Ecosystem engineering impacts of native and invasive alien freshwater decapods

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Background

Globally, invasive alien species directly threaten aquatic biodiversity, but ecosystem engineering impacts on geomorphology are less studied. Laboratory flume experiments have recently shown American Signal Crayfish (*Pacifastacus leniusculus*) are 'engineers' of riverbed topographic change via bioturbation, consequently leading to increased sediment transport. The context of other decapod species has now to be considered, including other invasive species such as the Chinese Mitten Crab (*Eriocheir sinensis*) and the Endangered native White Clawed Crayfish (*Austropotamobius pallipes*) these invasive species extirpate.

Aim and Hypotheses

The aim of this study is to compare the impact of native and introduced decapod crustaceans on river bed morphology and turbidity/suspended sediment concentration (SSC) dynamics. It was predicted both Signal Crayfish and Mitten Crabs will induce greater alterations to morphology and more fine sediment entrainment through bioturbation than the native crayfish.

Methods

Twelve outdoor re-circulating stream mesocosms at the University of Leeds' Field Research Unit (Fig. 1) were utilised. These are constructed from 6 m [L] X 0.3 m [W] x 0.15m [D] halved culvert pipes, with flow generated from electrical pumps. Sand, clay and natural gravel were added and allowed to settle under ambient flow (mean discharge ~0.06 $m^3 sec^{-1}$; ~5cm water depth). Treatments consisted of native *A. pallipes* (licensed by Natural England), the invasive *P. leniusculus*, *E. sinensis* and control containing no decapods. All individual decapods were of similar mass, with 2 individuals per channel. The experiment ran for 30 days. Suspended sediment, turbidity and topographic change of surface sediment was measured at the start and end. For the latter, water will be drawn down to expose sediment and high-resolution mm-scale 3D topographic models of the sediment surface morphology will be generated using structure from motion. This included measurements of roughness and topographic changes using digital elevation models of difference (DoD) (Fig. 2).

Main findings

Suspended sediment was increased in crayfish and crab treatments relative to controls, but did not differ between native or invasive species. Turbidity was found to be different between the treatments at the start of the study, but at the end of the experiment there was no difference, suggesting settlement of the decapods. The mean volume change of sediment however did not differ significantly based on DoDs. Similarly, there was no significant difference in surface roughness, though it was lower in *P. leniusculus* treatments. Different contexts, such as the decapod density, discharge, substrate type and structural heterogeneity of the mesocosms might have affected the results, and

could be investigated further. These results indicate that when invasive alien decapod species replace the declining native species, river bed sediment is unlikely to be impacted. However, because invasive species can achieve greater densities than native species, their impacts are possibly going to be more pronounced. Translocating *A. pallipes* to previously crayfish-free water bodies for conservation targets is also likely to alter suspended sediment concentrations.

Figure 1. Stream mesocosm flume array used to experiment on the impacts of native and invasive decapod crustaceans.

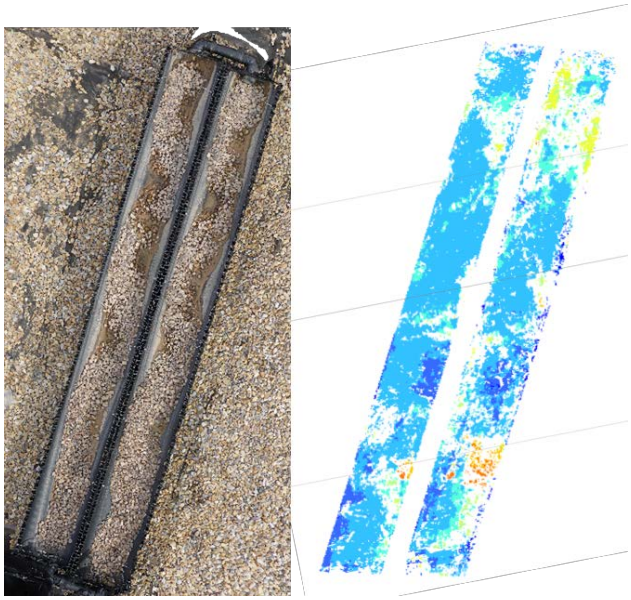

Figure 2. Example of a digital elevational model of difference (DoD) of flume sediment created for each flume mesocosm and compared between decapod species treatments.

Value of BSG Grant

The BSG grant matched funding required to build the mesocosms facility.