The responses of macroinvertebrates to gravel augmentation in two chalk streams

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Introduction

- Chalk streams exhibit unique physical conditions which can facilitate the development of highly diverse biotic communities.
- Anthropogenic deterioration, spanning millennia, has resulted in a large number of chalk streams **failing to adhere to ecological legislation** (e.g. Water Framework Directive).[1]
- Gravel augmentation is a technique commonly used to restore degraded English chalk streams (Figure 1).
- However, there is currently **insufficient evidence** to inform on the resultant ecological outcome of gravel augmentation.
- In particular, there is an need to fully elucidate the effects of gravel augmentation in **English chalk streams**, which have low erosive power and propensity to develop new habitat following restoration.[2]

In 2015, **84.8%** of English chalk rivers **failed** to achieve good ecological status [1]

Aim: To assess the responses of physical habitat and macroinvertebrate communities to gravel augmentation in two chalk streams.

Methods

- **Two case study gravel augmentation restoration** and control sites on the River Test (HS) and Itchen (EL) were monitored **pre- (3 months) and post- (15 months) restoration**.
- **Habitat and macroinvertebrate surveys** were carried out in **restored and control reaches** and were compared via statistical and graphical analysis.

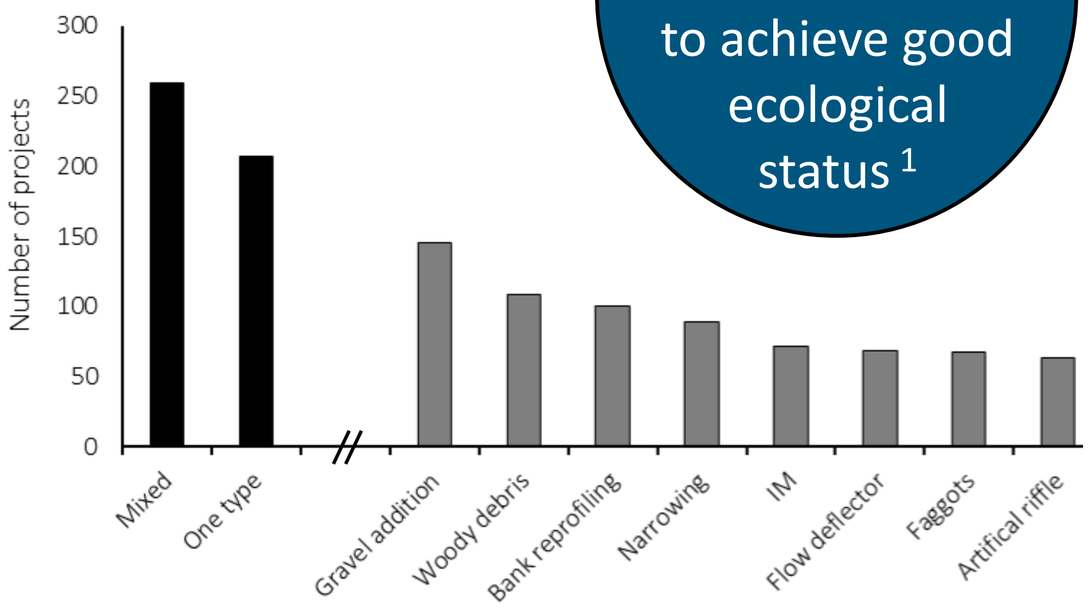

Figure 1 | The number of projects in the River Restoration Centre (RRC) National River Restoration Inventory (NRRI) database of English chalk river restoration projects using single or mixed restoration techniques (black bars) and the number of projects utilising the eight most commonly used techniques (grey bars).[3] IM = Infrastructure management.

Main results & discussion

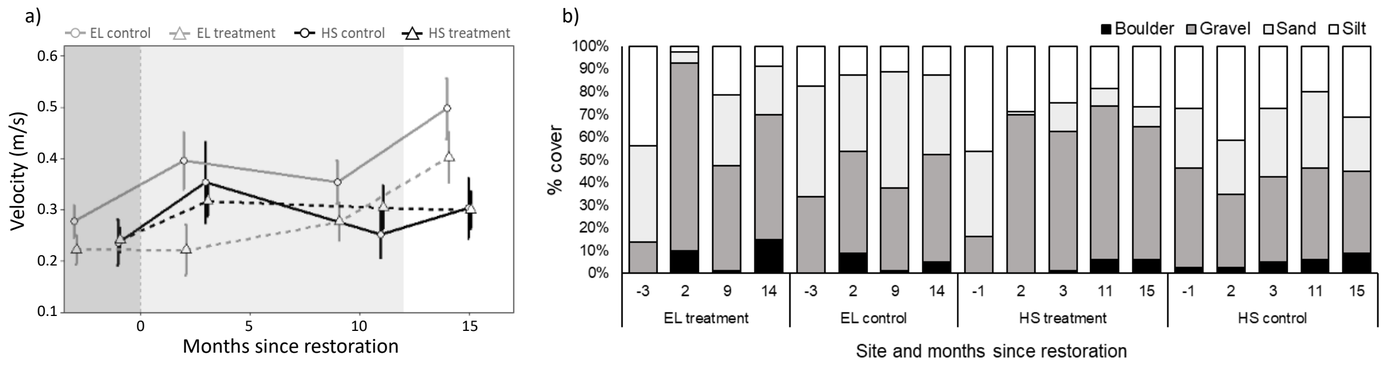

Figure 2 | (a) Flow velocity in restored (dashed) and control (solid line) sites pre- (dark grey area), <1 year post- (light grey area) and >1 year post-restoration (white area). Bars show standard error of the mean. (b) The percent cover of different substrates at the River Test (HS) and Itchen (EL) restoration sites pre- and post-restoration.

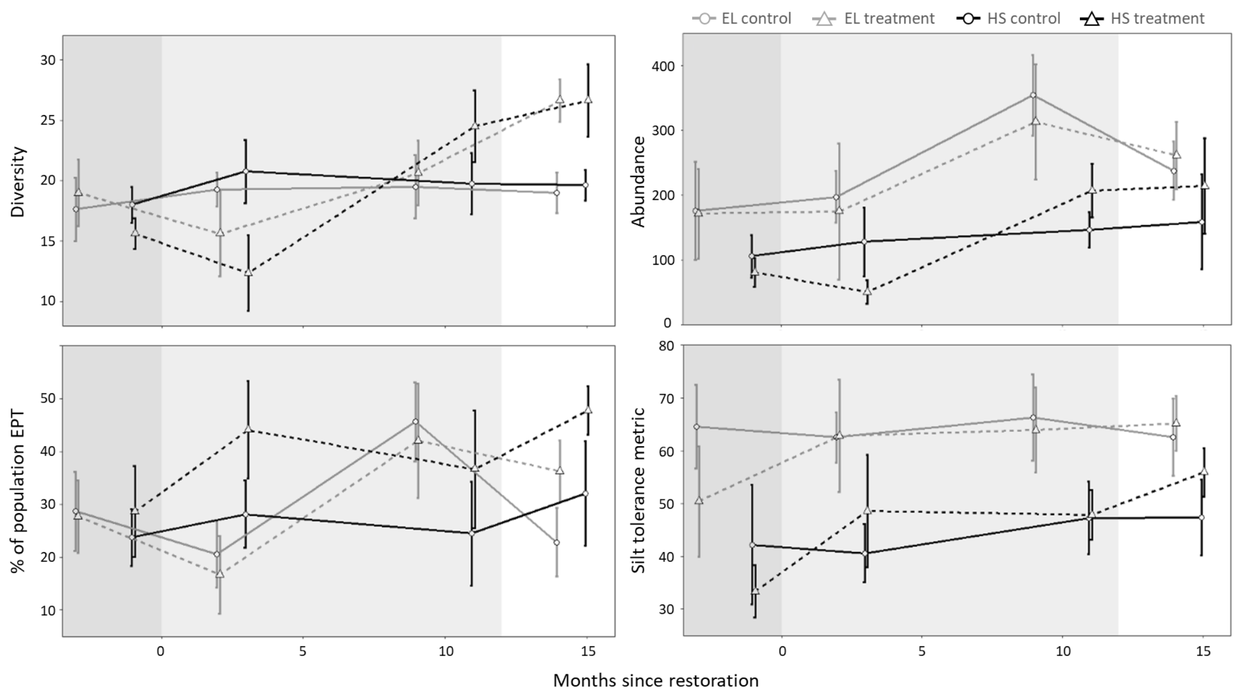

Figure 3 | Invertebrate metrics in restored (dashed) and control (solid line) sites pre- and post-restoration (see Figure 2 legend for details). **Diversity** refers to the number of different invertebrate families. **% of population EPT** refers to the percent abundance of mayflies, caddisflies and stoneflies. **Silt tolerance metric** refers to the tolerance of an invertebrate community to silt content, where lower values indicate a community more impacted by silt.

Physical and macroinvertebrate metrics pre- and post- restoration are presented in **Figures 2 and 3**, respectively.

Pre-restoration:

- Channels were incised, silted and deep with low velocity and heterogeneity; highly deviated from the expected condition of English chalk streams.
- Invertebrate communities did not differ significantly between control and restored sites, except that restored site communities were more impacted by silt. Communities were dominated by Aphelocheiridae, Bithyniidae, Ephemeridae, Ephemerellidae and Gammaridae.

Post-restoration:

- Restored reaches became shallower and more dominated by gravel and less by silt. No effect of restoration was observed on velocity nor within-transect heterogeneity.
- At <1 year post-restoration, invertebrate communities became more dominated by mayflies, stoneflies and caddisflies (EPT) in HS and by silt-intolerant taxa in HS and EL.
- At >1 year post-restoration, invertebrate communities in both restored sites were more diverse and more heavily populated by EPT and silt-intolerant taxa compared with controls. Restored sites were dominated by Elmidae, Ephemeridae, Ephemerellidae, Gammaridae and Hydropsychidae.

Conclusions

- **Gravel augmentation in English chalk streams can represent a valid mechanism by which habitat and invertebrate communities can be restored to a more favourable state.**
- **Most restoration effects were shown >1 year following restoration, highlighting the need to consider the temporal scale of restoration appraisals.**

1. **O'Neill, R. and Hughes, K.**, 2014. The State of England's Chalk Streams; WWF-UK: Surrey, UK.
2. **Sear, D., Armitage, P. and Dawson, F.** 1999. Groundwater dominated rivers. *Hydrological Processes*, 13, 255-276.
3. **RRC.** 2019. NRRI database: custom dataset containing rivers with chalk geology (provided on request).

EPSRC Engineering and Physical Sciences Research Council
Environment Agency
ICER International Centre for Ecohydraulics Research
University of Southampton Sustainable Infrastructure Systems