LEIBNIZ-INSTITUT FÜR OSTSEEFORSCHUNG WARNEMÜNDE

Input and fate of dissolved nitrogen compounds via submarine groundwater discharge into the Puck Bay (Poland)

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Diploma Thesis

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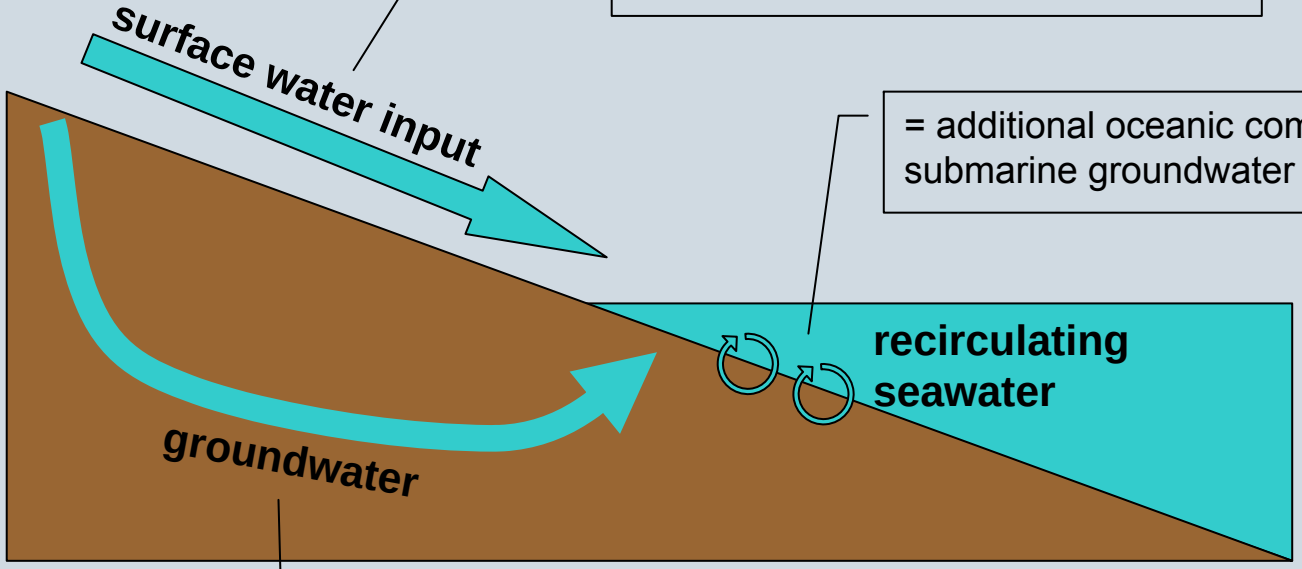
Input of terrstrial nutrients into the coastal ocean

Global river-derived nutrient inputs into the ocean have tripled since the 1970's (Smith et al. 2003)



> 10 % of the freshwater input (Burnett et al. 2006)
→Slow diffuse flow, relatively small volume
→ but: mostly much higher nutrient concentrations

Nutrient input via submarine groundwater discharge (SGD)

- volume of water discharged as SGD may be small relative to surface discharge
- increased concentration of dissolved solids compared to rain or river water
  → may be of great local importance

- ecological impact on:
  - productivity and biomass
  - species composition and distribution (Lapointe 1997)

- anthropogenic increases in groundwater nutrient concentrations
  → eutrophication (Johannes 1980)

- groundwater residence times can range from years to decades
  (Hu et al. 2006)

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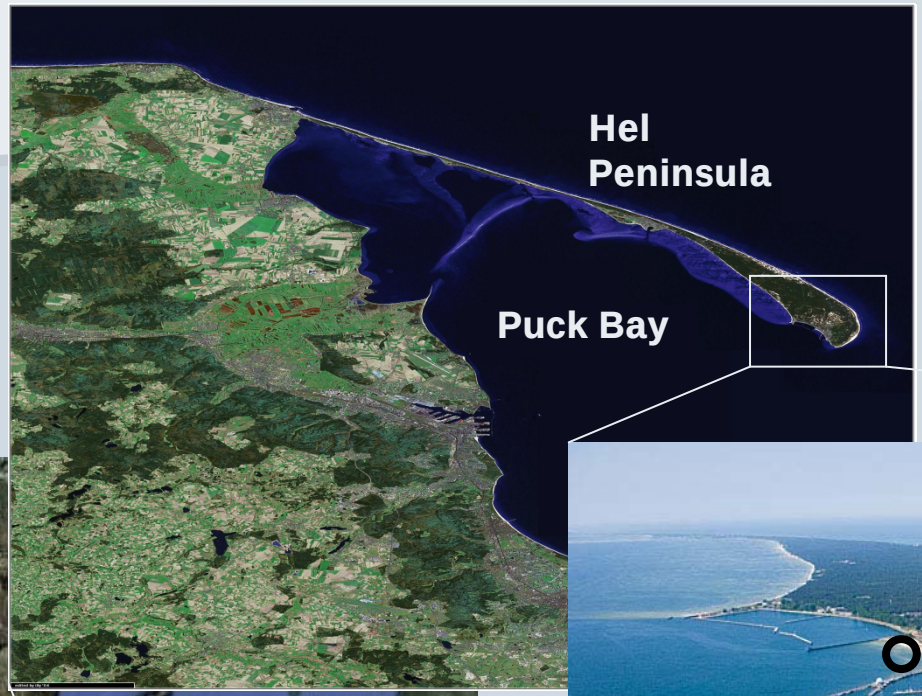
Sampling site

Hel (Poland)



Sampling campeigns

- September and November 2009
- May and October 2010

Main sampling site
Reference sampling site

SGD on Hel Peninsula

- Dominant N species in groundwater mostly nitrate (Smith et al. 2006)

- Samples from Hel peninsula during autumn 2009:
  very high ammonium concentrations (up to 5 mmol L^{-1})
  nitrate nonexistend or only in very low conentrations (max. 2 µmol L^{-1})
  high amounts of H_2S → no oxygen

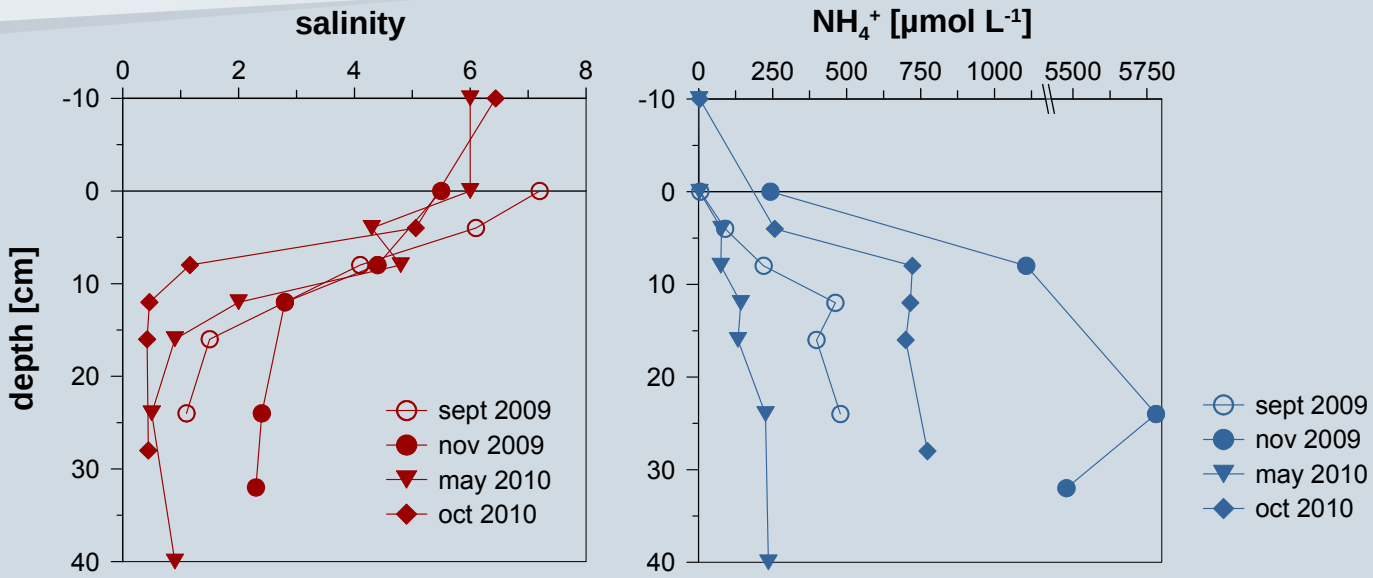
Diploma thesis

- Characterization of the spacial and seaonal N input via SGD into the Puck Bay

- Fate of dissolved N from submarine groundwater
  - Mixing and/or assimilation of ammonium ($\delta^{15}N$ signatures)
  - Tracking nitrogen from groundwater into the foodweb

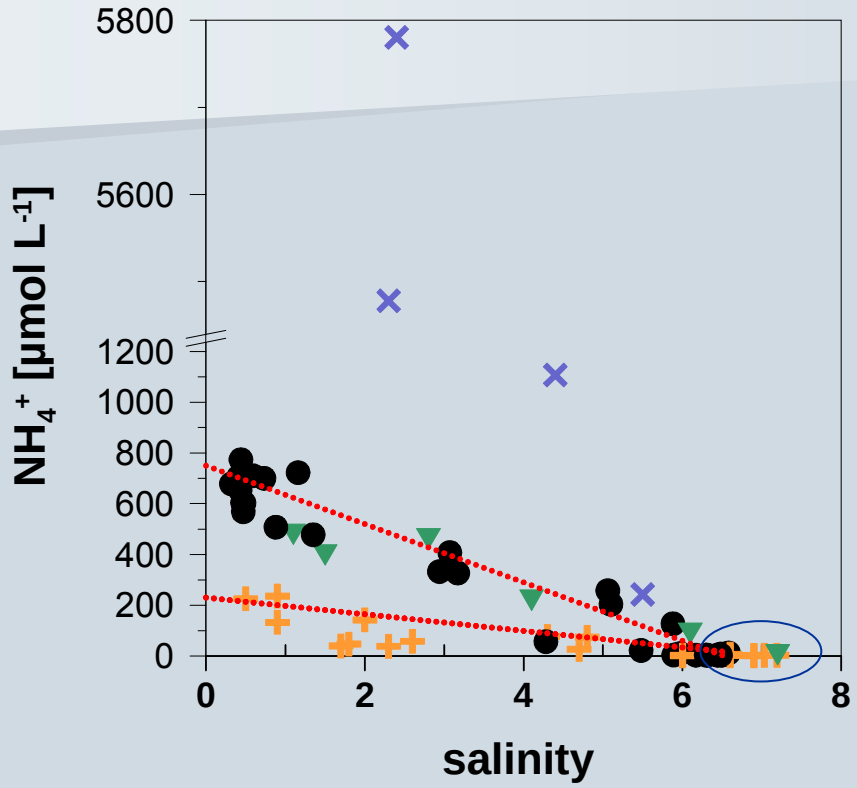
- Determination of the source of ammonium

Samples from fixed lances



- increasing NH_4^+ concentration with decreasing salinity
- highest NH_4^+ concentration during November 2009
- lowest NH_4^+ concentration during May 2010

Seasonal variability



- sept 2009
- nov 2009
- may 2010
- oct 2010
- conservative mixing
- water column

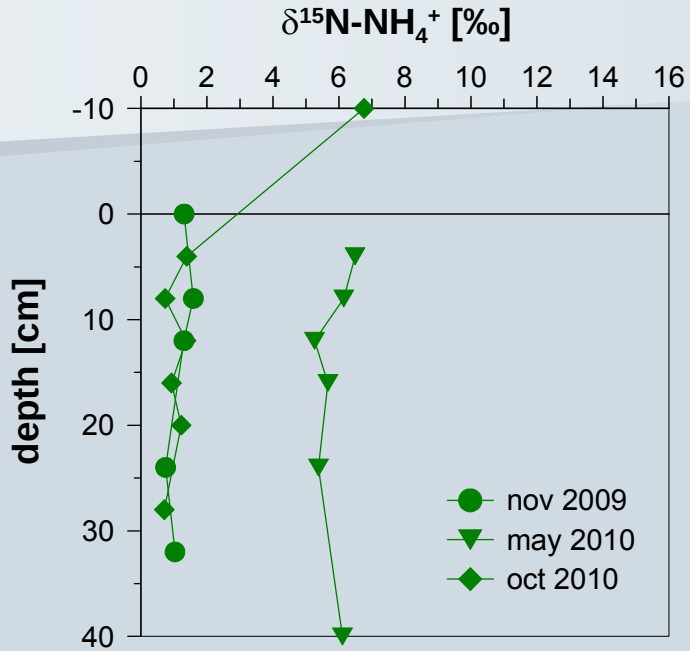
- conservative mixing
- different slopes

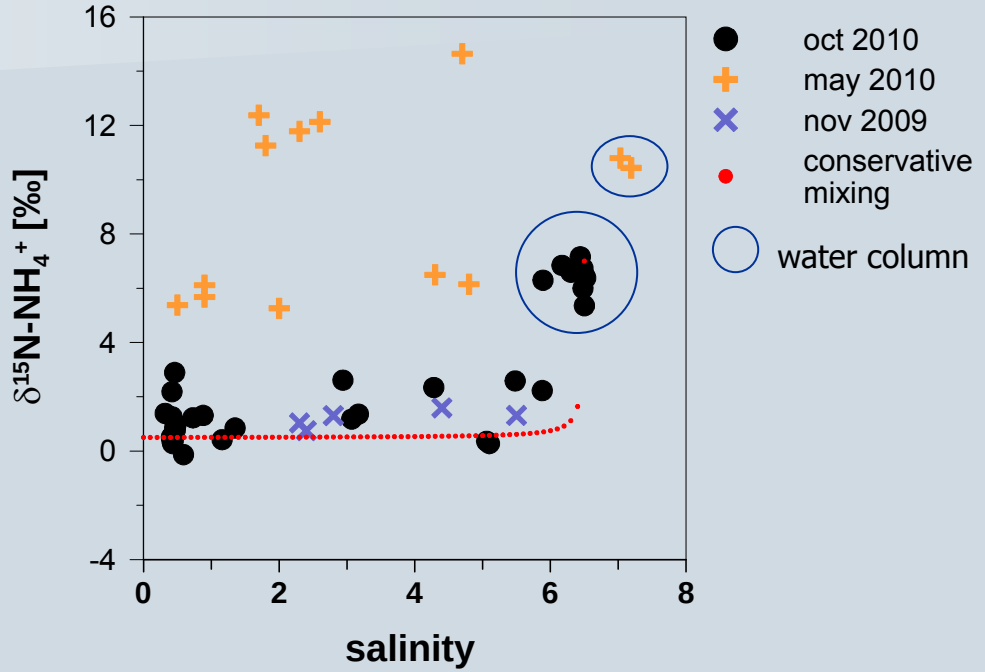
→ high variability

- May 2010: low NH_4^+ in spite of low salinity

  → rainwater influence?

Seasonal variability

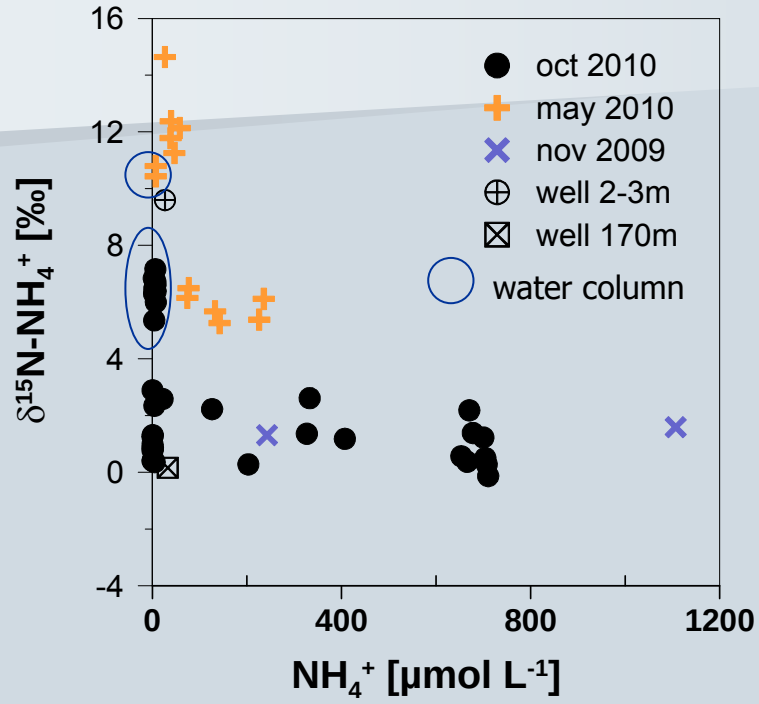




- similar $\delta^{15}N$ values within the autumn samples, in spite of different NH_4^+ concentrations
  → Conservative mixing

- higher $\delta^{15}N$ values during May 2010
  → rainwater usually low $\delta^{15}N$ values → no likely source

Groundwater source

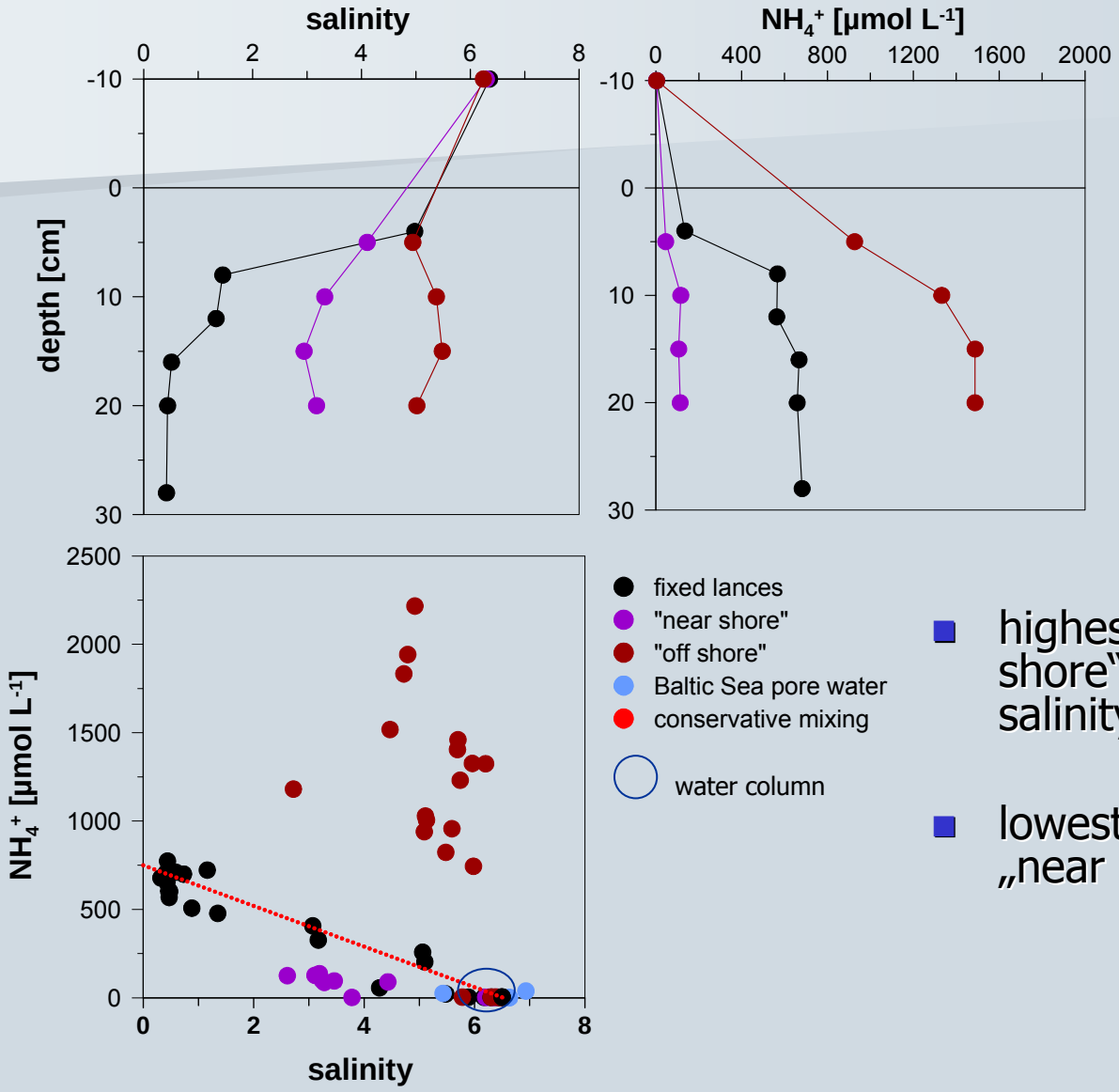


- low $\delta^{15}N$ values
  → degradation of terrestrial material
  leaf litter $\delta^{15}N$: -8 to 3‰ (Peterson & Fry, 1987)
- 170m deep well:
  → similar $\delta^{15}N$ values, but low NH_4^+ concentration
- 2-3m deep well:
  → $\delta^{15}N$ values around 10 ‰ and low NH_4^+ concentration

→ The sampled wells are not the source of the SGD

Spatial variability

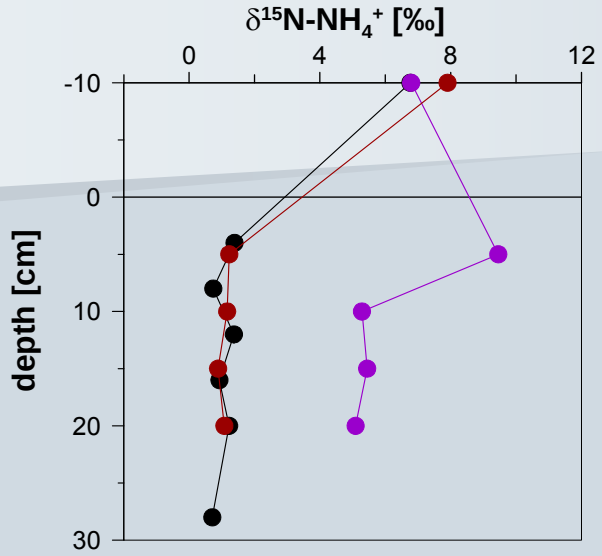
October 2010

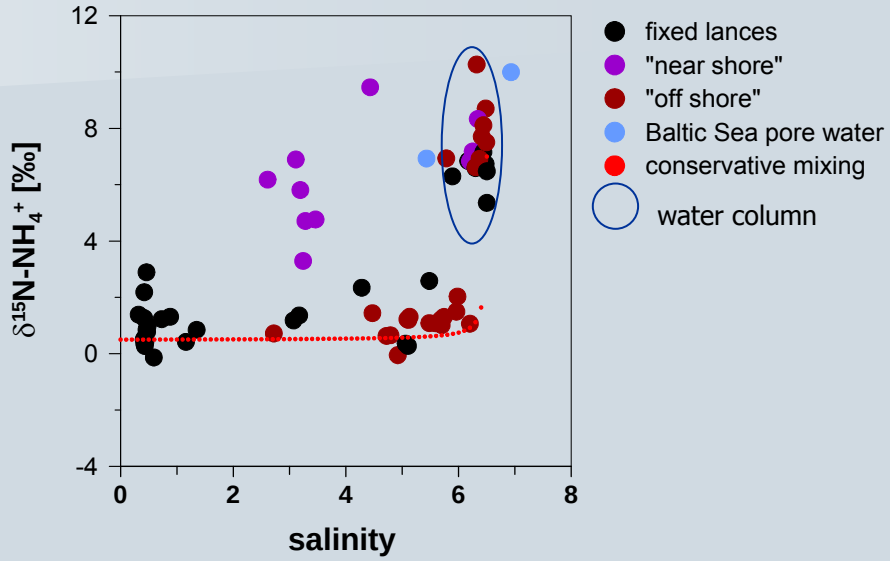


- highest NH_4^+ concentrations „off shore“ without decrease in salinity
- lowest NH_4^+ concentrations „near shore“

Spatial variability

October 2010





- samples from fixed lances and „off shore" samples show similar $\delta^{15}N$ values and conservative mixing of NH_4^+
- „near shore" samples show higher $\delta^{15}N$ values more similar to water column and Baltic Sea porewater samples
  → different source?

→ high spatial variability

Summary

- high spatial variability in salinity, NH_4^+ concentration and $\delta^{15}N$ values within the sediment

- mainly conservative mixing of NH_4^+ from groundwater into the water column

  → no processes like nitrification in the sediment

- no certain evidence for seasonality within the groundwater

  → samples during May 2010 may also show spatial variability

- low $\delta^{15}N$ values in NH_4^+ from groundwater indicate degradation of terrestrial material

→ no evidence for anthropogenic influence

Thank you!