Phytoplankton biomass and species succession in the Gulf of Finland, Northern Baltic Proper and Arkona Basin in 2006

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Key message

😊 Cyanobacterial blooms in the northern Baltic Proper in 2006 were below average.

😊 The blooms in the Gulf of Finland - the area that often suffers from vigorous blooms - were below average in their intensity.

😊 The blooms in the Arkona Basin were vigorous and above average.
Results and assessment

Chlorophyll-a, Gulf of Finland

Weekly mean 1992-2005
Standard deviation 1992-2005
Weekly mean 2006

Chla, mg/m³

January February March April May June July August Sept Octob Novem December

Julian week
Fig. 1. Annual variation of chlorophyll $a$ (mg m$^{-3}$) in the Western Gulf of Finland (top), the Northern Baltic Proper (middle) and the Southern Baltic Proper (including Arkona Basin, bottom). The blue curve shows the weekly mean and the red curve shows the standard deviation for the years 1992-2005. The black diamonds represent the weekly means in 2006. Image: FIMR/Alg@line.
Relevance of the indicator for describing developments in the environment

Eutrophication is considered one of the most serious threats against the Baltic Sea. It is defined as an increase in the rate of supply of organic matter to an ecosystem, and is most commonly caused by nutrient enrichment. Chlorophyll $a$ concentration, representing phytoplankton biomass, assesses the
eutrophication-driven alterations of the Baltic Sea. More importantly, it can address with an adequate precision the intensity and occurrence of cyanobacterial blooms. It must be kept in mind, however, that although highly responsive to changes in surface nutrient concentrations, chlorophyll $a$ is also a product of parameters not related to eutrophication, namely other biological factors, hydrography and climate.

**Policy relevance and policy references**
Although being a natural phenomenon per se, the algal bloom events have become more frequent, intense, and extensive due to the eutrophication of the Baltic Sea. Since the mid-90’s, the strength of cyanobacterial blooms have increased to levels to raise wide public concern. Currently, noxious and often harmful cyanobacterial blooms disrupt the functioning of the Baltic ecosystem, limit the recreational and economic use of the sea, and represent a clear and present health risk for humans and domestic animals. No signs of decrease of cyanobacterial blooms have been seen yet.

**Background information: low wintertime phosphate concentrations in northern Baltic**
The early spring of 2006 surface phosphate concentrations were lowest in ten years in the northern Baltic Proper and the Gulf of Finland, due to lack of vertical mixing. High levels of phosphorus were measured in the central and southern part of the Baltic during the same period. This caused high risk for cyanobacterial blooms in the southern and central Baltic areas.

**Assessment for the Gulf of Finland**
The spring bloom started in the first week of April, almost two weeks later than the previous year and the ten-year average. Both the peak and duration of the bloom were below average (Fig. 1, Fleming & Kaitala 2006). The algal community was dominated before the bloom peak by the diatom *Skeletonema costatum*, later also by other diatoms (*Chaetoceros* spp., *Achnanthes taeniata*, *Thalassiosira* spp.). When the bloom biomass began to decrease, dinoflagellates (*Wołoszynskia halophila*, *Scrippsiella hangoei* and *Peridiniella catenata*) and the prasinophycean *Pyramimonas* spp. became abundant as the diatoms formed resting spores.

The summer minimum phase lasted throughout June (Fig. 1). The dominating phytoplankton taxa were the green alga *Monoraphidium contortum* and the diatom *Skeletonema costatum*. The weather during the early June was changeable, but a high pressure weather type established around Midsummer and water temperature started to rise up promptly.

The algal biomasses in the late summer were at a level typical for the latest decade, and the highest Chl $a$ levels (between 5 and 117 mg m$^{-3}$) were observed in late August. The algal community was dominated by the cyanobacteria *Aphanizomenon flos-aquae* and *Anabaena* spp.. The dinoflagellate *Heterocapsa triquetra* was also common.

The first cyanobacteria surface accumulations were found at the mouth of the Gulf of Finland on 7th July, and on the following week surface accumulations were also found in the eastern Gulf of Finland. During the heat wave of late July and early August blue-green algae concentrations increased on the Finnish coast, although they remained mixed in the surface layer thanks to the prevailing windy weather. During the second week of August surface accumulations increased in the Finnish coast as well in the open sea areas. After mid-August the situation calmed down in open sea areas, partly following strong winds. Algal concentrations remained high along the Finnish coast. The algae, which had been mixed up in the surface layer, rose to the surface during calm weather. Very few surface accumulations were observed after the
end of August, although locally algal concentrations remained moderate in the water. To summarize, the blue-green algal season started later and was below average in intensity in the Gulf of Finland.

**Assessment for the Northern Baltic Proper**
The spring bloom started on April 6th, which is later than average, and lasted about three weeks (Fig. 1, Fleming & Kaitala 2006). All in all, the spring bloom was less intense than the previous year and the average, when taking into account both peak and duration of bloom. The spring bloom started with diatoms, mainly *Skeletonema costatum*, dominating. Later also dinoflagellates began to increase with *Woloszynskia halophila/Scrippsiella hangoei* and *Peridiniella catenata* abundant.

The summer minimum lasted from the end of May to the first week of June (Fig. 1). During this period the dinoflagellate *Peridiniella catenata* was usual and the golden alga *Dinobryon balticum* also relatively common.

The first cyanobacterial blooms were observed during the second week of July. The northern Baltic Proper did not suffer of extensive blooms as during the previous summer. The algal community was dominated by the cyanobacteria *Aphanizomenon flos-aquae* and *Anabaena* spp.. The dinoflagellate *Heterocapsa triquetra* was also common.

**Assessment for the Arkona Sea**
As during the previous year, the spring bloom was negligible. A slight rise in the chlorophyll a level reaching about 4 µg/l could be detected from the middle of March to the middle of April (Fig. 1, Fleming & Kaitala 2006). The diatoms dominated the early spring community, with *Skeletonema costatum* common. Small flagellates, such as *Chattonella aff.vVerruculosa, Apedinella radians* and *Dinobryon balticum*, increased in April.

A distinct summer minimum could not be detected in the chlorophyll a concentration, since the concentrations had great variability after the spring period (Fig. 1). Small haptophytes (*Chrysochromulina* spp.) were dominant in the early summer community, with colonial cyanobacteria (*Chroococcales* spp.) also abundant.

The most intensive blue-green algal blooms occurred in the southern Baltic Proper and the Arkona Basin. The first blooms occurred in the beginning of July, and massive blooms covered the area throughout the second half of July. *Nodularia spumigena* was the most common cyanobacteria species, with small colonial cyanobacteria (*Chroococcales* spp.) also present.

**References**

**Metadata**

**Technical information**
1. Data provider (source): Finnish Institute of Marine Research (FIMR)

Contact persons: Vivi Fleming-Lehtinen, Seppo Kaitala and Seija Hällfors.
2. Description of data: Original unit of measure: mg chl $\alpha$ m$^{-3}$. Semiquantitative phytoplankton analysis are based on the ranks 1 to 5 describing relative sample-based abundance of an algal species. In the cyanobacterial bloom map, visual observations are included.

Original data in WGS84-coordinates

Original purpose of the data: Phytoplankton monitoring of FiMR, Alg@line project

3. Geographical coverage: Gulf of Finland, Archipelago and Åland Sea, Baltic Proper, Arkona Sea


5. Methodology and frequency of data collection: The data has been collected using an automated flow-through sampling system on merchant ships, sampling depth ca. 5 m, weekly sampling during the period February/March-October/November in each year. Detection device Jasco 750 spectrofluorometer

6. Methodology of data manipulation: No data manipulation

Quality information
1. Strength and weakness (at data level)

Strength: Very high both temporal and spatial sampling frequency

Weakness: Satellite images are achieved only on clear weather. Ship-of-opportunity –measurements are restricted to the ships route, and dependant on it’s schedule; diurnal changes of data are not taken into account.

2. Reliability, accuracy, precision, robustness (at data level): Filtration and extraction of Chl $\alpha$ from samples according to accredited method SFS-EN ISO/IEC 17025. Procedure uncertainty: 5%.

3. Further work required (for data level and indicator level): More sophisticated statistical analysis

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