

Fine Sediment Transport Capacity & Vegetated Chalk Streams

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1. Introduction

Chalk streams and rivers are a unique habitat that are renowned for their crystal clear water and sediment free gravel beds (Walling & Amos, 1999). Water flow in chalk streams is retarded within dense patches of *Ranunculus* sp. (Sand-Jensen, 1998) and this has been associated with the localised trapping and accumulation of fine particulate sediment (Wharton et al. 2006). However increased stand growth can also cause localised increased water flow channels (Cotton et al. 2006). This can lead to fine sediment being dislodged and suspended to be washed downstream.

What is sediment transport capacity?

The weight and/or volume of sediment which can be carried by means of transport (stream flow/discharge) under given conditions (e.g. changing macrophyte cover)

2. Proposed Study Sites

The River Lambourn, Berkshire
The River Piddle, Dorset
The River Frome, Dorset



River Frome, Dorset

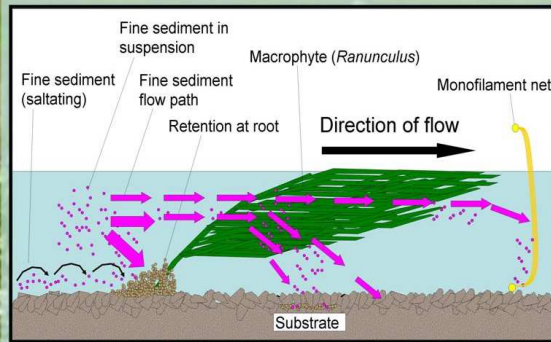
3. The Main Questions

a. What is the sediment transport capacity of *Ranunculus* dominated chalk streams over time?

- How is this affected by *Ranunculus* coverage?
- Are there any annual trends?
- Are there similarities between rivers?

b. How does *Ranunculus* morphology (e.g. rooting depth and strength) change with differing sediment accumulation?

- Is sediment accumulation the main factor?
- Egg before chicken? (macrophytes before sediment or visa versa?)



3a. Sediment Transport Capacity

Methodology

Fieldwork

- Map the stream and river reaches and then divide into transects
- Monthly recordings: macrophyte % area cover, sediment depth and total depth
- Sink sediment traps into the stream bed at randomly devised points to capture saltating sediment
- Find Q (water discharge) using a solute tracer e.g. NaCl concentration as it travels downstream
- Place monofilament nets (fine mesh size 63µm) (Minshall et al. 2000) at top of the reach to capture gross suspended fine sediment per unit time (time devised by Q)
- Simultaneously a net is placed at the bottom of the reach to capture the net suspended sediment per unit time
- Find major flow channels in macrophyte mosaics with a dye tracer (e.g. rhodamine)
- Install the net at the bottom of the reach, place dyed (fuschin) corn pollen (Georgian et al. 2003) into top
- Allow analogue seston to settle (time dependant on Q)
- Retrieve netting with retained corn pollen
- Take randomised sediment cores in areas around and under macrophytes, sampling roots and pollen
- Retrieve sediment traps monthly to devise a sediment budget in each reach

Laboratory Analysis

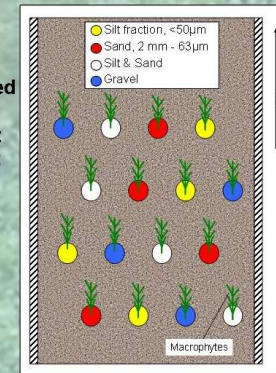
- Sediment trap samples can be analysed for sediment particle size (sieving) and organic content
- Comparison between gross and net suspended sediment samples
- Retention of corn pollen by *Ranunculus* stands using a coulter counter for corn pollen in samples (loss of suspended fine sediment to bedload)

Results can potentially be used for modelling and/or input into a GIS!

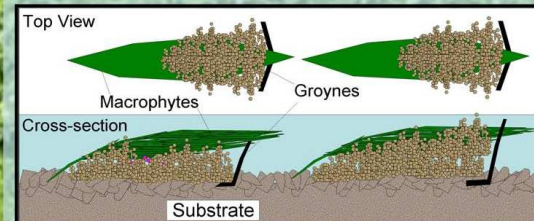
3b. Macrophyte Morphology & Sediment Accumulation Methodology

Laboratory and Flume Analysis

- Take *Ranunculus* fragments and samples from natural populations and grow under controlled conditions (e.g. flow, temperature & pH) in a lab
- After fragments are rooting, take plants & weigh for biomass, measure root length & shoot length. Take a sample of fragments and measure the surface area of shoots & roots (Bergey & Getty, 2006)
- Others plants are placed into aquatic plant pots with different representative sediment particle sizes (collected from a chalk river source): (i) Gravel only, (ii) Sand sediment (2mm - 63µm) & (iii) Silt <50µm. Pots will be covered by gravel to reduce erosion
- These will be placed (staggered) in a flume as a randomised block and left for a pilot period from one month to a year
- After which plants will be taken and measured for biomass, shoot and length differences
- For accumulation experiments a new set of fragments will be used, all previous methodology to be used except plants will be placed in the sediment medium which is most beneficial for growth
- A 'groyne' will be established made of mesh net downstream of each plant to stop erosion of sediment
- Different volumes of sediment can then be placed on top



- The study will be implemented in the growth season (summer), plants will then be monitored over time (months) for growth and/or dieback
- There is also possibility of using different sizes of plants for comparison of results
- Flume results can be compared with observations made in the field sites

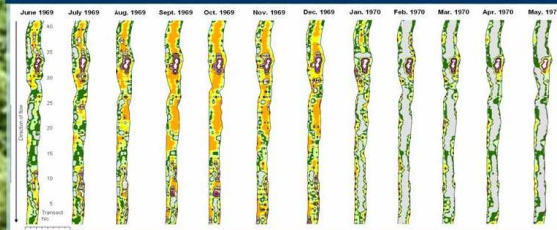


4. Predicted Results

- It is proposed that sediment transport capacity is influenced by macrophyte abundance. Overall, high macrophyte abundance will cause changes in sediment transport, which leads to higher sediment retention
- But it is hypothesised that in localised patches, flow will increase between macrophyte stands & sediment transport will increase
- It is predicted patches with high accumulation of sediment may cause 'die-back' of *Ranunculus*. This will possibly cause an increase in sediment transport due to localised erosion from increased flow
- Possible cause of *Ranunculus* loss due to burial which damages the structure (small plants), and loss of anchorage due to fine sediment (larger plants)
- Also it may be possible that larger *Ranunculus* is unable to adjust morphology to accommodate change in sediment depths

5. Implications of Study

- Better understanding of macrophyte-sediment interactions of chalk streams
- Retention and movement of contaminants
- Insight for management of sediment & macrophytes of chalk streams



Selected References

- Bergey, E.A. and Getty, G.M., 2006. A review of methods for measuring the surface area of stream substrates. *Hydrobiologia*, 556, 7-16.
- Cotton, J.A. et al., 2006. The effects of seasonal changes to in-stream vegetation cover on patterns of flow and accumulation of sediment. *Geomorphology*, 77(3-4): 320-334.
- Georgian, T. et al., 2003. Comparison of corn pollen and natural fine particulate matter transport in streams: can pollen be used as a seston surrogate? *Journal of the North American Benthological Society*, 22(1): 2-16.
- Minshall, G.W. et al., 2000. Physical factors influencing fine organic particle transport and deposition in streams. *Journal of the North American Benthological Society*, 19(1): 1-16.
- Sand-Jensen, K., 1998. Influence of submerged macrophytes on sediment composition and near-bed flow in lowland streams. *Freshwater Biology*, 39(4): 663-679.
- Walling, D.E. and Amos, C.M., 1999. Source, storage and mobilisation of fine sediment in a chalk stream system. *Hydrological Processes*, 13(3): 323-340.
- Wharton, G. et al., 2006. Macrophytes and suspension-feeding invertebrates modify flows and fine sediments in the Frome and Piddle catchments, Dorset (UK). *Journal of Hydrology*, 330(1-2): 171-184.

Acknowledgements

Supervisors: Dr. G. Wharton (QMUL)

Prof. R. Wotton (UCL)

This studentship is funded by NERC

