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Peatland Programme

Global Peatland Restoration

demonstrating success

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The International Union for the Conservation of Nature (IUCN) is a global organisation, providing an influential and authoritative voice for nature conservation. The IUCN National Committee 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.

The Commission on Ecosystem Management (CEM) is one of IUCN's six scientific Commissions. CEM is a network of volunteer experts, numbering close to 1,000, from around the world working on ecosystem management related issues, for example climate change adaptation, disaster risk reduction, Red List of Ecosystems, fisheries and ecosystem restoration and services. The Commission works closely with other IUCN Commissions, regional offices and global thematic programmes.

A Peatland Thematic group has been established within the IUCN CEM: http://www.iucn.org/about/union/commissions/cem/cem_work/peatland_ecosystems/

The IUCN CEM Peatland Thematic Group's work aims to highlighting the benefits of peatland ecosystems and explore new funding opportunities for peatlands based on ecosystem services. The group will encompass a truly international network of experts to share good practice build consensus on science and encourage national strategies for action to deliver peatland conservation and restoration.

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Restoration by wooden planks © Liu Lianzhong

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FOREWORD

In the nineteen sixties – when I was at primary school – my teacher would tell me how well we did in The Netherlands when we exploited those 'good-for-nothing' peat-moors for their fuel, and how excellent it was that our forefathers, a century earlier, made the moor-soils productive after peat-exploitation. My teacher came from such a converted peat-land and so we believed him. A classic win-win situation! Fifteen years later – at University – my professor cited the fate of peat-bogs in Florida where American entrepreneurs drained large areas to grow horticultural crops. This was a productive system while the peat decomposed. Once the peat was finished, they would move on to the next area to be drained. Again a win-win situation? We know better now, don't we?

In many places of the world peat lands are still exploited and drained on a large scale to satisfy short-term demand to the detriment of long-term benefits. Apart from nature-conservation values whose importance we should not underestimate even if they are difficult to capture in monetary terms, we have ample proof of the importance of peatlands for the delivery of such services as the provision of good quality drinking water. In Kenya and Uganda peatlands regulate the micro-climate in the valleys where they occur, elsewhere they provide essential habitat for fishes during their life-cycles and the list goes on. In more recent times, the importance of peatlands to combat climate change has been widely recognized. But do we act accordingly?

The International Union for the Conservation of Nature has developed an ambitious 4-year Programme which includes the conservation and restoration of peatlands, giving them a prominent place on the international agenda as an example of nature based solutions . Under the inspirational leadership of peatland champions, within the IUCN-UK National Committee Peatland Programme, work has been carried out to identify the lessons to be learned from the wide array of peatland projects around the globe. These projects illustrate key principles for ecosystem management. The results from ongoing peatland restoration projects in particular demonstrate that we can actually do something against degradation of ecosystems, reversing the downward trends and restoring ecosystem functioning and the delivery of ecosystem products and services. Such a message of hope is important, not only for peatlands but for all the other threatened ecosystems in our world, whether they are Drylands, mangroves or rainforests.

I am grateful to the IUCN UK Peatland Programme team for establishing an active expert group on peatlands within CEM, that has become a jewel on our crown. This document, reflecting the outcome of a peatland conference in York in 2013, is proof of that. It makes good reading and will inspire much needed action around the globe.

Piet Wit

Chair of IUCN's Commission on Ecosystem Management

INTRODUCTION

Peatlands evoke many different responses from people. For walkers, the mires of the Australian Alps or the Flow Country blanket bogs in Scotland, represent a place of freedom and release where they can watch raptors soar. For turf-cutters on the West coast of Ireland, they represent a way of life and the smell of a peat fire on a cold winter's night. For an entrepreneurial German farmer, the fenlands of Brandenburg are a home to her herd of water buffalo and her family. For the businessman, the peatlands of Indonesia represent a healthy return on investment, derived from the endless rows of oil palm that now dominate the landscape.

Many of us have a less direct connection with peatlands that would be just as powerful, if we only knew how much our lives depended on them. Peatlands often form at high altitude, and so play a role in filtering and regulating the flow of water into streams and reservoirs. In the UK for example, the majority of drinking water comes from peatland catchments. The fenlands of Biebrza in Poland protect land from flooding and filter and purify water, whilst providing a home for internationally important wildlife, like the Aquatic Warbler.

Whether we realize it or not, we are all bound together with the future of our peatlands. The water-logged conditions of a healthy peat bog mean that plant material decomposes very slowly, and accumulates as peat soil. This process locks up carbon absorbed from the atmosphere by the vegetation that grows in these areas. In this way, peatlands have withdrawn vast amounts of carbon from the atmosphere over the past millennia, making them the world's most efficient terrestrial carbon store (Joosten *et al.* 2013). A quarter of the world's soil carbon is held in peatlands (around 550 Gtonnes of carbon). The boreal and subartic peatlands alone contain 2-3 times more carbon than the world's tropical rain forests. Healthy peatlands can continue absorbing carbon dioxide year after year, over millennia, and have a net cooling effect on the global climate. However, a loss of just 1.5% of the world's peatlands is equivalent to all the carbon emissions humans create worldwide in a year. You can find out more about the benefits that society derives from peatlands in the next section.

What are peatlands and where are they found?

Peatlands are areas of land with a naturally accumulated layer of dead plant material (peat) formed under waterlogged conditions. Found across the Globe from the tropics to the poles, and in at least 175 countries, peatlands cover around 4 million km^2 or 3% of the world land area (Joosten *et al*. 2009).

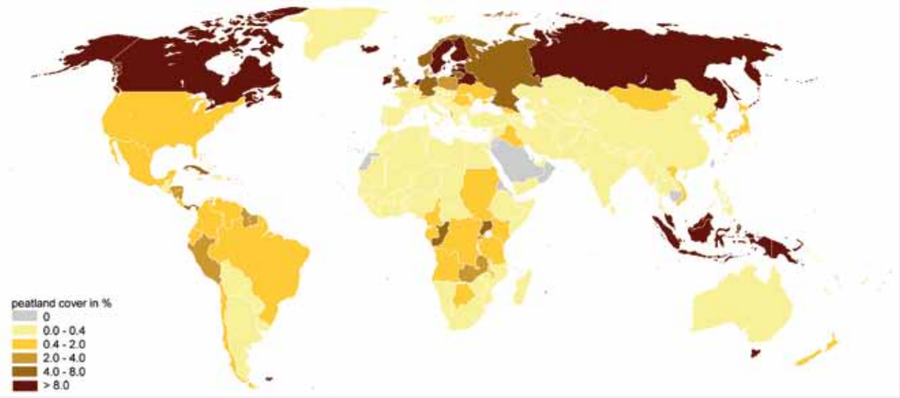

Figure 1: Global distribution of peatlands map.
Reproduced with kind permission from (Joosten 2009).

The challenge we face

Perhaps because so many of us are connected to peatlands in such indirect ways, it is easy to overlook their importance. Around the world, peat has been removed for fuel and horticulture, and peatlands have been drained in an attempt to make productive agricultural land, often with only short term benefit. These damaging activities are unsustainable, destroy habitats for wildlife and can turn peatlands into a significant source of Greenhouse Gases, which return to the atmosphere and contribute towards climate change (Couwenberg *et al.* 2011). Peatland damage also compromises the many other peatland functions society relies upon, from their ability to help provide sustainable farming and water regulation, to their use for recreation. Global carbon dioxide emissions from damaged peatlands may exceed 2 Gtonnes (excluding emissions from peat fires and peat mining) (Josteen 2010). Much of this comes from drained peatlands, whose emissions increased from 1 058 Mton in 1990 to 1 298 Mton in 2008 (> 20%), mainly from developing countries (notably Indonesia, China, Malaysia and Papua New Guinea). Degraded peatlands pose a high risk and, ultimately, high cost to society.

Heather burn © North Pennines AONB Partnership

Burning fen biomass Moscow Russia © Jan Peters

What can we do?

It is imperative that we safeguard our remaining pristine peatlands, and do what we can to restore peatlands that have been damaged by human use. The fact that we are now able to repair peatlands does not mean we can justify damaging pristine areas. Peatland soils and the habitats and species they support have developed over millennia and while restoration can help recover ecosystem function, it cannot replace the full extent of what has been lost on a site in any meaningful timescale. More severely damaged sites cost much more to repair and there is a greater risk of failure to achieve a stable peatland ecosystem or its natural biodiversity. Peatlands have been identified as a priority for action under international agreements, such as the UN Convention on Biological Diversity (CBD) and the Nagoya protocol, the UN Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol. Each of these promote the protection and restoration of peatlands as a key contribution towards reaching biodiversity and climate targets. The challenge now is to turn these objectives into action. The impact of a changing climate, which will further degrade already damaged peatlands, brings even greater urgency.

With strong national and global political recognition of the benefits of peatlands, restoration and protection have increased in recent years. Across the globe, dedicated groups and individuals are working to reverse the decline of peatlands, often developing innovative techniques for managing the land and engaging people. However, to reverse peatland degradation at a global scale, a combination of public and private investment is likely to be needed.

The development of new funding sources for ecosystem services has begun with voluntary and compliance carbon markets aimed at climate change mitigation. Ongoing work is required to learn from peatland restoration projects and quantify the benefits to help maximise the opportunity from such markets.

Peatlands are an important visitor attraction © Norman Russell

This document explores some of the examples of peatland restoration under different circumstances around the World in order to present an overview of the variety of benefits and inspiring ways in which peatland restoration can be delivered, and so avoid serious and costly consequences for society.

A NEW ERA FOR PEATLANDS

As Governments around the world begin to recognise the importance and value of healthy peatlands, and the problems arising from their damage, a new era for peatlands is emerging. This is an era in which society recognises and values the wider benefits of healthy peatlands and only uses them in ways which allow their natural function to continue and wildlife to thrive. Conserving the remaining natural peatland areas, repairing past damage and improved management are cost effective ways of helping address wider environmental problems, particularly climate change.

Peatland Ecosystem Services

Peatlands with their waterlogged and specialist environment hold a wide array of unusual and threatened wildlife and are important for the maintenance of global biodiversity. Peatlands are a priority under the Convention on Biological Diversity and in the Aichi targets which reinforce the need to conserve and restore them. With over 50% of the world's terrestrial and freshwater wetlands represented by peatlands, the Ramsar Convention of 1971 has identified this ecosystem as internationally important. Less than 10% of the global peatland area however is included in the Ramsar list of protected wetland sites. Conserving peatlands therefore requires measures beyond environmental site protection law.

Peatlands are a prime example of nature providing solutions to wider environmental problems that threaten human well-being. As a long term carbon store they are hugely important in climate change mitigation removing carbon from the atmosphere and storing it in the peat under waterlogged conditions. Drained peatlands on the other hand are a significant source of carbon emissions with less than 0.3% of the land area giving rise to almost 6% of total global anthropogenic CO_2 emissions. Restoring drained peatlands by rewetting has been demonstrated to reduce greenhouse gas emissions and this is now an accepted climate mitigation activity under international climate change agreements.

As a wetland ecosystem, peatlands have a key role in water catchments as a source of drinking water, regulating water supply and in maintaining healthy rivers and lakes. Peat also provides an archaeological and environmental archive preserving bodies, artefacts and information on past environmental conditions stretching back thousands of years.

Climate change strengthens the case for action to protect and restore peatlands. With the inevitable climate change impacts as a result of past human activity, peatland ecosystems face threats from changes in temperature and water balance, fire and extreme weather events. If functioning peatlands are to survive in a changing climate and continue to provide their valuable ecosystem services, they need to be in good

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ecological condition, which retains their water holding capacity. Degraded peatlands have greatly reduced resilience to climate change which is likely to lead to more rapid breakdown of the damaged ecosystem increasing carbon loss and reducing water regulating functions. Peatland wildlife, with its specialist plant and animal species will also have less chance of adapting to the changing climate in stressed, deteriorating and fragmented habitat conditions. Maintaining peatlands in good condition and restoring damaged areas to recover their water balance is therefore a key and urgent climate adaptation action.

Cladonia polydactyla © Erik Paterson

Cladonia portentosa © Erik Paterson

Restoring damaged peatlands is an urgent priority

While the use of drained peatland may bring significant short-term economic benefits for some people, the fact that it is inherently unsustainable clearly has long-term and wide spread socio-economic consequences. Investment now in the conservation and restoration of peatlands and promoting land-use which maintains peatlands as a wet ecosystem will provide long term sustainable benefits for local communities and the world at large.

The adverse impacts on climate change, biodiversity and water can continue long after the initial damaging activity has stopped, unless action is taken to recover the appropriate water levels. Simply abandoning the past drained peatlands presents severe fire risk and further degradation, soil subsidence and erosion. The longer the delay in taking remedial action, the greater the damaging consequences of degraded peatlands and the more costly it becomes to repair.

The disproportionately large consequences of peatland damage has been dramatically witnessed around the world. In Southeast Asia vast areas of drainage and deforestation of the natural peat swamp have given rise to extensive fires with smoke haze engulfing whole regions and reaching other countries. As well as the risk to human health, property and livelihood for millions of people the climate change impact of these fires has resulted in half the total global peatland emissions originating from this region. Estimates for the financial costs stretch into several billion dollars a year (Murdiyarso *et al.* 2004). In Russia, extreme hot weather in 2010 resulted in large fires covering around 2,000 km^2, including areas around Moscow, on peatlands that had been drained for agriculture and peat mining in the 1960s. In the UK, blanket peatlands which were extensively drained for agriculture between the 1940s and 1980s are causing drinking water quality problems which the UK water industry is having to spend several £million each year to address.

Rewetting and restoring damaged peatlands is a proven technology which has been adopted over several decades on different peatland types and a variety of land management conditions including agriculture, forestry and commercial peat mining (Parish *et al.* 2008, Cris *et al.* 2011). Different techniques exist for the variety of peatland conditions but the most important principles are to reverse the anthropogenic drainage, maintain the permanent water saturation of the peat body and to stabilize water levels in a way that supports the peat forming vegetation and associated peatland wildlife

In extreme situations where the surface peat forming vegetation has been lost through clearance such as commercial peat mining or widespread erosion following combinations of pollution, fire, intensive grazing and drainage then attempts at revegetating are required in addition to managing water.

Adjusting the management of less degraded peatlands through reducing grazing or burning is also an important restoration option in order to avoid further deterioration and more costly repair later on. Studies in the UK have shown that in upland peatlands the costs of repairing degraded sites with severe erosion can be ten times higher than more recently drained peatlands (UK Committee on Climate Change 2013).

Whilst the general principles of peatland restoration are well established more work is needed in developing techniques for the variety of different situations. Monitoring and scientific research is vital at this stage to assess the success of different methods and further quantify the benefits for climate, water and biodiversity. As more restoration projects develop across the world the benefits of sharing good practice and knowledge exchange are clear. Experience gained in restoring peat bogs in the UK has already proven useful in repairing eroding peatlands in China and Belarus and the extensive peat mining operations of Canada are showing what can be done to help repair mined peatlands elsewhere.

Delivering Results through an Ecosystem Approach

For many countries, the value of peatlands in their healthy state has not been widely appreciated in the past and as a result we face a legacy of damage from agriculture and forestry activity, drainage, pollution and exploitation. There is increasing experience of ecosystem approaches to management of natural and modified peatlands aimed at securing functions such as climate and water regulation and conserving biodiversity. The sustainable management of peatlands as wetlands can also provide win-wins, delivering multiple objectives including harvestable products in a system known as paludiculture (Joosten *et al.* 2012).The most secure future for farmers on peatlands is to protect the soil they depend on by keeping it wet.

Dropping off heather brash
© Moors for the Future Partnership

Across the globe, countries are demonstrating examples of peatland ecosystem management using innovative combinations of policy, science and practice, including novel methods of securing payments for ecosystem services. Following a call for action on peatlands at the IUCN 2012 World Conservation Congress and its inclusion in the IUCN Programme 2013 – 2016, there is a strong desire to share experience on peatland management and to scale up delivery.

The IUCN Commission on Ecosystem Management has identified five key steps towards an ecosystem approach (Shepherd 2008). The peatland case studies presented in this document illustrate how these steps have been applied.

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Determining the Stakeholders and Defining the Ecosystem Area

Peatland ecosystems are often large scale and affect wide communities of interest. Responsibility for peatland management can extend across different sectors of Government as well as regional and national boundaries. Strategic national plans can help coordinate these different sectors and bring decision making and stakeholders together toward common action for peatland. Several national governments have led the way in publishing specific peatland strategies (see for example, United Kingdom, South Africa and South East Asia case studies).

10 elements of strategic action for peatlands (Based on Joosten *et al.* 2012):

1. Identify occurrence and state of all peatlands.
2. Improve assessment of greenhouse gas emissions from peatlands.
3. Conserve all reasonably intact peatlands.
4. Prevent further degradation of already degraded peatlands including:
    - no further intensification of artificial drainage;
    - installing hazard monitoring and mitigation to avoid fire damage and soil erosion;
    - shift from agricultural and forestry practices that require drainage on peatland, to paludiculture; and
    - end uncontrolled selective or illegal logging.
5. Restore degraded peatlands by rewetting, reforestation (in the tropics), and subsequent conservation and/or paludiculture.
6. Target financial resources to peatland conservation, restoration and better management.
7. Stimulate and apply existing and developing climate financing mechanisms such as the compliance market and the voluntary market.
8. Involve local communities at the earliest stage and support communities to overcome their opportunity costs and dependence on unsustainable peatland use.
9. Ensure that greenhouse gas (GHG) criteria are integrated in credible certification and subsidy schemes for products that are derived from drained peatlands. Integrate these into national procurement policies.
10. Share experiences and expertise on peatland conservation, restoration and better management among countries.

At a local level, open and transparent partnership working has helped bring together different interest groups. Agreeing the need for peatland conservation and restoration in a way that meets stakeholders needs at an early stage can help overcome potential conflicts. Partnerships of local government administration, public bodies, businesses, local people, land managers and conservation interests can help agree on solutions which secure the peatland and meet the needs of people. Partnerships can operate at several levels of scale. In Sweden partnerships have been established for peatland restoration across several regions from the north to south of the country. The successful regional partnerships in the UK and Ireland illustrate how past conflicts between peatland conservation and land managers are being resolved. Having a strong lead body with project managers able to coordinate across the different groups, tackle concerns and report back on progress is an important part of successful projects.

A key aspect to many of the case studies is the inclusion of those users of peatlands with a direct interest in the ecosystem services such as farmers harvesting crops or grazing livestock, peat mining companies or tropical peat forest loggers. By working with these groups, ways have been identified to provide alternative sources of income based on sustainable use of the peatlands that retains the natural wet conditions and provide wider benefits. This can include harvesting wetland crops instead of those which require drainage, creating alternatives to peat sources for fuel and horticulture and providing employment in tropical peatlands through cultivating non-timber forest products (See case studies in Germany, Poland, Belarus, China, Indonesia and Canada).

Public participation is vital in ensuring that the benefits of peatlands and the costs to society resulting from their damage, are understood. In Germany projects teams holding ‘kitchen table’ discussions with farmers and owners of the Barndenburg Fens has helped agree plans for restoration. (See also UK, Ireland, South Africa, Ruerggai plateau in China, Bangladesh).

Ecosystem structure, function and management

There are well-researched links between biodiversity, ecosystem structure, function and the provision of ecosystem services. Land management changes ecosystems in various ways, and given the complex relationships between ecosystems and the services they provide to society, the impacts of changes in management can be unpredictable. A holistic approach to peatland management and restoration must ensure the ecosystem is functioning properly, providing services and supporting biodiversity, and this requires an in-depth understanding of the different processes and the impacts of land management. For many countries however, simply understanding where peatlands occur and what state they are in is still a major challenge ahead.

Several projects include scientific work to improve the evidence base which helps understand ecosystem function and in particular helps quantify the ecosystem benefits such as carbon and water. Monitoring and survey work on peatland restoration sites improves knowledge and experience which can be used to scale-up peatland restoration elsewhere (see UK, Poland, Bangladesh, Australia and Canada).

Emperor Moth Larva & Female Emperor Moth
© Erik Paterson

Economic Issues

Understanding the natural capital value of peatlands and the costs to society from their degradation is helping secure much needed funding from public and private business sources. Lack of awareness of the economic issues in the past led to widespread and often Government-funded damage to peatlands in a short-sighted attempt to make profit. In many developing and developed countries, peatlands occupy often remote areas, and support impoverished communities. However, new ways of managing peatland areas are being found which help bring much needed employment and economic benefits to these previously disadvantaged areas. In Europe, financial subsidies for farmers and forestry are beginning to recognise and reward those who restore and maintain healthy peatlands, in recognition of the wider benefits to society. In the UK, water companies faced with legal drinking water quality obligations are finding that restoration of damaged peatlands is more cost effective than expensive water treatment works downstream.

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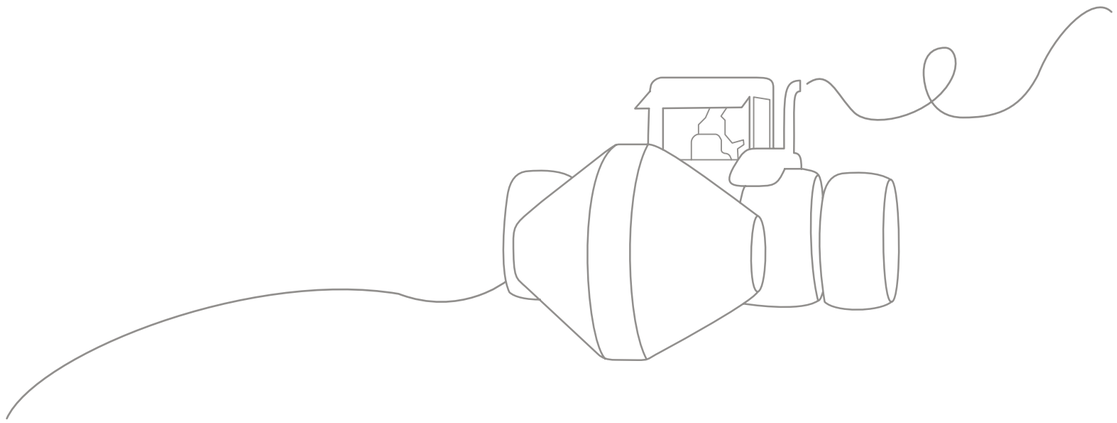
Many projects are looking at how to realise new employment opportunities as part of peatland restoration and long-term protection of peatland ecosystems. This employment can come from the development of innovative products such as *Sphagnum* farming in Germany and mosquito repellent in Indonesia or new ventures such as wildlife tourism or through the restoration and management of the peatland itself. In some cases the sustainable management of the peatland secures livelihoods that were under threat from the damage to the peatlands such as the grazing lands in Ruoergai Plateau in China.

Public funded measures have been adopted in some countries particularly in the EU states where incentives are given to land managers to conserve peatlands in recognition of the wider public benefits this brings.

Private funding from individuals and businesses for peatland restoration is an emerging opportunity with the development of carbon markets. Different systems are being established across the developed and developing nations under voluntary and compliance markets with various standards and methods for verifying the carbon claims. The potential for markets to support other ecosystem services such as water and biodiversity is also being considered and could prove very useful for peatlands which provide multiple ecosystem service benefits. In the UK, for example, a Peatland Code has been established, to create a “regional carbon market” for the UK, providing quality standards for projects and sponsors, selling a bundle of GHG emission savings, water quality and biodiversity benefits to the Corporate Social Responsibility market. The scheme is designed along similar lines to rules set for the voluntary carbon market, giving companies the prospect of potentially accrediting to these markets in future, where they might be able to make a return on their investment.

Adaptive Management over Space

Adaptive management has been described as “learning by doing” and typically involves researchers, policy-makers and practitioners working together to address environmental challenges at a landscape scale, learning from their mistakes, and from the experience of others working in similar contexts. Peatlands are often large scale ecosystems which extend across political and administrative boundaries. Being largely made up of water these systems are also vulnerable to damage in one area having a much wider effect across hydrological units. This brings challenges in having to address restoration at a large scale across whole landscapes and involving many different land managers. Tackling such large scale issues has been addressed and several projects now operate on individual sites extending over thousands of hectares or on groups of peatlands across a whole country. Coordinated deployment of machinery and high capital costs which would be prohibitive to individual land managers can be achieved through a lead body managing a major restoration project often involving several £million budgets (e.g. the various EU Life funded projects) or through large corporate interests such as peat mining companies in Canada and Ireland.



The flood management and drinking water supply benefits of peatlands illustrate the need for large scale considerations as damage to a peatland site can affect cities, towns and villages often many kilometres away from the peatland itself. Adaptation to the increased risk of flooding includes peatlands areas being restored to help reduce the downstream threat of flood damage.

Reinstating peatland function and extending fragmented peatland remnants is an adaptive action that helps bring the ecosystem into good condition to improve resilience and support any species changes in distribution under a changing climate.

Adaptive Management Over Time

Building long term security for peatlands requires restoration projects to look beyond the immediate task of repairing the ecosystem and consider how to sustain ongoing management into the future. Initiatives are being developed which aim to provide long term employment for local communities based on sustainable products from the peatlands such as reed products from fens in China. Ensuring that land managers and local people see some financial return from healthy peatlands is an important element in many of the long term plans for peatlands.

Returning degraded and abandoned peatlands into self sustaining wetlands, under a changing climate is one of the driving forces behind projects designed to prevent the recurrence of large peat fires in Australia, Indonesia and Russia.

Embarking on peatland restoration also requires long term investment in project management in order to address the uncertainties over different restoration techniques and to ensure restoration management at different stages in the recovery process. Peatland restoration can provide immediate benefits in terms of reducing carbon emissions or water regulation but it may take several years or decades to return the system to its fully functioning potential. Ongoing management of wildlife and particularly the management of livestock requires regular monitoring to ensure that management is delivering the required outcomes.

Common Hawker F Oviposition © Erik Paterson

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Juvenile Common Frog In Moss © Erik Paterson

EUROPE

Peatlands in Europe cover a total of 505,000 km^2 or almost 13% of the world peatland area. Past damage and ongoing threats to peatland from agricultural activity, forestry and peat mining have created a global hotspot for carbon emi--ssions from peatland, with Europe being responsible for around 30% of global peatland emissions

A variety of peatland types occur predominantly across the northern regions with Finland accounting for a third and Sweden a quarter of the resource respectively. Elsewhere in central and eastern Europe, extensive areas of peatland are found in Russia, covering around 8% of the territory. High rainfall areas such as the UK and Ireland, in the west of the region contain some of the deepest peat resources (extending to 12m in some cases) and support some of the best examples of Atlantic blanket bog habitat in the world. In contrast to these naturally treeless peatlands, there are large areas of forested peatland in Finland and Belarus

Europe's peatlands hold a considerable variety of plant and animal species that depend on these wetland habitats. Internationally important bird populations feed and breed on the peatlands and in recognition of this, many sites have been designated as Special Protection Areas under the EU Wild Birds Directive. Peatland habitats have also been given special recognition under the EU Habitats Directive with Special Areas of Conservation designated for a number of priority habitats listed in the Directive. Together, these protected peatlands form part of the Natura 2000 ecological network.

EU-wide assessment of protected peatland habitats of EU conservation concern has revealed that they are in unfavourable status throughout nearly all of their range. Past peatland damage has resulted in very significant damage to even the Natura 2000 sites, many of which require active restoration.

Funding under the EU Life Programme has assisted EU Member States in restoring and conserving peatlands, focusing primarily on Natura 2000. Over 260 LIFE projects have acted as a practical outdoor laboratory for testing the feasibility and techniques of peatland restoration. These projects have targeted the full range of peatland habitats and have supported pump-priming initial heavy investment costs to make long-term management easier as well as generating high-profile models of how conservation objectives can be achieved.

'Peatlands are a critical element of Europe's natural capital and investing in them as part of Europe's green infrastructure will not only significantly contribute to EU biodiversity goals, but will also provide multiple ecosystem benefits to society in the face of climate change.'

Micheal O'Briain, Deputy Head of the Nature Unit in European Commission, DG Environment.

PEOPLE AND PARTNERSHIPS

Taking action to restore UK peatlands

United Kingdom, Western Europe

A companion document 'UK Peatland Restoration; Demonstrating Success" has previously been published to present case studies illustrating achievements in restoring and conserving peatlands in the UK and British Overseas Territories (Cris *et al.* 2011). Here we provide a few examples to demonstrate some of the different activities being undertaken.

UK deep peat soils cover 27,000 km^2 or 11% of the total area of the country, with three main peatland types blanket bog, raised bog and fen. Blanket bogs found in the uplands make up the majority of peatland area and are used largely for grazing. Significant areas have been drained and burned in the past in attempts to improve livestock production. Large-scale drainage of naturally treeless peatlands also took place in the late 20th century for commercial forestry plantations. The lowland fens and raised bogs have largely been drained for agriculture with much being used as cropland.

Leadership in peatland restoration
Considerable work has been undertaken in the last two decades to help restore damaged peatlands much of this led initially by nature conservation bodies with funding from members along with government grants including EU funding under the Life Programme. More recently work has expanded to include private landowners as well as commercial water companies and the state and private forestry sectors.

Following a Commission of Inquiry on peatlands which set out recommendations for peatland action (Bain *et al.* 2011) the four UK Government Environment Ministers produced a joint Statement of Intent to conserve peatlands in the UK and British Overseas Territories (Defra 2013). The Scottish Government is responsible for over 60% of the UK's deep peatland and has made available £15 million funding for peatland restoration along with a strategic plan for Scottish Peatlands.

A. Blanket Bog Restoration

Flow Country

Flow Country – Covering over 4,000 km^2 and one of the largest Atlantic blanket bogs in the world, the internationally important peatlands of Caithness and Sutherland in Scotland saw vast areas drained for agriculture and forestry. An EU Life funded project supported by Scottish Natural Heritage and Forestry Commission Scotland has helped restore the site with drain blocking and tree removal. An RSPB nature reserve in the heart of the site attracts over 4000 visitors a year who contribute over £190,000 to the local economy. Land managers, crofters, foresters and conservationists are now working on a shared strategy with public bodies to further restore and manage the peatlands alongside scientific work to quantify the climate change and biodiversity benefits.

Afforested peatland in the Flow Country © RSPB

Marble Arch Caves, Cuilcagh Mountains

A 2,700 ha blanket bog in Northern Ireland which has been damaged by peat cutting for fuel, intensive sheep grazing and burning is having an adverse impact through flooding risk to a nearby cave system which is a major tourist attraction. A restoration programme has been in place for over ten years to block drains alongside public awareness work to help local people and visitors to enjoy and understand the importance of the peatlands.

Cuilcagh Moutain Park Blanket Bog © Fermanagh District Council

North Pennines

The North Pennines Area of Outstanding Natural Beauty Partnership (NPAP) is an alliance of statutory agencies, local authorities, voluntary and community organisations that is responsible for delivering work on the ground and coordinating the efforts of a wide range of partners. The peatland area of the North Pennines AONB covers over 1,000 km^2 of blanket bog in the north of England. Large scale peatland restoration techniques have been developed alongside work to raise the profile of the peatlands with local residents and visitors. The NPAP Peatland Programme also has a major research programme including remote sensing surveys to assess the condition of this extensive peatland.

© North Pennines AONB Partnership's Peatland Programme

Private water companies responsible for providing drinking water to some of the UK's largest cities are involved in peatland restoration work which is helping to reduce the costs of water treatment and management downstream of the damaged peatlands. The water companies have funded large-scale restoration work as well as survey and monitoring to assess the water, carbon and biodiversity benefits. The resulting investment is cost effective for the businesses and provides extra support for local employment and economies.

B. Fens

Anglesey and Lyn

A project in North Wales extending over 750 ha has been funded by the European Life+ Programme aimed at restoring fen habitat into favourable condition. The statutory conservation agency, Natural Resources Wales, is working with communities and farmers in the area to promote sustainable grazing management, rewetting and control of burning. As well as improving biodiversity the work is bringing wider benefits including improved drinking water quality.

Open Day for farmers and landowners at Cors Erddreiniog NNR, showing cuttings of Saw Sedge Cladium mariscus in the foreground, and the Pistenbully in the background.

C. Raised Bogs

Lancashire mosses

The Lancashire Moss land project was established to restore and expand fragmented lowland raised bogs in North West England. Many of the sites had been damaged by urban development, commercial peat mining for horticulture and by agricultural drainage. A large-scale restoration programme extending over 2000ha of lowland raised bog and lag fen habitat, is in place major rewetting projects and advice to farmers to support restoration. In two years the project engaged with over 4000 people including almost 7000 hours of volunteer activity in helping repair the peatlands.

Volunteers learning how to identify *Sphagnum* Moss © Lancashire Wildlife Trust

SPHAGNUM FARMING

Paludiculture on degraded bogs in Germany

Germany, Western Europe

A pilot project in Lower Saxony shows that producing *Sphagnum* biomass as an alternative to extracting fossil peat for 'growing media' (horticultural potting soil) may help reduce the loss of pristine bog ecosystems.

We all contribute to peatland destruction
To cover the growing demands from world-wide urbanisation, the cultivation of vegetables, fruits and flowers takes place in pre-prepared growing media, consisting mainly of slightly humidified peat ('white peat') which is built up in natural bogs by *Sphagnum* species. Extracting this fossil resource destroys raised bogs and their associated ecosystem functions, including carbon storage and water regulation. As a result, the stocks of white peat in most countries of western and central Europe are largely depleted, and living bogs have become so rare that the few remaining examples are strictly protected.

Looking for sustainable alternatives to peat
As the availability of peat becomes limited, the growing media industry is forced to source it from ever more remote areas. Thus there is an urgent need to develop sustainable alternatives for peat not only from ecological but also from economic and social point of view. The most promising alternative is *Sphagnum* biomass. Its use as a raw material for growing media in modern professional horticulture has been successfully tested and in some cases demonstrates even better results than the peat-based substrates developed over many years.

One decade of experience in *Sphagnum* farming
The cultivation and harvest of *Sphagnum* biomass (*Sphagnum* farming) aims to replace fossil peat in horticultural growing media with a renewable raw material. In contrast to conventional drainage based agricultural use or peat mining, wet cultivation, known as paludiculture, maintains the peat body as a carbon store. In cooperation with various research and industrial partners, Greifswald University has spent the last decade studying *Sphagnum* farming, including diaspore recruitment, plant establishment, optimisation of site conditions, productivity, and regeneration after harvest.

***Sphagnum* farming on former bog grassland (Lower Saxony, Germany)**
In spring 2011, the research team, set up by the university and peat industry, established an almost 5 ha large industry scale pilot site on agricultural bog grassland near Rastede (Lower Saxony, Northwest Germany). To do this, the team removed the upper topsoil, which was strongly degraded, and installed a water management system for irrigation and drainage. They then introduced *Sphagnum* diaspores with a manure spreader mounted on a former snow groomer.

After 1.5 years *Sphagnum palustre*, *S. papillosum* and *S. fallax* covered 95% of the area with an average lawn height of 8.3 cm (maximum 22.4 cm). The field site has already demonstrated the feasibility of large-scale *Sphagnum* farming and now enables the team to develop methodologies and machines to upscale the cultivation and harvest of *Sphagnum* biomass.

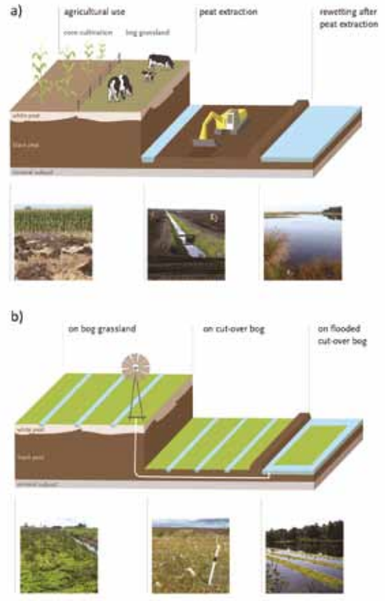
Vision of a new (peat) landscape
Within 10 years this project could demonstrate that *Sphagnum* farming in Germany is possible and promising. Methodologies have been developed for both:

- land-based cultivation on degraded bogs (i.e. formerly used as pasture or meadow and after peat mining)
- water-based *Sphagnum* cultivation on artificial floating mats on water bodies, resulting from peat, sand and lignite extraction.

As a result, a cultivation mosaic on different degraded peatland sites is conceivable.

An ambitious goal for the work ahead
Substituting all of the white peat consumed in German horticulture (ca. 3 million m³ per year) would require *Sphagnum* farming on ca. 40,000 ha. Considering there is more than 120,000 ha of bog grassland in Lower Saxony alone, this target seems achievable. Up-scaling the *Sphagnum* farming process is the next big challenge for the project and we are working on it!

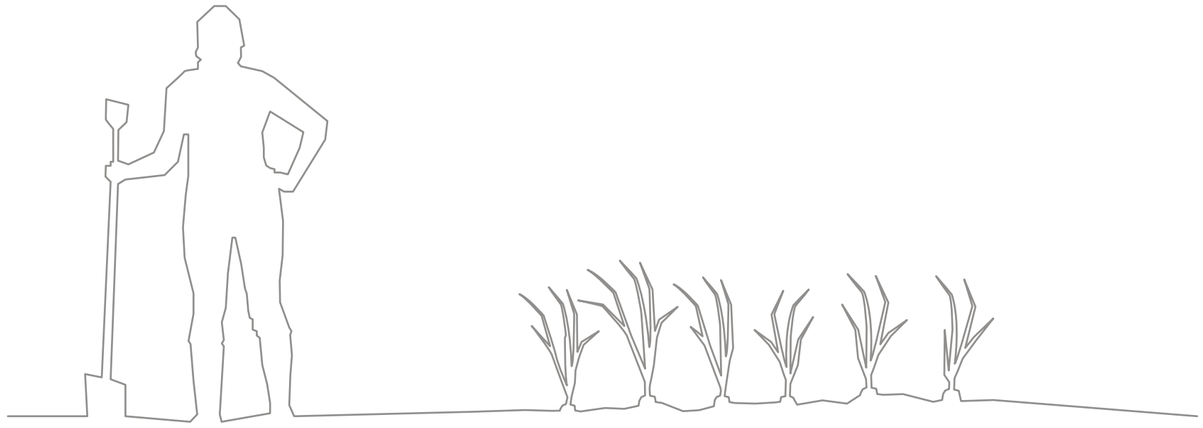
Workers of the peat company Moorkultur Ramsloh GmbH prepare a large-scale *Sphagnum* farming field on bog grassland in Northwest Germany (spring 2011) © Sabine Wichmann



Mosaic of degraded bogs
a) recent use and b) with *Sphagnum* farming

'Everybody everyday eats peat…if you eat vegetables, you eat peat… '

Professor Hans Joosten, Institute of Botany and Landscape Ecology / University of Greifswald, Germany



ADDED VALUE AND CLIMATE PROTECTION

Utilisation of biomass from rewetted peatlands in Germany

Germany, Western Europe

Re-wetting versus agriculture
In Mecklenburg-Western Pomerania peatlands cover 12% (about 300,000 ha) of the land area. The majority is currently drained for agricultural purposes which cause 27% of all whole CO_2 emissions of the region. Peatland rewetting is the best option for climate and nature protection but leads to a loss of land that can be used for agriculture and therefore reduce the income of the local farmers. For this reason there is a strong opposition against peatland rewetting meanwhile the subsidence of one to two cm per year goes on and on. But is there another choice for the farmers? Yes, Hans Voigt and Ludwig Bork are demonstrating alternative and economically beneficial uses of biomass produced from rewetted peatland in the Peene Valley.

Protect the 'Amazon of the North'
Consisting of 45,000 ha, the valley of Peene river is one of the largest fen areas in Germany and is known as the 'Amazon of the north' because of its wild character. From 1992 to 2008 large areas of fens in the Peene valley were rewetted, creating an outstanding nature conservation area.

Combining protection and alternative utilisation
When peatlands at Lake Kummerow (western part of the Peene valley) was rewetted, it affected also 400 ha of land that farmer Hans Voigt had been used for cattle breeding. The change in water level affected the species composition of the sites, lowering fodder quality and making the vegetation unsuitable for cattle breeding. To ensure financial stability for Hans Voigt and his family, an alternative use for the biomass, now mainly sedges, reed and reed canary grass, was needed. After several years of planning, and working in cooperation with on-going research projects at the University of Greifswald, thermal utilisation of fen-biomass was chosen as an alternative.

Progress and implementation of thermal utilisation
For the realisation of using fen biomass from wet peatlands, a specialised machinery is needed. With side adapted machinery the two to four tonnes of biomass per hectare can be cut, swathed and baled in late summer. Approximately 6,000 bales, each with a weight up to 250 kilograms, are harvested per year. A heating plant is now constructed by Ludwig Borg to convert these fen biomass to heat which cover the demands of 1000 apartments, a school and a kindergarten in the city Malchin, nearby. Additionally to the reduction of the emissions from the formerly drained peatland, the 1000 tonnes of harvested fen biomass provides a total energy supply of 4 GWh and replaces 375.000 litres of fossil heating oil.

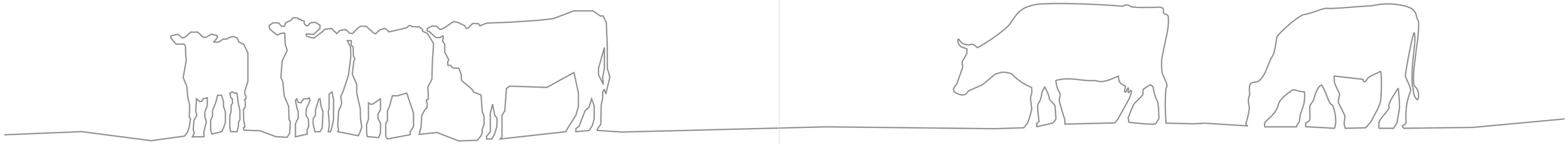
Adding value on rewetted peatland
The thermal utilisation of the fen-biomass enables farmer Hans Voigt to continue the use of his land, keep his employees and preserve the natural heritage. The local production of sustainable biofuels increase regional collaboration and added value. However, to increase acceptance of peatland rewetting and restoration for climate and regional development, it is vital to create local networks between land users, administration, district heating stations and energy user. Thanks to the initiative of Hans Voigt and Ludwig Bork the benefits of the alternative land use of peatlands, can now be presented to other communities and farmers to go in the same direction.

Mowing a fen meadow near Neukalen, Mecklenburg-West Pomerania © Philipp Schroeder

Networking in situ between local stakeholders: farmer, local energy supplier, consultant © Tobias Dahms

'After rewetting the adjacent Peene valley, we had to think of new ideas of utilisation, as our cattle would starve while having a full belly. The fodder wouldn't have the needed amount of digestible energy. It took us several years of planning and negotiating to finally get everyone's go for the thermal utilisation of the biomass.'

Hans Voigt, farmer at Schwinkendorf/Mecklenburg-Western Pomerania, Germany



BRINGING BACK THE WATER

Re-wetting Alkaline Fens in Brandenburg

Germany, Western Europe

From 2010 to 2015 Naturschutzfonds Brandenburg is leading the EU LIFE Nature Project. *Alkaline Fens in Brandenburg*, which aims to restore the condition of alkaline fens in 14 Natura-2000 areas in the federal state of Brandenburg

The initial situation
200 years ago alkaline fens were quite common in north-eastern Germany. Since then however, the changing profitability of agriculture has had a big impact. When profitable to do so, drainage ditches were used to make the fens arable so they could provide feed and bedding for cattle and other animals. When this was no longer financially beneficial on small and difficult sites, most of the fens were left to themselves. However the drainage ditches were still functioning, causing degradation and mineralisation of the peat soils. The increased availability of nutrients in combination with the lower water levels allowed reed, willow shrubbery and woods to overgrow the fens, dramatically altering the naturally open landscapes.

Alkaline fens – rare beauties
Alkaline fens are mostly developed on spring and percolation mires. They are nurtured by mesotrophic, slightly alkaline ground water and characterised by a rich diversity of plant species, e.g. *Menyanthes trifoliata, Succisa pratensis, Dactylorhiza incarnata, Liparis loeselii* and *Epipactis palustris*. Brown mosses such as *Drepanocladus vernicosus, Paludella squarrosa, Helodium blandowii* and *Scorpidium scorpidium* are particularly characteristic. The main threats to these sensitive habitats are fluctuating water tables or water tables below ground surface, which lead to increased eutrophication. As a result, this project aims to remove nutrients and stabilise the water tables close to the surface level.

The first step
To reduce nutrient impacts in the fens, the first step is biomass removal. Due to the difficult conditions on the wet and sensitive peaty soils specialist machines called “Pisten Bullies” are used for mowing and shrub removal in some project areas. In other areas, the project has worked in collaboration with local farmers to initiate a different approach, using Asian water buffalos to graze the wet meadows, keeping reed and other larger vegetation to a minimum level.

Bringing back the water
To improve the hydrologic conditions of the fen, the entire drainage system has to be deactivated. On sloped fens, the ditches are completely filled using degraded peat. The top peat layer is cut to a depth of 15-20 cm and to prevent the formation of new coherent drainage channels, small dams are left along the contour lines. These dams hold any water and provide starting points for the fen vegetation to settle into the new raw-soil locations.

Region and community: discussions at the kitchen table
Farmers and their families have lived and worked with moors and fens over centuries, mowing the difficult areas by hand. But after the formation of the GDR in the 1960s, family farms in Brandenburg were merged into large farming cooperatives (LPGs) and interest in small and difficult fen areas declined. To gain support for conservation activities, the project team approached local people directly and took an informal approach, holding discussions around kitchen tables to explain the importance of fens to owners and farmers.

Results
Restoration measures have been carried out in six project areas and initial results are good. 150 ha of reed have been mowed, 27 km of drainage ditches have been filled and peat has been cut on an area of about 14 ha. Water buffalos are grazing more than 30 ha. Monitoring of the hydrologic condition shows that water levels in the rewetted areas have mostly risen to the ground surface and fluctuations have been reduced significantly. Furthermore, a couple of months following these restoration measures, the project identified fen species in some areas.

Alkaline fen in Brandenburg © S. Luka

‘The country needs new Moors.’

Prof Dr Michael Succow , Michael Succow Stiftung

Water buffalos grazing fen meadows © H. Rößling

MANAGING WET FENS FOR BIODIVERSITY CONSERVATION AND SUSTAINABLE BIOMASS USE

Using peatland biomass for fuel at Biebrza

Poland, Western Europe

Peatland in Poland
Of the 12,548 km^2 of peatland in Poland, 84% is degraded with the majority (70%) used as hay meadows and pastures. However, since 2000 Poland has increased its efforts to conserve valuable mire habitats. Integrated management schemes have been developed that combine peatland conservation with economically sound agricultural and hydrological management on near-natural peatlands.

A little brown bird
Targeted bird conservation activities, particularly for the Aquatic Warbler (*Acrocephalus paludicola*), have been a major driver of the peatland conservation approach in Poland. In the early 20th century the Aquatic Warbler was widespread in temperate open wetlands from the North Sea coast to Siberia. However, due to large-scale destruction of its habitats the world population decreased severely and abandoned an important part of its former range. With a world population of only 10,200-14,200 singing males (the "counting unit" of this species), it is the only globally threatened passerine bird of continental Europe. The vast fen peatlands in Eastern Poland (mainly Biebrza National Park and Lublin region) hold 25% of the world population and are therefore of extreme importance.

New ideas for an old challenge
A recent project funded by EU LIFE is working towards the restoration and sustainable management of Aquatic Warbler habitat. The project is run by OTOP BirdLife Poland, and is working in partnership with governmental, NGO and private institutions. Due to overgrowth of the peatland habitat, many areas are no longer habitable for the Aquatic Warbler. Specialist machinery has been developed to mow large areas of delicate peatland; the adapted mountain piste-bashers are colloquially called 'ratrak'. In the Lublin region of Poland, around 1,200 ha of wet fens are now regularly mown and Biebrza National Park has made approximately 10,000 ha of public land available to be managed in this way.

The remaining challenge: efficient biomass use
As the biomass from the peatland mowing was too poor quality to be used for fodder, a follow-up EU LIFE project examined three other ways that it could be utilised; biogas production, composting and bulk fuel. A feasibility study showed that, both technically and economically, the best solution was the use of the biomass as a fuel. In February 2013, a facility was set up in Trzcianne to turn the biomass into briquettes/pellets with an annual target of c. 4,500 tonnes of dry biomass.

Life after LIFE
Analysis has shown that re-introducing mowing to halt succession of this habitat had a positive effect on the Aquatic Warbler populations in Bierza and the Lublin region, and has resulted in positive results for breeding productivity. These findings show that Aquatic Warblers benefit from habitat management as long as it remains consistent and is regularly adjusted to succession rate.

However, early botanical results have highlighted some unwanted effects of the new mowing machinery on fen micro-topography and, as a result, on plant diversity. The future management of near-natural fens in Eastern Poland depends primarily on the decisions made by the administration of protected areas (especially National Parks) and further research is needed to inform the spatial planning for mowing, especially in Biebrza National Park. Another factor in the on-going success of this peatland conservation project will be the impact of the agro-environmental scheme (AES) packages for the next funding period (2014-2020). If proper payments and well-tailored, flexible bird protection packages are made available, farmers will remain interested in managing their land for conservation purposes.

The Aquatic Warbler is a species characteristic for fen mires and the only globally threatened passerine species of continental Europe © Zymantas Morkvenas

Mowed fen mire in Biebrza National Park © Franziska Tanneberger

‘Our first LIFE project has introduced new mowing machinery that is able to implement habitat management on delicate peat soils, it facilitated that more than 10,000 ha of wet fens are now under regular management in Poland and Germany, and arranged for financial support for Aquatic Warbler-friendly habitat management through agri-environment programmes. And all this, we did for just the price of 500 m of new motorway in Poland!’

Lars Lachmann, OTOP project manager of the Aquatic Warbler LIFE project and RSPB Country Programme Officer Poland

LIFE TO AD(D)MIRE

Mire and wetland restoration in Sweden

Sweden, Western Europe

The Life to ad(d)mire project will restore 35 Natura 2000 sites in Sweden between 2010-2015. In total, 3000 ha of rich fens and large peatlands will be restored.

The aim
Funded by EU LIFE, this project aims to stop the decrease of Natura 2000 habitats and species through hydrological restoration and vegetation measures. It aims to restore 3852 ha in 11 Natura 2000 habitats, targeting six species in the Species and Habitat Directive and 14 species in the Birds Directive.

The focus
The Life to ad(d) mire project is focusing on two key issues:

- **The loss of mires and wetland due to disturbed hydrology**
  To restore the hydrological functioning of these sites, excavators are used to fill ditches with material from the site. This is carried out during the summer months. If there is a lot of vegetation alongside the ditches then this is either removed in advance of the restoration process (i.e. the winter before) or removed during the restoration work.
- **The loss of mires and wetlands due to loss of historical agricultural management.**
  At the sites where only vegetation measures are planned, the work is often carried out over several years. The actions taken include haymaking, mowing and removal of common reed.

Monitoring
The most important indicators of success are measured throughout the process, including birds, vegetation, ground water levels and water chemistry.

In most of the 35 mires and wetlands, groundwater pipes have been installed inside and outside the Natura 2000 site to monitor the groundwater levels before, during and after the restorations. Water samples are taken several times each year to monitor the water chemistry before, during and after the restorations, and aerial photos were taken before restorations started and will be taken again at the end of the project. The bird monitoring is carried out during the spring with each site being visited two or three times during that season.

Region and community
Since the project is taking part in so many regions is Sweden, from the agricultural south to the boreal north, the problems and measures differ in each and every one of the sites. In the south there are many stakeholders to consider and involve. In the middle part of Sweden there are restorations going on at old peat mining mires, where the historical values have to be taken into consideration. Finally, in the north the greatest challenge is the large distances between roads and sites. This has provided the project team with important experience with several varying factors, which is a great strength for land management in Sweden, and wider Europe.

A more positive future
The work of this project hopes to lead to a reduction of CO_2 emissions and cleaner ground water due to the reduction of nutrients and substrate transported to the surrounding rivers, creeks and lakes. The restoration will also decrease the level of landscape fragmentation, benefitting birds and other terrestrial species.

Projektledare Life to ad(d)mire © Lisa Tenning

‘When the bird watchers saw an unknown white tailed eagles (*Haliaeetus albicilla*) nest thanks to the high altitude of at the new bird tower, they were forever believers of mire restorations.’

J. Rova Regional project Manager County of administrative board of Jönköping

BLOCKING DRAINS IN IRISH RAISED BOGS

The Bord na Móna Raised Bog Restoration Project

Ireland, Western Europe

Background
Since its establishment in 1946, Bord na Móna (the Irish Peat Company) has acquired extensive areas of Irish peatlands to develop for fuel, energy and horticultural growing media. Several raised bogs that were partially drained in the 1980s were identified as having substantial ecological and conservation value, as well as significant restoration potential. They now form the core of the Bord na Móna Raised Bog Restoration programme (2009 to present) which forms part of the company's Biodiversity Action Plan (2010-2015).

Learning from previous experience – Abbeyleix Bog
In 2009, restoration work began at Abbeyleix Bog in Co. Laois. This work was managed and co-funded by Bord na Móna and the National Parks and Wildlife Service. Initially drained in the 1980s, the margins of the 109 ha bog had been cut for domestic use. To restore the raised bog habitat, drains were blocked to raise water levels, re-wetting the bog and aiding the development of *Sphagnum*-rich plant communities and peatland habitat function. Consultation was carried out prior to restoration with the local community and other stakeholders, including local authorities and the Irish Peatland Conservation Council.

Methodology
The methodology used was developed by the National Parks and Wildlife Service under the Dutch-Irish Restoration programme in the 1990s. A topographical survey was carried out to identify peat dam locations and this was then followed by an extensive drain-blocking programme. Work was carried out by a specially modified excavator and over 3500 dams were installed over a four month period (one for every 10 cm fall in height). This methodology has since been used successfully by Bord na Móna as part of the company's wider bog restoration programme at other sites including Cuckoo Hill Bog in Co. Roscommon in 2011, Moyarwood Bog, Co. Galway in 2012 and Ballydangan Bog in Co. Roscommon in 2013 (ongoing).

The results
After the restoration work was completed in 2011, Bord na Móna leased Abbeyleix Bog to a local community group who continue to develop the nature conservation, amenity and education potential of the site. The community organises regular clearance of invasive Rhododendron and also held a local Bioblitz event in 2013, yielding 355 species with new county records.

Bogs included in the restoration programme are currently being assessed to add to the NATURA 2000 network as SAC areas or as part of the national conservation network as NHAs (Natural Heritage Areas). The Bord na Móna sites will add considerably to the bog conservation and restoration network in Ireland in coming years.

Future Plans
At this stage over 400 ha of raised bog have been restored using this methodology and Bord na Móna will continue the rewetting of other sites in Cos. Galway and Roscommon with an additional 2000 ha targeted for restoration in coming years. Intensive drain-blocking is currently underway at Ballydangan Bog - one of the largest and wettest bogs in a cluster of bogs that will be restored and that form an important network for native Red Grouse locally. At such an early stage, it is difficult to make definitive conclusions about the impacts of this restoration but, in general, water levels have been responding quickly and are being maintained very close to the bog surface. Changes in habitat quality of these sites will be monitored to assess the success of the work, both in the short and long term. Monitoring of greenhouse gases is also taking place on the restored bogs to assess the potential offset of carbon by rewetting drained bogs.

Moyar Wood October 2012 © Bord Na Mona

‘In line with our New Contract with Nature, Bord na Móna is fully committed to progressing our bog restoration programme across our land holding and building on the successful initiatives taken to date. We expect to significantly increase our restoration activity in coming years as outlined in our Biodiversity Action Plan. The techniques and expertise used in the projects mentioned will be used to inform future projects so as to ensure continued success in this very important area.’

Gerry Ryan, Head of Land & Property, Bord na Móna

Abbeyleix © Bord Na Mona

WETLAND ENERGY

Sustainable use of wet peatlands in Belarus

Belarus, Eastern Europe

In Belarus the Wetland Energy project made a peat briquette factory think and invest in a new direction – using wetland biomass for production of renewable energy fuels.

The problem in Belarus Peatlands cover 15% of the land surface area in Belarus but more than half (1,505,000 ha) of this area has been drained for agriculture, forestry and peat mining. Drained peatlands are hot spots for greenhouse gas emissions. They leak nitrate to ground – and surface waters and are biodiversity deserts. Heavy soil degradation on some sites has made using the land unprofitable and frequent peat fires on these abandoned peatlands pose significant risks for the environment and for human health.

Alternatives needed and found Over the last fifteen years, about 50,000 ha of drained peatlands in Belarus have been rewetted and a further 500,000 ha may also be available for rewetting. On some of these rewetted peatlands, it is possible to implement paludicultures.

Paludiculture is a form of agriculture that allows farmers to manage wetlands (including many peatlands) for biomass production (e.g. reeds for insulation or biofuels) without draining or in other ways damaging peatland habitats. They increase biodiversity, mitigate nutrient losses to ground- and surface waters, and reduce greenhouse gas emissions to the atmosphere. Under ideal conditions even new peat can be formed. Using renewable biomass fuels in place of fossil fuels has major socio-economic benefits and the process also provides jobs in rural and often remote areas, prevents peat fires and promotes the reestablishment of wet peatland biodiversity

“Wetland Energy”: Cooperation with a peat factory
As local peat resources diminish and environmental concerns gain force, peat energy suppliers will have to think about alternatives. The EU-funded Wetland Energy project is working with a peat factory in the Grodno region of Belarus to optimise the production of renewable energy fuels from rewetted peatlands.

A paludiculture pilot project has been implemented at the Lida Peat factory which covers the full paludiculture cycle; from harvesting the biomass from rewetted sites to producing fuel-pellets.

Scaling up
This novel cooperation between a peat-briquette factory and nature conservation is very promising. Wetland Energy is now starting to assess the potential for upscaling the paludiculture concept to the national level, encouraging the other 25 peat factories in Belarus to follow the example demonstrated at the Lida Peat Factory. There is huge value in the raw materials produced when managing peatland habitat for biodiversity. Moreover, in some situations, applying paludiculture technologies may be the only option that ensures the financial viability of nature conservation management.

Managing soft wet organic soil by reed beds – challenging but feasible
Just as thatchers have developed new techniques for harvesting reed beds, conservation managers have also developed highly productive processes for harvesting reeds and sedges. These new developments (paludiculture) show that soft, wet soils can be utilised economically, minimising damage to the soil and vegetation.

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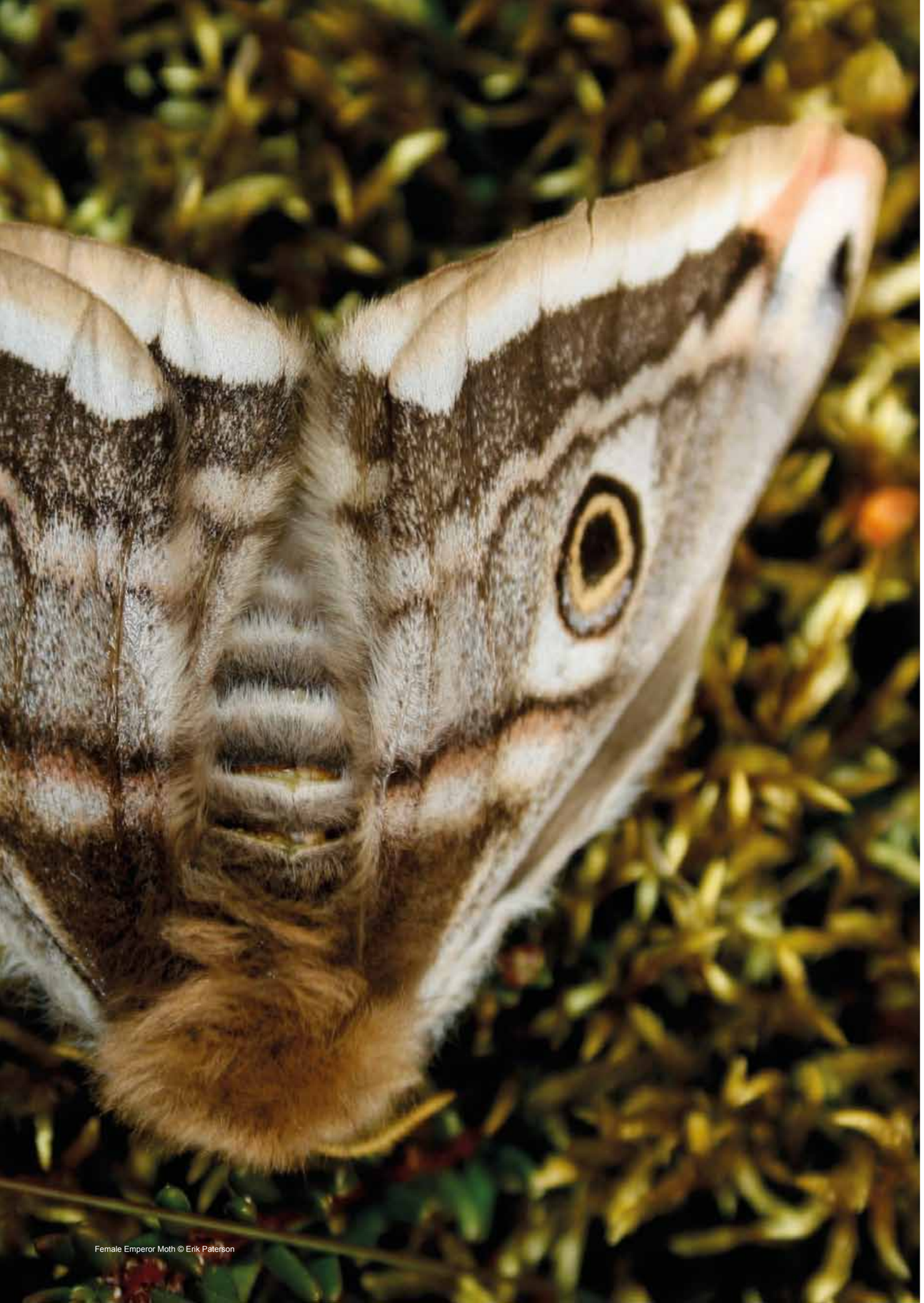
Cut-over peatland in Belarus seen from a helicopter. The abandoned peat mining site lies dry since years and birch and pine are only slowly re-vegetating the bare peat from the margin. Areas like this emit large amounts of greenhouse gases and are prone to peat fires, which also cause severe emissions. They need to be rewetted urgently and are promising for paludiculture, productive use under wet conditions. © Wendelin Wichtmann, 2008

This harvesting device for wet peatlands, based on snowcat technology, can be used on very wet and soft soils with minimum impact on the sensitive vegetation and peat layer. Yaselda lowlands © Wendelin Wichtmann, 2012

‘Fossil resources are finite. Belarus does not have sufficient domestic energy resources and imports about 80% from abroad. All enterprises in our country have the social and economic obligation to explore domestic and renewable energy sources. Utilisation of biomass energy from rewetted peatlands is a promising option for generating local welfare. One reasonable solution for Belarus is to develop technologies to process and combust pellets consisting of 100% biomass from paludiculture.’

Prof. Semjon Kundas, International Sacharow Environmental University Minsk



Female Emperor Moth © Erik Paterson

AFRICA

Peatlands in Africa have not been well mapped and the cover is estimated at a total of 4,856 to 13,210 km^2 or almost 1.3 to 3.4% of the world peatland area (FAO 2013) and 1 to 2% of the continents land surface. Ongoing threats to peatlands include deforestation, agriculture, mineral exploitation, pollution and peat mining (for energy) and have resulted in regional carbon emission hotspots such as in eastern Africa. The continent's peatlands contain 2.4% of global carbon in peat and release about 4% of global peatland emissions .

A variety of peatland types ranging from tropical peat swamp forest to temperate bogs occur predominantly across the lower lying western and central regions (i.e. Gulf of Guinea and the lower Congo basin) and the high altitude regions in Ethiopia southwards across central Africa (e.g. Rwanda and Burundi) into southern Africa (e.g. Lesotho and South Africa). Elsewhere coastal peat deposits are of note such as those on the Indian ocean sea-board (e.g. the Mfabeni mire in South Africa is about 45,000 years old with 12m of peat (Grundling *et al.* 2013)), whilst extensive mires occur associated with inland delta's such as the Okavango Delta and the Sudd in Botswana and South Sudan respectively (McCarthy 1993).

The biodiversity of Africa's peatlands are of global significance to biodiversity. They are locally important as botanical hotspots (e.g. the *Prionium serratum* fens in the Cape Floral Kingdom – the smallest but richest – or the Alpine *Sphagnum* bogs at the equator in central Africa) as well as contribute to migration routes for birds, both inter-continental and intra-continental species (e.g. the White Wing Flufftail – *Sarothrura ayresi* – migrating between Ethiopia and southern Africa (Drummond 2009)). However, more importantly is the fact that Africa's population are still predominately rural in nature. Therefore they heavily depend on peatlands and other wetlands for subsistence on a daily basis. Not only are these systems a source of water, protein and fibre; they are also heavily used for cultivation and grazing. And herein the paradox: in Africa, wetlands are often destroyed by people who need their natural attributes the most.

PEATLAND CONSERVATION AND REWETTING:

Working for Wetlands in South Africa

South Africa, Africa

The environment
South Africa is a semi-arid country with an average annual precipitation of 497mm – significantly lower than the global average of 860mm. This means that peatlands occur mainly in the wetter eastern and southern parts of the country. Evapotranspiration exceeds precipitation in most parts and peatlands are therefore groundwater dependant.

Degradation
Wetlands, including mires and peatlands, have been extensively used as an agricultural resource in South Africa. Practices such as damming, draining, cultivation, pasture and overgrazing have severely degraded about 50% of the country's wetlands. For example:

- The Palmiet (*Prenomium serratum*) fens in the Cape Fold Mountains are eroding due to overgrazing in the catchment area and the drainage of the peatlands for orchids.
- Drained peat swamp forests are used for banana plantations in the rural communities on the eastern subtropical coastal plain.
- In the Highveld plateau, peatlands are burnt and dried out as a result of timber expansion (e.g. Eucalyptus) or irrigation schemes.

Recognition of a problem
The South African government has acknowledged that wetlands provide valuable ecosystem services, and has recognised that a high level of wetland loss and degradation occur in the country. A wetland rehabilitation initiative called *Working for Wetlands* was established within the South African National Biodiversity Institute.

Working for wetlands
It is the vision of *Working for Wetlands* to facilitate the conservation, rehabilitation and sustainable use of wetland ecosystems, in accordance with South Africa's national policy and commitment to international conventions and regional partnerships. Working for Wetlands combines the provision of work, training and opportunities to the poorest of the poor with the rehabilitation of wetlands. During 2004-2013 the programme received a budget of about US$63million and created around 15,000 jobs (resulting in two million actual person days of work and 190,000 days of training) with women comprising approximately 60% of the work force.

Working for Wetlands combines proactive preventative measures (e.g. erosion control) with remedial interventions (e.g. rewetting) and focuses on the conservation of 20 peatlands. Rather than focusing exclusively on engineering solutions, the project aims to raise awareness and influence behaviour and practices that have an impact on wetland habitats. The aim is to maximise opportunities with respect to ecological integrity, water and food security, human well-being and poverty alleviation.

- The programme comprises of five key areas:
- Wetland rehabilitation
- Partnerships
- Communication, education and public awareness
- Capacity building
- Research and planning

The importance of conserving even small areas of peatland
Rehabilitation and good management of wetlands, such as peatlands, can generate multiple benefits, including poverty alleviation, combating of land degradation, maintaining biodiversity and mitigating climate change. Recognising this, and even though peatlands only make up a fraction of South Africa's wetlands, 40% of all rehabilitation projects undertaken by the *Working for Wetlands* Programme have targeted peatlands or their catchments.

A Working for Wetlands team busy constructing a gabion weir (purpose to arrest erosion and lift up the watertable) in the Wakkerstroom mire, South Africa.

PEATLAND CONSERVATION IN CENTRAL AFRICA

Recovery of the Rugezi Mire

Rwanda, Africa

The Rugezi Mire, Rwanda
The Rugezi Marsh is a peatland located in the north of Rwanda, to the east of Lake Bulera on the Uganda border. It is at an altitude of approximately 2050 m and in its natural state, this fen forms a dense floating mat on a 7-12 m peat layer in its deeper parts. The marsh plays a major role in the regulation of water flow to Burera and Ruhondo Lakes, which is the main source of hydropower in Rwanda. However, the increased demand for water and electricity for a growing population has resulted in a decrease in the amount of water in Rugezi Marsh.

Human activity leads to degradation
In the 2000's, the fen was affected by lowering water level and sedimentation. This happened due to degradation over the years caused by a variety of activities, including agricultural practices, draining of the area, fire and over-exploitation of non-timber forest products. Different illegal activities have also been noted, including grass cutting, illegal fishing, and the trade of Grey Crowned Crane chicks. By 2003, almost 56% of the swamp was destroyed by agricultural activities.

The northern sector of the mire was particularly degraded by human activity, including agriculture and livestock grazing. Previously covered by papyrus, the area has changed dramatically over the last 10 years. Formerly a stronghold for papyrus endemic birds, it is now poor in terms of biological diversity with a lower water table level.

The intervention of the Rwanda government
To conserve the habitat, draining and cultivation was prohibited in the most affected areas. A 20-50 m buffer zone was established around the mire consisting of *Alnusa cuminata* trees and agricultural activities were forbidden in all areas. The *Alnus cuminata* is native to the American continent and grows well in moist soil environments, such as the Rugezi mire. As well as acting as a buffer, this tree is valued for its wood, which dries easily and preserves well. It is therefore not only durable but easy to work and can be used for fuel wood, construction purposes and day-to-day items such as posts, poles and broom handles.

Recovery of the mire
The Rugezi mire has recovered well in the past 10 years. The water quality from the recovered area has improved remarkably compared to the northern sector still being cultivated, and the hydropower again has a sustained flow of water. The drained sections of the Rugezi fen (the Kamiranzovu and northern parts of the main trunk) are ideal sites for rewetting and other peatland restoration activities. However, the dependency of local communities on cultivation within the marsh, especially the Kamiranzovu section, will make this a daunting task. Future conservation efforts will have to include a strong socio-economic focus in all stages of planning and implementation.

Local communities are still allowed to harvest fodder by hand cutting
© Anton Linström

Cattle are now prohibited to graze on the Rugezi Mire, thereby preventing trampling. However, local communities are still allowed to harvest fodder by hand cutting © Anton Linström

Oak Eggar Male © Erik Paterson

ASIA

Asia embraces the largest single continental land mass together with a substantial number of island nations. Asian Russia has the world's largest extent of peat, at 1.177 million km^2, representing 8.6% of the country and around 75% of all peat recorded for Asia (Joosten 2010). A further 17.4% is provided by Indonesia, while China, Malaysia and Mongolia make up much of the remainder.

The arctic, sub-arctic and boreal peatland zones are represented exclusively by Russia, with polygon mires in the far north, palsa mires (mounds with ice cores) further south, giving way to patterned string mires then open raised bogs. Further south again are pine bogs and extensive sedge fens which give way to open steppe in which sedge fens and reed beds are the main peat forming systems (Botch and Masing 1983). In the extreme east, the Kamchatka Peninsula supports raised and blanket bogs which are distinct in being enriched with volcanic ash. The same is true for the peatlands of Japan, where the northern island of Hokkaido and the highlands of Honshu support raised bogs and even some small expanses of blanket bog in which frequent layers of volcanic ash provide additional minerals to the living vegetation (Hotes 2004).

The vast deserts of Kazakhstan give rise to only 50 km^2 of reed/sedge fen peatland, whereas the more benign climate of neighbouring Mongolia supports 27,200 km^2 of sedge fen and short-sedge steppe peatland. Given its size, China possesses rather modest amounts of peatland, although in absolute terms the area is still extensive at 34,770 km^2, found mainly in the high altitude on the Ruoergai Plateau of Sichuan and on the Tibetan Plateau. Like Mongolia, the peatlands here are short-sedge steppe communities with up to 5 m of peat. Turkey supports a range of small peatland systems, while in neighbouring Georgia there are *Sphagnum*-rich bogs and percolation fens still largely free from human impact.

The equatorial peat-swamp forests of Indonesia are probably the most well-known of the world's tropical peatlands, the island of Borneo supporting extensive swamp-forest systems formed on a peat which is almost entirely composed of woody remains, and supporting such iconic species as the orang-utan. These peatlands make Indonesia the second most important peatland nation in Asia after Russia, and many have extraordinary depths of peat, with 20 m not unusual. Indonesia holds more tropical peat-forest carbon than any other nation, with 65% (57.4 Gt) of the global total (Page, O'Rieley and Banks 2011).

The peatlands of Indonesia and East Malaysia have faced many pressures including a mega-rice project and latterly palm-oil plantations which have had significant environmental impacts. These include major ground subsidence following drainage, as well as massive peatland fires (Hooijer *et al*. 2006). However, the ASEAN Peatland Forests Project (APFP) is now supporting implementation of a multi-stakeholder Peatland Management Strategy for the peatlands of South East Asia, seeking to restore damaged peatlands and reduce the rate of further degradation.

In China, the Ruoergai Plateau peatlands are currently impacted by excessive grazing, leading to erosion of both vegetation and the underlying peat deposits. The UNEP, ENDO and EU have been promoting change to such management regimes and establishment of restoration programmes for the peatlands of the Ruoergai Plateau.

To some extent, the sheer scale of the Russian peatlands and the harshness of the climate have protected them from substantial human impact. Oil exploration and drilling have, however, created an increasingly large impact footprint. In response to the range of issues facing peatlands in Russia, an ‘Action Plan for Peatland Conservation and Wise Use’ has been established in order to stimulate an integrated approach across a range of sectors with an interest in peatlands.

WETLAND IN A DRY LAND

Harvesting reed for pulp and paper production at Wuliangsuhai Lake, Inner Mongolia

Wuliangsuhai Lake, Inner Mongolia

Common reed (*Phragmites australis*) is an abundant wetland plant in the eutrophic Wuliangsuhai Lake. Commercial harvesting provides a removal of nutrients and reduces the accumulation of Gyttja within the lake. Therefor reed harvesting maintains an important wetland area.

Plant accumulation
Situated north of the Yellow River and south of the Gobi desert, the 300 km^2 Wuliangsuhai Lake serves as a significant water source, providing many important ecosystem services for the arid region. As a terminal lake of the Hetao irrigation area it is mainly fed by drainage water from agriculture fields. This drainage water brings with it high levels of fertilizer, pesticides and organic particles, which result in enhanced growth of emergent and submerged vegetation.

Next to *Typha latifolia*, the lake is dominated by common reed, which covers half of the water. The “open” water area is mostly covered by *Potamogeton pectinatus*. The accumulation of organic sediments on the bottom of the lake causes the water, which is on average only 1 m deep, to rise by 7-13 mm every year and in the last 20 years a gyttja layer of about 12 cm has accumulated.

Use of reed
Harvesting emergent plants can slow down the silting rate and help to prevent the lake changing into a marshland. In addition, with an annual harvest of 100,000 tonnes of reed, reed selling contributes significantly to local livelihoods. The majority of the reed is sold to paper factories to be made into paper pulp, which provides a significant financial benefit to the lake administration. Minor parts of reed are also used in the production of mats for covering greenhouses.

Nutrient removal
At Wuliangsuhai Lake the reed harvesting annual removes 105 tons of phosphate and 417 tons of nitrogen by winter reed cutting (1995- 2010). These correspond to 14% and 13% respectively of the total phosphate and nitrogen influx.

Reed use in China
The utilisation of reed has a long tradition in China. For centuries, it has been used as a fodder plant, for building material and as a source of energy. In 2004, about 1 million hectares of reed beds delivered an annual yield of 2.6 Million tonnes. 95% of this harvested reed was used for pulp and paper production - about 10% of the total non-wood pulp and paper production in China.

Looking forward
China offers an example of how to use wetland resources for multiple purposes and how wetland plants can be used in a sustainable manner. As well as offering alternative ways to meet the growing demand for biomass and substitutes for fossil fuels, these examples of reed utilisation demonstrate the positive impacts of harvesting on eutrophic water bodies.

Baled reed transportation to the paper mills © Jan Köbbing

Reed mat making in a weaving loom © Jan Köbbing

Local farmers harvesting reed for fodder © Jan Köbbing

‘Removing emergent and submerged vegetation is crucial to maintain the lake.’

Professor Shang Shiyou, Department of Mechanical and Electrical Engineering of Inner Mongolia. Agricultural University, Institute of Agricultural and Animal Husbandry, Huhhot 010018, China

NATURE AND PEOPLE:

Peatland restoration for the Yellow River flow

Ruoergai Plateau, China

The importance of the Ruoergai Plateau
The Ruoergai Plateau comprises 4,733 ha of peatlands in the upper catchment of the Yellow River, straddling the border of Sichuan and Gansu provinces. These peatlands are of key importance for the conservation of alpine biodiversity – both in the peatland and adjacent grasslands. They also provide key habitat for endangered wildlife species such as black-necked cranes and a range of rare birds, fish, amphibians and plant species. The area supports two national nature reserves, two designated Ramsar Sites and two provincial nature reserves.

Human impact
The main threat to the Ruoerga peatlands comes from overgrazing, which has caused a lowering of the water table because of the drained canals and gully erosion. However, the increasing temperature in the Tibet Plateau due to climate change has also affected the area. As well as environmental impacts, the degradation of these habitats has a significant impact on local communities as there is a reduction in ranger land, water supply, fodder crops and tourism potential.

Raising awareness
Wetland International China, working with local and international partners, has supported local governmental sectors to recognise just how valuable the Ruoergai peatlands are. The organisation has worked to share knowledge and information about these peatlands both in and outside of China.

With support under the UNEP/Global Environmental Facility and EU-China Biodiversity Conservation, peatland restoration activities have been tested and demonstrated in some drained canals, gully erosion and peat cutover sites.

Conservation of land and culture
Peatlands are very important for water provision, grazing potential and tourism development. This restoration project aims to protect the ecosystem services provided by this habitat, such as water supply, carbon storage and sequestration, whilst conserving traditional Tibetan cultural heritage.

Working to prevent further degradation of the Ruoergai peatlands, several restoration methods have been put in place:

- Canals have been blocked using wooden planks, bags filled with peat, sand and/or boulders.
- Fencing has been used around some of the blocked canals to prevent trampling from yaks.
- Re-vegetation has been initiated to stabilise soil surface.
- Gullies have been blocked by bags filled with peat.
- A concrete dam has been built to hold back the water in the open peat (cut 2m deep).

The results
To date, approximately 1,568 ha of peatland has been restored with evidence of successful re-vegetation; vegetation such as *Halerpestes tricuspis, Equisetum heleocharis* has been identified at restored sites.

Concrete dam in peat extracted area © Zhang Ming

The results show that wood planks work well to increase water table level in the narrow and deep-water canals whilst sand or peat bags work better in the wide and shallow canals. The blocking of the gullies showed positive effects, and the installation of plastic pipes helped guide water flow to the canals when water table was high enough to overflow surface, controlling soil erosion.

From demonstration to local action
Demonstration sites helped persuade individuals and groups that restoration was needed for nature as well as community livelihoods. Local authorities have since recognised the effectiveness of the methods used and have provided funding for large-scale restoration. In addition, local government has prioritised ecological conservation as a long term objective.

However, the main challenge still facing the restoration of peatlands in the Ruoergai Plateau is overgrazing. Grazing is a traditional practice that local communities rely on heavily for their livelihoods. As more peatlands have been restored and/or designated as protected areas, the pressure of grazing on the remaining pastures has increased. To move forward with peatland conservation in this area, it is therefore important to explore and offer alternative livelihood options and reduce the dependency on livestock husbandry on drained or degraded peatlands.

Blocking canals by bag filled with peat, sand bags © Zhang Ming

POVERTY ALLEVIATION AND CLIMATE PROTECTION

Cultivating non-timber forest products Indonesia

Indonesia, Asia

With a population of over 240 million people, poverty is widespread in Indonesia; 2010 saw over 43 million people having to live from less than $1.25 a day.

Peatlands in Indonesia
Indonesia is home to the largest area of tropical peatland in the world. Most of this habitat occurs on the islands of Sumatra, Borneo and New Guinea. While New Guinea still hosts large areas of forested peatland, Sumatra and Indonesian Borneo (Kalimantan) have lost around 70% of their peat swamp forest over the past 30-40 years.

Dangers: deforestation, drainage, peat fires
Deforestation, drainage and peat fires in Indonesia are responsible for a significant proportion of global CO_2 emissions from land-use; drainage alone causes annual emissions of almost half a billion tonnes of CO_2 (Domain *et al.* 2012). With growing global demand for palm oil, the clearance and destruction of valuable peatlands is happening at an ever increasing rate. Oil palm and pulp plantations cover nearly 20% (2.2 million ha) of western Indonesia's peatlands (Miettinen *et al.* 2012a) and the remaining peat swamp forests suffer from illegal logging and fire. If these conditions continue, peat swamp forests are predicted to disappear in western Indonesia by 2030 (Miettinen *et al.* 2012c).

Poverty on peatlands
Many indigenous people suffer from poverty in the absence of sustainable land-use options on drained peatland. Although new plantations can offer employment and income, the loss of traditional livelihoods is an on-going challenge. In addition, the new infrastructure of plantations brings more people, and competition, into remote areas. The loss of soil fertility and rapid peat degradation associated with drained peatland will not only lead to more poverty but also the loss of habitable land.

The paludiculture-perspective
Restoration and paludiculture can be used to overcome peatland degradation and reduce poverty levels. By rewetting the land, the peat can be conserved and CO_2 emissions can be substantially reduced. This action reduces the likelihood of peat fires and associated haze, leading to direct health-benefits for the local people. The cultivation of native swamp forest trees for non-timber forest products (NTFPs) offers an attractive source of income and, in addition, reforestation can help restore peatland hydrology, microclimate and biodiversity.

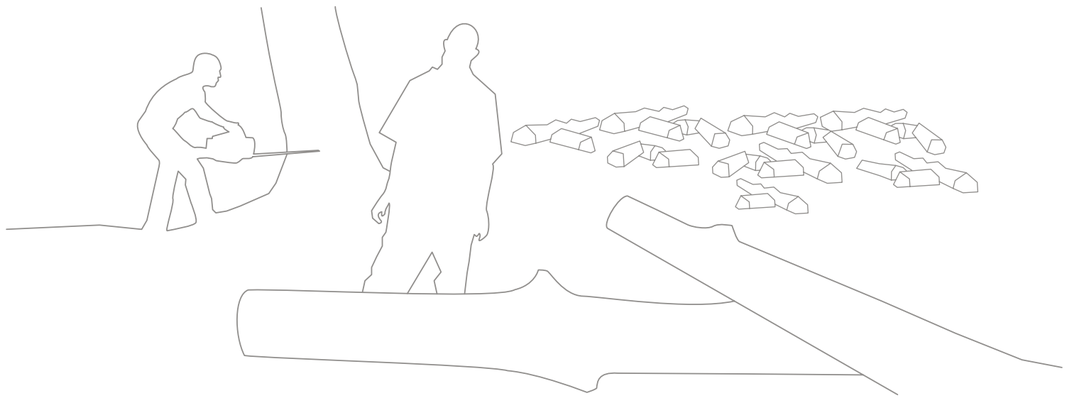
Successful cultivation: oil, latex, mosquito repellent
Examples of successful cultivation of native swamp trees are Jelutung (*Dyera polyphylla*; for latex), Tengkawang (*Shorea* spp.; for butter fat, oil) and rattan palms (Calamus spp.; for furniture, bags, mats). Another interesting tree for cultivation is Gemor (*Alseodaphne coriacea*). The bark of this tree is widely used as a mosquito repellent but, because it has become an important source of income, populations of Gemor are often overexploited. Cultivation would counteract the population decline and secure the supply of its bark.

The next step
The establishment of trial plantations of various peat swamp forest species on rewetted peatland is a critical step to further identify and widen the suite of highly valuable species. This step is also required to engage local people in possible paludiculture businesses that would counteract poverty and thus increase the value of peatlands in general.

Jelutung reforestation in the Central Kalimantan Peatland Project / Indonesia
© René Dommain

‘The current degradation and destruction of tropical peatlands in Southeast Asia is a grim picture. But if global and national leaders finally understand the scale of the on-going environmental disaster and if they decide to consequently promote sustainable land-use options as illustrated here then the peatlands of Indonesia and its people will have a future.’

René Dommain, landscape ecologist/palaeoecologist at the University of Greifswald, Germany



LOCAL AWARENESS FOR ACTION

Reviving the peatland ecosystem of Ganges Tidal Floodplain

Bangladesh, Asia

The situation
Bangladesh has approximately 224,700 ha of peatland habitat, covering around 1.6% of the total area of the country. These peatlands are distributed between the Ganges river floodplain and the Ganges tidal floodplain in Gopalgonj, Bagerhat, as well as in the adjoining parts of Khulna, Barisal, and Jessore districts of Bangladesh. There are also limited peat deposits in the Sylhet basins in the north-east of the country. Despite this coverage, peatland is viewed as marginal land in Bangladesh and has not received much attention over the years. Lack of public awareness and weak environmental regulations are the primary drivers of peatland conversion and depletion in the country.

The degradation of the peatlands
This project focuses on the peatlands of the Ganges tidal floodplain, which are characterised by the organic materials that occupy more than half of the upper 80 cm of the profile and can also be present in different layers within the same soil.

The main threats to this peatland ecosystem include;

- The use of peat soil as fuel for the conventional cooking stove used by local people
- The extraction of snails from the habitat to be used as feed for commercial shrimp farms
- The conversion of peatland to cropland through drainage and embankment
- The pollution from fertilizer and pesticide washout from nearby agricultural fields

Conserving the wetlands
A research team from Bangabandhu Sheik Mujibur Rahman Agricultural University took the initiative in the middle of 2012 to conserve the peatlands of the Ganges tidal floodplain. They carried out a baseline survey to assess the current status of the peatland, identify the major threats to the peatland ecosystem, and finally to design a framework to manage the resource. A GPS data of land use identified 29 different land use types in the area, including dry cropland, wet cropland, fish farm and settlement.

Importance of community
Raising awareness among the local community of how valuable the wetlands are, and increasing their participation in conservation efforts, has been identified as a vital aspect of managing this environment. So far awareness raising activities have been carried out with 120 farming families, as well as two schools.

Looking to the future
Using Geographic Information System (GIS) and remote sensing, a land use map of peatland will be generated to better understand the spatial temporal status of the habitat. It is recognised that increased collaboration between government, NGOs, educational institutions and the local community will play an important role in conserving this important natural resource and protecting the environment. The research team plan to work with the local farming community to identify alternative options for income generation, including multi-storied agroforestry systems and quail farming, so that peatland conversion can be avoided.

GLOBAL PEATLAND RESTORATION — DEMONSTRATING SUCCESS

Shrimp farm in Ganges Tidal Floodplain ecosystem.

Shell of snail harvested from Ganges Tidal Floodplain ecosystem.

Local awareness programme.

Viviparous Lizard © Erik Paterson

OCEANIA

The peatlands of Oceania occur in a wide range of landscapes and exist in many structural vegetation communities from the blanket bogs of the sub-antarctic islands located to the south and southwest of Australia and New Zealand, to the tropical swamp forests of many Pacific Islands; the tropical woodlands swamps of northern Australia and the high mountain peatbogs in New Guinea. Extensive closed valley peatlands occur in New Zealand and New Guinea while the most extensive and widespread peat bogs of Australia occur in Tasmania, as unique buttongrass moorlands (blanket bogs) covering in excess of one million hectares.

These moorlands and the New Zealand restionaceous sedge peatlands which may be up to 10 to 12 metres deep, occur only in the Australasian region. Significantly these and the majority of Australasian peatlands are dominated by species other than *Sphagnum* and generally, are of low species richness. The widely recognised *Sphagnum* bog peatlands of the montane and subalpine regions still only have *Sphagnum* as a component of the vegetation that is dominated by Restionacaeae, Cyperaceae and Epacridaceae species. Unlike the peatlands of the northern hemisphere, *Sphagnum* bogs in Australia and New Zealand occur as small and generally discrete areas where surface and / or subsurface drainage provides for growth of *Sphagnum* and the development and maintenance of the peatbeds. The limiting factor to *Sphagnum* peat accumulation is moisture availability and evapotranspiration, particularly during the summer months. Very low rates of peat development now occur with partly decomposed organic matter being dominant in the upper layers of peat profiles of most montane and temperate coastal peatlands of the Australian mainland. In contrast, New Guinea and tropical islands of Oceania, generally experience very high annual rainfall and peat accumulation is still occurring at a relatively high rate.

The degradation of peatlands is evident in all Oceanic countries as a result of drainage, domestic stock grazing, cultivation, burning and bushfires, peat mining, feral animal activities and other anthropogenic impacts. The impacts are arguably most significant in the Australia mainland peatlands where the individual peatlands are mostly small (<10 ha) and the total area of peatland is estimated to be in the order of only some 25000 ha. The peatlands of the high mountains of south eastern Australia cover only about 10000 ha but are a significant component of the upper catchments of the major rivers of south-eastern Australia. The majority of these peatlands are conserved within major national parks and protected areas but are still under threat from bushfires and feral animal impacts and are very sensitive to weather and climate changes.

As a response to the extensive bushfires that burnt across the Australian mainland Alps in 2003, a major peat bog research and restoration program was commenced in 2004 to ensure the recovery of the most damaged of the peat bogs and their significant hydrological role in the catchments, as well as the eco-services they provide to surrounding native vegetation communities and native animal habitats. This restoration program has expended approximately A$3m and has included basic techniques to provide for rehydration of dry peatbeds, through the blocking of burnt peat tunnels and peat incision, as well as more innovative techniques such as the shading of remnant hummocks of *Sphagnum* and patches of regenerating Empodisma. The shading of remnant areas of bog plants has resulted in regeneration rates and biomass production three to four times that of unshaded vegetation, with subsequent benefits to the protection and rehydration of dry and exposed peatbeds. The program has been recognised widely as a significant success and the techniques used will continue to be applied to existing degraded peatbogs, to provide for adaptation to and ecosystem resilience to predicted climate change impacts.

RESTORATION AFTER FIRE

Restoring the mires of the Australian Alps following the 2003 wildfires

Australia, Oceania

Background
The number and area of mires (fens and bog) of the Australian Alps has declined dramatically over the past 150 years due to grazing by domestic stock, recreation activities, infrastructure development, increasing feral animal damage, and exotic weed invasion. In addition to this degradation, the 2003 wildfires burnt over almost all the alpine, subalpine and montane fens and bog, with a further loss of about 15% of the functional mires existing at the time.

The damage
Following the 2003 wildfires approximately 70 large peat bog areas required restoration works to ensure that they recovered to a fully functional condition. The impacts of the fires varied and damage ranged from minor burning of some *Sphagnum* (moss) hummocks (mainly *Sphagnum cristatum*), to complete destruction of the bog and fen vegetative cover and partial burning of the underlying peat beds. The latter resulted in the loss of the functional hydrological role of the peats and as a consequence, the loss of the ecosystem services the bogs and fens provide to catchment water storage, flow regulation and runoff filtering.

The plan
A program of restoration and revegetation of the mires was started in March 2003 and continues to be implemented by field staff of the individual national parks within the Alps National Parks Co-operative Management Agreement. The aim is restore and enhance the capacity of the damaged areas to recover their functional hydrological role, and regenerate a stable natural mire vegetation complex.

Several mire recovery monitoring and research programs were also initiated immediately post-fire to both guide the restoration work and to quantify the benefits of the various restoration techniques and programs (Hope, *et al.* 2006). Photo monitoring points were established at all bog and fen restoration sites and several demonstration sites were also established to visually monitor the benefits of mire restoration and to act as ecological restoration education and interpretation sites.

Methodology
There are two main tenets for this ecological restoration work: one is that peat bog should recover their capacity to take up surface and subsurface flows so they regain their saturated state, and the other is the need for the recovery and restoration of a natural shade cover to provide for widespread recovery of mire plants particularly that of *Sphagnum* spp. regeneration.

The techniques used for the restoration of bog and fen ecosystems involved shading and protection of the remnant bog and fen plant populations, particularly *Sphagnum* species from high ultra-violet light levels and desiccation by covering the *Sphagnum* hummocks with shade cloth; the construction of straw-bale ‘dams’ in flow-lines to create/restore surface pools; the construction of subsurface organic matter dams to slow the flow of water from the peats; and the placement of coir and straw-filled jute mesh ‘logs’ as surface water-spreaders and sediment traps.

Results
Restoration works were applied to approximately 130 individual bog and fen sites burnt by the fires – about one tenth of the total number of bogs and fens burnt over by the fires. Approximately 300 ha of bog and fen ecosystem has been restored to functional and stable mires, with large areas of adjacent organic soils and associated shrub and grassland ecosystems benefiting from the improved soil moisture regime accruing from the mire restoration works.

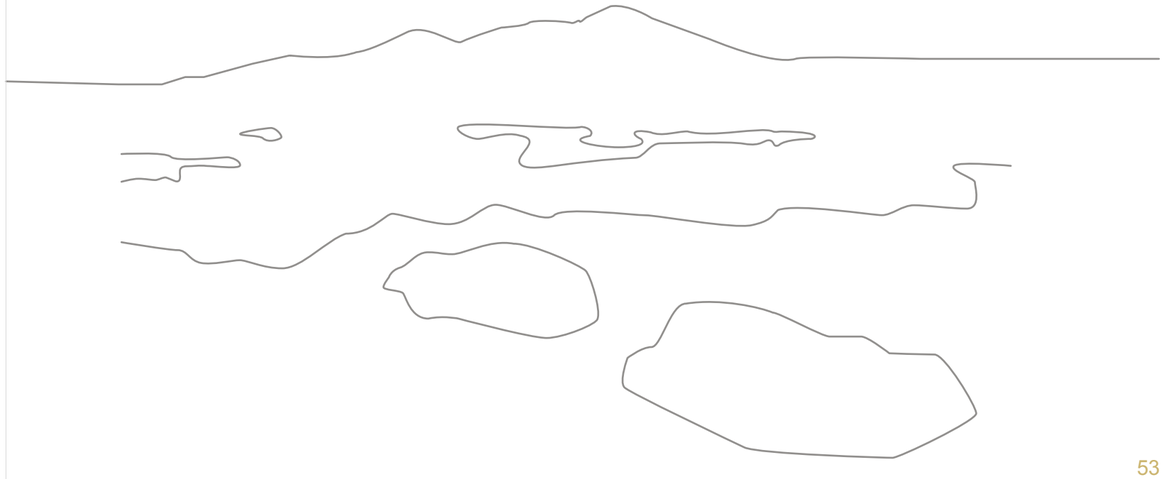
All bogs and fens, to which restoration works have been applied have recovered from a desiccated state to a saturated state, although the full recovery of this condition has taken between 15 months and six years. Based on past experience, full recovery of the functional role of the ecosystem and a complete bog and fen vegetation complex will still take many years to achieve.

A restored peat bog following deep incised and erosion as a result of burning in the 2003 wildfires © Roger Good

Shade cloth covering a core area of a damaged peat bog – providing shade for *Sphagnum* from high levels of UV © Roger Good

Subsurface hay bale dam constructed across a peat bog to retain subsurface flows © Roger Good

A restored bog three years after restoration works © Roger Good



Common Toad © Erik Paterson

AMERICAS

The Americas between them span much of the habitable range of latitudes, from northern hemisphere arctic to southern hemisphere tundra. Peatlands can be found at every point along this range. The estimated extent of peatlands in the Americas by the turn of the present century was a little over 1.54 million km^2, which represents 3.5% of the total land area (Joosten 2010). By far the largest proportion of this peatland resource is provided by Canada, which has 1.136 million km^2 of peatland covering almost 13% of its land area (Tarnocai *et al*. 2011). Indeed the arctic, sub-arctic and boreal regions of the Americas between them hold 82% of all known peatlands in the Americas. Brazil, Peru and the remaining lower 48 states of the US provide a major part of the remaining peatland resource, though every country on the American land-mass possesses some peat, as do many of the outlying islands.

The most extensive peatland systems in the Americas are the treeless polygon mires of the arctic and sub-arctic, together with the mosaic of 'muskeg' and patterned fen which dominates the boreal peatlands of Canada and Alaska (Zoltai and Pollett 1983). Further south, raised bogs and swamp forests become the commoner expression of peat formation, with raised bogs extending as far south as the mountains of North Carolina (Hofstetter 1983). On the oceanic fringes of both east and west coast, blanket mire occurs, often associated with coastal fogs (Price 1992). Further south and west, the Prairie Region is characterised by numerous small 'pothole' peatlands. The central plains of the US are also the drainage basin for the Mississippi, the lower reaches of which form a wide coastal flood-plain formerly dominated by peat swamp habitat, while further to the east are the extensive coastal peat swamps of Georgia and the Florida Everglades (Hofstetter 1983).

The peatlands of Central America occur mainly as coastal swamps or as treeless bogs in the highlands, but the major peatland system of northern and central South America is the Amazon Basin, where the bulk of the peat consists of woody remains from the low-growing forest cover (Junk 1983). Peatlands also occur along the Andes chain. In the far south, the raised bog and blanket mire landscapes of the Magellanic tundra complex reach their greatest expression in the eastern plain of Tierra del Fuego (Pisano 1983).

The northern arctic, sub-arctic and northern boreal peatlands remain largely untouched by human action, apart from the effects of oil drilling and associated road and pipeline construction. Further south, significant losses have occurred due to agriculture, forestry, peat harvesting and large-scale industrial development. Canada has a federal no-net-loss of wetlands policy which is supported by provincial wetland conservation policy. One of the main industry sectors is the horticulture peat harvesting industry which has pursued a major research and peatland restoration programme over the past 20 years.

In the US, at least a century of industrial-scale agricultural drainage has seen the conversion of much flood-plain peatland to agricultural land, most notably along the Mississippi. Recent catastrophic flooding events, however, are bringing about a rethink in policy, with restoration of some peatland areas forming part of an integrated flood-management approach.

The main pressures on the peatlands of Central America come from flood-plain and coastal development for agriculture and, to a lesser extent, tourism and urban development. Logging and agricultural land-claim are key threats to the peatlands of the Amazon Basin. The páramo peatlands of the Andes are under pressure from agricultural land-claim, afforestation and livestock grazing (Cuesta and De Bievre 2012). Grazing also affects a number of the peatlands in Tierra del Fuego.

FROM RESEARCH TO INDUSTRIAL PRACTICES

The Canadian horticultural peat industry

Canada, Americas

Peat for horticultural use
Canada is a major producer and exporter of peat for horticultural uses. The industry produces about 1.3 million metric tons of peat per year. Of the estimated 113,6 Mha of peatlands in Canada, nearly 25,000 ha are, or were at some point in the past, drained for peat harvesting. Some 14,000 ha are currently being actively managed. In the Canadian context, generally only *Sphagnum*-dominated peatlands with a peat thickness of 2 m or greater and an area of 50 ha or greater are of commercial value for the industry. At the end of the production, sites typically still have a relatively deep peat layer (> 0.5 m depth) and ombrotrophic conditions that help the restoration processes.

Starting with research
The horticultural peat industry has funded major restoration research programmes over the past 20 years, along with government agencies (e.g. the Natural Sciences and Engineering Research Council of Canada, Ministry of Environment in Québec and Ministry of Natural Resources in New Brunswick) and academic institutions (e.g. members of the Peatland Ecology Research Group - www.gret-perg.ulaval.ca). In total, more than $5,000,000 CDN has been invested by the industry to investigate ways to accelerate the restoration of bogs and to enhance their environmental functions. The goal is to re-establish self-regulatory mechanisms that will lead back to naturally functioning peat-accumulating ecosystems.

Restoration approach and results
The restoration approach (the 'moss-layer transfer technique') was developed through an extensive research program and is based on two main actions:

- Active reintroduction of peat bog plant species, along with various techniques to improve micro-environmental conditions for plant establishment;
- Rewetting

Machines widely used for agricultural or peat mining purposes can be used to collect and spread plants and mulches, making these techniques compatible with the restoration of large peat surfaces (typically when greater than 1 ha).

Monitoring of restored sites shows that typical bog plant cover establishes within a few years following restoration and is dominated by *Sphagnum* mosses. Restoration also returns the organic matter accumulation to values that are comparable to those of natural systems. The hydrological conditions necessary for moss establishment are improved as the water table rises quickly after ditch blocking, although it still fluctuates more than in natural peatland 10 years after restoration. Research suggests that it will take between 15-20 years to accumulate a thick enough moss layer (acrotelm) to regulate the water. It is also predicted that annual carbon balance can be returned to near natural conditions within 10-15 years following restoration.

Plant re-establishment in a bog restored after 1 years, here some *Sphagnum* mosses with *Polytrichum strictum* and *Drosera rotundifolia* © APTHQ

Applying the research to business processes
The research outcomes have been incorporated into the policies and practices of the Canadian industry. They have helped to inform new legislation, regulations and policies regarding responsible peatland and wetland management within national and provincial governments. In the province of Quebec, the industry benefits from a partnership with the Ministry of Finance and Economy that has resulted in large restoration projects, along with the training of peat companies' employees and the development of different tools for the industry (operation guide, LCA calculator, etc.).

The industry took a step further in engaging with the *Veriflora® Certification Standards* and the *Sector Specific Annex for Responsible Horticultural Peat Moss Production and Handling*. The Certification is intended to identify and encourage responsible production practices and to stimulate continuing improvement in the industry. One requirement of this certification engages the producer to restore all "new" post-harvested areas. After conducting a Social and Environmental Life Cycle Assessment, the industry is now working on its first Social Responsibility Report that will highlight the actions taken by the sector toward responsible management and will set the stepping stones for the future.

Visit of a restored sites with various stakeholders © APTHQ

The peat producers learn how to recognised that target species for restoration project during a Technology transfer workshop © APTHQ

'Responsible management of peatlands must include consideration of proper restoration practices as part of post-harvest use. The Canadian peat industry is committed to sustainable management of peatland ecosystems and has adopted the science based outcomes into its industry leading best practices for restoration.'

Paul Short, president Canadian *Sphagnum* Peat Moss Association

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Glossary

Blanket bog
Peat bog that forms in areas with a cool, wet oceanic climate, which means soils are continually wet across the landscape, allowing peat to form a “blanket”, even on slopes of up to 30 degrees.

Dwarf shrubs
Moorland plants such as common or ling heather (*Calluna vulgaris*); Bell heather (*Erica cinerea*); Cross-leaved heath (*Erica tetralix*); Bilberry or Blaeberry (*Vaccinium myrtillus*); Cowberry (*Vaccinium vitis-idaea*); Bearberry (*Arctostapylos uva-ursi*); Crowberry (*Empetrum nigrum*)

Geojute
Netting made from unbleached jute fibres. It is used to provide short-term stabilisation of soils and prevent erosion in revegetation projects

Geotextiles
A generic name used for natural netting materials used in revegetation such as Geojute.

Gyttja
A mud rich in organic matter, found at the bottom or near the shore of certain lakes.

Grip
Another name for a drain.

Heather bales
Bales of heather used to slow down drainage to raise the water table and encourage the formation of bog pools

Heather brash
Heather cuttings that spread on bare peat which reduce weathering from wind and rain, contain heather seed, and provide a medium for other plants to root into.

Lagg fen
An area encircling a raised bog where water draining from the bog meets surrounding mineral soils.

Paludiculture
A form of agriculture that allows farmers to manage wetlands (including many peatlands) for biomass production (e.g. reeds for insulation or biofuels) without draining or in other ways damaging peatland habitats.

Peatland Restoration
Intentional activity that initiates or accelerates the recovery of ecological conditions necessary to allow peatland vegetation and associated fauna to thrive and for peat accumulation to take place.

Peatland Rewetting
A form of restoration involving the raising and maintenance of water levels necessary to support peatland function.

Raised bog
Develops primarily, but not exclusively, in lowland areas where impeded drainage and resultant water logging provides anaerobic conditions, which slow down the decomposition of plant material, which in turn leads to an accumulation of peat. Continued accrual of peat elevates the bog surface above regional groundwater levels to form a gently-curving dome from which the term 'raised' bog is derived. The thickness of the peat mantle varies considerably but can exceed 12 m.


Sphagnum capillifolium © Erik Paterson

Sphagnum
A genus of mosses that includes a number of species which grow in peat bogs, and form peat when they decompose in anaerobic, waterlogged conditions. There are 34 species that occur in the UK, grouped into six “sections”. Of these Section *Sphagnum* with five species contains the real peat bog specialists, which are the main peat formers. These are *Sphagnum affine*; *S. austinii; S. magellanicum; S. palustre; and S. papillosum*. *Sphagnum* mosses are very sensitive to atmospheric pollution.

Acronyms & Abbreviations

The following in a list of the acronyms and abbreviations frequently used in this report.

AES
Agro-Environmental Schemes

GHG
Greenhouse Gas (emissions)

Gwh
Gigawatt Hour

Ha
Hectares

LNR
Local Nature Reserve

Mton
Metric ton or megatons

MRV
Measuring, Reporting and Verifying

NNR
National Nature Reserve, a national conservation designation, NNRs comprise the ‘jewels in the crown’ of protected areas in Great Britain

NPA
National Park Authority

RSPB
Royal Society for the Protection of Birds

SAC
Special Area of Conservation designated under the EU Habitats Directive

SPA
Special Protection Area designated under the EU Birds Directive

SSSI
Site of Special Scientific Interest. SSSIs are a national designation which protect a representative series of the best sites for species and habitats in Great Britain. In Northern Ireland they are called ASSI – Areas of Special Scientific Interest.


Sphagnum © Erik Paterson

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Bog Asphodel © Erik Paterson

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www.Sphagnumfarming.com

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http://www.paludikultur.de/
http://www.paludikultur.de/indexphp?id=vip
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Bringing back the water – Germany, Western Europe
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http://www.bordnamona.ie/our-company/biodiversity/

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Rene Dommain

Local awareness for action-Bangladesh, Asia
Hasan M Abdullah

OCEANIA

Restoration after fire – Australia, Oceania

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AMERICAS

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From research to industrial practices – Canada, Americas
Stephanie Boudreau
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GLOBAL PEATLAND RESTORATION — DEMONSTRATING SUCCESS

Flow Country © Norrie Russel

This booklet and associated material can be downloaded from

http://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 National Committee 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.

IUCN National Committee United Kingdom

Peatland Programme