



Logie Burn reach scale river restoration case study

Introduction

Case studies of geomorphic change in response to reach scale river restoration remain rare even over short (< 5 year) timescales. Field-based knowledge of channel morphology adjustment rates and styles for different river types are needed to reduce uncertainty over restoration outcomes and help inform river restoration planning. Low energy, sand-gravel bed rivers are common in areas used for farming and have a long history of human modification resulting in unnaturally uniform morphologies. Re-meandering is one method to improve such degraded rivers but where upstream sediment supply issues remain, recovery towards a complex meandering morphology could be impeded by deposition due to the lower sediment transport capacity of the new channel. This could in turn reduce flow conveyance leading to heightened flood risk locally and degrade habitats through siltation and nutrification. However, these potential responses have not received much attention.

In early October 2011, a 160 m reach of the lower Logie Burn (catchment scale: 31 km²), a straightened stream in Aberdeenshire, was reconnected to relict meanders to restore its meandering morphology, river habitat and riparian habitat diversity. Further aims were to reduce downstream phosphorous and fine sediment transfer into Loch Davan by enhancing in-channel storage capacity and raise the profile of this style of restoration for practitioners and stakeholders in the region.

Since July 2011, before and after monitoring of channel morphology, habitat, discharge, riverbed sediment and riverbed phosphorous responses has been undertaken within the restored reach and an upstream control reach. Alongside evaluating the rates and types of physical processes that occur, the monitoring aims to assess how well the scheme creates multiple benefits of:

- Reduced flood risk by slowing flow and increasing floodplain connectivity;
- Increased diversity of physical habitat;
- Reduced nutrient and fine sediment transfer into Loch Davan.

This short summary, gives initial results from the monitoring so far undertaken for the period July 2011 to November 2014.

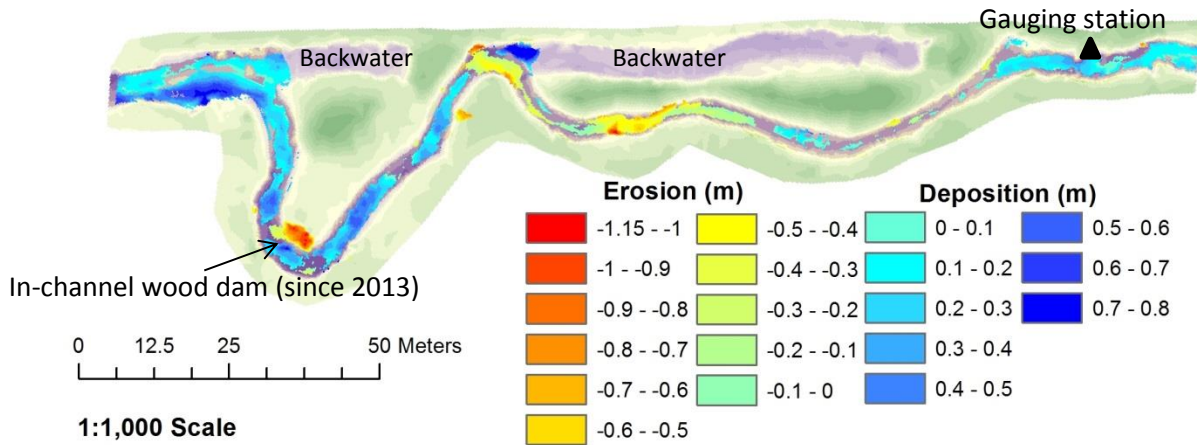


Figure 1: Digital elevation change map showing the distribution and magnitude of net deposition and erosion in the restored meandering channel (excluding backwater areas) between October 2011 and November 2014.

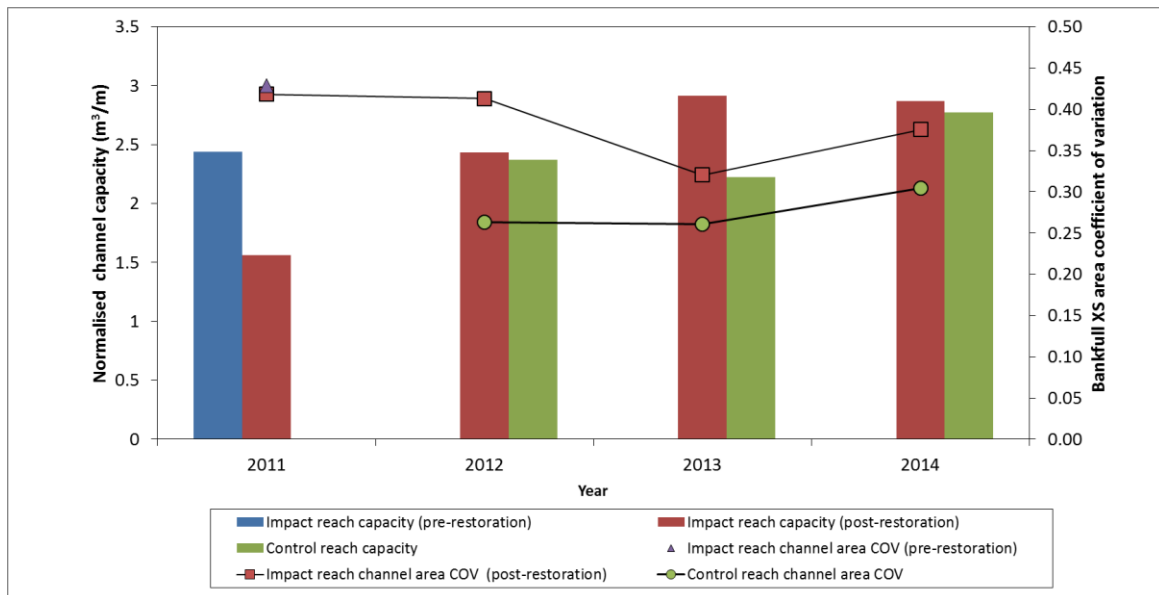


Figure 2: Channel volume capacity and channel cross section area coefficient of variation (COV; an indicator of morphological complexity) change between 2011 and 2014.

Key points

Morphological change

- During 2011 to 2014, discharge exceeded bankfull level (i.e. flows of geomorphic significance) for a total of 30 days.
- Morphological adjustment in the new re-meandering channel has been rapid and significant between 2011 and 2014 (Figure 1). This shows that re-meandering can help to ‘kick-start’ geomorphic processes (e.g. bar deposition, scour and creation of pools) and the input of woody material that in turn drives the natural recovery of habitat characteristic of meandering channels.

- Morphological change in the restored reach was greatest in the year following restoration (+20 m³ sediment volume change) reflecting the sensitive state of the channel after construction.
- During the 2013-2014 hydrological year, bankfull discharge was exceeded for over 17 days. This led to a net sediment gain of 19 m³ and 28 m³ in the impact and control reaches respectively.
- Despite the net deposition response, the channel capacity has increased to a level above the pre-restoration channel suggesting that conveyance adjustment can keep pace with the rate of deposition (Figure 2).
- Morphological complexity has increased to a level similar to the pre-restoration state which is higher than the control reach (Figure 2). Complexity has been in part driven by the natural incorporation of woody material into the channel, which has been initiated by channel adjustment through the erosion of channel margins.
- Bank protection measures installed in autumn 2011 (bankside tree planting and wooden revetments) due to concerns over river movement were not installed in appropriate locations. Trees have been washed away and revetments were ineffective as the bank margins were naturally stable (reinforced by mature trees and cohesive material); the stable river margins means the need for bank reinforcement is questionable.

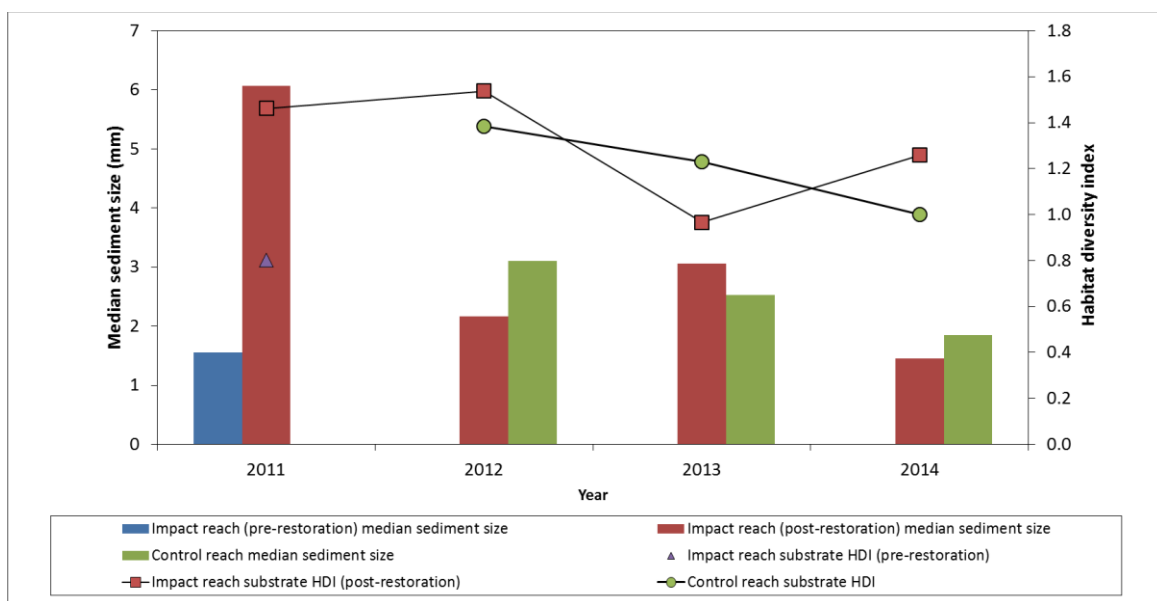


Figure 3: Reach scale median sediment size and river substrate habitat diversity (Shannon-Wiener index) change between 2011 and 2014.

Riverbed sediment change

- The reach scale riverbed median sediment size has adjusted to a level similar to the pre-restoration channel (1.5 mm) but slightly finer than the control reach (1.8 mm; Figure 3).
- Over the monitoring period, median sediment size has reduced in both the control and restored reaches. It is not clear if this is related to landuse changes, increased frequency of flows during the period delivering high fine sediment loads or morphological change trapping more sediment.

Habitat change

- The net gain of sediment (50 m³) in the restored reach since 2011 may be degrading the habitat quality of benthic areas as it contains a high proportion (58 % in 2014 based on bulk sampling) of fine sediment (i.e. < 2 mm particles).
- The diversity of visually assessed substrate habitat types has increased to a level higher than the pre-restoration and control reaches (Figure 3).
- The input of wood has created a greater extent of pools and diversity of flow types and is potentially attenuating peak flows by forcing floodplain overspill.

Research undertaken

This work was undertaken for the RESAS Work Package 2.4 (Methods for mitigating and adapting to flood risk) Project 1 (Natural Flood Management Catchment based assessment and demonstration of Natural Flood Management (NFM) opportunities and constraints) and Project 5 (Understanding and managing land and water resources in catchments for multiple benefits). Ongoing monitoring on a bi-annual frequency is planned for the next six years.

Policy implications

Degraded streams in farmland areas are often classified as having poor ecological status under the Water Framework Directive in part due to morphology – a supporting element of overall ecological status – being degraded. As a result they are a focus of SEPA's River Basin Management Plan process for restoration. Although differences in catchment scale controlling factors limit the transferability of findings and the timescale of the monitoring so far is short, the Logie Burn case study contributes to the limited evidence base on restoration in degraded, sand-gravel bed rivers. The monitoring shows that rapid adjustment of channel morphology and sediments in response to reach scale restoration is possible in these types of river channel. The restoration work has resulted in morphological complexity that is higher than the control reach, the occurrence of physical processes typical of meandering rivers and increased substrate habitat diversity. Although it is not possible to evaluate the ecological benefits of this scheme, any physical habitat benefit may have been offset by the continued input and deposition of fine sediment from upstream sources. The deposition rate of fine sediment may have also been exacerbated by the new river morphology. This highlights the potential pitfall of implementing river restoration at the reach scale without considering and tackling overriding pressures (e.g. altered flow and sediment supply regimes); it is thus essential that reach scale restoration planning is placed in a catchment scale context.

Authors

For more information about the Logie Burn river restoration monitoring project please contact Stephen Addy (Stephen.Addy@hutton.ac.uk).

Topics

Fluvial geomorphology, river restoration, sand-gravel bed rivers, river habitat