The contribution of instream wood to streambed organic matter controls on microbial metabolic activity – preliminary results

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- Organic matter (OM) quantity and quality is an important control of microbial metabolic activity (MMA) which drives ecosystem (dis)services like GHG production and nutrient turnover rates [1].
- Wood may make a significant contribution to streambed OM but it has been ignored or explicitly omitted in previous research.
- This research could have implications for estimates of GHG emissions from streams and for catchment management, which often leads to the introduction of instream wood, directly or indirectly.

Directly, e.g. installing coppice wood fascines or leaky dams.

Indirectly, e.g. replanting riparian zones or flood plains.

METHODOLOGY

Microcosms were established for 8 treatments with 5 replicates (n=40) and left for ~1 year, allowing time for microbial communities to stabilise and for wood to begin to mineralize, thus providing a carbon source. Kept outside at EcoLaboratory (University of Birmingham, UK), temperatures fluctuate with environmental conditions. Mesocosms are spiked, incubated and sampled for water (at 0 and 26 hours) and gas (at 0, 2, 6 and 24 hours) at several points throughout the year, allowing the observation of impacts under a range of typical environmental scenarios.

Mesocosm Components

- **River sediment –** 3 geologies (sandstone, chalk and limestone) and canopy covers (high forest, half riparian, no cover).
- **Hazel wood** – used to make fascines which are used in river restoration.
- **Artificial stream-water** - NO3 : 10. (mg/l) NH4 : 0.1 (mg/l). PO4 : 0.1. (mg/l)

Spike Components

- **Nitrate (50 mg/l)** – to measure nutrient turnover rates.
- **Resazurin (raz)** – a reactive tracer which is irreversibly bio-transformed to resorufin (rru). As a proxy for MMA.

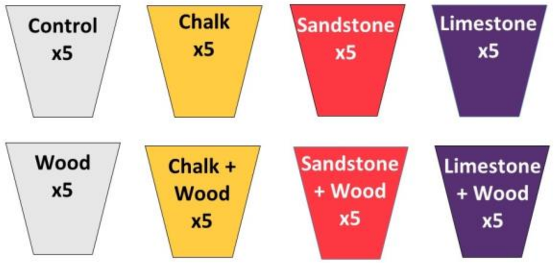

Figure 1: A schematic to represent the treatments and number of replicates of microcosms used in this experiment.

RESULTS

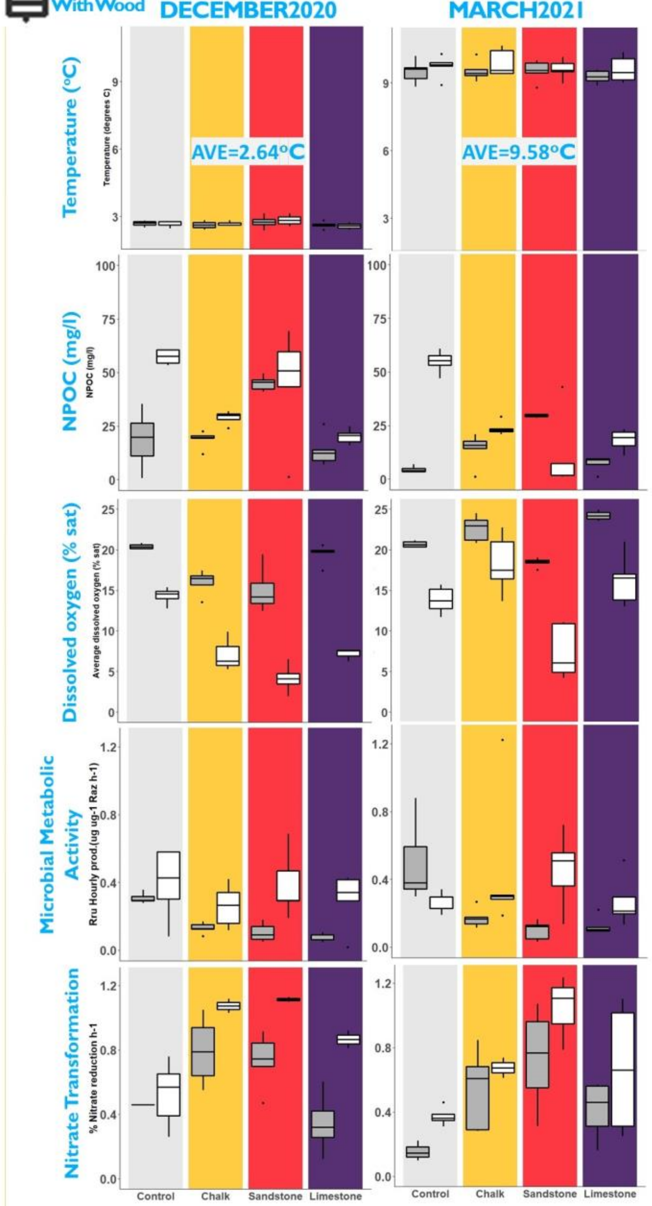

Figure 2: The effect of geology (control = grey, chalk = yellow, sandstone = pink, limestone = purple) and wood (grey = no wood, white = wood) on (from top to bottom) temperature (°C), dissolved oxygen (% saturation), non-purgeable organic carbon (NPOC) (mg/l), microbial metabolic activity (hourly production of resorufin (ug) / ug of resazurin) and % nitrate reduction h-1.

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Preliminary results suggest differences between geologies and treatment (wood or no wood) for all measured parameters in both periods. Non-purgeable organic carbon (NPOC) was higher in most treatments with wood additions, except in the chalk treatments in March 2021 only. The large range in values in the chalk with wood treatment may indicate some failure in the sampling or analysis procedure. Dissolved oxygen was lower in all treatments with wood additions. MMA was higher in all treatments with wood, except in the control treatments in March 2021. Nitrate transformation was higher in all treatments with wood.

DISCUSSION

The higher NPOC in treatments with wood additions may indicate mineralization of wood carbon into bioavailable forms. The biggest difference is observed in the control treatments (without sediment), of which those with wood additions also had the highest concentration of NPOC of any treatment. A possible explanation is that the sediment caused transport limitation of NPOC from the buried wood carbon into surface water, or that disturbance during sampling (i.e. mixing) caused physical breakdown of free-floating wood in treatments without sediment (which was observed visually), increasing the surface area and aiding mineralization.

Lower dissolved oxygen concentration and higher rates of MMA in treatments with wood additions suggests increased aerobic respiration compared to those treatments without wood. The increased nitrate transformation rate in treatments with wood additions compared to those without also suggests increased anaerobic respiration, for example denitrification. These differences could be accountable to the increased concentration of NPOC. However, it is likely that the wood additions also increase the exchange of waters between sediment water and surface water in the microcosms by creating preferential flow paths and effectively increasing hydraulic conductivity. In a system where transport is otherwise mostly limited to diffusion, this is likely to have a significant impact.

Analysis of GHG production rates, as well as destructive analysis (e.g. grain size analysis and carbon content and quality of sediments) after the sampling period is complete, will provide improved insight by which to identify the dominant mechanisms for the observed differences. Whilst the authors acknowledge the limitations of incubation experiments, these results may improve estimates of GHG production from river sediments, and contribute to mechanistic understanding of the controls of nutrient cycling in the river corridor.

KEY MESSAGES

- **The addition of wood may increase the concentration of bioavailable carbon.**
- **The rate of Microbial Metabolic Activity is increased by the addition of wood to river sediments.**
- **The rate of nitrate transformation is increased by the addition of wood to river sediments.**

About the Author

My background is in environmental and forest management. I am interested in ecosystem services, nature-based solutions, and how research impacts practice and policy.

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[1] Romeijn, P., Comer-Warner, S., Ullah, S., Hannah, D. and Krause, S. (2019). Streambed Organic Matter Controls on Carbon Dioxide and Methane Emissions from Streams. *Environmental Science & Technology*, 53(5), pp.2364-2374.