RSPB Ouse Fen – creating the UK's largest freshwater reedbed

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The Hanson-RSPB Wetland Project aims to create a c. 700ha wetland containing the largest freshwater reedbed (460ha) in Britain. This partnership project between the RSPB and Hanson UK has been overseen by Cambridgeshire County Council, which is the local mineral planning authority, and has resulted in the creation of RSPB Ouse Fen nature reserve. This forms part of a wider, near contiguous, 3,000ha wetland that includes RSPB Fen Drayton Lakes and the Ouse Washes. Here we describe the background to the project, the wetland's innovative design and construction, and the wildlife that the site so far supports.

Background

The wetland at Ouse Fen is being created following extraction of sand and gravel. In the late 1980s, much of the area that has subsequently become RSPB Ouse Fen reserve was identified as one of three major potential minerals sites in Cambridgeshire County Council's Minerals Local Plan. In 1993, ARC (Hanson's predecessor) submitted an application for planning permission to extract sand and gravel from the area. At that time, most of the land was anticipated to be of high agricultural quality (grades 2 and 3a) and it was proposed that it would be restored mainly back to arable land, together with a 50ha constructed wetland. The former would be achieved by removing the topsoil, excavating the sand and gravel beneath it, and then replacing the topsoil on these lowered areas.

During the planning consultation it was realised that the land was of lower agricultural grade than originally anticipated. As agriculture was no longer the only feasible end use, several nature conservation bodies advocated the benefits of a wetland-focused restoration. Planning permission was granted, with a condition that a feasibility study be undertaken to determine whether the restoration could instead be to wetland. The RSPB, on behalf of the conservation interests, was nominated to work with Hanson on this study. It concluded that extensive wetland restoration was feasible and could provide a major contribution

to UK biodiversity, in particular by benefitting threatened species such as Bittern *Botaurus stellaris*.

The feasibility study was submitted to Cambridgeshire County Council and consultation was initiated, including with the local community, who strongly favoured wetland restoration over conversion back to arable. Following an agreement between the RSPB and Hanson over the design, creation and future management of the new wetland, a revised application was submitted in 1999, which included the creation of a 700ha wetland. This was approved.

An aerial view of the Hanson-RSPB Wetland Project taken in 2018. Recently created reedbed and open water can be seen across the middle of the photograph. The pattern of short lines in the middle top of the photograph are trenches dug to search for archaeological artefacts before sand and gravel extraction. Hanson UK/Heidelberg Materials

Aims, design and construction of the wetland

The aim throughout has been to create a large enough area of reedbed and associated open water to support a significant breeding population of Bitterns, together with a range of non-reedbed habitats capable of supporting a diverse range of other wildlife. The focus on Bitterns was part of a wider strategy in the late 1990s, involving a range of organisations, to create and restore freshwater reedbeds in areas that would remain safe from coastal flooding. At the time, a large proportion of the UK's large freshwater reedbeds, and most of its breeding Bitterns, were in areas at risk of coastal flooding (e.g. Brown *et al*. 2012). The threat to these coastal reedbeds remains and is expected to increase due to ongoing climate-change driven rises in sea level.

Cell 7 under construction in September 2011. RSPB

The site is divided into separate hydrological units, referred to as 'cells'. One of the benefits of this is that it has enabled habitat creation to begin as soon as a particular area of sand and gravel has been excavated, instead of having to wait until quarrying has finished across the whole site.

The design of the earlier cells was focused on the requirements of Bitterns, but subsequent plans have aimed to create both suitable habitat for Bitterns and a more diverse wetland generally. Key components of this mix of habitats are

described below, with their approximate intended proportions across the site as a whole given in parentheses. The proportions of these habitats vary between cells with, for example, some cells being dominated by large meres, and others intended to comprise mostly drier wetland habitats.

- **Wet reedbed** (60%) with a long interface between Common Reed *Phragmites australis* (hereafter referred to as 'Reed') and open water to provide areas for Bitterns to feed on fish that penetrate the reedbed margin from adjacent open water (Gilbert *et al*. 2005), and for Bearded Tits *Panurus biarmicus* to feed on adult non-biting midges (Chironomidae) (Beemster *et al*. 2010). The aim is to provide a Reed/open water interface of >400m/ha. Breeding densities of many wildfowl are highest where there are more or less equal proportions of swamp and open water (e.g. Kaminski & Prince 1981). The wet reedbed is designed to have a water depth of around 0.6–1.0m in spring and a varied topography. A variant on this design, which includes larger expanses of wet reedbed with a lower proportion of edge habitat, may provide nesting areas for Bitterns, and potentially also Great White Egrets *Ardea alba* and Purple Herons *Ardea pupurea*, with lower risk of predation by Foxes *Vulpes vulpes*.
- **Drier reedbed with some marginal scrub** (10–20%) to provide nesting habitat for Bearded Tits and to develop a rich reedbed invertebrate fauna including species rare in, or absent from, wetter areas of reedbed (Kirby 1992; Hardman *et al*. 2012; Sears *et al*. 2013). These areas have a water depth of 0.2–0.4m in spring and are flat and large enough (>1ha) for the reed to be cut commercially. In some areas these shallower reedbeds will be grazed to create a fen-like habitat.
- **Shallow, <1m-deep open waterbodies with surrounding reedbed and fen** (20–30%) including an extensive, shallow drawdown zone, deeper ditches and isolated pools. These areas can be maintained as shallow, open water to provide feeding habitat for range-expanding, colonial nesting herons, egrets and Glossy Ibises *Plegadis falcinellus* (Ausden *et al*. 2014) through cutting and livestock grazing. They are akin to a 'blue border' – the ring of shallow, open water found on the grazed outer margins of reedbeds in some lakes elsewhere in Europe.
- **Permanent, 'deep' open water** forms a component (approximately 30%) of all the cell types above. This supports a diverse fish fauna including Rudd *Scardinius erythrophthalmus*, a species known to be important prey for Bitterns (Gilbert *et al*. 2003; Self 2005), and which is characteristic of shallow, mesotrophic, macrophyte-rich lakes. These areas are designed to remain as open water with a depth of 1.5–2.5m in spring, which is too deep for Reed or other emergent plants to grow, apart from as a floating mat.

More recent designs have also aimed to provide suitable tree and scrub nesting habitat for colonially nesting herons, egrets and Glossy Ibises on specially created islands. These are planted with Pedunculate Oaks *Quercus robur*, Alders *Alnus glutinosa* and willows *Salix*, and have been located away from paths to minimise human disturbance. The most recent design includes water-filled channels through the scrub to allow these large birds easier access to sheltered areas for nesting, as at Holkham NNR (Ausden *et al*. 2023).

The first stage of creating each wetland cell involves excavating and removing the typically 2–3m-deep layer of topsoil and other material (known as the 'overburden') above the sand and gravel and extracting the 2–5m layer of sand and gravel beneath it down to the level of the underlying clay. Each of these bowl-shaped 10–40ha cells is then landscaped using layers of overburden available from the next phase of topsoil stripping to create the wetland features agreed for each cell design.

The landscaping is carried out using bulldozers which, guided by GPS, set the height of their blade to the level shown in the design. This can achieve final land levels within 0.1m of those in the design, where this level of accuracy is required. The final topography of the cells may be modified, however, if there is more, or less, overburden available for landscaping than originally anticipated.

Higher areas around the outer margins of each cell are designed to become grassland with some patchy scrub, as are areas that do not contain significant depths of aggregates to justify quarrying. For earlier cells, planning conditions required topsoil to be placed on areas intended

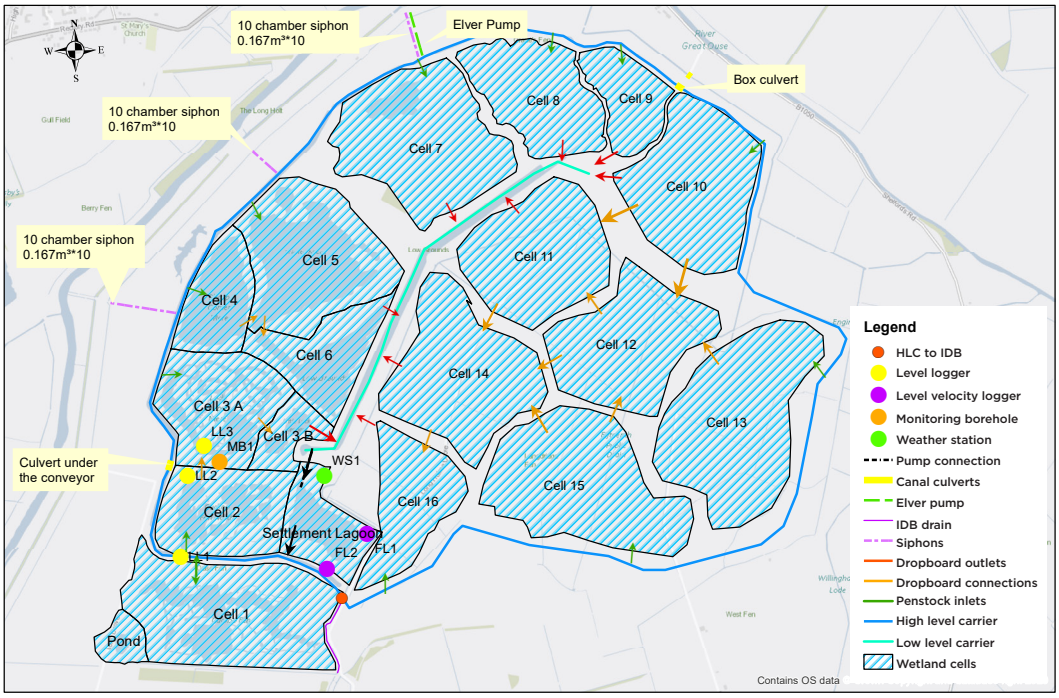

Figure 1. The hydrological design of Ouse Fen, showing the location of different wetland cells, the high level carrier and the low level carrier. As of summer 2024, cells 1–9 have been completed, cells 10 and 11 are under construction, while the remaining cells are yet to be excavated. Mott MacDonald

to become grassland, but this has not been done in subsequent cells to allow a less nutrient-rich sward to develop.

Hydrology

The hydrology of Ouse Fen has been designed so that it should continue to have sufficient water even with expected climate-change driven reductions in water availability in southern England in late spring and summer.

Wetland habitat has been created in a series of cells within a large, hydrologically sealed, low-level restoration area. This, combined with water control infrastructure, allows water levels in individual cells to be independently controlled, thereby allowing greater control over wetland management, including the ability to set back succession through periodic drying out and reflooding.

Water enters each cell via a penstock sluice, either from an engineered, clay-lined, high level carrier (HLC) (i.e. watercourse) around the perimeter of the wetland, or from one or more other cells that are themselves connected to this HLC. Water exits each cell over an adjustable drop board sluice. Water from the lowest cells is discharged into a low level carrier (LLC) (Figure 1).

The HLC will eventually be connected to the nearby River Great Ouse via two or more banks of siphons. Water will be siphoned from the river during periods of high flow at any time of year. Taking water during periods of high flow should mean that nutrient levels are lower owing to dilution and will also minimise any potential negative impacts of abstraction on water availability downstream or on the wildlife value of neighbouring protected areas. This connection to the river will allow fish to enter the wetland, and an associated eel pass is proposed to allow Critically Endangered European Eels *Anguilla anguilla* (referred to hereafter as 'Eels') to enter and make use of the wetland cells.

Once Eels are adult, they will not be able to return to the river from the wetland cells and LLC by themselves. The current plan is to net silver Eels in the LLC and transfer them to the river. In the meantime, until the siphons are installed, cells are supplied with water from quarry dewatering which is pumped into the HLC from the settlement lagoon on site.

Koniks grazing in cell 2 in 2023 and thereby helping maintain areas of open, shallow water on the outer edge of the reedbed, akin to a 'blue border'. RSPB

During spring and summer, water levels are allowed to draw down naturally in each cell, unless there is a risk of cells drying out too much.

Vegetation establishment

Cells 1–6 were planted with Reed seedlings. The first of these were bought from suppliers, but supplementary supplies of Reeds have been grown in a polytunnel from seed gathered on site. Early cells, particularly cell 1, were flooded to kill ruderal vegetation to provide largely unvegetated ground in which Reeds were planted. Water levels were then gradually raised to keep areas wet enough for the young Reed without completely submerging it. As the extent of reedbed has increased, it has no longer been considered necessary to plant Reeds in cells 7–9, which are downwind of established areas of reedbed, and are likely to receive windblown Reed seed. Vegetation in these three cells has instead been allowed to regenerate naturally, with water levels raised gradually over a longer period of time, both to facilitate the spread of Reed and to avoid any negative impacts on Water Voles *Arvicola amphibius* that have been translocated to these cells. Temporary fencing has been used to protect some areas of developing Reed from grazing by Greylag Geese *Anser anser* and Common Coots *Fulica atra*, and cattle grazing the surrounding grassland.

On the margins of cells 1–6, where topsoil was respread, soil nutrient levels have been too high to allow the establishment of more species-rich vegetation. In these areas, grassland establishment has been by natural regeneration. In the main visitor area around cells 7–9, where topsoil has not been respread, areas have been seeded with a mix containing forbs such as Ox-eye Daisy *Leucanthemum vulgare*, Red Clover *Trifolium pratense* and Common Knapweed *Centaurea nigra*, which are visually attractive and provide valuable sources of nectar for insects. Patchy scrub has also been established in some areas.

Ongoing management

An important approach to management is to periodically dry out and reflood individual cells on rotation, accompanied by other management during the dry phase, to set back succession. This is to provide a continuity of different successional stages across the site as a whole as, for example, waders and some wildfowl species favour earlier successional wetland habitat (e.g. White *et al*. 2013). So far this has been carried out in cells 1 and 2.

Cell 2 was dried out in autumn 2019, and part of its reedbed cut using a Softrak. Water was raised back to target levels during winter 2019/20. The largest contiguous area of reedbed in the cell could not be cut owing to soft ground conditions. The cell (which comprises about 19ha of grassland and 11ha of reedbed and open water) was then grazed between May 2022 and September 2023 by up to eight Koniks (ponies).

Cell 1 was dried out in 2020 and has received more intensive management. Part of its reedbed was cut using the Softrak in the late summer/autumn of 2020, and then kept dry and mob grazed by about 35 cattle for various periods between late spring and late autumn in both 2021 and 2022, with additional cutting of part of the reedbed in late summer 2021. Water was

raised back to target levels over winter 2022/23.

The Softrak has also been used to cut and open up areas of reedbed in other cells, including to provide nesting and landing areas for Common Cranes *Grus grus*, and to improve viewing of wildlife. The cut Reed has so far been stacked on site, as there is currently no economic use for it. As referred to earlier, dedicated areas for commercial cutting have been incorporated into the design of later cells, with a future provision of at least 8ha. This is expected to provide a sufficient area for an independent reed-cutting business.

Drone image of cell 1 in January 2024 after water levels had been partially raised following a period of drying out to set back succession. RSPB

Grazing by cattle and ponies has been used in combination with cutting to manage vegetation in order to provide areas of open, shallow water, as described earlier. It has not been possible to create suitably wide areas of shallow water in some older cells owing to the steepness of their outer edges. Grey Willow *Salix cinerea* scrub in the reedbeds has also been cut and its stumps treated with glyphosate to help maintain open conditions, although the extent of willow growth has declined, perhaps owing to increased deer browsing. Bundles of cut willow have been placed in the water in cells 3 and 5 to try to increase habitat structure underwater to benefit fish, while Yellow Water-lilies *Nuphar lutea* have been introduced to cell 3 for the same purpose.

The main focus of grassland management in areas left to natural regeneration has been to provide good hunting areas for raptors. These areas have been grazed predominantly by cattle, formerly also by sheep, and more recently also by Koniks, but with parts periodically left ungrazed to provide areas of rough grassland with a suitable litter layer for Field Voles *Microtus agrestis*.

American Mink *Neogale vison* have been controlled in order to benefit Water Voles. Foxes were controlled to reduce the risk of predation of Common Crane eggs and chicks, although this has now stopped as the nesting pair is thought to have been laying infertile eggs.

Monitoring

It has been important to understand the development of the fish fauna at Ouse Fen to inform future design, whether fish introductions might be required and, where they have taken place, to evaluate their success. Electrofishing and seine netting were carried out by contractors in 2010. Thereafter, fish populations have been assessed by RSPB staff electrofishing along fixed transects of known length. The areas of water in which electrofishing has taken place have not been isolated using stop nets, and so the results provide only a very approximate estimate of fish abundance but a nonetheless valuable measure of species composition. Electrofishing takes place in autumn, when it is less hindered by the presence of dense, submerged vegetation, but temperatures are still high enough for fish to be active and caught. Estimates of species composition by weight are based on individuals under 300g, as this is the size range targeted by most piscivorous birds. In practice, very few fish larger than this have been caught.

Breeding birds have been monitored using standard methods, including the use of tape playback to survey Water Rails *Rallus aquaticus*

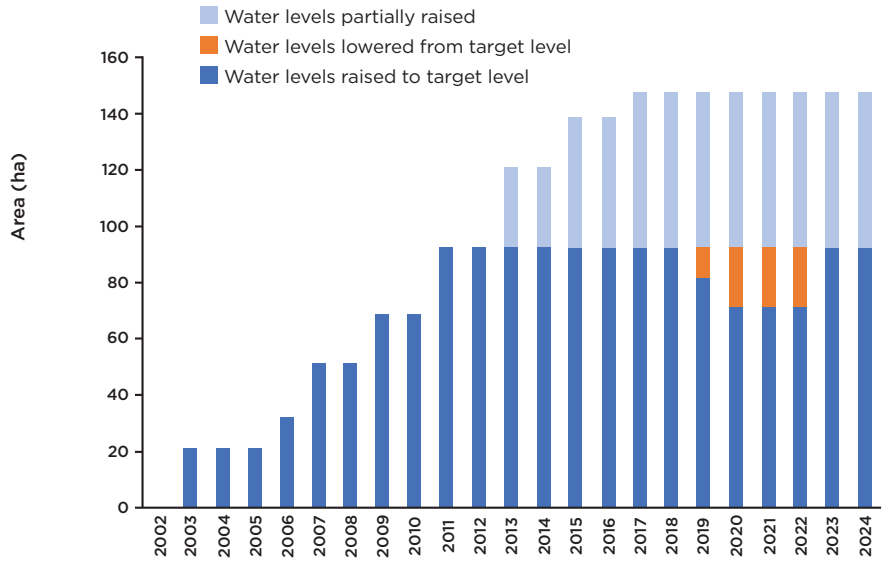

Figure 2. The total area of wetland cells at Ouse Fen in which water levels have been raised. Water levels were lowered from target level in two cells in 2019 and 2020 to help set back succession.

and night-time surveys for crakes (Gilbert *et al*. 1998). It has not been possible to monitor all key species in every cell each year, partly owing to time constraints, but also to avoid disturbance to nesting Common Cranes. Wintering and passage water birds have been monitored using monthly Wetland Bird Survey (WeBS) counts. Water Voles have been surveyed by searching for signs of their presence along fixed transects using standard methodology (Strachan *et al*. 2011). The extent of reedbed development has, in more recent years, been informally assessed using drone imagery.

How the site is developing

Groundworks have so far been completed and water levels raised, either partially or to target levels, in ten cells, resulting in the development of about 148ha of wetland vegetation and open water (Figure 2). Earthworks have also been completed in a c. 25ha 11th cell, but this has not yet been fully commissioned. New Zealand Pigmyweed *Crassula helmsii* has become established in the wetland cells at Ouse Fen, as it has at many other wetlands in the UK. This sometimes carpets channels where it outcompetes all other plants, thereby reducing feeding habitat for fish-eating birds. Within reedbed and its margins, however, it is less of a problem as it is presumably shaded out by Reed.

Fish

Cell 1 was initially connected to an existing Internal Drainage Board drain and has been colonised by a reasonable range of fish species: Roach *Rutilus rutilus*, Tench *Tinca tinca*, Spined Loach *Cobitis taenia*, Pike *Esox lucius*, Three-spined Stickleback *Gasterosteus aculeatus*, Ninespine Stickleback *Pungitius pungitius* and Perch *Perca fluviatilis*. Spined Loach has a very restricted distribution in the UK, limited to five river systems in eastern England. The majority of fish biomass in cell 1, as determined by electrofishing, comprises, Tench and Roach (Figure 3a).

Meanwhile, cells 2–6, which have only been connected to the HLC, have been colonised by a more limited range of species. Because of this, fish have been introduced to help establish a more diverse fish fauna that includes Rudd which, as described earlier, is an important prey species for Bitterns. Similarly, only a limited range of fish species has been found in the HLC, these mainly comprising Perch and Ninespine Stickleback, but with Roach and Spined Loach also present.

The first fish introductions took place in cell 3 where 1,500 Rudd, 1,000 Tench and 1,060 Perch were introduced in January and March 2018. This cell contains 16ha of wetland of which about 50% is open water. These and

subsequent introductions have been sourced from Environment Agency-approved suppliers. The introductions into cell 3 have proved successful, with these introduced species subsequently comprising the majority of fish biomass as determined by electrofishing (Figure 3b).

Roach, Rudd and Perch were subsequently introduced into cells 5 and 6 during winter 2021–22 and March 2023. Roach and Rudd were also introduced to the HLC in March 2023 together with Tench translocated from cell 1. It is hoped that fish from the HLC will be able to colonise the cells connected to it. It was also intended to introduce Silver Bream *Blicca bjoerkna*, a native species that is widespread locally but has a fairly restricted UK distribution, but these have proved difficult to source. No fish have been introduced to cell 4 so that we can monitor longer-term changes in the fish fauna in the absence of introductions.

Breeding birds

Monitoring has revealed the rates of colonisation of cells by different bird species and the overall succession of the wetland avifauna. The open conditions following construction of the cells have proved attractive to breeding waders, particularly in the case of cell 1, where flooding was used to suppress the growth of ruderal vegetation prior to Reed planting. The wetland creation area as a whole has supported up to 14 pairs of breeding Lapwings *Vanellus vanellus*, 11 pairs of Redshank *Tringa totanus*, five pairs of Little

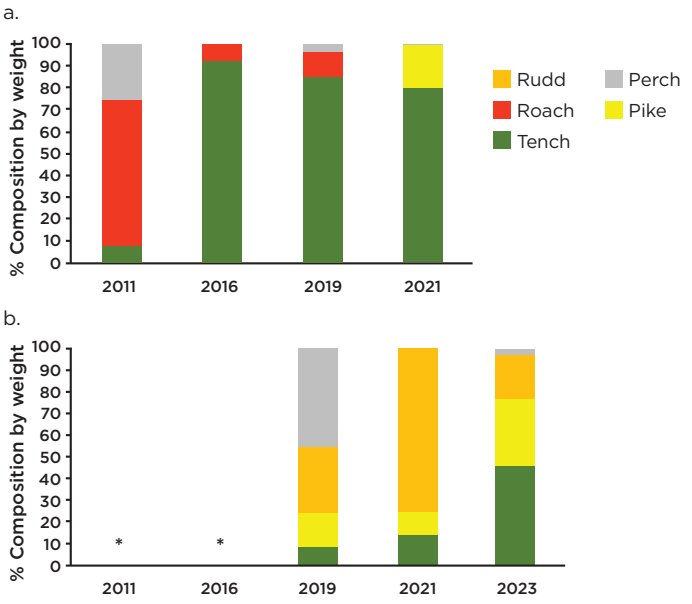

Figure 3. Percentage composition by weight of fish weighing < 300g in cells 1 (a) and 3 (b) as determined by electrofishing. Cell 1 has been colonised naturally by fish, but cell 3 had Rudd, Tench and Perch introduced to it in January and March 2018 (see main text). Electrofishing was carried out along set transects (five in cell 1 in 2011, 2016 and 2021, totalling 280m, but only two in 2019 totalling 190m; four in cell 3 in 2011 and 2016, totalling 585m; six in cell 3 in 2019, 2021 and 2023, totalling 610m).

*figures are not shown for cell 3 in 2011 and 2016 as in both years only a single Ninespine Stickleback was recorded along the transects.

An aerial photograph looking across cells 3–6 (with cell 3 in the foreground), taken in 2016, showing the high proportion of Reed/open water interface. RSPB

Table 1. Densities of breeding Bitterns and Marsh Harriers at Ouse Fen compared with their mean densities at other large RSPB reedbed sites in southern England with similar management objectives. Figures are given for all landscaped wetland cells at Ouse Fen (cells 1–9), and for cells that had target water levels for Bitterns over the period shown (3–6). During 2021–23, cells 1 and 2 were temporarily dried out, and cells 7–9 had not yet had their water raised to target level.

Site	Mean density per km² of reedbed and associated open water 2021–23	
	Bitterns (booming males)	Marsh Harriers (nests)
Ouse Fen (cells 1–9)	7.0	4.7
Ouse Fen (cells 3–6)	9.4	9.4
Ham Wall, Lakenheath Fen and Minsmere	7.8	5.0

Rare bird species that have held territory at Ouse Fen

White-spotted Bluethroat has previously held territory at Ouse Fen. Arterra Picture Library/Alamy Stock Photo

The developing wetland at Ouse Fen has supported an impressive number of bird species that are rare breeders in the UK and/or potential colonists, but which are not known to have nested at the site. Foremost among these are Little Crake *Zapornia parva* and White-spotted Bluethroat *Luscinia svecica cyanecula*, the former of which has not been confirmed as breeding in Britain since Victorian times, and the latter having been confirmed breeding in Britain only once, in 1996. Little Crakes have been recorded twice at Ouse Fen – a female was heard calling in May 2018 and a male was heard singing for 11 days in June 2023. Male White-spotted Bluethroats have also been recorded twice at Ouse Fen – on 19 June 2011 and from 6 May to 15 June 2012. Interestingly, a male also held territory at nearby WWT Welney in 2010 and 2011. A Great Reed Warbler *Acrocephalus arundinaceus* also held territory at Ouse Fen between 17th May and 22 June 2024.

A Red-necked Grebe *Podiceps grisegena* summered in 2011 and 2012 and courted Great Crested Grebes, while a pair of Black-necked Grebes *P. nigricollis* was present during the breeding season in 2022.

Records of Glossy Ibis, Cattle Egret *Bubulcus ibis* and Great White Egret have all increased at Ouse Fen in line with their dramatic national increase. This has been followed by the first recorded breeding by Cattle Egret in Cambridgeshire in 2021 and the first successful breeding by Glossy Ibis in Britain in 2022, both on the reserve a short distance from the wetland creation project.

Ringed Plovers *Charadrius dubius* and possibly as many as five pairs of Ringed Plovers *C. hiaticula*.

As tall emergent vegetation has established, cells have been rapidly colonised by high densities of breeding Reed Warblers *Acrocephalus scirpaceus*, Sedge Warblers *A. schoenobaenus* and Reed Buntings *Emberiza schoeniclus*. The reedbed specialists, namely Bittern and Bearded Tit, together with Marsh Harrier *Circus aeruginosus* and the wet scrub inhabiting Cetti's Warbler *Cettia cetti*, have all taken longer to establish (Figure 4). Colonisation of cells 3–6 by breeding Bitterns and Marsh Harriers has been slightly quicker than in cells 1 and 2. This is presumably because of the increasing number of both species present locally, and because Bitterns and Marsh Harriers that nest in new cells may also use habitat created elsewhere on site. The increases of both species in cells 3–6 during 2021 and 2022 are also likely owed in part to their displacement from cells 1 and 2 as a result of their drying out. Overall densities of breeding Bitterns and Marsh Harriers at Ouse Fen are similar to those in other large RSPB reedbeds in southern England that are managed to achieve similar conservation objectives, while cells at Ouse Fen that had target water levels for Bitterns supported higher densities of them than these other sites (Table 1). In 2024, the whole of Ouse Fen supported 12 booming Bitterns and seven Marsh Harrier nests.

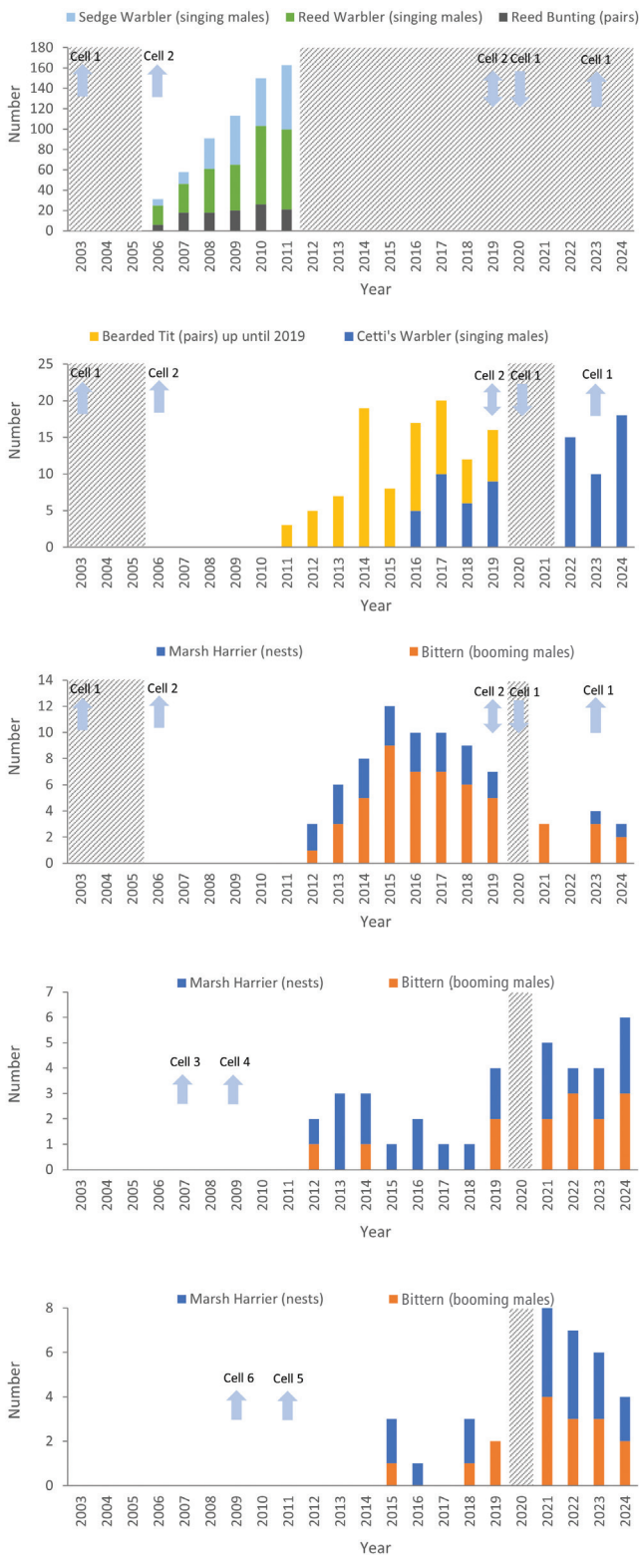

Figure 4. Changes in breeding populations of reedbed birds in cells 1–6 at Ouse Fen. Grey shaded areas indicate years when the species was not monitored; for 2020 this was due to Covid-19 restrictions. Upward- and downward-pointing blue arrows show when water levels were raised to their target level or cells were dried out, with cell 2 being dried out in autumn 2019 and returned to target water levels during winter 2019/20.

Reed Warblers, Sedge Warblers and Reed Buntings were only monitored over a 34.6ha sample area of cells 1 and 2 during a six-year period to establish initial changes in breeding numbers. Cetti's Warblers and Bearded Tits were only monitored in cells 1 and 2 (and the latter only fully surveyed until 2019), partly because of time constraints, but also because monitoring them more recently in cells 3–6 would have caused disturbance to nesting Common Cranes.

Water Rails have not been regularly surveyed, but a full survey of cells 1–4 using 'tape playback' in 2012 estimated ten territorial pairs. Ouse Fen has also supported a single pair of, albeit unsuccessful, nesting Common Cranes each year since 2019. The site also supports one or two reeling Grasshopper Warblers *Locustella naevia* each year, with probably as many as four in 2023.

A full survey of breeding wildfowl in cells 1–9 in 2023 estimated a total of 135 pairs of ducks, swans and geese, which included 28 pairs of Tufted Ducks *Aythya fuligula*, 24 pairs of Common Pochards *A. ferina* and 13 pairs of Shovelers *Spatula clypeata*. There were also five pairs of Great Crested Grebes *Podiceps cristatus* and

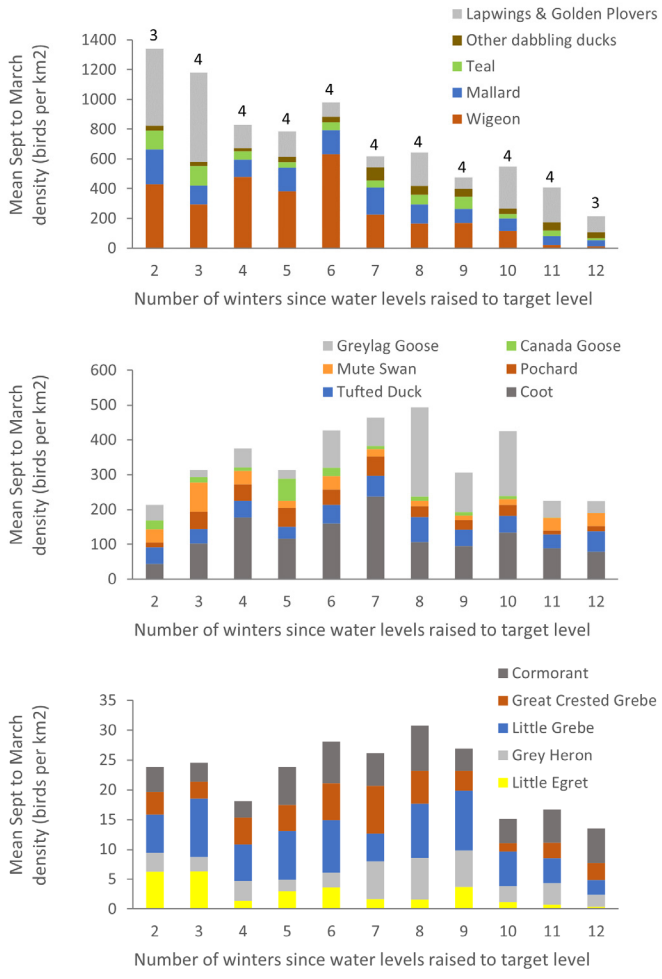

Figure 5. Changes in mean densities of water birds in cells 1–4 at Ouse Fen during the 12 years following raising of water to target level. Figures are mean values from monthly September to March Wetland Bird Survey (WeBS) counts. Figures above the bars in the top graph give the numbers of wetland cells contributing to the mean density shown in all of the graphs, with this number declining over time because of the different ages of cells. For most cells, WeBS counts only started in the second winter following raising of water levels, with the first counts in cell 1 being made in the third winter following raising of water levels.

three pairs of Little Grebes *Tachybaptus ruficollis*. Overall densities of breeding wildfowl in 2023 were considerably higher in the newer, partially flooded cells 7–9 (145 pairs per km² of wetland habitat), than in the older, more Reed-dominated cells 1–6 (59 pairs per km² of wetland habitat), demonstrating the value of providing areas of wetland at earlier stages of succession. In addition, a remarkable range of bird species have held territory or otherwise been present during the breeding season at Ouse Fen, with some of these nesting nearby (see box on p. 16).

As with some other large freshwater reedbeds in southern England, Ouse Fen can attract impressive numbers of Hobbies *Falco subbuteo* in spring, the maximum count so far being 37 in May 2021. The reedbeds at Ouse Fen also now support large numbers of roosting Marsh Harriers, the maximum number to date being 34 in December 2023.

Wintering birds

The wintering water bird fauna has also changed over time in tandem with succession (Figure 5). Total numbers of water birds have been highest during the first few years following raising of water levels and then gradually declined thereafter. This has mainly been due to a decline in numbers of Wigeon *Mareca penelope* and, to a lesser extent, Mallard *Anas platyrhynchos* and Teal *Anas crecca*, and with high numbers of Lapwings and Golden Plovers *Pluvialis apricaria* only present during the first few years following raising of water levels. Numbers of Little Egrets *Egretta garzetta* have also shown a clear decline over time. Water birds are probably less well recorded in older cells as these are obscured by Reed, but this is unlikely to have had a significant effect on these overall patterns. In late winter 2024 the reserve attracted by far its largest Starling *Sturnus vulgaris* murmuration to date, with an estimated 100,000 birds present.

Other wildlife

Signs of Water Voles are widespread in cells 1–6, although they do not appear to occur at particularly high densities. Water Voles were translocated into cells 7–9 in 2019 from drainage

A key aim at Ouse Fen has been to create suitable breeding habitat for Bitterns and in 2024 it supported 12 booming males, one more than the total UK breeding population in 1997. David Newell/Alamy Stock Photo

ditches in an area that was due to be excavated for sand and gravel. Transect surveys carried out in the first of these two cells in 2023 detected signs of their presence, although, again, probably only at low densities. The fixed transects in cell 9 were too dry in 2023 to be worth surveying for Water Voles.

The permanent water of the wetland cells at Ouse Fen supports large numbers of breeding Common Toads *Bufo bufo* and Smooth Newts *Lissotriton vulgaris* but, unsurprisingly given the lack of temporary waterbodies, Common Frogs *Rana temporaria* are rare. The invertebrate fauna of the developing areas of reedbed has not yet been fully investigated.

Conclusions

The wetland creation at Ouse Fen is a good example of developers, NGOs and planning authorities working together to develop and deliver a more strategic approach to restoration following mineral extraction, which has provided both environmental and social benefits, the latter through increased access to nature. Importantly, the wetland creation at Ouse Fen has contributed to a wider strategy to increase the area and quality of freshwater reedbed in areas safe from coastal flooding. This strategy has proved successful, with the majority of the UK's breeding Bitterns now in reedbeds safe from coastal flooding, and these reedbeds also providing valuable habitat for a wide range of other wetland species (Sears *et al*. 2013; Ausden *et al*. 2023; White *et al*. 2024). Key to the success of the work at Ouse Fen has been early NGO involvement in the design stage, early agreement of long-term management arrangements, and local community involvement from the outset.

The wetland at Ouse Fen already supports the full suite of breeding reedbed birds found in East Anglia, with the exception of the very rare Savi's Warbler *Locustella luscinioides*, while, as mentioned, densities of breeding Bitterns and Marsh Harriers at Ouse Fen are similar to those in other large reedbeds in southern England managed to achieve similar objectives. The success of Ouse Fen in attracting range-expanding colonial-nesting herons, egrets and Glossy Ibises is likely to depend largely on the extent and condition of wetlands in the wider area. Breeding colonies of these species typically need large areas of wetland habitat for foraging, in part because their strategy involves ranging over large areas to locate patches of temporarily abundant and accessible prey (Ausden *et al*. 2014). We nevertheless suspect that Great

White Egrets will start nesting at Ouse Fen in the not-too-distant future.

It is too early to assess the benefits of setting back succession through periodic drying and reflooding of cells at Ouse Fen, a process enabled by the innovative design of the wetland. This approach has, however, worked well at RSPB Ham Wall (White et al. 2013; Hughes 2018; White & Hughes 2022), and there is no reason to believe it will not provide similar benefits at Ouse Fen.

The results of electrofishing have demonstrated both the limited range of fish species that have naturally colonised wetland cells, as well as the success of introducing suitable but otherwise absent species.

A key next stage is connecting the created wetland to the water supply of the River Great Ouse. While this will have the benefit of increasing water supply and allowing Eels to enter the site, this increased connectivity will also bring with it the risk of entry of invasive non-native species, of which Floating Pennywort *Hydrocotyle ranunculoides* is a particular concern, along with various non-native fish species. It was notable that, even without this additional source of water, the clay-lined wetland cells at Ouse Fen wetland still retained sufficient water during the exceptional drought of summer 2022, in contrast to some other important reedbeds in East Anglia that are more connected to the surrounding water table. This is important, given that lack of water is expected to become increasingly acute in southern England due to a combination of a changing climate and increased human demand.

Ouse Fen is a great place to walk and see and hear wildlife. To plan your visit or join a guided walk around the reserve, please go to www.rspb.org.uk/ousefen.

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