January

STATION BY4 SURFACE WATER

Vertical profiles BY4 January

STATION BY2 SURFACE WATER

Vertical profiles BY2 January

STATION BY1 SURFACE WATER

Vertical profiles BY1 January

STATION W LANDSKRONA SURFACE WATER

Vertical profiles W Landskrona January Mean 1996-2010 St.Dev. Temperature °C Salinity psu Oxygen ml/l Depth 10 12 PO₄ µmol/l SiO₃ µmol/l DIN µmol/l

STATION Å17 SURFACE WATER

Vertical profiles Å17 January

STATION Å15 SURFACE WATER

Vertical profiles Å15 January

STATION Å13 SURFACE WATER

Vertical profiles Å13 January

STATION SLÄGGÖ SURFACE WATER

Vertical profiles Släggö January

STATION P2 SURFACE WATER

Vertical profiles P2 January

STATION FLADEN SURFACE WATER

Vertical profiles Fladen January

STATION N14 Falkenberg SURFACE WATER

Annual Cycles

Vertical profiles N14 Falkenberg January

STATION ANHOLT E SURFACE WATER

Vertical profiles Anholt E January

STATION HANÖBUKTEN SURFACE WATER

Vertical profiles Hanöbukten January

STATION REF M1V1 SURFACE WATER

STATION BY38 SURFACE WATER

Vertical profiles BY38 January

STATION BY32 SURFACE WATER

Vertical profiles BY32 January

STATION BY31 SURFACE WATER

Vertical profiles BY31 January

STATION BY29 SURFACE WATER

Vertical profiles BY29 January