IUCN UK Committee Peatland Programme
*Briefing Note Nº* ***11***

# Peatland restoration

IUCN National Committee United Kingdom
Peatland Programme

## Introduction

Peatland restoration involves giving aid to a complex ecosystem which has been damaged in some way. A reasonable analogy is a patient brought to a hospital for urgent treatment. When arriving at Accident & Emergency, the first priority of the medical team is to stabilise the patient's condition. Only after the patient's condition has been assessed and then stabilised can the team begin to think about the longer-term process of healing and recovery. A similar logic is applied to peatlands. First, stabilisation is required to prevent further degradation, following which restoration can focus on the recovery of the ecosystem.

## Stabilisation of condition: The immediate priority

Stabilisation is the over-riding priority to prevent further erosion of peat and greenhouse gas emissions. Even where damage is not extensive, the situation can worsen over time and so early intervention is necessary to ensure recovery and avoid the need for greater degrees of intervention at a later stage.

Returning to the analogy of a patient requiring care, while a rapidly deteriorating patient may require immediate attention, it is also true that 'a sticking-plaster now' can forestall far graver problems later, particularly where resources are limited.


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***Raise water table***

***Exclude oxygen and prevent decomposition***

Stabilisation of a peatland may involve procedures which under normal circumstances would be considered damaging in their own right. These techniques are, however, sometimes necessary to prevent oxidisation of peat and water loss. Essentially, **peat only accumulates in the absence of air**, so air must be blocked and **oxygen-fuelled micro-organisms prevented from decomposing the accumulated peat**. This can be achieved by **stopping the bog system from losing water and by re-establishing a waterlogged state**.

***Repair vegetation layer***

Part of the solution to prevent further loss from a damaged peatland as quickly as possible can include blocking drains or sealing off internal peat-pipes caused by shrinkage and subsidence. In the case of a human patient who has lost skin it is important to seal the wound to prevent dehydration and infection. Similarly, for a peat bog, if the skin (peat-forming vegetation) has been lost, the bog will dehydrate and the peat become 'infected' with aerobic micro-organisms which will begin to break down the accumulated peat store.

As long as there is water loss and the system lacks a peat-forming vegetation, the peat bog has not been stabilised and its condition will continue to deteriorate, even if only relatively small parts of the bog have apparently been damaged. It is self-evident that a human patient with a wound, even a small wound, from which there is continued blood loss is in a deteriorating condition, and the same is true for a peat bog and loss of water. What is not so evident is that even when a peat bog has responded positively to restoration management, whole-site responses to former damage may still be operating. For example historic damage, even post-restoration, can lead to changes in the whole morphology of a bog unit through shrinkage and subsidence.

**Healing and the sometimes long road to recovery**

It is as well to remember that medical treatment rarely heals, as such; the purpose of medical intervention is generally to stabilise the condition of the patient sufficiently to enable the body to begin healing itself and to do so as speedily and effectively as possible. Peatland restoration management is no different. The fundamental process of recovery is performed by the peatland system itself. The role of restoration management should therefore be focused on enabling the recovery process to occur as speedily and hopefully as (cost-) effectively as possible. It is worth noting that cost-effectiveness is not the same as 'cheap': investment of time, effort and finance must be sufficient to produce an effective result.


***Restoration can take decades, or longer…***

Like the human body, peatland systems have innate recovery mechanisms. Many, even most, peatland systems exist because the particular conditions which give rise to peat formation predominate in that particular locality through a combination of factors such as climate and topography. Consequently peat-formation will tend to occur at this locality simply because natural systems, having evolved over millions of years, tend to adopt a form best suited to the prevailing conditions in any given locality. Diverting the system from such a path will generally require active inputs such as drainage, tree planting, frequent burning, intensification of natural grazing, chemical processes which release atmospheric pollution, or various forms of animal husbandry. If these inputs of effort cease, in time the peatland system will revert naturally to the lowest energy condition – namely active peat accumulation given the prevailing conditions – but it may take 50 years, or 500 years, depending on the severity of the impact. Indeed it is fair to say that, given time, there are few, if any, states of peatland degradation which are wholly irreversible, but in some cases the timescales may be far beyond what society can reasonably contemplate.

***…but bear in mind peatlands can take thousands of years to form***

Time is thus an important and effective part of the healing and recovery process and one which is often omitted from the restoration manager's tool-box. Sometimes time is not merely the most cost-effective means of achieving a desired recovery outcome, it may be the *only* feasible tool to employ. Time is, however, relative. For many peatland systems that have been accumulating peat at various rates for 7,000 years or more, a period of even 300 years can represent little more than a minor blip in the life of the system. In peatland restoration management, however, time is often seen as a luxury because funding bodies demand evidence of value for money and proof of success within relatively short funding cycles. A funding organisation may, for example, be keen to see the fruits of its expenditure at the end of a project funding-cycle of only three years.

***Some peatland features restore quickly but others are slower to recover***

This attitude to funding and reporting highlights a marked imbalance betweenforest management and peatland management: if a forest is being established, funding bodies tend to recognise that trees require decades to become established.  Curiously, the same recognition is not afforded to peatland restoration although peatlands typically have lifespans as old as, or even significantly longer than, forests. Concerns about responses within the first five years, or even after the first year of restoration management, occasionally threaten to influence policy and funding streams, yet the same approach would not be applied to a woodland scheme. Some peatland responses can be extraordinarily and surprisingly rapid and therefore fit within such short timescales, but the majority are not and must be given time to stabilise and establish. This is a fundamental rule of peatland restoration management – a rule that should be recognised by policy makers, academic researchers and practitioners alike.

***Current pressures and historic impacts determine restoration***

***Once lost, the historic peat archive can never be restored***

There is one important caveat to the principle that most peatland systems stabilised by prompt action can recover if given sufficient time; the lost peat archive. This historical record, one of the most distinctive features of peatland ecosystems, cannot be recovered yet it is often overlooked or dismissed as being of largely ‘academic’ interest. In contrast, a huge level of public interest, which continues to this day, surrounded the discovery of half an Iron Age bog body in a bog in Cheshire. ‘Peat Marsh’ or ‘Lindow Man’ as he is more formally known, continues to be one of the most popular exhibits in the British Museum. Furthermore the record of plant, insect and microbial materials found preserved in the peat have given us an extraordinarily detailed picture of how our landscape has changed since the end of the last Ice Age and gives us clear indications of how natural systems have responded to climate-change events in the past. No matter how sophisticated peatland restoration techniques become, however, once lost, the peat archive can never be restored.


The other caveat to apply to the recovery phase is that there is an element of unpredictability about it. Although a number of management interventions are now well established and can offer predictable outcomes in terms of achieving stabilisation and setting the system on the road to recovery, there are always site-specific factors which influence the restoration trajectory. Current pressures and historic damage combine to determine the response to a restoration activity. Understanding the site characteristics such as peat structure, supporting hydrology and remaining vegetation structure can therefore help to maximise restoration efficiency and manage the expectations of that restoration.

**What does the stabilisation/recovery**

As well as the more obvious forms of treatment for damaged peat bog systems (sealing of drains and other evident forms of water loss, re-establishment of a healing ‘skin’ of peat-forming vegetation), in many cases there are more serious physical changes to the

**sequence mean for peat bogs in practice?**

system that have occurred as a result of human action. Drainage results in shrinkage and subsidence of the peat, re-shaping its morphology; peat extraction (domestic or commercial) radically re-shapes the bog surface; forestry results in drainage of the peat but the weight of the trees also compresses the peat surface; erosion removes peat and creates complex drainage networks that destroy any natural surface pattern. Each of these can result in significant ongoing hydrological, morphological and carbon-storage changes to the bog system, meaning that its condition has not yet stabilised.

***Drainage initiates a cycle of slumping, compression and further subsidence***


In such circumstances, however, peat bogs show remarkable powers of regeneration, provided that damaging activities have halted and that the system is given time. For example, when the naturally-formed shape of a peat bog is altered by peat cutting, the cut face becomes a steep zone of water-table draw-down which cannot be sustained under prevailing conditions. Consequently the peat associated with the cut face will undergo a triple response (see Drainage Briefing Note 3). Firstly there will be an initial period of slumping as ‘free’ water is lost from the face. Next the weight of drained material will press on the peat beneath to force more water from the peat, resulting in further steady subsidence. Thirdly, wherever the peat is no longer waterlogged it will begin to oxidise and be lost to the atmosphere as $CO_2$, causing yet further subsidence. This re-shaping of the bog surface will continue until a water-table shape is achieved that can be sustained by the prevailing conditions. This may mean that the *entire* shape of a raised bog is altered over a period of decades or even centuries as a result of what appears to be relatively minor damage to one small part of the margin. During all this time, the condition of the bog cannot be considered stable. In lowland raised bogs it is not even necessary for the bog to be cut; merely lowering water levels in the ‘lagg fen’ which surrounds a raised bog will cause a similar process of progressive subsidence and carbon loss.

***Oxidation of the peat and release of $CO_2$***

***Peatland system moves towards equilibrium state with prevailing environmental conditions***

Ultimately, however, this progressive pattern of subsidence is not irrevocable. Through the process of subsidence, the bog approaches a new morphology which is better able to sustain the modifications to the bog system. As subsidence progresses the hydrological stresses are steadily reduced until, eventually, the new stable shape – generally involving a smaller, lower bog – is attained. At this point, depending on prevailing conditions, the bog may be in a position to begin growing and expanding again. This process will happen faster if the bog is allowed, or encouraged, to re-wet and re-vegetate with peat-forming vegetation. The floor of previous peat cuttings, for example, thus rises as fresh peat accumulates, to meet the descending surface of the bog. The two will eventually knit together to form a system that is once again stable.  Examples of this can be found in both raised bog and blanket bog.

***Altered conditions can lead to loss of specialist species***


The re-shaping process may take many centuries to complete, raising concerns about loss of peatland-ecosystem richness during the period of stabilisation. The bog becomes drier during this period, often with loss of bog pools or *Sphagnum* hollows and all the biodiversity associated with these (see Biodiversity Briefing Note 2). Typical bog vegetation, albeit a somewhat drier bog vegetation, nevertheless tends to persist on all but the smallest examples of raised bog, and even here, where birch and oak trees may become the dominant vegetation on tiny remnant upstanding blocks of peat, it is common to find hummocks of *Sphagnum* round the bases of these trees, in effect just waiting to expand once the block has subsided to a new stable shape.

***Physical restructuring of the peatland may be required***

There may be a requirement to intervene and short-circuit the subsidence process either by re-shaping the cut peat face, or by placing peat material from elsewhere against the cut face. There are two issues worth considering and weighing up if such actions are contemplated. Firstly, re-shaping the cut peat face will rarely compensate completely for the original effect of peat removal. Consequently subsidence can be expected to continue, albeit perhaps at a slower rate but at the cost of losing part of the irreplaceable peat archive and carbon store which formed the original bog structure. Most of this archive can survive in some form during drying and subsidence, but once it is dug away it can never be re-captured. Secondly, peat material moved from elsewhere to shore-up a cut peat face is technically no longer 'peat' because 'peat' is a material formed *in-situ* – a *sedentate*. Once moved, it becomes a *sediment* – an organic material which has lost its chronological cohesion both within itself and with its surroundings.

***Reverse historic damage***

***Address present-day land management issues***

Usually, by far the most effective approach to subsiding raised bogs in the lowlands is to raise the water table in the surrounding lagg fen to something approaching its original level (see natural lagg fen around Teiči Nature Reserve, Latvia – right). This will generally have significant implications for adjacent land, but where such re-establishment of the lagg fen has been achieved, the effect on the bog has been dramatic and wholly positive. In the case of blanket bog, the most effective first step is usually to block any drains present on the site, although many sites also have recurring or ongoing land management pressures which need to be addressed in tandem, such as burning or afforestation. Where the bog has additionally been re-shaped by, for example, forestry plantations or domestic peat cutting, the most effective strategy is to re-establish a peat-forming vegetation which can then re-shape the bog system through the accumulation of fresh peat.

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| ***Intervene to halt large scale erosion processes*** | In contrast, where the peat is being actively eaten away by weathering and (see Weathering and Erosion Briefing Note 9), stabilisation of the system may justify rather more radical forms of intervention. Unlikely though it may seem, even the worst examples of such erosion have at least some prospect of recovery if *Sphagnum* and other peat-forming species are able to re-establish. Such re-establishment is increasingly possible now that heavy atmospheric pollution is substantially diminished across most of the UK. Erosion gullies choke up naturally with peat-forming vegetation to form pools. These in turn re-wet the surrounding bog system by helping to maintain high, stable water tables in the surrounding erosion haggs, while the gullies no longer act as drainage sinks on the system. There are areas of the UK blanket bog landscape where the rate of peat loss is so great, however, that unless radical and immediate action is taken there will be little peat left. Indeed in parts of the Peak District, Shetland and NW Scotland this has already occurred. While there is evidence of re-colonisation even in these areas, it is clear that it will be a very long time before any significant peat depth can develop. Action now to reverse or prevent this scale of loss therefore involves reducing the weathering process by placing at least an 'artificial skin' over the bare peat surface in the form of a temporary vegetation sward. This reduces weathering and erosion but does not significantly decrease water loss and 'infection' by aerobic micro-organisms deep into the peat. At the same time, blocking some of the major gully systems to trap mobilised peat, while also holding back water just as naturally-choked gullies do, aids in raising and stabilising water tables in the surrounding erosion haggs.   |
| **Trajectories and targets for restoration** | The peat bogs of the UK have been so substantially altered by human action that it is now difficult to say with any certainty what the 'natural' condition of any given bog might be, although the peat archive may give a broad indication of what could be possible. In some ways, however, trajectories and targets for peat bogs are relatively straightforward because, as indicated above, the recovery process is actually in the hands of the bog itself. Whatever state is supported by prevailing natural environmental conditions will be the state towards which the bog will develop (see Biodiversity Briefing Note 2). In practice, targets for restoration are focused on achieving a state that enables natural processes to bring about recovery of the bog.<br><br>**Targets for restoration should, therefore, be based on the stabilisation of the bog. This means preventing water loss, preventing penetration of air into the peat and re-establishment of peat-forming vegetation. If all three are adequately addressed, the natural resilience of peat bog systems should then begin to take over and begin the process of re-establishing the peatland state that is best supported by the prevailing conditions.** |

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| **Gaps in knowledge** | Identified gaps are:<br>• The extent to which ongoing or recurring impacts such as burning, grazing, atmospheric nitrogen deposition and drainage (particularly of lagg fens around raised bogs) continue to constrain restoration trajectories;<br>• The timescales necessary for restoration from particular starting-points;<br>• The relationship between restoration state and carbon balance;<br>• Adequate monitoring of restoration starting-point and trajectory to accumulate and expand restoration knowledge-base;<br>• Documented evidence of ecosystem services arising from peat bog restoration;<br>• Appropriate indicators for restoration state in differing parts of the UK;<br>• Extent of 'climatic envelope' for raised bogs and blanket bogs in the UK which may thus constrain restoration actions (given that relict raised bogs are found as far as the south coast of England).<br><br>To assess the future impact of restoration and management of peatlands and allow for learning and adaptive management, a cohesive network of intensively monitored demonstration sites is needed. The existing demonstration sites across the UK require coordination to synthesise information and facilitate learning. |
| **Practical Actions** | Seek policy protection and commitment to long-term monitoring for high-quality 'reference' sites (e.g. Nature Conservation Review sites), which act as best-available regional examples of peat bog systems for use as reference points against which restoration trajectories can be measured.<br>Map present restoration activities across the UK and the opportunities available for peatland restoration.<br>Use initiatives such as the Peatland Code to change perception of peat bogs and their associated ecosystem services, and highlight the fact that peatland areas can be restored to healthy, carbon storing systems without excluding other land uses.<br>Establish protocols for monitoring of restoration start-points and trajectories.<br>Maintain and update the Peatland Compendium. |
| **More Information** | IUCN UK Peatland Programme: www.iucn-uk-peatlandprogramme.org<br><br>SNH Peatland Action restoration guidance notes and videos: www.snh.gov.uk/climate-change/taking-action/carbon-management/peatland-action/peatland-action-videos<br><br>Moors for the Future Partnership: www.moorsforthefuture.org.uk/science<br><br>Yorkshire Peat Partnership: www.yppartnership.org.uk/restoration<br><br>Conserving bogs: the management handbook: http://issuu.com/peat123/docs/conserving_bogs<br><br>*This briefing note is part of a series aimed at policy makers, practitioners and academics to help explain the ecological processes that underpin peatland function. Understanding the ecology of peatlands is essential when investigating the impacts of human activity on peatlands, interpreting research findings and planning the recovery of damaged peatlands.*<br><br>*These briefs have been produced following a major process of review and comment building on an original document: Lindsay, R. 2010 'Peatbogs and Carbon: a Critical Synthesis' University of East London. published by RSPB, Sandy. http://www.rspb.org.uk/Images/Peatbogs_and_carbon_tcm9-* |

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| | *255200.pdf, this report also being available at high resolution and in sections from: http://www.uel.ac.uk/erg/PeatandCarbonReport.htm*<br><br>*The full set of briefs can be downloaded from:www.iucn-uk-peatlandprogramme.org.uk*<br><br>*The International Union for the Conservation of Nature (IUCN) is a global organisation, providing an influential and authoritative voice for nature conservation. The IUCN UK Peatland Programme promotes peatland restoration in the UK and advocates the multiple benefits of peatlands through partnerships, strong science, sound policy and effective practice.*<br><br>*We are grateful to Scottish Natural Heritage, Natural England, Natural Resources Wales, the Forestry Commission RSPB Scotland and the Peter de Haan Charitable Trust for funding support.* |
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