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Report from the SMHI monitoring cruise with R/V Aranda

Survey period:	2019-09-12 - 2019-09-19
Principal:	Swedish Meteorological and Hydrological Institute (SMHI), Swedish Agency for Marine and Water Management (SwAM).
Cooperation partners:	Finnish Environment Institute (SYKE)

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SUMMARY

During the expedition, which is part of the Swedish national marine monitoring program, Kattegat, the Sound and the Baltic Proper, was visited. All stations in Skagerack were cancelled due to very harsh weather.

The surface temperature was normal for the season and varied between 14.5 - 17.5 ° C in the upper water mass. In the Baltic, there was a strong thermocline throughout the area, usually at about 30 meters depth with cold underlying water, in the Kattegat the temperature in the underlying water was not as cold. The salinity was slightly higher than normal in the surface of the Kattegat and the southwestern Baltic, while in the Gotland basins it was at normal values with slightly higher levels in the deep water.

The levels of nutrients in the surface water were low, which is normal just after summer. Dissolved inorganic nitrogen was depleted down to the halocline both in the North Sea and in the Baltic, while phosphate was still present in small amounts in surface water.

In the Baltic Proper, acute oxygen deficiency (<2ml/l) prevailed at the bottom of the Arkona Basin and oxygen-free conditions with hydrogen sulphide closest to the bottom of the Hanö Bay and Bornholm Basin. In the Gotland basins, oxygen was close to 0 ml/l from about 70 meters depth and hydrogen sulphide was found at all stations, at BY38 already at 60 meters. At BCSIII-10 in the south-east, no hydrogen sulphide was found and the oxygen content never dropped below 2ml/l.

The next regular expedition is scheduled for 13th – 20th October..

Photo on cover: Sunny with a weak halo and a short moment of calm sea inside Öland at station RefM1V1. Photo: Örjan Bäck.

RESULT

The expedition was conducted on board the Finnish research vessel Aranda and started in Helsinki on September 12, 2019 and ended in the same port on September 19.

The wind speed was around 15 m/s during most of the expedition, except at the west coast where wind speeds exceeded 20 m/s with rough sea. Westerly winds dominated but during the latter part of the expedition winds turned north. Due to the strong wind, several samples with zooplankton net had to be cancelled.

After the visit to the station Ref M1V1 inside the southern tip of Öland, Aranda experienced problems with one generator, however, the smaller of Aranda's two engines could be started and used during the remainder of the expedition. This led to reduced marching speed and that Aranda was more affected by the hard weather.

On the way north through Kattegat on Sunday evening 15/9, the already bad weather conditions deteriorated with stronger winds and very rough sea, in combination with reduced engine power, a decision was made to turn south and cancel all stations in the Skagerack and all remaining stations in Kattegat. A total of six stations in the Skagerack and two in the Kattegat were cancelled.

The day before the expedition started, SMHI participated in an inter-calibration together with SYKE, the Finnish Environment Institute, and FMI, the Finnish Meteorological Institute, at Aranda. In an inter-calibration, you sample and measure together to compare if the results are equivalent or investigate and rectify if you find differences. The Estonian vessel Salme also participated in the inter-calibration with personnel from EMI, the "Estonian Marine Institute" and "Department of Marine Systems" at Tallinn Technical University.

Additional buoy work was planned during the expedition, which could partly be carried out. The sea buoy at Huvudskär was to be lifted and inspected and serviced, however the weather was too bad to be able to safely lift the buoy so it was inspected only at a distance. However, the wave buoy at Knoll's ground, between Öland and Gotland, could be salvaged for service and a new one was laid out without problems despite relatively harsh weather.

A visit to a station at Östergarnsholm, east of Gotland, was planned to help Uppsala University change sensors and pick up a bottom-mounted curent meter. But long delays due to the severe weather meant that this had to be postponed to SMHI's next expedition in October. In Ocotber FMI also plans to follow up and perform work on its nearby buoy.

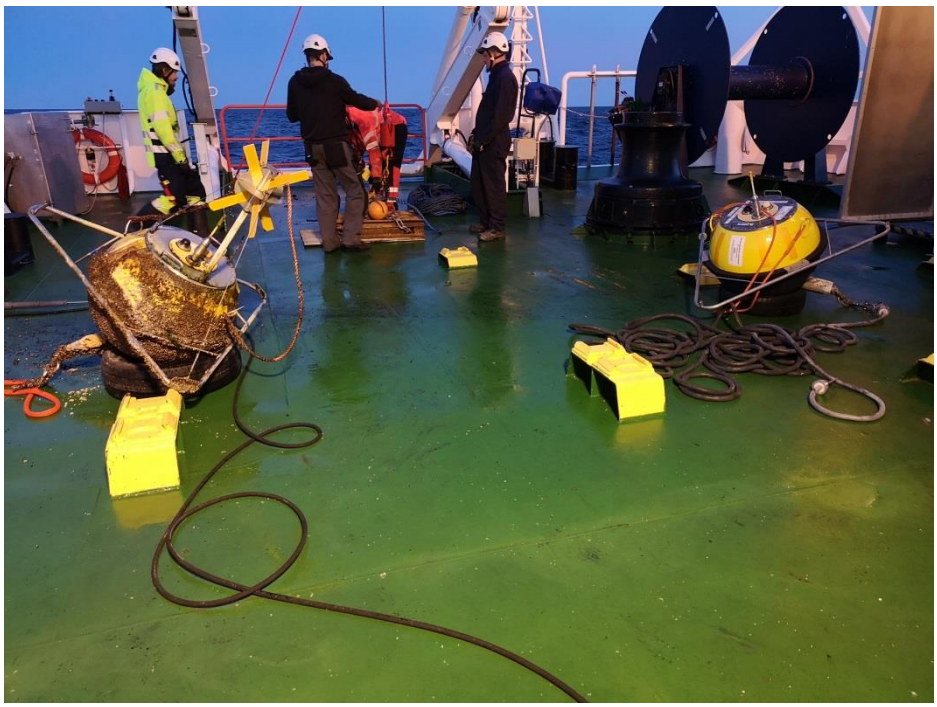

Figure 1. Wave bouys at deck, to the left the one that was tkaen up for service and to the right the new one to be deployed at Knolls ground. Photo: Örjan Bäck

During the expedition, in addition to regular sampling, sampling was also performed to determine DNA within the project "DNA barcoding of marine phytoplankton" financed by the Swedish Agency for Marine and Water Management (SwAM) which includes all national monitoring stations where plankton is tested and will continue throughout 2019. Additional water and plankton samples were also taken to measure the selenium for EAWAG in Switzerland (Swiss Federal Institute of Aquatic Science and Technology).

Under expeditionen utfördes utöver ordinarie provtagning även provtagning för bestämning av DNA inom projektet ”DNA-streckkodning av marina växtplankton” finansierat av Havs- och Vattenmyndigheten som omfattar alla nationella övervakningsstationer där plankton provtas och kommer pågå under hela 2019. Extra vatten- och planktonprover togs också för mätning av selen åt EAWAG i Schweiz (Swiss Federal Institute of Aquatic Science and Technology).

Normally, no biological samples have been analyzed at the time of writing this report, but eventually there will be an algae report for the current month where more information on phytoplankton is available: https://www.smhi.se/publikationer/publikationer/algrapporter

This report is based on data that have passed a first quality control. When data are published at the national oceanographic data centre some values might have changed after further quality controls have been performed. Data from this cruise will be published as soon as possible on the data center’s webpage, normally within a week after the cruise.

Data can be downloaded here: http://www.smhi.se/klimatdata/oceanografi/havsmiljodata (only available in Swedish).

Data kan hämtas från SHARKweb här: http://www.smhi.se/klimatdata/oceanografi/havsmiljodata

Skagerack

Due to storm and rough seas, all sampling in the Skagerack was cancelled during the September expedition.

Kattegat and the Sound

In the Kattegat two stations were cancelled due to strong weather, these were; Fladen and the second visit to Anholt E.

The surface temperature was just over 16°C in both the Kattegat and the Sound. The salinity in the surface was about 21 psu at W Landskrona, in the Sound, and increased north of this to 22 psu at Anholt E and 26.5 psu at N14 Falkenberg. At W Landskrona and N14 Falkenberg, these values are significantly higher than normal and at Anholt E slightly higher than normal. In the Sound, spring layers for both temperature and salt content were just under 15 meters and at N14 in the Kattegat about 20-25 meters. At Anholt E, pycnoclines were found between 20-25 meters, a strong halocline and a weak thermocline. Deeper down, just above 35 meters, another thermocline was found where the temperature dropped from about 15 °C to 10 °C.

The levels of nutrients in the Kattegat were low and normal above the spring layer at all stations. In the Sound, higher values of phosphate and silicate are normally measured as the water flows northwards and originates from the Baltic Sea. At the time of measurement in September, water was pressed into the Baltic Sea by the harsh weather and the water originated from the Kattegat. Dissolved inorganic phosphorus (DIP) in the form of phosphate was about 0.1 µmol/l and dissolved inorganic nitrogen (DIN) was below the detection limit of 0.1 µmol/l Kattegatt, slightly higher in the Sound, about 0.2 ĩmol/l. The silicate levels were about 3 µmol/l in the upper body of water, which is slightly higher than normal for N14 Falkenberg, at Anholt E the levels were slightly lower at 2 µmol/l. Below the pycnocline, the concentrations towards the bottom increased as expected.

Low fluorescence values were noted above the pycnocline, which was followed by very low values further down the body of water.

At Anholt E, the oxygen content during the spring layers went down to 3ml/l, at N14 Falkenberg which is about 4 ml/l closest to the bottom and in the Sound just below 3 ml/l, values that are all normal for September.

Baltic Proper

Throughout the Baltic Proper, there was a well-mixed upper water layer with temperatures from 14 to 17.5 ° C, warmest in the Hanö bight and north-western Baltic Proper with temperatures above 17 ° C, which is slightly higher than normal. The salinity in the surface layer was higher than normal throughout the south-western Baltic Proper, up to 8.7 psu at BY1 in the west, then decreasing eastwards to 7.3 psu at BCS III-10. Normal levels between 6.5 and 7 psu were found in Below the well-mixed upper layer there was a strong thermocline at all stations except at BY1 where the temperature was around 16 ° C throughout the water column. Also at BY2 there was warmer water, around 16 ° C, closest to the bottom, which indicates inflowing saltier and warmer water from the Kattegat. The thermocline was found around 30 meters at all stations except at BY38 Karlsö depth where it was at 15 meters and at BCS III-10 where it was at 50 meters depth. The permanent halocline in the Baltic Sea, was observed at almost all stations at about 50 to 70 meters deep, in the Arkona basin at BY1 and BY2 somewhat shallower.

The concentrations of dissolved inorganic nitrogen (nitrate, nitrite and ammonium) and phosphorus (phosphate) were very low above the thermocline, which is normal in September when growth of phytoplankton has consumed all nutrients. Nitrogen was generally around the detection limit of 0.1-0.2 µmol/l depending on the parameter. The phosphate content varied between 0.1-0.2 µmol/l, lowest in the north and slightly higher in the southern parts. At the coastal station south of Öland, values of about 0.3 µmol/l were measured in the surface water. The silicate concentrations above the thermocline in the eastern Baltic Proper were above normal, which it has been for a long time, levels between 11 and 14 µmol/l. In the western parts such as the Bornholm Basin, the Hanö Bight and the Arkona Basin, the levels were at normal levels, 7 to 10 µmol/l. Below the halocline, the nutrients increased towards the bottom, which is normal, in the Western Gotland Basin higher levels than normal of inorganic nitrogen were noted between 10 to 15 µmol/l while it is normally below 10 µmol/l (in the form of ammonium under oxygen-free conditions), similar conditions were observed during the expedition in August.

The oxygen situation in the Baltic Proper remains poor, in the Arkona Basin the oxygen content at the bottom was below 2 ml/l, which is the limit for hypoxia. Both in Hanö Bight and the Bornholm Basin, the bottom water was completely oxygen-free (anoxic) and hydrogen sulphide was present. At station BCSIII-10 in the southeast, the oxygen content dropped to about 2 ml/l closest to the bottom In the Eastern Gotland Basin, it was anoxic or near zero oxygen from about 70-80 meters depth and hydrogen sulphide was noted at BY10 closest to the bottom, at BY15 from about 150 meters depth and at BY20 already at 80 meters. In the Western Gotland Basin at BY32, oxygen was low at 70 meters and at 80 meters and down hydrogen sulphide was measured, at BY38 hydrogen sulphide was observed at 60 meters.

In the water above the thermocline, low levels of fluorescence were measured, indicating moderate presence of phytoplankton, no large peaks could be observed. Below the thermocline, the fluorescence was close to zero.

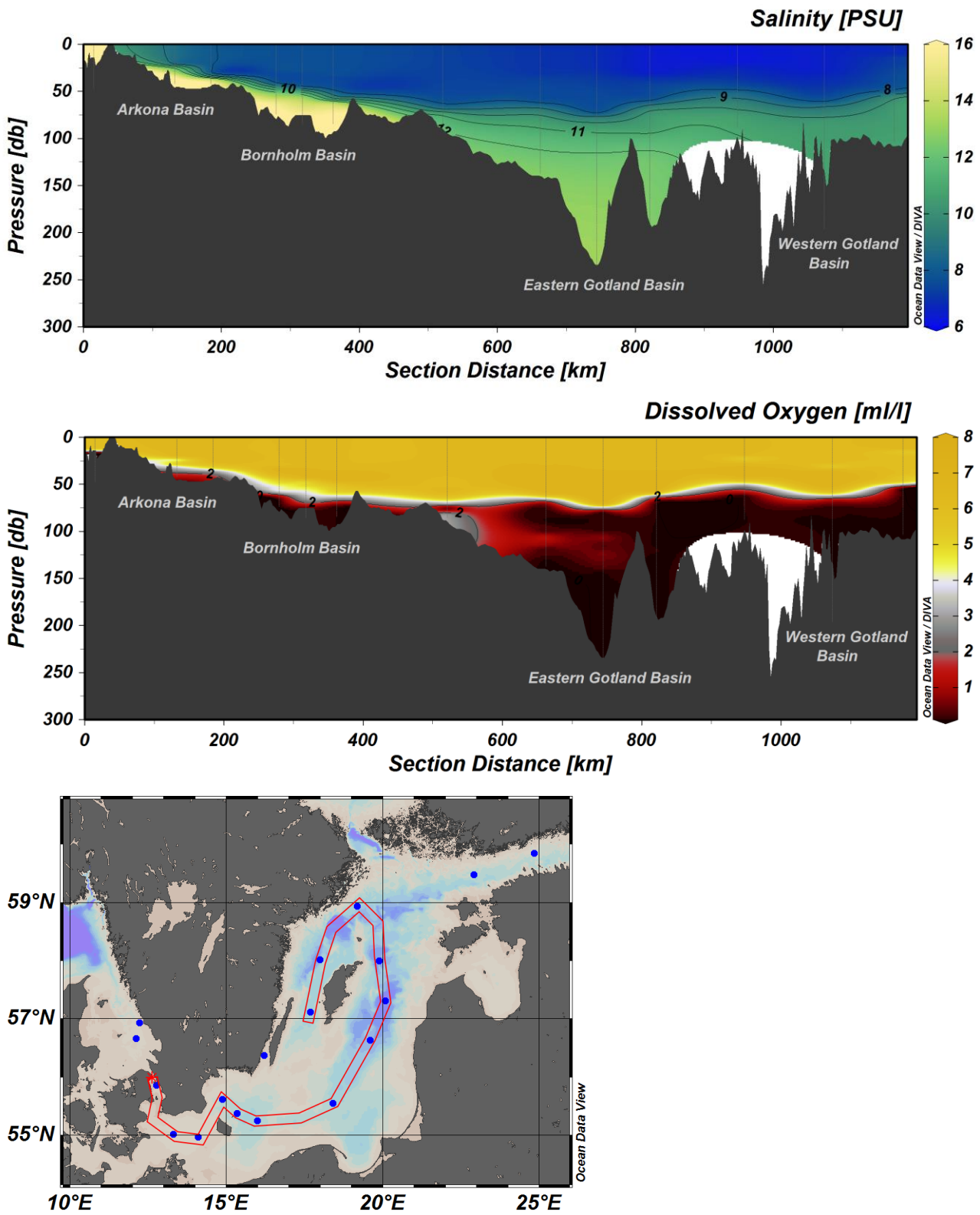

Figure 2. Transect showing dissolved oxygen and salinity from the Sound, through the Baltic Proper, to the Western Gotland Basin. Grey lines mark the positions that the plots are based on and below is a map showing these positions.

PARTICIPANTS

Name	section	Role	From
Örjan Bäck		Cruise leader	SMHI
Lars Andersson			SMHI
Kristin Andreasson			SMHI
Sara Johansson			SMHI
Johan Håkansson		Quality managger	SMHI
Erik Udehn	Helsingfors-Landskrona	Bouy technician	SMHI

APPENDICES

- Track chart
- Table over stations, sampled parameters and number of sampling depths
- Map of bottom water oxygen/hydrogen sulphide concentration
- Vertical profiles for regular monitoring stations
- Monthly average surface water plots for regular monitoring stations

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