Physical Geography
Water, Climate, Environmental Change

The Dependency of Hyporheic Nutrient Cycling on Season and Sediment Type

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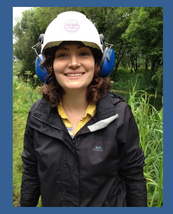

Motivation

- To investigate the factors controlling nutrient cycling in streambed sediments, particularly the hyporheic zone (HZ)

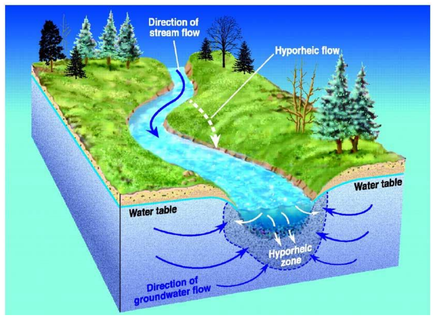

Fig 1: The hyporheic zone in streambed sediments[1].

Introduction

- Pollutants, such as nitrate and ammonium, can cause eutrophication in surface waters
- The HZ is the transition zone where surface water and groundwater mixes, increasing biogeochemical reactivity[2]
- This enables the HZ to reduce pollutant concentrations and prevent them from entering the stream

a

b

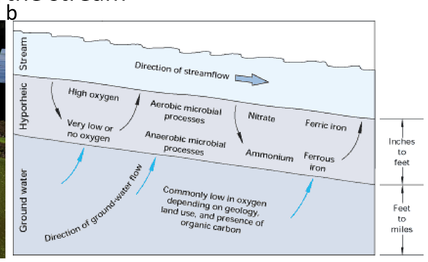

Fig 2a: Eutrophication of a river due to high nutrient concentrations, b. Processes and characteristics within the hyporheic zone, leading to increased chemical reactivity in these zones[3]

Methodology

- Samples were taken in Mill Brook, BIFoR
- Porewaters were sampled at 10 and 20 cm depth from multilevel mini-piezometers (depths typical of the HZ) and diffusive equilibrium in thin-film gels (at 0-15 cm)
- Surface water and groundwater samples were also taken
- Samples were analysed on a continuous flow analyser for NH_4 and NO_3

References

1 Alley *et al.*, 2002. Flow and Storage in Groundwater Systems. *Science,* 296, p.1985-1990.

2 Krause *et al.* 2011. Inter-disciplinary perspectives on processes in the hyporheic zone. *Ecohydrology*, 499, p.481-499.

3 Winter *et al.*, 1998. Natural Processes of Ground-water and Surface-water Interaction. In: Winter *et al.* (Eds.). 1998. *Ground Water And Surface Water A Single Resource*. U.S. Government Printing Office. Ch. 2.

Sediment and Season Impact on Nutrient Cycling in Streambed Sediments

NO_3 concentrations were:
- Greatest in the gravel bedform
- Greatest at 10 cm than 20 cm
- Influenced by season

NH_4 concentrations were:
- Greatest in the sand control reach
- Greatest at 10 cm than 20 cm
- In autumn in the sand control reach
- In autumn and winter in the sand bedform

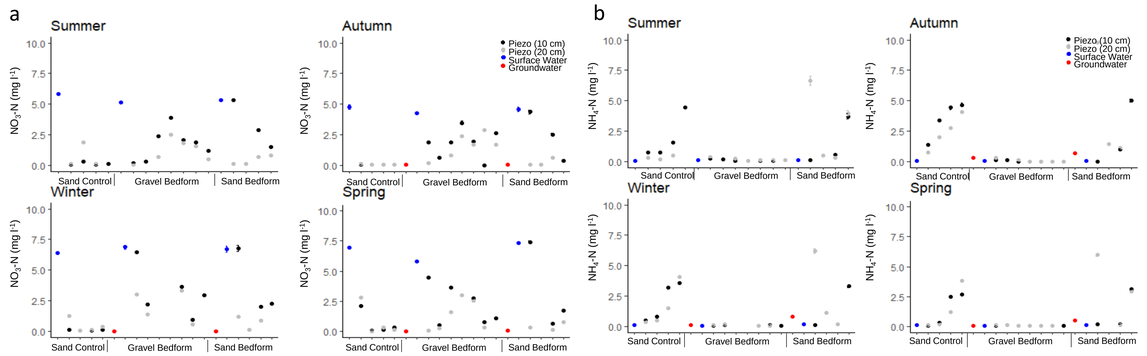

Fig 3: Nitrate (a.) and ammonium (b.) concentrations from porewaters, surface water and groundwater in Mill Brook, BIFoR

High-resolution Vertical Nitrate Profiles in Streambed Sediments

- Nitrate concentration generally decreased with depth
- Largest nitrate concentrations observed in the top 5 cm of the streambed
- Little difference between the sand control and sand bedform in spring to autumn
- In the winter the control reach showed little variation in nitrate concentration with depth, whereas the sand bedform showed large concentrations in the upper cm's, with concentration decreasing with depth
- In the sand control reach the vertical profiles showed little variation with depth in autumn and winter
- In the sand bedform the vertical variation was depressed in autumn

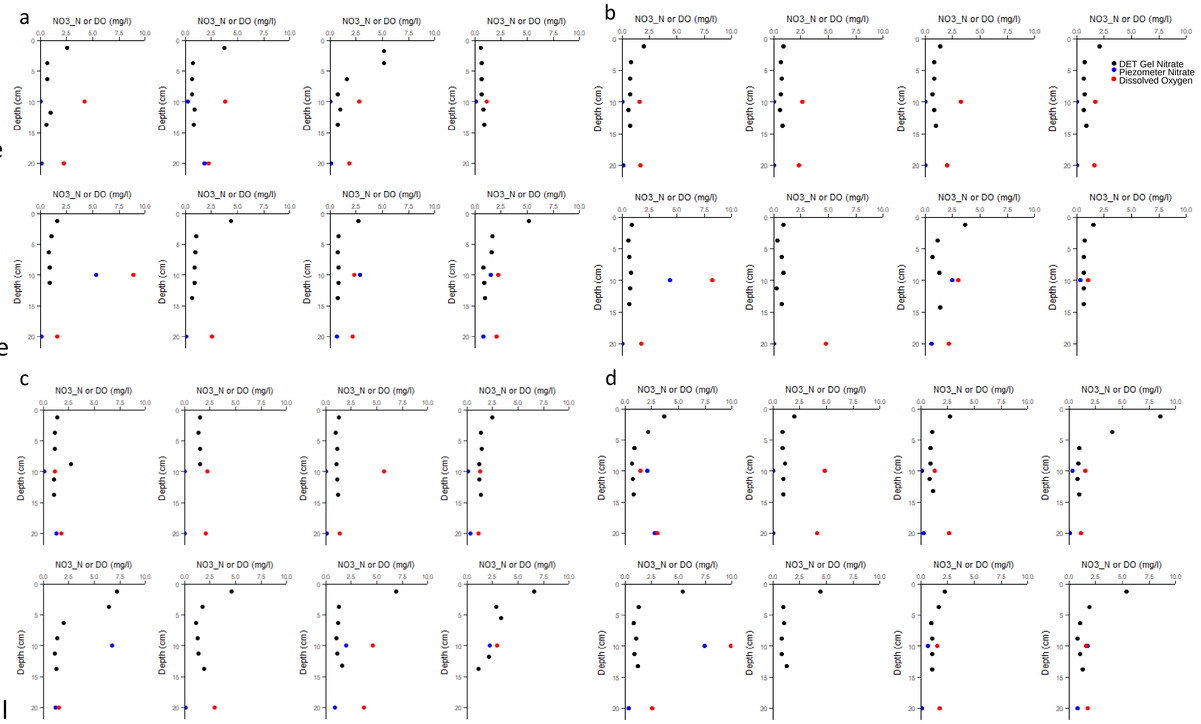

Fig 4: Nitrate concentration against depth during a. Summer, b. Autumn, c. Winter and d. Spring. The top row of each panel is data from the sand control and the bottom row is data from the sand bedform

Conclusions

- Streambed nutrient cycling is controlled by sediment type and season
- High-resolution vertical nitrate profiles show that nitrate concentrations

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