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Spatial distribution of the winter nutrient pool 2014

Key message

Most prominent changes in this year assessment of the winter nutrient pool, when compared with last winter (2013), are the lower levels of DIP in Kattegat and the Belt Sea and increased DIP-levels in the Gotland basin. DIN-levels are in general lower than last winter.

In general, the DIN concentrations for the Baltic Sea still remain below those observed in the 1993-2002 period and the concentrations of DIP is still higher.

Results and assessments

Relevance of the indicator for describing developments in the environment

Eutrophication is the supply of excessive amounts of nutrients to an eco-system. The spatial distribution of the primary bio-available nutrients, in the surface waters during the low-productive winter, shows the availability of nutrients for the spring bloom. The winter concentration of nutrients may also highlight problem areas and changes in the spatial distribution may indicate changes in the hydrography, or the effect of remedial work.

Dissolved inorganic phosphorous (DIP) is essential for phytoplankton development. While rivers deliver phosphorus to the Baltic Sea, most of this phosphorus is chemically bound to particles, and is not directly available for biological use. Large amounts of DIP enter the Baltic with inflows of salt water, and phosphorus is also released from bottom sediments during periods of anoxia. Deep water DIP can become bio-available if it is transported to the surface waters, but this transport is hampered by the permanent stratification. After the inflows of winter 2002–2003, phosphorus concentrations in the surface water of the Baltic Proper increased significantly.

Dissolved inorganic nitrogen (DIN) is composed of nitrate, nitrite and ammonium compounds, which are also required by phytoplankton. While DIN concentrations are much higher than DIP in surface waters, marine phytoplankton requires 15-16 times as much DIN as DIP, often causing a lack of DIN to limit phytoplankton activity. Where DIN is used up, those bacteria that can fix nitrogen from the air can still flourish, making use of the remaining DIP, and causing blooms. Cyanobacteria exhibit this behaviour, and so flourish in the Baltic. Mapping the excess of dissolved inorganic phosphorous (DIP) in winter may hence serve as a warning for areas where cyanobacteria blooms are likely. Some cyanobacteria are toxic. Nitrogen is cycled within the water column and sediment, while ‘fresh’

nitrogen is also supplied, directly or via rivers, by agricultural run-off and sewage discharges, and also through atmospheric deposition.

Silicate is supplied to the Baltic via rivers, as a result of weathering processes and is recycled in the marine system. An excess of silicate is typical of the Baltic, due to the large supply of river water, and the high concentrations present in the deep anoxic water. Excess silicate is not considered problematic in the Baltic.

Assessment of the winter nutrient pool 2014

Figure 1-3 illustrates the spatial distribution of the winter nutrient pool for the period December 2013 to February 2014. Each marker in the maps represents a monitoring station and data is averaged for the upper 10 meter from December 2013 to February 2014.

Figure 4 illustrates the difference in the winter nutrient pool between winter 2014 and winter 2013.

Figure 5 illustrates the difference between the winter 2014 and the surface winter average of the period 1993-2002.

Dissolved inorganic nitrogen (DIN)

Typically, there is a gradient in the DIN concentration from the Bothnian Bay in the north, where concentrations are higher, to the southern Baltic where concentrations are lower. DIN increases again in Kattegat. In general, concentrations of DIN are higher close to land than offshore, this is unsurprising as the major source of DIN to the Baltic is land run-off. Compared to the previous assessment of the winter nutrient pool 2013 DIN was lower this winter except from southern Eastern Gotland Basin and parts of Kattegat. When compared to the decade stretching from 1993-2002, DIN concentrations during winter 2014 were in general lower.

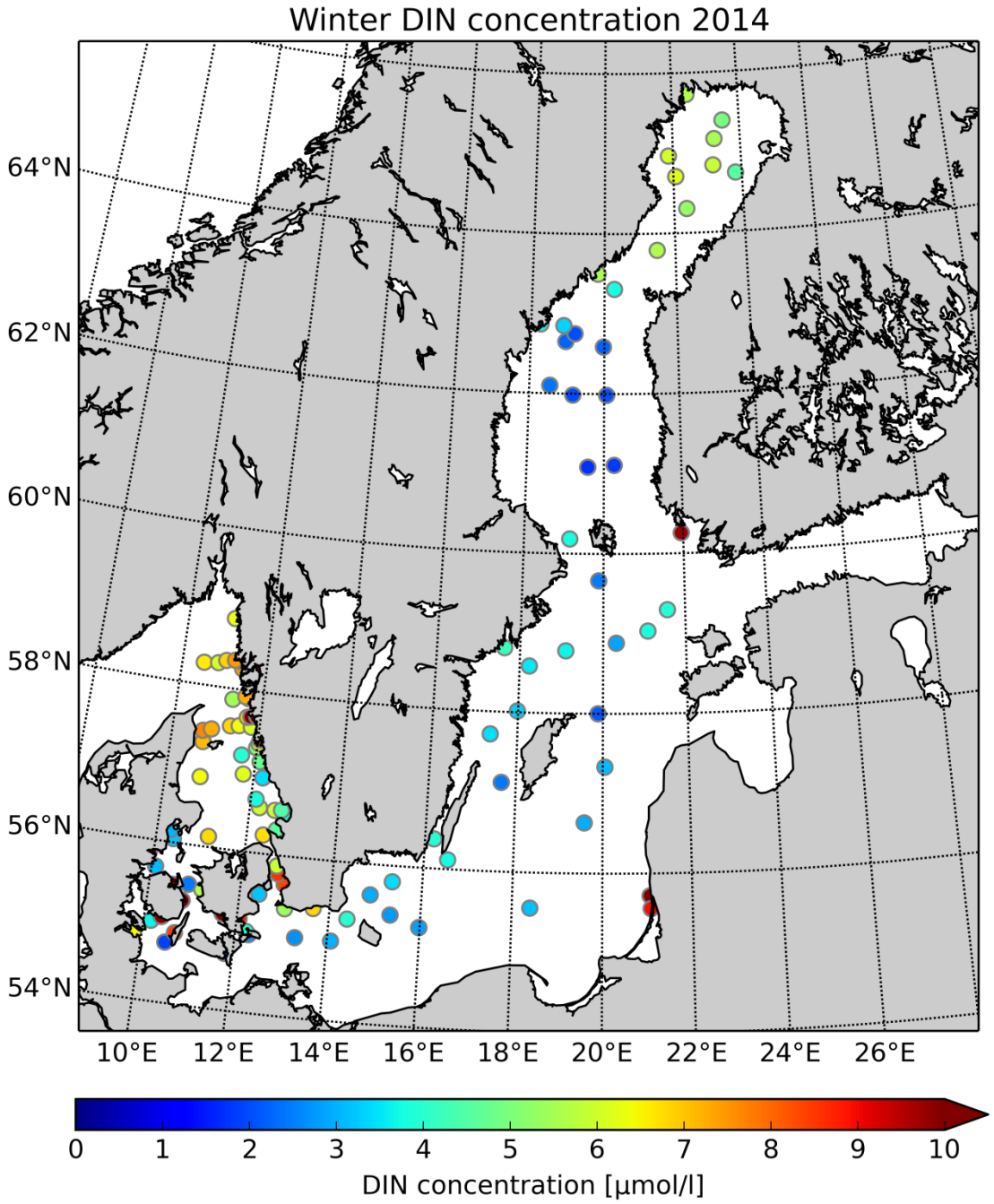

Figure 1. Mean DIN concentrations (µmol/l) in surface waters 0-10 meter: December 2013 - February 2014.

Dissolved inorganic phosphorous (DIP)

The concentrations of DIP are to a certain extent the reverse of the DIN concentrations: concentrations are very low in the Bothnian Bay, and increase southwards towards the Bothnian Sea, the Baltic Proper and the Danish Straits. The highest values are again found closest to land. In the Baltic Proper, this is partially due to upwelling along the Swedish east coast, from the Hanö Bight northwards. This occurs because the deep waters of the Baltic Proper have very high DIP concentrations, and when the wind blows from the west, the deep water 'wells up' along the Swedish east coast. Compared to the previous assessment 2013 DIP has now lower levels in Kattegat and the Belt Sea and higher in the Gotland basin. In the Gulf of Bothnia DIP-levels have not changed

much since last year except from in the Quark where it is higher levels. Compared to the 1993-2002 period the DIP levels are in general still higher for the winter 2014.

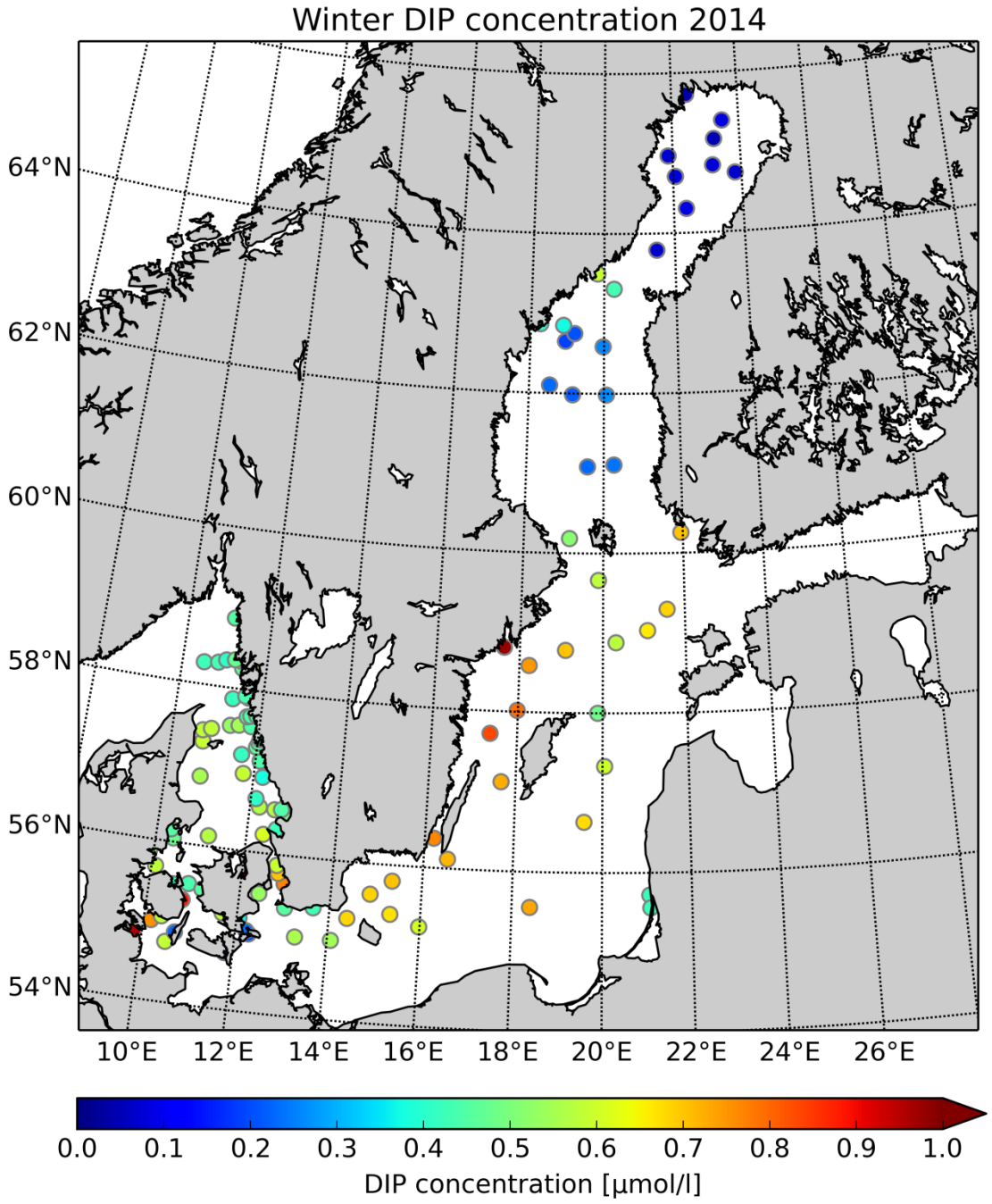

Figure 2. Mean DIP concentrations (µmol/l) in surface waters 0-10 meter: December 2013 - February 2014.

Silicate (Si)

The Si concentrations are, like DIN concentrations, highest in the Bothnian Bay, as the great rivers deliver large amounts to the bay. This is even the case in the Bothnian Sea. In the Baltic Proper, concentrations are higher along the Swedish coast due in large part to wind-induced upwelling (the oxygen-free deep waters of the Baltic Proper contain high concentrations of silicate). High concentrations in the Danish Straits are probably caused more through resuspension of material

rather than direct run-off from land. Concentrations of Si have decreased in Kattegat compared to the last winter 2013. There are also lower Si-levels in Gulf of Bothnia, except from the Quark where it has increased. Parts of the Gotland basin have also increased Si-levels. Compared to the 1993-2002 period the Si levels are now in general higher except from the Great Belt, the Arkona and Bornholm basins.

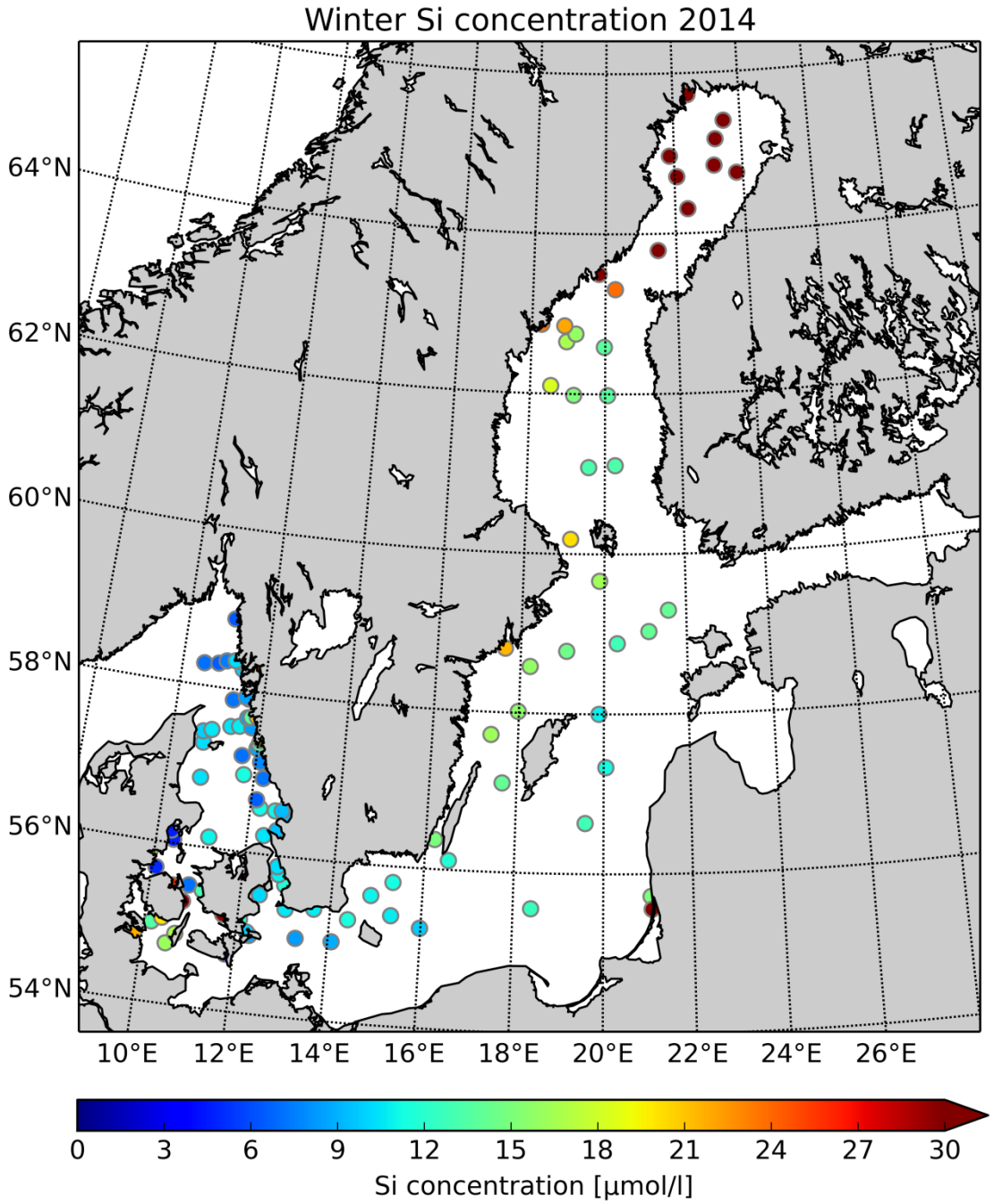

Figure 3. Mean Si concentrations (µmol/l) in surface waters 0-10 meter: December 2013 - February 2014.

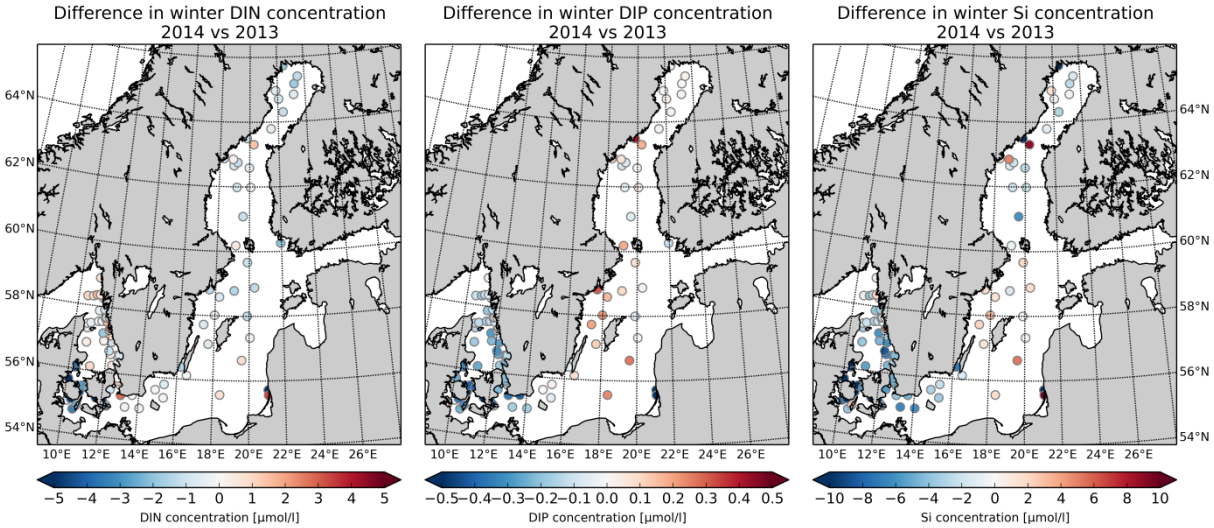

Figure 4. Difference in the winter nutrient pool between winter 2014 and winter 2013. DIN: left, DIP: centre and Silicate: right.

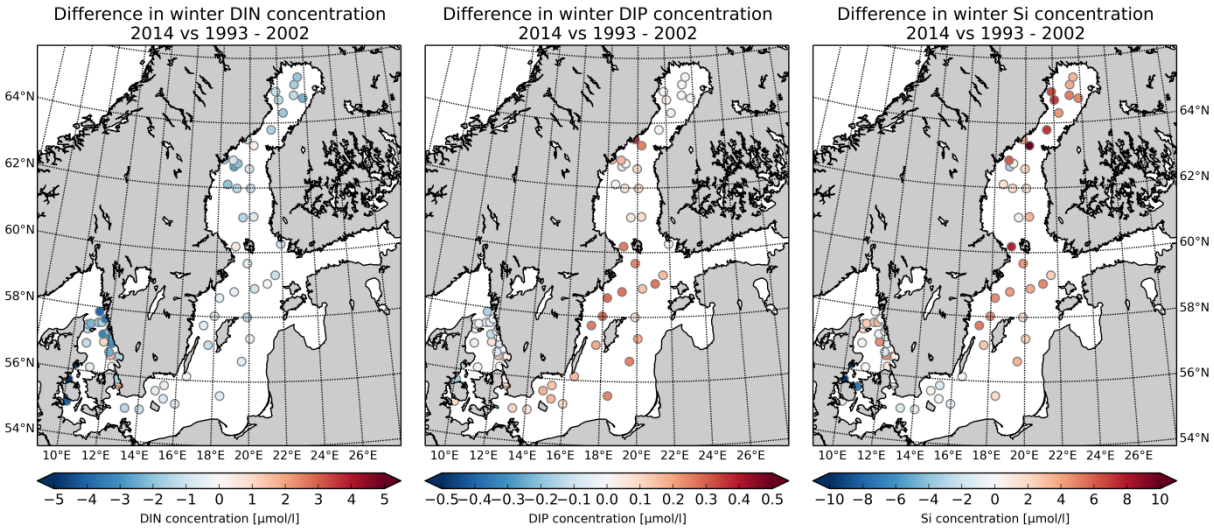

Figure 5. Difference between winter 2014 nutrient concentrations (DIN: left; DIP: centre; Silicate: right) and the 1993-2002 surface winter means.

Policy relevance and policy references

Eutrophication, the excess of nutrients, is one of the major problems facing the Baltic Sea. A major part of the HELCOM Baltic Sea Action Plan is focused on reducing eutrophication and the negative impacts it has on the Baltic Sea ecosystem. Also European directives such as the Water Framework Directive and the Marine Strategy Framework Directive identify eutrophication as a major hinder which could prevent the Baltic Sea from achieving Good Environmental Status in the near future.

The Helcom COMBINE programme uses nutrient data to help quantify the effects of anthropogenic activities. This Baltic Sea Environmental Fact Sheet contributes to the programme's requirement for information on:

- the winter pool of nutrients
- the supply of nutrients and nutrient limitation in coastal waters

References

Anon., 2000, 'Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (Water Framework Directive)', in Official Journal of the European Union 327, 22 December 2000, pp. 1–73. Available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32000L0060:EN:NOT

Anon, 2008, 'DIRECTIVE 2008/56/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)', in Official Journal of the European Union 25.6.2008 L 164/19 - 164/40. Available online at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0056:en:NOT

Helcom COMBINE Manual (Annex C), http://www.helcom.fi/Monas/CombineManual2/CombineHome.htm, December 2003. Data This study used data collected under the HELCOM COMBINE programme, and archived for HELCOM by ICESsupplemented with data collected by SMHI 2007/8.

Data

Data is primarily from the HELCOM data archive held at the International Council for the Exploration of the Sea (http://www.ices.dk). Data collected for the HELCOM COMBINE programme are collected and analyzed according to fixed, agreed techniques which are the same for all HELCOM countries. Laboratories participate in quality assurance consortia such as QUASIMEME and are almost uniformly ISO accredited for good laboratory practice.

These data were supplemented by coastal data collected as part of Swedish regional monitoring programmes and made available by the oceanographic data centre at SMHI through the database SHARK (Svenskt Havs ARKiv).

Surface water values are here defined as the mean over 0-10 m. When analysing the winter period, an average of the months December, January and February is used. However, the HELCOM data archive does not yet include all data from 2014. Data is normally reported by the contracting parties on annual basis to ICES and all data for 2014 will therefore not be available until 2015. This results in that some stations are based on December 2013 data only. In the current fact sheet, this mainly concerns data in Kattegat Danish Coastal waters and Arkona Basin

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