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Catfield Fen, Ant Broads and Marshes NNR, Norfolk

12. Lowland fens

Climate Change Sensitivity: **High**

Introduction

Lowland fen is highly sensitive to changes in the quality and quantity of water supply and its seasonal availability, all of which are likely to alter significantly under climate change. The direct impacts of changes to precipitation and temperature pose a severe threat to lowland fen habitat and may in many cases be compounded by increasing demand for water leading to increased abstraction.

Sea level rise and associated saline intrusion will pose an increasing threat to fen close to the coast.

Habitat Description

Fens are wetlands that occur on peat and mineral soils and which can receive water from various sources (groundwater, surface run-off and river flooding, as well as rainfall), unlike bogs, which receive water at their surface only from precipitation. Fens are complex and dynamic systems. They frequently form complex mosaics with a number of associated habitat types, including wet woodland (fen carr), bogs, lowland heathland and lowland meadow.

The character of a fen is largely determined by the landscape setting, and the quantity, quality (in terms of macro-nutrients N, P & K) and chemistry (eg pH) of the water that supplies it. These various factors interact to create an extremely wide range of conditions in which fen vegetation occurs, and result in the development of a very wide range of vegetation types. In order to understand the likely impacts of any external pressure on a fen, it is essential that the ecohydrological function of the individual wetland (ie where the water comes from, how it moves through the site, the chemistry and nutrient status of the water, the nature of the substrate, and vegetation present) is understood. Management is also important, and understanding the influence of historical management as well as current practice is necessary.

Fens occur across the pH range, from acid through to highly alkaline, along a nutrient gradient from highly eutrophic through to oligotrophic, and along a wetness gradient from seasonally waterlogged through to permanent standing water. The vegetation changes across these gradients, with many transitional forms. At the acidic low-nutrient end of the spectrum, fens can resemble bogs, with abundant Sphagnum mosses, cotton grasses, cranberry and ericaceous shrubs. As base content increases, species such as devil's-bit scabious *Succisa pratensis* and marsh cinquefoil *Potentilla palustris* increase.

The change in fen bryophyte composition is a strong indicator of changing environmental conditions, and as base-richness increases, a range of very distinctive non-Sphagnoid mosses and liverworts develops, known as the 'brown-moss' layer. This has a very important function in maintaining moisture levels, providing both a rooting substrate for vascular plants, as well as a home for numerous rare and declining invertebrates such as Geyer's whorl snail *Vertigo geyeri*, soldier flies and crane flies. Alongside these bryophytes, low-growing sedges and sedge allies such as dioecious sedge *Carex dioica* and black bog rush *Schoenus nigricans*, and more photogenic species such as butterworts *Pinguicula*, bird's-eye primrose *Primula farinosa* and marsh valerian *Valeriana dioica* are found.

In areas where base-rich water occurs in more nutrient rich conditions, tall species-rich fen may develop, eg the Broads fens. These fens are typified by the presence of common reed *Phragmites australis*, large sedges, yellow loosestrife *Lysimachia vulgaris*, hemp agrimony *Eupatorium cannabinum*, and some scarcer species such as greater water parsnip *Sium latifolium*, cowbane *Cicuta virosa*, and saw sedge *Cladium mariscus*. They are often a later successional stage of 'swamp', an early successional fen type characterised by more-or-less permanent standing water and often dominated by sedges, reed or reedmace.

Fen meadow vegetation develops in various situations, sometimes as a result of regular cutting or grazing of tall-herb fen, but also around the drier margins of wetter fen types, and in drained ex-fen sites. It tends to be associated with slightly lower summer water tables than 'true' fen (although this is not always the case) and consequently has a greater representation of grassland plants in among wetland species.

Lowland fen is found across England, from sea level up into the hills. Certain types of fen are restricted to parts of the country where the necessary environmental conditions occur; for example, base-rich low nutrient fens are limited to areas with calcium-rich groundwater, and basin fens with floating acidic rafts tend to occur in hummocky, often post-glacial, landscapes. The estimated area of lowland fen in England is 25,785 ha¹⁹.

Potential climate change impacts

Cause	Consequence	Potential impacts
Increased mean temperatures	Longer growing season	<ul style="list-style-type: none"> Increased plant growth will require altered management requirements, especially cutting regimes and stocking density.
Hotter summers	<p>Higher nitrogen concentrations resulting from reduced water volume and increased mineralisation.</p> <p>Higher evapotranspiration</p>	<ul style="list-style-type: none"> Increased nutrient loading may lead to eutrophication of ditch networks and an increased dominance of invasive generalist species. Higher evapotranspiration is likely to compound the effect of drought – see below.
Altered seasonal rainfall patterns	Increased seasonal variation in water table levels	<ul style="list-style-type: none"> Loss of wetland specialists with narrow hydrological requirements.
Drier summers	<p>Increased soil moisture deficit</p> <p>Drought</p> <p>Increased abstraction for agriculture and domestic use leading to reduced water availability</p> <p>Low flows, leading to reduced dilution of pollution and nutrient enrichment</p>	<ul style="list-style-type: none"> Drying out of fens in summer, leading to a loss of individual species and changes in community composition. Drying and oxidation of peat, followed by a release of nutrients, leading to further changes in community composition. Colonisation and competition by species more suited to lower water tables and drier conditions. Lower water tables leading to ground conditions becoming suitable for intensification of grazing or conversion to arable cropping, leading to a direct loss of habitat? Changed community composition, with increasing dominance of invasive, generalist species.
Wetter Winters	Increased risk of polluted run-off	<ul style="list-style-type: none"> Increased nutrient inputs from in-washed sediment, leading to the loss of nutrient-poor vegetation types.
Increase frequency of extreme rainfall events	<p>Increased frequency of flooding</p> <p>Unpredictable inundation of floodplain fen.</p>	<ul style="list-style-type: none"> A shift in species composition to favour those species able to cope with long-term inundation. Increased nutrient input, leading to benefits for those species able to utilise enhanced levels, and the potential loss of nutrient-poor fens. Increasing difficulty of management, leading to potential abandonment. Increased peat slippage and erosion in sloping valley head mires.
Sea Level Rise	<p>Saline Intrusion</p> <p>Increased frequency of saline inundation</p>	<ul style="list-style-type: none"> Changes in community structure of sites near the coast, with a shift from freshwater to brackish communities. A shift towards salt marsh habitat.

¹⁹ JNCC [Extent & Distribution of UK Lowland Wetland Habitats](#).

Adaptation responses

Maintaining and enhancing the quality and quantity of water is likely to be the main objective of adaptation. There are various existing drivers that require action to improve availability of water and water quality, including the Water Framework Directive (WFD) and the Environment Agency's Restoring Sustainable Abstraction programme. It is critical that risks to fens from climate change and other pressures are considered in the context of these, and that actions to improve resilience as well as the current status are identified and included in relevant programmes and plans, particularly the WFD River Basin Management Plans, which are updated at five-year intervals, and the Water Companies' Asset Management Programme (AMP) associated with the five yearly price review.

The requirement for a flexible management regime of grazing and/or cutting that is able to adjust to seasonal variation in rainfall is also important. This will remain a challenge due to the low financial returns that management of these habitats provides.

Removing or reducing pressures on wetlands, including groundwater abstraction, drainage and nutrient enrichment will continue to be important. As well as dealing with licensed activities such as abstraction, this may involve the designation of larger areas to protect land around wetlands, and improved management of soil and water within catchments.

Restoring natural hydrological processes on and around wetland sites is likely to improve the resilience of features. This may not always be appropriate, for example on sites that have been created and sustained wholly by human intervention, but in most circumstances it should be seriously considered. In the first instance, this will require an understanding of how the site functions hydrologically, and any existing pressures and modifications to the wetland. For example, many fen sites retain artificial drainage networks which have been perpetuated for no reason other than 'it's always been there'. Consideration should be given to removing this drainage unless it is critical to a very high value feature or infrastructure/property.

Climate change is likely to alter the successional processes of wetland communities and active management is likely to be required to maintain the various stages in their current form, if that is the desired option.

National strategic documents such as the England Wetland Vision can be used to help identify priority areas for restoration and creation of fenland habitat, as part of sustainable drainage and flood defence systems.

Lowland fen communities will change under climate change and the extent to which change is accepted and managed will need careful consideration in each location, taking account of the particularly circumstances.

Some of the potential adaptation options for this habitat are outlined below.

- Determine and characterise all aspects of the water regime, reference hydrological state, existing state, pressures and threats, and the feasibility of restoration options, to ensure that any interventions are carried out with full knowledge of the site's value and function.
- Ensure appropriate management through cutting or grazing combined with scrub management where required to ensure that habitats do not develop into scrub or woodland.
- Ensure management is sufficiently flexible to provide appropriate management under a range of growing conditions. For example, ensure sufficient land to provide alternative grazing in years when fen is flooded.
- As far as possible, restore the natural function of floodplains. For example, consider restoring the connectivity of the floodplain, and filling in drained springs.
- Evaluate the existing drainage within and around fen sites as part of an ecohydrological characterisation and identify which drains should be filled in or blocked and those which may be necessary to maintain water levels within the site. This will depend on landscape context and historical management.
- Remove sources of nutrient enrichment by increasing the area of extensively managed land around the wetland, and implementing good practice throughout site catchment.
- Increase the heterogeneity of habitats on larger sites by varying management regimes to produce a mosaic of habitat types, including open, unshaded areas free from scrub encroachment or trees, through to more wooded areas.
- Where circumstances dictate consider actions that enable water tables to be artificially maintained during the spring and summer including the use of artificial structures.
- Monitor and address potentially harmful invasive native and non-native species. This might include the use of surveillance to detect the arrival of species at an early stage (while they can still be eradicated) and the identification of potential sources of invasive species in the surrounding area.
- Identify and protect sites and areas within sites where the water quality and quantity is likely to be assured in the future.
- Where currently present, aim to maintain areas that are permanently wet/inundated habitats with little fluctuation of water levels.
- Where long term water availability is unlikely to be maintained, revise the objectives for the site and determine the most effective management options to facilitate change. For example, manage the site through grazing to facilitate the transition into a species rich lowland meadow type habitat, or allow and encourage scrub and tree development to move the site towards wet woodland. However, care will be needed to separate the impacts of climate change from avoidable pressures. Long-term strategic planning will be required to determine the rate of loss of sites adjacent to the coast, and to identify appropriate locations and mechanisms for offsetting that loss through habitat creation and restoration inland.
- Locations for the restoration or creation of fen habitats should be identified at the planning stage of flood management schemes within river floodplains.

Boardwalks Local Nature Reserve, Peterborough.



Relevant Environmental Stewardship options

Maintenance/Restoration of fen (HQ06/07)

This option is targeted at maintaining or restoring areas of fen that are typically dominated by rushes, sedges and wetland grasses. Through the continuation or reintroduction of appropriate management, the option is designed to retain and/or increase botanical diversity.

Creation of fen (HQ08)

This option is targeted at areas of potential fen, which may have been recently drained, cultivated and/or which lie adjacent to existing areas of fen. The management objectives will vary depending on the location, type of vegetation present and on the past management of the site. Although the development of increasing botanical diversity will often be a major objective, many of these sites will have the potential to also support birds and invertebrates.

Wetland cutting (HQ11)

The aim of this supplement is to support a cutting regime where this is the most appropriate form of management for the habitat. In addition, this option may maintain local techniques and traditions otherwise at threat of loss.

Wetland grazing (HQ12)

The aim of this supplement is to support a grazing regime where this is the most appropriate form of management for the habitat.

Further information and advice

Scottish Natural Heritage (2011) [The Fen Management Handbook](#)

This handbook is produced by Scottish Natural Heritage aims to improve managers' understanding of fens and how they function, to explain why fens need management, and to provide best practice guidance.

Centre for Ecology & Hydrology [Wetland toolkit for Climate Change](#)

The Wetland Toolkit for Climate Change guides the user in the application of tools developed to assess how climate change in the 2050s (2041-2070) might impact on wetland ecohydrology in England and Wales. The guidance and the tools are designed to be used by anyone concerned with the impacts of climate change on wetlands. It is anticipated that the main users will be site managers concerned with the status of their wetlands.

Environment Agency [A Wetland Framework for Impact Assessment at Statutory Sites in England and Wales](#).

Wetland scientists at the University of Sheffield have developed a way of classifying wetlands based on an understanding of where their water supply comes from and the environmental and landscape conditions in which the wetland has developed.

Understanding how a wetland 'works' means that important habitats can be protected, as we can assess where, when and how changes in certain aspects such as groundwater supply and water quality may affect the wetland.

Environment Agency (2010) [Ecohydrological Guidelines for lowland wetland plant communities, 2004, and Fens and Mires update 2010](#). A simplified approach to the methods described above.

JNCC (2008) UK BAP habitat description [Lowland Fen](#).

Relevant case studies

[The Great Fen project](#)

The Great Fen is a 50-year project to create a 3,700Ha landscape of mixed wetland habitats around Woodwalton Fen and Holme Fen National Nature Reserves in Cambridgeshire. Adaptation to climate change is an integral part of the project, both by providing flood water storage to reduce the impact of climate change on local communities, and by helping wildlife move and adapt to changing climatic conditions.

Key evidence documents

Keller, J.K., White, J.R., Bridgham S.D. & Pa S To R, J. (2004) Climate change effects on carbon and nitrogen mineralization in peatlands through changes in soil quality. *Global Change Biology* 10, 1053–1064.

Graves, A.R. and Morris, J. 2013. [Restoration of Fenland Peatland under Climate Change](#) Report to the Adaptation Sub-Committee of the Committee on Climate Change. Cranfield University, Bedford.