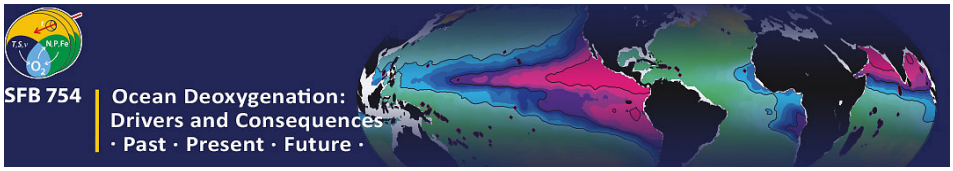

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Efficient removal of nitrogen and phosphorus in a eutrophic coastal system recovering from hypoxia

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Increased anthropogenic inputs of nitrogen and phosphorus from land have led to eutrophication of marine environments worldwide. Coastal systems can reduce the flux of nutrients from land to the open sea, thereby acting as a coastal filter. The key processes that remove nitrogen and phosphorus in coastal areas are denitrification and phosphorus burial [1]. Recent modeling of nutrient dynamics in the Stockholm Archipelago, which is a eutrophic coastal system that is recovering from hypoxia, suggests that at least 72% of the nitrogen input and 62% of the phosphorus input from land is retained in the archipelago [2]. This is a more efficient removal of nutrients than on average for coastal environments in the Baltic Sea, where typically only 16% of nitrogen and 53% of phosphorus is retained [1].
Here, we assess the benthic processes controlling this efficient removal of nitrogen and phosphorus in the Stockholm Archipelago. Based on data for 4 locations, we demonstrate that, similar to model predictions [2], area-specific rates of nitrogen removal due to benthic denitrification are highest in the inner archipelago and decrease towards the open sea. The recycling of N through DNRA and production of N2 by anammox play only minor roles (generally <1% nitrate reduction) throughout the archipelago. Significant contributions of anammox to N2 production (>30%) are found only at the outer archipelago site where overall N2 production is lowest. Rates of phosphorus burial in the archipelago are high due to the combined effect of high concentrations of phosphorus in the sediment and high rates of sediment accumulation. Most of the phosphorus is buried in the form of organic matter. Inorganic forms of phosphorus act as both a temporary and permanent sink for phosphorus. We will discuss the potential future trends in nitrogen and phosphorus removal in the archipelago, the link with changes in bottom water hypoxia, and the potential role of import of nutrients from the open Baltic.

[1] Asmala, E., Carstensen, J., Conley, D.J., Slomp, C.P., Stadmark, J., and Voss, M. (2017). Efficiency of the coastal filter: Nitrogen and phosphorus removal in the Baltic Sea. Limnology and Oceanography 62(S1).

[2] Almroth-Rosell, E., Edman, M., Eilola, K., Meier, H.M., and Sahlberg, J. (2016). Modelling nutrient retention in the coastal zone of an eutrophic sea. Biogeosciences, 13(20), 5753.

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