Lowland raised bog, Duddon Mosses NNR, Cumbria.

17. Lowland raised bog

Climate Change Sensitivity: **Medium**

Introduction

An intact, fully functioning lowland raised bog is expected to be relatively resilient to projected climate change, although both changes to patterns of rainfall, including extreme events and summer warming, will place increasing pressure on the habitat. In England, however, there are no raised bogs in this condition.

The impact of historic and current land management has a significant impact on the vulnerability of sites. Damage through peat cutting or drainage (both on and off-site) that alters the hydrology of sites has significant adverse impacts on the ability of the bog to withstand reduced rainfall and extreme events such as drought. Degraded bogs are also more vulnerable to climate change impacts on the quality and quantity of ground water.

In England, most remaining lowland raised bog habitat is found on the central or core area of the original dome. Surrounding this is an area of degraded peatland, often now under alternative land use, making the remaining bog increasingly vulnerable to off-site impacts and land-use change.

Habitat Description

Lowland raised bogs are peatland ecosystems which develop primarily in lowland areas such as at the head of estuaries, along river flood-plains and in topographic depressions. In such locations drainage has been impeded by a high groundwater table or by low permeability of the substrata. The resultant water-logging provides anaerobic conditions which slow down the decomposition of plant material, which in turn leads to an accumulation of peat. This accrual of peat, with its *Sphagnum* moss surface, over time, elevates the bog surface above groundwater levels to form a gently-curving dome from which the term 'raised bog' is derived.

In England, lowland raised bogs are a particular feature of cool, rather humid, regions such as the north-west lowlands, but remnants also occur in some southern and eastern localities, for example in Somerset, South Yorkshire, Sussex and the Fens.

The accumulation of peat separates the bog surface from the influence of groundwater, so that it becomes irrigated exclusively by rainfall and is termed 'rain-fed'. Consequently, the surface of a 'natural' lowland raised bog is typically waterlogged, acidic and deficient in plant nutrients. This gives rise to a distinctive suite of vegetation types, which although low in overall diversity, support specialised plant assemblages dominated by a range of *Sphagnum* mosses, as well as vascular plants adapted to waterlogged conditions such as the cotton grasses *Eriophorum spp.* Lowland raised bogs also support rarer plants such as the bog mosses *Sphagnum pulchrum* and *Sphagnum imbricatum*, as well as a number of higher plants which have become increasingly scarce in the lowlands, including bog rosemary *Andromeda polifolia*, great sundew *Drosera anglica*, and cranberry *Vaccinium oxycoccos*.

The raised bog surface may support a patterned mosaic of pools, hummocks and lawns; a micro-topography created in part by the growth of the plants themselves. This provides a range of water regimes which support different species assemblages. *Sphagnum* mosses are the principal peat-forming species in lowland raised bogs, and their dominance in the living vegetation layer gives a bog its characteristically 'spongy' surface. The ability of this layer to store water is critical in keeping the bog surface wet during the summer.

A number of plant communities can be found on raised bogs. Plant communities that are typical of natural raised bogs include the bog pool communities, raised and blanket mire. In addition, a number of communities, including *Scirpus cespitosus - Erica tetralix* (deer grass-cross-leaved heath) wet heath; *Calluna vulgaris - Eriophorum vaginatum* (common heather-cotton grass) blanket mire; *Eriophorum vaginatum* (cotton grass) blanket and raised mire; *Molinia caerulea - Potentilla erecta* (purple moor grass-Tormentil) mire; and *Betula pubescens - Molinia caerulea* (birch-purple moor grass) woodland, can be found on raised bogs which have been subject to some disturbance such as drainage or peat-cutting.

Lowland raised bogs also support a distinctive range of animal species, including a variety of breeding waders and wildfowl, as well as invertebrates. Rare and localised invertebrates such as the large heath butterfly *Coenonympha tullia*, the bog bush cricket *Metrioptera brachyptera*, and mire pill beetle *Curimopsis nigrita* are found on some lowland raised bog sites.

There has been a large decrease in the area of lowland raised bog. The area of lowland raised bog in England retaining a largely undisturbed surface is estimated to have declined from around 37,500 ha to 500 ha since the start of the nineteenth century.

Round-leaved Sundew Drosera rotundifolia, Dersingham Bog, Norfolk. © Natural England/Allan Drewitt

Potential climate change impacts

On fully functioning intact bogs, climate change modelling suggests that many of the dominant species will remain relatively unaffected by projected climate change (Berry & Butt 2002), as when in good condition lowland raised bogs are self-controlling systems. However, most English lowland raised bogs are vulnerable because they have been drained. Their surfaces are at risk from drying out, leaving them more prone to erosion, the effects of drought, and fire damage.

The table below highlights the potential climate change impacts to English lowland raised bogs, all of which are degraded in some manner.

Cause	Consequence	Potential impacts
Increased mean temperatures	Longer growing season	■ Bog vegetation may become less dominant. Change is likely to be influenced by the interaction with the hydrological conditions on any given site and the pattern of rainfall.
Hotter summers	Increased evapotranspiration	■ A reduced water table could lead to a potential increase in purple moor-grass *Molinia caerulea* and/or heather *Calluna vulgaris* and silver birch *Betula pendula*, which will intercept rainfall, increase transpiration and encourage the development of flow paths associated with root systems. ■ Already degraded bogs will be more vulnerable than intact bogs, and are more likely to suffer from drying out, which in turn will impair the natural hydrological regime and the ability of the *Sphagnum* carpet to persist.
Drier summers	Drought	■ Water table draw down will become more marked in the future, especially in the east and south. ■ Altered vegetated community composition, with a possible shift in the dominance of specialist species. ■ Increased oxidation rates and wind erosion of existing bare peat. ■ Increased fire risk, especially where degraded bog is dominated by heather or grasses such as purple moor-grass *Molinia*. ■ Peat will become more susceptible to accidental fire damage.
	Drier ground conditions	■ Improved accessibility for visitors could lead to increased erosion and incidence of wildfires.
Wetter winters	Increased surface water run-off	■ Increased run-off could lead to increased erosion in bogs with degraded hydrology, and an increased risk of bog-burst (bog-slide, bog flow), where wet peat can slide sideways off the raised dome.
Storm events	Increased rainfall intensity	■ Heavy rainfall and more surface water will intensify problems of erosion.
Combined		■ Lowland raised bogs are more vulnerable when their hydrology has been degraded and the surface dries out, leaving them more prone to erosion, the effects of drought, and fire damage. ■ Most remaining bogs are small and isolated, meaning that the populations they support are at greater risk of local extinction due to reduced interchange of populations.

Adaptation responses

As already stated, a large proportion of lowland raised bogs are degraded as a result of cutting, drainage, over grazing and atmospheric pollution. In all cases, this results in bogs ceasing to function as rain-fed systems, increasing their vulnerability to changes in ground water quantity and quality. In these cases, active restoration of the hydrology to reduce the reliance on ground water, through actions to improve the water retention of the site, will improve the resilience to both climatic and non-climatic drivers. Restoration activity is nearly always constrained by ingress of other land use. A fully functioning raised bog will need restoration out to the edge of the peat body or the installation of an appropriate hydrological barrier.

Bogs are dependent on a reliable high water table, and in the longer term, as climate change progresses, actions that increase the water table and water retention on sites will become increasingly important. The restoration of lowland raised bogs has multiple benefits. It increases the resilience of the habitat to climate change and improves the delivery of other ecosystem services, such as carbon sequestration and flood risk management.

In the longer term, it may become increasingly difficult to maintain active blanket bog in more climatically marginal areas in the south and east. However, habitat restoration and appropriate management to improve resilience should remain a priority, but should be kept under review.

Potential actions

- Cease peat cutting and ensure optimum management is in place to eliminate damage to bog surfaces by machinery or other means. Over-grazing by livestock can lead to poaching, compaction, surface contamination, and loss of grazing-sensitive plants. At the other extreme, a lack of grazing, coupled with drier conditions, on raised bogs usually favours widespread expansion of bracken, tall heather, birch and pine.
- Develop a full understanding of the hydrology and define the functional boundaries of the site.
- Restore natural hydrological regimes and high water tables through blocking or re-profiling drains to encourage the growth of *Sphagnum*. Where the surface is either complex or very open and featureless, e.g. after peat milling, water may need to be penned, for example through extended pile or peat bunds.
- Where sites may have dried out and been colonised or planted with trees, remove up to 95% of native trees, and all invasive non-native species. After extraction, keep water levels raised to reduce re-colonisation, as evapotranspiration from trees and scrub will exacerbate drying effects.
- Review the hydrology of land surrounding the site to identify off-site drainage impacts, and also consider pressures such as abstraction, pollution and nutrient enrichment. Take action to reduce adverse impacts, for example through the creation of wetland to buffer the core area, or by diverting drains.
- Following restoration of the hydrology, re-vegetate areas of bare peat using best practice restoration techniques and appropriate plant species mixes. Initially, this should help to prevent or reduce further peat loss, but in the longer term will help to restore active peat formation.
- Identify areas where the hydrological regime is currently, or in the future may be, sufficiently impaired to prevent bog development, and determine the most appropriate alternative objectives. This might involve retaining a high water table for as long as possible to maintain ecosystem services such as carbon storage and water management.
- Use or develop a full understanding of the hydrology and extent of peat to determine whether the area of lowland raised bog could be expanded through habitat restoration or creation.

Relevant Countryside Stewardship options

WT10 Management of lowland raised bog

This option supports the maintenance of water levels at the surface of the bog fed only by rainfall. It also requires the control of scrub and other undesirable species and the maintenance of structures required to control water levels.

Where appropriate, the following supplements can be used to support the grazing and cutting of lowland raised bogs.

WT12 Wetland grazing supplement

This option supports the appropriate grazing management of wetland habitats.

WT11 Wetland cutting supplement

Options to raise the water table and encourage appropriate land management on land surrounding the bog may also be appropriate.

Further information and advice

IUCN Peatland Programme - **Climate change mitigation and adaptation potential**.

JNCC (2011) **Towards an assessment of the state of UK peatlands**. Report 445.
This report assesses the state of the UK peatlands, based on available information on the extent, location and condition of peat soil and peatlands, vegetation, land cover, land use, management and a range of environmental influences.

Evans, C., Worrell, F., Holden, J., Chapman, P., Smith, P. & Artz, R. (2011). **A programme to address evidence gaps in greenhouse gas and carbon fluxes from UK peatlands**. Report 443.
This report provides the proposed structure for a measurement programme to improve quantification of the carbon and greenhouse gas fluxes to and from UK peatlands, and allow for the development of more robust UK emission factors for peatland areas.

Worrall, F., Chapman, P., Holden, J., Evans, C., Artz, R., Smith, P. & Grayson, R. (2011) **A review of current evidence on carbon fluxes and greenhouse gas emissions from UK peatlands**. Report 442.
This review considers the current evidence on carbon and greenhouse gas fluxes from UK peatlands under differing land management states, to identify the additional evidence needs required to generate robust emission factors for UK peatlands.

Yorkshire Peat Partnership (2014). **Conserving Bogs - The Management Handbook**. A practical manual to the methods and techniques to effectively manage and conserve bogs. Second Edition.

Relevant case studies

Improving Habitat Management: restoring a lowland raised bog at Blawhorn Moss National Nature Reserve, Central Scotland.
A case study of the transformation of Blawhorn Moss National Nature Reserve (NNR) - a lowland raised bog in the central belt of Scotland that demonstrates how improving habitat management can increase a bogs resilience to climate change.

Restoration of degraded peat surfaces and cut peat faces : Glasson Moss SSSI.
The South Solway Mosses SAC is a Lowland Raised Bog, designated for Active Raised Bogs and Degraded raised bog still capable of natural regeneration. This project aimed to restore cut over degraded peat surfaces and cut peat faces covering 1.3ha.

Key evidence documents

Aerts, R., Wallén, B. & Malmer, N. (1992). Growth-limiting nutrients in *Sphagnum*-dominated bogs subject to low and high atmospheric nitrogen supply. Journal of Ecology, 80, 131–140.

Berry, P.M. & Butt, N. (2002). **Climate change impacts on raised peatbogs: a case study of Thorne, Crowle, Goole and Hatfield Moors**. English Nature Research Reports Number 457.

Bottrell, S., Coulson, J, Spence, M. & Roworth, P. (2004). **Impacts of pollutant loading, climate variability and site management on the surface water quality of a lowland raised bog, Thorne Moors, E. England, UK**. Applied Geochemistry 19, 413–422.

Lindsay, R. 2010. **Peatbogs and Carbon: a Critical Synthesis** University of East London. published by RSPB, Sandy.

Lindsay, R., Birnie, R. & Clough, J. (2014). IUCN UK Committee Peatland Programme, Briefing Note No10 - Peat Bogs, Climate and Climate Change.