Linking stream sediment deposition and aquatic habitat quality in pearl mussel streams: implications for conservation

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Introduction

The introduction of fine sediments into streams is considered to have a major effect on habitat quality affecting the reproduction of sensitive species like unionid mussels and salmonid fishes. To date, there is a lack of information on the magnitude and spatio-temporal resolution of sediment introduction. This study aimed to quantify the spatio-temporal deposition of fine sediments in headwater streams in relation to physicochemical streambed conditions and the status of *Margaritifera margaritifera* and *Salmo trutta*.

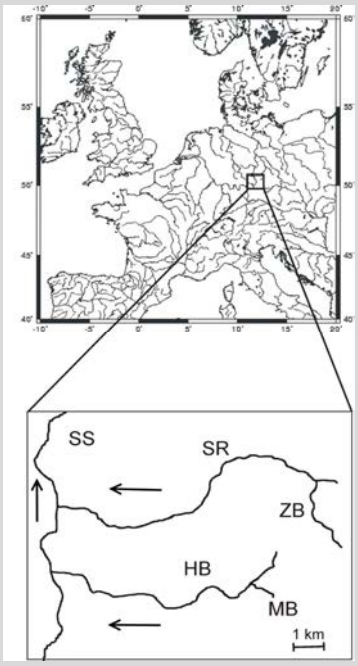

Figure 1: Schematic map of the study area. MB stands for Maehringsbach, ZB for Zinnbach, SR for Suedliche Regnitz, HB for Hoellbach and SS for Saechsische Saale which drains into the Elbe River. Arrows indicate stream flow direction.

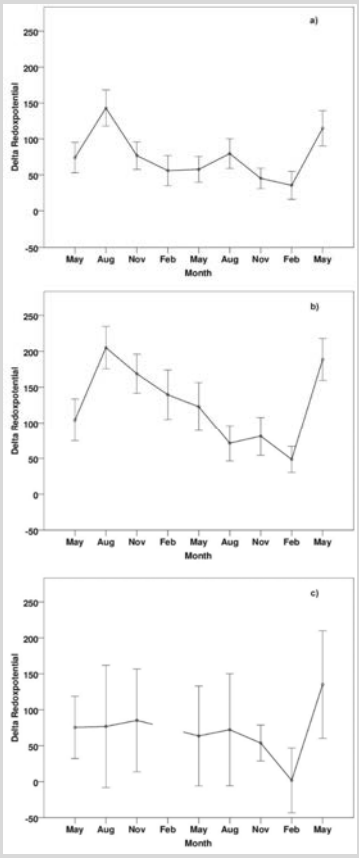

Figure 6: Average difference of redox potentials between free-flowing water and 5 cm substratum depth from May 2009-May 2011 in a) the Suedliche Regnitz (n = 486), b) the Zinnbach (n = 216) and c) the Maehringsbach (n = 54).

Materials and Methods

The study area is located in north-eastern Bavaria, Germany in the Saechsische Saale drainage, a subdrainage of the Elbe river (Fig. 1). Three pearl mussel streams with different recruitment status were selected. Based on the location of erosion hotspots and illuviation pathways, 14 study reaches were distributed across those streams (Fig. 2). At every study reach, physicochemical parameters and sediment deposition rates were recorded (Fig. 3). Sediment traps were buried to line up with the substratum surface and emptied every four weeks between June 2009 and May 2011 (Fig. 4). Samples were wet sieved at the laboratory to seperate different grain sizes. Physicochemical parameters were measured every three months and comprised penetration resistance, redox potentials, water depth and flow velocity. Redox potentials were measured in the free-flowing water and in the interstitial zone in 5 and 10 cm depth.

Results

Sediment deposition revealed high spatio-temporal variability (Fig. 5). Mean sediment deposition over all streams and reaches was 8.8 kg m^{-2} $month^{-1}$ of which 3.4 kg m^{-2} $month^{-1}$ were fine sediments <0.85 mm. A strong connection to discharge independent of season and vegetation cover was observed, with peak values in February/March 2011 and summer 2010. Consequently, discharge explained 53% of the variation in fine sediment deposition (linear regression analysis; r = 0.730; r^2 = 0.532; p = 0.003).

Fine sediment deposition was significantly lower in the Maehringsbach, where pearl mussels still recruit, with average and maximum values of 2.6 and 7.9 kg m^{-2} $month^{-1}$ as compared to 4.1 and 20.3 as well as 3.2 and 17.6 kg m^{-2} $month^{-1}$ in the Zinnbach and Suedliche Regnitz, respectively.

Physicochemical conditions in the Maehringsbach constantly remained in a range suitable for freshwater pearl mussel. In contrast, especially redox potential in the substratum considerably varied by season in the Suedliche Regnitz and Zinnbach, regularly reaching values unsuitable for juvenile recruitment (Fig. 6).

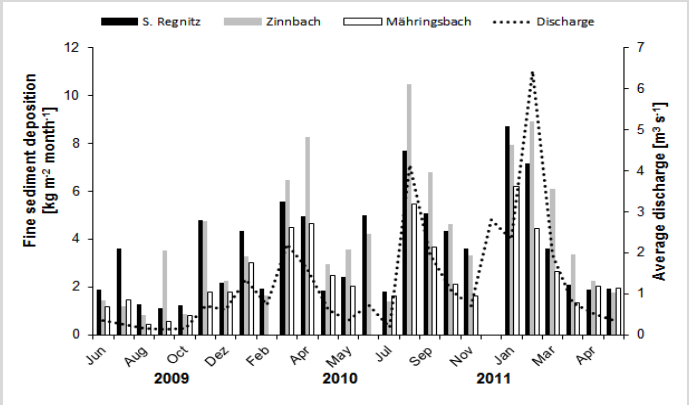

Figure 5: Fine sediment deposition (columns) and discharge of the Suedliche Regnitz (dotted line) from June 2009-May 2011.

Conclusions

The problem of fine sediment introduction into pearl mussel streams can only be solved by integrative catchment management.
Monitoring of habitat conditions and/or restoration success has to take spatio-temporal variability of physicochemical conditions into account.
⇒ Monitoring should integrate conditions over a longer period of time and needs to cover worst case conditions, e.g. during summer low flow, at least.
⇒ Investigations need to consider spatial variability by an adequate number of study reaches and sampling points as also indicated by Braun et al. (2012).

Figure 2: Erosion hotspot with illuviation pathway in the catchment of the Suedliche Regnitz

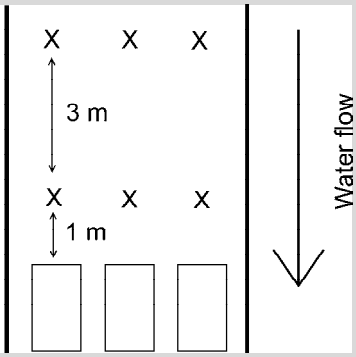

Figure 3: Schematic representation of a study reach, rectangles representing sediment traps and crosses representing sampling sites for physicochemical parameters.

Figure 4: Sediment traps buried to line up with the adjacent streambed surface.

Further readings

Denic M & Geist J (2014) Linking stream sediment deposition and aquatic habitat quality in pearl mussel streams: implications for conservation. River Research and Applications: in press. DOI: 10.1002/rra.2794

Braun A, Auerswald K, Geist J (2012) Drivers and spatio-temporal extent of hyporheic patch variation: implications for sampling; PLoS ONE 7; e42046; 1-10