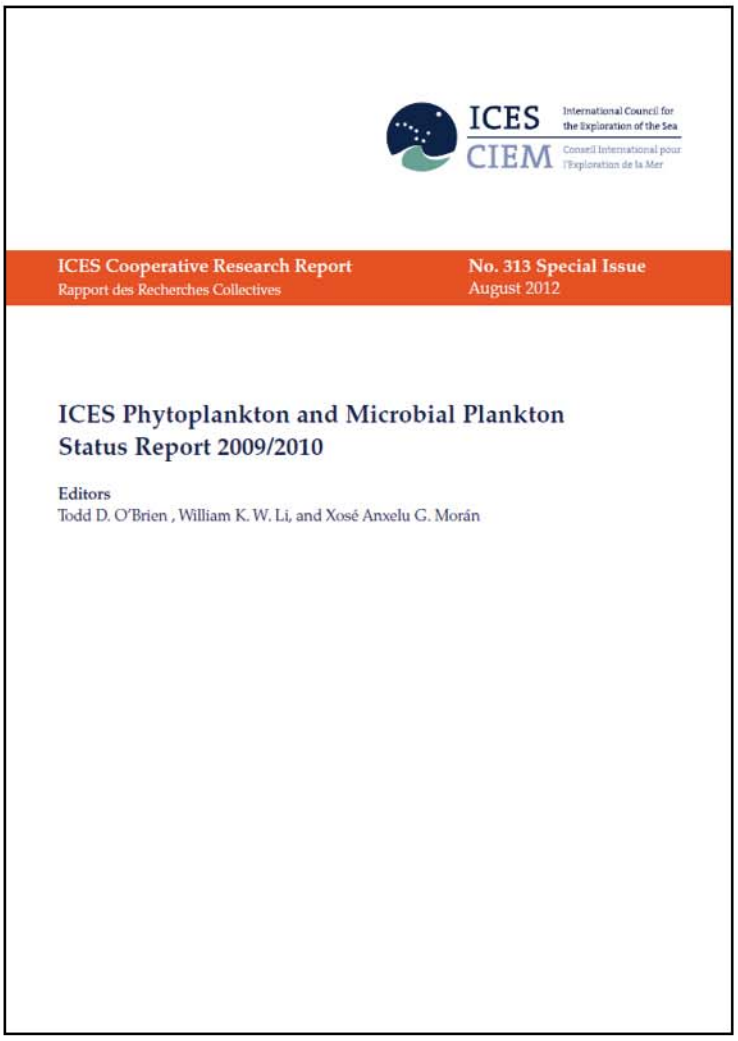


The pages in this PDF contain a single section extracted from the

ICES Plankton and Microbial Plankton Status Report 2009/2010

The full electronic document is available online at:
http://WGPME.net

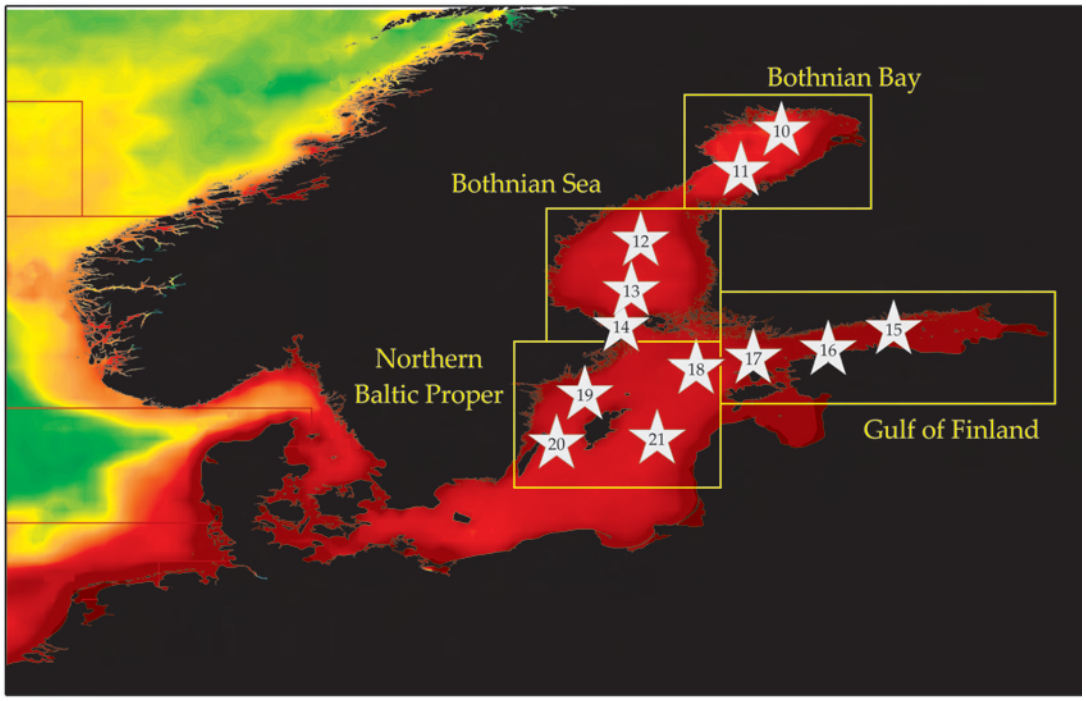
Full-color printed copies are available from:
http://ICES.dk

O'Brien, T. D., Li, W. K. W., and Morán, X. A. G. (Eds). 2012.
ICES Phytoplankton and Microbial Plankton Status Report 2009/2010.
ICES Cooperative Research Report No. 313. 196 pp.

The time-series analyses and figures used in this report were created using COPEPODITE:
http://www.st.nmfs.noaa.gov/copepodite

5.1 Northern Baltic Sea (Sites 10–21)

Sirpa Lehtinen



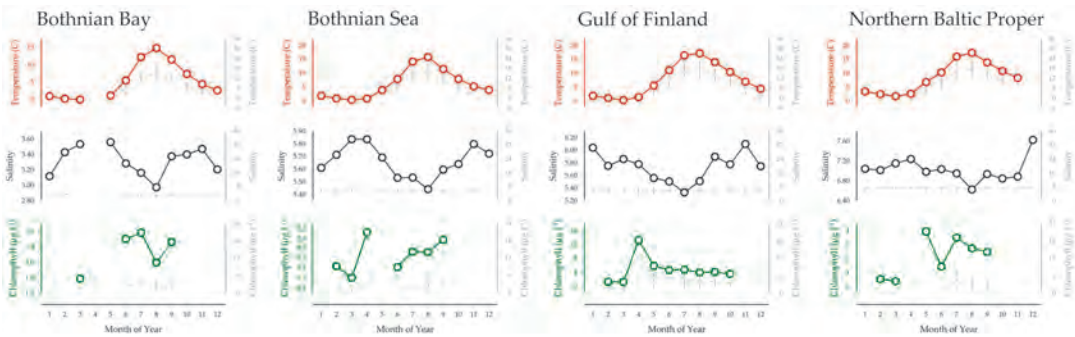


Figure 5.1.1
Location of Finnish Environmental Institute (SYKE) phytoplankton monitoring stations in the northern Baltic Sea (Sites 10–21), and their corresponding environmental summary plots (see Section 2.2.1). The yellow boxes and labels indicate the four subareas described in the report text.

The Northern Baltic Sea consists of four subareas: Bothnian Bay, Bothnian Sea, the Gulf of Finland, and the northern Baltic Proper (Figure 5.1.1). In the frame of the international COMBINE-monitoring programme of the Helsinki Commission (HELCOM), the Marine Research Centre of the Finnish Environment Institute (SYKE) samples phytoplankton yearly in August at twelve open-water stations (Sites 10–21) and in numerous coastal stations (not considered in this report). This sampling has been carried out since 1979, with the data available in the main ICES database. Sampling, processing, and analysis of the samples have been carried out according to the compulsory manual and the HELCOM PEG (Phytoplankton Expert Group) taxa and biovolume list (Olenina *et al.*, 2006; HELCOM, 2010). For the purposes of this report, the twelve open-water stations have been combined into four geographical subareas: Bothnian Bay, Bothnian Sea, Gulf of Finland, and northern Baltic Proper. Additional time-series results for the individual sites, as well as additional SYKE coastal monitoring sites, are available online at http://wgpme.net/time-series.

5.1.1 Bothnian Bay (Sites 10–11)

The Bothnian Bay is the most northern part of the Baltic Sea, characterized by low salinity (ca. 2.9–3.5), the strong influence of river waters, and the long duration of ice cover (over 150 d). In addition, Bothnian Bay is the only predominantly phosphorus-limited Baltic Sea subregion, most notibly during summer (Tamminen and Andersen, 2007). The maximum bottom depth is 148 m, with a mean depth of 40 m. The open-water sampling stations in the Bothnian Bay are F2 (Site 10, 65°23'N 23°27'E) and BO3 (Site 11, 64°18'N 22°21'E).

Seasonal and interannual trends (Figure 5.1.2)

Diatoms, especially *Chaetoceros wighamii*, dominate during the spring bloom, but dinoflagellates, like *Peridiniella catenata*, are also important. During summer, cryptophytes and chlorophytes are numerous. In autumn, there is usually another diatom peak. In the Bothnian Bay, the diazotrophic cyanobacteria is not as common as in other parts of the Baltic Sea; one reason for this is probably the predominant phosphorus limitation.

Since the start of the monitoring programme in 1979, salinity has decreased, whereas silicate has increased. Temperature and chlorophyll *a* have a slightly rising trend, but neither is statistically significant. Diatoms, dinoflagellates, cryptophytes, euglenophytes, and heterotrophs have all decreased significantly in the Bothnian Bay since sampling began in the mid-1980s.

5.1.2 Bothnian Sea (Sites 12–14)

Surface salinity in the Bothnian Sea is ca. 5.4–5.9. The maximum depth of the Bothnian Sea is 293 m, with a mean depth of 60 m. The open-sea sampling stations in the Bothnian Sea are US5B (Site 12, 62°35'N 19°60'E), SR5 (Site 13, 61°05'N 19°35'E), and F64 (Site 14, 60°11'N 19°08'E).

Seasonal and interannual trends (Figure 5.1.3)

The phytoplankton community in the Bothnian Sea is usually nitrogen-limited during summer, as it is in all of the other more southern areas of the Baltic Sea. Species such as the mixotrophic haptophyte *Chrysochromulina* spp. and cyanobacteria *Aphanizomenon* sp. and *Nodularia spumigena* are important during summer (Andersson *et al.*, 1996). Other important species are the diatom *Thalassiosira baltica* and dinoflagellate *Peridiniella catenata* in spring, and photosynthetic ciliate *Mesidinium rubrum* after the spring bloom.

Since the start of the monitoring programme in 1979, temperature and chlorophyll *a* have increased, whereas salinity and silicate have decreased. Diatoms, dinoflagellates, cryptophytes, and heterotrophs have decreased significantly, whereas chrysophytes and the endosymbiotic ciliate *Mesodinium rubrum* (not shown) have increased.

5.1.3 Gulf of Finland (Sites 15–17)

The surface salinity in the Gulf of Finland is ca. 5.4–6.1. The maximum depth of the Gulf of Finland is 121 m. The open-sea sampling stations in the Gulf of Finland are LL3a (Site 15, 60°04'N 26°20'E), LL7 (Site 16, 59°51'N 24°49'E), and LL12 (Site 17, 59°29'N 22°54'E).

Seasonal and interannual trends (Figure 5.1.4)

The phytoplankton community structure is complex and shifting, owing to unstable mixing conditions in the Gulf of Finland. Dinoflagellates *Scrippsiella* sp., *Biecheleria baltica*, and *Gymnodinium corollarium* are important spring-bloom species. Late-summer communities in the Gulf of Finland are characterized by cyanobacterial blooms. Nitrogen limitation and low nitrogen-to-phosphorus ratio are supposed to promote the cyanobacterial blooms because diazotrophic cyanobacteria are able to fix nitrogen from the atmosphere. In addition to filamentous cyanobacteria, colonial cyanobacteria and cryptophytes as well as other small flagellates are numerous in the summer communities of the Gulf of Finland.

Since the start of the monitoring programme in 1979, temperature and chlorophyll *a* have increased, whereas salinity and silicate have decreased (Figure 5.1.4). Dinoflagellates have decreased in August, although their biomass and proportion in the spring bloom have increased (Klais *et al.*, 2011). Cryptophytes, euglenophytes, and heterotrophs have also decreased. Suikkanen *et al.* (2007) found that late-summer cyanobacterial biomass increased in the Gulf of Finland from the late 1970s to the beginning of the 2000s. In this August-only analysis, this cyanobacteria increase was not evident in the Gulf of Finland or in the northern Baltic Proper in the 2000s (Figure 5.1.5), possibly owing to differences in time-span or time-series analysis methods.

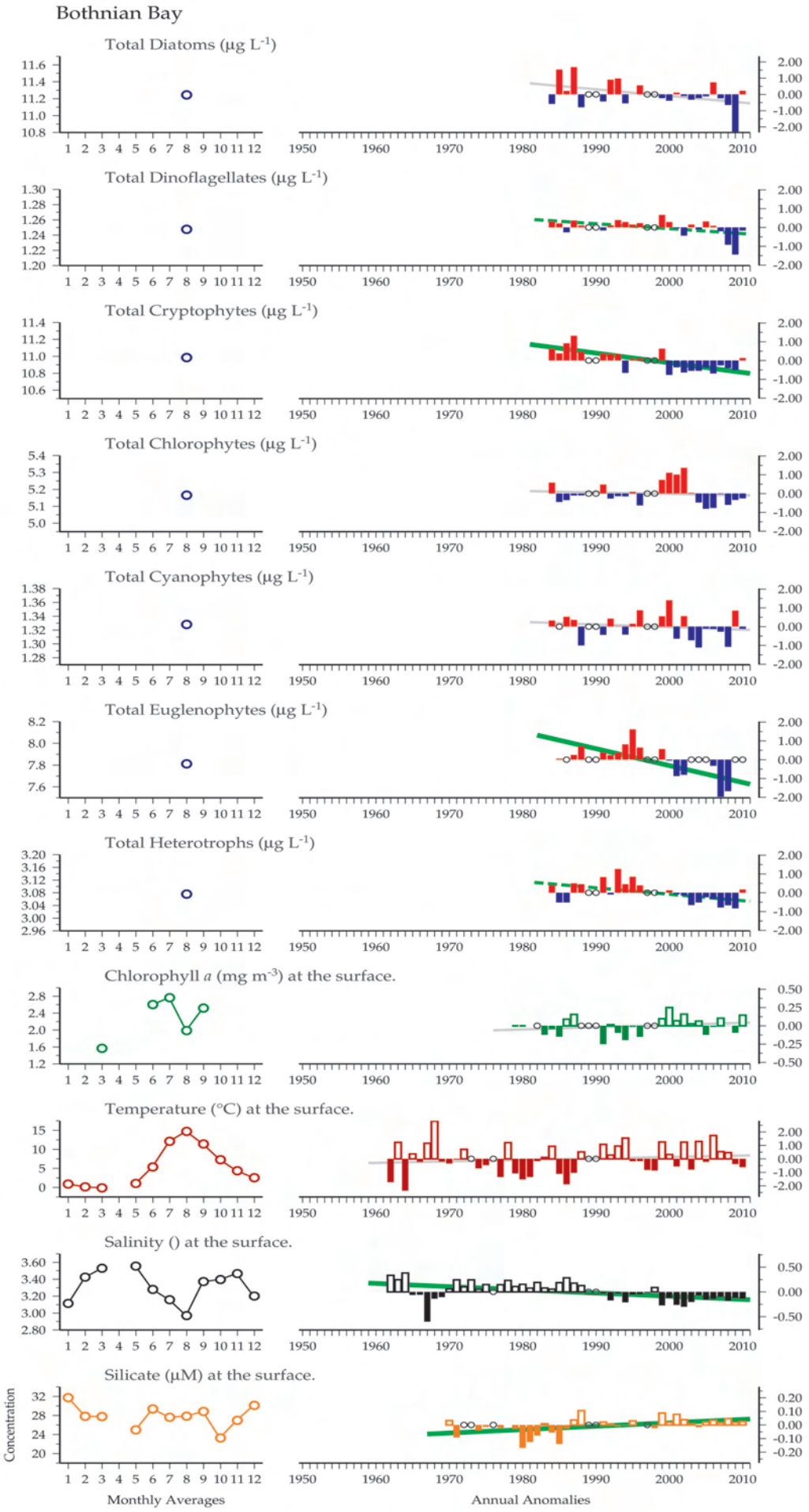
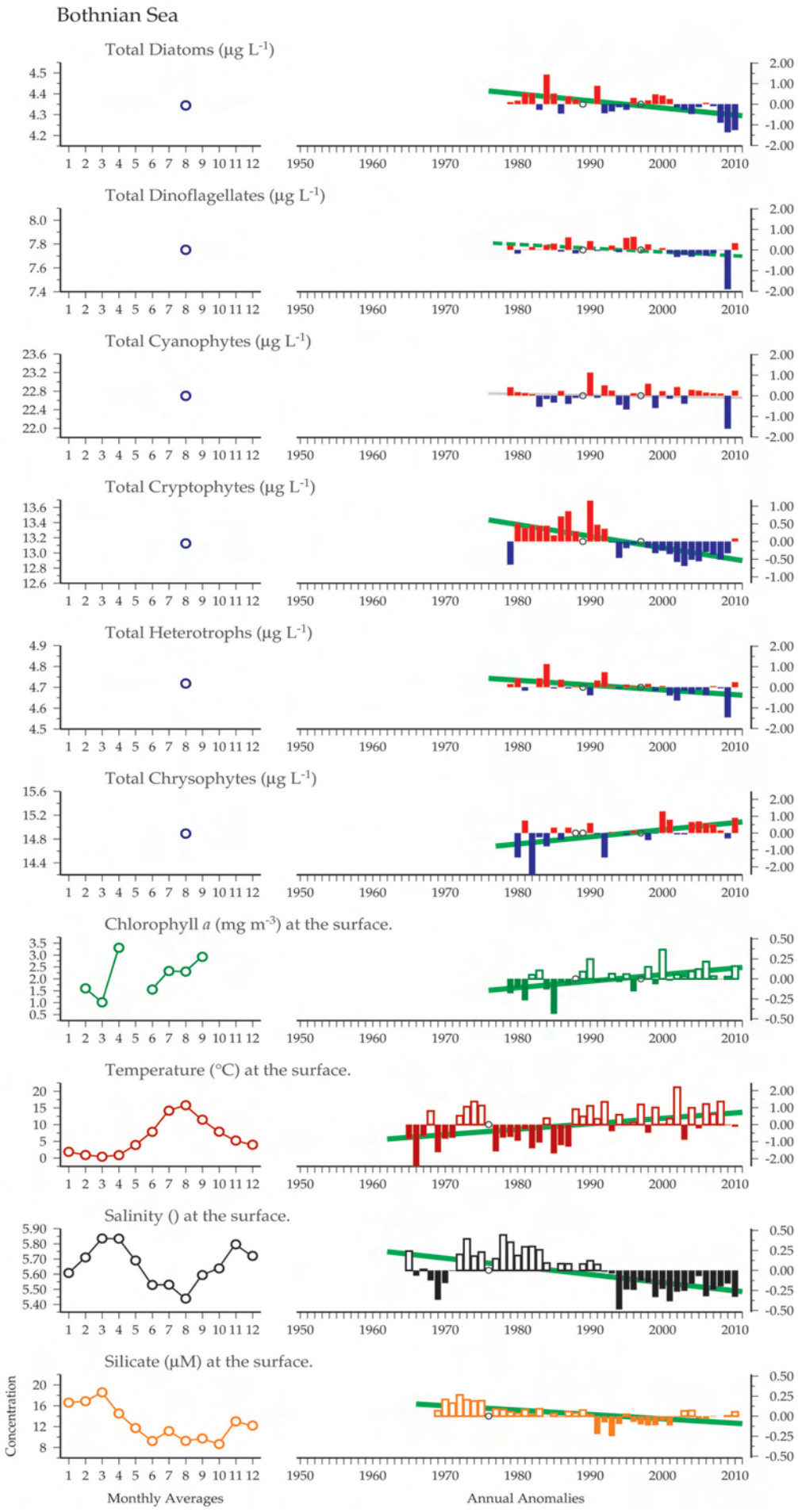


Figure 5.1.2
Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of select cosampled variables at the Bothnian Bay plankton monitoring site. Additional variables from this site are available online at http://wgpme.net/time-series.

Figure 5.1.3
Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of select cosampled variables at the Bothnian Sea plankton monitoring site. Additional variables from this site are available online at http://wgpme.net/time-series.



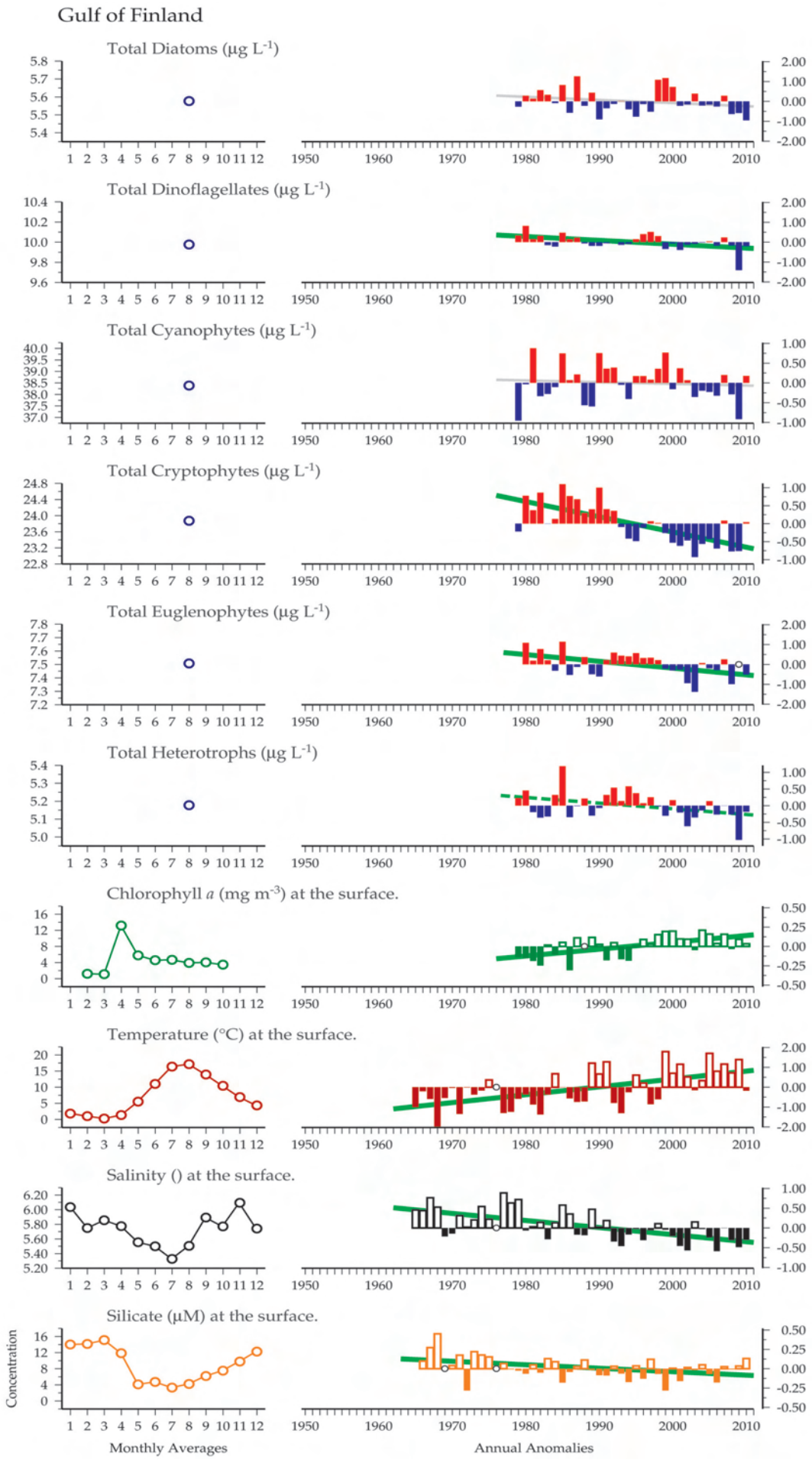


Figure 5.1.4
Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of select cosampled variables at the Gulf of Finland plankton monitoring site. Additional variables from this site are available online at http://wgpme.net/time-series.

5.1.4 Northern Baltic Proper (Sites 18–21)

Surface salinity in the northern Baltic Proper ranges from 6.6 to 7.6. Bottom depths in the Baltic Proper can exceed 400 m. The open-sea sampling stations in the northern Baltic Proper are LL17 (Site 18, 59°02'N 21°08'E), LL23 (Site 19, 58°35'N 18°14'E), BY15 (Site 20, 57°19'N 20°03'E), and BY38 (Site 21, 57°07'N 17°40'E).

Seasonal and interannual trends (Figure 5.1.5)

Dinoflagellates *Scrippsiella* sp., *Biecheleria baltica*, and *Gymnodinium corollarium* are dominant spring-bloom species in the northern Baltic Proper, and cyanobacteria blooms are typical in late summer (Wasmund *et al.*, 2011).

Since the start of the monitoring programme in 1979, temperature and chlorophyll *a* have increased, whereas silicate and salinity have decreased. Cryptophytes and euglenophytes have also decreased significantly.

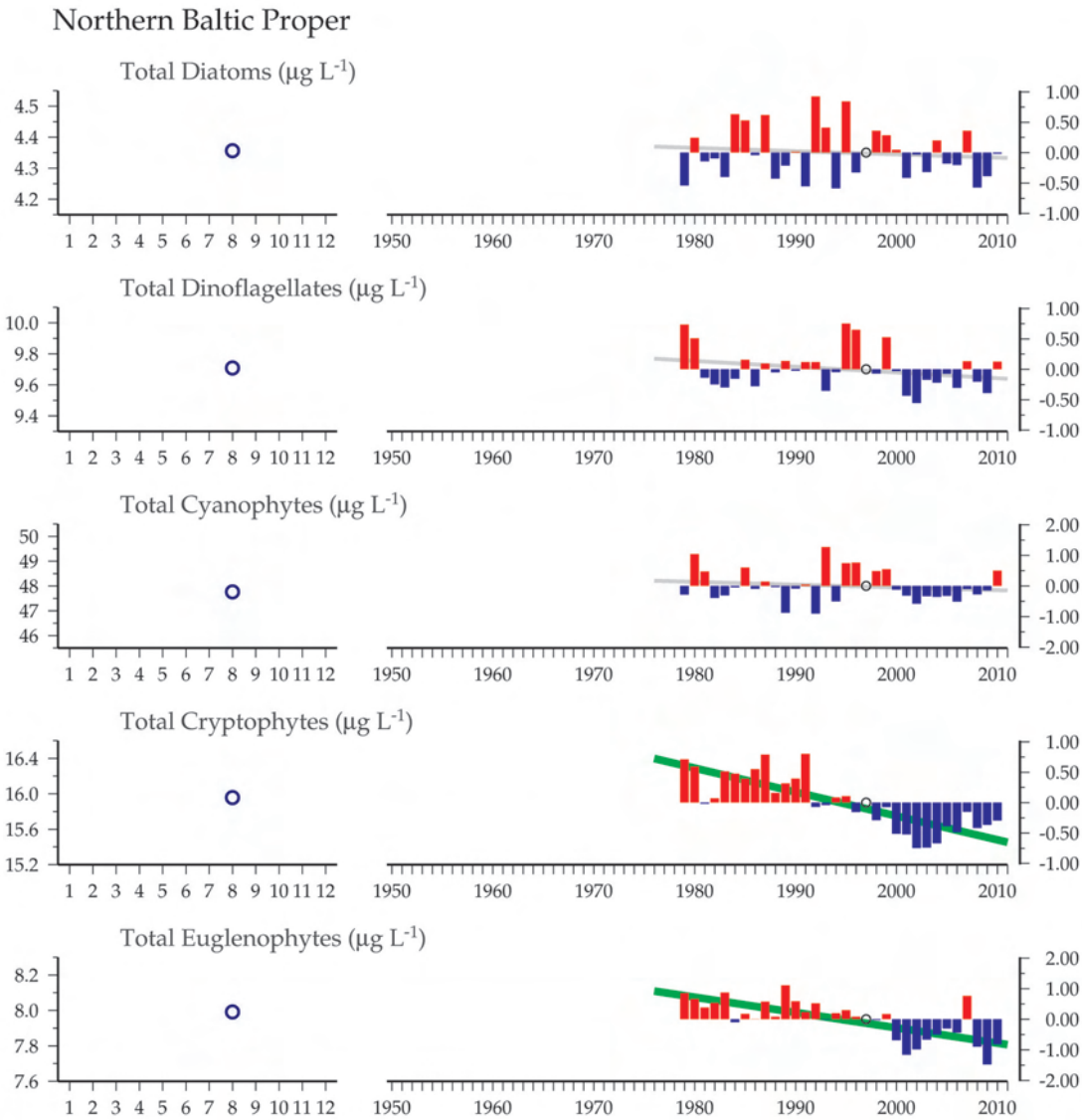
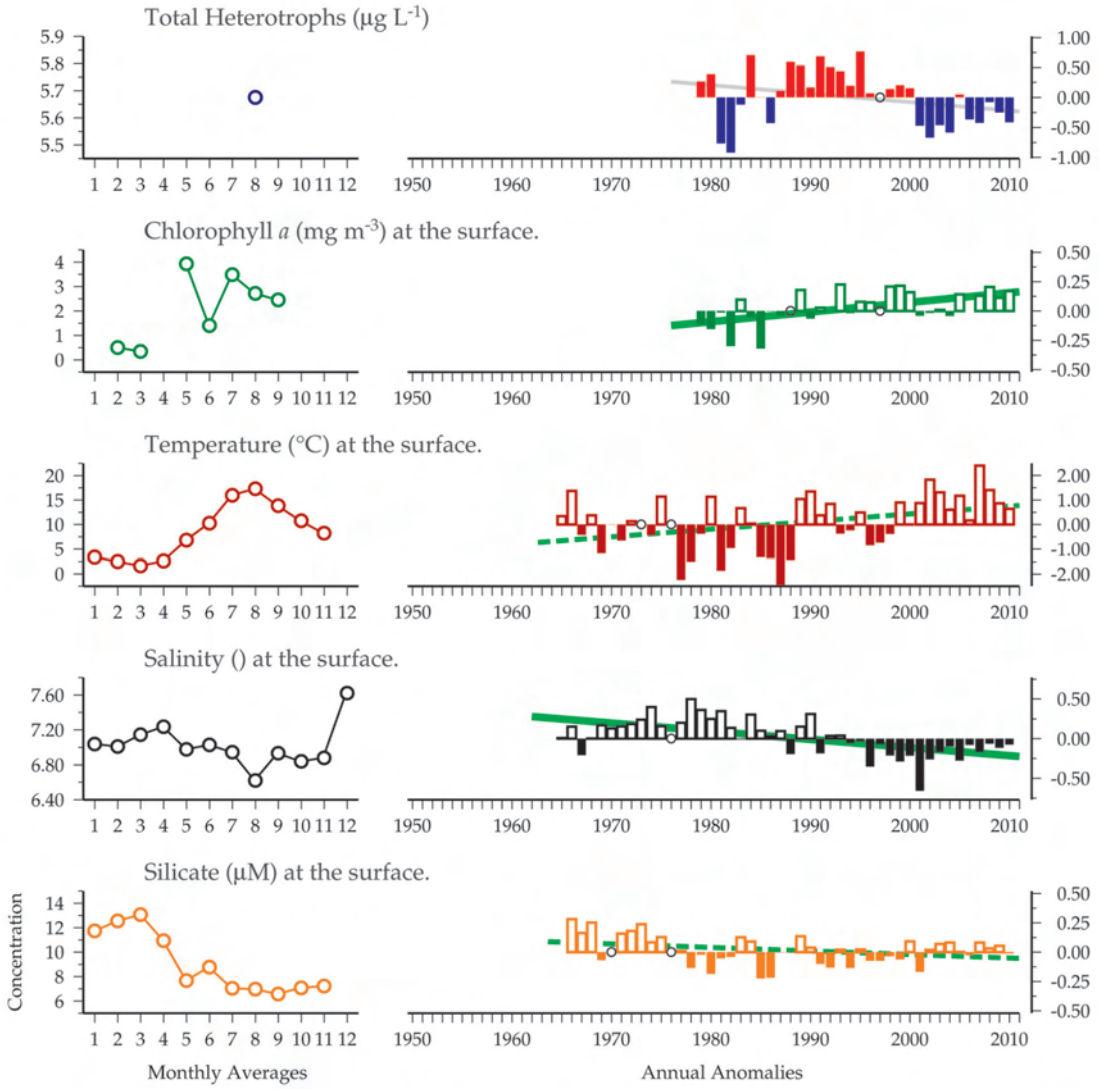


Figure 5.1.5 (continued on facing page)
Multiple-variable comparison plot (see Section 2.2.2) showing the seasonal and interannual properties of select cosampled variables at the northern Baltic Proper plankton monitoring site. Additional variables from this site are available online at http://wgpme.net/time-series.



5.1.5 Overall northern Baltic trends

Since the start of the monitoring programme in 1979, chlorophyll *a* has increased in all northern subareas. Although chlorophyll *a* has increased, the biomass of major phytoplankton groups has generally decreased based on the results of microscopic phytoplankton counts. The chlorophyll *a* increase could be the result of, for example, an increase in picoplankton, which is not included in the phytoplankton results because its analysis would require special samples that need to be counted with an epifluorescence microscope. Also, for some reason, chlorophyll *a* production may have been more efficient than in earlier years. Diatoms have decreased, especially in the Bothnian Bay and the Bothnian Sea, and dinoflagellates have also decreased significantly in all subareas except the northern Baltic Proper. In this long-term data from August, the diatoms:diatoms+dinoflagellates ratio did not show any trend (figure not shown), although Klais *et al.* (2011) have demonstrated that in the spring bloom, the share of dinoflagellates has generally increased in the Baltic Sea owing to the increase in dinoflagellate biomass and decrease in diatom biomass.

Cryptophytes, euglenophytes, and heterotrophic flagellates have decreased in all subareas. Chrysophytes have increased in the Bothnian Sea, and the endosymbiotic ciliate *Mesodinium rubrum* has increased in the Bothnian Sea (figure not shown, but available online). There is a possibility that *M. rubrum* has not been counted consistently from all earlier samples, which may affect the results.