

# Assessing the hydrogeomorphological effects of large woody debris in rivers: A study of both natural and restored wood in the River Blackwater, UK.

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## INTRODUCTION

Large Woody Debris (LWD) has performed a vital function in river systems worldwide, enriching hydromorphological diversity and thus enhancing ecological conditions (Montgomery *et al.*, 2003). Human modification of the landscape has widely removed this natural legacy, so restorations are attempting to re-establish functioning of wood in rivers, with the aim of improving ecological status under the Water Framework Directive (Newson & Large, 2006).

**Research aim:** To determine the effectiveness of LWD restorations to improve hydraulic and morphological diversity, in comparison to natural LWD within a relatively low energy, lowland river.

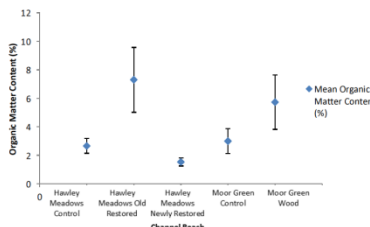
**Hypothesis:** Improvements in channel form (hydromorphological diversity) and process (hydraulic and organic matter retention) will occur in a succession from channels with no wood, to restored, to natural associated with increasing jam complexity.

## RESULTS

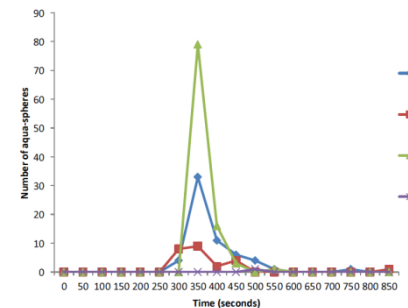
All restored LWD is of a partial class, recording smaller dimensions and lower blockage ratios than the active, complete and partial jams at Moor Green. At the meso and micro-scales, the restored channels showed lower hydraulic and substrate diversity, with greatest ranges of vertical and lateral flow velocities and highest flow turbulence surrounding the natural jams. Morphological features at Moor Green, including scour pools and gravel bars supported this hydraulic data, whilst these features were absent at Hawley Meadows.

The range of velocities observed at HMOR and HMNR were higher than in the control, signifying a hydraulic response to restored LWD. At Hawley Meadows, greatest flow diversity was evident at HMNR surrounding LWD of higher orientations and larger dimensions.

Organic matter content was highest at HMOR, followed by the natural wood reach, combined with lowest mean particle size. Substrate characteristics at HMNR were similar to the control. The sluggish nature of the Hawley Meadows control was improved in HMOR and HMNR, with lower substrate depths and higher longitudinal velocities recorded.



The release of 100 flow tracers within each reach signified greater hydraulic retention in the natural wood channel compared to the restored reach, whilst an improvement was evident between HMOR and the control.



## CONCLUSIONS AND RECOMMENDATIONS

- Evidence largely supports the hypothesis; improvements in channel form and process linked to increasing jam complexity.
- A significant enhancement of ecological potential is signified in the old restored channel, supported by higher gravel abundance, greater flow diversity and improved hydraulic and organic matter retention.
- Hydraulic and organic matter retention were evident at HMOR, suggesting the development of a dynamic equilibrium between the flow and sediment regime.
- Improved hydraulic diversity at HMNR, yet low organic matter content signifies an immediate hydraulic response yet delayed substrate adjustment after LWD restorations.
- Channel coverage and orientation of wood are the most significant LWD properties influencing hydromorphological change. These properties should aim to maximise the hydromorphological response without initiating socio-economic risks.
- LWD restorations should encompass a case-specific approach with structures appropriate to channel dimensions.

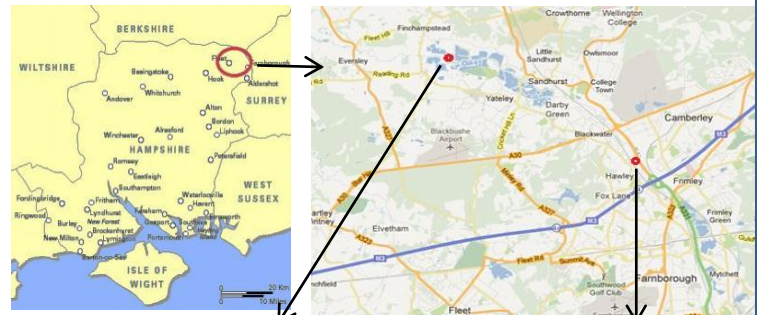
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## METHODS

The urban catchment of the River Blackwater, Hampshire encompassed two contrasting sites. The modified channel section at Hawley Meadows is the site of two LWD restoration projects undertaken in March 2007 (Hawley Meadows Old Restored (HMOR)) and March 2012 (Hawley Meadows Newly Restored (HMNR)) by the Environment Agency and Blackwater Valley Countryside Partnership. Moor Green Lakes situated further downstream consists of a woodland channel with natural LWD; used as a comparison of hydromorphological impacts. Non-woody control reaches were studied at both sites to determine the local impacts of LWD. A hydromorphological assessment included River Corridor Surveys, River Habitat Surveys, geomorphological mapping of LWD, combined with in-channel measurements of velocity, water depth, substrate depth and calibre, organic matter content and particle size analysis. Surveyed topographic data was mapped against hydraulic and substrate indices using ArcGIS to display spatial variations. A novel flow tracer experiment determined hydraulic retention based on the methodology first used by Milner & Gilvear (2012).



Moor Green Lakes (Active jam).



Hawley Meadows (Restored LWD).

