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BIODIVERSITY UNDER THREAT – FRESHWATER WETLANDS IN THE EAST ANGLIAN FENS

Wetland ecosystems have great biodiversity and ecological value. They are threatened globally – and the United Kingdom is no exception.

More than 99% of the freshwater wetlands of the East Anglian Fens were drained in historic times. Several thousand square kilometres have been converted to arable land. No other area of Britain has experienced landscape transformation on this scale in historic times.

Only small fragments of the original wet fens survive, but those remaining areas include some of the areas of highest biodiversity in the British Isles.

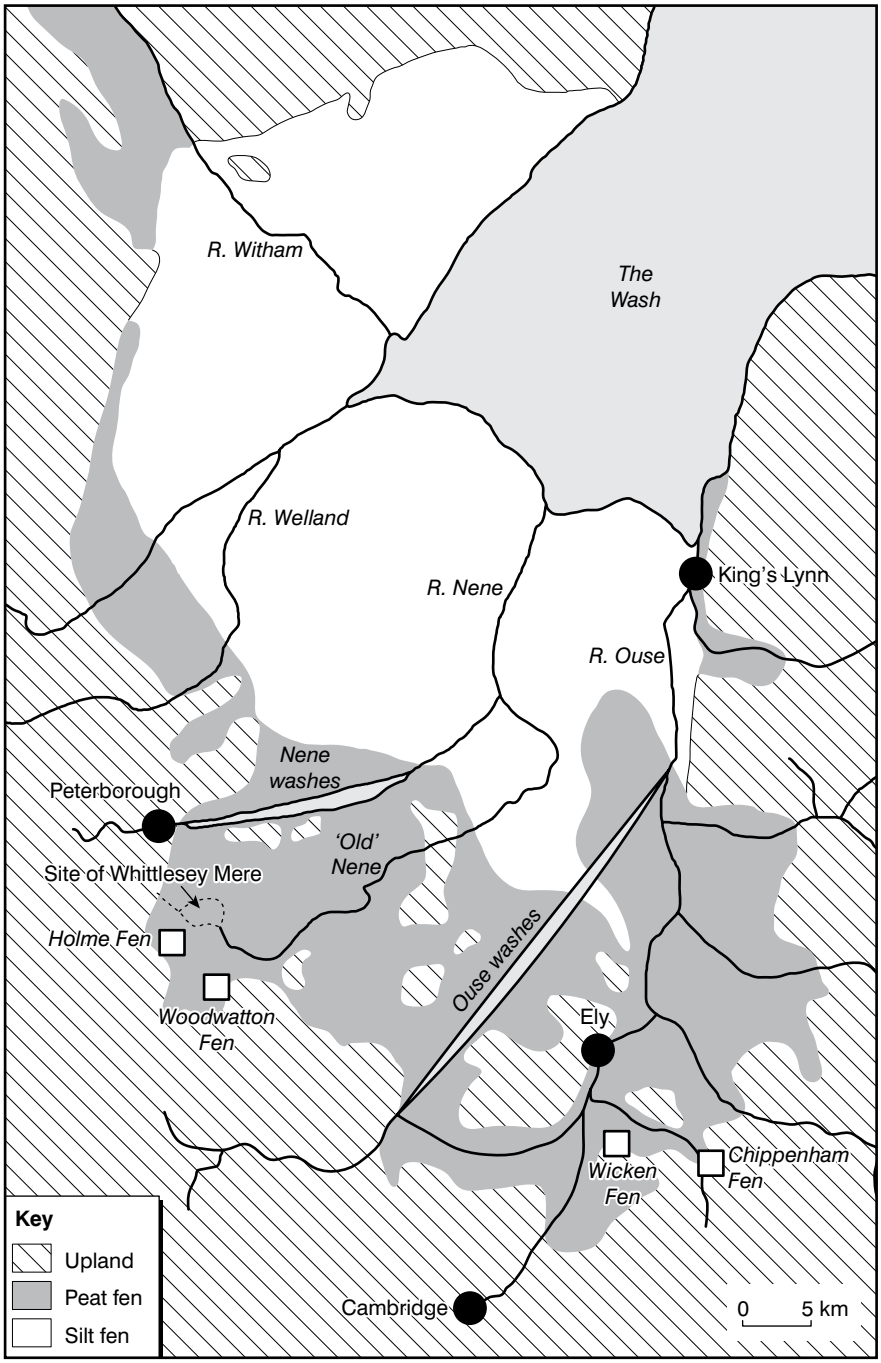
This **Geofile** looks at ambitious plans to conserve and restore the wetland biodiversity of the East Anglian Fens. It also examines the importance of ecological theory in making management decisions for biodiversity.

The East Anglian Fens

The Fens are a low-lying area of East Anglia, stretching from Cambridge in the south to the Wash and Lincolnshire in the north. Most of theregion lies below 10 metres above sea level, and extensive areas are below sea level. Hundreds of kilometres of sea and river embankments protect the area, and the Fenland Internal Drainage Board maintains an extensive network of pumps, drains and sluices to prevent flooding.

Drainage has created one of Britain's most productive areas of intensive arable farming. Today's fen landscape is characterised by vast open fields, intersected by geometrical drainage ditches and occasional tree-line windbreaks.

Figure 1: The Fens, showing the position of the four freshwater wetland nature reserves.



Source: Friday (1997), p.2.

Historically, however, the entire area was a huge and complex wetland mosaic. The undrained fen was a wild area of floodplain wetland of around 3850 sq km in extent. Rivers in this flat landscape were slow-flowing and flood-prone. Wetland habitats included large shallow lakes such as Whittlesey Mere (the second largest lake in England, until its drainage in 1851), extensive sedge and reed beds, waterlogged woodlands, and seasonally flooded grassland habitats. Waterlogging allowed the development of thick layers of peat (partially decomposed organic matter), which now forms the basis for today's dark, organic-rich fenland soils.

The area's biodiversity also supported a productive local economy for many hundreds of years. Peat was used for fuel, sedge and reeds were cut for thatch, and large quantities of wildfowl and fish were sold for food in the surrounding towns and cities of Lincoln, King's Lynn, Wisbech and Cambridge.

Less than 0.02% of the original floodplain wetland habitat remains;

fragments of it survive in the four small nature reserves shown in Figure 1. Wicken, Chippenham, Holme and Woodwalton Fens occupy a total area of just 7 sq km. In addition, the Ouse and Nene washes, marked on Figure 1, are areas of seasonally flooded washlands used for winter flood control and valuable for wetland birds today.

Drainage of the Fens

Drainage has revolutionised the fen landscape and ecosystems. Figure 1 shows the extent of the original fens. The inland portions of the fens were peat-based, and the seaward part of the fens was underlain by silt (alluvium) deposited by rivers or the sea.

Local efforts to drain the fens date back at least to Roman times. Large-scale drainage took place in the 17th century. Entrepreneurs, known as 'adventurers', contracted Dutch engineers to straighten existing rivers and construct artificial canals. The most famous of these engineers was Cornelius Vermuyden, who oversaw the construction of two great channels, 21 miles long, to drain the central fens – the Old Bedford River and the Forty Foot Drain, which form the boundaries of the Ouse Washes. Water from low-lying land was brought into these channels by pumps powered by the wind (and later by steam, diesel and electricity).

Fen drainage continued on a smaller scale into the twentieth century, and some remaining areas of wetland were drained for food production during the Second World War.

Throughout this period, many farmers and landowners saw fen drainage as an act of civilisation, rather than ecological vandalism. Alan Bloom wrote in *A Farm in the Fen* (1944): '... the thought that the Adventurers' Fen might ever be allowed to revert [to wetland] had scarcely entered my head ... Land, good land, now that it has been so hardly won back from dereliction, should never again be neglected or diverted from its true purpose.'

Wetland habitats in the East Anglian fens

The biodiversity of wetland habitats in the fens has made them important sites for scientific study since the 19th century – the insect life of Wicken Fen was studied by Charles Darwin, amongst others.

Figure 2: Vegetation succession from open water to woodland in the Fens

SUCCESSIONAL STAGE		KEY SPECIES
Fen woodland	Time	Birch, oak
Fen carr (wet woodland)		Willow, alder
Sedge fern		Sedge
Closed reed swamp		Reeds, reed mace
Open reed swamp		Bullrush, water lilies
Submerged aquatic plants		Pondweeds
Open water		Plankton

Source: Godwin (1978)

In the mid-20th century, some of the pioneers of plant ecology worked at Wicken Fen. Their studies of ecological succession showed that plant communities gradually colonise open water to create a predictable sequence of wetland habitats. Figure 2 shows the sequence of undisturbed vegetational succession from open water to marsh, swamp, carr (wet woodland) and Fen woodland.

The depth of open water gradually decreases as organic matter accumulates on the lake bed. In time, aquatic plants such as water lilies and reeds are able to take root. Their stems and leaf fragments in turn accumulate, making water levels shallower still. Sedge, a tall, grass-like wetland plant, eventually colonises this wet peat. As the ground surface eventually rises above water level, it is colonised first by moisture-tolerant tree species, forming the dense wetland tangle of shrubs and trees which make up fen carr. The woody roots continue to consolidate the ground and slowly raise its level until taller trees such as oak and ash invade.

Friday (1997, p.15) comments: 'If dead plants are the body of the Fen, then water is its lifeblood.'

Human activity and animal grazing would often have interrupted this sequence on the original fens. Peat was dug for fuel, and reeds and sedges harvested for fuel and thatch, maintaining areas of vegetation communities as marshland plagioclimax.

Before the drainage efforts of the 17th century, fenland consisted of a vast mosaic of these successional stages (seres), together with some areas of acidic mossy bog. Only tiny fragments of each habitat are preserved today, set in a drained landscape of intensive arable farming.

The variety of successional stages and habitats is one reason for the high biodiversity of the fen wetlands. Wicken Fen is the flagship nature reserve of the Fens – one of the oldest nature reserves in the country, and one of the earliest acquisitions of the National Trust, when first purchased in 1899. It is extremely rich in wildlife. The total species list for Wicken Fen stands at 8230 species, the most of any UK nature reserve. Figure 3 lists some of the major species groups which have been identified at Wicken Fen, including over 1000 species of moth and butterfly, 1000 species of beetle, almost 2000 different flies, 30 mammals and over 200 species of bird.

Despite the removal of more than 99% of the original fen wetlands, the remaining fragments are remarkable for their biodiversity. Their protection is one of the most important ecological challenges in lowland England, and the focus of ambitious long-term conservation projects.

Island biogeography

Island biogeography is the study of isolated plant and animal communities. Ecologists have found huge variation in different islands' species diversity. The results of their studies have since been shown to have great importance for wildlife conservation in other habitats as well.

The pioneers of island biogeography were the American ecologists MacArthur and Wilson, who studied the species richness of tropical islands in Florida and Panama in the 1960s. They found that size and distance of isolation are the two most important factors in explaining an island's species diversity.

Large islands have more species, for several reasons:

- They tend to contain a wider range of habitats than smaller islands.

Figure 3: Major species groups at Wicken Fen

Species Group	Number of Species
Birds	232
Mammals	30
Fish	20
Amphibians	4
Reptiles	3
Trees, flowers and grasses	429
Butterflies	35
Moths	1088
Algae	327
Mosses and liverworts	132
Lichens	86
Fungi	399
Molluscs	88
Woodlice and water fleas	128
Spiders	251
Millipedes and centipedes	20
Bees and wasps	572
Sawflies	131
Bugs & aphids	343
Caddisflies	53
Mayflies	13
Dragonflies and damselflies	24
Beetles	1527
Flies	1893

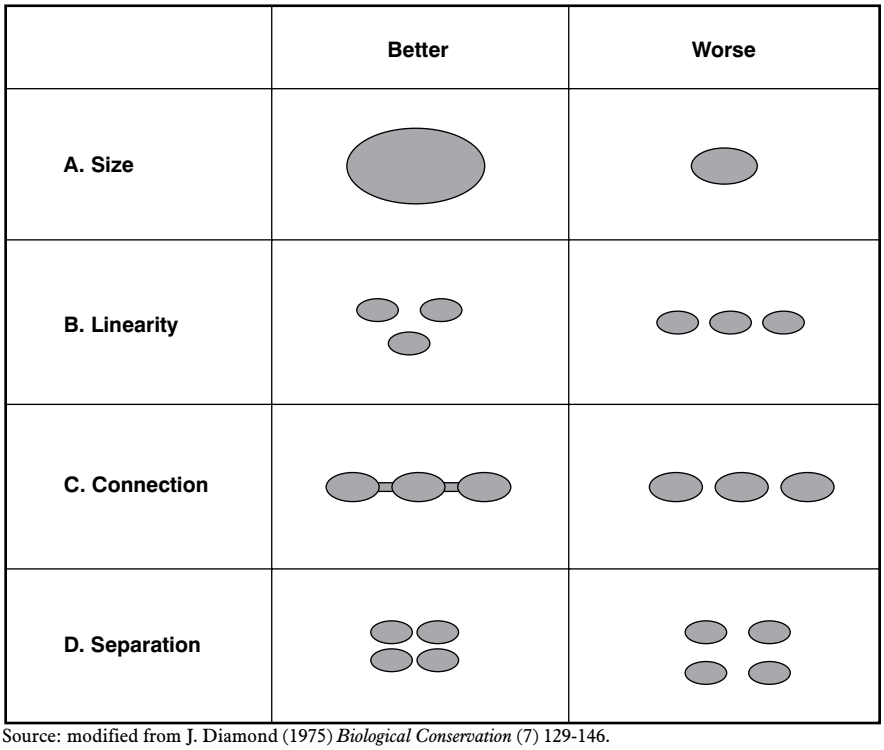
Source: www.wicken.org.uk/wildlife_species.htm, accessed June 2010.

- They support longer food chains: predator species at the top of the trophic pyramid require large numbers of prey for survival.
- They are less vulnerable to extinction due to chance events such as fires.

Isolated islands are difficult to colonise, because most species find it difficult to bridge gaps between suitable habitats. Highly mobile bird or insect species can travel large distances; a few wind- or water-borne seeds may cross the oceans – but other types of plants and animals are limited by isolation.

Even large islands isolated by only a few miles exhibit some species depletion. This is why Britain has three native snake species, while Ireland has none. Britain has five owl species; Ireland has three. The effects of size and isolation are much more dramatic in smaller and more remote island ecosystems.

Figure 4: Some design principles for nature reserves, derived from island biogeography theory



Source: modified from J. Diamond (1975) *Biological Conservation* (7) 129-146.

Nature reserve design

Conservationists have applied the findings of island biogeography to the design of nature reserves. This is because many nature reserves are islands of rich habitat suitable for many plant and animal species, surrounded by a sea of unsuitable habitats. The analogy applies well to the fen wetland fragments.

Habitat fragmentation in the fens means that wetland fragments are islands within a human-altered landscape. Despite their impressive remaining biodiversity, today's small and isolated fen fragments have lost some of the original species of the pre-drainage fenland. Their size also makes them vulnerable to impacts from the surrounding intensive farmland. Threats include eutrophication from fertiliser run-off and drying out as water flows from the wetlands to the surrounding drained fields (Figure 5).

Figure 4 shows some important lessons from island biogeography for the design of nature reserves. Larger and closer reserves, and those linked by habitat corridors (C) such as carefully managed river environments between wetlands, are preferable. Island biogeographical theory predicts that larger and closer reserves will have a higher biodiversity than those that are smaller and more fragmented – even if the total area of protected land is the same.

Some conservationists are increasingly attracted by more radical ideas of landscape-scale restoration ecology, often known as 're-wilding'. Instead of creating an archipelago of small and scattered reserves (the 'chain of pearls' model), it is argued that only larger nature reserves can provide the range and scale of habitats required to create viable populations of rare plants and animals. The Royal Society for the Protection of Birds (RSPB) has endorsed this vision for large-scale change in a strategy which it calls *Futurescapes*.

An area of reclaimed polder close to Amsterdam in Holland provides a possible template for fenland restoration ecology. The Oostvaardersplassen reserve is a 5700 hectare (57 sq km) area of fen vegetation, wet woodland and grassland which is grazed by herds of herbivores including wild ponies, and to which the sea eagle has recently returned to breed.

Examples of fenland species which require large areas of habitat include birds such as the bittern and the marsh harrier, which nest almost exclusively in extensive reed-beds. Amongst mammals, otters were once common but are today only gradually

re-establishing their range in the area. These would be some of the most high-profile species to benefit from large-scale habitat restoration in the fens.

Beavers have probably been extinct in the fens for a thousand years, although due to hunting rather than habitat loss. There are no plans to reintroduce the beaver to East Anglia, despite the possible headline value of such a proposal.

The Wicken Fen Vision and the Great Fen Project

Two of England's most ambitious conservation projects are seeking to recreate fenlands on a large scale in East Anglia.

The Wicken Fen Vision is administered by the National Trust, and involves a proposal for the expansion of the existing nature reserve at Wicken Fen, between Cambridge and Ely. The reserve has four major designations: it is a National Nature Reserve, a Site of Special Scientific Interest, a Special Area of Conservation, and a RAMSAR site of international importance protected under the Convention on Wetlands.

The intention is gradually to acquire farmland from 120 different landowners within the 5300 hectare (53 sq km) Vision area, as it becomes available through sale or bequest over the next 100 years. Habitat restoration will create a mosaic of fenland wetland habitats, so that the reserve will consist largely of seasonally wet grassland, with some areas of woodland, reeds and open water. The current nature reserve attracts around 40,000 visitors per year, and the Vision slogan, 'Space to breathe, space to think, space to explore', emphasises the recreational benefits of accessible nature reserve for expanding local populations.

Land acquisition to date has more than doubled the size of the reserve, to 758 hectares. The process of habitat restoration has begun by stopping infield drainage and allowing permanent vegetation to develop. The National Trust has introduced Highland cattle and Konik ponies to some of the new areas of land – an echo of the free-roaming herds of large herbivores which grazed the original fens in prehistoric times.

The Great Fen Project, between Huntingdon and Peterborough, is administered by the Environment Agency, Natural England and the local counties' Wildlife Trust. It is a proposal to link the two existing National Nature Reserves of Woodwalton and Holme Fens (Figure 5). Over a number of decades, the Project aims to create a complex of wetland habitats covering 3700 hectares (37 sq km) from this area of agricultural land. Like the Wicken Fen Vision, the Great Fen Project envisages expansion of recreational opportunities by creating visitor centres, boat moorings and cycle paths.

Increasing biodiversity and expansion of recreational opportunities are these projects' two main aims. However, the projects' steering groups point to two further environmental benefits of wetland expansion.

The first is hydrological. By allowing seasonal flooding, wetlands act as a flood control safety valve in a managed landscape. Their variable water levels give opportunities to attenuate flood peaks and protect downstream areas of urban and arable land.

Wetland conservation also has a role in climate change. Wetland peat is a major 'carbon sink' – a terrestrial store of carbon. As peat dries out, the carbon oxidises and is released to the atmosphere as CO_2. The ground level in parts of the fens has fallen by several metres as peat has shrunk in this way since drainage. Halting drainage of the area will create saturated soils, which will in turn prevent oxidisation and retain the carbon stored in peat.

The proposals are not without controversy. Some local farmers and one Cambridgeshire MP are concerned that high-quality arable land is being lost, at a time when the UK should be concerned about food security. A 'Save our Fens' petition to the Prime Minister gathered 418 signatures in 2010. Supporters of the Wicken Vision and Great Fen proposals say that the areas affected represent less than 0.1% of the total arable area of the UK.

Figure 5: Tributary of the River Nene at Holme Fen – a rare fragment of wet fen birch woodland. Note the artificially straightened channel, and the green algae indicating eutrophication.

Bibliography and further reading

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Focus Questions

1. What are the main past and present threats to freshwater wetland habitats in East Anglia?

2. Explain the relevance of the ecological theories of plant succession and island biogeography to nature conservation.

3. Outline the benefits and problems of large-scale habitat restoration in the East Anglian Fens. To what extent do you agree that the Wicken Fen Vision and the Great Fen Project are realistic and responsible ways of promoting biodiversity?