Phytoplankton biomass and species succession in the Gulf of Finland, Northern Baltic Proper and Southern Baltic Sea in 2011

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Key message
😊 Annual phytoplankton succession followed normal pattern in the Baltic Sea. In the Gulf of Finland the spring bloom was well developed and the peak biomass value was higher than the long term mean.

😢 In the southern Baltic Sea the phytoplankton biomass was higher during the spring bloom and high summer. Diatoms dominated the spring bloom species composition and especially the diatom Detonula confervacea showed increase in abundance. During the summer bloom higher amount of blue-green algae was observed. Observed chlorophyll a values were within long term standard deviations except during one week in the southern Baltic Sea.

😄 In the Gulf of Finland chlorophyll a levels were low during late autumn.

Results and assessment
**Chlorophyll-a, Northern Baltic**

![Graph showing annual variation of chlorophyll-a (mg m\(^{-3}\)) in the western Gulf of Finland (upper), the northern Baltic Proper (middle), and the Southern Baltic Proper (lower). The blue curve represents the average for the years 1992-2010, the black diamonds the measurements made in 2011. Image: SYKE/Alg@line.](image)

**Chlorophyll-a, Southern Baltic**

![Graph showing annual variation of chlorophyll-a (mg m\(^{-3}\)) in the western Gulf of Finland (upper), the northern Baltic Proper (middle), and the Southern Baltic Proper (lower). The blue curve represents the average for the years 1992-2010, the black diamonds the measurements made in 2011. Image: SYKE/Alg@line.](image)

*Fig. 1.* Annual variation of chlorophyll a (mg m\(^{-3}\)) in the western Gulf of Finland (upper), the northern Baltic Proper (middle), and the Southern Baltic Proper (lower). The blue curve represents the average for the years 1992-2010, the black diamonds the measurements made in 2011. Image: SYKE/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.

Assessment for the Gulf of Finland 2011

The spring bloom began in late March and reached its peak in mid April in the open gulf. The timing and the peak value were about the same as the weekly average between 1992 and 2010. Diatoms (*Thalassiosira levanderi*, *C. holsaticus*, *C. wighamii* and *Achnanthes taeniata*) dominated at the beginning of the bloom, while the dinoflagellates (*Peridiniella catenata* and *Biecheleria baltica*) increased in abundance during April. In the eastern gulf and southern coast of Finland the spring bloom was most intense in the beginning of
May according to satellite observations. Diatoms (mainly *Skeletonema costatum* coll., *Chaetoceros wighamii* and *Achnanthes taeniata*) were relatively common also in mid May, when large-sized heterotrophic dinoflagellates (*Protoperidinium* spp. and Gymnodiniales spp.) and choanoflagellates (*Diaphanoeca sphaerica* and *Calliantha natans*) became common.

In early June the phytoplankton biomass was low and nanoflagellates (small dinoflagellates Gymnodiniales spp., chrysophycean *Dinobryon facilifera* and *D. balticum*, the euglenophycean *Eutreptiella* sp., and the haptophycean *Chrysochromulina* spp.) formed the main part of it. Also the toxic dinoflagellate *Dinophysis acuminata* was moderately common. The filamentous blue-green algae *Aphanizomenon flos-aquae* and *Dolichospermum* spp. (*Anabaena* spp.) increased with the increasing water temperature and became dominant in the beginning of July, while *Nodularia spumigina* filaments increased to common in mid July. Surface occurrences started to appear in late June/early July in the entrance and western gulf. They were mixed by winds in the water column, but in the turn of the month large aggregations were observed in upper water near the surface. Coastal occurrences continued until late September.

Small colonial blue-green algae (*Woronichinia* spp., *Cyanodictyon* spp., *Lemmermanniella* spp.) and nanoflagellates, mainly cryptophytes and prasinophytes, dominated during the autumn. The phytoplankton biomass (measured as chlorophyll *a*) was somewhat lower than the weekly average between 1992 and 2010. The diatoms *Coscinodiscus granii* and *Actinocyclus octonarius* occurred in low numbers in September and October. No late diatom bloom was observed.

**Assessment for the Northern Baltic Proper 2011**

The spring bloom started in early April and reached its peak in the end of month. The chlorophyll *a* peak value was slightly lower compared to the weekly average between 1992 and 2010. The species dominating the bloom were the diatoms (*Thalassiosira levanderi*, *T. baltica*, *Chaetoceros wighamii*, *C. holsaticus*, *C. ceratosporus*, *Achnanthes staeniata*), and dinoflagellates of the species complex *Biecheleria baltica/Scrippsiella hangoei/Gymnodinium corollarium* and *Peridiniella catenata*.

After the spring bloom nanoflagellates became abundant in mid May. The dominating taxa were the colonial chrysophyte *Dinobryon balticum*, small dinoflagellates (Gymnodiniales spp., *Heterocapsa rotundata*) and the dictyochophycean *Pseudopedinella tricosta*, later the haptophycean *Chrysochromulina* spp. Some larger dinoflagellates, *Dinophysis* spp. and *Protoperidinium* spp., were also moderately common. In mid June the blue-green algae *Aphanizomenon flos-aquae*, *Dolichospermum* spp. (*Anabaena* spp.) and *Nodularia spumigina* became more common, but the chlorophyll *a* values remained lower than the long time average.

Surface accumulations of blue-green algae covered also this summer parts of the Baltic Proper in July, and the phytoplankton biomass (measured as chlorophyll) was slightly higher than the weekly average between 1992 and 2010. *Aphanizomenon flos-aquae* was the dominating blue-green alga in July. Most filaments of *Dolichospermum* spp. and *Nodularia spumigina* disappeared in the end of July and narrower filaments of blue-green algae (*Pseudanabaena* spp., *Planktolyngbya* sp.) and small colonies of blue-green algae (*Aphanathece* spp., *Cyanodictyon* spp., *Woronichinia* spp.) became more abundant.

The phytoplankton biomass (measured as chlorophyll *a*) was clearly smaller than the long-time average in September and October. The most abundant species were diatoms (*Actinocyclus octonarius*, *Cyclotella choctawhatcheeana*, *Chaetoceros danicus*, and *C. impressus*), small colonies of blue-green algae and
nanoflagellates. Most of the *Chrysochromulina* spp. cells disappeared during September and the cryptophytes *Teleaulax* spp. and *Plagioselmis prolonga* became dominant.

**Assessment for the Southern Baltic Proper 2011**

The spring bloom started in the beginning of March and reached its peak in mid March. The peak value was clearly higher than the weekly average between 1992 and 2010. The diatoms *Thalassiosira levanderi*, *T. baltica*, *Detonula confervacea*, *Chaetoceros* spp. and *Skeletonema costatum* coll. predominated the species composition. Euglenophytes (*Eutreptiella* sp. and *Eutreptiella braarudii*) were rather common, while the typical spring dinoflagellates *Peridiniella catenata* and *Gymnodinium corollarium* were observed only in minor amounts. *Skeletonema costatum* coll. and *Thalassiosira levanderi* were still dominating in mid April. The diatom *Diatoma tenuis* was moderately common in mid May.

The filamentous blue-green algae *Nodularia spumigena* and *Aphanizomenon flos-aquae* and small colonial blue-green algae (*Cyanodictyon* spp., *Aphanathece* spp., *Cyanonephron styloides*, *Snowella* spp.), were relatively abundant in mid June. The haptophycean nanoflagellates *Chrysochromulina* spp. dominated though in cell numbers.

Phytoplankton biomass (measured as chlorophyll *a*) was considerably higher than the weekly average between 1992 and 2010 in late July and early August. The filamentous blue-green algae *Nodularia spumigena*, *Aphanizomenon flos-aquae* and *Dolichospermum* spp. (*Anabaena* spp.) and small colonial blue-green algae (*Cyanodictyon* spp., *Aphanathece* spp., *Lemmermanniella* spp., *Cyanonephron styloides*) were still relatively abundant in July, while in August the filamentous cyanobacteria dissappeared and the numbers of some diatoms (*Chaetoceros impressus*, *C. throndsenii*, *C. tenuissimus*, *Cylindrotheca closterium*, *Nitzschia paleacea*) increased. Nanoplankton fraction was more varied in August, consisting mainly of *Chrysochromulina* spp., *Pyramimonas* spp., *Plagioselmis* spp., *Eutreptiella* sp. and small Gymnodiniales spp.

Nanoflagellates (*Pyramimonas* spp., *Eutreptiella* sp., *Teleaulax* spp., *Plagioselmis prolonga*) and diatoms (*Dactyliosolen fragilissimus*, *Skeletonema costatum* coll., *Proboscia alata*, *Cerataulina pelagica*) were relatively common in September. Diatoms of the genus *Pseudo-nitzschia* were abundant in October. The invasive alien dinoflagellate *Prorocentrum minimum* occurred in small numbers from late July to mid November and the diatoms *Pseudoosolenia calcar-avis* and *Chaetoceros* cf. *convolutus* with the more regularly occurring autumnal diatom *Coscinodiscus granii* were observed from August to mid November.

**Metadata**

**Technical information**

1. Data provider (source): Finnish Environment Institute SYKE. Contact persons: Seppo Kaitala, Seija Hällfors and Petri Maunula.

2. Description of data: Original unit of measure: mg chl a m$^{-3}$. Semiquantitative phytoplankton analyses 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 the Baltic Sea, SYKE, Alg@line project

3. Geographical coverage: Gulf of Finland, Northern Baltic Proper, Southern Baltic Proper


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 Chlorophyll a 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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