Biotic versus abiotic forcing of fluvial sediment dynamics: How much sediment do crayfish supply to river systems?

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Aims

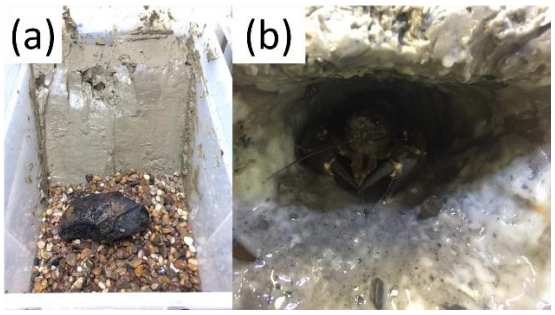
The invasive signal crayfish (*Pacifastacus leniusculus*) is recognised as an important driver of fine sediment dynamics in rivers, and their burrowing behaviour likely reduces bank stability and may lead to accelerated bank collapse. However, the causes of this novel behaviour only observed in British rivers are unknown. My PhD thesis intended to undertake field surveying of invaded rivers to understand the ecological, hydrological, and geomorphic drivers of burrowing activity. This project aimed to extend the scope of my thesis, by undertaking 'black box' experiments in a laboratory setting to validate and understand the processes observed in the field.

Methods

A bentonite clay 'riverbank' was constructed at one end of each of 14 identical mesocosms (Figure 1), into which crayfish were introduced. Any burrows that were constructed were measured at 12 hour intervals. Experimental treatments of an alternative shelter (large cobble, deep silt substrate, no shelter), crayfish population densities (one, two or four crayfish), and crayfish from different source populations (where burrows were present and absent) were tested in a factorial manner to understand their relative importance in driving crayfish burrowing behaviour.

Main Findings

The availability of coarse substrate as an alternate shelter reduced burrowing behaviour in low population densities, but increase burrowing behaviour in high population densities (Figure 2). This is likely because without an alternative shelter, crayfish spent time fighting and interacting as opposed to constructing burrows. This suggests that the addition of coarse materials to rivers may not reduce the burrowing behaviour of signal crayfish, and should not be used as a management strategy. No differences were observed between populations, suggesting that burrowing is not a learned behaviour and that zoogeomorphic effects may be observed from any expanding or transplanted populations. Further work is therefore important to replicate these experiments with native signal crayfish and other invasive populations. This grant pump primed further funding to pursue this research question.



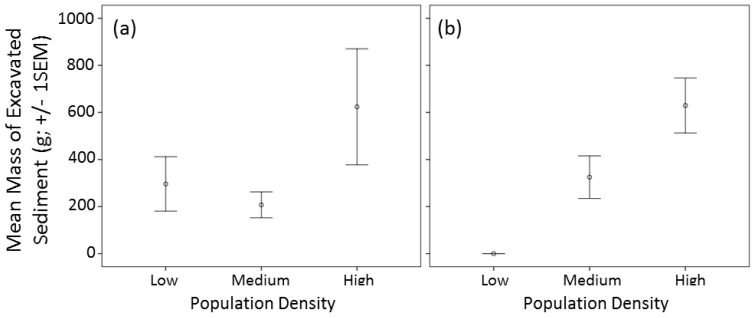


Figure 1 (left). (a) Artificial bentonite clay banks were constructed in 14 mesocosms to investigate the relative importance of the presence of alternative shelters, increased population densities, and different source populations as drivers for signal crayfish burrowing. (b) A burrow constructed in a mesocosm by a crayfish.

Figure 2 (right). The mean mass of excavated sediment in (a) the absence and (b) the presence of an alternative shelter, under low, medium and high population density scenarios.

Value of BSG grant

This grant has been instrumental in the context of this project and in my PhD. My PhD research was advertised as a field based project, and this grant has substantially extend its scope by funding laboratory experiments to better understand the mechanisms and processes observed in the field. The funding facilitated the purchase of key equipment (14 aquaria and kit; bentonite clay), without which these experiments could not take place. The results of these experiments pump primed further funding to extend the scope of the project, by undertaking the same experiments with native and invasive crayfish in Montana, USA. The results of this project and the extended work formed the basis of a key chapter of my PhD, and a second chapter using the methods and equipment established here. The results of this project were presented at the European Geosciences Union (April 2018) and the BSG Annual Meeting (September 2018), and were presented in combination with the extended work at the London Freshwater Group (March 2019), the Symposium for European Freshwater Science (June 2019), and the American Geophysical Union fall meeting (December 2019). These results have formed the basis for a manuscript currently in preparation.