BogFest 2017

Poster Abstracts

Impact of Blanket Bog Restoration and Drain Blocking Techniques on Vegetation and Insects on Migneint

Stefanie Carter
Aberystwyth University

In the beginning of 2011, eight ditches were blocked, four of which were dammed (construction of peat dams) and four were reprofiled (compressing of base of ditch, infilling, replacing of vegetation and construction of dams), whilst four ditches were left open. In 2015 and 2016 vegetation was surveyed in areas adjacent to all twelve ditches, soil moisture readings were taken, emergence traps were set up in order to catch adult crane flies and pitfall traps were erected to catch ground beetles. Grass and sedge cover was higher next to reprofiled ditches, *Sphagnum* cover was higher next to reprofiled ditches and dwarf-shrub cover was higher next to open ditches. These results suggest that ditch blocking was beneficial for vegetation but the response was not consistent across both blocking techniques, possibly due to high variability in the system. Crane flies and ground beetles did not show any pattern in respect to the blocking treatments. This may be due to a lag effect or an indifference of the insects to restoration if drainage had not altered their habitat too severely. Weather patterns may have had a strong impact on insect populations during the field seasons.

Mend our Mountains

Estée Farrar
British Mountaineering Council

Water Management at Canal & River Trust

Sarah Edwards
Canal & River Trust

Water is the lifeblood of the canals and rivers that we care for. The canal network has a rich engineering heritage that can prove challenging from a water management perspective. As well as providing water for navigation, the water also supports the riparian environment, including Sites of Special Scientific Interest and a multitude of canal-side businesses. This poster describes some of the roles of the Water Management team within the Canal & River Trust and the strategic work being carried out to maintain and protect the water supply for the future.

For Peat's Sake: Gathering the Evidence on What Works in Wetlands

Claire Wordley & Nigel Taylor
Conservation Evidence

We have gathered the global evidence on what works to conserve and restore peatlands, which will soon be available online for free. Come and find out more about what we've found out and how you can get involved!

NATURA 2000 MOORS FOR THE FUTURE PARTNERSHIP IUCN National Committee United Kingdom Peatland Programme Life

Is there LIFE on Irish Raised Bogs? The Living Bog Story

Ronan Casey
The Living Bog. LIFE Raised Bog Restoration Project

The largest raised bog restoration project ever undertaken in Ireland is currently underway thanks to a partnership between the EU LIFE Programme and the Irish government's Department of Culture, Heritage and the Gaeltacht.

'The Living Bog' is set to improve over 2,600 hectares of raised bog on 12 individual raised bogs across seven counties and, in turn, raise awareness and appreciation of this unique Irish landscape. Ireland's raised bogs date back over 10,000 years and are among the world's oldest surviving, near-natural ecosystems. They are home to hundreds of rare plants and many of Europe's rarest animals, birds and insects, but they have almost completely disappeared.

Over 310,000 hectares were mapped in the 1800's but today, less than 8% is suitable for conservation and within Ireland's SAC network of 53 individual bogs, just 1% is said to be active, living bog. With 60% of the remaining raised bog habitat in Western Europe held in Ireland, the onus is on the Irish to restore what they have left.

Often referred to as Ireland's rainforest, living bogs are of great importance for biodiversity, flood control, carbon storage, education and science.

Bogs were intricately linked with Irish culture and tradition, but the demand for peat moss by the horticultural sector, the use of peat for electricity generation and the mechanisation of turf-cutting accelerated their decline. Practically every Irish bog was 'opened' for drainage, with most mortally wounded.

Thanks to the EU LIFE Nature + Biodiversity fund, that decline is to be stopped somewhat. Over 15,000 dams on almost 200km of drains will help, but there's more to The Living Bog than that… The project aims to secure local community co-operation, and foster a greater national understanding of the importance of Ireland's raised bogs. As local communities take ownership of the bogs, there will be a significant socio-economic spin-off for them. The project will also pilot many hydrology and restoration techniques, so Ireland's raised bogs can once again become the lungs of Ireland.

EnviroSAR Managing Wildfire Disturbance in Moorlands and Heathlands: Introducing the Moors for the Future Pilot

Gail Millin-Chalabi, Ioanna Tantanasi & Adam Johnston
EnviroSAR Ltd

Systematic monitoring of burned areas as a result of wildfires is challenging in UK moorlands and heathlands due to a lack of resources to regularly survey post-fire damage on the ground (McMorrow, 2011). In addition, current Earth Observation (EO) services such as the European Forest Fire Information System (EFFIS) use optical data, which provide only limited temporal coverage due to the regular occurrence of cloud cover in these more temperate moorland and heathland ecosystems (Millin-Chalabi, 2016). EnviroSAR address these limitations by using Synthetic Aperture Radar (SAR) and Interferometric SAR (InSAR) for delivering regular burned area information derived from Sentinel-1A and -1B data. The SAR/InSAR technique has previously been demonstrated for characterisation of wildfires pre-2011 using the older C-band and ASAR sensors (Millin-Chalabi et al., 2014, Millin-Chalabi, 2016 and Amici et al., 2016). To deliver a first pilot for UK moorlands EnviroSAR is collaborating with Moors for the Future Partnership (MFFP) to validate SAR/InSAR results with ground based datasets. Furthermore, an initial Spatial Data Infrastructure (SDI) using ERDAS APOLLO Enterprise has been developed to deliver burned area results for the MFFP pilot in the Peak District National Park.

The bespoke EnviroSAR geoportal is currently hosted at The University of Manchester and is supported by our technical partner Sterling Geo and the Satellite Applications Catapult as a result of EnviroSAR winning the Copernicus Masters Sustainable Living Challenge in autumn 2016. This new downstream EO initiative aims to help wildfire stakeholders (water companies, conservation groups, insurance companies, fire and rescue services) better understand patterns of wildfire occurrence in the UK to address more effectively the economic and environmental issues caused post-fire (response costs, erosion, flooding, water discolouration).

Long Term Peatland Monitoring Network

Clifton Bain
IUCN UK Peatland Programmge

The IUCN UK Peatland Programme (IUCN UK PP) has highlighted major gaps in basic peatland monitoring, particularly in relation to erosion of degraded peatlands, subsidence (which influences commonly deployed monitoring such as dipwells) and the recovery of peatland vegetation post-restoration. Current funding for this type of 'routine' or 'traditional' monitoring is limited and often short term. There is also a lack of coordination and coherence among different peatland projects where data is gathered.

Useful data can be generated though 'simple monitoring' i.e. using low tech equipment that can be installed without specialist input e.g. cranked wires to measure *Sphagnum* growth, copper rods to look at water table depth fluctuations, peat anchors to provide a baseline for peat loss/accumulation. Engaging organisations with the staff and support to gather and maintain relatively easy to collect data over long periods can provide valuable long term data sets, which are currently lacking. Even where projects are short term, having a coordinated, standardised set of baseline monitoring plots will be useful in allowing future comparisons. Data relating to these processes could help to support management interventions, refine metrics for the Peatland Code, inform the limit of influence of peatland drainage etc. In addition, building a network of monitoring plots through a collaborative project has the potential for improving communication between partners and raising awareness of peatland issues among the wider audience. Examples of iconic monitoring plots include the Holme Fen post and the Black Hill trig point.

The Peatland Code

Jillian Hoy
IUCN UK Peatland Programme

The Peatland Code is an example of an innovative funding mechanism to help restore and conserve peatland ecosystems as a key part of our global natural capital. Despite the growing recognition of peatland importance, the scale of funding currently available is insufficient to tackle the threats and past damage. Historically peatlands were valued only as a resource to be damaged and converted into something else due to the lack of awareness of the benefits of healthy peatland ecosystems and the costs to society arising from their damage. A new era for peatlands demands that society ensure that the values of peatlands are reflected in the support given to those who manage them sustainably. In this way, new partnerships can be supported with local communities, farming and other land managers and NGOs working collaboratively with business to secure healthy peatlands.

The emergence of various ecosystem markets, primarily carbon but potentially other services, provides an opportunity to bring private funding alongside government funds to help secure peatland conservation and restoration. Various compliance markets do exist that include peatlands, but these apply only in developing regions of the world despite the fact that the developed nations are hotspots for greenhouse gas emissions from damaged peatlands and urgently need funds. The voluntary market is available globally but peatland restoration is not usually economically viable in a market where the price of carbon is low. The Peatland Code has been established to help overcome these barriers and provides a mechanism that can attract investment for a wide range of benefits and engages with businesses' social corporate responsibility.

Peatland Project Map – An Online Tool for Sharing Case Studies

Joanna Richards
IUCN UK Peatland Programme

The Peatland Project Map is an online tool that showcases peatland projects, be they restoration, research, sustainable management, community engagement or communications, with a particular focus on UK case studies. Based on the Peatland Compendium, which was created following a 2009 Defra-funded project and managed by Moors for the Future Partnership, the map has been re-launched and is ready to accept new peatland case studies.

This poster provides an introduction to the tool and information on what it displays and how it might be used.

NATURA 2000
MOORS FOR THE FUTURE PARTNERSHIP
IUCN National Committee United Kingdom Peatland Programme
Life

Sphagnum Restoration on Degraded Blanket and Raised Bogs in the UK using Micropropagated Source Material: A Review of Experimental Trials

Simon Caporn
Manchester Metropolitan University

There is an increasing demand for a supply of *Sphagnum* to facilitate the restoration of bogs in damaged landscapes and in the developing practice of *Sphagnum* farming. Usually, *Sphagnum* is translocated from donor to receptor sites and spread at a diluted rate to cover large areas of bare or degraded peatland. However, this practice is often constrained by a limited source of local, donor *Sphagnum* of the desired species and by a range of difficulties inherent in the transfer of the moss from one site to another. To overcome these problems, here we describe the propagation of *Sphagnum* from vegetative material in sterile tissue culture and the potentially unlimited production of juvenile plants in a variety of forms. Field trials on degraded upland blanket bog and on a lowland cut-over peatland in northern England over 10 years explored the planting methods and potential of this new approach for *Sphagnum* production. The challenges faced in establishing micropropagated *Sphagnum* plants on peatland surfaces in challenging environments appear comparable to the usual issues encountered in conventional *Sphagnum* restoration and cultivation. Our results show that micropropagated *Sphagnum* provides a productive and reliable form of propagule offering great potential in restoration and *Sphagnum* farming.

Sphagnum Micropropagation

Neal Wright
Micropropagation Services Ltd

17 species have now been micropropagated to provide large quantities of clean, pest, disease and weed-free *Sphagnum*. Micropropagated *Sphagnum* of a wide range of species has been shown to establish and grow profusely on both upland and lowland restoration sites, with BeadaHumok™ (micropropagated *Sphagnum* grown into small hummocks); BeadaGel™ (long strands of micropropagated Sphagnum in protective, nutrient gel) or BeadaMoss® (tiny *Sphagnum* plants in solid gel, protecting and supporting growth and allowing easy handling/distribution). The latest results of trials are reported.

A View of the Moors for the Future Partnership's MoorLIFE2020 Project

Charlotte Kenyon
Moors for the Future Partnership

Conservation works to protect blanket bog in the South Pennines SAC will include bare peat stabilisation works, raising water tables and improving water quality by blocking erosion gullies, re-introduction of native shrubs, managing invasive species, and increasing the diversity of and amount of *Sphagnum* moss.

Monitoring works will include producing a baseline land cover map, monitoring biodiversity and ecosystem services and wider landscape scale changes in vegetation cover. Socio-economic impacts and benefits to moorland users including visitors, businesses, agricultural and land management will also be part of the monitoring activities. A programme of engagement activities will include working with landowners and managers, and engaging with urban and rural communities.

The €16 million project will receive €12 million funding from the EU LIFE programme, the largest ever award to a UK nature conservation project. It is co-financed by Severn Trent Water, Yorkshire Water and United Utilities.

Clough Woodland Project: A Summary of the Partnership Project to Create New Native Woodland in the Derbyshire Derwent Catchment for a Range of Benefits

Matt Buckler
Moors for the Future Partnership

Diversifying Molinia Monocultures using Sphagnum Propagules

Michael Pilkington
Moors for the Future Partnership

An increasing dominance of *Molinia caerulea* on blanket bogs of the South Pennines and other upland habitats is widely attributed to decades of inappropriate regimes of burning and grazing, aided by the deposition of atmospheric pollutants. The long-term objective for many such degraded habitats is for their restoration towards habitats that are rich in indicator species, including Sphagna. Traditional methods of controlling *Molinia* consist of repeated cycles of high disturbance activities including burning, herbicide spraying and flailing, followed by seeding. The aim of this trial is to increase the cover and number of *Sphagnum* species on blanket bogs dominated by *Molinia* swards using a single flailing intervention, accompanied by the application of *Sphagnum* propagules.

Mapping at a Landscape-Scale – an Illustration of the Challenge of Working Across the Multiple Boundaries in the South Pennines Special Area of Conservation

Jorge Auñón
Moors for the Future Partnership

Optimising Restoration for Ecosystem Services: A Case Study on How we can Tailor Capital Works to Increase Flood Risk Reduction Benefits

Matt Buckler
Moors for the Future Partnership

Restoration Management Recommendations for Restoring Bare Peat

Matt Buckler
Moors for the Future Partnership

Sphagnum Reintroduction in the South Pennines – Advances to Date

Matt Buckler
Moors for the Future Partnership

Trajectories Towards Recovery on Blanket Bogs

Michael Pilkington
Moors for the Future Partnership

The uplands of the Dark Peak and South Pennines contain some of the most highly degraded upland blanket bog habitats in the world, with extensive areas of eroded bare peat, a paucity of indicator species, especially peat forming *Sphagnum* mosses, in addition to lowered water tables and increased storm flows. Since 2003, Moors for the Future Partnership have carried out extensive restoration work on these areas (discussed in Buckler et al., 2009) and, through intensive monitoring regimes, have found strong trajectories of recovery towards Favourable Condition. However, much work remains. This poster outlines some of the results so far and our objectives for the future.

Cumbria BogLIFE

Andrew Cole
Natural England

The county of Cumbria in north-west England still has 5,480 ha of lowland raised bog, of which 1,178 ha is degraded. Therefore, there is an urgent conservation need to restore these raised bogs. The Cumbrian BogLIFE+ project targets the restoration of degraded lowland raised bog within three Natura 2000 network sites: Bolton Fell Moss, South Solway Mosses and Roundsea Wood and Mosses. These sites have a combined area of 2,807 ha, representing around 50% of lowland raised bogs in Cumbria.

Monitoring Restoration of the Humberhead Peatlands National Nature Reserve

Richard Smith
Natural England

This poster will outline the monitoring undertaken as part of the LIFE-funded restoration project on the lowland, raised bogs of the Humberhead Peatlands National Nature Reserve, South Yorkshire. It has been achieved through a partnership between Natural England and the University of York. Monitoring has covered a range of physical, biological and socio-economic approaches: from assessing water level changes to responses of nightjar, invertebrates and vegetation, plus assessments of ecosystem services.

A Modelling Approach to Identify Peat Depth and its Use within Habitat Management Plans

Ida Bailey
Natural Power Consultants

Peat bogs are a valued feature across many upland areas of Wales. These upland areas also provide a good wind resource, which has led to many wind farms being located in these areas. As a result of the planning process, many wind farm developments commit to the restoration of the peatland on which the wind farm is located, often through the implementation of a Habitat Management Plan (HMP). Natural Power Consultants were commissioned to produce a HMP for the Pen-y-Cymoedd Wind Farm, South Wales. The development comprises of 76 turbines and has a proposed HMA of 1,441ha. In order to identify the macrotope peat bodies present within the HMA, peat depth information was required. Due to the extent of the HMA and the labour costs associated with peat probing the entire area, a peat depth modelling approach was adopted. Predictive models of the presence of deep peat given three predictors (slope, elevation and topographic wetness index) were built with boosted regression trees (BRT), with 10-fold cross validation, using the dismo package in R. Peat depth data were divided into a training dataset, used to calibrate the models, and a testing data set, used to evaluate model predictive performance. Eight models were fitted in total, each with different settings. The best model contained 3,200 trees and classified 75% of the test data correctly. The top model found that slope and elevation were the most influential predictors, with relative contributions to the model of 39% and 36%, respectively. Topographic wetness index contributed 25%. Predicted extents of deep peat within the HMA were mapped using this model, which was then used to inform the habitat management prescriptions for the site. This model provides a valuable resource for rapidly assessing and understanding the presence of deep peat habitats present within a site.

Pennine PeatLIFE: Peatland Restoration in the Northern Pennines – Colder, Wetter & Higher

Alistair Lockett
North Pennines AONB Partnership

Overview of the Pennine PeatLIFE Project. A multi-year peatland restoration project run in partnership by the North Pennines Area of Outstanding Natural Beauty (AONB) Partnership, Yorkshire Wildlife Trust and the Forest of Bowland AONB Partnership. It aims to restore damaged peatlands across three protected landscapes in the North of England.

Application of Terrestrial Laser Scanning to Quantify Erosion Rates in Blanket Bogs of North Spain

Guaduneth Chico León & Ben Clutterbuck
Nottingham Trent University

Blanket bogs are rare and protected priority habitats that form extensively in oceanic climate conditions in the northern Hemisphere. In North Spain, blanket bogs have been studied mainly in Galicia. In other regions of north Spain only one blanket bog (Zalama, in the Basque Country) has been identified and is now protected. In 2017, the author discovered further significant areas of blanket bog in the Cantabria and Castilla y León regions. These areas, unmapped until now, are unprotected and experiencing significant erosion pressures. Quantifying the rate of erosion in these areas and determining whether restoration actions at Zalama have been successful is key to promoting further blanket bog conservation efforts in Spain.

This study uses Terrestrial Laser Scanning (TLS) to map and monitor erosion in three of these blanket bog areas (Zalama, Ilsos de Zalama and Collado de Hornaza). A number of 'fixed' survey pins to align multi-temporal scan data were installed at these sites and areas were surveyed in May and July 2017. TLS provides ultra-high resolution (<1.5 mm) data and it was possible to compare the two datasets to identify areas of erosion and accumulation.

Alignment of multi-temporal scans with an accuracy < 6.5 mm was achieved and erosion has been detected in all three study sites. At Zalama, where bare peat stabilisation has been undertaken, very little change determined (-2.09 mm ± 2.63 mm). In the other two areas where peat is exposed to natural erosion and livestock trampling, significantly greater ($p < 0.05$) rates of change from -9.90 mm ± 6.70 mm (Ilsos de Zalama) to -25.78 mm ± 23.67 mm (Collado de Hornaza) were identified.

The rates of erosion determined over a period of two months in unprotected areas are extremely high for peatland ecosystems. Restoration actions appear to have had a significant impact on these, and may predominantly occur as a result of the exclusion of livestock. This suggests that further restoration should be undertaken in unmapped areas of blanket bogs in north Spain to preserve this habitat for future generations and improve the biodiversity and peatland status.

Impacts of Gully Blocking on Blanket Peat Designated a GCR (Geological Conservation Review) Feature: Featherbed Moss, Peak District, UK

Jillian Labadz, Ben Clutterbuck, David Butcher, Roger Hart, David Topliss & Nicholas Midgley
Nottingham Trent University

A collaboration between the National Trust and Nottingham Trent University is monitoring impacts of gully blocking on blanket peat. Thomason's Hollow (north side of Featherbed Moss) is designated for its geological interest. Ten adjacent gullies were selected; six for blocking, four controls. Data presented here range from April 2013 to March 2017, with blocks installed in 2014. Two approaches were adopted, blocking either the top 50-100 m or the entire length of each gully.

Erosion pins were installed for a relatively short time prior to blocking. No significant differences were found between gullies in that time. During two full years after blockage, the majority of pins experienced lowering of surrounding ground level, but no gully experienced median annual lowering >10mm. Fully blocked gullies had statistically lower erosion rates than the other treatments. There is therefore clear evidence that the gully blocking has not made erosion worse. However, numerical differences are small and it is not yet clear that there is a causal beneficial relationship.

Blocked gullies showed reduced flow compared to control gullies. Where dams are installed on the entire length, a greater impact on flow is observed compared to those where only the top is blocked. There is no clear change in water table levels across the site. Only seven of the 58 dipwells are adjacent to pooled water following blocking. Compared to some other locations, the gullies here are deeper, and when pooled, the water level in the gully is often not near the top of the gully. Prior to blocking, there was no significant difference in water quality between gullies. Post-blocking, water colour (Hazen), UV absorbance and DOC concentration were all significantly lower in blocked gullies. The improvement in water quality may arise from reduced 'within-gully' peat decomposition and continued monitoring is advised.

How can Community Approaches to Flood Resilience Add Value

Robin Gray[1], Stuart Bradshaw[2], Bede Mullen[3] & Amanda McDermott[4]
[1]South Pennines Local Nature Partnership; [2]Terrain Geotechnical Engineers, [3]University of Central Lancashire & [4]2B Landscape Consultancy Limited

In December 2015, the Calder Valley suffered the most significant flooding event in recent times. 2,781 homes and 4,416 businesses were flooded causing unparalleled and significant damage. In the aftermath of these events there has been an emphasis on emergency response, recovery and resilience (Andrew, 2015).

Citizen science has been seen as a way of increasing collective knowledge of historical flood events and also helping to predict future events both here and abroad (Le Coz et al., 2016) but there has been little research on the use of citizen science to increase resilience at the community level.

Slow The Flow Calderdale is an unincorporated charitable organisation founded in 2016. Volunteer-led including engineers, scientists and land managers/ specialists; the group works alongside statutory services to understand flood events and work on practical solutions. The group has:

- Found willing landowners to implement small scale Natural Flood Management measures
- Worked with schools and community groups to implement monitoring using simple single-board computers (i.e. Raspeberry Pi)
- Carried out river surveys with volunteers to help validate hydrological models
- Created a volunteer workforce to assist in implementing Natural Flood Management measures
- Raised awareness amongst residents, working with schools and universities to deliver a Science of Floods workshop and showing how residents can help themselves to 'slow the flow' through developing household projects including rain-gardens and reducing flow from individual properties.

The poster will address the opportunities and challenges of the Slow the Flow approach.

United Utilities' SCaMP Project: Monitoring of the Effects of Blanket Bog Restoration over a Decade

Sarah Ross
Penny Anderson Associates Ltd

United Utilities' Sustainable Catchment Management Programme (SCaMP) aims to improve catchment quality for nature conservation, raw drinking water and carbon retention via implementation of a suite of habitat restoration measures e.g. grip blocking and bare peat restoration. Monitored over a 10-year period, and set to continue to 2020, the results form a significant dataset for the analysis and interpretation of the effects of restoration on peat groundwater levels, water colour production/release and vegetation. Data from SCaMP catchments in the North-West of England are presented and discussed.

Developing a Peatland Management Portal for Priority Upland Habitats in the UK

Lydia Cole
Rezatec

The UK's extensive peatland resource is a key component of the nation's carbon storage and sequestration facility, as well as a source of drinking water for the majority of the population. After decades of drainage, over-grazing and other anthropogenic impacts, many of our peatlands are in a highly degraded state. In order for Water Companies to continue to extract drinking water from these ecosystems and to reduce the cost of downstream processing, primarily through more sustainable upstream catchment management, the condition of the UK's peatlands needs to be better understood. Rezatec is working with a number of UK Water Companies to develop a low-cost tool for monitoring peatland condition over large, remote areas. Through a combination of open-source satellite-derived data and strategic ground surveys, we are developing a landscape intelligence tool that can be used to map peatland extent, depth and integrity across water catchments.

RSPB & United Utilities Dove Stone Partnership

Dave O'Hara
RSPB

Restoration of blanket bog and wider moorland edge habitats at Dove Stone in the north-west of the Peak Distict National Park has continued the ground-breaking work of United Utilities' Sustainable Catchment Management Programme. Our aim is to increase biodiversity, improve water quality and enhance the visitor experience across the 4,000 ha partnership area. Following bare peat restoration, water table restoration and innovative approaches to *Sphagnum* establishment are the main elements of our blanket bog work, and local volunteers have been key to success. Monitoring of bird populations is showing ongoing increases in breeding wading birds. The Partnership won the Natura Award for Conservation in 2016, recognition of excellence in the management of a Natura site.

Natural Flood Management in the Trent Catchment

Chloe Palmer
The Trent Rivers Trust

The Trent Rivers Trust has delivered a number of Natural Flood Management projects in the lowlands. We have worked with farmers to create NFM features on farmland and to restore the connection between the river and the floodplain. Our poster will be a simple illustration of how we identify the scope for NFM measures and some practical examples from our projects across the Trent catchment.

The Effect of Weathered Bedrock on Pool Water Chemistry in Highly Eroded UK Peatlands

Clare Gee
University of Leeds

Over past decades the UK peat uplands have suffered from severe erosion on a widespread scale, due to historical pollution and land use practices. This has resulted in increasing levels of carbon loss to atmosphere and in water runoff as dissolved and particulate organic carbon (DOC and POC). In some areas, such as the Peak District, deep erosion gullies have formed, cutting through metres of peat to the bedrock below and holding shallow pools of peaty water. Laboratory column experiments were used to investigate the effects of the interaction of weathered bedrock, from three geologically distinct areas (limestone, coarse sandstone and schist), with peaty water, testing the hypothesis that the rock type would significantly affect the water chemistry and the DOC and POC in the water. Results indicate that the different bedrock chemistry does have a significant effect on the pool water. Over the 40 days of the experiment, changes in cation and anion content and pH were observed to be different for each rock type, along with differences in water colour which is a proxy for the organic content composition. These were significantly different for several measures from the control columns of pool water without any bedrock. On limestone and schist-rich clays, the higher pH and higher concentrations of Ca, Al, Fe and Mg ions appears to inhibit the loss of carbon through the formation of organo-metal complexes which form precipitates and settle out to some degree. This was observed to a much lesser degree on coarse sandstone bedrock. This has implications for upland restoration practice where erosion to bedrock has occurred and the treatment of water containing DOC.

Blanket Peatland Restoration Leads to Reduced Storm Runoff from Headwater Systems

Emma Shuttleworth[1], Tim Allott[1], Martin Evans[1], Mike Pilkington[2], Jon Walker[2] & David Milledge[3]
[1]University of Manchester; [2]Moors for the Future Partnership & [3]Durham University

Headwater catchments across the UK are important sources of runoff generation, but are significantly degraded by peat erosion which has been linked to increased flood risk downstream. Over the past 15 years there has been a proliferation of projects to restore the structure and function of upland blanket mires, primarily through the alteration of surface cover by revegetation of bare peat and the blocking of erosion gullies. These restoration measures have potential to alter stormflow delivery from blanket peat catchments and contribute to Natural Flood Management, but their impacts on headwater storm hydrographs and the implications for downstream flood risk are currently poorly quantified.

This paper reports a five year, before-after-control-intervention (BACI) study of peatland water tables, overland flow generation and storm hydrograph characteristics at three experimental headwater micro-catchments in the South Pennines, UK. This represents the first rigorous experimental assessment of the impact of blanket peat restoration on catchment runoff. We evaluate the hydrological impacts of two standard blanket peat restoration interventions; revegetation of bare peat, and revegetation of bare peat with additional gully blocking.

Following revegetation there was a significant decrease in depth to water table and an increase in the prevalence of hillslope overland flow production. There were no significant changes in storm runoff coefficient (volume of stormflow runoff) following either restoration treatment. Storm hydrographs following revegetation had significantly longer lag times (106% increase relative to the control), reduced peak flows (27% decrease relative to the control), and attenuated hydrograph shapes. With the addition of gully blocking the effects is almost doubled, with lag times increased by an extra 94% and peak flows reduced by an additional 24% relative to the control.

Nature based solutions to flood management typically focus on either enhancing water storage or slowing the transmission of water through the catchment. Upland peatlands are often mischaracterised as ‘sponges’, and assumed to mitigate downstream runoff through additional storage. However, this study suggests that the primary process controlling the observed changes in storm hydrograph behaviour is retardation of overland stormflow due to increased surface roughness. The significant changes to lag times and peak flow provide a convincing evidence base that the restoration of degraded headwater peatlands can contribute to Natural Flood Management and the reduction of downstream flood risk.

Charcoal Production and Degradation in Peatland Vegetation Fires

Oscar Kennedy-Blundell
University of Manchester

Peatlands are important due to their high carbon storage and carbon sequestration potential, with UK peatlands storing an estimated 2-5 billion tonnes of carbon. These ecosystems are often subjected to rotational prescribed burning, as well as episodic uncontrolled wildfires. Biomass is consumed in fires where some is emitted to the atmosphere as gases and particulates, and some converted to charcoal.

Charcoal is sometimes referred to as black carbon (BC). Although only a small amount of BC may be produced in a fire, it is very rich in carbon, and work suggests that BC may persist in the environment for hundreds or even thousands of years. The high carbon density and long residence time of BC make it an important part of the carbon cycle, yet the production and subsequent degradation of BC from peatland vegetation fires is under-researched.

My PhD will investigate the physical and chemical characteristics of BC produced under a range of burn conditions. In addition to this, degradation studies will be carried out in both field and laboratory to assess how elemental and physical characteristics of BC change with sample exposure over time. This poster will outline the aims and key methods of planned research activities.

Controls of Fluvial Carbon Flux from Eroding Peatland Catchments

Sarah Brown
University of Manchester

Fluvial networks are being recognised as areas of carbon transformation, with eroded particulate organic carbon processed to dissolved organic carbon and CO_2, completing a pathway for eroded terrestrial organic carbon to be released into the atmosphere. Previous studies indicate biodegradation and photodegradation as key processes affecting the transformation of organic carbon in fluvial systems, with initial concentrations of dissolved organic carbon (DOCi) identified as a control on the rates of carbon mineralisation. This experimental study manipulates temperature and incident light intensity to investigate carbon mineralisation processes in ex-situ simulations of erosion into peatland fluvial systems. By directly measuring gaseous CO_2 emissions the relationship of temperature and light intensity to carbon processing was identified. When no particulate organic matter (POM) is added to experimental flasks, simulating a system not impacted by erosion, biodegradation is consistently the dominant process affecting mineralisation, independent of sample DOCi. Sample DOCi accounts for 79% of the variation seen in models of carbon efflux from simulated erosion experiments, while temperature and light intensity account for 11% and 3% respectively. When POM is added to samples with a low DOCi, temperature continues to be the dominant variable driving mineralisation rates. However, the same scenario with samples having a high DOCi, CO_2 production is driven by photodegradation and models of CO_2 efflux are more accurate if light intensity is log10 transformed. This study presents novel data regarding the interaction of environmental variables and fluvial carbon processing, suggesting peatland erosion introduces further complexity to these dynamic systems where processes and variables are interdependent. Given anthropogenic climate change is thought to be a dominant risk factor perpetuating peatland erosion, understanding the role and fate of eroded POM is likely to be of increasing importance to carbon budgeting and ecosystem function studies.

Tracing Peatland Geomorphology: Sediment and Contaminant Movements in Eroding and Restored Systems

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The blanket peats of the Peak District, Southern Pennines, UK, embody many problems and pressures faced by peatlands globally, and are amongst the most heavily eroded in the world. In severely eroded peatlands, topography is highly variable, and an appreciation of geomorphological form and process is key in understanding the controls on sediment release, and in mitigating the negative impacts of peatland erosion. The near-surface layer of the peat is contaminated by high concentrations of anthropogenically derived, atmospherically deposited heavy metals, and whilst not desirable, this legacy of lead pollution and its release offer a unique opportunity to trace peatland sediment movements.

Several mechanisms and controls have been shown to be important influences on particulate carbon (POC) and lead (Pb) release (i) the presence of vegetation is key in stabilising the peat's surface and trapping mobilised sediment; (ii) sediment preparation influences the timing of POC and Pb release; (iii) antecedent water tables may control the timing and the nature of sediment entering the fluvial system during storm events; and (iv) the degree of degradation influences both Pb storage and release. At the landscape scale, peatland restoration significantly mitigates sediment production in eroding peatlands and substantially reduces carbon and pollutant export. At the catchment scale, sediment preparation and hydrological connectivity are important controls on the magnitude and timing of sediment and lead fluxes from eroding peatland catchments. At the plot scale, complex small scale spatial patterns of contaminant storage in eroding headwater catchments can be explained by interactions between topographic setting and vegetation cover, and the mobilisation of sediment by wind and water.

This deeper understanding of sediment movements is important in the context of: (i) the release and reworking of legacy contamination and carbon; (ii) the response of blanket peats to climate change; (iii) informing future restoration strategies.

Trajectories of Water Table Recovery following Re-vegetation of Bare Peat

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The restoration of eroding UK peatlands is a major conservation concern, and landscape-scale interventions through the re-vegetation of bare peat is becoming increasingly extensive in areas of upland Britain. Water table is the primary physical parameter considered in the monitoring of many peatland restoration projects and there is a wealth of data on individual monitoring programme, which indicates that re-vegetation significantly raises water tables. This paper draws on data from multiple restoration projects carried out by the Moors for the Future Partnership in the Southern Pennines, UK, covering a range of stages in the erosion-restoration continuum, to assess the trajectories of water table recovery following re-vegetation. This generated projections of future water table recovery, which will be of benefit to land managers and conservation organisations to inform future restoration initiatives.

Long Term Subsidence Monitoring by using the ISBAS InSAR Technique: Validation over Bad a Cheo Forest, North East Scotland

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This work evaluates the accuracy of interferometric synthetic aperture radar measurements of peatland surface motion. This is achieved by comparing the results obtained using the interferometic ISBAS technique to field data from the Bad a Cheo forest in the Flow Country in the North East of Scotland. 56 ERS C-band images, covering the period 1992-2001, and 46 Sentinel-1 C-band images, covering the period 2015-2016, were used for the analysis. We show that the ISBAS measurements are able to identify deformation patterns over peatland areas where deformation is a consequence of afforestation, climate change and drainage. It was found that the ISBAS results agree with the trend as measured on the ground although the rates themselves are smaller than the levelling benchmarks, particularly over forested areas where the coherence is less stable; in non-forested areas, over points with more stable coherence, there is better quantitative agreement. These results show that there is a potential for the ISBAS method to be able to report on trends in subsidence and heave over peatland areas. With Sentinel-1 satellite radar acquisitions now every six days, there is the possibility of improved coherence and confidence over forested and non-forested areas alike across the whole of the UK.

Use of Satellite Radar to Measure Seasonal Fluctuations in Water Table Depth over Peatland

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Over an 18 month period differential interferometric synthetic aperture radar (DInSAR) was used to determine a time series of surface motion over both slow growing wet healthy peatland and dry subsiding degraded peatland. Seasonal trends in surface motion were extracted from time series of surface motion. Two distinctly different trends were observed. Drier subsiding sites display maximum uplift in the late winter (Feb/Mar) and maximum subsidence in the late summer early autumn (Sept/Oct). Wetter growing sites display maximum uplift in early winter (Nov/Dec) and maximum subsidence in mid-summer (May/June). To test a preliminary hypothesis that this surface motion is a response to changes in water table depth an InSAR time series from a wet *Sphagnum* dominated peatland within the Munsary peatlands was compared to simultaneously measured water table depths, and rainfall from the nearest weather station at Wick Airport. Results clearly show that over healthy *Sphagnum*-rich peatland DInSAR results correspond to both seasonal and higher frequency changes in water table depth. Although more work is required to check reproducibility over a range of peatland types and conditions these results illustrate the potential of DInSAR to track meaningful variations in water table depth.

Quantifying Carbon Accumulation and Loss in Afforested Peatlands

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Over the course of the Holocene the development of peatlands has led to the storage of up to 600 Gt carbon globally. There is a growing recognition that these deposits are of international importance, and must be understood and conserved. This was not always so. The Flow Country of northern Scotland is one of the largest blanket bogs in the world. During the late 20th Century the development of new planting techniques combined with tax incentives to encourage forestry across large areas peatland.

The effects of this planting are poorly understood. As many of the stands reach harvesting age, the question arises of whether the bogs should be restored. To address this it is of critical importance to quantify the loss of carbon from the peat, and evaluate it against the accumulation of carbon in trees.

Tephrochronology can be an important tool as part of a stock-based approach to quantify carbon in such systems. Peat deposits in the Flow Country are known to contain several layers cryptotephra originating from eruptions in Iceland (most notably Hekla 4). Recently developed core scanning techniques using x-ray fluorescence and x-radiography allow for rapid identification of these layers. The tephra may then be used to delineate isochrones in the peat, allowing for comparison between cores from forested stands and unplanted bog.

This interdisciplinary project uses paleoenvironmental techniques to answer current conservation questions. It will also provide one of the most complete records of tephra in the north of Scotland.

Application of Topographic Position Index (TPI) Tool on Unmanned Aerial Vehicle (UAV) Derived Digital Surface Models (DSM)

Mark Brown
Yorkshire Peat Partnership

This poster outlines advances we have made in the application of a Topographic Positon Index (TPI) and a Slope Position Classification (SPC) on high resolution topographic models of the surface of blanket bogs. This work came about as a means to detect fine scale variations in topography. Many physical and biological processes at work on a peat bog are highly correlated with topographic position. At the very least we can identify water shedding units and water collecting areas. By thresholding the continuous TPI values at a given scale we can categorise the surface of the bog into discrete slope position classes.

Geospatial Analysis of Degraded Peat Bog Habitats Utilising High Resolution Datasets Captured using Unmanned Aerial Vehicle (UAV) Technology

Mark Brown
Yorkshire Peat Partnership

Since 2012 the Yorkshire Peat Partnership has been using Unmanned Aerial Vehicle (UAV) technology to survey blanket bog habitats throughout the northern Pennines. During this time we have developed many techniques and methodologies to analyse the high resolution datasets that are created as a result of these surveys. This information is used to inform our restoration efforts as well as being a valuable tool for monitoring and research. Unmanned aerial vehicles play a key role within the Yorkshire Peat Partnership and are now a well-established tool within our organisation. This poster outlines some of the techniques that we have developed based around geospatial analysis of high resolution datasets. This includes but is not limited to surface analysis, hydrological analysis, 3D visualisation, automated mapping of bare peat, cross section profiles and subsurface modelling of peat reserves.

The Impacts of Restoration Work on Peatlands in the Yorkshire Dales

Jenny Sharman & Rosie Snowden
Yorkshire Peat Partnership

The Yorkshire Peat Partnership has been restoring damaged peatland sites since 2009. The restoration work is part of a continuous improvement programme, governed by regular monitoring. In 2017, the most significant findings suggest reprofiled and dammed grips have a far greater average vegetation cover (82%) than their dammed, but non-reprofiled counterparts (65%). There is also less erosion present on reprofiled grips. Although reprofiling may increase methane release as suggested by Green et al. (2011), this significantly higher rate of vegetation and decreased erosion suggests reprofiling is worthy of revisiting as a successful restoration method. Other results show average vegetation cover to be 47% on bare peat areas, two to three years after brashing, seeding and sphagnum inoculation. This suggests a need to re-visit the methodology with particular attention to improving success rates on exposed south-west facing slopes. 94% of peat dams continue to be intact up to three years after restoration work, with the outcome of grip damming suggesting a trend towards more bog-dominated vegetation, with a reduction in common heather *Calluna vulgaris*; an increase in common cotton grass *Eriophorum angustifolium*, hare's tail cotton grass *Eriophorum vaginatum*, and an encouraging increase in bog-forming sphagnum species such as *Sphagnum papillosum*.