Peatland Connections: Building Prosperity

Poster Session Abstracts

Sharing the evidence base: monitoring & research

Carbon dioxide and methane fluxes on a degraded lowland bog undergoing restoration with micro-propagated Sphagnum

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The site for this study is Cadishead Moss, an 8 ha fragment of Chat Moss, previously drained and hand-cut for peat, then colonised by trees. The Lancashire Wildlife Trust has undertaken scrub removal and re-wetting for conservation purposes and the site is now mostly re-vegetated with Eriophorum angustifolium in wetter areas and Molinia caerulea in drier areas, and an increasing cover of Sphagnum mosses, mostly through re-introduction, as local source-material is scarce.

To demonstrate the benefits of restoration in terms of the change in carbon fluxes over time, carbon greenhouse gases (GHGs) were measured with a Los Gatos Ultraportable GHG Analyzer, fortnightly during the growing season and monthly during plant senescence, over a period of two years, along with environmental variables. Measurements were made via permanent collars inserted in to areas of naturally regenerating Eriophorum angustifolium and introduced Sphagnum material, micro-propagated through tissue-culture techniques, with control plots in Eriophorum-only and bare areas.

It appears that re-wetting a degraded bog does not necessarily create large CH4 emissions, even with a cover of plants containing aerenchyma, but CO2 emissions are elevated in high temperature and low water table periods.

Do spatial models improve peat depth predictions?

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Peatlands develop due to a complex set of internal physical and biogeochemical processes and external factors such as the climate and topography. Peatlands are significant stocks of global soil carbon and therefore improving the prediction of peat depths is an important part of assessing their magnitude. Yet there have been few attempts to account for both internal and external processes when predicting peat depth. Using blanket peatlands as a case study, we compared a linear and spatial (geostatistical) model including several sets of covariates applicable to peatlands around the world that have developed over hilly or undulating terrain. We hypothesised that the geospatial model would simulate the internal processes that can mediate peat accumulations on plateaus and shallow slopes. We found that the geostatistical model performs better than the linear model in all cases. The geostatistical model better predicts areas of deeper peat and we show that its predictive performance in these areas is dependent on depth measurements being spatially auto-correlated. Where they are not, model performance is only marginally better than the linear model. Therefore, we recommend that practitioners carrying out depth surveys account for variation in topographic features, and that sampling approaches produce spatially auto-correlated observations.

Does the rewetting of peatland cause an increase in Bog Asphodel?

***Anne Hand**, Exmoor Mires Partnership*

Bog Asphodel (Narthecium ossifragum) is an indicator plant for blanket bog, most obvious as patches of the distinctive yellow inflorescences in June and July. A typical stress tolerating plant, the rhizomes persist in damp acidic conditions. Vegetative growth as ramets of fleshy, slightly curved leaves, is dependent on sufficient light and a relatively stable water table. Bog asphodel can also be poisonous to sheep and cattle causing severe photosensitivity, skin inflammation and liver damage in sheep, nephrotoxicity in cattle, and even death (ref). Both the leaves and the fruits contain harmful toxins, but ingesting Bog asphodel leaves does not necessarily cause a toxic reaction because sensitivity varies from year to year. Lambs are particularly susceptible.

The aim of the research was to assess the Bog asphodel threat to livestock grazing the shallow peatlands of Exmoor following restoration works. The distribution and abundance of Bog asphodel was measured at over 40 restored sites across Exmoor, both before and after restoration by ditch blocking. Cattle grazing behaviour was followed at two contrasting restored sites over one grazing season to assess the likelihood of cattle grazing in areas abundant in Bog asphodel. For each habitat type that was monitored the contribution of Bog asphodel to the sward quality was measured.

Monitoring peatland restoration for carbon sequestration using satellite data

***Kirsten Lees,** University of Reading*

Monitoring the carbon sequestration potential of peat bogs, particularly areas undergoing restoration, is of great interest to policy makers. Many traditional methods of monitoring carbon uptake are small-scale, time-consuming, and expensive. Our work using satellite data has the potential to provide long term monitoring cheaply and easily at a landscape scale. Temperature and Greenness (TG) models using remotely sensed data can give estimates of ecosystem photosynthesis, but have not previously been tested at peatland sites.

This study is particularly focused on the Forsinard Flows RSPB Reserve in Northern Scotland, where large areas of peatland which were previously planted for commercial forestry are now undergoing restoration to peat bog conditions. Our research includes applying the TG model principles at different scales and under different conditions, considering drought stress in the laboratory, and growing season change in the field.

This TG model has shown good results in matching carbon uptake from traditional methods, and we are now confident that it is a valuable addition to the methods used to monitor peatland restoration for carbon sequestration.

Peatland Restoration and Natural Flood Management

Conrad Barrowclough, *Exmoor Mires Partnership*

Peatland restoration has been ongoing on Exmoor since the 1990s. The bulk of this work has been on the designated (Site of Special Scientific Interest) upland blanket bog. As knowledge and experience has grown the areas of work has grown with it. Our restoration now takes from the blanket bog at the top of the catchment to the valleys mires in the bottom, and everything in between. With this has come a widening of our restoration tools from traditional peat blocks to the use of willow faggots in the deep ditches draining the valley mires. This 'Natural Flood Management' technique enables us to slow the flow, trap sediment and create an amazing area of living willow scrub. Alongside this, our monitoring has captured fine resolution peat cutting imagery and landscape impact, all of which will feed into future understanding of the impact of peatland restoration on the landscape of Exmoor.

Simulating the long term impacts of peatland drainage

Dylan Young, *University of Leeds*

Peatlands store globally quantities of carbon, but often this store has been damaged by artificial drainage or by networks of gullies. As a result, the damming of ditch drains and gullies has become widespread. However, data about peatland drains and their restoration are often recorded over a few years, or occasionally decades, and therefore the longer-term response of peatlands is poorly understood. We used a peatland model to explore the effects of drains and their damming in 2-D over decades to centuries. Our results show a rapid loss of peat as a result of increased decomposition. Most losses occurred within 100 years of drainage and water tables had not returned to their pre-drainage dynamics even centuries later. Although damming the drain halted peat losses and restarted peat accumulation, the amount of peat lost in 100 years of drainage had not been recovered 200 years after restoration. The response of the peatland to restoration varied according to the proximity to the drainage feature and to the up- and downslope position. Our study shows how peatland models can be used to explore spatially complex responses to disturbance and to provide information for making decision about peatland drainage and restoration.

Slowing the flows; Post-forestry blanket bog restoration on the North York Moors

Hannah Lehnhart-Barnett, *University of Liverpool*

Peat moorlands form a significant component of the upland hydrological cycle, with the capacity to alleviate flooding during high intensity rainfall events. The development of effective methods for post-forestry peat moorland restoration has so far been limited by a lack of empirical models that assess hydrological changes associated with restoration. The upland ombrotrophic mire, May Moss, at 150 ha, is the largest intact blanket bog in eastern England. In 2006-8, the Forestry Commission facilitated the removal of forestry from a third of the mire and since 2010, hourly hydroclimate data have been collected from the adjacent intact and restoring sites. The data is used to assess the controls over changes in the peatland water balance particularly evapotranspiration and intra-annual water table variability, and to test hypotheses about â€˜slow-the-flowâ€™ in the context of managed peat moorlands. Strong intra-annual climate control over peatland hydrology includes high

winter water tables, driven by minimal evapotranspiration losses and higher rainfall. Summer water table draw-down, governed by evapotranspiration, varies between years reflecting the frequency and magnitude of summer rainfall events. This work complements on-going practical research on best restorative methods, while also providing a more holistic analysis of the environmental factors affecting peat moorland restoration.

Peatlands & the Historic Environment

Historic Environment Best Practice In Peatland Restoration

***Martin Gillard**, Exmoor NPA*

Spatially-extensive programmes of peatland restoration have been established on the uplands on southwest England since the 1990s.. The uplands of southwest Britain also contain some of the most important and best preserved/visible archaeological landscapes and sites in Britain (part of the 'cultural' ecosystem services group cf. Gearey et al. 2015), as well as being ecological designated for national and internationally. Upland peatlands do not sit in isolation from the cultural landscape, and are very much a part of the Historic Environment. Broadly speaking, the Historic Environment in peatlands can be considered in four ways: (a) landscapes/sites preserved under and around peat; (b) monuments/artefacts preserved within peat; (c) surface traces of human exploitation of peatlands; and (d) the archaeo-environmental record preserved within the peat (Gearey and Fyfe 2016; Bray 2017). All of these can be demonstrated in southwest Britain. The archaeo-environmental record can further provide long-term ecological datasets to assist in measuring restoration successes. A major success of the peatland restoration projects in the southwest has been the explicit recognition of importance of the Historic Environment, and appropriate inclusion of this within the restoration project. This poster describes how this has been achieved and presents what we consider best practice for the Historic Environment in peatland restoration programmes. This includes: (i) including Historic Environment representatives on project steering committees from their inception; (ii) identifying funding to undertake appropriate Historic Environment work; (iii) desk- and field-based Historic Environment survey for restoration sites within their appropriate landscapes; (iv) incorporation of archaeo-environmental knowledge and recognising the potential benefits to restoration practice, (v) involving local communities in archaeological work wherever possible, and disseminating the results.

The value of (paleo)ecology to archaeology and the Historic Environment

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The close connections between the Archaeological–Palaeoecological–Ecological communities are particularly evident at peatland sites. The waterlogged conditions which make peatlands important in terms of biodiversity and modern Ecology also result in the exceptional preservation of the organic deposits at depth. These sediments contain palaeoecological remains used to identify past economies and reconstruct landscapes and environments, as well as preserving organic archaeological remains.

Although we have a common desire for the long-term preservation of peatlands and their constituent deposits, the impact of environmental changes on the preservation of Palaeoecological and Archaeological remains is often overlooked. However, better understanding these impacts is vital in determining the viability of their long-term preservation in-situ; obtaining initial condition data (e.g. through molecular analysis and/or scoring systems) is rarely undertaken, yet provides a crucial baseline against which subsequent data can be compared.

Using a series of case studies, we will demonstrate the importance of peatlands to the fields of Archaeology and Palaeoecology. By illustrating the importance of the archive preserved within these landscapes, we argue the need to recognise the potential effect on the Historic Environment of mitigation strategies.

Natural capital financing for peatlands

What is Natural Capital

Hazel Trenbirth, *Office for National Statistics*

Natural Capital is the term that refers to all UK natural assets which form the environment around us. The accounts link assets to the benefits they provide, such as clean air and water, and the ability to walk in woodlands. Natural capital accounts offer a consistent way of monitoring our natural assets and can help identify the drivers of ecosystem change. To measure Natural Capital ONS is developing eight broad habitat-based ecosystem accounts (mountain, moorland and heath (MMH), woodlands, farmland, freshwater, coastal margins, marine, urban and semi-natural grassland), plus cross-cutting accounts, including peatlands.

We need these natural capital accounts as Gross Domestic Product (GDP) only tells us part of our economic story. It hides and excludes services provided by natural capital and only focuses on flows, not stocks. We can also monitor losses and gains in our natural capital and provide an integrated information set for further analysis of economy-environment interactions. The accounts can inform resourcing and management decisions and highlight links with economic activity and pressures on natural capital.

Peatland Code

Jillian Hoy, IUCN UK Peatland Programme

The Peatland Code is a voluntary standard for UK peatland projects wishing to market the climate benefit of restoration. The Peatland Code provides assurance and clarity for business and other investors in peatland restoration projects through independent validation and verification. The Code works on the basis that during restoration, carbon savings are made through rapid emissions reductions.

Showcasing peatland restoration techniques & partnership working:

Holme Fen National Nature Reserve

Christopher Evans, *Natural England*

Holme Fen is one of the largest lowland birch woodlands in England but is on 3 metres of peat that was previously a raised bog. The area was drained in the 1850s and since then the land around has dried out and the site itself has shrunk over 3 metres, shown by the famous Holme Fen Posts. The site has for many years been considered for peatland restoration with several papers written on whether it would be possible and how to go about it.

After much discussion an arrangement was made with the local drainage board to divert two drains in around 2012 to enable better control of the water table in the central part of the site. This year further work has taken place using Defra Peatland funding. An area of 1750 trees has been felled and further damming work on the controlled drains has been instigated to maximise levels in the drain. Further work has been identified and pressure is being put on the drainage board to maximise levels in the other drains that flow through the site.

The difficulties are that the site is SSSI for woodland and changes are needed to undertake further works. There is debate around felling further trees, but evidence suggests without this work the peat will struggle to make use of rainfall. The drainage board does not see the benefits of restoring peat, however younger members of the board are more than happy to try some of NEs ideas to lift the water in the drains or change the drainage system.

Photos and maps showing restoration so far, drainage systems can be displayed along with relevant information of this very untypical peatland.

Marches Mosses BogLIFE Project

Natural England

Future-proofing Britain's 3rd largest raised bog. (LIFE 15NAT/UK/000786) -Fenn's, Whixall & Bettisfield Mosses and Wem Moss National Nature Reserves

Pennine PeatLIFE

Rapid and Reliable Restoration of Sphagnum using Micropropagated Sphagnum as BeadaHumok 1 & 2

Neal Wright1, Anna T. Keightley2, Simon J.M. Caporn1*, 1: Micropropagation Services (EM) Ltd (BeadaMoss®), Leicestershire 2: Manchester Metropolitan University;*

Micropropagated Sphagnum grown into small hummocks (BeadaHumok™) has been shown to establish and grow profusely on both Upland and Lowland restoration sites. Results from trials across England, Wales and Germany will be discussed. Trials showed significantly improved growth of micropropagated Sphagnum over clumps of translocated Sphagnum e.g. Cors Fochno

BeadaHumok™ thrived better (385% increase area) vs translocated (137% increased area). Similar results seem over 2 years in the Peak District.

Analysis shows one plug of micropropagated Sphagnum (BeadaHumok™) contains as many as ~110 strands/plants. 17 species are being micropropagated, enabling pure species to be grown in very large quantities and ensuring Sphagnum is free of pest, disease and weed transfer. BeadaHumok™ can be produced as pure species or in specific mixtures. Local origin material can be produced for site requirements and requires just a few strands as starting material with no damage to donor sites.

In spring 2018 ~850,000 BeadaHumok™ were planted, together with 350,000 in 2017 means that over 800 hectares of peatland have now had a wide range of species of Sphagnum successfully reintroduced. Resulting in improved biodiversity and enhancing the carbon balance of these peatlands (Anna Keightley MMU) and hopefully reducing the risk of future wildfires.

Shearing Good Practice

Forestry Commission Scotland

An efficient way of removing trees from afforested peatland.

South West Peatland Partnership

***Morag Angus**, Exmoor Mires Partnership*

This peatland restoration project is focused on the moorlands of Bodmin, Dartmoor and Exmoor. These peatlands of south-west England are very important for water, carbon storage, biodiversity, cultural history, recreation and farming. They are recognized by the IUCN Peatland Programme's Commission of Inquiry as being the most vulnerable in the UK to the impacts of climate change, due to their southerly position. They may be the first to stop accumulating peat, as climates warm and rainfall patterns change. These peatlands are therefore at 'high risk', need to be prioritised nationally and restored for the benefit of all and future generations. The moors of Bodmin, Dartmoor and Exmoor hold significant regional and national deposits of peat in the form of blanket bogs and valley mires. These wetland habitats are complex ecosystems that support diverse and unique ecology of national and international importance. Over centuries, human interventions have and still are impacting upon the overall quality and distribution of wetland mire habitats and upland moors. The demise of such wetlands across extensive swathes of the moors has resulted in changes in the moorland ecology, including the loss of iconic species such as dunlin, golden plover, and *Sphagnum* mosses. The challenge is to prevent further losses and halt the decline, while actively pursuing measures to improve and restore these degraded habitats. The project is reliant on a partnership of multitude organisations that includes government agencies, non-governmental organisations, landowners and farmers. In order to achieve this large-scale, 1680 hectares, restoration proposal, the sites across the 'Three Moors' have been chosen for the extent and significance of their damaged condition so that the most possible restoration benefits can be realized.

Ugie Peatland Partnership

The Ugie Peatland Partnership (UPP) was set up at the end of 2017 with the primary purpose of working together to restore 1500 hectares of degraded peatland within the River Ugie catchment area in Aberdeenshire. The partnership includes Peatland Action, Scottish Water, Royal Society for the Protection of Birds (RSPB), Scottish Natural Heritage (SNH), Aberdeenshire Council, International Union for Conservation of Nature (IUCN), Scottish Environment Protection Agency (SEPA) and Forestry Commission Scotland. The 8 organisations of the UPP all contribute valuable expert knowledge and advice in order to help reach our aim.

Around 20 sites have been identified as priority areas that would benefit from restoration and being put on the road to recovery. Funding is provided jointly from Peatland Action/Scottish Natural Heritage and Scottish Water. The first restoration project within the River Ugie catchment will start in winter 2018. Site surveys of the area and liaison with land managers is ongoing and we hope to have a more projects starting in 2019.