Optimising Ecological Restoration for Ecosystem Service Benefits

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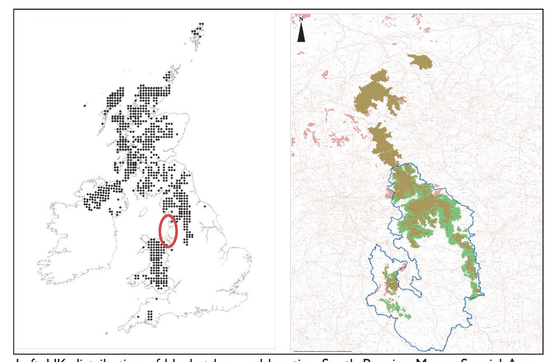
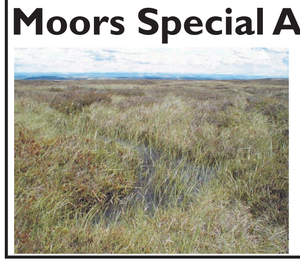
Ecological restoration projects have historically focused on biodiversity targets. More recently, the recognition of the value and importance of the ecosystem service benefits of the natural environment has seen the adoption of the ecosystem services approach to nature restoration, conservation and management. With this approach has come a change, and expansion, in the drivers for ecological restoration and the outcomes it delivers. Using a case study of blanket bog restoration in the UK and the delivery of natural flood risk mitigation we demonstrate how we are adapting a 'toolbox' of ecological restoration techniques towards optimisation for specific, and multiple, ecosystem services.



Left: UK distribution of blanket bog and location South Pennine Moors Special Area of Conservation (SPM SAC; red); Right: SPM SAC (green), distribution of blanket bog (red) and Peak District National Park boundary (blue).

1. The need for blanket bog restoration in the South Pennine Moors Special Area of Conservation (SPM SAC), UK



Blanket bog is a deep peat wetland habitat. Just 3% of blanket bog within the SPM SAC is currently classified as being in 'Favourable' condition (left). In fact, in 2005, over 15 km^2 was in the most degraded condition, extensive areas of bare, eroding and severely desiccated (low water tables) peat (right). The reason so much of the blanket bog is so damaged is due to historic industrial pollution from surrounding cities and towns, and wildfires, inappropriate management and recreation pressures. The pollution killed off the majority *Sphagnum* mosses in the region. Sphagnum spp. are ecosystem engineer species and the main peat forming peat forming blanket bog plant.

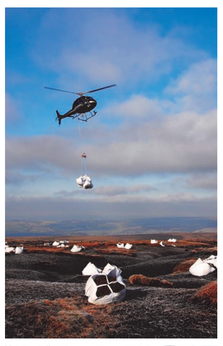
2. Landscape-scale blanket bog restoration in the English Uplands – the ecological restoration toolkit

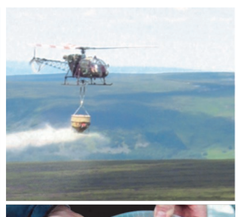
Gully Blocking

Gullies are erosion channels caused by the by the movement of water through and over the peat mass.

Gully blocking techniques are adapted from those used to block artificial drainage ditches (grips). Materials that can be used include wood (left), plastic, stone (right) and heather.

The aim, depending on method, is to trap sediment, slow water velocities (the erosional force of run-off) and raise the water table.





Bare Peat Stabilisation

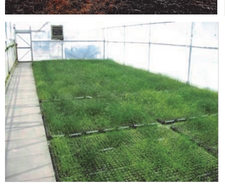
1. Heather brash

Heather is cut and spread onto bare peat to provide a protective cover over bare peat slowing erosion (far left).

2. Nurse grass crop

Preparatory treatments of lime and fertiliser are essential for the nurse crop to become established (near left, top).

The site is then seeded with a mixture of native and non-native grasses to ameliorate environmental conditions to enable the establishment of native plant species.



Diversification

Plug planting

5 blanket bog species grown as 'plugs' (left, top) (bilberry, crowberry, cloudberry, cotton-grass 2 spp — all 'indicator' species) and planted out (bottom left) to:

- Increase biodiversity
- Restore a rhizosphere
- Increase structural complexity as the rhizomes or extensive surface growth aid surface stabilisation.

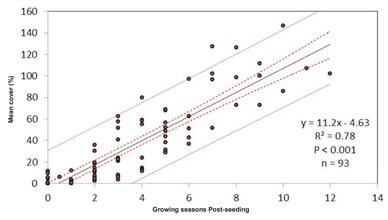
Sphagnum reintroduction

We carried out a 5 year R&D project to investigate the potential to regenerate Sphagnum on degraded moorland sites (Sphagnum spp. are indicator spp.). We found the main factor limiting the distribution of Sphagnum in the Peak District is a lack of Sphagnum as a source of material, rather than current environmental conditions. We developed Sphagnum propagation techniques and landscape-scale trials of sphagnum delivery forms (beads, plugs, 'slime') against natural recovery and locally sourced translocated sphagnum.

3. The benefits of the toolkit

Biodiversity recovery

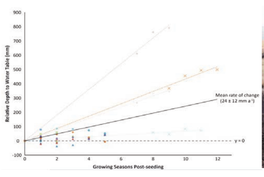
The extent of bare peat is reduced from 100% to <10 % within 5 years of stabilisation.
Across sites that we have restored over the last 13 years, the cover of indicator plant species required as part of the assessment of the blanket bog to be in Favourable Condition increases linearly with no indication of a change of rate over the 12 years we have been monitoring our sites (below). Indicator species coverage increases by 11% per growing season for the 12 years. There is, however, variability between 'individual sites', each different environmental conditions, treated in different years.



Hydrological recovery

Water levels in the peat mass increase linearly for 12 years following 'restoration' (below, left) with an average annual increase in water table height of 24 mm; but not yet achieving levels associated with 'intact' sites (within 100 mm of the peat surface).

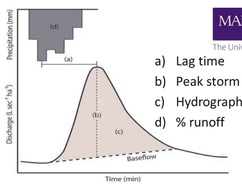
Water tables are monitored across cluster of dipwells — pipes installed into the peat in which we can monitor water levels either manually (below, right) or automatically using electronic loggers.



Flood Risk Management Benefits

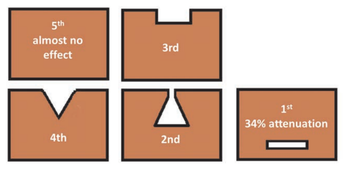
We have tested the impact of our bare peat stabilisation toolkit in delivering Natural Flood Risk Management (NFM) through monitoring peak storm flow and lag times and % runoff (below). We have monitored the impact of stabilisation for 4 years so far.

Lag times have increased by 40 minutes and peak storm flows reduced by 30%; with strongest effect achieved just one year after seeding with grass. The proportion of rainfall leaving stabilized catchments has not changed - so the effect is slowing the flow of water rather than increasing water storage.



a) Lag time
b) Peak storm flow
c) Hydrograph shape index
d) % runoff

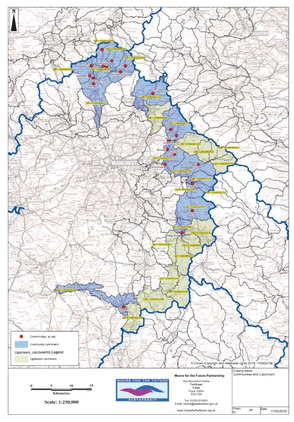
4. Optimising the toolkit for flood risk management



Development of techniques

Gully block design
We have modelled the impact of different gully block designs on peak storm flows and lag times (top left). Cascades of 6 of the 'best' option modelled achieved 46% reduction in Peak Discharge and increased lag times by over an hour.

We have also trialled gully block design 'on the job', including dams twice as high as our standard size to provide additional temporary storm water storage (bottom left).

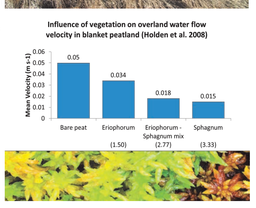


Spatial planning

Identifying 'communities at risk (C@R) of flooding' and prioritising the waterbody catchment that these are within or downstream from enables us to spatially optimise where we use the optimised NFM techniques we are working to develop.

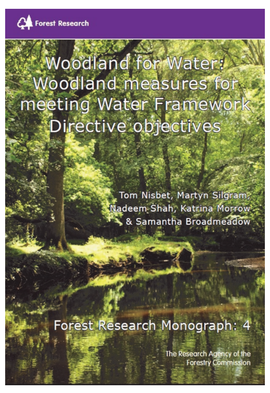
The map (left) shows C@R (red) and the catchments they are within (blue) and downstream of (green).

5. Linking upland habitat solutions for NFM benefit



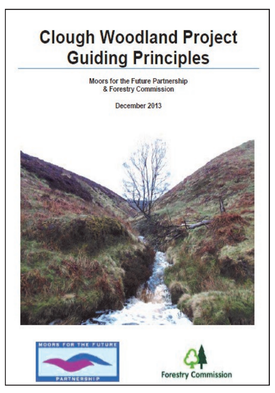
Address lower priority blanket bog issues within the same water body catchment

In addition to addressing the priority blanket bog issue of bare and eroding peat, within catchments containing C@R we are investigating other priority conditions including blanket bog dominated by (top left), purple moor grass (top right) and cotton grass (bottom left). On these areas we aim to diversify towards Favourable Condition (with indicator species), particularly Sphagnum mosses. Sphagnum greatly increases surface roughness to 'slow the flow' (bottom, right).



Upland woodland restoration and creation

We have developed a programme of works under the 'Woodland for Water' initiative of the UK Forestry Commission and Environment Agency (EA). This aims to create and manage woodlands for WFD and flood risk reduction objectives. Spatially targeting efforts on the slopes below blanket bog restoration will deliver additional NFM benefits.



Development of guiding principles for creation of woodland in upland valleys (cloughs)

Development of guiding principles established the process, methods and outcomes of potential upland woodland creation within the SPM SAC, Peak District National Park and Dark Peak and South Pennines SSSIs (a UK conservation designation) to support successful woodland creation schemes within these protected and sensitive landscapes.

6. Case study – the Pennine town of Glossop

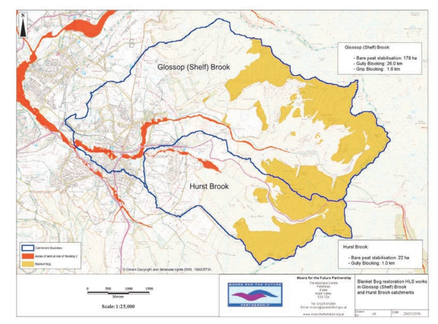
Glossop is a town at the foothills of the Dark Peak hills within the SPM SAC. It is the largest upland community at risk of flooding in the region with ~270 properties classified at risk of flooding (right top).

Identifying the NFM opportunity
We are delivering two agri-environment schemes in conjunction with Natural England (NE - statutory conservation organisation) and landowners, within the two main waterbody catchments above Glossop. These will stabilise 200 ha of bare peat, 27 km of erosion gullies and 1.6 km of drainage grips to a value of £1.3 Million. Because of our work evidencing the impacts of these works on NFM, and because the statutory agency responsible for Flood Risk Management, the Environment Agency (EA), is also part of our partnership we identified the NFM benefit that these schemes would deliver.

Communication of works and plans to the statutory flood risk agency (EA)
Details of schemes and potential NFM benefits were communicated to the EA in order that: 1) the works could be factored into forecasts and plans; 2) to highlight NFM investment into the catchments / C@R that could be used as leverage to unlock additional FRM funds; 3) inform more efficient and effective us of flood risk management specific funds.

Trials of gully blocks optimised for NFM benefit
With the permission of NE, we will be trialling gully block designs optimised for temporary storm water storage within the schemes.

Scoping and working up additional NFM opportunities in the catchments
On the back of this work the EA have provided funds for us to scope out upland (clough) woodland creation opportunities with the catchments for additional NFM benefits.



We'd be very happy to hear from anyone who is doing similar work to share learning and experiences of what's worked, and not worked

Contact us:

www.moorsforthefuture.org.uk

@moorsforfuture Moors for the Future

A Moors for the Future Partnership project in the EU designated South Pennine Moors Special Area of Conservation.

Delivered by the Peak District National Park Authority as the lead and accountable body (the Coordinating Beneficiary).

On the ground delivery is being undertaken largely by the Moors for the Future staff team with works also undertaken by the National Trust High Peak and Marsden Moor Estate, the RSPB Dove Stone team and Pennine Prospects (the Associated Beneficiaries).

Funded by the EU LIFE programme and co-financed by Severn Trent Water, Yorkshire Water and United Utilities.

With advice and regulation from Natural England and the Environment Agency, and local advice from landowners.