Nitrogen cycling in coastal Gulf of Finland II:

Nitrification

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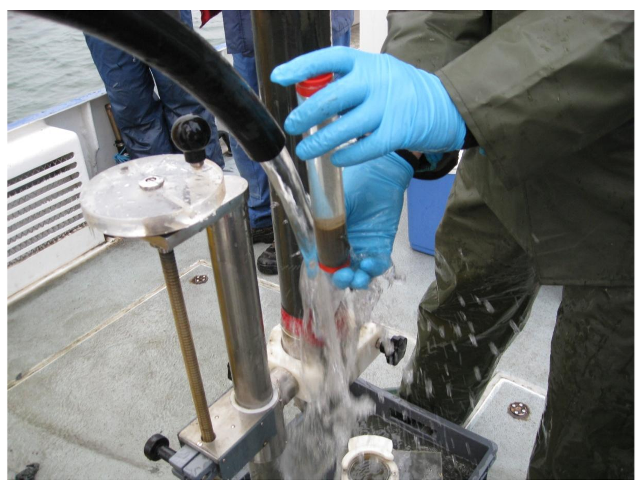
Introduction

The substrate for denitrification and anammox is produced in nitrification process where ammonia (NH_3) is oxidized to nitrite (NO_2^-) and nitrate (NO_3^-). Hence nitrification is an important factor controlling nitrogen removal. Nitrification rates are controlled by various environmental parameters, such as oxygen[1] and NH_4^+ availability[2], temperature[1,3], organic load[3,4] and salinity[1]. These parameters vary with season and the purpose of this work is to determine how the seasonal changes in the controlling parameters affect the nitrification rates.

Materials and methods:

Nitrification was estimated in two coastal Gulf of Finland sites (Storfjärden and Muncken) by using the $^{15}NH_4^+$ oxidation technique[6,7] and comparing the results to coupled nitrification-denitrification rates measured by the isotope pairing technique (IPT)[5] (see Hietanen et al.). $^{15}NH_4^+$ oxidation technique measures nitrification potential and coupling between nitrification and denitrification. It also gives information about the availability of NH_4^+ in the nitrification layer. This technique requires the measurement of $^{15}NO_3^-$, $^{29}N_2$, and $^{30}N_2$ production because nitrification is often so tightly coupled to denitrification that the ^{15}N-label from NH_4^+ is instantly transferred to NO_3^- and from there to N_2 gas. The $^{15}NO_3^-$ production was measured by using the SPINMAS technique[8] that combines an automated sample preparation unit for inorganic nitrogen species to a quadrupole mass spectrometer.



Results

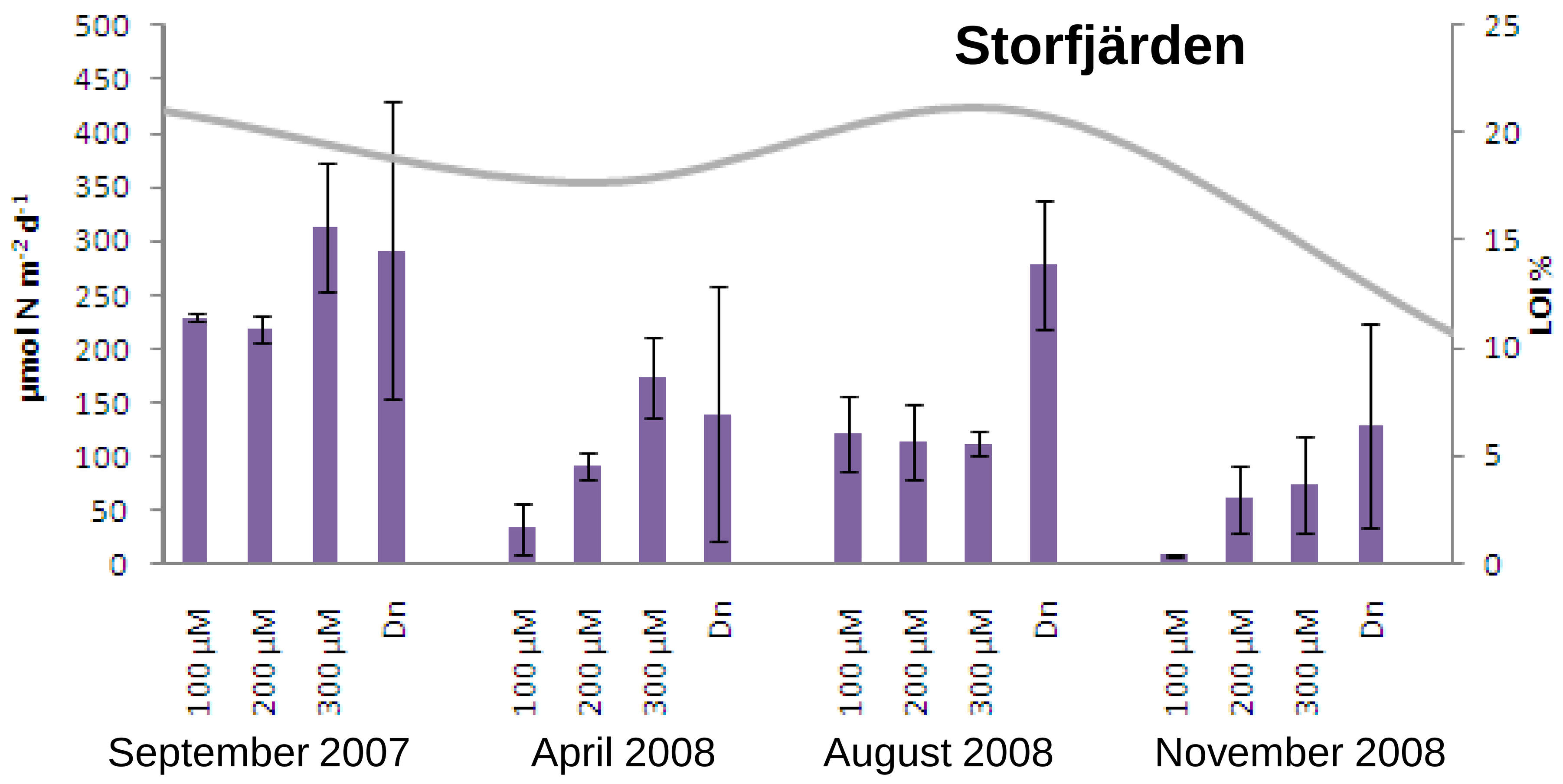


Figure 1: The amount of ^{15}N transferred to N_2 gas from different $^{15}NH_4^+$ additions (100 µM, 200 µM and 300 µM) and coupled nitrification-denitrification (Dn) rates. Dn rates are the actual nitrification rates. The line represents LOI values.

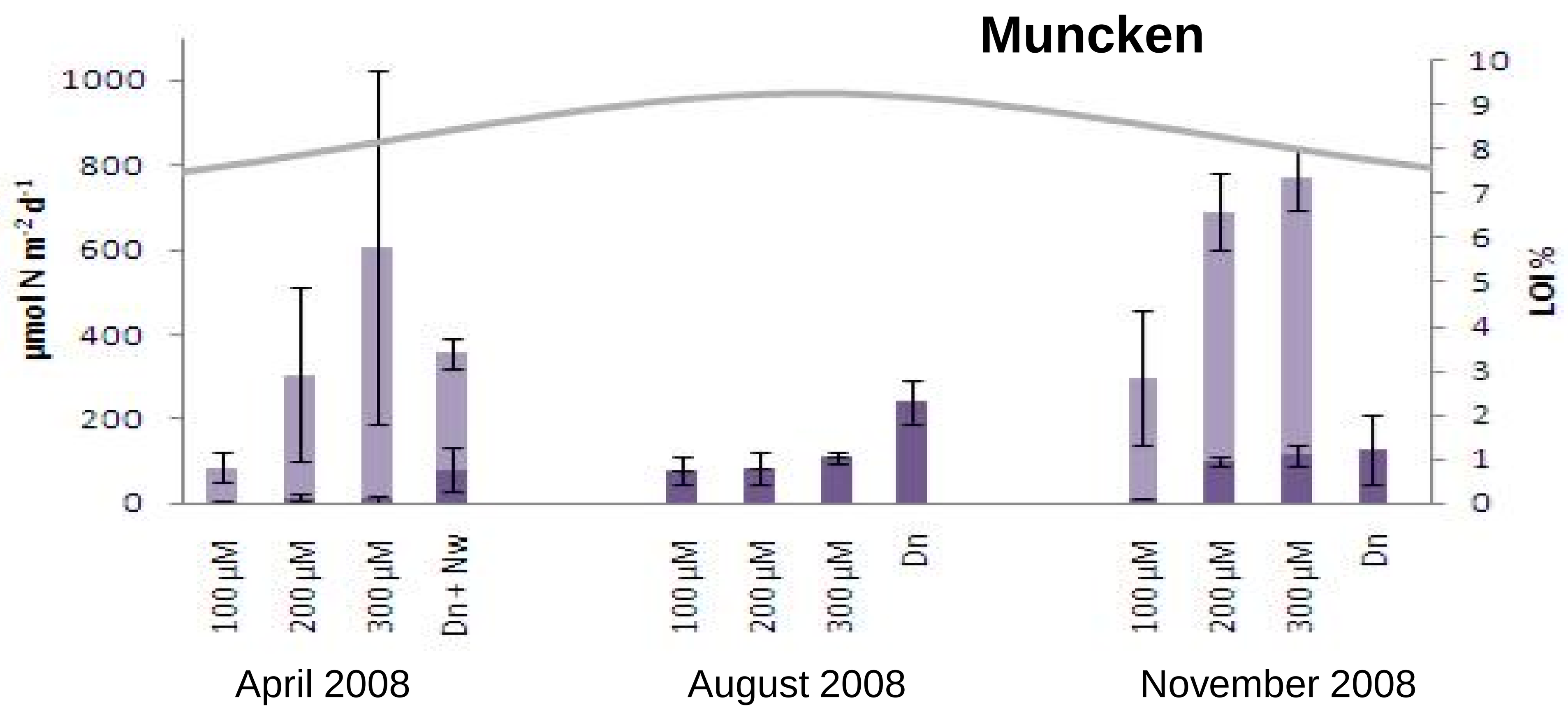


Figure 2: The amount of ^{15}N transferred to N_2 gas (dark purple bars) and NO_3^- (light purple bars) from different $^{15}NH_4^+$ additions (100 µM, 200 µM and 300 µM). Dn (dark purple bars) stands for coupled nitrification-denitrification, and Nw (light purple bar) for nitrification producing the NO_3^- to the watercolum. Dn+Nw (April), and Dn (August and November) are the actual nitrification rates. The line presents LOI values. Note the different scales from Storfjärden

Results and conclusions:

- In the deeper accumulation basin (Storfjärden), denitrification always captured all nitrate produced in nitrification. Nitrification in April was ammonia limited.
- In the more shallow area (Muncken) denitrification did not always capture all nitrate produced in nitrification and some nitrate diffused to the water column. Nitrification in April and November was ammonia limited. At the ambient ammonia availability, in April there was nitrate efflux from the sediment, and in August and November nitrate influx to the sediment.
- The difference in capability of denitrification bacteria to capture all produced nitrate between the two stations might be organic carbon limitation of denitrification bacteria in Muncken in spring and late fall. Low nitrification potentials in late summer could be caused by inhibition by organic load.

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