Concentrations of Chlorophyll-a in the Greater North Sea and Celtic Seas

MSFD Descriptors 5: Eutrophication
MSFD Commission Criteria: 5.2: Direct effects of nutrient enrichment

OSPAR COMMISSION

Key Message Decreasing (improving) trends in chlorophyll-a concentration are found in the Sound and Skagerrak (1990–2014), and in the offshore parts of the Greater North Sea (2006-2014). There is a small upward trend (low confidence) in the offshore Celtic Seas. Elevated concentrations are found in some coastal areas

Background

OSPAR's strategic objective with regard to eutrophication is to combat eutrophication in the OSPAR Maritime Area, with the ultimate aim to achieve and maintain a healthy marine environment where anthropogenic eutrophication does not occur. Chlorophyll-a is one of a suite of five eutrophication indicators. When assessed and considered together in the OSPAR Common Procedure (Agreement 2013-08) in a multi-step method, the suite can be used to diagnose eutrophication.

Elevated levels of phytoplankton biomass can be a direct effect of nutrient enrichment. Chlorophyll-a is measured as a proxy for the (carbon) biomass of phytoplankton. An image of the OSPAR Maritime Area based on satellite data shows the spatial distribution of chlorophyll-a on a day during the phytoplankton spring bloom (April) and a day in summer (July) (**Figure 1**). The highest chlorophyll-a concentrations are found in coastal waters.
In this assessment, chlorophyll-a concentrations in various sub-areas of the Greater North Sea and the Celtic Seas are described. Temporal trends have also been analysed.

The present assessment is an intermediate step towards coherent assessment of chlorophyll-a at the level of regions and sub-regions.

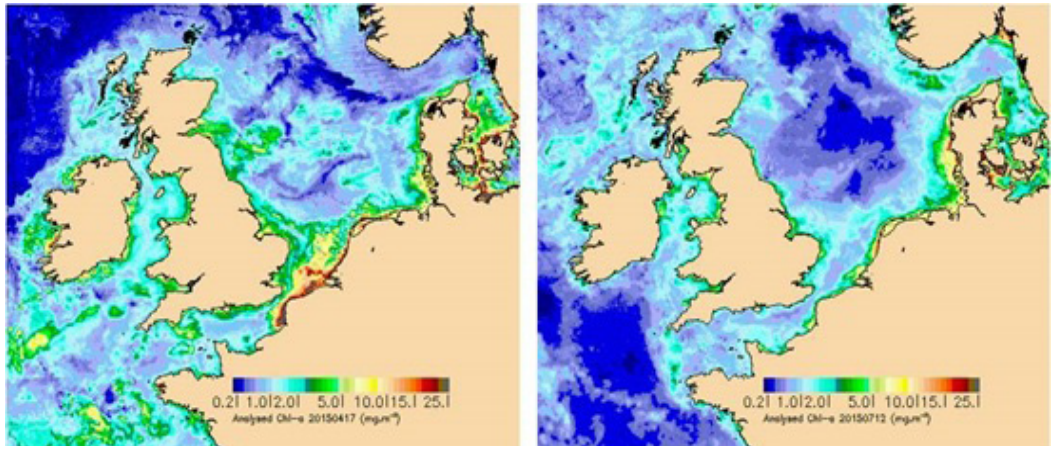


Figure 1: Satellite images of chlorophyll-a concentrations (left) on a day in April during the spring phytoplankton bloom in the North Sea and (right) on a day in July with lower summer concentrations of chlorophyll-a ©Francis Gohin, Ifremer, pers. comm.)

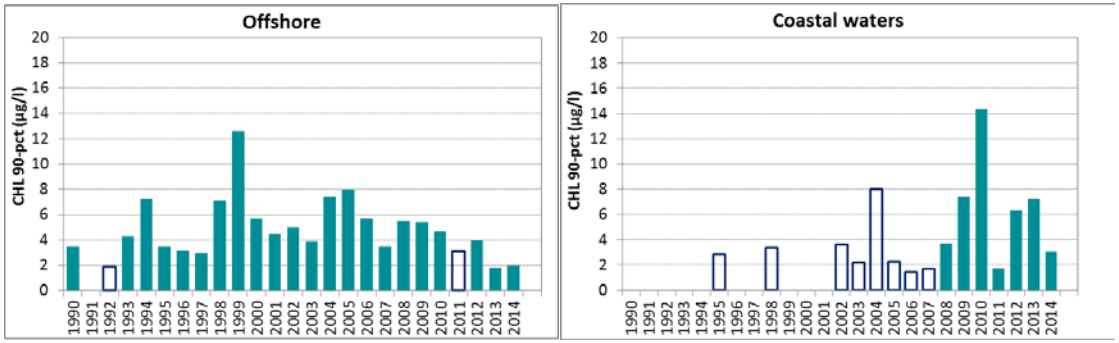
Results

In general, chlorophyll-a concentrations in coastal areas are higher than concentrations in offshore waters (**Figure 2**). Over the entire period of the assessment (1990–2014), statistically significant trends in the 90-percentile of chlorophyll-a during the growing season were downward in two areas, the Skagerrak offshore and the Sound. A statistically significant upward trend was observed in the offshore waters of the Celtic Seas, but the latter dataset contained a relatively high number of years with missing data. Also, this dataset contains data from different laboratories with different analytical methods, which may have led to a bias in the calculated 90-percentiles.

Chlorophyll-a was not assessed in the English Channel, Bay of Biscay and Iberian Coast, because data were too limited data for recent years (2004–2014).

There is high confidence in the methodology and high confidence in the data availability.

Northern North Sea



Southern North Sea

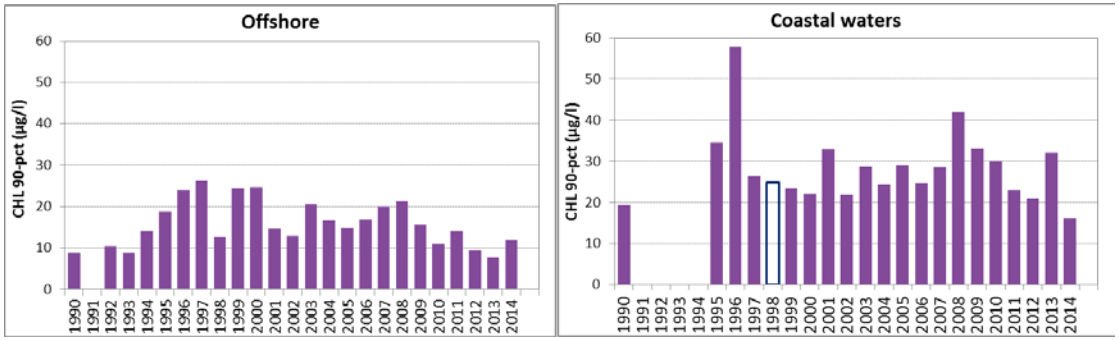
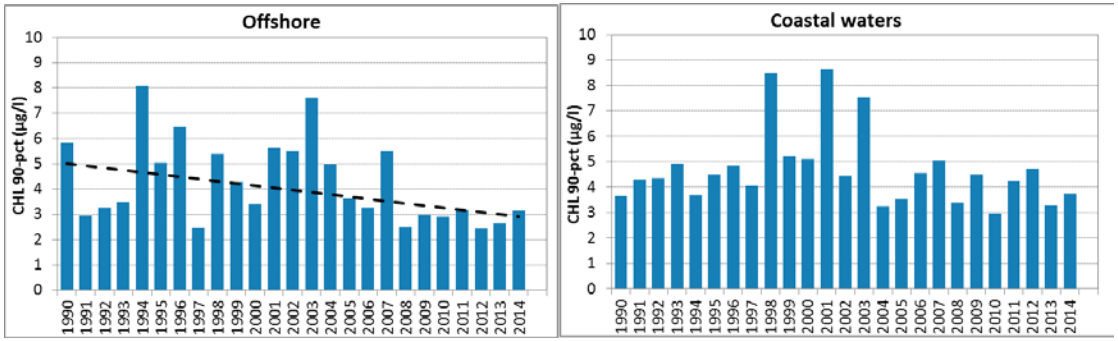


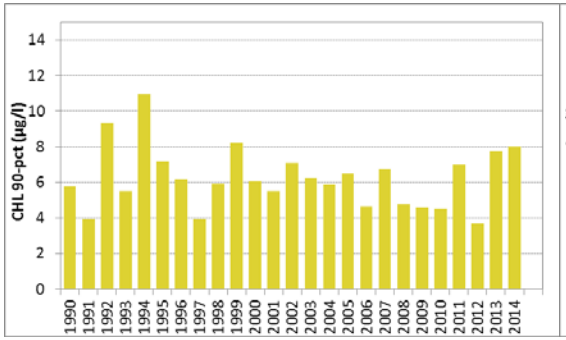
Figure 2: Continued overleaf

Concentrations of Chlorophyll-a in the Greater North Sea and Celtic Seas

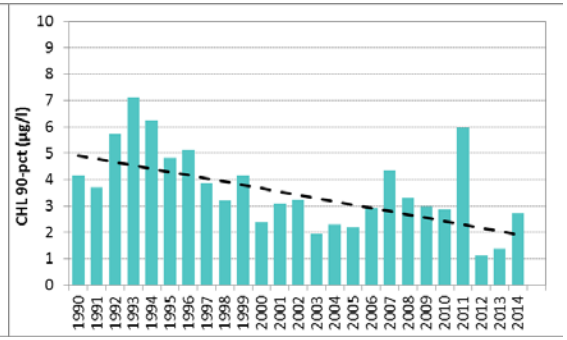
Skagerrak



Kattegat



Sound



Celtic Seas

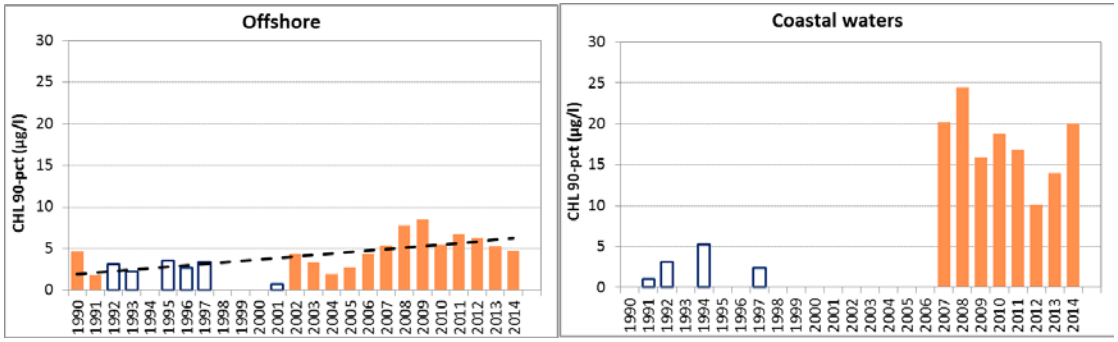


Figure 2: The 90-percentile growing season (March–September) chlorophyll-a concentrations in the OSPAR sub-areas assessed: northern and southern North Sea and Celtic Seas offshore (salinity ≥30) and the coastal salinity zone (salinity 18 to <30); Skagerrak offshore (salinity >27) and the coastal salinity zone (salinity ≤27); the Kattegat and the Sound. Coloured bars = years with at least five months of observations; white bars = years with three or four months of observations. The dashed line = statistically significant linear trend ($p<0.05$)

Conclusion

Chlorophyll-a concentrations are higher in coastal waters than in offshore waters. The highest concentrations are observed along the continental coast of the southern North Sea.
Over the assessment period (1990–2014), statistically significant trends in chlorophyll-a concentration during the growing season were downward in two areas, the Skagerrak and the Sound. A significant upward trend was observed in the offshore waters of the Celtic Seas, but there are years of missing data. In other areas, there were no significant trends over the years 1990–2014. Over the period 2006–2014, statistically significant downward trends were observed in the offshore parts of the southern and northern North Sea.

In coastal and marine systems a direct relation between nutrient inputs and concentrations on the one hand, and chlorophyll-a concentrations on the other, cannot always be observed. This is due to time lags and to factors other than nutrients that influence growth and loss of phytoplankton biomass (such as light conditions, grazing, shifts in species composition, and transport processes), and the often large spatial and interannual variability in growth conditions within the areas assessed.

Knowledge Gaps

Analytical methods for chlorophyll-a and monitoring design differ between countries, hampering comparability of the monitoring results.

Satellite remote sensing is another method for measuring chlorophyll-a across the entire OSPAR Maritime Area, because it provides a common data source and offers a solution for data scarcity in many areas. Work has commenced to investigate how this can be applied and organised in the North Sea, including in situ validation of satellite data and guidelines for harmonised sampling and analysis.

The current assessment uses large-scale assessment areas, where spatial heterogeneity hampers trend detection, highlighting the need for finer-scale spatial assessment.

This document was published as part of OSPAR's 2017 Intermediate Assessment.
The full assessment can be found at www.ospar.org/assessments