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A mechanism by which the Baltic Sea may restore itself from eutrophication caused by P released from sediments during anoxia

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The finding that anoxic periods may terminate spontaneously demonstrates that the Baltic proper possesses a mechanism to restore itself from eutrophication due to anoxia, and a high-resolution study of sediment core data shows that terminations of anoxic periods have been rapid (Jilbert and Slomp, Geology, 41(11), 2013). This natural mechanism of self-restoration from eutrophication has not earlier caught much interest in the Baltic Sea literature. The crucial quality of a restoration mechanism should be that it may shut off the internal P source during a sufficiently long time TR during which the P content in the water column will decrease and approach a new equilibrium concentration determined by the P supply by external sources and the Kattegat inflow. Here TR is the inherent, system specific, time of restoration estimated by an appropriate model to be in the range 10-15 years for the Baltic proper.

Oxygenation of deep bottoms may shut off the internal P source. This may occur in the Baltic proper if the well oxygenated surface layer expands vertically. Such an episode occurred in the period 1985 – 1992 when the top of the halocline sank to 100 m from its usual depth at 60 m. The depth of the surface layer, defined by the top of the halocline, is determined by a balance between the negative buoyancy supply to the deepwater by new deepwater from Kattegat and the buoyancy removal by erosion of deepwater during vertical convection in the surface layer in autumn and winter. The halocline may sink if the salinity of new deepwater from the entrance area is low during an extended period. The deepwater volume then decreases and the surface layer expands vertically. It is suggested that a large-amplitude vertical expansion of the surface layer of duration comparable to TR provides a mechanism of self-restoration. Due to the huge variability of the salinity of new deepwater such periods are likely but should be rare. A model to estimate the return time of such periods has been developed. Based on inflow statistics estimated from sea level records, the return time of periods of self-restoration is estimated to 500 - 1000 years.