IUCN UK Committee

Peatland Programme

COMMISSION OF INQUIRY ON PEATLANDS

This report should be cited as:
Bain, C.G., Bonn, A., Stoneman, R., Chapman, S., Coupar, A., Evans, M., Gearey, B., Howat, M., Joosten, H., Keenleyside, C., Labadz, J., Lindsay, R., Littlewood, N., Lunt, P., Miller, C.J., Moxey, A., Orr, H., Reed, M., Smith, P., Swales, V., Thompson, D.B.A., Thompson, P.S., Van de Noort, R., Wilson, J.D. & Worrall, F. (2011) IUCN UK Commission of Inquiry on Peatlands. IUCN UK Peatland Programme, Edinburgh.

October 2011

Published by the IUCN UK Peatland Programme

ISBN 978-0-9570572-1-0

The report and associated Commission of Inquiry material can be downloaded from www.iucn-uk-peatlandprogramme.org

The International Union for the Conservation of Nature (IUCN) is a global organization, providing an influential and authoritative voice for nature conservation. The IUCN UK Peatland Programme promotes peatland restoration in the UK and advocates the multiple benefits of peatlands through partnerships, strong science, sound policy and effective practice.

Design by Dirty White Design

Front cover image © Laurie Campbell/SNH

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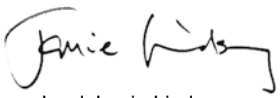
FOREWORD

This IUCN UK Commission of Inquiry on Peatlands presents one of the most extensive assessments of peatlands undertaken in the UK to date. It identifies the state and value of peatland ecosystems and develops ways to safeguard and restore their natural capital.

Peatlands are vitally important for people, but this has not been widely appreciated until recently. As a result the majority have been damaged or destroyed. The valuable role of peatlands has been highlighted internationally by the United Nations Environment Programme. The UK National Ecosystem Assessment also emphasises the special importance of peatlands, particularly in relation to climate change mitigation and adaptation. Peatlands support important wildlife habitats, hold vast carbon stores, collect and supply much of our drinking water, provide archives of archaeological and environmental information and offer breathing spaces and a sense of place for many people.

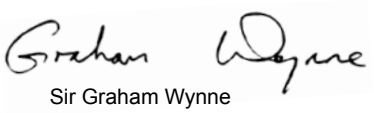
Peatlands are a huge asset for society but we need to take urgent steps to ensure the peatland resource, with its biodiversity, is properly managed and secured for the future. This is an even more urgent task in the face of a changing climate, which could accelerate the deterioration of damaged peatlands. As it becomes clear across the world that damage to peatlands comes at great cost, ways of halting damage and restoring peatlands have been developed. In the UK, we have some world-leading examples of peatland restoration and the expertise to manage them at a landscape scale. There is considerable support across the different land management communities to bring peatlands back into good condition, but to date there has been no obvious, coordinated, driving-force to make it happen.

The IUCN UK Commission of Inquiry on Peatlands has brought together over 300 contributors from over 50 organisations drawing on a wide range of expertise from science, policy and practice. It comes at a crucial time, with high level strategic decisions being made at a national and international level on climate change, biodiversity, water and agriculture, which will impact on the way we manage our peatlands and how we pay to keep them in a healthy state. This Assessment draws together the Inquiry's findings and clearly demonstrates the value of healthy peatlands to society, the damage which has been done to them, and the huge liability of doing nothing to repair this damage.



Lord Jamie Lindsay

Prof Andrew Watkinson



Sir Graham Wynne

Patrons of the IUCN UK Commission of Inquiry on Peatlands

ACKNOWLEDGEMENTS

The Commission of Inquiry was led by the IUCN UK Peatland Programme and managed through partnership. A wide range of sectors engaged in the production of scientific reviews and responded to an open consultation process. The Inquiry process was supported by discussions at the two IUCN UK Peatland Programme conferences 'Investing in Peatlands: the Climate Challenge' in Durham, 2010, and 'Investing in Peatlands: Delivering Multiple Benefits' in Stirling, 2011, along with contributions of written and oral evidence from the inquiry open event in Edinburgh in November 2010, organised with kind support of the University of Edinburgh. Land management organisations have been closely involved in the Inquiry, and opportunities were given to those with practical peatland management experience to input to the findings.

We are grateful to our Commission of Inquiry patrons Lord Jamie Lindsay, Professor Andrew Watkinson and Sir Graham Wynne for high level support and steering. The Inquiry was chaired by Martyn Howat, and Steve Chapman provided the overall scientific coordination. The core panel of the Inquiry was a team of peatland specialists from science, policy and practice comprising Andrew Coupar, Scottish Natural Heritage (SNH), Martin Evans, University of Manchester, Prof Hans Joosten, University of Greifswald, Wetlands International, Richard Lindsay, University of East London, Harriet Orr, Environment Agency, Matthew Shepherd, Natural England, Prof Pete Smith, University of Aberdeen, Vicki Swales, Royal Society for the Protection of Birds (RSPB), Prof Des Thompson, SNH, and Prof Robert Van de Noort, University of Exeter.

The Commission of Inquiry and Assessment Report preparation was supported by an advisory panel. The following organisations have been extensively consulted during the course of the Inquiry and on the content of the report and have made important contributions to the development of the thinking behind it.

Cairngorms National Park Authority, Centre for Ecology and Hydrology Edinburgh, Corrour Estate, Countryside Council for Wales, Department for Environment Food and Rural Affairs, Environment Agency, English Heritage, Forestry Commission, Heather Trust, John Muir Trust, Lancashire Wildlife Trust, Moorland Association, Moors for the Future Partnership, National Farmers Union, National Farmers Union Scotland, National Trust, National Trust for Scotland, Natural England, NERC Carbon Landscapes and Drainage Network, Northern Ireland Environment Agency, North Pennines AONB Partnership, Royal Society for the Protection of Birds, Scottish Environment Protection Agency, Scottish Government, Scotland's Moorland Forum, Scottish Land and Estates Moorland Group, Scottish Natural Heritage, Scottish Water, Scottish Wildlife Trust, United Utilities, University of East London, Welsh Government, Yorkshire Peat Partnership, Yorkshire Water and Yorkshire Wildlife Trust.

The Joint Nature Conservation Committee Soils and Upland Lead Coordination Networks provided advice and information as input to the activities of the Commission of Inquiry.

The work of the IUCN UK Peatland Programme and the Commission of Inquiry is funded primarily by the Peter De Haan Charitable Trust and hosted by the Yorkshire Wildlife Trust and Scottish Wildlife Trust. We are particularly grateful to Peter De Haan for his personal support and interest. Additional funding for the Commission of Inquiry was received for the production of reviews and Sfor meetings from English Heritage, the James Hutton Institute, the Moorland Association, the North Pennines AONB Partnership, the Rural Economy and Land Use Programme, Scottish Environment Protection Agency and Scottish Natural Heritage.

Considerable in kind support was provided by academic institutions, consultancies, government departments and agencies and NGOs in producing technical reviews, providing evidence at the Inquiry event and participating in core panel and advisory panel activities, as well as by many individuals throughout the consultation, reflecting the strong desire to see action for UK peatlands.

We are very grateful to Mary Church for organising the Commission of Inquiry events and successfully coordinating the design and publication of the Inquiry report and associated material. We also thank Tom Edwards for thoroughly editing the report and helpful suggestions.

Disclaimer

This Assessment Report is the result of the IUCN UK Peatland Programme's synthesis of the contributions to the Inquiry and may not necessarily reflect the views of all those involved.

The Assessment Report is based on significant input from twelve technical reviews produced as contributions to the Commission of Inquiry, namely

- Joint Nature Conservation Committee (2011) Towards an assessment of the state of UK peatlands. JNCC report no 445.
- Worrall, F., Chapman, P., Holden, J., Evans, C., Artz, R., Smith, P. & Grayson, R. (2010) Peatlands and Climate Change. Report to IUCN UK Peatland Programme. Edinburgh.
- Littlewood, N., Anderson, P., Artz, R., Bragg, O., Lunt, P. & Marrs, R. (2010) Peatland Biodiversity. Report to IUCN UK Peatland Programme. Edinburgh.
- Lunt, P., Allott, T., Anderson, P., Buckler, M., Coupar, A., Jones, P., Labadz, J. & Worrall, P. (2010) Peatland Restoration. Report to IUCN UK Peatland Programme. Edinburgh.
- Worrall, F., Clay, G.D., Marrs, R. & Reed, M.S. (2010) Impacts of Burning Management on Peatlands. Report to IUCN UK Peatland Programme. Edinburgh.
- Labadz, J., Allott, T. Evans, M., Butcher, D., Billett, M., Stainer, S., Yallop, A., Jones, P., Innerdale, M., Harmon, N., Maher, K, Bradbury, R., Mount, D., O'Brien, H. & Hart, R. (2010) Peatland Hydrology. Report to IUCN UK Peatland Programme. Edinburgh. (funded by the North Pennines AONB Partnership.)
- Geary, B., Bermingham, N., Chapman, H., Charman, D., Fletcher, W., Fyfe, R., Quartermaine, J., Charman, D., Van de Noort, R. & Heathcote, J. (2010) Peatlands and the Historic Environment. Report to IUCN UK Peatland Programme. Edinburgh. (funded by English Heritage.)
- Reed, M., Buckmaster, S., Moxey, A., Keenleyside, C., Fazey, I., Scott, A., Thomson, K., Thorp, S., Anderson, R., Bateman, I., Bryce, R., Christie, M., Glass, J., Hubacek, K, Quinn, C., Maffey, G., Midgley, A., Robinson, G., Stringer, L., Lowe, P. & Slee, B. (2010) Policy options for sustainable management of UK peatlands. Report to IUCN UK Peatland Programme. Edinburgh.
- Joosten, H. (2011) Peatlands, policies and markets. Report to IUCN UK Peatland Programme. Edinburgh.
- Moxey, A. (2011) Illustrative economics of peatland restoration. Report to IUCN UK Peatland Programme. Edinburgh.
- Keenleyside, C. & Moxey, A. (2011) Public funding of peatland management and restoration in the UK – a review for IUCN UK. Report to IUCN UK Peatland Programme. Edinburgh.
- IUCN UK Peatland Programme (2011) Brief summary of the state of peatlands in British Overseas Territories. IUCN UK Peatland Programme. Edinburgh.

We thank all authors for their considerable input and all funders for making this possible. Parts of these reviews have been used and quoted to prepare this Assessment Report.

All contributing material, including the above reviews, submissions to the Open Inquiry and conference proceedings, is available as resources on the IUCN UK Peatland Programme website www.iucn-uk-peatlandprogramme.org

More detailed briefing notes for key subjects will be provided by the partnership.

EXECUTIVE SUMMARY

"Restoration of peatlands is a low hanging fruit, and among the most cost-effective options for mitigating climate change."

Achim Steiner UN Under-Secretary General and Executive Director UN Environment Programme (UNEP)

Peatlands are areas of land with a naturally accumulated layer of peat. These are formed under waterlogged conditions from carbon rich, dead and decaying plant material. In the UK mosses, mainly *Sphagnum* species, are the main formers of peat.

Peatlands are found in at least 175 countries – from the tropics to the poles – and cover around 4 million km^2 or 3% of the world's land area. In Europe, peatlands extend to ca. 515,000 km^2. The UK is amongst the top ten nations of the world in terms of its total peatland area. The UK has between 9-15% of Europe's peatland area (46,000-77,000 km^2) and about 13% of the world's blanket bog – one of the world's rarest habitats. There are three main types of peatland in the UK: blanket bogs, raised bogs and fens. The international importance of the peatlands found in the UK give it an especial responsibility for their management and conservation.

The IUCN UK Commission of Inquiry on Peatlands has gathered up-to-date knowledge from science, policy and practice. The assessment focuses on blanket bog and raised bog peatlands, because they represent over 95% of all UK peatland habitat and offer an opportunity to make early and substantial progress in delivering a combination of economic, social and biodiversity gains. However, we recognise that lowland, river and groundwater-fed fen peatlands are also vital carbon stores, as well as existing and potential areas of rich biodiversity, which have also been subject to intensive and damaging management. Fen peatlands share many of the issues affecting rain-fed peatlands but with distinct differences in terms of their functions, threats and pressures, which merit further investigation.

A multidisciplinary team of experts produced this Report. It provides an authoritative assessment of the available evidence, based on peer-reviewed scientific consensus about the state of peatlands, the impacts of different activities on peatland ecosystems and the services they provide and the benefits of restoring and conserving them. The assessment explores mechanisms and processes for peatland conservation action, recognising the different social, economic and environmental drivers. The evidence-gathering approach was inclusive, engaging individual land managers as well as a wide range of organisations, which in itself has helped to foster joint action for peatland conservation and restoration.

The Assessment Report sets out the main conclusions, highlighting gaps and opportunities for further action. It identifies ways to secure additional funding and develop expertise to help land managers restore the UK's peatlands and to allow decision makers to take better account of their multiple benefits.

KEY FACTS

Peatlands provide essential services to society, globally, nationally and locally.

Peatlands are vitally important in the global carbon cycle and UK greenhouse gas budgets. They represent the single most important terrestrial carbon store in the UK. Blanket and raised bog peatlands cover around 23,000 km^2 or 9.5% of the UK land area, with current estimates indicating they store at least 3.2 billion tonnes of carbon. A loss of only 5% of UK peatland carbon would equate to the total annual UK anthropogenic greenhouse gas emissions. Healthy peat bogs have a net long-term 'cooling' effect on the climate.

Peatlands include the largest remaining semi-natural habitats in the UK. Our peatland habitats host nationally and internationally important biodiversity. Many of the typical peatland species, however, are showing marked population declines. The best available evidence suggests that less than 20% of the UK's peatlands are undamaged. The remaining peatlands are eroded, modified or destroyed through extraction or conversion to other land uses. Even the best protected sites (under EU wildlife legislation) have suffered, with less than 50% in a favourable condition. However, much of the damage could still be reversed. British Overseas Territories also support large areas of peatlands, particularly in the Falkland Islands, with estimates of over 5,470 km^2 of deep blanket peat.

Peatlands are important for drinking water. In the UK, 70% of all drinking water is derived from surface water that comes mainly from upland catchments, which are generally peat dominated. Healthy peatlands provide high-quality water that is much cheaper to treat for drinking - damaged peatlands produce higher concentrations of organic 'brown water' carbon, which has to be removed at high cost.

Peatlands are national treasures. They provide a sense of place for many communities. As waterlogged soils, peat deposits provide a rich archive of cultural and environmental change stretching back over 10,000 years. Peatlands have preserved some of the oldest and most intriguing archaeological remains including roads, tracks, houses and settlements, monuments, artefacts and bog bodies. The archive, that is peat itself, has contributed greatly to our understanding of global climate change.

Peatlands have been identified as a priority for action under international agreements. Global agreements such as the UN Convention on Biological Diversity (CBD), the UN Framework Convention on Climate Change (UNFCCC) and the Ramsar Convention on Wetlands include obligations and opportunities for countries to maintain and restore peatlands. These agreements highlight the need for policies and funding to better reflect the value of peatland habitats for the services they provide. At an EU level, legislation on wildlife and water also recognises the importance of peatlands. By drawing on the work of a wide range of public-body and private partnerships, the UK Government and devolved administrations have an opportunity to demonstrate good practice in peatland protection and restoration to other European countries and globally.

Blanket bog of the Flow Country, Forsinard © RSPB

Peatlands rely on water. When drained, peatlands waste away through oxidation, adding carbon dioxide to the atmosphere – then, they are a liability. A variety of activities have resulted in peatlands being damaged including drainage for agriculture or forestry, track building and peat extraction. Fire, overgrazing, climate change and atmospheric deposition can exacerbate the effects of drainage. Lowered water tables on peat bogs encourage the growth of plant species that do not easily form peat or that actively degrade the existing peat stock, resulting in losses of soil carbon and emissions of carbon dioxide to the atmosphere.

Damaged peatlands are expensive. Damaged and degraded peatlands place a substantial financial burden on society because of increased greenhouse gas emissions, poorer water quality and loss of other ecosystem services. Damaged peatlands may also exacerbate costly flood events, when water is rapidly conveyed from peatlands through drainage ditches and erosion gullies into downstream areas.

Peatland restoration is cost-effective. The cost of peatland restoration is considerably lower than the ongoing costs to society from leaving peatlands damaged. Early intervention also has lower restoration costs. Peatland restoration is cost-effective in reducing emissions of carbon to the atmosphere, improving water quality (reducing the costs for drinking water treatment) and conserving biodiversity. Peatland restoration can also help with climate change mitigation and adaptation. Funding for peatlands under current government schemes, particularly through the Common Agricultural Policy (CAP), can be an effective means of supporting management and restoration, but there is no doubt that more could be done through current funding instruments. Peatland restoration also presents new funding opportunities through links with business and industry, carbon markets and payments for delivery of ecosystem services within agri-environment schemes. This in turn could lead to better support for rural communities and the creation of green jobs.

The UK has world leading expertise in peatland restoration. The UK has globally relevant examples of peatland restoration and considerable land management expertise in tackling different forms of peatland damage, with many demonstrable successes. This creates an opportunity for peatland restoration to make a positive contribution towards meeting the UK's biodiversity objectives and ambitious targets to reduce greenhouse gas emissions. There are several successful landscape scale restoration projects in the UK, for example blanket bog restoration in the Flow Country in Scotland, Lake Vyrnwy and Migneint in Wales, Exmoor, Dartmoor, Peak District and Pennines in England and restoration of lowland raised bogs in Cumbria, Lancashire, and Northern Ireland.

Functioning blanket bog, Forsinard © Norman Russell

Damaged peatlands are substantially less resilient to climate change than healthy ones. Given rapid climate change, which is likely to impact widely and adversely on biodiversity, soils, water supply and quality, there is an even more urgent need for action to protect and restore peatlands. Available evidence suggests that a healthy peatland is a more resilient peatland in the face of environmental change. Good management and restoration also help to secure peatland wildlife and ecosystem services, under a changing climate. Restoration therefore helps to safeguard important goods and services into the future and, at the same time, can help to meet the UK's emission-reduction targets. Not restoring peatlands will lead to increased greenhouse gas emissions from damaged peat carbon stores under a changing climate.

Peatland natural capital is not fully represented in national accounting. The fact that the true value of peatlands and the costs of damaging them are not reflected in the resources available to conserve them represents a clear example of market failure. The value of peatlands as a carbon store and in mitigating climate change is not yet fully taken into account in the national greenhouse gas inventory. In addition, there are monitoring gaps in relation to the state of peatlands, progress towards biodiversity objectives, delivery of ecosystem services and application of policy measures such as agri-environment schemes. Improvement in these areas would allow better accounting and reporting of progress against government objectives and international obligations.

Sphagnum © Norman Russell

PEATLANDS: AN URGENT AGENDA

Securing the benefits we derive from peatlands requires an urgent step-change in action to redress past damage. A speedy response to protect and restore our peatlands under a changing climate is challenging – but will cost us dear if we delay.

This Inquiry therefore calls for the multiple benefits of peatlands to be understood and appreciated. Our vision is for the UK's peatlands to be functioning to their full natural potential. There should be no further loss of near-natural peatlands in the UK, and all recoverable peatlands should be restored to a peat forming state, resilient to climate change and with long-term safeguards. **Our four-pronged peatland strategy comprises:**

- **Conserving** peatlands in good condition, through management that maintains a favourable state, and preventing further damage to healthy peatlands (even the best protected peatland sites have suffered, with less than 50% in a favourable condition, so the first priority must be to prevent any further deterioration).

- **Restoring** partially damaged peatlands through land-use changes and active habitat management to return them to a peat forming state with typical peatland vegetation and animal species (including blocking drainage ditches, altering livestock numbers or adjusting burning management).

- **Intervening** to repair severely damaged peatlands through major operations, such as woodland removal, gully blocking and re-vegetating bare peat.

- **Communicating** the contribution peatlands make to meeting environmental, economic and social goals – critically, to help combat climate change and to halt the loss of biodiversity.

Peatlands are an important visitor attraction
© Norman Russell

Results of grip damming © Andrew Keen

We need strong public and business policy responses to achieve this, focused on three actions:

a. Introducing a UK and devolved government **policy framework** to protect and maintain existing peatlands and ensure restoration of damaged areas. Peatland policy objectives and delivery should be 'joined-up' across climate change, biodiversity, water, heritage, development and access legislation.

b. Ensuring the necessary **funding** is in place to protect and restore the UK's peatlands. This requires continued use of the key funding streams, such as the EU Common Agriculture Policy (CAP), and maximising any additional opportunities through forthcoming reform. Other funds should be sought through the EU Environment – LIFE+ Programme, with additional core government funding alongside the development of business investment in ecosystem services.

c. **Coordinating action** to encourage partnerships to secure an effective evidence base, with monitoring and reporting on progress, along with knowledge exchange, education and advice.

More detail on the actions needed to achieve our vision is set out in Chapter 7 of this report.

Targets and timescales

The management and restoration of the UK's peatlands is an ambitious goal, with best estimates of 2.3 million ha of blanket and raised bog, of which around 1.8 million ha is damaged in some way. By creating a better framework to integrate public and business policies and by putting the right funding mechanisms in place, we should be able to secure a much better future for our peatlands by 2050. A positive interim target would be to work towards having 1 million ha of peatlands in good condition or under restoration management by 2020 – a timescale consistent with UK and international biodiversity objectives as well as commitments to tackle global climate change.

MOVING TOWARDS HEALTHIER PEATLANDS

a. Policy framework

We need to muster the considerable peatland expertise and potential resources across the public and private sectors to achieve the scale and urgency of action required, recognising the challenges of the current economic climate.

a1. Clear government signals need to empower public bodies, the private sector, NGO's and communities to maintain and restore peatlands.

- Establish a UK wide, coordinated, funded peatland restoration delivery programme with agreed areas, targets and timescales, reflecting international commitments on peatlands.

a2. Coordination and cooperation across government sectors and agencies would help deliver peatland biodiversity objectives and secure ecosystem benefits.

- Recognise the important role of peatlands under all relevant public body duties, e.g. climate change mitigation and adaptation, biodiversity conservation and water regulation.
- Take forward opportunities for delivery of landscape and cross-catchment scale projects with cooperation across different administrative boundaries.
- Establish a high-level peatland group to facilitate cross agency coordination and to report on progress against peatland objectives.

a3. Develop an ecosystem-based approach to peatland policy.

- Adopt an ecosystem-based approach with healthy functioning peatland habitat as the shared goal, rather than simply maximising individual services from peatlands.

a4. Have better collaboration across public bodies, business, NGOs, and communities with stronger connections between end-beneficiaries and those delivering services on peatlands.

- Support collaborative working at the site level to deliver peatland management and restoration, showcasing good examples nationally and internationally.
- Explore mechanisms to encourage better connection between peatland managers and beneficiaries of the ecosystem services.

Bog pool at Blar nam Faoileag © Norman Russell

b. Funding

There are opportunities to greatly improve the sharing of costs experienced by society in terms of damaging impacts to water, loss of biodiversity and carbon emissions and the support given to the management of peatlands. Put simply, we want to vastly reduce these costs. Support towards this includes direct government and business funding along with government action to facilitate international funds, business and private investment for peatland management and restoration.

b1. Improved funding through the CAP, both Pillar I direct payments and Pillar II Rural Development Programmes (especially agri-environment and forestry measures) for peatland management and restoration.

- Improve the alignment of funds within the four UK country programmes to the provision of benefits for biodiversity, climate change and water.
- Ensure appropriate payment levels and integration with private/public funding initiatives to incentivise land managers and cover the costs of providing public benefits from peatlands.

b2. Use public and private resources in a coordinated way to support peatland restoration and management.

- Establish core government funding specifically to support peatland projects, and encourage public bodies and the business sector to work jointly in funding peatland work.

b3. Development of new sources of funding for peatland conservation and restoration.

- Explore opportunities to support business-led carbon investment in peatlands including developing a Peatland Carbon Code.
- Support water company investment in upstream land management.
- Explore other funding opportunities such as payment schemes for ecosystem services, biodiversity offsets and habitat banking.

c. Coordinated action

c1. Establish nationally coordinated and funded peatland accounting.

- Monitor the state of peatlands.
- Report on progress towards biodiversity targets and delivery of international and national objectives, greenhouse gas emissions savings and other ecosystem service benefits.
- Assess the effectiveness and progress of policy measures, including agri-environment measures.

c2. Provide support for a UK peatland hub for information and consensus building, training and partnership working between scientists, policy advisers, businesses and land managers.

- Provide a one-stop shop for information.
- Showcase cost effective and flexible solutions for peatland restoration and management through demonstration sites.
- Facilitate effective collaborations between policy, practice and academic research.

c3. Encourage trans-disciplinary research on peatlands.

- Provide solutions for effective peatland conservation/restoration.
- Improve the evidence base for the services that peatlands provide and the effects of restoration.

c4. Communicate the importance of peatlands, highlighting their benefits to society including market and non market values.

- Build on the wealth of peatland projects and stories to provide the tools for wider communication, engaging expertise to incorporate peatlands more extensively in media and education.

CONCLUSION

Throughout the course of this Inquiry, it has been evident that there is a large community of interested people and organisations willing to help deliver the vision for peatlands – but needing the right signals and support. We now want to see a significant shift in public attitudes and support towards realising the immense value of peatlands in making the planet healthier for us – and for nature.

1. INTRODUCTION: WHY ARE PEATLANDS IMPORTANT?

"Peatland conservation is a prime example of a nature-based solution to climate change but we urgently need to switch from aspiration to action to secure the benefits that peatlands provide."

Julia Marton-Lefèvre Director General, International Union for the Conservation of Nature

This Assessment Report first defines peatlands and explains the Commission of Inquiry's focus on blanket bogs and raised bogs. It provides a description of the global and national distribution of peatlands and assesses their key ecosystem services and biodiversity importance. The report then looks at the state of peatlands in the UK, which leads to the evaluation of future options. The final part of the report develops a vision for peatlands with suggestions for key actions across policy, industry, land managers, NGOs and science. The report concludes by outlining the next steps of the IUCN UK Peatland Programme. However, it will remain the responsibility of key actors in policy, science and practice to take forward the shared agenda and harness the opportunity to safeguard our peatland natural capital.

Peatlands are habitats with carbon-rich peat soil. They are manifestly important for human well-being. Despite covering only 3% of the global land surface, they globally comprise 30% of all soil carbon. Peatlands include the largest remaining areas of semi-natural habitats in the UK supporting bog and fen habitats and species that are protected under international and national legislation. As iconic landscapes they offer breathing spaces for millions of people, support livelihoods and provide a sense of place for many communities. The peat itself harbours a rich palaeo-ecological and historic archive with preserved artefacts from past human societies and a wealth of information about our changing environment, land management and climate. Peatlands are important source catchments for drinking water and also have a role in the regulation of water flows.

Blanket bog of the Flow Country, Forsinard © RSPB

However, the majority of the peatland resource is damaged or deteriorating, through drainage, peat cutting, fire and the effect of livestock. Climate change is likely to cause further deterioration of damaged peatlands with increased erosion, carbon loss, floods and risk of wildfires. This ongoing deterioration of the UK's peatlands represents a highly significant hidden cost to society, particularly through increased greenhouse gas emissions, wildlife loss and reduced water quality.

Restoration of damaged peatlands to a naturally functioning state is vital to ensure that carbon stored in the peat soil is locked up long into the future and to safeguard nationally and internationally important wildlife. Restoration ensures that these vital ecosystem services are maintained. Restoration is a cost-effective way of resolving some of our most urgent environmental problems and avoiding increasing future costs, as problems become larger and restoration becomes harder and more expensive.

Peatland restoration and conservation are already at the heart of high level strategic decisions being taken at a national and international level to deal with climate change and the way land and water is managed. Global conventions on biodiversity and climate change have seen world leaders agreeing on the need for urgent action on peatlands. At the EU level, the reform of the Common Agriculture Policy, the delivery of the Water Framework Directive and goals of the EU Biodiversity Strategy 2020 (European Commission 2011) present key opportunities to help protect and restore peatlands at a far greater scale and rate than we have achieved in the past.

At the UK and devolved government level, natural heritage, agriculture, water, climate change and development planning policy all recognise peatlands as important. However, these policy commitments are not yet effectively coordinated or operating at the right scale and intensity to properly redress the past damage, even within our most protected peatland sites. This report explains how a UK wide, coordinated, funded peatland restoration delivery programme with agreed areas, targets and timescales could achieve effective conservation of the UK's peatland natural capital with its important biodiversity and services. As a globally influential and peatland-rich nation, the UK is in a strong position to show leadership by resolving the current failure to recognise peatlands' values and by investing in restoration and sustainable management.

2. WHAT ARE PEATLANDS?

"Peatlands are a crucial component of the Earth's interacting landscape, biosphere and climate systems. It is therefore right that we should do all we can to protect peatlands so that they can continue to support a healthy Earth system and provide a wide range of global, national and local benefits for future generations."

Joseph Holden, Professor of Physical Geography, University of Leeds

Peatlands are areas of land with a naturally accumulated layer of peat, formed from carbon rich dead and decaying plant material under water logged conditions. Mosses, mainly *Sphagnum* species, are the main peat formers in the UK. Semi-natural and undamaged peatlands can accumulate carbon at a rate of 30-70 tonnes of carbon per km^2 per year (Billett et al. 2010; Worrall et al. 2010b). In the UK, many peatland areas have been accumulating carbon since the retreat of the last glaciers approximately 10,000 years ago and some peats are more than 10 metres deep.

Peatlands develop under a range of different wetland vegetation, including lowland or upland fens, reed beds, wet woodland and bogs. The Commission of Inquiry focuses mainly on blanket bogs and raised bogs on deep peat (depths of at least 30-50 cm), while recognising the importance of other peatland types such as fens.

Blanket bog in the Flow Country © Norman Russell

Definitions as used in this report

Peatlands	Land with a carbon rich peat soil. The soil may or may not be currently covered by peat forming vegetation.
Deep peaty soil	Peat soils of depths greater than 30-50 cm[1] and up to 12 m in some places.
Peat-forming vegetation	Vegetation composed of species, such as *Sphagnum* mosses or cotton grass, that grow in waterlogged conditions and that decompose only slowly. High water tables and cool climatic conditions further slow plant litter decomposition, forming peat.
Restoration	Restoration returns semi-natural vegetation cover, with its typical species and habitats, to damaged peatland, reducing or halting carbon loss and ideally allowing peat accumulation to take place again. Restoration management may range from slight adjustments, such as altering grazing levels, to more substantial works such as changing hydrology through ditch blocking or stabilising peat through re-vegetation of bare eroding peat.
Blanket Bog	A habitat where deep deposits of peat blanket the landscape. Includes habitat areas with peat accumulation as well as degraded habitat with peat oxidation and erosion. Natural blanket bog is usually rich in *Sphagnum* mosses although there are many degraded variants, often with less *Sphagnum* and more sedges, grasses and heather.
Raised Bog	Bog habitat characterised by an accumulation of peat that rises above the surrounding landscape often in lowland wet floodplains and/or often over surface of existing fen peat. Includes both active and degraded versions with semi-natural vegetation.
Ecosystem services	The benefits people and society obtain from the natural environment, eg regulating services such as climate change mitigation through carbon sequestration and storage.

For full definitions please refer to the glossary provided in JNCC report 445 (JNCC 2011)

1 Peat soils are defined as having at least 30 cm depth of peat at European level, but have been mapped using 40cm depths in England and Wales, and 50 cm depths in Scotland and Northern Ireland. In many areas, the accuracy of these maps means that there is considerable variation in the actual depth of peat in mapped peatland areas (see JNCC 2011).

Peat Structure

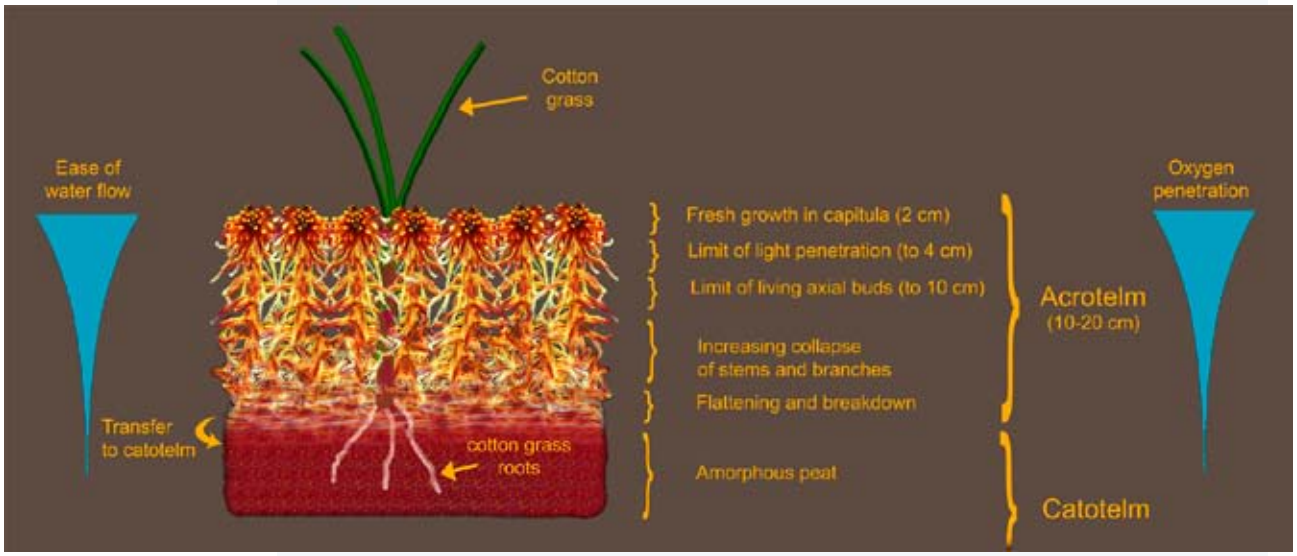


Figure 1 Peat structure in a natural, functioning bog; reproduction with kind permission from Lindsay (2010), based on Clymo (1992)

Natural peat-forming blanket bogs and raised bogs are characterised by having a two-layered structure, which influences the way peat is formed, carbon is fixed and water flows.

The surface layer, the acrotelm, is composed of the most recently deposited material (top 10-20 cm). This top layer has a live matrix of growing plants, most often *Sphagnum*. Here, carbon is sequestered and peat is formed and passed to the lower layer, the catotelm.

The base layer, the catotelm, remains permanently waterlogged and anaerobic. The lack of oxygen slows decomposition to extremely low levels. This layer therefore acts as a passive storage layer of deposited peat for millennia. Without some form of living acrotelm, peat does not accumulate in the catotelm (Lindsay 2010).

Within the surface peat layer, the water table fluctuates and water moves quite freely. In the permanently water-logged catotelm water movement is extremely slow. Run-off and nutrient transfer almost all occurs in the upper peat layer, with up to 95% of run-off confined to the top 10 cm (Holden 2009).

Fens

Sutton Fen RSPB Reserve, Norfolk © Ben Hall, RSPB Images

Fens are important peatland habitats. The UK supports a wide variety of different fen types, which are among our most species rich and rare habitats. Restoration of fen peatlands is important, as these can support some of our deepest peat, and have been widely subject to the most intensive drainage and agricultural management, leading to rapid loss of biodiversity, stored carbon and water regulating functions. Fen habitats are not fully covered by this Commission of Inquiry, but recent years have seen an increase in UK fen activity, notably the Wetland Vision Partnership www.wetlandvision.org.uk, the Fen Management Handbook www.snh.gov.uk/docs/B823264.pdf the Great Fen project, the Anglesey and Llyn Fens LIFE project and others.

3. WHAT IS THE DISTRIBUTION OF PEATLANDS?

"Peatland management remains both influenced and dependent on continued agricultural infrastructure of farms and crofts. As we move from the past policy drivers which intensified environmental pressures, we now need the right incentives for farmers to help deliver the peatlands in a state that provides wider benefits."

Jonathan Hall, Head of Rural Policy, National Farmers Union Scotland

Found from the tropics to the poles, and in 175 countries, peatlands cover around 4 million km^2 or 3% of the world land area (Joosten 2009). In Europe, peatlands extend to ca. 515,000 km^2. The UK has between 9-15% of Europe's peatland area and about 13% of the world's blanket bog (Tallis 1998).

There are three main types of peatland in the UK: blanket bogs, raised bogs and fens. All three types of peatland habitats are protected under international and national wildlife law. They include six habitat types identified as priorities for conservation within the UK Biodiversity Action Plan (Littlewood et al. 2010; Natural England 2010; JNCC 2011).

The UK Biodiversity Action Plan lists 23,000 km^2 of bog and fen peatland habitat in the UK covering about 9.5% of the UK, with the majority in Scotland (UK Biodiversity Group 1999). Peaty soils in the UK, however, are much more extensive and indicate where peatland habitats existed in the past. Deep peaty soils cover around 33,000 km^2 with shallow peaty soils covering another 47,000 km^2 – a third of all UK soils (JNCC 2011). In the UK, blanket and raised bogs make up 95% of all peatland habitats (Table 1). The majority of UK bog peatlands are in private ownership.

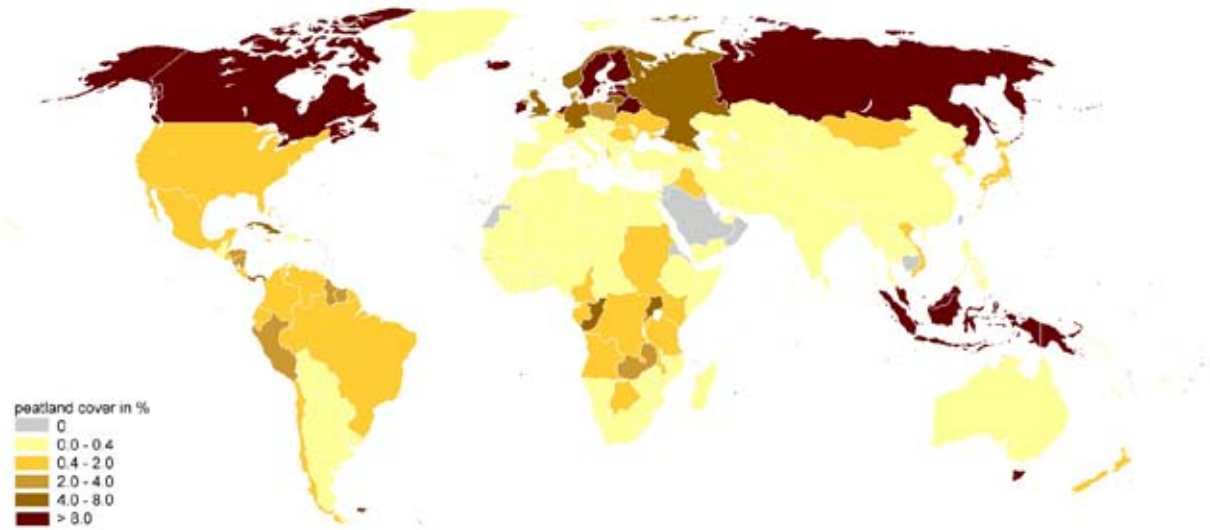


Figure 2 Distribution of peatlands across the world; reproduction with kind permission from Joosten (2009)

Table 1 Summary of organic-rich soils extent and bogs and fen UK BAP type extent; adapted with kind permission from JNCC (2011)

	Soil map data		UK BAP data	
	Shallow peaty or organo-mineral soil [km^2]	Deep peaty or organic soil [km^2]	Bogs [km^2]	Fens* [km^2]
England	7,386	6,799	2,727	80
Wales	3,592	706	718	62
Northern Ireland	1,417	2,064	1,609	30
Scotland	34,612	23,269	17,720	86
Total area	**47,007**	**32,838**	**22,775**	**258**
UK area cover	**19.30%**	**13.48%**	**9.35%**	**0.11%**

* current best estimates of fen habitat, but actual area may be much larger (Peter Jones, CCW, pers. comm.)

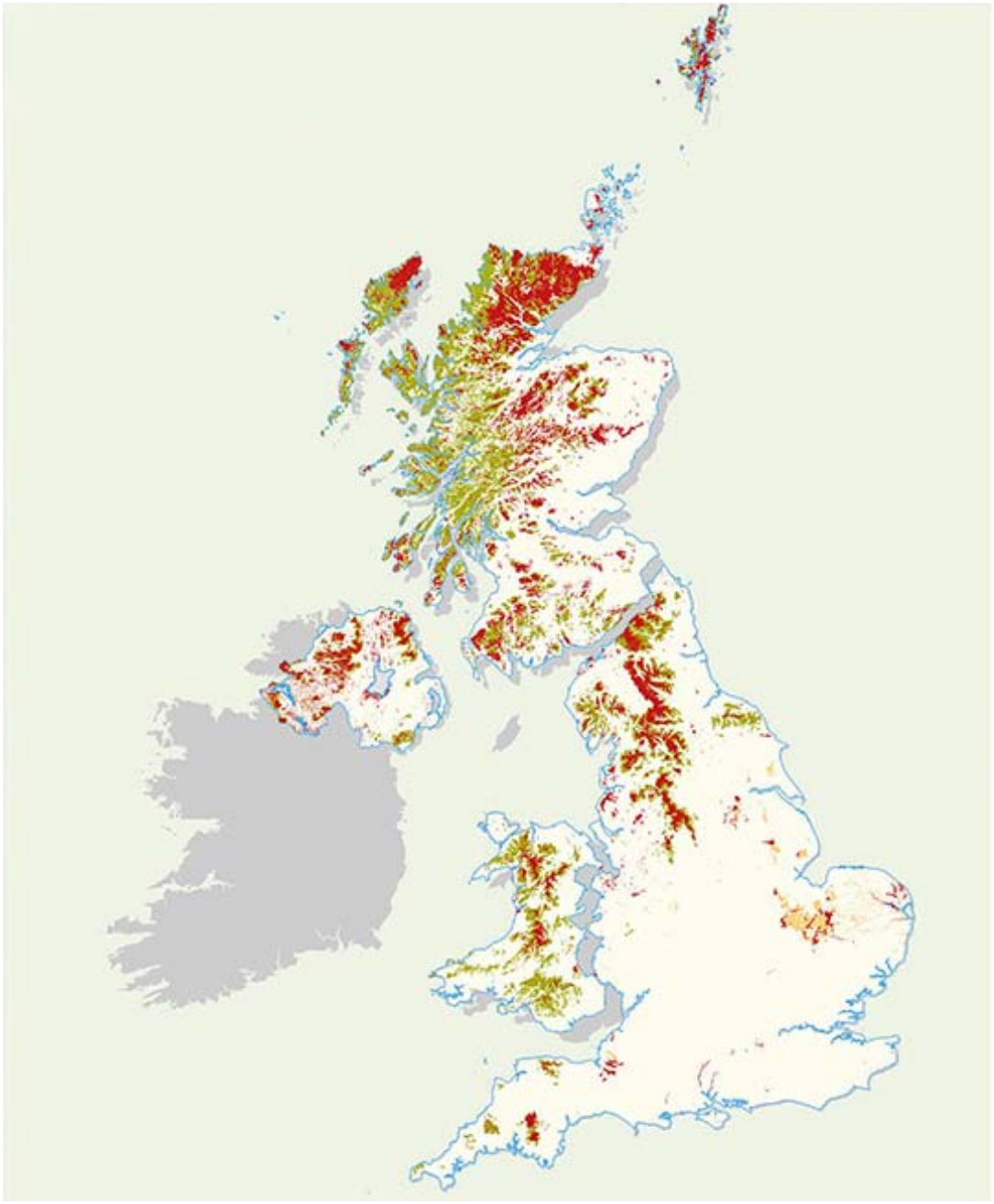


Figure 3 Peat and peaty soils of the United Kingdom (map reproduced from JNCC 2011). Deep peat soils (dark brown), shallow peaty soils (green), wasted deep peat soils (light brown). Peat in South-East England is largely fen peat. Reproduction by permission of OS on behalf of HMSO@ Crown copyright and database Right 2010, MLURI 100019294, AFBI 1:50000 soil digital Data, National soil Maps @ Cranfield University, BGS 1:50000 digital data (license 2006/072)

Peatlands in British Overseas Territories

UK Overseas dependencies also support some large areas of peatlands, particularly in the Falkland Islands. The Falklands may support some of the least disturbed soils on the planet, with soil processes progressing here, largely, undisturbed for 150 million years. Some 45% of the 12,173 km^2 Falkland land area is thought to be blanket peat (over 5,470 km^2) (Wilson et al. 1993). This area is comparable to deep peat coverage in England. The remaining area of lowland Falklands are dominated by shallower peaty soils.

Important peatland areas are also found in South Georgia, a Ramsar site with coastal peatlands, the Bermuda islands with inland peat marshes and wet woodlands as well as Gough and Inaccessible Islands of the UK overseas territory of Tristan da Cunha, which are designated as a biological World Heritage Site and a Ramsar site in recognition of their international importance site for birds and wetland communities. Other examples include the mountain top humid cloud forests of St Helena and Ascension Islands and peat swamp forests in the Turks and Caicos Islands and the Cayman Islands.

The extensive peatlands in the UK overseas territories are threatened by many of the same factors that have affected peatlands in the UK home territories: fire, livestock, drainage, agricultural improvement and forestry planting, leading to erosion and potential loss of the peat carbon. In addition to these, the delicate and unique ecosystems of many of these small island territories have been threatened by the introduction, accidental or deliberate, of alien species, which can overrun native vegetation or directly predate wildlife.

Work in the Falklands and Bermuda is now underway to restore and conserve the peatlands and to prevent future threats. For more information see brief summary of peatland in British Overseas Territories with web links to further information (IUCN UK Peatland Programme 2011).

Peatland in the Falkland Islands © Jim McAdam

4. WHAT KEY SERVICES ARE DELIVERED BY PEATLANDS?

"There appear to be few downsides to peatland restoration and a real potential for cost savings in providing long term public water supply. Peatland restoration offers a more sustainable future in water quality terms, as we're addressing the causes of poor water quality, not treating the worsening symptoms."

Andrew Walker, Catchment Development Leader, Yorkshire Water

Peatlands are extremely important for human well-being (Bonn et al. 2009a; van der Wal et al. 2011). What sets peatlands significantly apart from other ecosystems is their capacity for long-term carbon storage (Lindsay 2010; Joosten 2011). Undamaged peatlands are waterlogged, which slows down decomposition and enables semi-decomposed plant remains to be laid down as peat. Carbon is removed from the atmosphere into the plant tissues by photosynthesis and it is then stored in the dead plant remains, often over millennia, as a thick layer of peat. This also allows for the preservation of palaeo-environmental and archaeological remains. Since peatlands occur in areas of high rainfall, peatland dominated upland catchments are also source habitats for drinking water and play a role in flood water regulation. They also provide places of solitude with a sense of freedom and inspiration for millions of people. As waterlogged ecosystems, peatlands are habitats for many specialised, rare and endangered species recognised as important under international and national law. Many of these regulating and cultural benefits provided by peatlands take the form of non-market 'public goods' and are not traditionally paid for through market transactions. The importance and value of these services have been underestimated in the past.

In contrast, despite being less well suited for agriculture and forestry due to their waterlogged condition, peatlands have been exploited for provisioning goods, such as food and timber, often to the detriment of the ecosystem and its provision of other services. In general, this production was encouraged by grants and subsidies, e.g. for agricultural drainage and forestry planting (Condliffe 2009). These incentives no longer remain, yet the true value of the services provided by a functioning peatland is not fully reflected in funding for sustainable management. Below, we illustrate the potential of peatlands to provide valuable services to society and the impact of damaging activities as well as the potential for restoring these by focussing on four main services.

4.1 Climate regulation

Globally, peatlands store more carbon than the world's rainforests.

Peatlands are globally important in the world's efforts to stop dangerous climate change for two reasons. Firstly, they store an enormous amount of carbon. Peatlands cover only 3% of the world's land surface yet form a huge store of carbon, more than twice that of the world's forest biomass, and containing 30% of the total global soil carbon (Joosten 2011). They constitute the most spatially efficient store of carbon of all terrestrial ecosystems. A loss of just 1.6% of global peat would equate to the total global annual anthropogenic greenhouse gas emissions. When peatlands are damaged e.g. by fire or overgrazing this carbon can be released, turning a carbon sink into a source. A growing international awareness of their vulnerability is leading to an increased pressure to minimize human impacts on peatlands (Joosten 2009; Verhagen et al. 2009).

Secondly, undamaged bogs remove carbon dioxide from the atmosphere (sequestration) through photosynthesis in mosses and other peatlands plants and the carbon is stored in the peat which is composed of the dead, plant

remains. Temperate peatlands contain on average seven times more carbon per hectare than any other ecosystem of that climatic zone. This is because even the most productive non-peatland ecosystems eventually reach a stage where the carbon capture slows down and the total amount of carbon stored in the soil and vegetation levels off. In peatlands, the soil carbon store keeps growing as the peat deposit deepens.

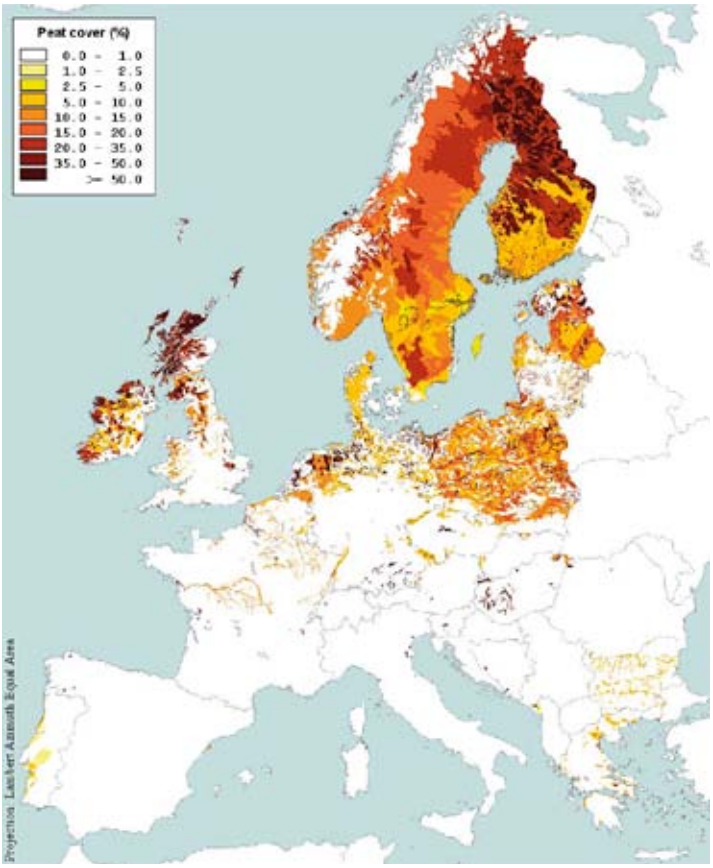
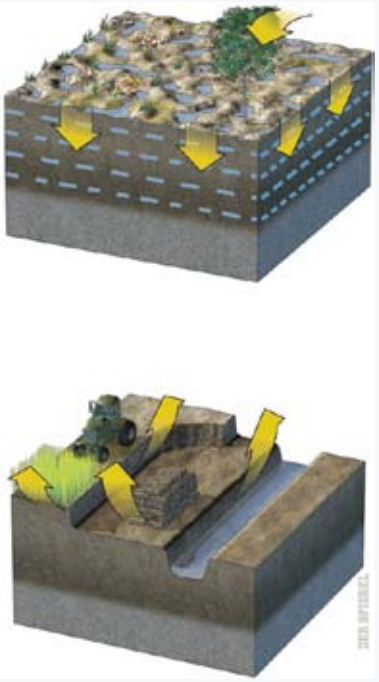


Figure 4 Peatland distribution across Europe. The UK hosts a high percentage of deep peat soils largely in the form of blanket bog peatlands; from Montanarella et al. (2006), reproduced by permission of the journal Mires and Peat, acknowledging the European Soil Bureau Network and the Joint Research Centre, Ispra (I), European Commission as the original source.

At a European scale, the UK's peatlands contain among the highest concentrations of stored carbon (Figure 4). Within the UK, peatlands represent the single most important terrestrial carbon store with deep peat bogs containing over 3,200 million tonnes of carbon (Worrall et al. 2010b), approximately twenty times that of UK forests. Scotland holds around half of the UK's peatland carbon. This store can only be maintained, if peatlands remain wet, or are rewetted where they have dried out. A loss of only 5% of UK peat carbon would equate to the total annual UK human green house gas emissions. It is therefore vital for the UK to avoid the huge losses arising from peatland damage in order to meet its international obligations in tackling global warming.

Semi-natural and natural bog peatlands may remove approximately 30-70 tonnes of carbon per km^2 per year from the atmosphere (Billett et al. 2010; Worrall et al. 2010b). However, peatlands also produce methane – a greenhouse gas that is several times more potent than carbon dioxide. Some studies suggest that in the short-term, peatland carbon sequestration is at times outweighed by methane emissions. In the long-term, however, given the relatively short lifespan of methane in the atmosphere, the amount of carbon sequestered outweighs the methane emitted. So, overall, intact blanket and raised bogs reduce the amount of greenhouse gases in the atmosphere.

Peatlands need to stay wet



Peatlands occur naturally in wet places. A continuously high water table prevents normal decomposition of plant material. In this way, carbon that plants assimilated during their lifetime is stored in the soil (carbon sequestration). This leads to the formation of peat, which is deposited layer on layer over millennia and stored sometimes for millions of years (carbon storage).

Drainage, peat extraction, afforestation, inappropriate burning or conversion to agriculture, lower the water table. As a result the peat becomes exposed and aerated. The stored carbon reacts with oxygen, decomposes and is released as carbon dioxide into the atmosphere (greenhouse gas emissions).

Furthermore, these activities lead to degradation of wildlife habitat, erosion and a decline in water quality as well as to the loss of the historic peat archive.

Figure 5 Schematic gas fluxes of carbon dioxide from natural peatlands and degraded peatlands; reproduction with kind permission from DER SPIEGEL (Bode et al. 2010)

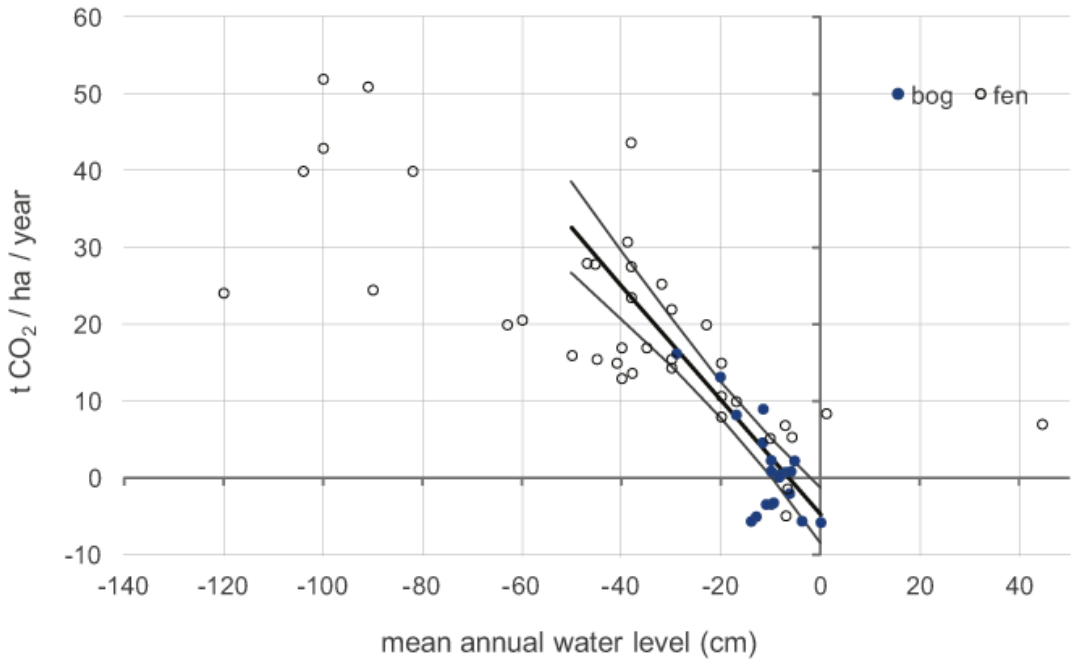


Figure 6 Annual CO_2 emissions of peat soils are higher under reduced mean annual water tables; reproduction with kind permission from Couwenberg and Van den Akker (see also Verhagen et al. 2009; Couwenberg et al.2011)

When drained, peatlands become major sources of greenhouse gases. Small disruptions to the hydrology of peatlands can upset the balance from carbon sink to carbon source. Lowered water tables allow oxygen to penetrate the formerly permanently waterlogged peat allowing rapid decomposition (Figure 5, 6).

Damaged UK peatlands are releasing almost 3.7 million tonnes CO_2e (Carbon dioxide equivalent[2]) each year (Worrall et al. 2011) – equal to the average emissions of around 660,000 UK households, more than all the households of Edinburgh, Cardiff and Leeds combined.

How much CO_2 is released from drained peatlands depends on the type of land use and geography. The more intensively the peatland is drained, the quicker the peat degrades (oxidises) and the higher the losses of greenhouse gases. These emissions continue for as long as the peat remains drained and may continue for hundreds of years until all the peat is lost. It is this combination of 'large' and 'long-term' emissions that make the climate effect of drained peatlands fundamentally different from that of other ecosystems (Joosten 2011).

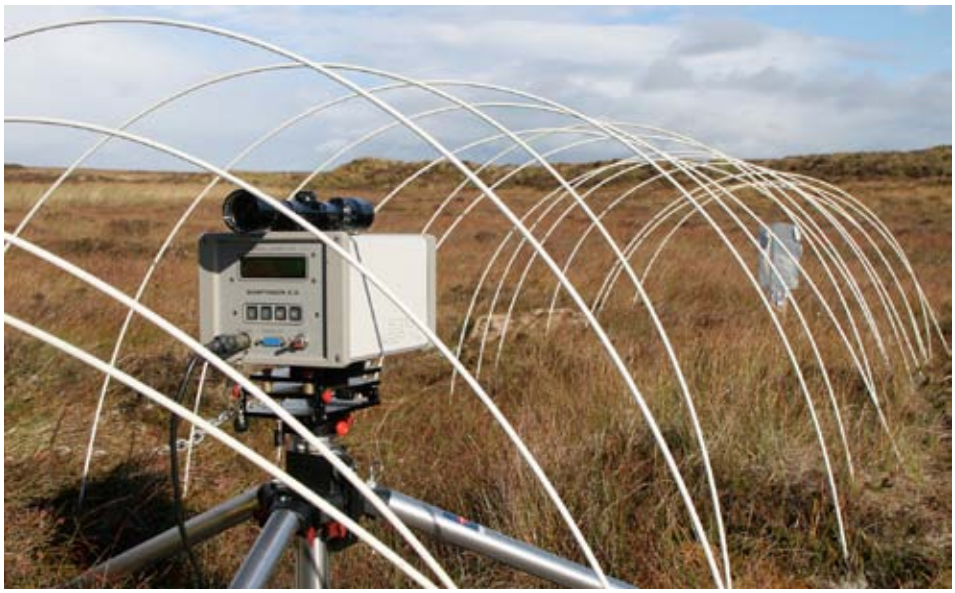
There are several routes by which soil organic carbon is lost from peat bogs (Worrall et al. 2010b). Losses can be as a gas – carbon dioxide (CO_2) or methane (CH_4), as particulate organic carbon by direct erosion or as dissolved organic carbon in rainwater drainage and runoff. Carbon borne away in water may generate greenhouse gases further downstream (Battin et al. 2008;

2 The carbon dioxide equivalent (CO_2e) allows the different greenhouse gases to be compared on a like-for-like basis relative to one unit of CO_2. www.carbontrust.co.uk

Pawson et al. 2008). Different types of losses and routes of loss impact on other ecosystem services such as drinking water quality. There are now significant advances to develop standardised methods for assessing greenhouse gas emissions from peatlands using vegetation cover as a proxy (Couwenberg et al. 2011). In addition, research is in progress to establish the extent to which non-gaseous particulate or dissolved peatland carbon lost into watercourses results in greenhouse gas emissions.

Globally 500,000 km^2 of drained peatlands release as much as 2,000 million tons of CO_2 annually, with the UK as one of the top twenty peatland CO_2 emitting countries (Joosten 2009, 2011). International climate change agreements are focussing on reducing the emissions of greenhouse gases with targets of up to 80% reduction on 1990 levels by 2050. The United Nations Framework Convention on Climate Change (UNFCCC) provides the framework for action to reduce greenhouse gas emissions (Kaat & Joosten 2009). The technical capacity, practical methodologies and user-friendly guidance for reporting and accounting for the most significant sources of emissions from peatlands are already available or within reach before the start of the Kyoto Protocol's second commitment period in 2013 (Joosten 2011). Under proposed changes to the Kyoto Protocol rules on land use, peatlands could feature more strongly in national greenhouse gas accounting processes, with greater recognition given to the benefits of rewetting damaged peatland. Standards for trading carbon credits from peatland on the high-quality-level international voluntary market have been available since March 2011 with a verified carbon standard (www.v-c-s.org).

Restoration of peatlands is a low cost and effective method of reducing greenhouse gas emissions from peatlands. This is true for heavily degraded and eroded peat bogs as well as for those still supporting bog habitats where the water levels are lowered.



Gas flux monitoring at Forsinard © Norman Russell

Peatland rewetting may be significant in relation to national climate change targets. Figure 7 illustrates that rewetting a gripped peatland by blocking drainage ditches has the potential to reduce emissions by over 250 tonnes CO_2e per km^2 per year. This takes into account the temporary, increased methane emissions which can arise in some situations from restoring peatland. Even with methane emissions the benefits of restoration clearly outweigh the carbon losses from damaged peatlands (Baird et al. 2009).

The climate change impacts of peat bogs and restoration

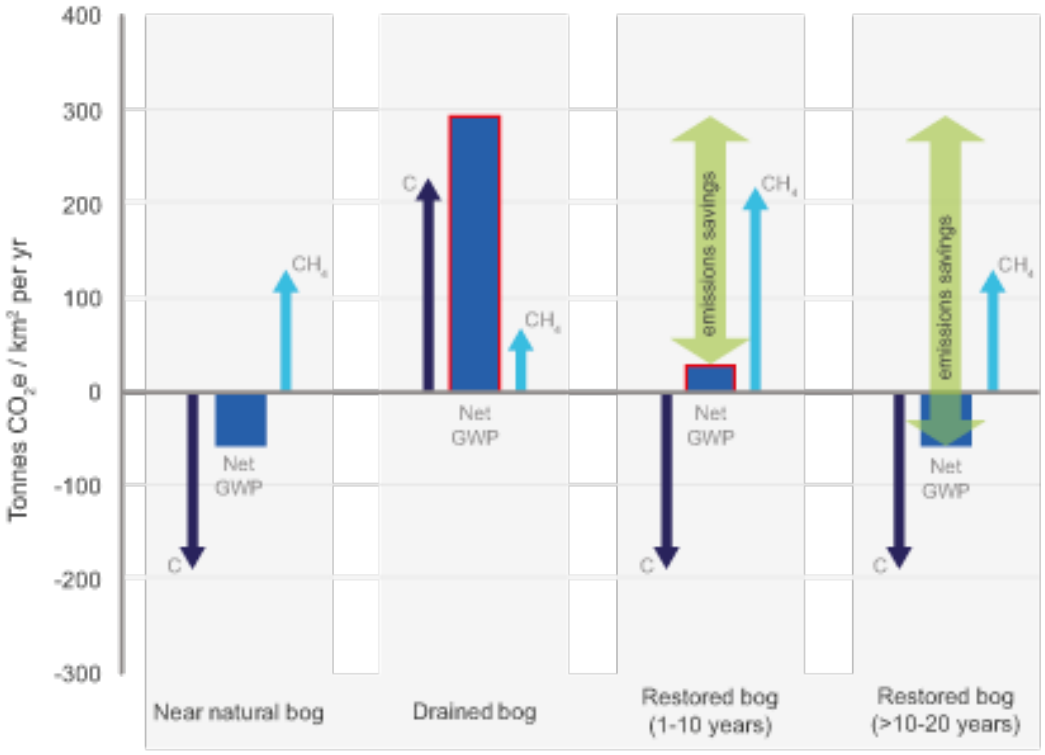
The carbon benefits of peatland restoration are threefold: reduced loss, transitionary gain and a long-term gain (from Worrall et al. 2010b).

Reduced loss: Restoration changes a damaged peatland from a large net source of carbon to a greatly diminished source.

Transitionary gain: The transitionary stage from damaged to restored peatland can be of carbon benefit due to both reduced losses and net gains of carbon. For example, gully restoration might allow the re-vegetation of a gully floor, reducing peat erosion and allowing peat to accumulate in the gully as well as trapping carbon in the new vegetation.

Long-term gain: Restored peatlands generally accumulate carbon and provide a long-term sink as atmospheric carbon is laid down as peat. Not all restored peatlands may be immediate carbon sinks (due to localised, temporary, methane emissions in some cases) but all have a smaller global warming potential than damaged peatlands. Restoration is therefore beneficial from a greenhouse gas emissions mitigation perspective (Baird et al. 2009; Worrall et al. 2010b; Joosten 2011).

Global warming potential of peat bogs



Sphagnum, the sign of a healthy bog © RSPB

Brown syke grip © Andrew Keen

Blocked grip, Flow Country © Norman Russell

Results of grip damming © Andrew Keen

Figure 7 Global Warming Potential (GWP) of UK peat bogs under natural, drained and rewetted state (figures are illustrative, using conservative estimates, based on Silvola et al. 1996; Byrne et al. 2004; Wallage et al. 2006; Holden et al. 2007; Minkkinen et al. 2007; MacNamara et al. 2008; Billett et al. 2010; Worrall et al. 2010b; Couwenberg et al. 2011; Worrall et al. 2011).

4.2 Biodiversity conservation

Peatlands form a highly significant part of the UK's natural heritage value. Nationally, conserving and reversing the deterioration of *Sphagnum* dominated bog habitat is a major priority for the UK Biodiversity Habitat Action Plans for blanket bog and raised bog and for several Species Action Plans. Because of the extreme conditions in peatland habitats they generally lack a high diversity of species per unit area. But those plants and animals which do occur are of high biodiversity importance because of their rarity or threatened state nationally and internationally. The presence and abundance of these important peatland species gives a more valuable indication of the state and health of the ecosystem than simply using measures of species diversity or richness.

Sundew, a carnivorous plant © Norman Russell

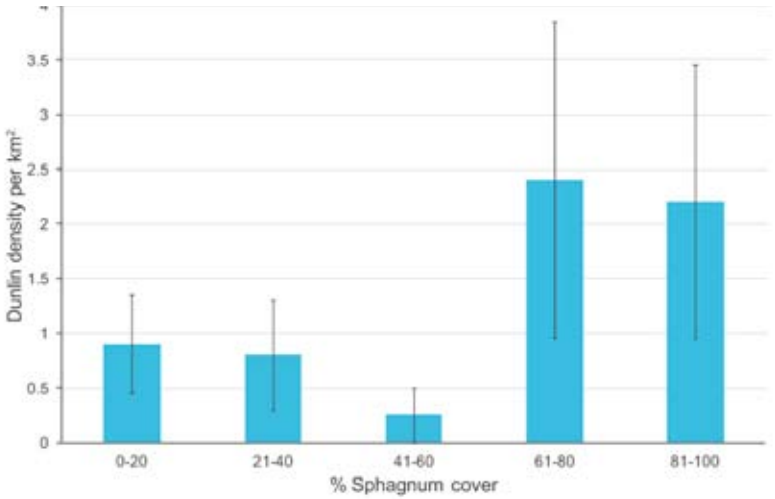
Peatlands support a large proportion of the plant and animal species which are adapted to waterlogged, acidic and nutrient-poor conditions (Littlewood et al. 2010). These species include a range of rare, threatened or declining animals and plants, such as rare species of *Sphagnum* mosses (e.g. *Sphagnum austinii*) or invertebrates (such as the bog hoverfly *Eristalis cryptarum*). UK peatlands support an important bird assemblage with an exceptionally high proportion of species with legal protection under UK and European conservation law. Bird species for which UK peatlands are especially important for conservation include golden plover (*Pluvialis apricaria*), greenshank (*Tringa nebularia*), red-throated diver (*Gavia stellata*), dunlin (*Calidris alpina*) and common scoter (*Melanitta nigra*). Areas of peatland, such as the Flow Country in Scotland, support some of the highest breeding densities of greenshank in Europe.

Bog cranberry © Norman Russell

Blanket bogs and raised bogs are priorities for conservation under the EC Habitats Directive. The high importance of UK peatland habitats, bird, invertebrate and plant assemblage is recognised in the designation as Special Protection Areas (SPA) and Special Areas for Conservation (SAC) under EU wildlife legislation. In England, 2196 km^2 of deep peaty soils are designated as SPA and/or SAC. For Scotland the areas of qualifying habitat in SACs are: blanket bog 2164 km^2, active raised bog 22 km^2 and degraded raised bog 19 km^2. Nationally, a large proportion of peatlands are included in land areas that are designated for their biodiversity as Sites or Areas of Special of Scientific Interest (SSSI/ ASSI) and for their landscape value as National Parks and Areas of Outstanding Natural Beauty. In England, 2478 km^2 SSSIs are on deep peaty soils, of which 2226 km^2 is blanket bog or raised bog.

Northern Emerald Dragon Fly (*Somatochlora arctica*)
© Laurie Campbell/SNH

As peatland species are highly adapted to acidic, waterlogged and nutrient-poor peatland conditions, they are very sensitive to changes in land management activity as well as climate change and atmospheric deposition of pollutants.



Dunlin © RSPB

Figure 8 Dunlin populations are closely associated with areas of high *Sphagnum* cover in peat bogs; graph reproduced with kind permission of RSPB (Stephen et al. 2011).

Sphagnum mosses are key to peatland ecosystem functioning

Sphagnum mosses are keystone species for providing a range of ecosystem services. *Sphagnum* mosses are the main peat forming species, thereby contributing to carbon sequestration and carbon storage. Furthermore, *Sphagnum*-dominated vegetation does not facilitate methane release unlike vegetation dominated by various vascular plants (Frenzel & Karofeld 2000). Some *Sphagnum* species hold up to 20 times their dry weight in water and with their fibrous structure play a significant role in moderating water flow and thus helping to reduce downstream impacts of heavy rain.

There are 34 *Sphagnum* species in the UK, of which only five species are major peat formers, and two of these are rare today. *Sphagnum* species have their growing points at the tips and are therefore easily damaged or destroyed by grazing, burning, trampling and drainage.

Sphagnum tenellum © Andy Amphlett

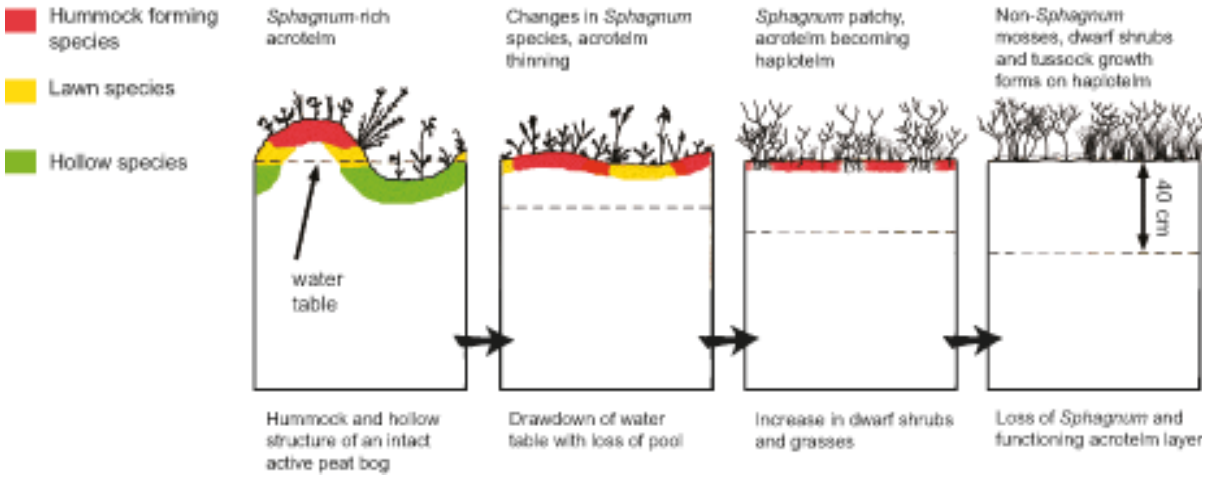


Figure 9 Effects of a lowering water table on vegetation. With lowered water table, the peat surface will also subside and shrink - not shown in this graph for simplicity; reproduction with kind permission of Lindsay (2010)

A fully functioning, carbon sequestering peatland contains a mix of specialised peatland plant species (with a prominent representation of *Sphagnum* mosses). Lowered water levels are characterised by a replacement of *Sphagnum*-rich hummocks, lawns and pools to a flatter surface dominated by heathland species (sedges, grasses and heather). Figure 9 also shows how particular species of bog *Sphagnum*, some of which are nationally important, are vulnerable to falling water tables (Lindsay 2010). Vegetation type and structure can therefore be an effective guide to the state of a peatland.

Peatlands are popular places for people to visit, for example, the peatland dominated upland English National Parks receive close to 60 million day visitors a year. This is on a par with visits to the UK's greatest monuments. Typical peatland wildlife provides an unusual and stimulating experience that attracts visitors from the UK and abroad, providing employment and tourism income (Macpherson Research 1997). Many peatlands are in remote upland areas and therefore offer experiences of wilderness and solitude, physical challenge and inspiration, not easily experienced elsewhere (Bonn et al 2009b).

Peatlands are an important visitor attraction © Norman Russell

4.3 Water regulation

Peatlands are the headwaters for some of the UK's major water supply areas. They can also play a role in regulating flood flows to downstream areas.

Water derived from functioning peatlands is naturally of very high quality. However, over the last 30 years, the amount of dissolved organic carbon (DOC), the brown colour of peaty water, has doubled across many UK catchments (Labadz et al. 2010). To meet drinking water quality standards set out in the European Drinking Water Directive, DOC has to be removed from drinking water supplies, as otherwise chlorination during water treatment results in the production of carcinogens. Removing DOC can be extremely costly for water companies, especially if new treatment processes need to be added.

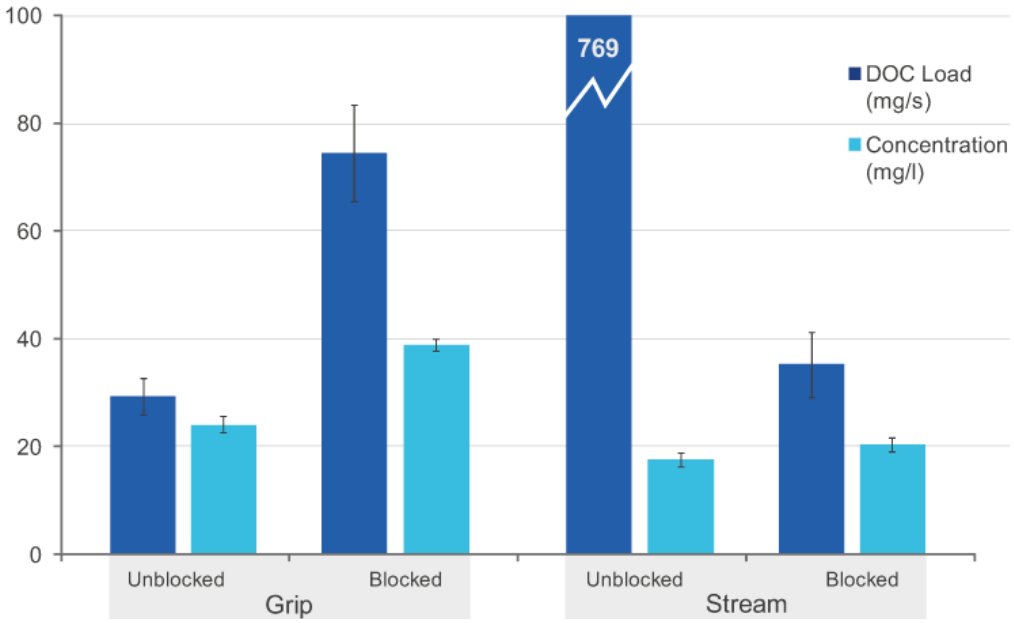


Figure 10 Effects of grip blocking on DOC levels. While DOC levels initially increased in grips after blocking in the first 18 months, overall DOC concentrations in streams, however, did not change and reductions in flow led to very large reductions in load (data from Lorraine Wilson, see also Wilson et al. 2011b)

A number of reasons for increased DOC have been put forward, including responses to increased temperatures (Worrall & Burt 2004) and recovery from the effects of acid rain (Monteith et al. 2007). These processes act at a large spatial and temporal scale. At a localised, catchment scale, there is evidence that peatland condition and management can contribute to colour production with damaged peatlands being associated with higher colour. For example, dominant heather cover can lead to enhanced DOC levels in comparison to *Sphagnum*-dominated blanket bog vegetation (Limpens et al. 2008, Holden et al. 2011). Some studies point to the importance of recent burns in increasing water colour (Yallop et al. 2010). The evidence on the direct effects of burning is conflicting, possibly because of the use of different methodologies (Worrall

et al. 2010c; Holden et al. 2011) and may be linked to the different scales of investigation of these studies (Clark et al. 2010b).

Restoring peatlands within water catchments can help to improve water quality (as peatlands often lie across catchment borders, action may be required over more than one catchment). Grip blocking has been found to reduce dissolved organic carbon in streams (Wallage et al. 2006; Armstrong et al. 2010; Wilson et al. 2011b). Sediment and associated particulate organic carbon loads from water coming out of degraded peatlands can also be very high, with bare peat areas exporting up to 260 kg sediment per km^2 per year or 100 kg carbon due to erosion (Evans et al. 2006). Re-vegetation can stop surface erosion within 3-4 years and thereby minimise sediment and particulate organic carbon export (Evans et al. 2009).

Restoration of damaged peatlands may also contribute to some amelioration of flooding. The water table in intact peatlands fluctuates a little, but is usually close to the surface. The capacity to store significant additional water is therefore low and rain runs off intact peatlands quickly. However, the creation of drainage channels accelerates the rate at which water leaves a peatland. Blocking grips is likely to lead to less flashy peak flows a longer water retention time and therefore slower run off rates (Figure 11, Labadz et al. 2010; Wilson et al. 2011a). The greatest effect will result from blocking grips with large upslope 'catchments' (contributing areas) (Lane et al, 2004). Blocking grips elsewhere in the peatland unit, however, is still important for restoring peatland function including increased *Sphagnum* growth.

Run off may also be accelerated by the loss of vegetation, increased areas of bare peat and desiccation, in damaged peatland, which can lead to peat becoming so dry that water will no longer infiltrate and thereby enhance quick run-off and potentially exacerbate flood impact. Conversely, in areas with vegetation cover flow peaks can be reduced and slightly delayed compared to

High levels of dissolved organic carbon (DOC) may be lost from degraded peatlands
© Martin Evans

bare peat (Grayson et al. 2010). Catchment modelling indicates similar results at a large scale (Holden in Bonn et al. 2010) and plot scale studies point to *Sphagnum* being important in reducing flow velocities (Holden et al. 2008). Slower run off and less flashiness helps with flood amelioration. Whilst grip blocking does seem to have the potential to influence local runoff, evidence is still being gathered about how far these benefits can be seen downstream.

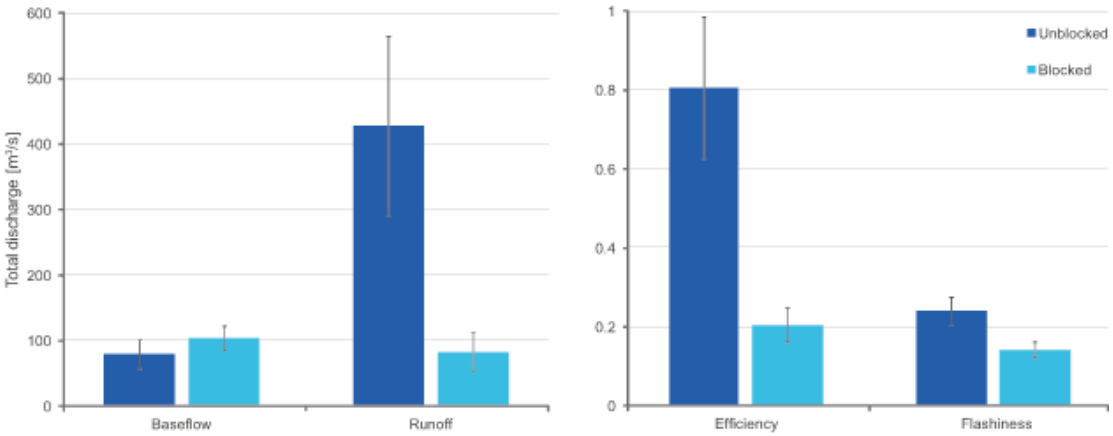


Figure 11 Change in baseflow and runoff after grip blocking. Blocking grips leads to reduced runoff with more water retained on the bog (Efficiency index) and a less concentrated flood response (Flashiness index). Data from Lorraine Wilson, see also Wilson et al. (2010; 2011a)

4.4 Sense of place: historic environment conservation

Peatlands offer a tremendous insight into our past (Geary et al. 2010). Some of our peatlands began forming after the last Ice Age and others developed later, but UK peatlands in both uplands and lowlands have their origin in prehistory. Some of the most evocative archaeological discoveries of the last century come from peatlands. For example, the 4th millennium BC footpath, the 'Sweet Track' in the Somerset Levels, and the best preserved ancient human remains in the UK, the 'bog body' known as Lindow Man from Cheshire, were found in peatlands.

Lindow Man – the Iron Age bog body retrieved during peat cutting in Lindow Moss, Cheshire, in 1984 © Trustees of the British Museum

Peatlands maintain a unique archive of our cultural past. Beneath the peat, large tracts of prehistoric landscapes lie protected from modern disturbances. The waterlogged peat matrix itself is an oxygen-free environment, and in such conditions objects and structures made of wood and plants survive for millennia. The peatlands in the UK have preserved some of the oldest roads and tracks, houses and settlements, monuments and artefacts. It has been estimated that in excess of 20,500 archaeological sites exist beneath and within the peat in the UK (Geary et al. 2010). Peatlands themselves also form part of the historic landscape and contain evidence of peat cutting, which goes back to the Roman period and continued through the Middle Ages, offering an alternative source for fuel. Some peatlands were designated as medieval royal hunting forests (forest in this period meant any land supporting game and was not necessarily tree covered).

Late Neolithic trackway and platform on Hatfield Moors, South Yorkshire © Henry Chapman

Complex stratigraphy of peatlands tells stories about past environmental change © Norá Bermingham

Peatlands also record environmental change, as the peat layers of different depth can be dated. This archive includes the history of the peatlands themselves, in the form of the remains of the plants that make up the peat and of the insects that lived on the bogs. We can also learn of past changes in the landscape beyond the peatlands, which can be reconstructed from the pollen that blew into peatlands. Occasionally, microscopic glass-like particles from volcanic eruptions, known as tephra, settled down on peatlands. Together, these archives of the environmental past provide unequalled information on past climate and environmental change. Studies undertaken in peatlands have contributed greatly to our understanding of global climate change (Charman 2002).

Peatlands provide many people with a ‘sense of place’. As large semi-natural landscapes, they can provide local communities a sense of inspiration and connectedness with their natural environment. This is reflected in many ancient local stories, legends and poems. Whilst peatlands have come to be regarded and valued as wildernesses in some places, elsewhere peatland landscapes have been formed through the centuries-long utilisation of the peat itself, and this activity has contributed to the way communities understand peatlands. Many communities have memories of people utilising peatlands for fuel, field sports or agriculture in the past and more recently. Identification and presentation of this cultural and natural heritage can benefit local economies through the development of associated tourism.

Peat itself is used in some products and production processes. For example, *Sphagnum* mosses were used for surgical dressings in the First World War. In parts of the North and West Highlands and Islands of Scotland peat is still cut and used as a fuel. Peat smoke is used in the production of some Scottish single-malt whiskies, with the smoke absorbed by the malt giving a distinctive flavour. The water sources for many whisky distilleries also arise in peatlands. In this way, peat has a significant role in an important part of the Scottish economy and helps define local identities. One of the issues facing peatlands is that memories of the past activities have largely involved damage to the peatland. The challenge ahead is to manage peatland uses in ways that minimise the damage and to look at new economic and employment opportunities such as recreation and tourism or work in peatland restoration with volunteers and contractors.

When peatlands deteriorate, their ability to provide a cultural and environmental archive diminishes. Peat extraction, drainage, and other damaging land management cause the exposure, oxidation and eventual destruction of these archives. Peatland restoration is needed in order to preserve the historical value of peatlands for future generations.

5. WHAT IS THE STATE OF UK PEATLANDS?

"Making a commitment to maintain and restore peatlands in line with national and international biodiversity objectives offers the prospect of wider carbon and water benefits. There is clear evidence on the benefits of peatlands to society and, critically, mounting experience on how to manage them across the UK."

Susan Davies, Director of Policy and Advice, Scottish Natural Heritage

The best available evidence suggests that less than 20% of UK blanket bog is in a natural or near-natural condition (Littlewood et al. 2010). The majority of UK peatlands are not peat forming: 16% are severely eroded, 10% have been afforested, 11% are affected by past peat cutting and 40% have been modified or destroyed by conversion to agriculture (Littlewood et al. 2010).

Within the most important, nationally and internationally protected sites (SSSIs/ SACs / SPAs), only around half (58%) of the blanket bog habitat is considered to be in favourable condition (JNCC 2011). Of the remainder, only 15% is considered to be recovering as a result of restoration work. For designated lowland raised bog sites, the situation is even worse, with only around 20% considered to be in favourable condition although 35% of the remainder is under restoration management.

Peatland species are also under threat. Most of those identified as priority for conservation under UK Biodiversity Action Plans (BAP) are still declining (JNCC 2011).

The UK Blanket Bog Habitat Action Plan set a target of restoring 845,000 ha of blanket bog by 2015 (UK Biodiversity Group 1999), of which 620,000 ha could be readily restored by adjustment in management. There are also many more heavily eroded areas that need intensive restoration, including 22,500 ha targeted by the UK BAP.

It is difficult to present a detailed picture of the state of UK peatlands because different countries within the UK have developed different soil definitions and different approaches to recording land use and cover (JNCC 2011). For Great Britain (excluding Northern Ireland), the Countryside Survey 2007 data indicates that, among survey kilometre squares with the most organic soils, around a quarter of the survey squares remain dominated by “bog” or blanket bog vegetation. However, for England for example, this matches only around half of the area mapped as BAP priority habitat (JNCC 2011) suggesting some degradation. Some 18% of this sample area is vegetated with acid grassland, 11 % is planted with coniferous forest and 13% supports upland heath, perhaps reflecting rotational burning management.

Scotland retains the largest areas of semi-natural and bog habitats over its peatlands, although the Land Cover Mapping for Scotland indicates large areas of peatland dominated by “moorland” and coniferous forestry as well as bog vegetation. England’s blanket bog peatlands are largely semi-natural but around a third of English blanket peatlands are subject to rotational burning, a fifth have been drained by upland grips and a seventh are severely eroded. England’s raised bog peatlands retain less bog or semi-natural vegetation: two fifths have been drained for agriculture, a sixth are afforested and at least a seventh continues to be affected by peat extraction. Almost all blanket and raised bog in England is subject to damaging levels of historic atmospheric sulphur deposition and ongoing nitrogen deposition. In Wales, three fifths of the blanket bog habitat is described as “modified” (often supporting heath or grassy vegetation) and a little under half the raised bog habitat is also modified. Northern Ireland’s blanket bog peatlands are mainly vegetated with bog and semi-natural vegetation, although most have been affected by drainage and peat cutting in the past. Northern Ireland’s raised bogs continue to decline in condition and extent.

The overall picture shows that the majority of upland blanket bogs retain semi-natural vegetation, but continue to suffer the legacy of past activities such as peat cutting and moorland drainage. They are subject to continued large-scale land management such as rotational burning or forestry and may be subject to damaging pollution. The UK's raised bog peatlands are subject to similar threats, but continue to suffer from ongoing or recent peat extraction and have been subject to greater agricultural intensification. The issues faced by peatlands within the UK are similar across all constituent countries and affect huge areas of our most treasured wildlife habitats and landscapes. Past and present management of our peatlands and the vegetation this has created, continue to affect the ability of peatlands to deliver the key ecosystem services they provide to the benefit of society.

There are different stages and drivers of bog degradation

i. Intact fully functioning peatlands

Intact or semi-natural peatlands are normally peat forming, because the water level remains high throughout the year.

Functioning blanket bog, Forsinard © Norman Russell

ii. Degraded peatlands

Degraded peatlands have different characteristics on a continuum between slightly damaged bog and bare peat. These peatlands may have been affected by drainage or a combination of land management activities and pollution. The vegetation composition and structure reflect the degree of change with dominance of bog mosses being replaced by grasses or heather.

Drained Weardale bog © North Pennines AONB Partnership

Brown syke grip © Andrew Keen

Afforested peatland in the Flow Country © RSPB

Upland grazing © Penny Anderson

Some of the key damaging impacts are:

Gripping (or ditching): drains are cut into the peat to lower water levels. Large areas of peatland were drained with agriculture subsidies in the late 20th century. Although new drains are no longer funded, the old drains continue to have an effect.

Afforestation: about 10% of UK blanket bog has been planted with commercial forestry. Afforestation on deep peat may require drainage, cultivation and fertilisation, which can lead to peat shrinkage, cracking and oxidation which significantly increases greenhouse gas emissions. Since 1990, there has been a steep decline in new plantings on deep peat soils. The UK Forestry Standard (Forestry Commission in press) discourages planting forests on deep peat soils and on sites that would affect the hydrology of adjacent bog sites. In Scotland, there is an interim general presumption against woodland creation on soils with peat exceeding 50cm in depth. Re-stocking deep peat sites is discouraged, and these areas can be the focus for open habitat restoration (Anderson 2010; Morison et al. 2010).

Sheep and deer management: heavy grazing and trampling by sheep and deer changes both the composition of vegetation and its structure. Overgrazing damages sensitive plants and can cause more rapid surface water flow. It generally increases erosion, eventually leading to bare peat and gullies. Light grazing may be beneficial for peatland biodiversity helping reduce competing vegetation.

Fire: managed burning on sporting estates is used to encourage new heather growth with a varied age structure for grouse. Poorly managed burning on blanket bog can damage bog vegetation and encourage heather growth. Burning for livestock and deer is widespread, but more sporadic in frequency and less well recorded, though individual burns tend to cover larger areas. Over frequent burning can damage blanket bog vegetation causing peat degradation.

Damaged peat bogs are drier and thus the risk of accidental wildfire is particularly high and one of the most severe threats to peatland carbon stores, water quality and wildlife. Wildfires are also extremely expensive. For more information see work by the FIRES partnership group (McMorrow et al. 2009; FIRES 2010).

Heather burn © North Pennines AONB Partnership

Windfarms: the main new built development activity on peatlands is for windfarms (Stunell 2010) and communication mast construction. Associated works, such as access tracks and turbine foundations, can damage peatland hydrology causing the vegetation to change or allow erosion with ecological and carbon loss effects often beyond the footprint of the construction area. A methodology for calculating the carbon impact of windfarms on peat has been developed (Scottish Government 2011). Planning guidance and voluntary agreements with the wind industry recognise the need to limit the carbon impact of development and to avoid deep peat and areas of high environmental and landscape significance (Scottish Renewables 2010). Windfarms can also be associated with peatland restoration work to help bring carbon and ecological improvements.

Windfarm south of Farr, Inverness-shire © Duncan Brown

Commercial peat extraction: commercial peat extraction occurs mainly on raised bogs to provide peat for gardening. The mechanised peat removal has a major ecological impact, stripping away the living layer and subsequently exposing large quantities of peat to oxidation and loss of carbon. Neighbouring areas of bog within the same hydrological unit can become degraded as a result of the drastically lowered water table. Currently, nearly 3 million cubic metres of peat are sold for horticultural use every year in the UK, one third of which comes from UK peatlands. The main users are amateur gardeners (69%), followed by industry (30%) and a small percentage by local authorities (1%) (Defra 2010). Most peat use in the UK can readily be replaced by more sustainable alternatives. The growing media industry has developed high quality products often using composted green wastes which are now widely used.

Commercial peat extraction © RSPB

Bare peat on Kinderscout © Aletta Bonn

Eroded gully © Aletta Bonn

Carrots growing on peaty soil on Lakenheath Fen, Suffolk, in 1995 © Andy Hay (RSPB Images). Since acquiring the site in 1995, the RSPB have been working to restore 200ha of arable land back to a wetland.

iii. Bare peat

Bare peat can arise over large areas, after commercial peat cutting or in areas of heavy degradation arising from land management and pollution, e.g. by erosion started by wild fires, intensive trampling by livestock, atmospheric deposition of pollutants or a combination of these.

Bare peat can be exposed after wildfires on drained peatlands.

Gully erosion is a localised form of bare peat.

iv. Cultivated peatland

Cultivated peatlands still retain a significant depth of peat, but the plant cover has been artificially changed for agriculture, e.g. to grassland for grazing or to arable crops. This is generally found on lowland peatlands, particularly fens, but also widespread on some raised and blanket bog areas especially in northwest England and the north and east Highlands of Scotland.

Wasted peatland has lost both its peat-forming vegetation and a significant depth of peat soil. Agriculturally wasted peatlands are thought mainly to occur in lowland England, however, extensive examples also occur in Wales.

5.1 Burning on peatlands

During the public consultation process, stakeholders suggested that managed burning was an important driver of ecological change on peatlands. It was considered that other key drivers, such as forestry (Morison et al. 2010), wildfires (FIRES 2010) or peat extraction for horticulture (Defra 2010), were effectively reviewed elsewhere. The Inquiry therefore included managed burning as a review topic, focussing on blanket bog and raised bogs, as distinct from burning on upland heath.

Burning has occurred over centuries and the palaeo-ecological record shows that many peatlands shifted from a *Sphagnum* dominated vegetation to less peat forming vegetation after fire. Understanding the consequences of managed burning today needs to be seen in the context of the current damaged state of many peatlands having been affected by past fire, drainage and intensive livestock grazing.

Managed burning on sporting estates is used to encourage new heather growth to create a mosaic of stands of varied age structure for grouse (Worrall et al. 2010c), particularly on upland heaths on mineral soils or shallow peat. On deep peat the practice is largely restricted to the east Scottish Highlands, Southern Uplands and the Pennines (see Figure 12). Burning for sheep grazing is widespread but more sporadic and less well recorded.

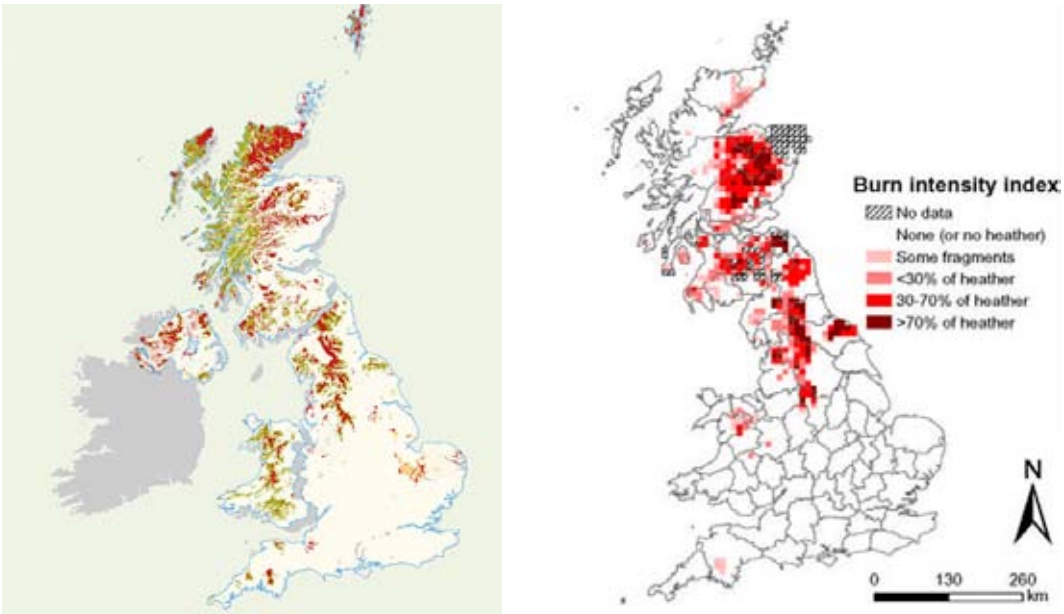


Figure 12 a) Distribution of peat soils in the UK (see Figure 3 this report, reproduction with permission from JNCC 2011). **b)** Burn intensity index across the UK. The index of burning reflects the extent of 'strip' burning presented at a 10 km resolution from mainly 2005 – 2006 satellite images. Note, Shetland is omitted, but no strip burning occurs there; reproduction from Anderson et al. (2009) with permission from Elsevier

Poorly managed 'hot' burns can have severe damaging consequences for peatland ecology, hydrology and soil processes. Such burning can degrade bog habitat, with reductions or loss of key bog species and structural diversity and can encourage more typically heath species (Ratcliffe 1964; Rowell 1990). Burning can also impact on aquatic invertebrate communities in watercourses in peatland catchments (Ramchunder et al. 2009). Recovery back to bog species after a fire depends on the frequency and intensity of the burn along with other factors such as the condition of remaining bog vegetation, water levels, livestock numbers and altitude. It has been suggested that 'cool' burns, under the right controlled conditions, may be compatible with the initial stages of peatland restoration management while rewetting takes place. There are few studies on the benefits and practicalities of burning over other techniques such as cutting or layering (Lunt et al. 2010).

In bogs with high water tables and ample *Sphagnum* growth, burning should not be necessary as the growth of *Sphagnum* forces heather to generate new shoots as the peat builds up (Adamson & Kahl 2003).

A number of studies point to the importance of vegetation type being associated with different greenhouse gas balances. *Sphagnum* dominated vegetation with a high water table is shown to have greenhouse gas benefits over heather dominated deep peat (Lindsay 2010; Couwenberg et al. 2011). Thus if management alters the vegetation cover of sites, it is likely to alter the greenhouse gas balance (Worrall et al. 2010b)

Studies suggest that there are benefits for carbon budgets from the absence of burning on deep peat compared to burning (MacDonald 2008; Worrall et al. 2010a). The specific impacts of 'cool' burning over other forms of burning on the overall carbon budget is not yet clear.

Water colour is a major concern in drinking water catchments and an indicator that carbon is being lost from the ecosystem. Recent reviews suggest that on balance, burning impacts on water quality and results in increased colour (Holden et al. 2011). *Sphagnum* and cotton grass dominated vegetation has been associated with the lowest levels of colour (Limpens et al. 2008). Areas of dominant heather vegetation on deep peat (Holden et al. 2011) and areas of new burn on deep peat have been associated with increased water colour (Yallop et al. 2010). Further work is required to determine whether the source of this colour results from the act of burning or subsequent dominance of vascular plants over *Sphagnum*.

Good practice guidance on prescribed burning has been produced in partnership with statutory agencies and moorland managers (Defra 2007; SEERAD 2008; WAG 2008) with proposals for further guidance to be developed (Best Practice Burning Group 2010). There is general agreement amongst these groups that burning should be managed to avoid adverse impacts on active bog and to seek to restore blanket bog on deep peat areas modified by past land management and/or atmospheric pollution. Research is underway to assess the effects of burning on peatland biodiversity, river eco-hydrology and carbon export (e.g. EMBER and several ongoing Defra funded research projects).

In a changing climate with greater emphasis on mitigation and adaptation, determining appropriate burning management on degraded deep peat areas requires further monitoring and research. A more coordinated and consistent approach to describing the different peatland types and states is urgently required in future studies to avoid the confusion that has arisen from generic research on “peatlands” and “heather moorland”.

5.2 External drivers: pollution and climate change

Atmospheric deposition of pollutants also affects peatlands. Whilst the levels of pollution cannot be directly altered on site, it may be possible to reduce the level of impact on the peatland habitat through site management to limit other compounding pressures, such as drainage and fire. Historically, atmospheric pollution across the South Pennines and South Wales has contributed to the loss of *Sphagnum* and the acidification of head waters and soils. Sulphate deposition has been linked to inhibition of dissolved organic carbon production (Monteith et al. 2007), and recovery from acidification has led to a rise in water colour. Nitrogen deposition, arising from fertilisers, transport emissions and factory farming can also causes species change and, for example, allows for *Sphagnum* species, which are typically found in more nutrient-rich fens, to grow on bogs. In England, it has been estimated that 98% of blanket bog peatlands and 100% of raised bog peatlands are subject to levels of nitrogen deposition that are damaging to these habitats (Natural England 2010).

Climate change is predicted to make damaged peatlands more vulnerable to degradation through drying, particularly where temperatures increase and rainfall decreases (Clark et al. 2010c; House et al. 2010). Climate change is also likely to change the species composition, affect water quality, and potentially increase greenhouse gas emissions from peatlands, although it is not yet possible to determine the rate at which this might occur (Clark et al. 2010a). The peat archive shows that peatlands have previously responded to changes in climate by shifts in peat forming vegetation (biotic response) to moss species which can tolerate drier climates and continue the role of laying down peat and storing carbon (Dise 2009; Lindsay 2010). Peatland restoration is particularly important given the threat of climate change, as restored peatlands are likely to be more resilient to additional stresses from climate change impacts.

6. OPTIONS FOR THE FUTURE

"With an increasing responsibility to deliver more sustainable land management, peatlands demonstrate how this can be done with minimal outlay in comparison with other less understood interventions."

Ian Crosher, Peat, Soils & Climate Change Adaptation, Natural England

We are at a pivotal point in determining the future of our peatlands. The global threat of ongoing loss of biodiversity (TEEB 2010; UKNEA 2011) and climate change requires urgent action to help reduce greenhouse gas emissions and provide adaptive strategies for resilient ecosystems.

- Damaged UK peatlands are already releasing almost 3.7 million tonnes CO_2e each year (Worrall et al. 2011) - equivalent to the average emissions of around 660,000 UK households. These emissions are likely to increase with further peatland deterioration as the climate changes. Net emissions can be reduced through restoration action.
- Peatlands are recognised as one of our most threatened and valuable habitats under international and national wildlife legislation. However only 18% of bogs have vegetation that can be described as 'near-natural'.
- Water companies are acutely aware of the cost implications of brown water from degraded peatlands. Rising levels of dissolved organic carbon from peat catchments has a high treatment cost that inevitably means higher water bills.
- Climate change is likely to cause more extreme weather. Damaged peatlands may exacerbate flooding and have a higher wildfire hazard - highly damaging to the peat carbon store and biodiversity as well as being very expensive to control.

To date, UK policy obligations in relation to peatlands have had a limited impact (Reed et al. 2010). There is a clear choice to be made: business as usual, leaving the majority of peatlands to deteriorate, or concerted action to protect and restore peatlands.

The stark choice: effects of business as usual or active restoration management

	Business as usual	Peatland restoration management
Climate change mitigation	Significant greenhouse gas emissions from currently damaged peatlands. A loss of 5% of UK peatland carbon equates to the total annual UK greenhouse gas emissions.	Safeguarding the biggest UK terrestrial carbon store. Key opportunity to deliver greenhouse gas emissions savings from damaged bogs by restoration. Potential to contribute to UK national climate change targets under Kyoto Protocol, Land use, land-use change and forestry (LULUCF).
Climate change adaptation	Loss of resilience for peatland function, habitats and species. Potential exacerbated flood impact and wildfires with associated costs.	Reduced vulnerability to changing climate and extreme weather events with reduction in further peatland degradation and associated impacts water and carbon. Maintaining important peatland biodiversity and helping species/habitats to adapt to changing climate.
Water quality	Increased water quality deterioration. Failing of 'good ecological status' and Water Framework Directive requirements. Anticipated need for new water treatment can be very costly.	Improved condition of catchments with water quality problems. Quick reduction of sediment loads with benefits for fisheries and reservoir storage. Decrease in water colour and treatment costs.
Biodiversity	Further decline in condition and loss of important peatland habitat and species of national and international conservation importance. Protected areas remain largely in unfavourable condition. Reduced connectivity between surviving peatland habitat units – making species more vulnerable to local extinction.	Peatland habitats and typical species brought into favourable condition, within protected areas and in the wider countryside. Deliver international obligations and agreements for peatland conservation and restoration (Ramsar, EC Habitats Directive). Reaching EU, UK and country specific biodiversity targets. Connectivity of peatland ecological networks increased.
Sporting	Salmon breeding habitats affected through sedimentation. Gullies and erosion leading to potential reduction in quality of habitat for grouse on deep peat.	Improved habitat condition for game populations on deep peat and increased mosaic of habitats in upland areas.
Recreation	Recreation opportunities affected by wildfire risk, erosion and loss of wildlife.	Enhanced landscape and wildlife experience.
Historic environment	Loss of important relics and palaeo-environmental information.	Preservation of historic environment and palaeo-archive including important information about past climate change impacts.

6.1 Business as usual

Eroding peat with deep gully formation in the North Pennines © North Pennines AONB Partnership

With the majority of peatlands in a damaged state, simply leaving them alone could create further liabilities as they deteriorate. Damaged peatlands are rarely stable. Rather, they undergo ongoing degradation, as drains erode and form deep gullies, and vegetation composition changes from blanket bog vegetation to dwarf shrub heath, due to lower water tables or associated management. Increases in heather, grasses and trees can cause yet more peat drying and degradation. High livestock densities and inappropriate burning or wildfires can make a bad situation worse, triggering further erosion and the eventual creation of bare peat areas. Drained peatlands also impact on the hydrology and biodiversity of adjacent peatland causing further deterioration.

6.2 Conservation and restoration

Safeguarding the carbon store of peatlands is both straight-forward and low cost (Parish et al. 2008; Joosten 2011). Conserving our best peatlands and avoiding further damage to them is an important priority that requires continued action, but with the majority of peatlands in a damaged state we must also direct our efforts at restoration.

Achim Steiner, the United Nations Environment Programme Director, observed "restoration of peatlands is a low hanging fruit, and among the most cost-effective options for mitigating climate change". Restoration with simple dams, for example, often made from peat on-site, is sufficient to reduce drainage, raise water tables and quickly conserve the carbon store, even re-instating carbon sequestration by re-starting peat accumulation.

A stitch in time saves nine

UK expertise in peatland restoration

The UK is world leading in peatland restoration. Information on over 120 UK peatland projects was collated in the UK Peat Compendium (see www.peatlands.org.uk).

As sites deteriorate, restoration becomes more complicated and expensive. Highly degraded aerated peat is difficult to re-wet. Early action is therefore far more effective. Severely damaged bogs, with bare peat, require both drainage blocking to raise the water level and re-vegetation of bare peat. Such degraded surfaces are inherently difficult to deal with as the peat must first be stabilised and then re-vegetated with seed from brash, with plug plants or through *Sphagnum* propagation (Lunt et al. 2010). Re-vegetation must be done in conjunction with action to re-wet the peat, as otherwise the peatland will continue to lose carbon. Tackling the issue of adverse livestock numbers is a more complicated issue requiring policy intervention through agri-environment schemes, for example, but is nevertheless essential.

6.2.1 Success of peatland restoration

Peatland restoration can vary from simple grip blocking to major engineering.

In partially damaged peatlands, short-term measures such as changing livestock numbers and controlling burning management as well as ditch blocking can be successful in recovering peat forming mosses within a few years. On more degraded peatland, especially those with very low water tables and bare peat, peatland restoration is slower. Stabilisation of the peat surface can be achieved in around 5 years, however, full hydrological restoration may take 20-50 years: a challenge given typical funding timescales.

There is clear evidence that re-wetting of peats by drain blocking can be effective in raising water tables and promoting recovery of bog vegetation, providing it is done effectively. Grip blocking has been shown to reduce the loss of particulate organic carbon and also appears to reduce dissolved organic carbon, although there may be short-term increases (Labadz et al. 2010; Wilson et al. 2011b). It can also reduce the peak of stream-flow downstream, following rain (Wilson et al. 2010). A range of vegetation management practices have been deployed to restore peatlands including restriction of grazing (particularly in association with re-vegetation of bare areas) and removal of scrub and trees. In the Flow Country, for example, average *Sphagnum* cover increased from 15% to 25% within 6 years after tree removal (Stephen et al. 2011). In extremely damaged sites, seeding bare peat with a nurse crop of grasses, sometimes with lime, fertiliser and heather brash, allows for rapid re-vegetation and stabilisation of bare peat. Although difficult, re-vegetation has been shown to stop erosion and associated particulate organic carbon loss within 3-5 years (Evans et al. 2009). Once the peat is stabilised, *Sphagnum* re-introduction can be used to help restore hydrological function and to re-start carbon sequestration (peat accumulation). This is a commonly used technique in Canadian peat workings and is being trialled currently in the Peak District and the Yorkshire Dales National Parks.

Restoration at Kinder Edge © Moors for the Future

Restoration at windfarm site © Scottish Power Renewables

Grip re-profiling © North Pennines AONB Partnership

Restoration at Blackpitts © Exmoor National Park Authority

6.2.2 Partnership as key to success

Peatland restoration has wide benefits across a range of social, environmental and economic agendas. While peatland restoration was once primarily aimed at conserving and enhancing biodiversity, the wider benefits of restoration for other ecosystem services has led to broad partnerships across a range of sectors. The Yorkshire Peat Partnership, for example, encompasses moorland managers, Yorkshire Wildlife Trust, two National Park Authorities, Nidderdale Area of Outstanding Natural Beauty, Natural England, Environment Agency, National Trust and Yorkshire Water. Other good examples of partnerships are the North Pennines AONB Partnership Peatscapes project, Moors for the Future Partnership in the Peak District, the peatland partnerships in the Flow Country of northern Scotland, the Mires-on-the-Moors project in Exmoor and Dartmoor, the Sustainable Catchment Management Programme (SCaMP) project as well as the Pumlumon, Migneint and Lake Vyrnwy projects in Wales. These involve local land managers, local authorities and government agencies, NGOs such as the RSPB, the National Trust and the Wildlife Trusts and industry such as water companies.

Partnerships make restoration happen © Mark Reed

Within these partnerships, different areas of public policy and business interests can be addressed in a way which engages communities and operates across whole peatland units, at a landscape scale. Diverse topics such as climate change, game management, wildfire reduction, wildlife conservation, obligations under the Water Framework Directive and Drinking Water Regulations are all wrapped into a single project. Large partnerships can also generate an economy of scale and allow an accumulation of skills and capacity to aid peatland restoration on individual land holdings that would otherwise find it difficult to achieve results on their own.

6.3 Peatland restoration: a good investment

In recent studies, stakeholders valued carbon storage next to water regulation and biodiversity conservation as the most important ecosystem service of blanket bogs (Bonn et al. 2010; Christie et al. 2011; UKNEA 2011).

Peatland degradation reduces these services. The costs of this degradation have yet to be fully quantified but are likely to be significant (drinking water treatment costs to tackle water colour are a good example) and more costly than peatland maintenance and restoration. A recent ecosystem services valuation estimated that blanket bogs in terms of climate regulation and other services are worth £226 million per year to the UK economy (Christie et al. 2011).

Restoring peatlands can be cost-effective in relation to the market price of carbon (Natural England 2010). Moxey (2011) compared the cost of peatland restoration with other carbon abatement measures in the UK climate change programme. Although some mitigation measures, such as improved fertiliser usage in agriculture or domestic air source heat pumps for renewable heat, may be implemented at no cost or even negative cost, £6 to £13/tonne CO_2e for drain blocking in peatlands compares favourably with a range of other mitigation measures such as anaerobic digestion (£1-24/tonne CO_2e), afforestation sequestration (£0-41/tonne CO_2e) and renewable biomass or biogas heat generation (£18 and £56/tonne CO_2e). Peatlands have an estimated abatement

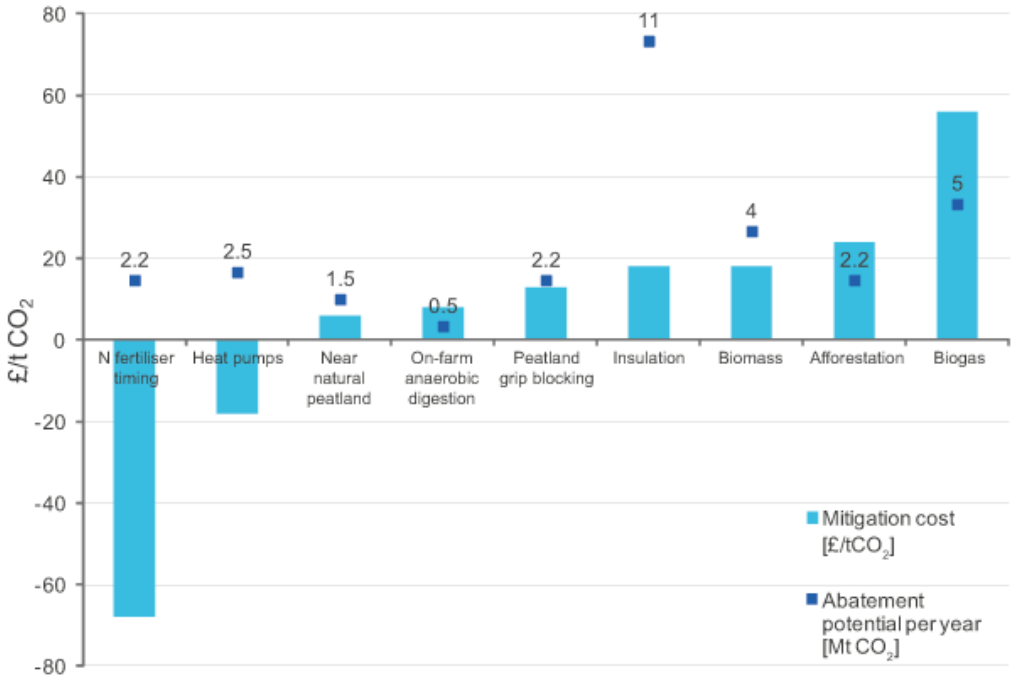


Figure 13 Illustrative GHG mitigation costs and abatement potential (Moxey 2011)

Table 2 Example emission factors relative to emissions from 1ha degraded peatland (precautionary emissions figure used for a gripped and drained peatland, see Figure 7)

Activity	Example	Annual emissions
1 ha damaged peatland (drained, gripped)		2.6 t CO_2e
9489 km Executive petrol car*	Just under average UK annual car mileage	2.6 t CO_2e
2653 km articulated lorry*	Two lorry trips from Lands End to John O'Groats	2.6 t CO_2e
4770 kWh Electricity consumption*	Average energy consumption of a UK household	2.6 t CO_2e

*derived from Defra/DECC (2010)

potential of around 2.2 million tonnes CO_2e per year, based on the 845,000 ha of peatland to be restored under the UK Blanket Bog HAP and a mid estimate of 2.6 tonnes CO_2e per ha per year saving (Figure 13, Table 2, for more detail see Moxey 2011).

Restoration is also a good investment for water quality regulation. Models developed by United Utilities and Yorkshire Water predict that an increase of one Hazen (water colour unit) per megalitre per day of water treated will result in an increase in treatment costs of between 10p to 20p. When modifications to a works are required or new pipes need to be laid costs start to become increasingly significant. A typical magnetic ion-exchange (MIEX) process added on to a 10 megalitre per day conventional three stage water treatment works may cost between £5 and £7 million to construct. Naturally, an additional process would only be installed if all other more cost effective solutions have been exhausted. In addition to the initial capital cost, MIEX is an energy intensive solution that greatly contributes to the operational cost and carbon footprint of the treatment process (Kate Snow, Andrew Walker, pers. comm.).

The level of benefits that peatland management can bring will of course vary from site to site, dependent on individual site conditions (level of degradation in particular) and the value of the various services a peatland generates. Valuing services is not straight-forward, with better estimates currently available for carbon than for water or wildlife conservation. Further work to improve the available cost-benefit information would help guide land management decisions and ensure better funding for sustainable peatland management by illuminating the short and long-term economic benefits of ecosystems services secured.

7. SECURING THE FUTURE OF UK PEATLANDS

"Looking after our peatbogs goes hand in hand with good game management, and repairing damage enhances the environment we rely upon for our livelihoods."

Lindsay Waddell, Chairman, National Gamekeepers Organisation

"Peatland restoration in Wales is beginning to achieve real benefits for biodiversity and carbon - and increasingly on a landscape scale. However, long-term funding support is needed to expand this work from its initially modest beginnings into an ambitious national peatland restoration programme that reflects the biodiversity and wider ecosystem service value of these fantastic places."

Peter Jones, Peatlands Ecologist Countryside Council for Wales

Peatland restoration makes sense. Securing the benefits we derive from peatlands requires an urgent step-change in action to redress past damage. A speedy response to protect and restore our peatlands under a changing climate is challenging, but will be more costly with delay.

Restoration of bare peat on Black Hill in the Peak District, 2006 and 2009 © Moors for the Future Partnership

This Inquiry calls for the multiple benefits of peatlands to be understood and appreciated. Our vision is for the UK's peatlands to be functioning to their full natural potential. There should be no further loss of near-natural peatlands in the UK and all recoverable peatlands should be restored to a peat forming state, resilient to climate change and with long-term safeguards. **Our four-pronged peatland strategy comprises:**

- **Conserving** peatlands in good condition, through management that maintains a favourable state, and preventing further damage to healthy peatlands (even the best protected peatland sites have suffered, with less than 50% in a favourable condition, so the first priority must be to prevent any further deterioration).
- **Restoring** partially damaged peatlands through land-use changes and active habitat management to return them to a peat forming state with typical peatland vegetation and animal species (including blocking drainage ditches, altering livestock numbers or adjusting burning management).
- **Intervening** to repair severely damaged peatlands through major operations, such as woodland removal, gully blocking and re-vegetating bare peat.
- **Communicating** the contribution peatlands make to meeting environmental, economic and social goals – critically, to help combat climate change and to halt the loss of biodiversity.

The management and restoration of the UK's peatlands is an ambitious goal, with best estimates of 2.3 million ha of blanket and raised bog, of which around 1.8 million ha is damaged in some way. By creating a better framework to integrate public and business policies, and by putting the right funding mechanisms in place, we should be able to secure a much better future for our peatlands by 2050. A positive interim target would be to work towards having 1 million ha of peatlands in good condition or under restoration management

by 2020 – a timescale consistent with UK and international biodiversity objectives – as well as commitments to tackle global climate change.

Significant gains could be made for biodiversity if this goal is achieved. Securing 1 million ha of peatland under restoration management would meet the UK Biodiversity Action Plan targets for blanket and raised bog restoration (845,000ha) and could bring all designated sites into favourable or recovering state. In terms of greenhouse gas benefits, emissions savings factors to be applied for reporting peatland rewetting are currently being developed at an international level by the IPCC, but taking a conservative estimate could mean savings of 2.5 million tonnes CO_2e per year (assuming 2.5 tonnes CO_2e savings per ha per year, Figure 7). This equates to 1% of the annual greenhouse gas reductions which need to be made from now to reach the UK climate change target for 2027.

The total costs of meeting this target would be in the order of £240 - £690 million for restoration. Spread over several years this is not a high cost considering the benefits. The total is only a fraction of the current annual budget for agri-environment schemes, itself a minor component of government support for agriculture. There is also the potential to access climate change budgets, and to leverage private investment, including carbon markets.

To achieve this vision requires a strong public policy response, focussed around three main sets of actions:

a. Introducing a UK and devolved government **policy framework** to protect and maintain existing peatlands and ensure restoration of damaged areas. Peatland policy objectives and delivery should be ‘joined-up’ across climate change, biodiversity, water, heritage, development and access legislation.

b. Ensuring the necessary **funding** is in place to protect and restore the UK’s peatlands. This requires continued use of the key funding streams, such as the EU Common Agriculture Policy (CAP), and maximising any additional opportunities through forthcoming reform. Other funds should be sought through the EU Environment – LIFE+ Programme, with additional core government funding alongside the development of business investment in ecosystem services.

c. **Coordinating action** to encourage partnerships to secure an effective evidence base, with monitoring and reporting on progress, along with knowledge exchange, education and advice.

7.1 Policy

7.1.1 Current approach

In the UK and devolved administrations, there is no overarching peatland policy or strategy with clear objectives towards delivering functioning peatlands (Reed et al. 2010).

Several international agreements on biodiversity, climate change and wetlands have emphasised the need for peatlands to be included in national governance mechanisms, policies, plans and investment strategies (see Table 3).

The urgency of action required is underlined by challenging targets for biodiversity and climate change. The EU Biodiversity Strategy seeks to halt the loss and degradation of ecosystems by 2020 (European Commission 2011), whilst the UK 2020 climate change target is to reduce greenhouse gas emissions from 1990 levels by at least 34% (42% under the stronger Scottish targets).

Table 3 Key international commitments recognising peatlands

	Detailed plans	Requirements	References
UN Convention on Biological Diversity	Strategic Plan for 2011-2020 and Aichi Targets. EU Biodiversity Strategy to 2020	Conservation and restoration of peatlands, highlighting their role in mitigating and adapting to climate change Halt loss of biodiversity and degradation of ecosystems by 2020, and restoring them 100% more Habitat Assessments for SACs show improved conservation status	**Nagoya, Japan COP10. Decision X/2 and X/33** www.cbd.int/decision/cop/?id=12268 http://ec.europa.eu/environment/nature/biodiversity/comm2006/pdf/2020/1_EN_ACT_part1_v7%5b1%5d.pdf
UN Framework Convention on Climate Change	Kyoto Protocol and LULUCF	Protect and enhance carbon reservoirs Account for losses/gains from peatlands	**Kyoto Protocol Article 2, 1 (a)(ii)** http://unfccc.int/kyoto_protocol/items/2830.php
Ramsar Convention	Strategic Plan 2009-2015 and Global Action Plan for Peatlands	Establish and manage a network of protected sites Encourage wise use and recognition of ecosystem service benefits	**COP 10 Resolution X.1** www.ramsar.org/cda/en/ramsar-home/main/ramsar/1_4000_0__
EU Habitats Directive	Blanket Bog Raised Bog and Fens - listed habitats.	Classify protected sites and ensure favourable status of peatland habitats across their natural range, including typical species	**Council Directive 92/43/EEC (Annex 1, 71 Sphagnum Acid Bogs)** http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm
EU Water Framework Directive	Horizontal Guidance on Wetlands	Prevent deterioration, protect and enhance aquatic ecosystems. Delivery through River Basin Management Plans Peatlands included as ecosystems which influence water quality or quantity as well as those dependent on groundwater	**Council Directive 2000/60/EC** http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32000L0060:EN:HTML www.uicnmed.org/web2007/cdflow/conten/5/pdf/5_1_2/WetlandsHorizontalGuidance/Wetland-final.pdf

The UK and devolved governments have a range of policy instruments that could be directed at protecting and restoring peatlands (see Table 4), but there is limited information available on the contribution these initiatives make (Keenleyside & Moxey 2010).

Table 4 Categories of policy instruments

Category	Type	Peatland Examples
Direct State Control	Public ownership of land. Areas managed by public bodies	Peatlands within the Public forest estate, managed by Forestry Commission Peatland managed by e.g. Scottish Water/NI Water Small areas of peatlands owned and managed by local authorities
Classic Regulation and Advice	Prohibited activities, licences/permits, planning zones, delivery of conservation objectives	Minerals controls on peat extraction Renewable energy policy SSSI, SPA, SAC legislation The UK Forestry Standard Heather and Grass burning code Deer Control Schemes
Financial Instruments	Grants, subsidies, tax incentives, user fees, taxes, external funds eg EU LIFE +	CAP agri-environment and forestry measures for peatlands, land management payments e.g. in SSSIs
Capacity Building	Skills training, capital grants, infrastructure funding	None at present
Information Provision	Leaflets, websites, research and advisory services	Peatland research under Scottish Government Main Research Provider contracts or Farming for a Better Climate programme, Defra Peat Partnership
Creating New Markets / Voluntary Payment Schemes	Payments for ecosystem services, voluntary schemes, corporate social responsibility schemes	None at present, although research work under way on Payments for Ecosystem Services through Defra

In recent decades, peatland policy across the UK has focussed on securing networks of protected sites. This approach has largely been successful in preventing new developments from adversely affecting designated sites. Inappropriate windfarm development proposals on designated sites have been resisted in parts of the UK where government planning policy acknowledges that ambitious renewable targets can be met without compromising wildlife site protection (Scottish Government 2011). UK site protection policy reflects international obligations to go beyond protection and includes measures to promote restoration of damaged peatland habitat. This has, however, been hampered by a lack of core funding and insufficient payment under agri-environment schemes and other land management incentives.

Most of the UK's peatland, however, is not designated. Outside protected areas, peatlands can be targeted by developers in the belief that these are not considered to be environmentally important. Peatland restoration is also given lower priority in non-designated areas under some agri-environment measures.

Securing peatland habitats at a favourable conservation status in their natural range to avoid reduction in area and maintain typical species, is an obligation under the EC Habitats Directive. Adapting to climate change also requires larger peatland units than the currently often fragmented habitat, and for the habitat to be in good condition across its full hydrological (or landscape) area (see also Lawton et al. 2010). Forestry policy is one area, which has embraced the need to protect functioning peatlands wherever they occur by discouraging planting of trees on deep peat, whether in protected areas or not (Forestry Commission in press).

Drain blocking at Lake Vyrnwy using heather bale and peat dams © LIFE Active Blanket Bogs in Wales

Removal of self seeded Sitka spruce at Lake Vyrnwy © LIFE Active Blanket Bogs in Wales

7.1.2 A revised policy framework

A strong national steer at UK and individual country level could help muster the considerable peatland expertise and potential resources across the public and private sectors to achieve the scale and urgency of action required.

The Inquiry has identified an urgent call for a high level government commitment to conserve and restore peatland in response to the recognised benefits. A consistent message throughout the Inquiry was the need for government sectors (e.g. environment, agriculture, climate change, water, planning, culture) working to this shared objective rather than pursuing each ecosystem service in isolation. Strategic goals and monitoring of progress under different policy instruments would allow progress to be better accounted for and trigger more decisive and concrete policy action.

Evidence gathered from stakeholders pointed to the need for integrated policies across different sectors, effective implementation of existing policy and strengthened policy in key areas:

Biodiversity	Biodiversity Action Plan objectives and targets identified at UK and devolved administration levels supports effort at the local Biodiversity Action Plan level, provides positive feedback and a framework to monitor progress towards national and international targets. Clearly identifying funds and peatland action in this process will help coordinate effort across the public and private sector and extend peatland conservation and restoration beyond designated sites.
Common Agriculture Policy	The CAP is a major funding stream and reform of the CAP after 2013 is anticipated to enhance its role in helping to mitigate and adapt to climate change, combat biodiversity loss and improve water quality. Construction of the post 2013 agri-environment schemes in each of the devolved administrations is one of the most important ways in which public policy can be aligned to manage and restore peatlands. Rural development programmes (funded through Pillar II of the CAP) are critical in this reAppropriate agri-environment and forestry measures need to be made available for the full range of peatland restoration and management requirements. Monitoring of progress and effectiveness of these measures in relation to peatlands should be established by the country administrations.

Water	Delivering water quality and flood management obligations under the EU Drinking Water, Water Framework and Flood Risk Management Directives (Council Directive 98/83/EC, Directive 2000/60/EC and Directive 2007/60/EC respectively) are powerful drivers to encourage peatland restoration. Sustainability duties on the water industry support peatland restoration as a cost effective alternative or compliment to water treatment. UK Government, devolved administrations and the regulators, should highlight these duties in relation to peatlands to promote further investment across the UK water companies. The EU Water Framework Directive embraces all peatlands, but UK guidance is needed to explain the relevance of blanket and raised bogs to complement the work on wetlands produced by the Ramsar Convention (Trepel 2004). River Basin Management Plans present a good opportunity to conserve and restore peatlands at a catchment scale, but also need to recognise that many peatlands lie across catchments.
Climate Change	The important role of peatlands in mitigating and adapting to climate change is recognised under international climate change agreements. The UK has the potential to showcase its significant peatland restoration projects at an international level and to use these to help inform policy through monitoring and research. Focussed action and investment in peatland restoration provides a cost-effective approach to reduce carbon emissions that would sit comfortably alongside other measures. Greenhouse gas accounting –The second Kyoto Protocol commitment phase from 2013 will potentially allow accounting of a new activity 'peatland rewetting and conservation' (see Joosten 2011 for full details). Practical methodologies and user-friendly guidance for reporting and accounting for the most significant sources of peatland emissions are available at international level and need to be developed at the UK level. Adaptation policies - The need to restore damaged peatlands in order to build resilience and avoid unnecessary loss of biodiversity and ecosystem services should be highlighted in UK and devolved government statutory frameworks and plans for adaptation. The role of peatlands in helping communities adapt to increased flood risk should also be recognised.

Planning	Planning policy can play a key role in conserving and restoring peatlands by guiding development away from important peat areas with a presumption against development on peatlands. The Forestry Commission presumption against new woodland planting on deep peat habitat (Forestry Commission in press) should be considered by statutory planning authorities for other forms of development. Local planning authorities urgently need to be guided not to permit further peat extraction development on new or existing sites (as in the draft National Planning Policy Framework for England, DCLG 2011) and to ensure proper peatland restoration on extraction areas. Planning tools such as the Scottish Government's windfarm and peatlands carbon calculator (Scottish Government 2011) should be considered for other forms of development on peatlands. Authorities should also be encouraged to map peatlands at a catchment level to guide partnership, identify restoration opportunities and reduce planning conflicts. Opportunities for planning gains (community infrastructure levies, habitat banking) could provide mechanisms to support peatland restoration.
Management of state land and role of statutory undertakers	A number of public bodies, including the Forestry Commission and the Ministry of Defence, manage important peatland areas. Opportunities to help deliver functioning peatland habitat should be identified strategically with investment targeted at delivering restoration.
Heritage conservation	Whilst natural heritage is protected under biodiversity policy and cultural heritage under protection of monuments policy, a policy gap has been identified in which the valuable archive of environmental information and archaeology preserved in the peat itself is not protected under public policy. The protection of geological sites under, for example the Countryside and Rights Of Way Act 2000 in England, as Geological Conservation Review sites could be extended to apply to peat, with a strong direction to protect long time series records or geographically isolated peat archives. Management activities to protect these records should also be implemented. In most cases the best approach would be to restore the peatland through re-wetting.

a. Key approaches for a policy framework

We need to muster the considerable peatland expertise and potential resources across the public and private sectors to achieve the scale and urgency of action required, recognising the challenges of the current economic climate.

a1. Clear government signals need to empower public bodies, the private sector, NGO's and communities to maintain and restore peatlands.

- Establish a UK wide, coordinated, funded peatland restoration delivery programme with agreed areas, targets and timescales, reflecting international commitments on peatlands.

a2. Coordination and cooperation across government sectors and agencies would help deliver peatland biodiversity objectives and secure ecosystem benefits.

- Recognise the important role of peatlands under all relevant public body duties e.g. climate change mitigation and adaptation, biodiversity conservation and water regulation.
- Take forward opportunities for delivery of landscape and cross-catchment scale projects with cooperation across different administrative boundaries.
- Establish a high-level peatland group to facilitate cross agency coordination and to report on progress against peatland objectives.

a3. Develop an ecosystem-based approach to peatland policy

- Adopt an ecosystem-based approach with healthy functioning peatland habitat as the shared goal, rather than simply maximising individual services from peatlands.

a4. Have better collaboration across public bodies, business, NGOs, and communities with stronger connections between end-beneficiaries and those delivering services on peatlands.

- Support collaborative working at the site level to deliver peatland management and restoration, showcasing good examples nationally and internationally.
- Explore mechanisms to encourage better connection between peatland managers and beneficiaries of the ecosystem services.

7.2 Funding

It is only recently that the benefits to society of fully functioning peatlands have been realised. Indeed, for centuries peatlands have been considered as wastelands to be 'improved' with little appreciation of the costs of peatland degradation, so much so that it was funded at public expense by subsidies and tax incentives for forestry and agriculture. Subsidies for activities which directly led to peatlands being damaged have now been largely removed. But an equivalent level of investment to restore the damage is not yet in place, and peatlands continue to deteriorate even within protected sites.

There is a disconnect between the costs experienced by society in terms of damaging impacts to water quality, loss of biodiversity and carbon emissions from degraded peatlands and the lack of support given to the management of peatlands. Peatlands can be seen as a repository of largely un-priced public goods of major national importance (Hubacek et al. 2009). Policy intervention is required to address these market imperfections and failures, with the provision of benefits better reflected through payments for ecosystem services to those who manage peatlands. This is especially important given that peatlands mainly exist in rural and often remote areas where communities face challenges of lower employment and economic opportunities. With no current mechanism to reward those who maintain functioning peatlands there is no perceived benefit.

Public policy needs to develop effective funding mechanisms that ensure peatlands are well managed and restored to ensure the full suite of ecosystem services is maintained long into the future.

Flow Country, RSPB Forsinard Reserve © Norman Russell

CAP

The Inquiry examined many different funding streams that, if properly integrated together with core government funding, could deliver peatland restoration and management without substantially increasing cost to the tax-payer:

The UK's devolved CAP Rural Development programmes and agri-environment/ forestry measures are already significantly contributing to the management and restoration of UK peatlands. Within the four UK country programmes there is a need for improved funds to better reflect ecosystem service benefits and contribute to wider government objectives for biodiversity, water and carbon:

- Ensure an appropriate range of payments across peatland management activities at the right level of payment to incentivise initial and ongoing management.
- Explore opportunities to integrate private /public initiatives to fund payment for ecosystem services as a means of helping ensure payments reflect the costs to the land manager of peatland restoration and management.
- Promotion of whole farm conservation and management encompassing payment for maintaining and restoring peatlands. A coordinated approach to support collaborative payment applications for peatland management at a landscape scale across multiple land holdings.
- Improved monitoring of environmental objectives under the payment schemes to allow proper assessment of effectiveness and progress.

Business support

The food and drink industry in the remote rural areas of the UK where peatlands exist often rely on a clean healthy natural environment as branding to promote their products. In some cases industry are involved directly in helping restore peatlands as part of their contribution to maintaining a healthy environment. There are opportunities for companies and businesses to engage more with those who manage the peatlands to find out about the wildlife and other features which can help brand the products. Businesses are also keen to support environmental projects through their corporate social responsibility activities, such as the donation of the Co-operative Foundation to the Moors for the Future Partnership to regenerate Sphagnum on degraded peatlands. With better information and understanding of the importance of peatlands, more businesses could be willing to help.

Discussing ditch blocking © North Pennines AONB Partnership
Restoration beside windfarm © Scottish Power Renewables

Developer contributions	The planning system allows for agreements with developers to undertake environmental management projects. The renewable energy industry has already made significant investment in restoring and maintaining peatland habitats in areas around windfarm developmentsm but this need to be more widely applied and better enforced. Several thousand hectares of peatland are now under active management. For example, Scottish Power Renewables has a multimillion pound investment programme that includes managing 8,150 ha of peatland as part of its Habitat Management Plan. By putting in place scientific monitoring and sharing data with other stakeholders, where possible, the industry can also help improve our understanding of the effectiveness of peatland restoration (Scottish Renewables 2010).
Water	Water companies are some of the largest peatland landowners in the UK. Individual companies are already investing in peatland restoration to stabilise and improve the hydrology of deep peat systems in drinking water catchments. Repeating such investment during the next asset management programme could deliver considerable benefits. Furthermore, there is considerable research work and survey that could be undertaken as part of these projects, which could contribute to improving our understanding the effect of peatland management on water quality. Similar opportunities for restoration and survey exist in the public water sector. The UK public and private water industry as a whole could benefit from a coordinated approach to its research and information exchange.
Carbon	There is potential for new funding for peatlands through private financing initiatives under carbon markets. In the short-term it should be possible to provide standard information to support companies or trust fund holders who wish to fund projects that deliver climate change and wider environmental/ biodiversity benefits as a matter of corporate social responsibility (Rabinowitz & d'Este-Hoare 2010), rather than seeking to offset carbon emissions or earn tradable credits. In the longer term, it may be possible to access additional funds, if peatland restoration projects were to become part of a programme that could enable carbon credits to be traded on voluntary carbon markets. This will require some form of peatland carbon code with firm standards, accreditation and a national register to prevent double counting with the governments own greenhouse gas reductions (Joosten 2011).

b. Key approaches for funding

There are opportunities to greatly improve the sharing of costs experienced by society in terms of damaging impacts to water, loss of biodiversity and carbon emissions and the support given to the management of peatlands. Put simply, we want to vastly reduce these costs. Support towards this includes direct government and business funding along with government action to facilitate international funds, business and private investment for peatland management and restoration.

b1. Improved funding through the CAP – both Pillar I direct payments and Pillar II Rural Development Programmes (especially agri-environment and forestry measures) for peatland management and restoration.

- Improve the alignment of funds within the four UK country programmes to the provision of benefits for biodiversity, climate change and water.
- Ensure appropriate payment levels and integration with private/public funding initiatives to incentivise land managers and cover the costs of providing public benefits from peatlands.

b2. Use public and private resources in a coordinated way to support peatland restoration and management.

- Establish core government funding specifically to support peatland projects, and encourage public bodies and the business sector to work jointly in funding peatland work.

b3. Development of new sources of funding for peatland conservation and restoration.

- Explore opportunities to support business-led carbon investment in peatlands including developing a Peatland Carbon Code.
- Support water company investment in upstream land management.
- Explore other funding opportunities such as payment schemes for ecosystem services, biodiversity offsets and habitat banking.

7.3 Coordinated action

The management and restoration of the UK's peatlands is an ambitious but achievable goal. With a better framework to integrate public policy and the right combination of funding mechanisms in place, this goal could be realised within a generation – a timescale required under international law and as part of the UK's commitment to tackle climate change. However, achieving this goal will require focus and coordination.

The Commission of Inquiry identified the following areas as crucial:

Coordination and partnerships across policy areas

Policies that affect peatlands extend across key sectors such as environment, climate change and water management. National level partnerships involving all relevant Government agencies and departments are required to conserve and restore peatlands (Reed et al. 2010).

Developing programmes that achieve multiple objectives across government policy areas will reduce costs. Spatial land use policy at a national level is particularly useful in this regard in helping to resolve peatland conservation with seemingly conflicting policies, such as forestry expansion and renewable energy development, as well as helping partnerships to work towards shared objectives. Management zoning for varying peatland objectives, e.g. strict nature reserve, recovery areas or sustainable management under different land management objectives such as agriculture or grouse moor, can help balance the different land use interests within a landscape.

Research and evidence

Any investment should be based on sound evidence. Current knowledge shows a clear overall benefit for conserving and restoring peatlands but more work is required to fully quantify the individual benefits, particularly in relation to climate change mitigation and water. Targeting research to inform policy and investment decisions and monitoring the effectiveness of investment will allow better targeting of investment and reporting of outcomes. A more coordinated approach is required:

- Key peatland policy research requirements, against which the academic community can plan their study and knowledge exchange, should be supported through initiatives such as CAMERAS (Coordinated Agenda for Marine, Environment and Rural Affairs Science www.camerasscotland.org), LWEC Programme (Living with Environmental Change, www.lwec.org.uk) and UK Research Councils thematic programmes.
- To assess the future impact of restoration and management of peatlands and allow for learning and adaptive management, a cohesive network of intensively monitored demonstration sites is needed. There are already a range of successful research collaborations between restoration projects and universities across disciplines, such as the Rural Economy and Land Use ‘Sustainable Uplands’ Project and others. There are also several peatland research and observation sites in the UK, such as the CEH carbon catchment sites, from which important lessons can be learned. These need coordination to synthesise information and facilitate learning.
- Guidance for standardised monitoring of restoration projects is required to assess success of restoration measures. Methods need to be practical, low cost and maintenance, compatible across a range of sites and conditions, and easy to conduct after little training. Monitoring must become integral to restoration projects to assess effects of restoration. Monitoring needs clear objectives, appropriate study design and controls.
- Finances for restoration monitoring, including before and after treatment, need to be made available as an integral part of project

budgets to assess the success of restoration and impact on biodiversity and ecosystem services, as changes in peatland functioning following restoration may take many years.

- Long-term monitoring of peatland ecosystems in a range of conditions is needed to help assess the impacts of climate change and the effectiveness of resilience measures (Murphy et al. 2009). The opportunity to involve peatland sites in targeted monitoring within the Environmental Change Biodiversity Network (ECBN) should be considered. In addition, continued support and collation of fragmented peatland datasets should be provided to assess long-term change, e.g. Countryside Survey, Environmental Change Network, UK Acid Waters Monitoring Network.

Planning fieldwork © Aletta Bonn

While some questions can be answered through monitoring, others need concerted primary research effort. Particular research gaps identified by the Inquiry include:

- The state of peatlands is not fully understood or mapped, and better information is required on peat depth and carbon storage throughout the UK.
- Better information is needed to assess the contribution of peatlands to national greenhouse gas fluxes. Methods need to be developed to measure, report and verify the contribution of peatlands to greenhouse gas fluxes in line with the conclusions of the United Nations Climate Change conference in Cancun 2010. A full quantification of the UK's peatland greenhouse gas balance under different land management and restoration scenarios is required. (A review by the Joint Nature Conservancy Council has outlined a research programme which would achieve this, and needs to be adopted and implemented by UK research councils and agencies and funded by the EU, UK government and industry).

- To address the need to halt rising trends of dissolved organic carbon, further research is needed to assess the impact of land management, such as burning, vegetation composition and restoration on the quality of water derived from peatlands.
- Better understanding and valuation is needed of the costs and benefits of peatland restoration on peatland ecosystems services and biodiversity. There is also a need to account for the opportunity cost of not taking action to conserve peatlands and the ecosystem services they provide.
- More research is needed into how different restoration techniques, change in vegetation cover or land-use affect run-off and contribute to mitigating flood risk.
- The lack of consistent methodologies in some areas of peatland research needs to be addressed to allow for better evaluation and comparison of studies. Examples include different approaches to measuring dissolved organic carbon fluxes from peatlands, or vague, inaccurate or missing definitions of the peatland habitats used in different studies, eg. often mixing upland heath and blanket bog.

Establishing a peatland ecosystem research focus within the LWEC programme to foster focussed research on peatlands would be extremely useful. This should include a strong engagement of practitioners and policy advisers within the process of identifying, conducting and publishing research to increase relevance, ownership and swift integration of results into practice.

Effective knowledge exchange

There is a need for ongoing development and sharing good practice based on scientific evidence. This evidence is, however, often not available in accessible format to end users to inform practice on the ground or to justify public spending. Ongoing synthesis of highly dynamic peatland research and active knowledge exchange between knowledge users and providers are required.

This Inquiry has gathered available evidence to date and collated a consensus in this report. The assessment shows that sufficient evidence is already available to allow policy development to fully support peatland conservation and restoration, in principle, to maintain essential ecosystem services and support important biodiversity. Further quantification of the benefits is required however to improve delivery.

As a next step, a centralised authoritative information hub would benefit policy advisers, practitioners and researchers. A UK peatland hub could support collaboration between research providers and stakeholders engaged in delivering peatland restoration and sustainable management by providing:

- A Peatland network: Coordinate and provide ongoing support for the different peatland projects to share successes and to provide training on peatland management to support land managers.
- Development of a demonstration site network: Showcase cost effective solutions for peatland restoration and management that will meet government commitments towards climate, soil, water and biodiversity goals.

- Training & Monitoring: Provide peatland ecology training among researchers and land managers including monitoring guidance. Support the collation and analysis of monitoring data to assess impacts of restoration on biodiversity and ecosystem services.
- Development and sharing of good practice based on scientific evidence: synthesise and communicate peatland research to users in accessible formats and thereby provide a stronger evidence-base for policy and practice.

Monitoring and engaging people

There are opportunities to engage people in survey and monitoring. Many volunteers are already employed in monitoring for restoration projects. One compelling idea is for a Big Peat Watch that could provide a far better estimate of the carbon stored in UK's peatlands by involving people to measure peat depth across the UK. A scoping study, as part of the national peat depth and carbon content project, is underway with Natural England and the North Pennines AONB Partnership.

Monitoring in the Flow Country © Norman Russell

Creative ways of engaging people © Peak District National Park Authority

Local partnerships

Local partnerships involving different agencies, local authorities and multiple land owners/managers are required to conserve and restore peatlands across whole peatland units (rather than confined to single owner/managers). This brings water catchment and landscape scale benefits. Successful partnerships to conserve and restore peatlands include those where one organisation has taken a lead, committing resources to drawing partners together and helping to forge a shared agenda, often drawing in new resources from international funds or the private sector.

Critical to these partnerships is engaging the land management community. Most UK peatlands are owned and managed by private individuals and companies, although there are also significant state and civic society interests. There is a collective expertise here that can be marshalled through stakeholder groups such as Scotland's Moorland Forum. Advice and guidance to the land management community is important. There is a strong need to provide peatland management guidance (a free web-based resource would be particularly useful) and to share good practice in relation to survey and monitoring, and simple, low cost peatland restoration techniques.

Communications

Peatlands have been described as having been the *Cinderella* of Britain's wildlife resource, badly treated and their importance poorly understood. Addressing the gap between the real benefits of peatlands and the public knowledge of these is important if their future is to be secured. Public engagement activities are already taking place through demonstration site visits of restoration partnerships or through visitor centres by National Parks and civic society organisations. Other opportunities include engaging school children where imaginative and interactive climate change activities on peatlands, such as the National Parks Moorland Indicators of Climate Change Initiative (MICCI), lead by the Peak District National Park, or the Changing Environment Landscape Lab programme of the North Pennines AONB Partnership have been successfully deployed. These experiences should be shared and good programmes replicated across the UK.

National media opportunities to engage interest in peatlands through outlets such as the BBC should be pursued utilising the wide range of peatland showcase sites in nature reserves and peatland partnerships. Coordinated effort across NGOs and public bodies to collate the wildlife spectacles, people engagement stories and heritage interests would help provide a valuable resource to communicate the peatland benefits through various media.

Students take to investing peatlands. Moorland Indicators of Climate Change Initiative (MICCI) © Peak District National Park Authority

c. Key approaches for coordinated action

c1. Establish nationally coordinated and funded peatland accounting.

- Monitor the state of peatlands.
- Report on progress towards biodiversity targets and delivery of international and national objectives, greenhouse gas emissions savings and other ecosystem service benefits.
- Assess the effectiveness and progress of policy measures – including agri-environment measures.

c2. Provide support for a UK peatland hub for information and consensus building, training and partnership working between scientists, policy advisers, businesses and land managers.

- Providing a one-stop shop for information.
- Showcasing cost effective and flexible solutions for peatland restoration and management through demonstration sites.
- Facilitating effective collaborations between policy, practice and academic research.

c3. Encourage trans-disciplinary research on peatlands.

- Provide solutions for effective peatland conservation/restoration.
- Improve the evidence base for the services that peatlands provide and the effects of restoration.

c4. Communicate the importance of peatlands, highlighting their benefits to society including market and non market values.

- Build on the wealth of peatland projects and stories to provide the tools for wider communication, engaging expertise to incorporate peatlands more extensively in media and education.

8. IUCN UK PEATLAND PROGRAMME: NEXT STEPS

"We've always had a strong ecological case for investment in peatlands, thanks to the work of the Peatland Programme we now have a compelling economic case too."

Jonathan Hughes, Director of Conservation, Scottish Wildlife Trust

The Commission of Inquiry is one of the initiatives undertaken by the Peatland Programme under its three year strategy 2009-2012. The Inquiry process and the wider work has helped build important partnerships and demonstrated that progress can be made through a coordinated effort across science policy and practice.

The Peatland Programme has provided critical and previously missing capacity to coordinate policy, practice and research. Maintaining the momentum of the Peatland Programme after the initial 3-year privately funded period is an important part of this vision.

A continued Peatland Programme will focus on:

UK Peatland Hub: Proposals for funding and managing a Hub are still to be considered by the various partners and in the meantime the Peatland Programme will facilitate further discussion and undertake some of the work of the Hub.

Advisory Panel: The Inquiry process was supported by an informal UK partnership of individuals from across the statutory agencies, voluntary bodies and land managing interests. The Peatland Programme intends to facilitate further meetings of this group and to engage with relevant devolved Country initiatives with a view to identifying agreed peatland actions arising from the Inquiry that could be implemented, with progress monitored and reported.

Stakeholder events and briefings: The Peatland Programme will organise a series of stakeholder knowledge exchange events and produce a range of briefings exploring in more detail key topics covered by the Inquiry. These will include:

- Carbon funding and national greenhouse gas accounting
- Survey and monitoring methods on peatlands
- Evaluation of ecosystem service benefits and biodiversity
- Land management advice

Conferences: The Peatland Programme has held two major annual conferences with the next conference ‘Investing in Peatlands – Demonstrating Success’ planned for 26-28 June 2012 as joint symposium with the British Ecological Society. The aim of these is to pull together and inform the wider peatland policy, practice and research community.

Communications: The Peatland Programme will continue to gather media resources and make these available through its website. This will help facilitate the development a strategic approach to peatland communications across Government and NGOs.

Restored blanket bog after ditch blocking © Exmoor National Park Authority

9. CONCLUSION

“Science has shown that peatlands deliver important services to society. We need to continue to understand more about their condition and resilience whilst getting on with conserving and restoring them, so that we can ensure the best for their long-term future.”

Tim Burt, Professor of Geography, Durham University

Throughout the 18 month course of this Inquiry, it has been evident that there is a large community of interested people and organisations willing to help deliver the vision for peatlands – but needing the right signals and support. Greater effort towards realising the immense value of peatland ecosystems in their fully functioning condition offers so much in return, for all of us and for nature. Conversely if we delay in pursuing a strong vision for peatlands then we impose greater costs to society in future. We have identified some of the main hurdles and barriers and set out clear approaches which could help deliver the urgently needed action, building on the huge range of peatland expertise that exists in the UK and abroad.

West Allenheads 2010 © Nick Mason, North Pennines AONB Partnership.

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“Peatland conservation is a prime example of a nature-based solution to climate change but we urgently need to switch from aspiration to action to secure the benefits that peatlands provide.”

Julia Marton-Lefèvre, Director General,
International Union for the Conservation of Nature

The report and associated Commission of Inquiry material can be downloaded from
www.iucn-uk-peatlandprogramme.org

The International Union for the Conservation of Nature (IUCN) is a global organization, providing an influential and authoritative voice for nature conservation. The IUCN UK Peatland Programme promotes peatland restoration in the UK and advocates the multiple benefits of peatlands through partnerships, strong science, sound policy and effective practice.

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