IUCN UK Committee Peatland Programme
Briefing Note N°1

Peat Bog Ecosystems: Key Definitions

IUCN National Committee United Kingdom
Peatland Programme

What are bogs?

Bogs are particular types of **wetlands** which are **waterlogged only by direct rainfall**. This contrasts with ***fens*** where groundwater, enriched by the chemistry of mineral soils, causes waterlogging. Fens are more widespread in the UK lowlands and are thus more familiar to many people, but are often mistakenly referred to as 'bogs', despite being fed by groundwater. The water entering a bog contains only those nutrients found in rainfall, which is slightly acidic and almost devoid of nutrients.

Rainfall-fed wetland systems

Water-logging prevents decomposition

Water-logging in both bogs and fens **prevents the complete decomposition of dead plant material.** This un-decomposed plant material **steadily accumulates as a thickness of *peat*, the presence of which is the defining feature of a peatland**.

Peat formation

Peat is thus a relatively amorphous organic deposit which consists of semi-decomposed plant material mixed with varying amounts of mineral, or inorganic, matter. In the case of UK peat bogs the content of mineral matter may be as low as 2% by weight, whereas fen peat generally has higher mineral-matter contents because such peat is waterlogged by mineral-enriched groundwater.

Mire

The internationally-recognised term for a **peat-forming system is a *mire***. It is not generally possible, however, to determine whether or not a peatland is *actually* forming peat at the present time. Consequently the EU Habitats Directive defines ***'active'*** bog as a system which supports a significant area of vegetation which is normally peat forming because the presence of such vegetation is readily determined. The term 'active' bog also incorporates bogs which have suffered a temporary setback such as fire damage or drought, and also includes areas which have been damaged but which are now showing significant signs of active recovery, such as eroded bog in which the gullies are re-vegetating.

Peat soils may be intensively farmed with no mire vege-tation, but still remain peatlands

It is nevertheless possible to have a peat soil from which the peat-forming vegetation has been completely removed or replaced, most commonly by human action. In such cases the system is no longer an actively peat-forming ***mire***, but it remains a ***peatland*** because it still possesses a peat soil even though the present vegetation is not capable of forming peat. This is the most widespread condition for peat soils in the UK **lowlands** because many such peatlands are now intensively farmed as arable cropland or grass pasture. Other lowland peat sites have had their surface vegetation removed to facilitate the extraction of peat for horticultural use. In the **uplands**, extensive parts of the landscape are similarly peatlands which are no longer peat-forming, in this case because past atmospheric pollution, drainage, afforestation, burning and overgrazing have removed the key peat-forming species from the vegetation.

Primary bog

Secondary bog

In the case of a peatland, the surface vegetation is just one part of the whole ecosystem. The body of peat beneath the vegetation provides the other key component. An important distinction therefore also exists between a **primary bog surface**, where the surface and peat beneath have been created by natural peat accumulation, and a **secondary bog surface**, where peat had been removed by human action to create an artificial

morphology. A key distinction between primary and secondary surfaces is that, where a primary surface is retained, the overall shape of the bog together with its entire peat archive remains largely intact, whereas in creating a secondary surface the shape of the bog becomes markedly artificial and part of the archive is removed. Such secondary surfaces are generally created by agricultural land-claim, peat cutting or open-cast mining. Perhaps surprisingly, drainage and even forestry may still retain a primary surface even though subsidence may result in significant changes to the morphology of the bog (see ***Drainage Briefing Note 3***). Consequently restoration of a stable bog hydrology after drainage or forestry *may* be somewhat easier and (ultimately) more complete than is the case for the complex morphologies and truncated peat archives of secondary surfaces.

History of peatland development

The accumulated peat laid down in a peatland is a particularly unusual and important feature. It provides an opportunity to examine the entire history of the ecosystem's development in the form of the plant remains laid down at each stage. The peat archive also stores a record of the surrounding landscape in the form of pollen grains blown onto the peatland surface and subsequently preserved in the peat. Using a combination of plant remains (***macrofossils***) and pollen (***microfossils***) it is possible to reconstruct pictures of past landscapes and climatic periods, in the case of UK peatlands as far back as 10,000 years. Finally, and possibly of most significance, the peat archive holds enormous quantities of carbon gathered from the atmosphere by living plants in the surface layer, or **acrotelm** (***see Biodiversity Briefing Note 2***), as they photosynthesise and grow. When these plants die their semi-decayed remains are locked away in the peat under anaerobic waterlogged conditions, limiting further decay and loss of carbon. Once stored in the waterlogged zone as peat, the carbon is locked up for millennial timescales.

Macrofossils

Microfossils

What is peat?

No single definition!

Varying depth criteria

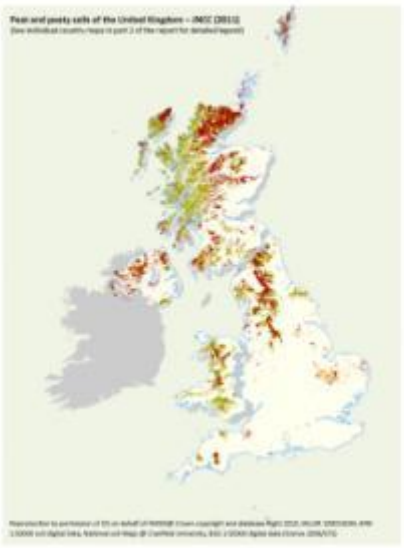
Estimates depend on definitions

Impact on peat-area estimates in the UK

There is **no single formal definition of 'peat'** and **'peatland'**, differing interest groups having differing definitions. Thus **ecologists use a minimum peat depth of 30 cm** while **geological surveys may use 1 m** as the threshold. The Soil Survey of Scotland uses a minimum depth of 40 cm for pure-peat soils, whereas the limit for the Soil Survey for England and Wales ranges from 30 cm to 50 cm. The proportion of mineral content also varies between definitions, with some allowing as much as 70% mineral matter (even 30% organic matter generally being higher than is found in most other soils). Some peatland surveys refer to areas of all peat soils whereas others consider only peat-forming mire habitat. Consequently **estimated values for the extent of peatland in the UK are entirely dependent upon the definition used**. Using the ecologists' definition, therefore, peatland is very much more extensive in the UK than if, for example, the geological definition were to be used.

Following an analysis by JNCC, the current best estimates of peatland distribution can be seen in the Table below. The soils data provide evidence for the present and former extent of peat-forming habitat – *i.e.* total extent of ***peatland*** – while the Biodiversity Action Plan data provide an estimate of the existing ***mire*** area together with the area currently undergoing, or proposed for, restoration. It should be noted that the soils category '***Shallow peaty or organo-mineral soils***' incorporates many pockets of deeper peat and should not thus be taken to represent only thin peat.

	Soils data		UK Biodiversity Action Plan ***mire*** areas*	
	Shallow peaty or organo mineral soils (km^2)	Deep peaty or organic soils (km2)	Peat-forming bogs (km^2)	Peat-forming fens (km^2)
England	7,386	6,799	2,727	80
Wales	3,592	706	718	62
Northern Ireland	1,417	2,064	1,069	30
Scotland	34,612	17,269	17,720	86
Total area	47,007	26,838	22,775	258
UK area cover	19.3%	11%	9.35%	0.11%



* Either existing or planned for restoration

Bog vegetation

Few groups of plants

Sphagnum species as habitat architects

Hummocks, lawns and hollows

Undulating bog surface

Resistance to decay

Being so nutrient poor, undisturbed ***peat bog*** **vegetation is generally dominated by a few groups of plants** – especially *Sphagnum* bog mosses and cotton grasses (the latter are in fact sedges, not grasses, though the main *Carex* sedge group is characteristic of fens rather than bogs). ***Sphagnum*** **mosses play a particularly important role** because, packed together to form a continuous carpet, they often create the ground surface in which all other plants grow, and because some *Sphagnum* species grow as densely-packed **hummocks** while others grow as **low-growing lawns** and yet others grow as **hollows**, together they create a **characteristically undulating bog surface.**

Sphagnum is also important because it is itself **highly resistant to decay**, and in addition contains a chemical called **sphagnan** which inhibits almost all microbial activity making it effectively sterile. Packs of *Sphagnum* were consequently used in World War 1 as a wound dressing. Within a bog the presence of sphagnan means that decomposition in the waterlogged peat virtually ceases.

Bog growth
0.5 to 1mm per year

The nutrient poverty of bog waters means that peat bogs grow rather slowly, **accumulating around 0.5 - 1 mm of peat each year**, but, having created this peat, the combination of nutrient poverty, the anaerobic conditions, the resistant nature of *Sphagnum* tissues and the presence of sphagnan combine to ensure that this peat

Raised bog

Blanket bog

undergoes little further decomposition. As a result, many areas of UK peat bog have been accumulating these small increments for as much as 10,000 years, and have consequently generated peat depths of up to 10 m. Such depths are typical of ***raised bogs*** which occur as isolated peatlands in the UK lowlands, with examples recorded as far south as the Kent coast. In the UK uplands, however, where the climate is generally wetter, peat has come to smother entire landscapes in what is termed, appropriately, ***blanket bog***, and although the peat is more extensive than in the lowlands it is also generally thinner, with an average maximum depth of 6 m, partly because much blanket bog has been forming for a shorter period of time (often 5-6,000 years) and also because the sloping nature of much ground prevents effective water-logging and results in greater nutrient through-flow. In the wettest parts of upland Britain, slopes of up to 40° may still have some peat formation, albeit rather shallow, whereas in drier regions even quite modest slopes may be sufficient to restrict peat formation to a thin organic layer or even prevent its formation altogether. As a result, the very extensive blanket bog landscapes of the UK uplands consist of a peat mantle which varies substantially in thickness from a few centimetres to several metres, and such variation may sometimes be found over distances of less than 50-100 m.

Classifying bog landscapes

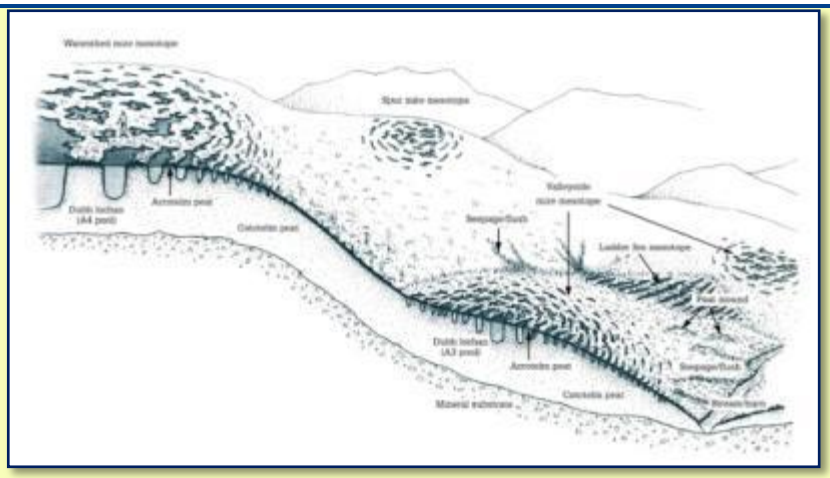
Inter-connected mosaic of individual peatland units

UK classification compares poorly with other European countries

Mire units characterised on basis of position in landscape, shape, and hydrology

Blanket *mire* landscapes *(below)* **consist of an inter-connected mosaic of individual peatland units, mostly bogs but also some fen systems**, which are each characterised by their **topographic position and morphology**. These characteristics reveal much about the functioning of each unit and are thus **important as a means of identifying the part played by each unit** within the overall blanket mire landscape. Although **many peat-rich western nations such as Sweden recognise and describe these peatland units as a standard process, the UK does not**. Consequently most of the UK blanket bog landscape is described only in terms of rather broad vegetation types, which ultimately **results in poor understanding of key site features and condition *(see Biodiversity Briefing Note 2, and Briefing Notes 3, 5, 7, 8, 9)***.

As a minimum, the **individual peatland units of a peat-dominated landscape should be separated from true heaths and upland grasslands** by the presence of thin organic soils in these latter types. The individual **mire units should then be identified and characterised on the basis of their position in the landscape and their shape, as well as their overall hydrology**. The first two features are reasonably straightforward but the third is critical because it helps to separate bog units fed only by direct rainfall from fens receiving water from the surrounding catchment.



Types of upland bog: watershed bogs saddle bogs spur bogs valleyside bogs

In the uplands, the underlying landform plays a key part in determining both location and morphology for the main centres of mire formation *(above)*. This gives rise to a relatively limited range of hydromorphological bog types. ***Watershed bogs*** dominate broad watershed summits between main river systems. ***Saddle bogs*** occupy saddles between two or more summits. ***Spur bogs*** form on terraces below the main watershed summits. ***Valleyside bogs*** hang from lower valley sides, occupying the ground between steeper valley slopes and the river system at the valley bottom. These basic types can also intergrade in a variety of ways. Between these bog units there may be a range of fen systems ranging from small springs and flushes to wide flood-plain fens or basin fens.

Lowland raised bog

Types of raised bog

In the lowlands, position in the landscape and history of formation give rise to various **forms of *raised bog*. *Flood-plain raised bog*** is formed on river flood-plains and typically contains sediment layers derived from flood events at least in the lower levels of the peat deposit, thus giving rise to a somewhat complex hydrology in these basal layers. ***Basin raised bog is*** formed over an isolated basin, with the main source of hydromorphological variation here being the depth of the basin. A shallow basin will generally form a *'typical'* raised bog which develops through the steadily infilling of the basin by fen peat, then bog peat. In contrast, a deep, steep-sided basin such as a kettle hole will typically form a floating raft which may eventually thicken to form a dome over the trapped water body to create a *'schwimgmoor raised bog'*, although care must be taken here to establish that a true dome exists because the majority of such examples are *basin fens* or *basin transition mires* rather than true raised bogs. **E*stuarine raised bog*** is formed on the flood-plain of an estuary and will typically contain sediment layers from both riverine flood events and marine incursions within its lower peat layers, resulting in a complex basal hydrology. All three main raised bog types can inter-grade with each other on occasion.

Basin raised bogs formed on plateaux associated with the fringes of upland areas can also escape their original basin confines and begin to cloak limited areas of hill slope lying downslope from such plateaux, sometimes merging with other basin raised mires to form small expanses of semi-continuous peat. These sites are termed ***intermediate bogs*** because they have features of both raised and blanket mire..

Hydrology

Mapping of 'flow lines'

Bogs shed water; fens receive water

Mesotope

Macrotope

Overall hydrology is a critical factor in determining whether a peatland is likely to be bog or fen, particularly in a blanket mire landscape. The surface hydrology can, however, be determined relatively easily using the basic principle that water always flows downhill, and does so using as direct a route as possible. Consequently for an area of mire landscape **it is a relatively simple task to draw a series of lines which always cross at right angles the contours shown on a map** of the ground *(left)*. These drawn lines represent the direction of surface-water flow and reveal those **areas of ground which shed water (usually the bogs) and those which receive or collect water (generally the fens).**

On this basis it is then possible to identify individual mire units, termed ***mesotopes*** *(right)*, determine whether they are likely to be bog or fen, and finally determine their overall hydrological character. All individual mire units which link with other mire units together form part of an inter-connected mire complex or ***macrotope***. An extensive blanket mire landscape may incorporate many such mire complexes, or macrotopes, within the overall landscape, and each macrotope may consist of many individual mire units which are hydrologically linked to each other because the peat mantle extends continuously beneath them all. Boundaries between individual mire complexes occur where this peat mantle is broken by a major stream, rock outcrop, or, as is often the case now, a major road or railway.

The mire complex and the individual mire unit represent just the first stages in describing the character and health of a peat bog system. Additional appropriate descriptive measures are also discussed in ***Biodiversity Briefing Note 2***.

Definitional Confusions

Is moorland the same as bog?

Damaged blanket bog can resemble upland heath or grassland

Natural tendency to return to blanket bog

Moorland **is widely used to describe open upland landscapes**, but this term **embraces upland heath and upland grassland as well as blanket bog** and therefore often causes confusion in terms of the differing habitat characteristics. The first two habitats are not wetlands and are therefore quite distinct in their functioning from blanket bog. In particular, true upland heaths and upland grasslands do not contain the substantial quantities of carbon stored in the peatland components of such moorland landscapes.

When blanket bog is damaged it can, however, **superficially resemble either upland heath or upland grassland, but such damaged blanket bog is without exception still wet with a moisture content of more than 75% water by dry weight, and its underlying processes remain those of a wetland**.

Its natural tendency will thus be to return to a functioning blanket bog wetland, a tendency only prevented by repeated human intervention. The effects of such interventions on the peat bog habitat are described in the accompanying set of briefing documents.

Consequences ***Extent of UK peat still not well established***	Varying figures for the extent of peat have been generated over the years, but the substantial differences between these figures (see above) arises partly because differing definitions have been used to generate these figures but also because differing scales of measurement have been employed. The UK peat bog resource (and associated carbon store) represents the largest remaining expanse of semi-natural terrestrial habitat in the UK but its **total extent remains poorly documented**, particularly in relation to thinner areas of peat and in regions of complex terrain. In addition, published scientific papers have given rise to conflicting accounts of habitat behaviour and carbon-storage processes when they have used terms such as 'moorland' to define their study sites, or where they have defined damaged blanket bog as 'upland heath' or 'upland grassland'.
Areas at risk of being confused	All areas of peatland are at risk of being confused with other habitats, particularly if the term '***moorland***' is used, but especially areas of thinner peat (less than 1 m deep), areas of complex terrain where peat of variable depth occurs as part of a 'soil complex', and damaged peatlands where there is the potential for confusion between superficially similar upland heath or upland grassland.
Gaps in Knowledge	Identified gaps are: • **Clear and consistent maps of the peatland resource**, including peat depth, at local, regional and UK levels, with explicit description of mapping resolution and mapping constraints. • Recognising nonetheless that peat bog habitat is one of the largest semi-natural habitats remaining in the UK and thus has a potentially major part of play in providing ecosystem services at the landscape scale, there is a continuing need to identify the **inter-relationships between particular ecosystem services and differing peat bog types and conditions**. • A widespread better understanding of how to apply topographic mapping to the identification and characterisation of individual peatland units would be needed to underpin this.
Practical Actions	Practical actions: • Support is required for clear and consistent resource mapping, with depth measurements in particular required on a more extensive basis, given the importance afforded to the carbon store contained within UK peatlands. • The identification and characterisation of individual peatland units should be undertaken as a standard descriptive process, using the SSSI Selection Guidelines for Bogs (as well as Lindsay 1995 and Lindsay 2010) to define these units and their components (*macrotopes*, *mesotopes*, *microtopes and nanotopes*). See also: http://jncc.defra.gov.uk/pdf/SSSIs_Chapter08.pdf http://www.uel.ac.uk/erg/PeatandCarbonReport.htm
Other Benefits	Given the broad dominance of peat-rich soils throughout much of the UK uplands, such areas are likely to play a key part in delivering a wide range of ecosystem services at the landscape scale, including particularly carbon storage and water supply, but this will only be achieved if the peat bog habitat is correctly identified, characterised and thereby managed in an appropriate way. If this can be achieved, these peat-dominated

	landscapes can help to underpin a sustainable rural community as well as providing key benefits to society (*e.g.* water supplies, carbon storage and sequestration) as a whole.
More Information	Underpinning scientific report: http://www.rspb.org.uk/Images/Peatbogs_and_carbon_tcm9-255200.pdf (low resolution) http://www.uel.ac.uk/erg/PeatandCarbonReport.htm (high resolution : downloadable in sections) IUCN UK Peatland Programme: http://www.iucn-uk-peatlandprogramme.org/ Natural England Uplands Evidence Review: http://www.naturalengland.org.uk/ourwork/uplands/uplandsevidencereviewfeature.aspx Scottish Natural Heritage Report on peat definitions: http://www.snh.org.uk/pdfs/publications/commissioned_reports/701.pdf Peatland Action: http://www.snh.gov.uk/climate-change/what-snh-is-doing/peatland-action/ *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.* *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_tcm9-255200.pdf* *The full set of briefs can be downloaded from:www.iucn-uk-peatlandprogramme.org.uk* *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.* *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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