SEASONAL BENTHIC NITROGEN CYCLING IN A BALTIC SEA ESTUARY

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Motivation and Goals

The Baltic Sea has a long history of anthropogenic eutrophication and bottom water anoxia. In the past 10 years, bottom water anoxia have further expanded and now not only include the central deep basins, but also parts of the coastal zone. In order to understand the drivers behind the spreading anoxia, more data on the benthic nitrogen cycling processes are urgently needed.

The aim of this study is to quantify the seasonal variability of nitrification/denitrification/anammox rates in a coastal system with an established eutrophication gradient and periodic bottom water hypoxia.

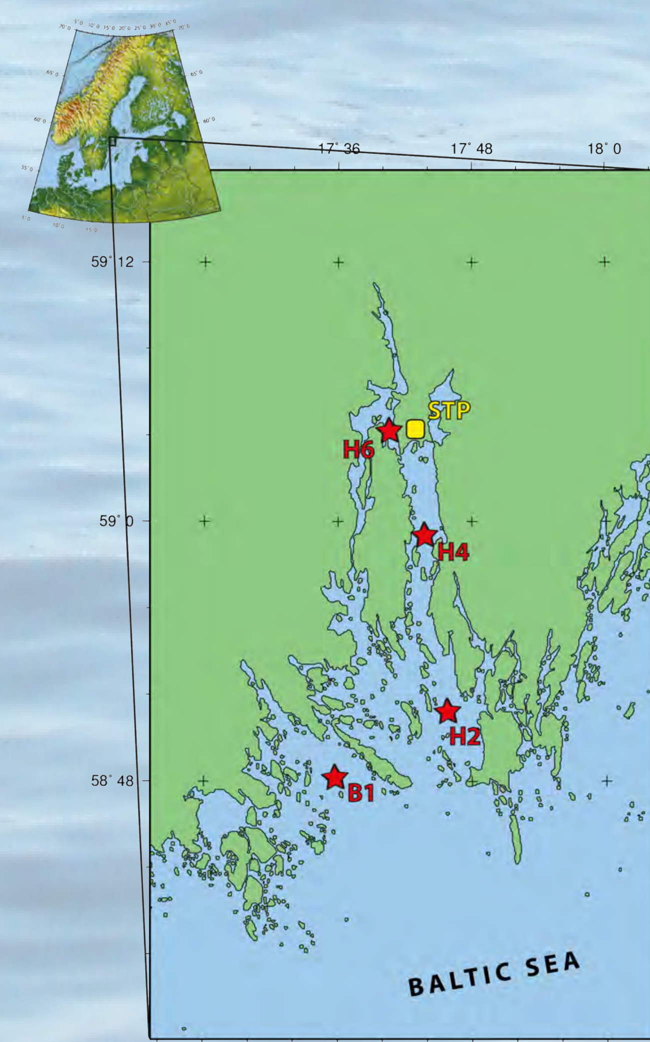
	Depth (m)	T (°C)	Salinity (‰)	O_2 (µM)	NO_3^- (µM)
B1	40	1.5-5.6	7.0-7.3	139.7-387.5	0.8-5.2
H2	32	4.2-5.1	6.4-7.1	223.4-375	0.9-2.8
H4	31	1.6-6.8	6.5-6.9	186.9-347.5	0.7-6.3
H6	40	1.6-7.9	6.4-6.6	54.7-365.6	2.4-8.7

Ranges of measured bottom water features during the sampling campaigns (May 2011-January 2012). Sampling was not performed at station H6 in May and at station H2 in May and January.

Activities

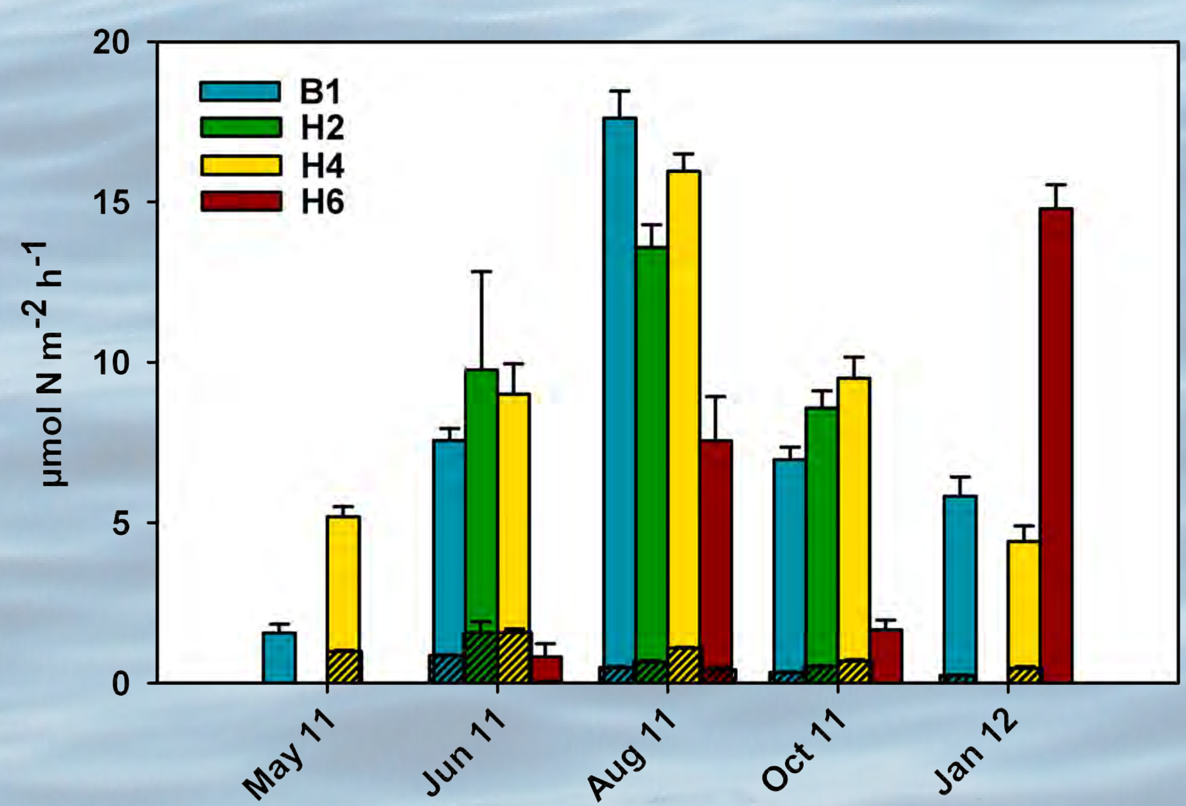
› Quantification of nutrient and O_2 fluxes using intact core incubations

› Measurements of oxygen microelectrode profiles, and denitrification and anammox rates in core and slurry incubations at different concentrations using ^{15}N-labeled nitrate and ammonium

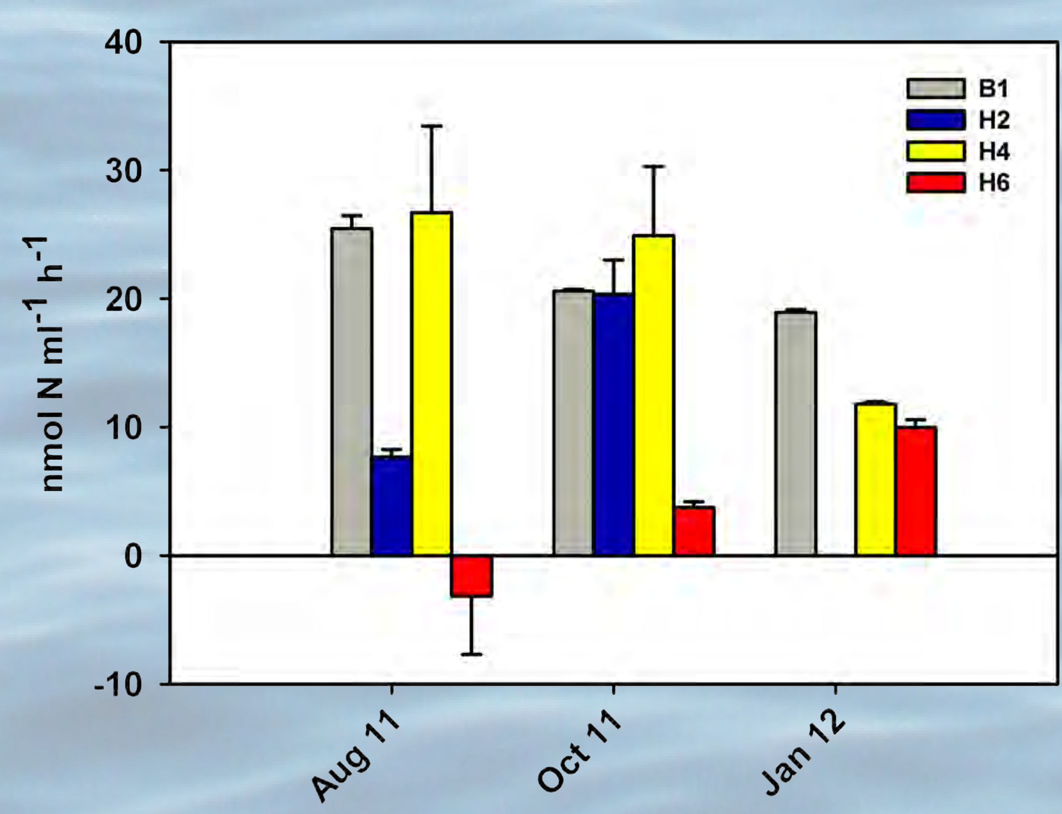


Map of Himmerfjärden estuary showing the four sampling stations (red stars) and the location of the sewage treatment plant (STP, yellow rectangle).

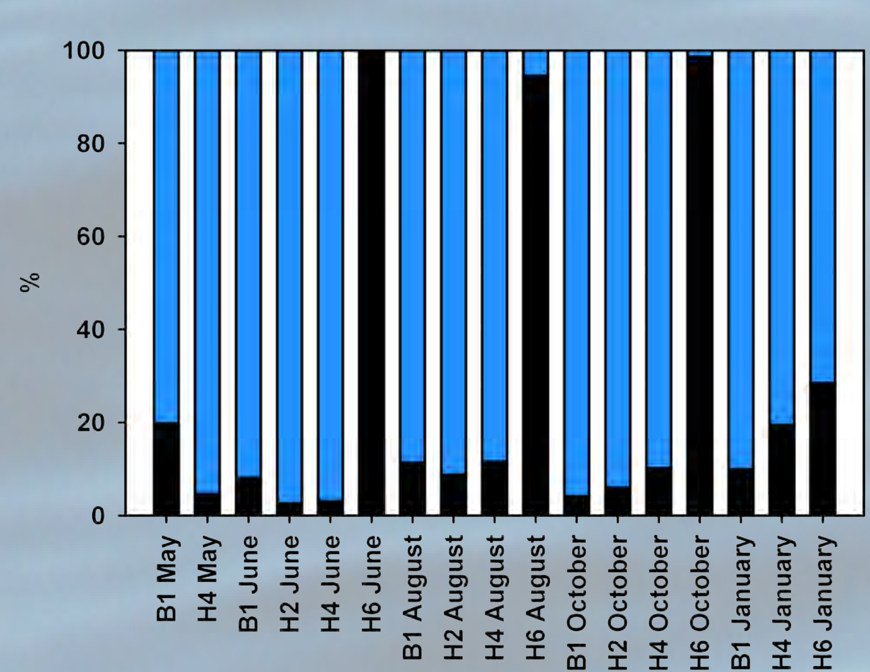
Results



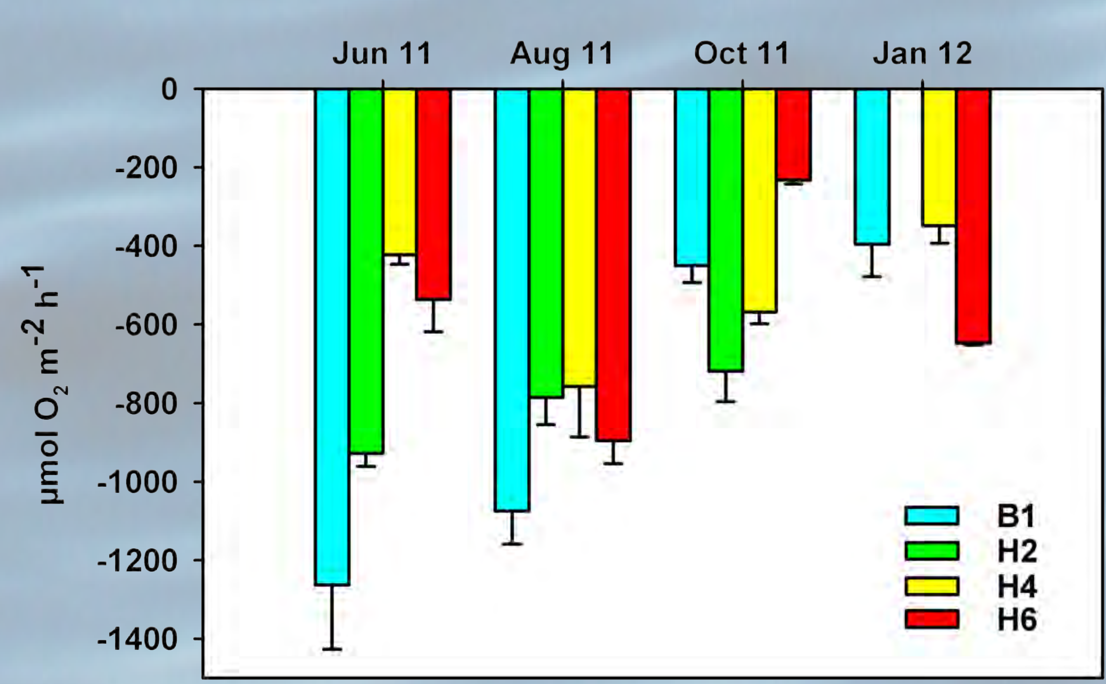
Total N_2 production measured with r-IPT (mean ± SE, n=12). Shaded bars represent anammox rates while couloured bars without pattern represent denitrification rates.



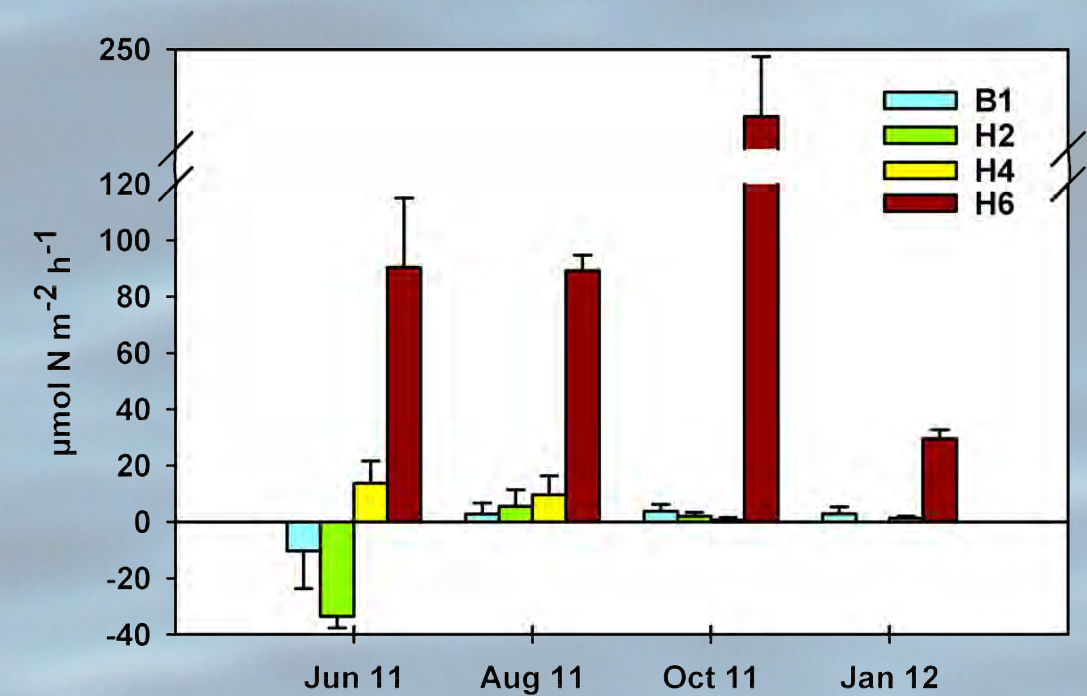
Potential nitrification rates (mean ± SE, n=6).



Contribution (%) to total N_2 production of Dn (blue bars) and Dw (black bars) (mean ± SE, n=12).



Sediment oxygen uptake (mean ± SE, n=4)



Benthic fluxes of ammonium (mean ± SE, n=4)

Conclusions and Implications for the Environment

- Strong temperature dependence of denitrification rates
- Tight nitrification/denitrification couple: Himmerfjärden sediments are neither a strong sink of water column nitrate nor a strong source of nitrate
- Anammox, while present, is not the dominant N_2 loss process
- 'See-saw' effect of denitrification rates
  - High organic matter loading + low temperatures: high N_2 loss
  - High organic matter loading + high temperature: low N_2 loss
  - Low organic matter loading + low temperatures: low N_2 loss
  - Low organic matter loading + high temperature: high N_2 loss
- **Temperature increase and reducing conditions can limit the transformation of fixed nitrogen into nitrogen gas and thus enhance eutrophication**
- **More *warming experiments* are urgently needed in this field of study**

Recommended literature

Bonaglia et al., 2014. *Biogeochemistry 119, 139-160.*
Conley et al., 2009. *Env. Sci.Tech. 43, 3412–3420.*
Deutsch et al., 2010. *Biogeosciences 7, 3259-3271.*
Hietanen et al., 2012. *Limnol. Oceanogr. 57, 325–337.*

Acknowledgements

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