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The Baltic proper eutrophication - a runaway system that passed the tipping point at the end of the 1950s

Anders Stigebrandt

University of Gothenburg, Marine Sciences, Gothenburg, Sweden (anders.stigebrandt@marine.gu.se)

The magnitude of the annual biological production in the Baltic proper is determined by the phosphorus (P) concentration C in the surface layer in winter. C is proportional to the total P supply TPS to the water column. TPS has three components; the land-based supply LPS ; the ocean supply OPS ; and the internal supply IPS from anoxic bottoms. The OPS is minor. The land-based P source, LPS , culminated in the 1980s and at present it has about the same value as in the early 1950s. Despite this, C still increases, and the present time C is at least 3 times higher than C in the 1950s. This runaway evolution of the Baltic proper P content demonstrates that the evolution of C cannot be explained only by the evolution of the external sources LPS and OPS . The runaway behaviour suggests that there is a positive feedback between the state C and the supply TPS . It is shown that the internal P-supply IPS provides such a positive feedback via its dependence on the area of anoxic bottoms A_{anox} , because IPS is proportional to A_{anox} and A_{anox} is proportional to C so that IPS is proportional to C . The internal supply IPS thus increases with C if there are anoxic bottoms. Anoxic bottoms start to occur when C passes the threshold value C_t which occurs when TPS passes the threshold value TPS_t . This happened in the Baltic proper at the end of the 1950s. A time-dependent P model describes the evolution of C in the Baltic proper from 1950 to the present quite well.