Ecological regulation in the Elbe estuary - changes of the riverine load restores the oxygen budget and the planktonic food web

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Estuarine ecosystems are controlled by a multitude of factors, each influencing the other. Abiotic factors like temperature, light, nutrients, and salinity play a large part in the control of growth, distribution, and abundance of estuarine populations at the base of the food chain, such as microbes and phytoplankton. Every part of the complex web of biotic and abiotic factors fits together to make a system that is resilient to external changes.

In the Elbe Estuary, the water quality of the extended freshwater region is mainly driven by the input from the river. As a consequence of changes of the political situation in central Europe at the end of the last century, the loading of the estuary had dramatically altered. Before 1990, the river water quality was dominated by organic carbon from municipal and industrial wastewater inputs while nowadays organic carbon derived from riverine primary production is dominating. In parallel, nutrient and heavy metal loads have been clearly diminished. We show and analyse the changes of the oxygen content in the Elbe Estuary during the last four decades and relate them to the altered riverine load.

The results of a Mann-Kendall Trendtest prove a positive trend in the oxygen concentrations during the last decades with a breakpoint during the years 1991-1993. Beside, we also use the Kendall rang correlation coefficient to investigate the influence of the variability of the river discharge on the oxygen content of the estuary. The changes have led to an improvement of the abiotic habitat quality and thus to high chlorophyll and zooplankton densities in the upper section of the estuary. Thereby the spawning habitat of the twait shad (*Alosa fallax*) located at the lower end of the freshwater region has been partly restored and the food basis of the fish larvae and juveniles has been widened.