# The history and future perspectives of Baltic Sea Eutrophication

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## Abstract

This presentation illustrates the past and present situation in the Baltic Sea with an outlook on future development. The semi-enclosed and highly stratified Baltic Sea has intermittently experienced anoxic conditions in the bottom water, however, they have greatly increased in the past decades. Reasons are clearly related to nutrient input from nitrogen-fixing cyanobacteria and river loads that fuel a vicious cycle promoting surface water blooms and deoxygenation. Ecological status is believed to deteriorate with climate change due to warming and enhanced stratification but the Baltic Sea can still recover with appropriate measures for reducing nutrient inputs.

Keywords: eutrophication, hypoxia, nutrients, dead zones, Baltic Sea,

## 1. History of eutrophication and current understanding of the problem

The Baltic Sea has experienced high waterborne nutrient inputs from point and diffusive sources in the catchment area as well as nitrogen in atmospheric deposition. Inputs increased until the 1980s, thereafter significantly reduced. Nitrogen and phosphorus inputs are the main cause stimulating excessive phytoplankton blooms and consequently oxygen depletion. The riparian states cooperating under the HELCOM umbrella have adopted the Baltic Sea Action Plan that aims to restore good ecological status of the marine environment by 2021. However, the legacy of nutrients in the sediments and in anoxic waters makes recovery time much longer. The reasons are complex and related to biogeochemical and physical transport processes in the system (Fig. 1, Vahtera et al. 2007). Coastal waters fulfill an important filter function for land-derived nutrients, but anoxia can counteract this important ecological function.

## 2. The future of the Baltic Sea under a rapidly changing climate

Observations and models both document rapidly changing environmental conditions for the Baltic Sea, in particular rapidly rising temperatures by up to 4°C that cause further declines in oxygen supply, enhance respiration, extend the growth period for plankton and likely supports toxic phytoplankton blooms. These effects are further enhanced by continued high nutrient inputs from rivers and higher internal nutrient turnover. Measures to relieve nutrient loading will still lead to decreasing pressure from eutrophication and make the sensitive ecosystem more resilient to climate change.

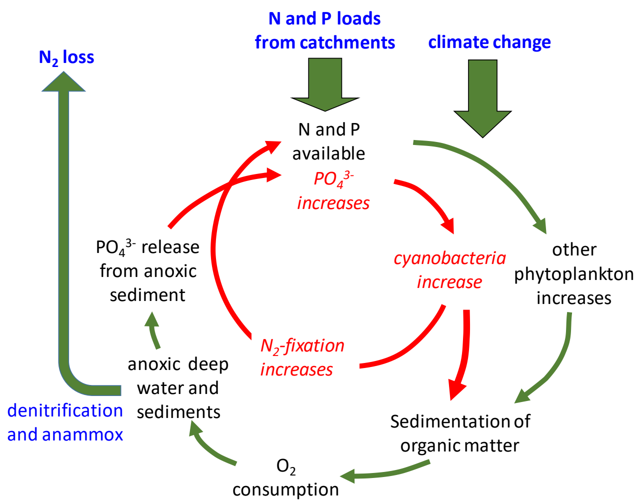


Figure 1. The vicious cycle linking eutrophication with blooms of cyanobacteria and oxygen depletion (after Vahtera et al. 2007)

Vahtera, E., D. J. Conley, B. G. Gustafsson, et al. 2007. Internal ecosystem feedbacks enhance nitrogen-fixing cyanobacteria blooms and complicate management in the Baltic Sea. AMBIO **36**:186-194.