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# Nutrient transformation in the hyporheic zone - A panacea for river restauration or a ticking time bomb

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The 'hyporheic zone' or 'interstitial' characterises the area of intensive mixing between groundwater and surface water within the streambed of a river. Its physical conditions, as for instance the hydraulic conductivity and residence time, control fluxes and exchange rates between groundwater and surface water. Because of its often steep and dynamic redox gradients, the hyporheic zone can represent an area of high chemical activity. Previous studies described how the transport and redox processes in the hyporheic zone can cause effective nutrient attenuation, e.g. by denitrification. Hence, regulatory bodies and catchment management plans hope for the hyporheic zone to delimit the negative impact, polluted groundwater has for the stream ecological health. In this study we investigate, how the hyporheic connectivity, defined by the spatial and temporal coincidence of physical streambed characteristics and redox chemical conditions, controls the nitrogen transport and transformation in the streambed of a North English river. For the streambed sediments of a ca. 250m stream reach, pore water nitrate/nitrite and ammonia concentrations were monitored together with common anions, redox conditions, dissolved oxygen levels and rates of groundwater up-welling and surface water mixing in a dense system of nested piezometer for a two year period. The results of this study indicate, that hyporheic nutrient transformation can well exceed the usually assumed streambed depths of a few cm and may occur in depths of up to 1m. Our investigations furthermore detected, that within the research area the hyporheic passage has a spatially very variable impact on the exchange fluxes and nitrogen concentrations and transformation rates in the streambed. Nitrate attenuation due to denitrification was found in some areas as well as nitrification in others. The

spatial patterns of nitrate attenuation or release areas were controlled by the hyporheic connectivity, described by the overlay of flow pattern and residence times within areas of spatially very variable redox conditions. The hyporheic nitrate contributions were furthermore found to have a seasonally variable impact on the in stream concentrations. The results of this study proof, that hyporheic impacts on in stream nutrient concentrations can be far more complex, even on a small scale, than it has been acknowledged so far.