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A 20-year time series of Baltic Sea benthic phosphorus fluxes: a long term and system-scale view on the anoxia-eutrophication feedback

ASTRID HYLÉN[1], SEBASTIAAN VAN DE VELDE[2,3], ELIN ALMROTH-ROSELL[4], MIKHAIL KONONETS[1] AND **PER O. J. HALL**[1]

[1]University of Gothenburg
[2]Université Libre de Bruxelles
[3]Royal Belgian Institute of Natural Sciences
[4]Swedish Meteorological and Hydrological Institute

Presenting Author: per.hall@marine.gu.se

Phosphorus (P) is a key nutrient for marine primary productivity. High P concentrations are responsible for coastal eutrophication and hypoxia. Because P is preferentially released from marine sediments in oxygen-depleted conditions, a positive feedback exists between anoxia and P eutrophication. This feedback works over multi-year timescales; long-term studies are thus critical to understanding the tight link between oxygen and P, and ultimately to help us mitigate the risks of deoxygenation. The Baltic Sea is a prime example of a coastal system where this anoxia-eutrophication feedback has led to an expanding anoxic area since the 1950's. Because the Baltic Sea comprises of several subbasins that differ in environmental parameters (salinity, organic matter deposition, iron oxide loading), it also provides a unique case study to investigate the relation between anoxia and benthic P recycling under different environmental conditions.

Here we present data of *in situ* sediment-water flux measurements and sediment core investigations from 30 stations covering all of the Baltic sub-basins, sampled over 20 years. We combine this with data from previous studies and monitoring to investigate the role of water column oxygenation on the sedimentary P cycling. We find that the DIP efflux increases with water depth, suggesting shuttling of particulate P from shallow to deep areas. Transient reoxygenation of the sediment temporarily increases the sedimentary P content, confirming an important role of iron oxides in the short-term retention of P in the sediment. However, due to low formation of authigenic P minerals, this transient sink is not efficiently transferred into a stable, long-term burial form. This is corroborated by sediment cores that show a shift to higher sedimentary C:P ratios after the onset of eutrophication and anoxia, but no considerable change in total P concentrations – indicating no substantial change in P burial when shifting from oxic to anoxic conditions. Overall, our results indicate that an important difference exists between short-term sedimentary storage of P and long-term burial of P, which should be considered in mitigation activities.