The Brecks Fen Edge and Rivers Landscape: Identifying Important Freshwater Areas

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Summary

This report describes the results of an Important Freshwater Areas analysis to inform the development of the HLF-supported Brecks Fen Edge and Rivers (BFER) landscape project area.

Important Freshwater Areas are locations of regional or national importance for freshwater biodiversity typically comprising groups of important freshwater habitats or wetlands, or areas with significant concentrations of freshwater Species of Conservation Concern. They are identified by bringing together: (a) all currently available information on the location of priority and designated freshwater and wetland habitats, and waterbodies supporting biological assemblages classified as being at High status under the Water Framework Directive and (b) post-1988 data on the distribution of c.1000 freshwater Species of Conservation Concern (mainly protected, priority and Red-listed species). Habitats considered include all freshwaters (e.g. ponds, lakes, headwater streams, rivers, ditches, canals) and all freshwater wetlands (e.g. fens, bogs, rush pastures, floodplain and coastal grazing marsh etc). For completeness, the analysis was undertaken for the whole of The Brecks National Character Area to enable the Brecks Fen Edge and Rivers project to draw on information from the larger Brecks region.

The Brecks as a whole is identified nationally as an Important Freshwater Area. Within this area, at regional level, 12 areas were identified as Important Freshwater Areas comprising several alluvial river valley systems, pingo and fluctuating mere complexes and areas of valley fen, with important concentrations of sites on and around the edge of the Ministry of Defence Stanford Training Area (STANTA) and on former heathland managed by the Forestry Commission. The areas identified are:

- Foulden, Gooderstone and Oxborough area
- Thompson alluvial corridor
- West Tofts alluvial corridor
- Thompson and Stow Bedon area
- Frost Common area
- Lakenheath RSPB
- East Harling valley and fens
- Lakenheath and Pashford Poors
- East Wretham and Fowlmere area
- Liitle Ouse alluvial valley corridor
- Little Ouse valley fens
- Lark alluvial valley

Nine of these twelve areas overlap substantially or partially with the Brecks Fen Edge and Rivers project area.

The analysis shows that about 70% of freshwater Species of Conservation Concern are associated with ponds, small lakes and fen systems, compared to 5% found only in rivers, with about 25% that are generalists found in both still and flowing water. The analysis highlights the exceptional importance for freshwater biodiversity of naturally formed pingo ponds, including sites which support some of the highest concentrations anywhere in Britain of freshwater Species of Conservation Concern.

Contents

1 Introduction

1.1 Important Freshwater Areas

The Important Freshwater Areas concept was developed by Freshwater Habitats Trust, working with a range of freshwater specialists, to provide the information needed by all those involved in the protection of freshwater biodiversity. Practically, a number of information-related problems currently face those delivering freshwater conservation projects including:

To stem the decline in freshwater biodiversity and prevent further losses and extinctions of freshwater species, both regionally and nationally, it is essential that we first protect the remaining high quality areas, the Important Freshwater Areas, and then strategically restore and create new high quality habitats to extend these areas, and so improve connectivity and resilience.

The core principles of the Important Freshwater Areas concept has been developed by Freshwater Habitats Trust with national freshwater species and habitats experts, major land-owning and managing organisations and statutory bodies. Following initial national trials, and two national workshops in 2014 and 2016 developing methods, Freshwater Habitats Trust has tested the concept in pilot studies in two CaBA (Catchment-based Approach) catchments and in Oxfordshire. Funded by Natural England, the CaBA National Support Group and the Patsy Wood Trust, the work is intended to help catchment groups and other involved in freshwater management to plan work to protect freshwater biodiversity as a whole.

Identifying Important Freshwater Areas requires the collection and collation of data on both species and habitats of importance, including over c.1,000 freshwater or water-dependent species of conservation concern (see following sections). Once compiled the data are used to identify areas where conservation action should focus to return maximum benefits for biodiversity. The key principle is to protect the existing hotspots (many of which are still declining in quality) and build out from these areas. The identification of Important Freshwater Areas provide a basis for the development of conservation projects to protect, restore and improve connectivity for freshwater, subject to constraints of land use and land ownership, and informed by the concept of natural ecosystem function.

This approach, applying the same broad principles of protecting and expanding from the best sites to benefit biodiversity, can be taken at any scale. At the landscape and catchment level the IFA process can be used to provide a working tool to identify areas which are clearly of high importance and those areas which are likely to require further investigation to determine whether they may also be important. Thus the tool has the purpose of focusing effort on protecting and building out from existing hotspots, and encouraging further field survey to determine whether gaps really are gaps.

1.2 The Brecks

Following on from the successful Breaking New Ground Landscape Partnership Scheme, a new landscape partnership application was submitted to the Heritage Lottery Fund in June 2017. The application was successful at Stage 1 and received funding to develop its stage 2 bid for £2M of funding towards a £3m scheme concentrating on Landscape and Heritage of the Brecks Fen Edge and Rivers. The partnership is hosted by Suffolk County Council.

The Brecks are known to be an important area for freshwater biodiversity. In the first interim analysis of Important Freshwater Areas (Figure 1), undertaken by Freshwater Habitats Trust, Breckland was one of approximately 20 areas in England and Wales recognised for their exceptional freshwater biodiversity, including the project area of the Brecks Fen Edge and

Rivers Landscape project area. This ranks the region alongside areas such as the New Forest and Norfolk Broads in its importance for freshwater biodiversity.

Although The Brecks are drier than the surrounding landscapes (e.g. The Fens, the Norfolk Broads), the quality and diversity of its wetlands means that it supports exceptional freshwater biodiversity. The Brecks is particularly known for its pingos, natural ponds that were formed by freezing and thawing of upwelling groundwater during the last glacial period, the fluctuating meres, its valley fens and for chalk rivers and streams. The pingos in particular are amongst the most species rich freshwater environments in Western Europe.

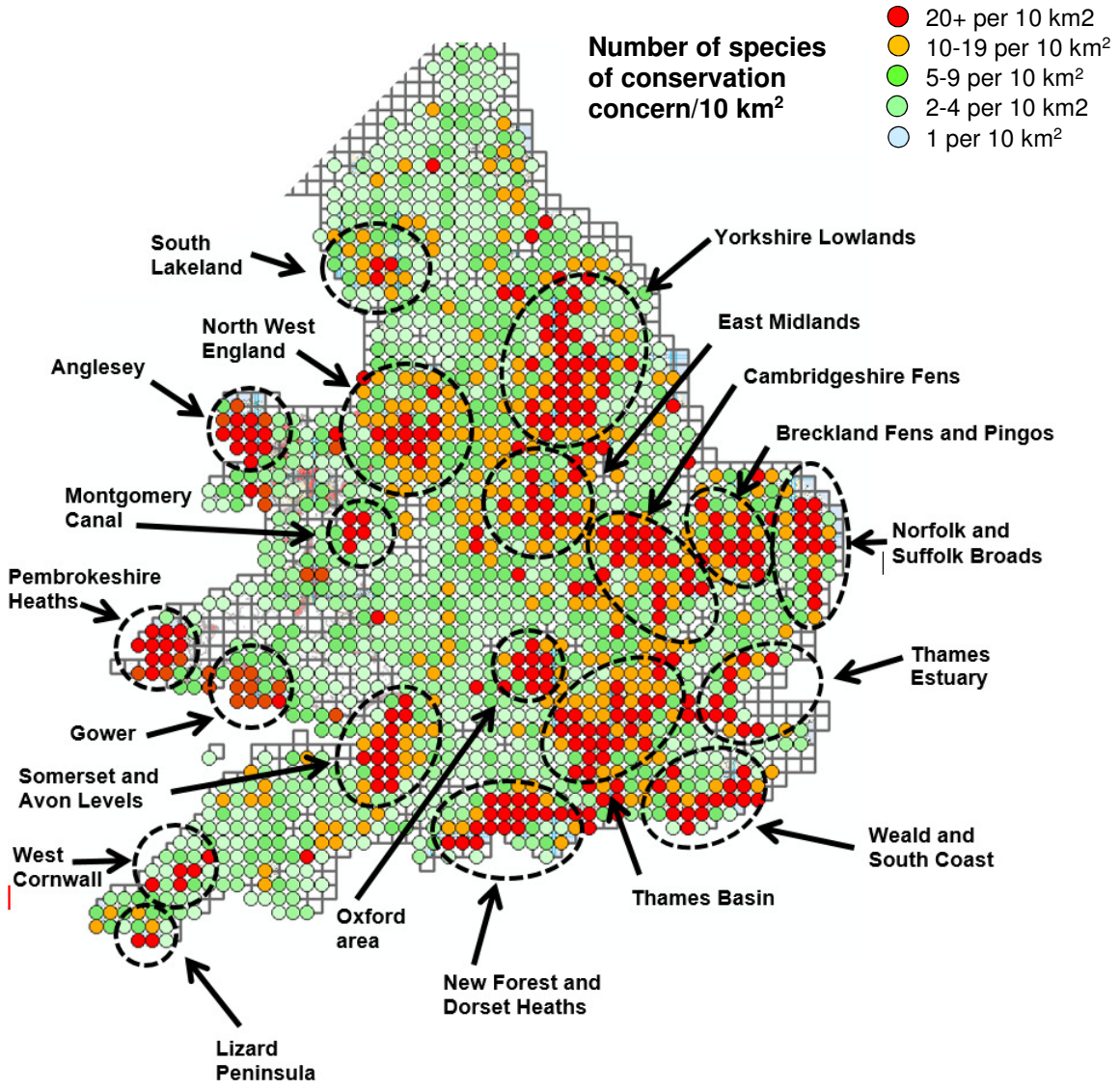


Figure 1. Pilot national map of Important Freshwater Areas based on the frequency of species of conservation concern at the 10 x 10 km square level.

1.3 Objectives of Important Freshwater Area mapping in The Brecks

In developing the Important Freshwater Areas map the work had the following objectives:

- To develop a good understanding of where the Important Freshwater Areas are located in The Brecks region, allowing the links between freshwater areas and key species diversity to be ascertained.
- To use the map and associated data to generate a strategy for a community / citizen science and schools-based approach to gathering missing data and establishing the framework for a long-term monitoring strategy
- To feed into landscape scale management, County Wildlife Site (CWS) management planning and strategy planning
- To facilitate a focused approach to restoration and conservation works on freshwaters in the project area.

The overall objective of the work was to provide information which can be used to tackle the freshwater biodiversity crisis – the ongoing loss and decline of freshwater biota which is still occurring widely in the English landscape. Specifically we aimed to identify areas which are already important for their freshwater biodiversity, so that these can be adequately protected, and use the information to build out from these areas to restore freshwater biodiversity across the landscape taking into account the Lawton principles of “bigger, better, more and joined up”.

2. Identifying Important Freshwater Areas

2.1 Method overview

The main steps to identify the locations of high priority areas for protecting freshwater biodiversity are, in principle, relatively simple. They are:

- Collect relevant biological, physico-chemical and geographical data.
- Collate and verify the datasets.
- Analyse/map data to identify sites/areas that are of high value for their freshwater species and habitats.
- Prioritise sites according to constraints and opportunities, and develop plans to protect and build out from these areas.
- Consult widely and engage with local groups before developing projects in those locations.

2.2 The data

2.2.1 Data types

The data required to identify high priority areas for freshwater conservation include:

- **Species data**: primarily data for species of conservation concern, i.e. species of principal importance and those which have conservation status of Nationally Scarce and above on national lists. Indicator and regionally important species can also be included. The data used are ‘recent’, from 1988 onwards.

- **Habitat and site data**: this includes the location of habitats of principal importance (i.e. priority habitats), clean water sites, Water Framework Directive sites with specific biological quality elements at High status and designated sites (e.g. SSSIs, SACs) of importance for freshwater.
- **Landscape, landuse and geology data**: including the extent of floodplain, semi-natural landuses like woodland and unimproved grassland.
- **Ordnance Survey data**: particularly the location of water bodies in the landscape.

2.2.2 Data sources

Data to support the identification of Important Freshwater Areas came from a variety of sources. A lot of the data is now open access and published by government departments, agencies, public bodies and local authorities (see https://data.gov.uk/). Datasets obtained from this source include habitats of principal importance, flood risk, designated sites, etc. Similarly, summarised Water Framework Directive data is now available from the Catchment Data Explorer http://environment.data.gov.uk/catchment-planning/. Those dataset that are specific to an organisation, like the National Trust and Wildlife Trust land holdings, were obtained on request. Data on species were obtained from the following complementary sources:

- National Biodiversity Network (NBN)
- Local record centres: we obtained species data from Norfolk Biodiversity Information Service (NBIS) and Suffolk Biodiversity Information Service (SBIS).
- Botanical Society of Britain and Ireland (BSBI)
- Expert recorders: records were provided to us from entomologist Martin Hammond, who has done several surveys of ponds and pingos in The Brecks, and by the national beetle recorder Garth Foster.

2.3 Key datasets

2.3.1 Freshwater Species of Conservation Concern

Freshwater plant and animal Species of Conservation Concern are those which are either rare or declining according to national or international legislation and red lists including:

- The International Union for Conservation of Nature (IUCN), which uses standard criteria based on species population decline and the risk of extinction.
- National Red lists, which are increasingly standardised on IUCN-type criteria. The older lists are still based on a species' distributions. For example, if a species has been recorded in 16-100 hectads (10 x 10 km square) in Great Britain, it is considered Nationally Scarce.
- Species of principal importance are those listed in the Natural Environment and Rural Communities (NERC) Act 2006. These species are also commonly called priority species or BAP species. Each country in the UK has its own list of species of principal importance which is based on the list for the UK. The English list includes 943 species of principle importance, and about 10% of these are aquatic or associated with freshwaters.
- Species requiring special protection are also listed in schedules of the Wildlife and Countryside Act (WCA) 1981 and in Annex II of the Habitats Directive.

Species can accumulate conservation designations. For example, otters are protected under Wildlife and Countryside Act 1981, Annex II of the Habitats Directive and is also as species of principal importance. Inevitably, this can be confusing and JNCC is very helpfully keeping an up to date spreadsheet which collates the various conservation designations for species of conservation concern (http://jncc.defra.gov.uk/page-3408) and also provides definitions for the various conservation designations (http://jncc.defra.gov.uk/page-3425).

For the identification of Important Freshwater Areas, a broad list of species of conservation concern was drawn up, including aquatic species, 'wet' species and those species which are dependent on an aquatic species (e.g. the Frogbit Smut). A small selection of indicator species which are not of conservation concern were also included:

- Stoneworts because they are indicator of a Habitat Directive Annex I habitat type[1] and clean water habitats.
- Species indicator of Exposed Riverine Sediments.
- Water shrews, which are very vulnerable to pollutants, including pesticides, and to drainage schemes and bank clearance. The level threats for this species is currently uncertain because they are never very abundant and therefore difficult to monitor[2].

In total, the draft Important Freshwater Areas list of Species of Conservation Concern currently includes 346 plant, 593 invertebrate and 28 vertebrate species and this is the list that was used for The Brecks (see summary in Table 1). Groups which are still to be added include fungi, algae and aquatic micro-invertebrates. The data available for these groups is relatively scarce or difficult to access, or their conservation status is unclear, although progress is ongoing. The draft Important Freshwater Areas list was drawn up in discussion with species experts during the first consultation stages of the Important Freshwater Areas project. It can be requested from Freshwater Habitats Trust.

[1] Habitat Directive 3140: Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.
[2] http://www.mammal.org.uk/species-hub/full-species-hub/full-species-hub-list/species-water-shrew/

Table 1. Summary of the draft Important Freshwater Areas list of Species of Conservation Concern

Taxonomic group	Number of Species of Conservation concern
Invertebrates: water and semi-aquatic beetles	275
Plants: flowering plants	205
Plants: mosses, liverworts, ferns, quillworts, horsetails	129
Invertebrates: true flies	125
Invertebrates: caddis flies	75
Invertebrates: mayflies and stoneflies	29
Invertebrates: true bug	27
Invertebrates: dragonflies and damselflies	24
Invertebrates: molluscs	22
Vertebrates: fish	20
Invertebrates: crustaceans, spiders, lacewings, alderflies, anemones, bryozoans, leeches, worms	16
Lichens	12
Vertebrates: amphibians and reptiles	5
Vertebrates: mammals	3

2.3.2 Habitats of Principal Importance

Habitats of principal importance are those that have been identified as needing special protection. This is because they either support high value species and biological communities (either because they are very diverse or special in some other way), or they have declined in extent or quality.

A UK list was first drawn up, but as a result of devolution, each country in the UK now has its own list of habitats of principle importance, also commonly called priority or BAP habitats. In England, habitats of principle importance are listed on Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006 (England). Those habitats of principal importance relevant to freshwaters and wetlands which were included in the Important Freshwater Areas analysis described in this report are listed in Table 2 below.

Table 2. Freshwater and wetland habitats of principal importance

Habitat name	Descriptions
Rivers	A wide range of river types are included, encompassing all natural and near-natural running waters in the UK. This habitat type includes headwater streams, chalk streams, active shingle rivers and streams and rivers with high hydromorphological or ecological status.
Eutrophic standing waters	Nutrient-rich waterbodies typically found in lowland England including natural lakes, reservoirs and gravel-pit lakes but excluding small standing waters like field ponds. Often degraded by nutrient enrichment.
Mesotrophic lakes	Relatively infrequent in the UK, these lakes have medium levels of nutrients. They are largely confined to the margins of upland areas in the north and west. Mesotrophic lakes are extremely important for a suite of rare aquatic plants and fish.
Oligotrophic and dystrophic lakes	These low nutrient lakes usually have catchments on hard, acid rocks and are found mostly but not exclusively in the uplands. They support relatively sparse plant communities dominated by specialist plants like shoreweed.
Ponds	This habitat type covers High Quality Ponds defined according to a set of biological criteria, thought to represent about 20% of the total pond resource. Priority ponds are often 'nested' within other habitat types, including grassland, heathland, woodland, wetlands, sand dune systems and floodplain mosaics.
Blanket bog	Blanket bogs are peatland habitats which are exclusively rain-fed. They are extensive primarily in the uplands and in western England but can in other upland areas where conditions are cool and wet.
Lowland raised bog	Peatland ecosystems in areas such as the heads of estuaries, along river floodplains or in natural depressions where waterlogging leads to the accumulation of peat, eventually forming a dome above the groundwater level which fed primarily by rain water. In England mainly but not exclusively found in the north-west.
Coastal and floodplain grazing marsh	Grazing marshes are periodically inundated grassland with a network of ditches which are often rich in plants and animals depending on clean water and a long history as wetland habitats. Grazing marshes are particularly important for wetland birds.
Lowland fens	Fens are peatlands which receive water and nutrients from the soil, rock and ground water as well as from rainfall. Species-rich fens can support very diverse communities of plant and animals. Larger fen sites are largely confined to the East of England, but smaller fens occur throughout the country.
Upland flushes, fens and swamps	Fens located on peat or mineral-based substrate in upland situations, which receive water and nutrients from surface and/or groundwater sources as well as rainfall. This habitat type is widespread but local and often occurs in small patches as part of upland wetland mosaics.
Reedbeds	Reedbeds are wetlands dominated by stands of the common reed *Phragmites australis.* They often occur as part of a mosaic of habitats including fen, wet woodland and wet grassland. Reedbeds tend to support species poor plant and invertebrate communities but are one of the most important habitats for birds in the UK.
Purple Moor Grass and Rush Pastures	Pastures defined by their plant community - purple moor grass and rushes - which often occur in a mosaic with other habitat types like wet heath, grassland and wetlands. Most commonly, but not exclusively, found on acid soils in lowland areas of south-western England.
Wet woodland	A relatively broad woodland type which occurs on poorly drained or seasonally-wet soils usually, but not exclusively, with alder, birch and willow. Often found as part of a mosaic of other woodland or wetland habitats, e.g. in fens or on floodplains.
Aquifer-fed naturally fluctuating water bodies	In England, this habitat type is only relevant to the meres of Norfolk which occur over chalk in Breckland and have extreme fluctuations in water level, including periods of drying out.

2.3.3 Water Framework Directive ‘high’ ecological status

Water Framework Directive classification tools categorise waterbodies according to the ecological health of their biological communities and physico-chemical characteristics into five categories: High, Good, Moderate, Poor and Bad. The overall ecological status is established using a ‘one out, all out’ policy. For example if a waterbody has High status for its macroinvertebrate community but Moderate status for macrophytes, its overall status will be Moderate.

Water Framework Directive 'High status' can be defined as the biological, chemical and morphological conditions associated with no or very low human pressure. There are very few rivers and only one lake classified as ‘High’ status in England. However, the various biological and physico-chemical elements used to give an overall WFD status can be reviewed individually including fish, macroinvertebrates, plants, water quality and hydrogeomorphology. Sites which are ‘High’ status for an individual element (e.g. fish, invertebrates) are, by definition, as good as they can get for that element. Inherently these are sites of high conservation interest which require protection.

Water Framework Directive data is available for a selection of waterbodies in most landscapes: essentially rivers, larger streams and lakes, and those small water bodies that are specifically cited in European protected areas (i.e. Special Areas for Conservation). It should also be noted that there are usually one or a few monitoring points in each of the waterbodies monitored, usually in the lower reaches and so this does not necessarily reflect the quality of the headwaters.

3. Important Freshwater Areas in The Brecks

3.1 Waterbodies

The Brecks is a relatively dry region when compared to the surrounding landscapes (Figure 2). Running and standing water bodies in The Brecks include the R. Little Ouse, R. Lark, R. Wissey and various streams, meres, lakes, ponds, ditches, springs and fens (Figure 3).

Biological and physico-chemical data on aquatic habitats is generally scarce, and even more so on small waters: headwater streams, ditches, ponds, springs and flushes. Understanding what is monitored by the statutory agencies or other initiatives is important so that data gaps can potentially be addressed as part of future projects, including citizen science projects.

A small proportion of the waterbodies in The Brecks are monitored for the Water Framework Directive, essentially the main rivers and larger tributary streams and two lakes (Stanford Water and Thompson Water) (see Figure 3 inset).

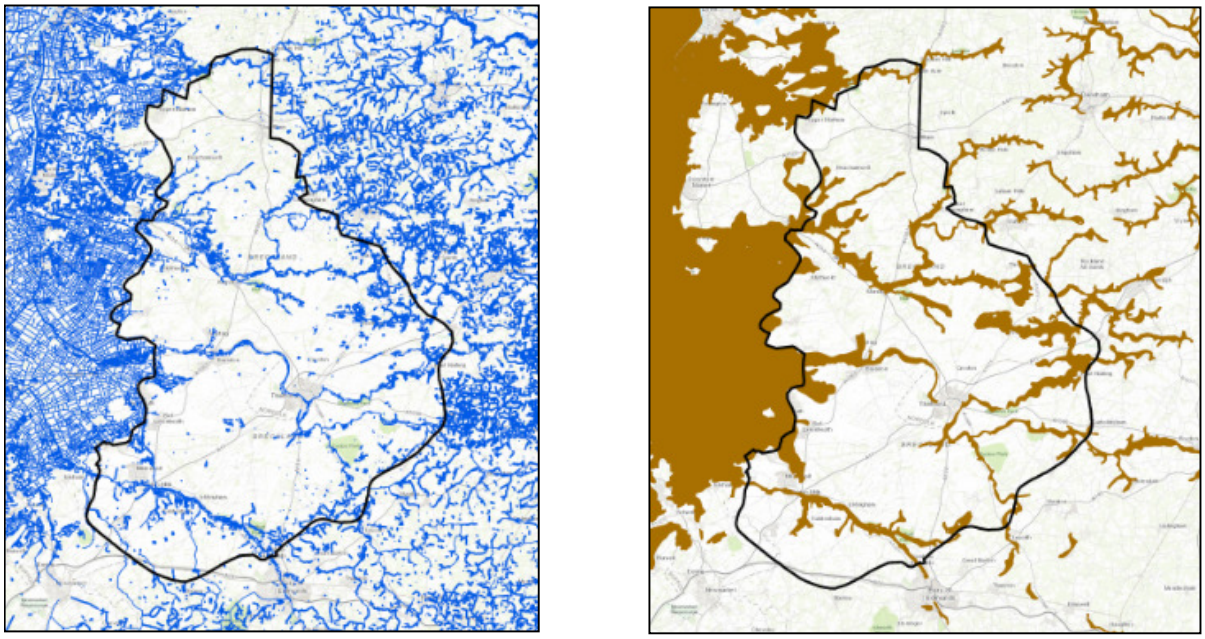


Figure 2. (Left) Surface water in and around The Brecks. (Right) Alluvial deposits. The project area is shown by the black line.

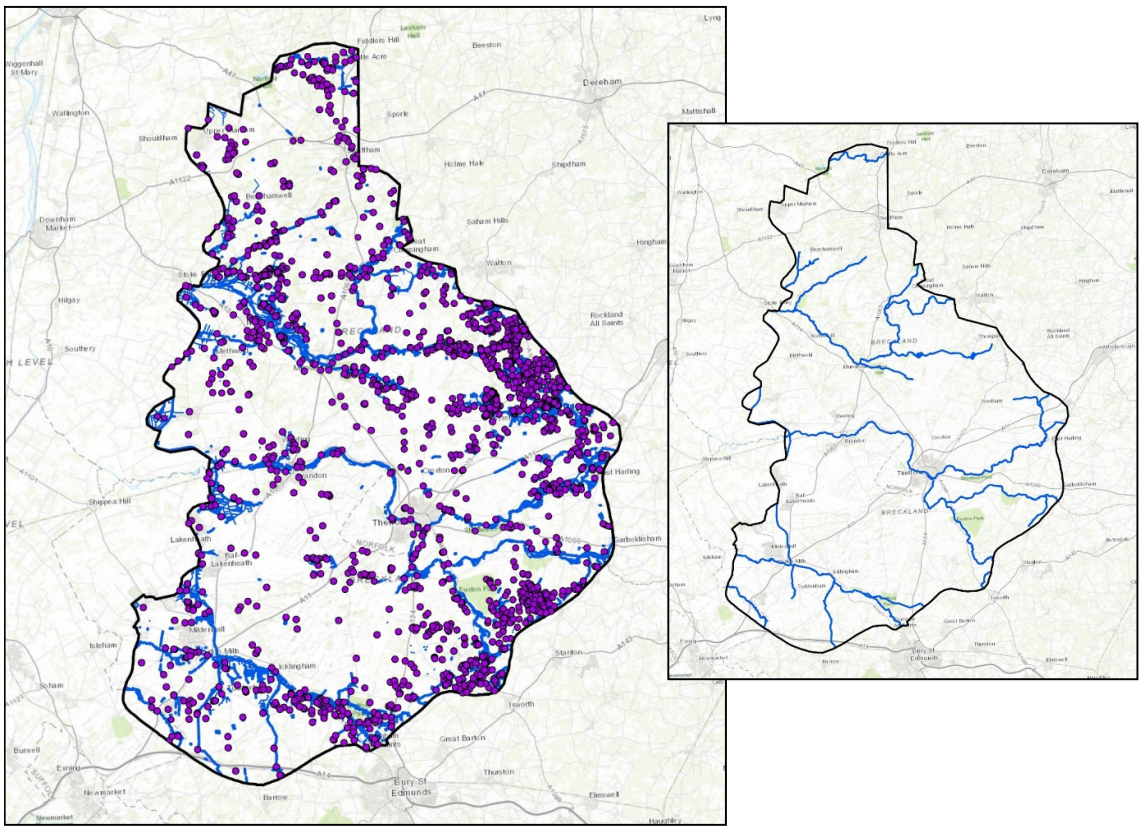


Figure 3. Rivers, streams, ditches, lakes and ponds in The Brecks. Ponds are marked in purple and exaggerated as they tend to be too small to be seen on map at this scale. Inset: Waterbodies monitored for Water Framework Directive.

3.2 Habitat and site mapping

3.2.1 Designated sites and land ownership

The Brecks area includes sites of national and international importance for their freshwater and wetland wildlife (Figure 4). A large proportion of The Brecks is designated as Sites of Special Scientific Interest (SSSIs), including several SSSIs which are water-dependent[3]. Note that SSSIs not designated for their aquatic or wetland habitats can also support priority freshwater habitats and species of conservation concern. Several SSSIs in The Brecks are of international importance and are designated as Special Areas for Conservation (SACs), all of which are water-dependent. The Brecks has four National Nature Reserves, including Cavenham Heath which is also an SSSI and encompasses wet woods, fen, water meadows and riverbanks. In addition to the statutory designations the majority of The Brecks region is also designated as Living Landscape areas by Norfolk Wildlife Trust and Suffolk Wildlife Trust.

At the regional and county level, The Brecks includes areas designated as Local Nature Reserves, including the Great Eastern Pingo Trail, and County Wildlife Sites. There are also many sites owned and/or managed by Norfolk Wildlife Trust and Suffolk Wildlife Trust, as well as one National Trust site. Often these locally designated sites are abutting or at the

[3] Based on unpublished data by Natural England.

same location as sites with national designations. Unsurprisingly, there is also significant overlap between priority habitats and designated sites (see next section).

Designations afford some protection to these sites, particularly those with statutory designations that are owned or managed by nature conservation NGOs or by sympathetic landowners. However, even well-managed freshwater designated sites are commonly exposed to damaging impacts from their surroundings, particularly due to hydrological or water quality impacts, and atmospheric deposition and non-native species. For example intensive landuse around some fen sites is bringing in nutrient and other pollutants via inflow streams or groundwater. Underdrains in fields in the upstream part of fen catchments can also affect hydrological processes. A long-term vision is necessary to address these issues through e.g. land purchase and/or deintensification of the upstream catchment, supported by agri-environment schemes, so that water quality and hydrology can be restored.

In the short-term, actions are needed to ensure the freshwater biodiversity of those sites is protected so that the risk of extinction is reduced. So, for example, if the SSSI unit is very small and grazing may not be possible, active management by volunteers or contractors should be considered to maintain the habitat for the nationally rare species at these sites, until the long-term vision can be realised.

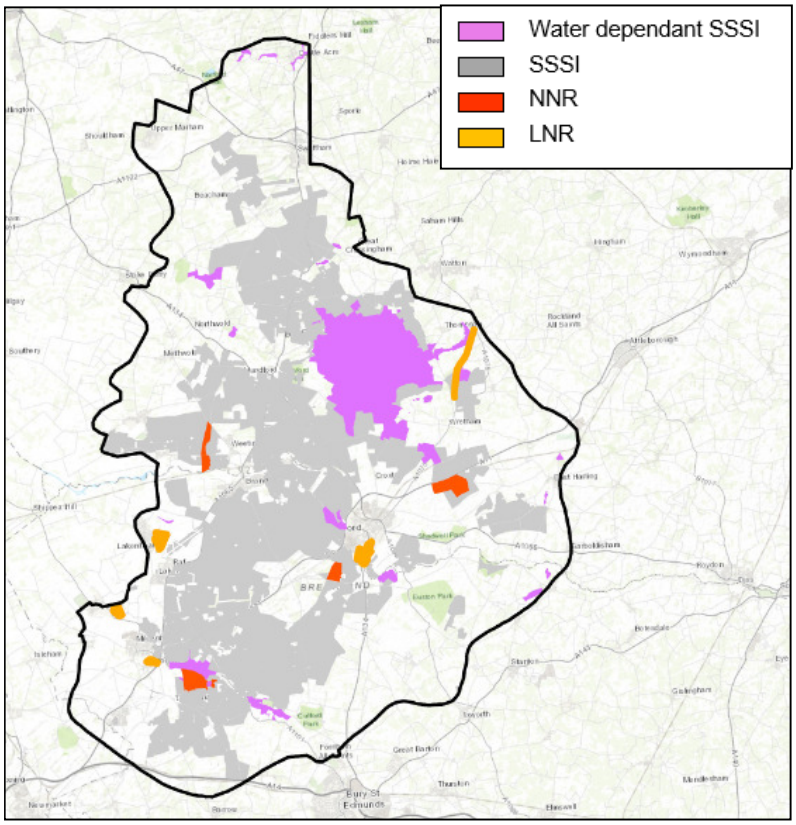


Figure 4. National Nature Reserves (NNRs) and Local Nature Reserves (LNRs) overlaying SSSIs in The Brecks, including those considered water-dependent marked in purple.

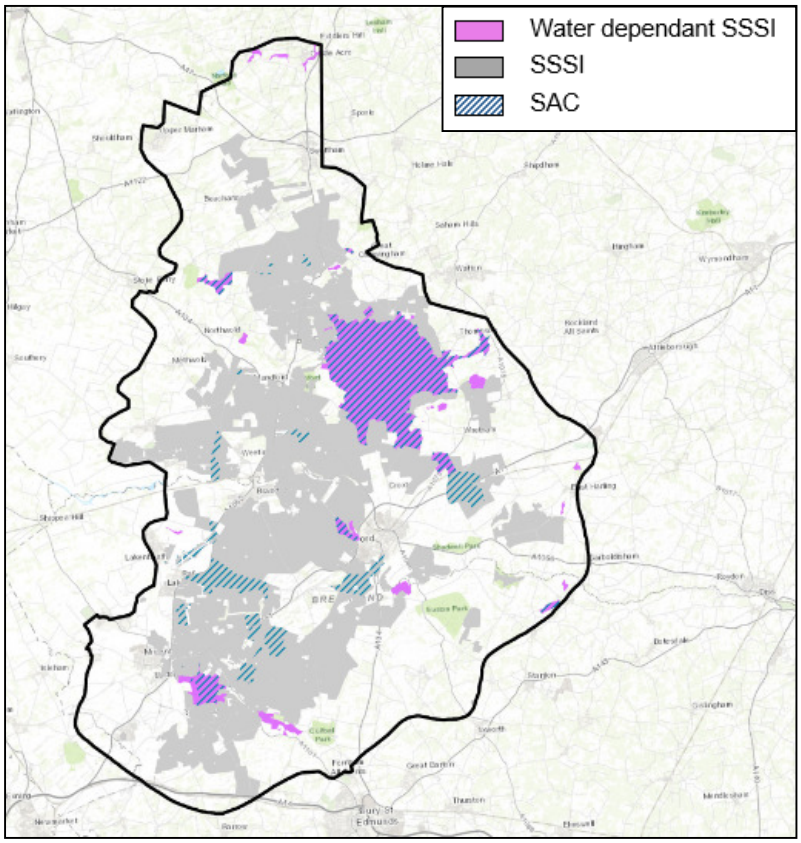


Figure 5. SACs and SSSIs including those considered to be water dependant marked in purple.

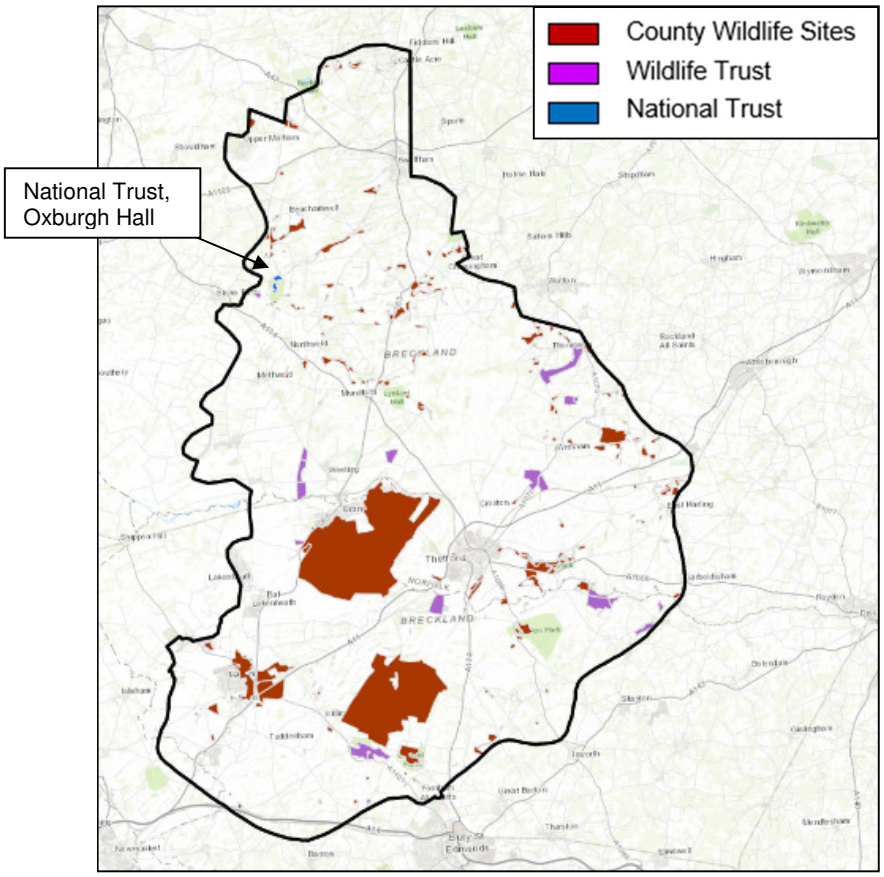


Figure 6. County Wildlife sites, Wildlife Trust and National Trust boundaries.

3.2.2 Habitats of Principal Importance (Priority habitats)

The location of aquatic and wetland priority habitats in The Brecks was established using the national dataset of habitats of principal importance from www.data.gov.uk.

Aquatic and wetland priority habitats in The Brecks include chalk rivers, ponds, lowland fen, reedbeds, coastal and floodplain grazing marsh, rush pasture, and lowland meadows (Figures 7 and 8).

A brief description of each priority habitat type in The Brecks is given below:

- **Chalk rivers**: There are a number of chalk rivers in The Brecks including the Little Ouse River, R. Wissey, R. Nar and R. Lark.
- **Ponds:** The draft dataset for priority ponds shows that some 23% of the ponds in The Brecks are likely to have priority status. There are also three Flagship ponds sites (Figure 8).
- **Lowland fens:** There are small areas of fen scattered around The Brecks. These are the remains of what was once more extensive fen habitat and still support outstanding important concentrations of freshwater biodiversity. Some of these sites are designated as SSSIs but many are not. Fens tend to suffer from fragmentation, and/or poor management (particularly lack of extensive grazing), and/or nutrient pollution from surrounding agricultural land.
- **Floodplain grazing marsh:** there are many areas of floodplain grazing marsh mapped in The Brecks. This habitat type is shortly to be reclassified by Natural England

'floodplain wetland mosaic' and is intended to be treated as an area which will be a priority for freshwater and wetland habitat restoration and creation.

- **Lowland meadows:** There are many patches of lowland meadow in The Brecks. More can be found in Norfolk than in Suffolk. Areas adjacent to existing lowland meadows are potentially locations for new freshwater habitat creation.
- **Purple moor grass and rush pasture:** The mapping shows four small areas of this habitat in The Brecks.
- **Reedbed:** Small areas of reedbed habitat are dotted throughout The Brecks, the largest example being at Cavenham Heath NNR along the margins of the R. Lark.
- **Priority headwaters:** These are areas where it is considered that small streams are likely to in good ecological condition based on the occurrence and extent of low intensity landuse. Priority headwater areas are mostly concentrated in England's upland areas and only make up a very small proportion of the lowland headwater resource. The Brecks is one of the largest areas in lowland England where streams are considered likely to be priority headwaters.

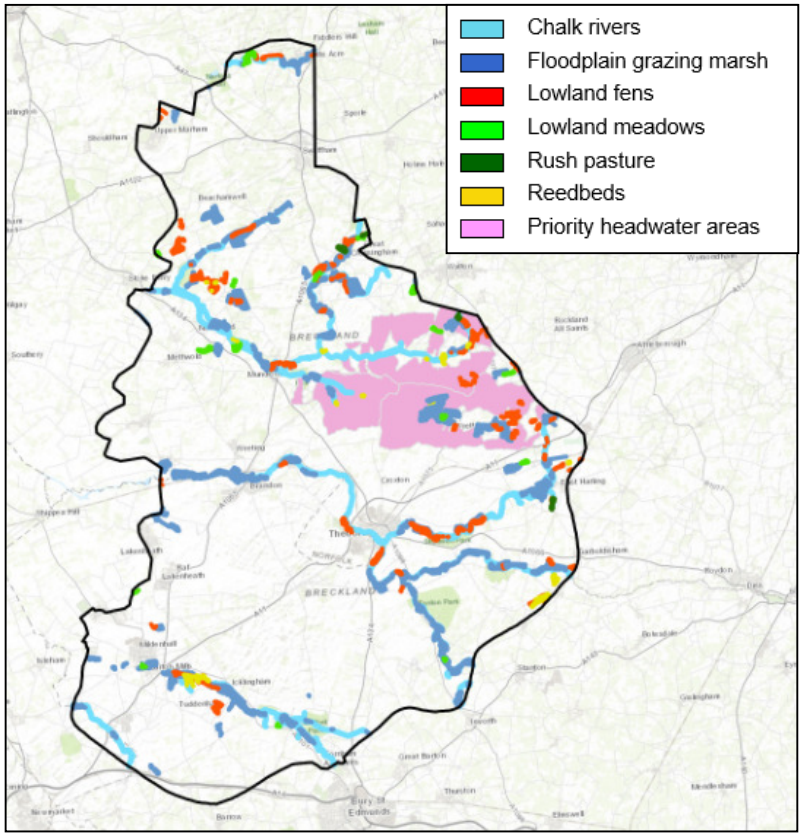


Figure 7. Aquatic and wetland habitats of principal importance in The Brecks.

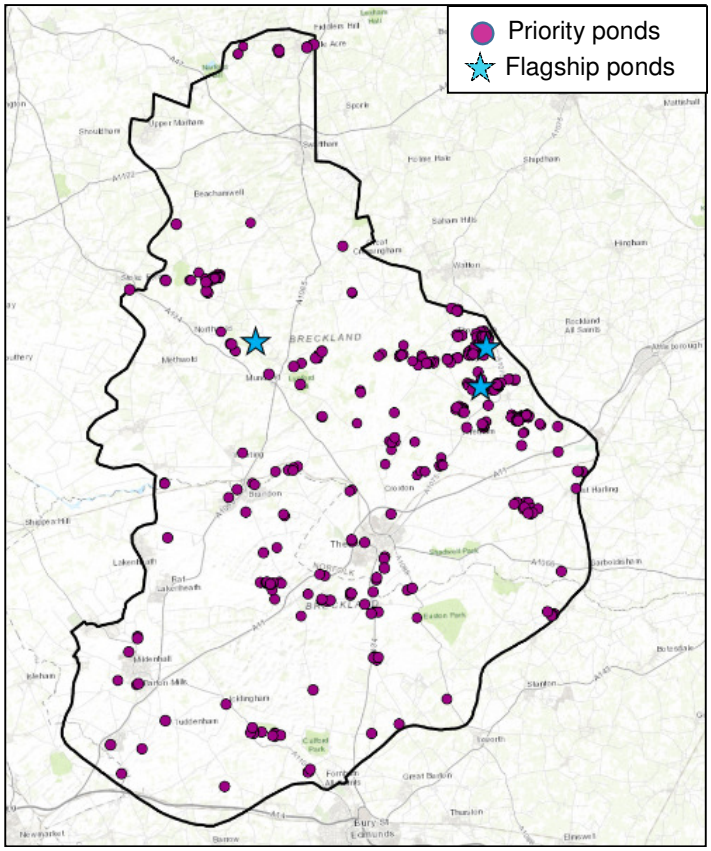


Figure 8. Priority ponds and Flagship pond sites in The Brecks.

3.2.3 Water Framework Directive classification: High status sites

The various elements of Water Framework Directive classification can be looked at singly to identify High status sites for those elements. None of the 27 waterbodies in The Brecks surveyed for Water Framework Directive are classified as High for their overall ecological quality. There are 14 waterbodies with High status for invertebrates, 2 with High status for macrophytes and 4 with High status for phosphate (Figure 9). There is insufficient data available for the two lakes which are monitored for Water Framework Directive to identify any individual High status biological elements.

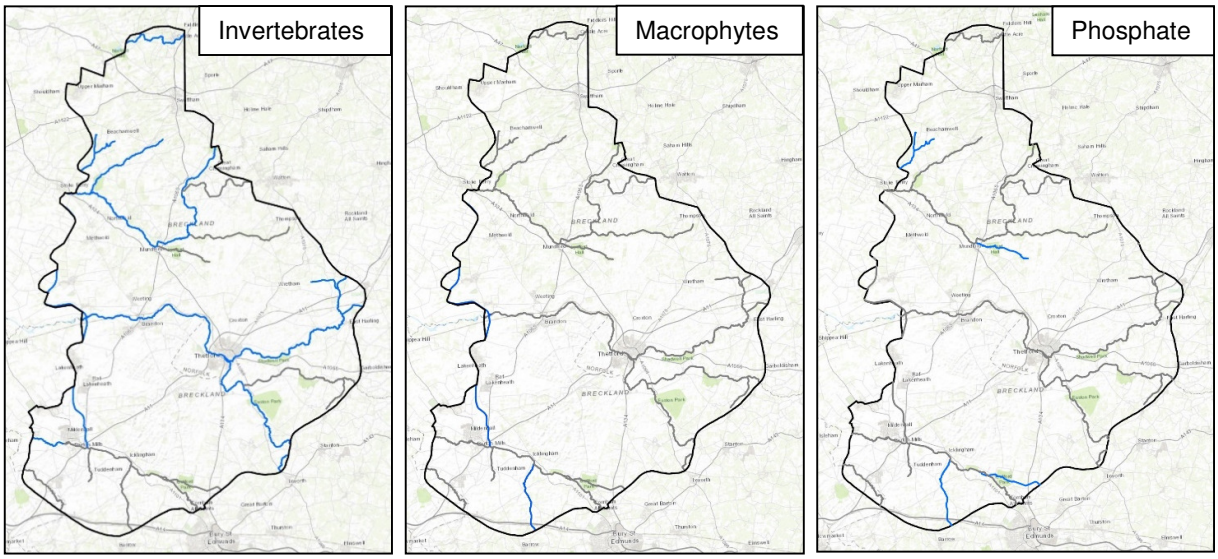


Figure 9. Waterbodies with High Water Framework Directive status (shown in blue) for invertebrates (left), macrophytes (centre) and phosphate (right) in The Brecks.

3.3 Species of Conservation Concern

A total of 227 species of freshwater plant and animal Species of Conservation Concern occur in The Brecks region (see table of all species in Appendix 1). Table 3 shows the number of species per group, the number of species in each group according to their conservation designation and whether species are widespread in their geographical distribution nationally. For practical convenience Species of Conservation Concern are divided into those which are widespread (e.g. great crested newt, otter) and those which are restricted (e.g. Mud Snail, Water-violet) as the practical approaches to the conservation of these two groups usually differ substantially.

Over half the species in Table 3 have Nationally Scarce status, which means that they are only found in 16 to 100 hectads (10 x 10 km squares) in Great Britain. There are relatively few species of principal importance (i.e. priority or BAP species) in The Brecks, and records are mostly for relatively widespread species like Common Toad and Bullhead. There are five BAP invertebrates, of which two species have only been recorded once (Norfolk Hawker and Scarce Four-dot Pin-palp beetle), Pond Mud Snail has only three records and Shining Ram's-horn Snail has 8 records. There are many records for the BAP species White-clawed Crayfish but none since 2008 and it is widely believed that this species has disappeared from The Brecks. There are six plant priority species in our dataset, including three which have very restricted distributions and are only found at one or two sites in The Brecks: Norfolk Bladder-moss (East Wretham Heath), Flat Sedge (Market Weston Fen and Thompson Common) and Greater Water-parsnip (Hurst Fen and a farm site near the R. Thet).

Overall, the largest group of Species of Conservation Concern was invertebrates, including a range of different groups of insects, snails and bivalves (160 species). Beetles make up over 60% of invertebrate species recorded (99 species). All these species, except two (White-clawed Crayfish and a diving beetle *Agabus uliginosus*) are restricted or even very restricted in distribution. Invertebrates are often overlooked in freshwater conservation projects because of the lack of detailed knowledge of their ecology or expertise locally but they are normally, as in The Brecks, a very large proportion of the total freshwater biodiversity. Plants included 58 Species of Conservation Concern, the bulk of which were flowering plants. Of

these 17 are relatively widespread but have declined significantly in England because of habitat loss or degradation (see England Red Data Book for vascular plants). The 14 vertebrate species included amphibians, reptiles, fish and mammals, and all these species are relatively widespread except for the River Lamprey, Sea Lamprey and Pool Frog (it's only site in Britain being in The Brecks).

Unsurprisingly, there are major differences between groups: some groups are better recorded than others, either because they are more widespread (e.g. Grass Snake) or because there is a more active recording scheme for those groups (e.g. reptiles and amphibians). The figures for the number of records in Table 3 are indicative only: some species on designated sites have very restricted distributions but are monitored relatively intensively compared to others.

70% of the Species of Conservation Concern are only found in standing waters, compared to less than 5% exclusive to running water habitats, showing the importance of ponds, pools and lakes for freshwater and wetland wildlife (Figure 10). There is, however, overlap between habitats, highlighting the need to including all types of waters in conservation action for the water environment at the catchment scale: a quarter of species can be found in both standing and running waters (Figure 10).

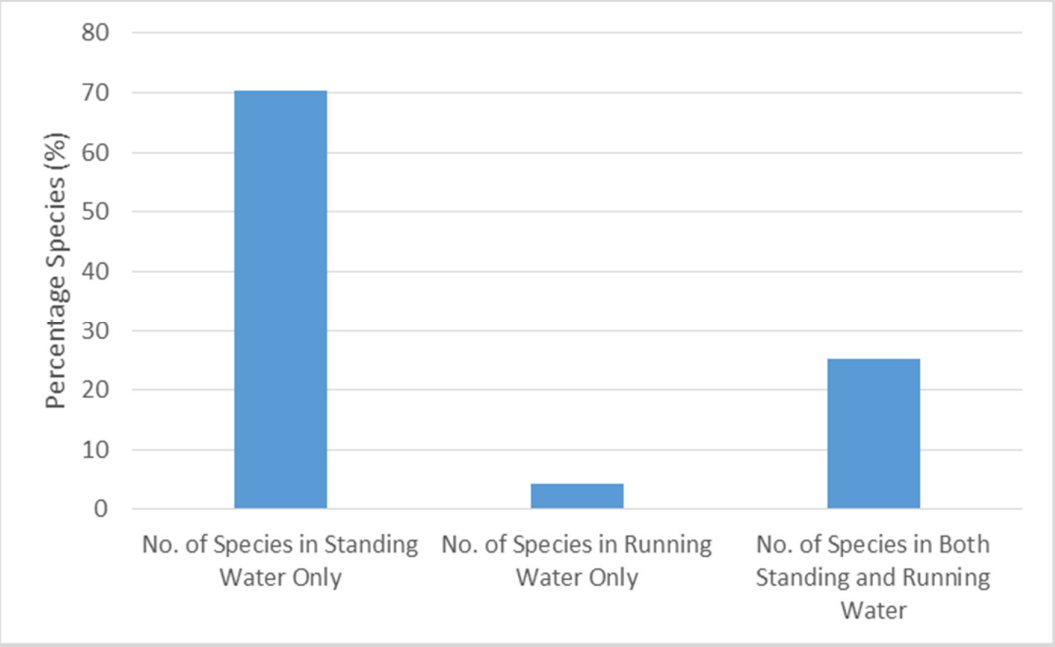


Figure 10. Proportion of species associated with different types of freshwater and wetland habitats

Table 3. Conservation designations of Species of Conservation Concern in The Brecks

Taxon Group	Number of Species	No. Records	Widespread	UK BAP (Priority Species)	UK Red Data Book	England Red Data Book (plants)	Wildlife & Countryside Act	Ann I Habs Dir (Habitats)	Ann II Habs Dir (species)	Nationally Scarce (plant/invert)	Nationally Rare (invert)	Other designation
Invertebrate - alderfly	1	1								1		
Invertebrate - beetle	94	1742		1	30					60	2	2 ERS
Invertebrate - caddis fly	9	19			1					7	2	
Invertebrate - crustacean	1	50	1	1			1		1			
Invertebrate - dragonfly	4	143		1	4		1					
Invertebrate - mollusc	5	98		2	1					5		
Invertebrate - stonefly	1	1									1	
Invertebrate - true bug	3	6			1					1	2	
Invertebrate - true fly	37	102			2					35	1	
Plant - fern	1	6								1		
Plant - Flowering plant	47	745	17	5	15	40		8		9		
Plant - liverwort	2	10								2		
Plant - moss	3	13		1	1					2		
Plant - stonewort	5	16			1			5		4		
Vertebrate - amphibian	3	449	2	3			2		1			
Vertebrate - fish	7	960	5	3		1			6			
Vertebrate - mammal	3	898	3	1			1		2			
Vertebrate - reptile	1	294	1	1			1					
Grand Total	227	5553	30	19	56	41	6	13	10	127	8	2

3.3.1 Areas with concentrations of Species of Conservation Concern

The map of all freshwater plants and animals of conservation concern in The Brecks (Figure 11) shows a high concentration of records in the following areas:

- River Lark alluvial valley
- Little Ouse alluvial valley
- Little Ouse valley fens
- Elveden Forest
- West Tofts alluvial corridor
- East Wretham Heath
- East Harling valley and fens
- Thompson Common and Stow Bedon
- Thompson alluvial corridor
- Frost's Common and Hills and Holes (Hockham CP)
- Foulden and Oxborough Area
- River Nar

Some caution needs to be used in interpreting areas of high concentration of records as these do not automatically represent high diversity area. Although areas rich in records of Species of Conservation Concern usually indicate high diversity sites, in some cases they may simply reflect frequent recording of a small number of species. For this reason, species density (the number of Species of Conservation Concern per 1 km square) provides a better indication of the importance of sites and is used to identify freshwater biodiversity hotspots map (Figure 12). Where there are areas with no records this is largely due to a lack of freshwater habitats, although it is clear that some areas are only patchily surveyed.

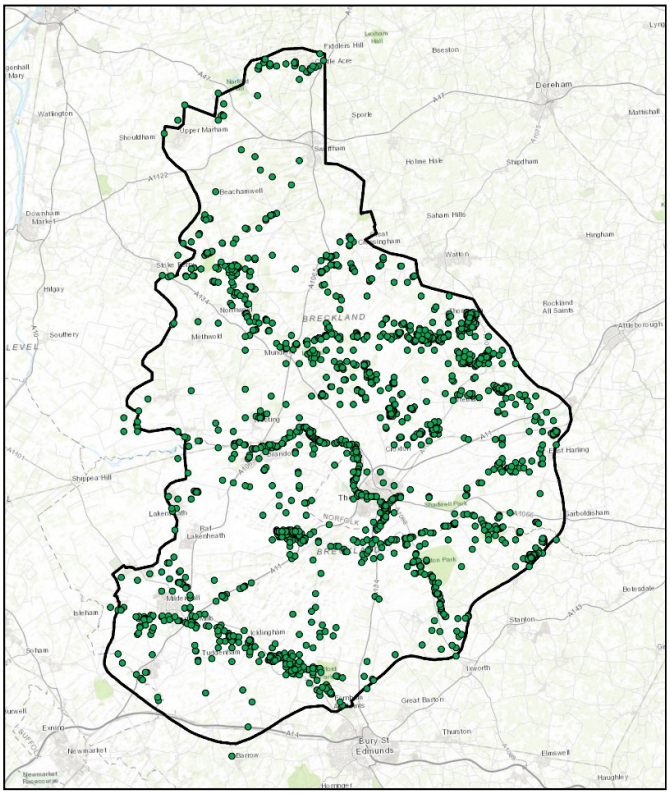


Figure 11. Distribution of all species of conservation concern

3.3.2 Biodiversity hotspots

The number of Species of Conservation Concern present in each 1 km square is shown in Figure 12 and confirms the importance of fen sites and pond complexes, which tend to support exceptionally diverse assemblages of freshwater plants and animals in high quality habitats with many Species of Conservation Concern. They are also small and potentially vulnerable to impacts from the surrounding land use. Other diverse habitats include areas with a wide range of waterbody types, reinforcing the importance of wetland mosaics including both running and standing waters.

Records for aquatic beetles have contributed to the very high number of species at sites such as Thompson Common, 51 water beetles that are Species of Conservation Concern have been recorded in grid square TL9396. Indeed, this 1 km square is probably one of the richest for threatened and endangered freshwater species in Britain. However, even without the beetle data Thompson Common remains a hotspot for biodiversity (see plant biodiversity hotspot map Figure 13).

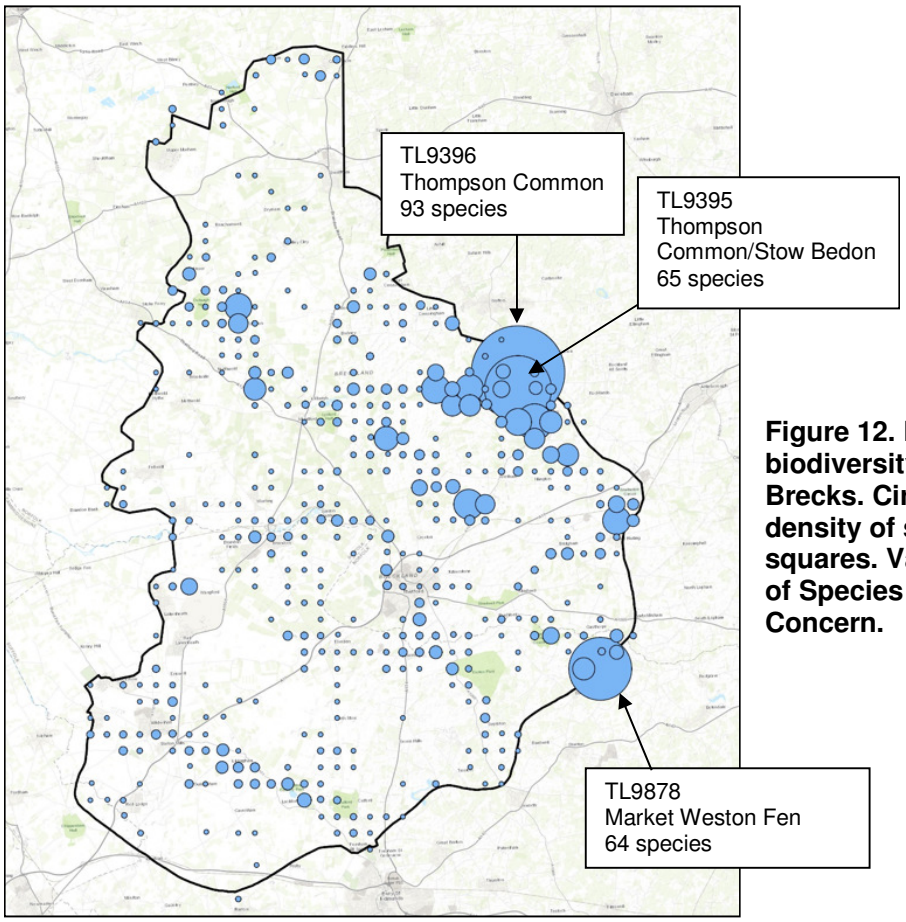


Figure 12. Freshwater biodiversity hotspots in The Brecks. Circle show the density of species per 1 km squares. Values are number of Species of Conservation Concern.

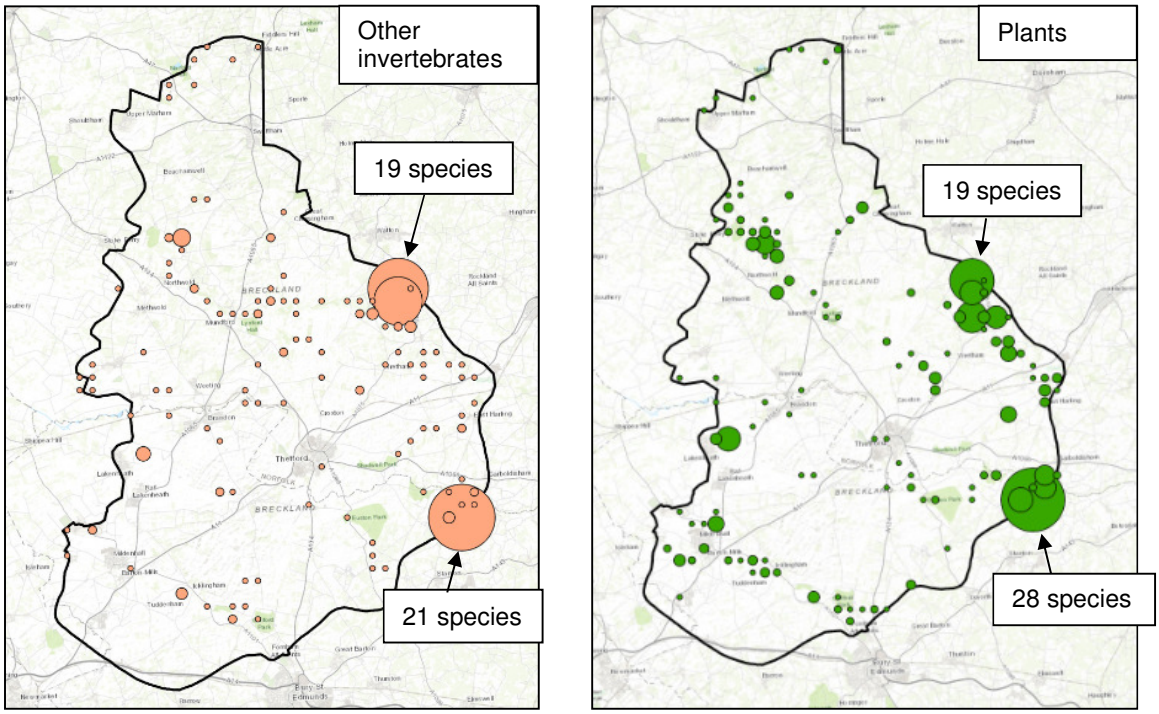


Figure 13. Biodiversity hotspot maps for other aquatic invertebrates, excluding water beetles (Left) and plants (Right). Circles show the density of species per 1 km squares.

3.3.3 Restricted and Widespread Species

Analysing the data in terms of widespread and restricted species can help prioritise sites further by highlighting those areas which support rare plants and animals – those most likely to suffer from local extinctions.

Figure 14 shows the location of restricted species of plants and invertebrates. This shows clusters of restricted species around Foulden, Gooderstone and Oxborough, Thompson Common and Stow Bedon, Poor's Allotment, East Wretham Heath and Fenmere, and Market Weston Fen. Note that there are fewer sites/areas for restricted plants, which reinforces the need to better protect the sites where restricted plants occur.

Comparing the distribution of restricted species and all species (i.e. Figures 14 and Figure 11) also highlights areas where there seem to be many records, but where the records are for a small number of widespread species. So, for example, the bulk of the records for the R. Lark and Little Ouse consist of species such as European Eel, Otter, Water Vole, Bullhead and Brown Trout – all widespread species.

Figure 15 shows the distribution of the four most widely recorded widespread species.

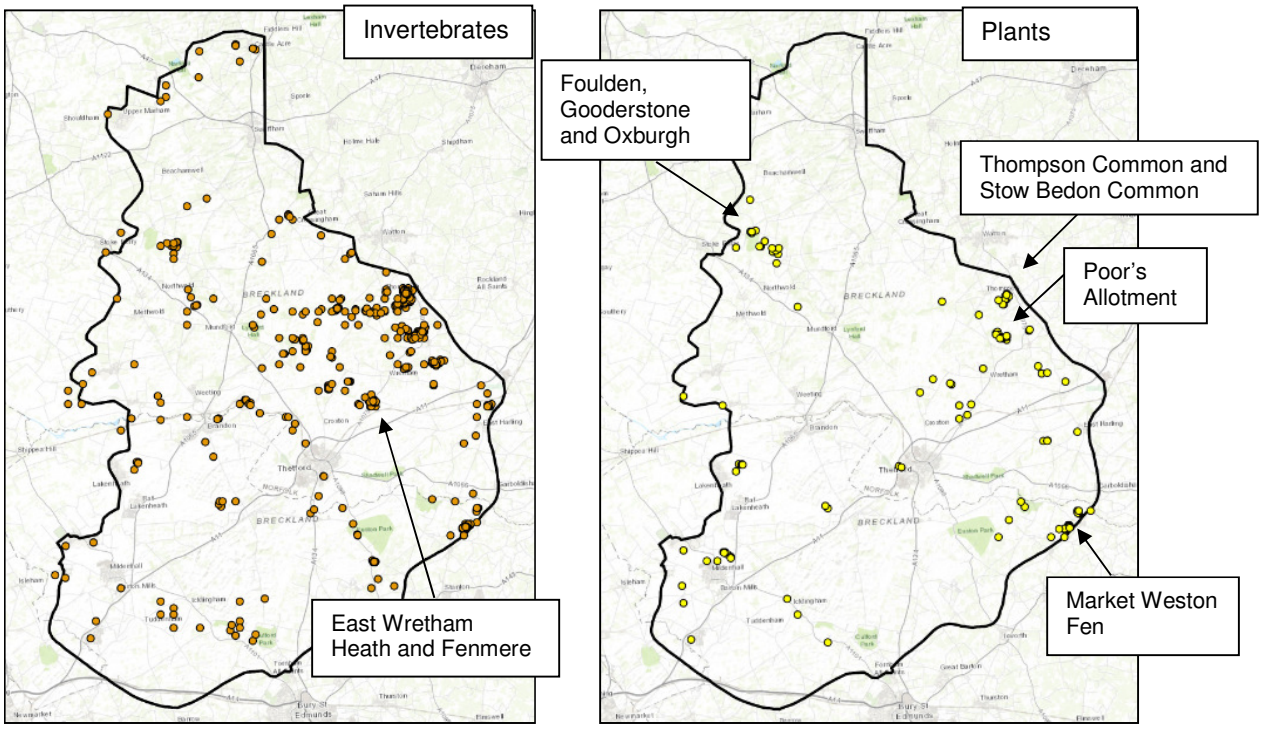


Figure 14. Distribution of Species of Conservation Concern with a restricted distribution in The Brecks.

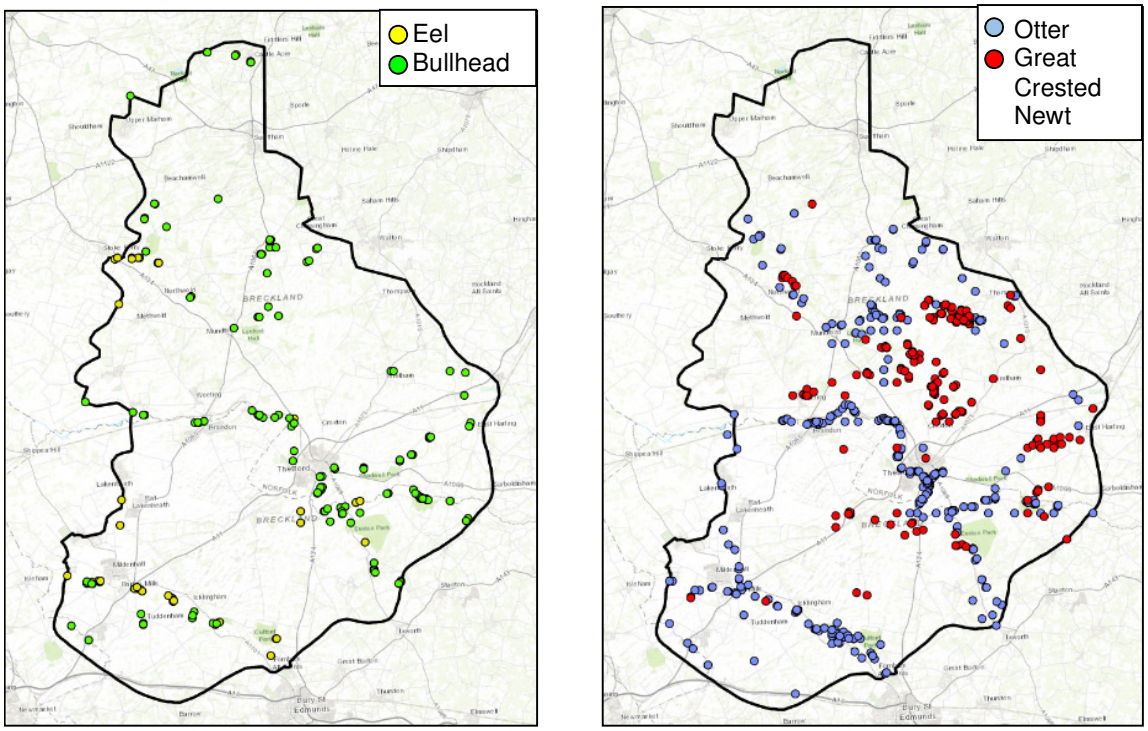


Figure 15. The four most recorded widespread Species of Conservation Concern in The Brecks. (Left) European Eel and Bullhead and (Right) European Otter and Great Crested Newt.

3.4 Combining Datasets

The broad 'areas of importance' for freshwater biodiversity, where practical conservation work should focus, are shown on the species density and heat maps below.

Areas highlighted by this process can be prioritised according to habitat quality data presented in previous sections prioritising those areas with:

- **Presence or high density of restricted species records**: the heat map in Figure 17 below is overlaid with the species data, which shows where restricted species are clustered, essentially at sites with high species and habitat diversity including floodplain wetland mosaics, running and standing waters.
- **Designated sites**: Water-dependent SACs and SSSI and many county wildlife sites and local nature reserves cover a lot of the highlighted areas. However there are also large parts of the important areas for freshwater wildlife which are not covered by national or local nature conservation designations.
- WFD rivers with biological elements at High status: areas around many of these rivers are generally included in the 'areas of importance' identified by species data (Figure 18). However some rivers and streams could be investigated further in terms of water quality and biology, such as R. Gadder (high status for inverts) and Cavenham stream (high status for macrophytes and phosphate). Priority habitats mostly within the 'areas of importance'.

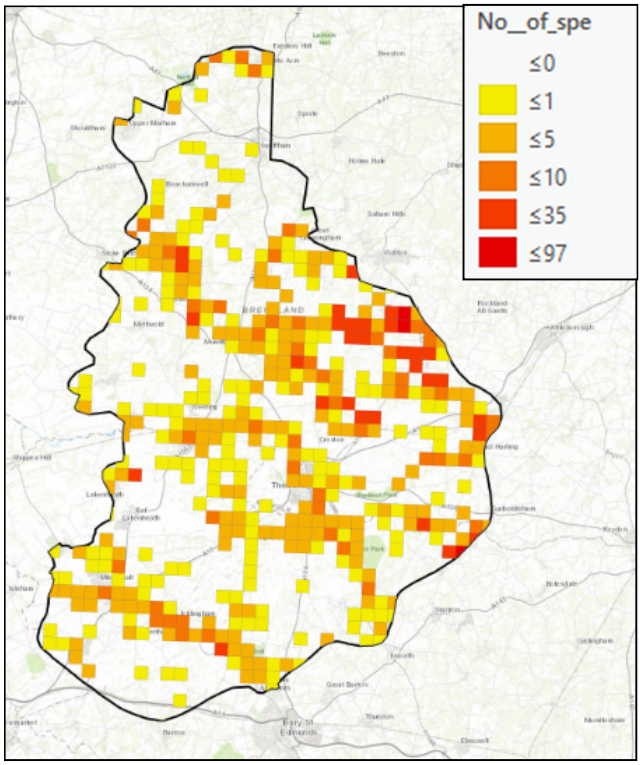


Figure 16. Density of Species of Conservation Concern per 1 km grid square.

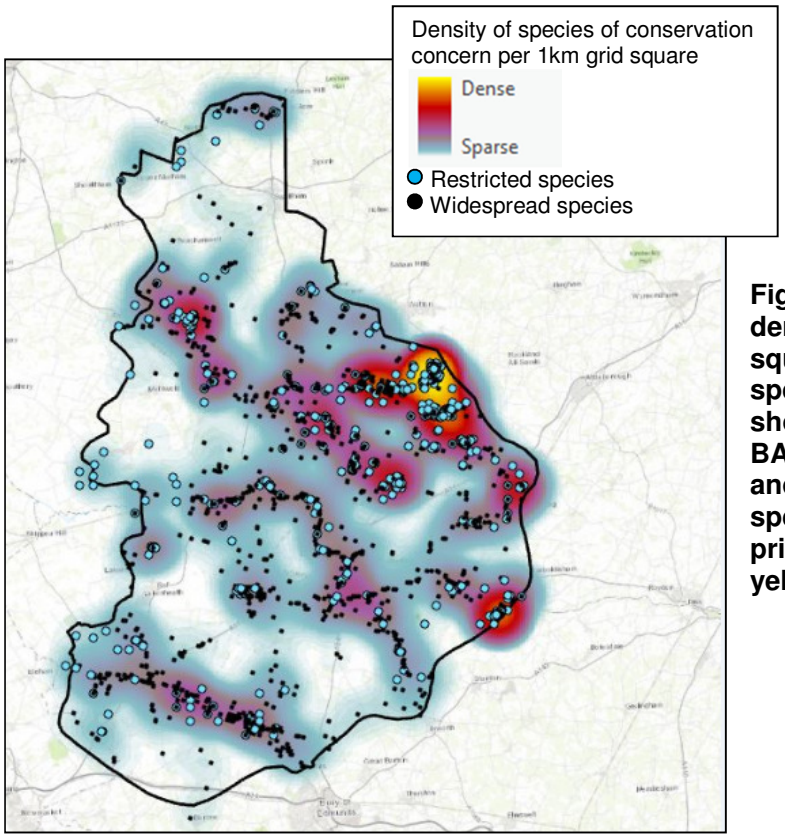
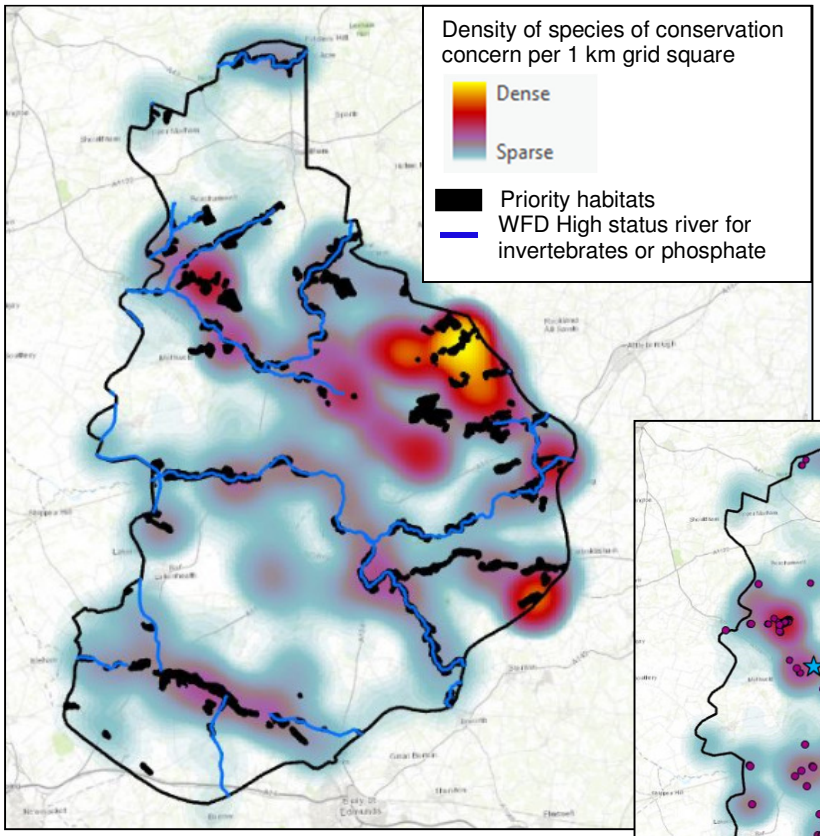


Figure 17. Heat map of the density of species per 1 km square in The Brecks, with species records overlaid, showing restricted BAP/priority species in blue and widespread BAP/priority species in black. High priority areas are shown in yellow/red.



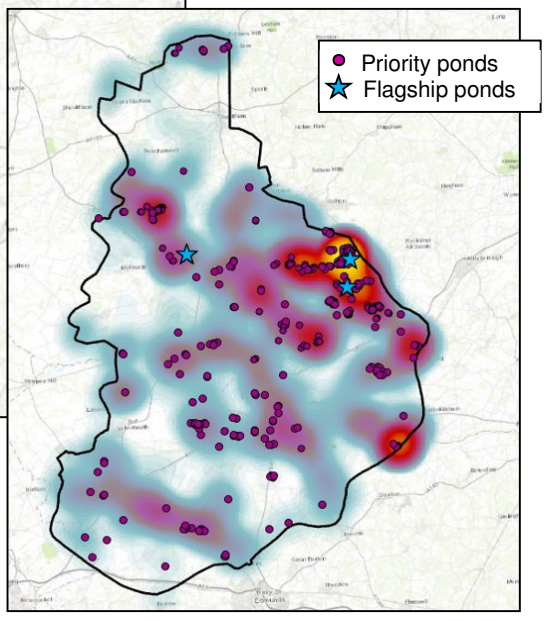


Figure 18. Heat map of the density of species per 1 km square in The Brecks, overlaid by priority habitats in black and WFD High status rivers for invertebrates and phosphate. Inset (Below right): heat map of the density of species per 1 km square overlaid by Priority ponds and Flagship ponds.

3.5 Important Freshwater Areas in The Brecks

The final prioritisation of Important Freshwater Areas in The Brecks is shown on the map below (Figure 19). In total, eleven areas were identified which are high priorities for freshwater biodiversity.

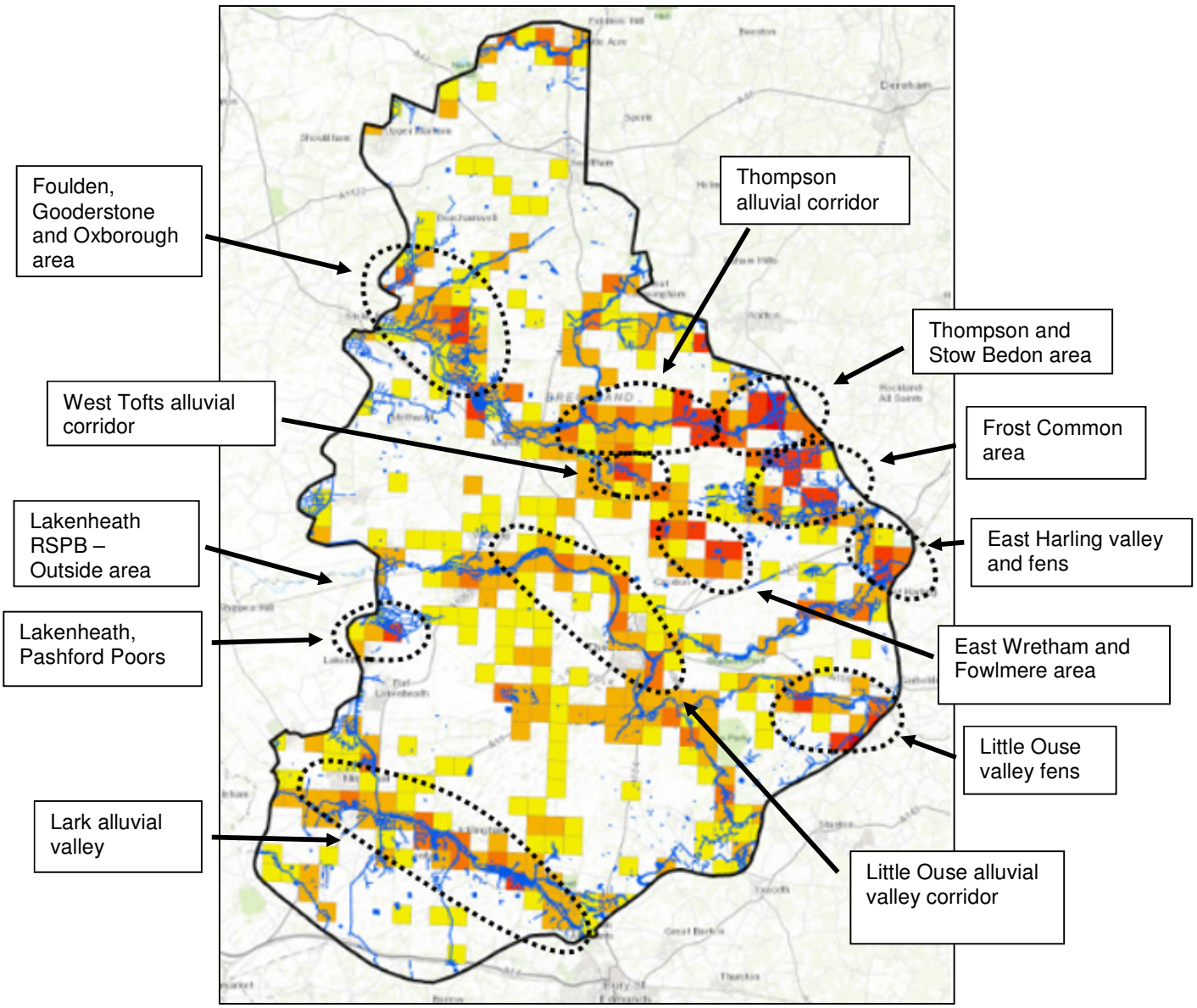


Figure 19. Important Freshwater Areas in The Brecks. A copy of this map with the Brecks Fen Edge and River current project area is shown in Appendix 2.

3.6 Areas for further investigation

There are a number of areas in The Brecks where further investigation of the distribution of Species of Conservation Concern and of potential priority freshwater habitats would be valuable.

These include:

- the ponds and streams of the STANTA range, potentially one of the largest concentration of high quality ponds in lowland England. Only limited data are available from these sites.
- off-river waterbodies and wetlands in the main river valley (e.g. Lark, Little Ouse)
- smaller stream valleys (e.g. Wissey, Gadder).
- other ponds and small lakes scattered across the area
- smaller isolated headwaters (e.g. Cavenham Stream).

An objective of the Citizen Science programme will be to establish a stratified random survey network on a range of the smaller water (still and flowing) across the project area.

4. Citizen science

4.1 Introduction

The Important Freshwater Areas map and associated data were used to generate a strategy for a community / citizen science and schools-based approach to gathering missing data and establishing the framework for a long-term monitoring strategy.

Monitoring of freshwater species in The Brecks, and indeed the UK as a whole, is extremely patchy. Historically, monitoring has concentrated on a small number of charismatic species or has relied on ad-hoc recording which makes it hard to undertake robust analysis to identify change and the reasons for change. Knowledge gaps such as these create critical barriers to habitat and species protection. Citizen science is a tool which can help to fill these gaps if used appropriately.

The Brecks Fen Edge and Rivers landscape citizen science work will follow the broad principles that were adopted and developed in the course of the HLF funded national project 'People, Ponds and Water'. Here Freshwater Habitats Trust took the approach of focussing on activities which maximised the direct benefits of people's survey work by ensuring that volunteers obtained information which makes a real contribution to freshwater biodiversity conservation (i.e. will actually be used in decision making about site management and species protection).

The 'People, Ponds and Water' volunteer survey network, 'PondNet', collected statistically robust data to identify trends in pond quality and pond species, including uncommon plants and animals. Getting volunteers to collect statistically robust data requires standardised methodologies and a randomly stratified sample of sites. The surveys included environmental metrics; giving information that will help to explain the reasons for changes in biological quality, and ultimately help to guide the direction of freshwater management.

Effective citizen science freshwater biodiversity survey work needs to take account of the strengths and limitation of citizen surveyors. In order to involve and engage with as many volunteers as possible it is important to include easy entry-level survey activities within the citizen science program. There will also be many volunteers who have more experience who will be keen to try more difficult surveys and to increase their skills. Through taking part in the citizen science all volunteers will improve their knowledge of the freshwater environment.

Freshwater Habitats Trust's experience nationally indicates that a particular problem for volunteer surveyors can be the 'taxonomy barrier. Many commonly employed freshwater survey methods (invertebrate surveys requiring lists of taxa, generating standard lists of common wetland plants) require substantial training, practice and experience. Such surveys can be overwhelming and dispiriting for all except the most highly skilled volunteers. A better approach is to (a) focus on individual distinctive species, which avoids the need to know many different kinds of plants or animals and (b) to make use of techniques which can be applied by virtually everyone and also provide useful data. Particularly important in this respect is assessing nutrient pollution using rapid test kits, which were extensively used nationally in 'People, Ponds and Water', and new environmental DNA technology.

For this reason the likely survey strategy for the Brecks Fen Edge and Rivers project area should ideally combine professional surveys, focused mainly on generating wetland plant lists, and citizen surveys focused on (a) restricted species (b) fish and amphibians surveyed using environmental DNA and (c) levels of nutrient pollution, surveyed using rapid test kits. These are described in more detail below.

4.2 Professional surveys – plants and invertebrates

We expect to make some use of professional surveyors to assess pond, river and stream quality in the project area. Plant species surveys are particularly useful because they are comparatively quick for experienced surveyors, so relatively low cost, provide high quality data and fit with a range of existing national monitoring programmes. In some locations in The Brecks invertebrate surveys are also likely to be valuable but they are typically 10 times more expensive than plant surveys (i.e. for a given sum of money about 10 times more sites can be surveyed for plants than invertebrates). The PondNet project has shown that, although volunteers were keen to learn about plants and invertebrates, they found it very difficult to complete full invertebrate and plants surveys. The QA analysis of PondNet plant survey data showed that plants were rather poorly assessed by volunteers. Only two out of the five ponds checked had richness totals that were within 75% of the total obtained by the QA surveyor (80% and 92% similarity). The main reason for this is that it is not possible to adequately train a volunteer to the required skill level in just one training day. With this in mind, it would be more beneficial for these surveys to be carried out by professional or semi-professional ecologists who have the knowledge and experience to carry out the surveys to a high level of accuracy. It is unlikely that we would find professional surveyors who would do these surveys as volunteers.

The programme of professional survey work would fit into national monitoring networks for ponds and streams established by Freshwater Habitats Trust, and linking into programmes we are running already with National Trust at a national level and which are we expect to be developing further nationally with Forestry Commission.

Broadly speaking our work to date indicates that around 50-100 sites are likely to be needed in an area of the size of the Brecks Fen Edge and Rivers project area to detect a 30% change in species numbers with 70% power in metrics which are based on multi-species data (e.g. plant lists, family level invertebrate data) and somewhat larger samples where only a single species is involved.

4.3 Restricted species

The results of PondNet showed that, although volunteers struggled to do full plant and invertebrate surveys, they can be trained to identify and survey for individual plant and animal species. As restricted species occur at a relatively small number of sites, a targeted approach is required for these species. Sites that are known locations for the species of interest will be sampled and the abundance of the species at those sites recorded. Given the large proportion of species associated with ponds, small lakes or fens these are likely to be the main focus of this work, but this approach is also relevant to restricted river and stream species (e.g. the recently discovered, extremely rare but quite distinctive caddis fly, the Scarce brown sedge). The same sites will be surveyed each year to reduce variability and get a better measure of change. Measuring abundance, rather than presence/absence is preferable for localised species as analysis suggests that even targeted surveys focusing on occupancy within a grid square where a species is known to occur would be insufficient to measure change. Assessing abundance is advantageous as falling populations will be detected before the species becomes absent from the pond.

Of the restricted species surveyed for PondNet, three occur in The Brecks: Tubular Water Dropwort, Greater Water Parsnip and Pond Mud Snail. Other rare species in The Brecks could be chosen. Plants are easier for volunteers to survey and identify and species which could be monitored include Water-violet, Fen Pondweed, Opposite-leaved Pondweed and Greater Water-parsnip.

The number of sites surveyed is relatively small and is likely to be, in effect, a census of all of the available sites. We expect there to be a maximum 5-10 sites available for survey for each species of concern.

4.4 eDNA for Great Crested Newts

Environmental DNA (eDNA) is DNA that is released into the water by plants and animals in a host of ways: from their skin, faeces, mucous, hair, eggs and sperm, or when they die. Surveys for eDNA involve simply collecting a water sample, and analysing it for traces of DNA. These replace the need for repeat night time visits because they are based on one water sample collected at any time during the breeding season. In a trial project of the eDNA kits done by Freshwater Habitats Trust, the kits were found to be highly effective at detecting Great Crested Newts when they were present (99% effective), versus traditional torch surveys (75%). However, there is a cost consideration as a single use eDNA kit cost c. £100.

PondNet is the first national survey in the world to use eDNA to monitor amphibian populations. Analysis of the PondNet results showed that all Great Crested Newt surveys completed in full (2015-2017) were completed using eDNA (380 ponds). Where traditional torching surveys were used the surveys were only partially completed. The eDNA approach worked significantly better for volunteers. eDNA surveys also have the benefit oof being an entry level activity for volunteers with little or no training required.

The survey design of great crested newts would be to include both ponds expected to have newts and those where newts are thought to be absent. This is necessary to have a greater chance of detecting both positive and negative change. For example, if only ponds with newts are surveyed, the only change that can be detected is loss. To assess whether newts are increasing their range, it is necessary to include site which are expected not to have newts. Typically, such surveys are balanced 50:50 occupied to unoccupied ponds. It is likely that some survey work could be combined with the Ministry of Defence to help reduce costs.

There are currently records for great crested newts in 81 1 km grid squares in The Brecks.

4.5 eDNA for fish survey

Fish surveys are normally undertaken by professional teams using electrofishing equipment to catch fish mainly in rivers and streams that can be waded. Such work can only be undertaken by professional biologists, and is quite expensive (or put another way, relatively few sites can be surveyed).

Environmental DNA tests are now available that can be used to generate a list of all the fish present at a site from a single sample. Like the great crested newt surveys these can by collected by anybody, taking about an hour at a typical site, and provide data of high technical reliability. They open up the potential to survey widely across landscapes, although costs are at present still relatively high (c£150/site).

A network of sites across the project area of c.30-50 locations is technically and financially feasible.

4.6 Clean water testing

Freshwater Habitats Trust's 'People, Ponds and Water' project included a citizen science water quality survey called 'Clean Water for Wildlife'. The aim was to raise awareness of the true extent of nutrient pollution and identify clean water habitats in England and Wales. Volunteers used 'quick kits' to test nitrate and phosphate levels in a range of waterbodies. Nutrient pollution is invisible so often doesn't seem 'real' to people. Using quick kits makes it possible for people to easily 'see' pollution for the first time. Clean Water for Wildlife proved itself to be a hugely popular entry level survey, with 68% of volunteers having never taken part in a survey before. Water quality testing is a simple and effective way of increasing people's awareness of the importance of clean water and biodiversity.

High quality waterbodies, relatively unpolluted, are likely to be an important feature of the Important Freshwater Areas in the project landscape. To assess the proportion of clean and polluted waters inside and outside of these areas we will focus water blitzes to provide data which gives information on each of the Important Freshwater Areas and on the landscapes around them.

We expect that up to 2500 samples will be undertaken from a 'blitz' of sites to create a broad impression of water quality across the project area. These should create a picture of where existing clean water is located, and identify areas where further pollution control is needed.

4.7 Summary of overall strategy

Overall the strategy for a community / citizen science and schools-based approach will be to:

(a) fill gaps in knowledge of the freshwater environment by gathering missing data on water quality using rapid nutrient test kits, assess the occurrence of selected uncommon species and use eDNA to assess the status of great crested newts and, potentially, fish in the project area for the first time.

(b) establishing the framework for a long-term monitoring strategy: this will set up the first round of sampling for revisiting in the future (say in 5-10 years time, as part of project legacy) enabling medium term improvements/deterioration in the quality of the landscape to be assessed. If possible we will establish a landscape-wide wetland plant baseline survey as part of this process. This network of sites will comprise 50-100 sites spread across the area in a stratified random sample for biological records and c.500-1000 sites for water quality analysis.

The strategy will include areas within and outside the Important Freshwater Areas in order to assess the extent of change in higher quality areas and 'the ordinary countryside'.

5. Potential restoration areas

The Important Freshwater Areas mapping helps to facilitate a focused approach to restoration and conservation works on freshwaters in the project area.

Broadly, the Important Freshwater Areas show those locations where protection of existing habitats and species is a priority, and indicates the areas of search for projects to extend these habitats or species ranges. As far as possible, to protect freshwater biodiversity, protection, restoration and new habitat creation projects should be:

- Close to, or in the case of rivers and streams physically connected to, existing high quality habitats; note that new ponds should not usually be directly physically connected to other waters – just in close proximity
- Where new habitats are created more distant from existing habitats (e.g. more than 1 km) they should as far as possible be clean water systems i.e. in landscapes generating clean water
- If necessary, carefully controlled introduction/reintroductions of Species of Conservation Concern should be considered. Such work should carefully follow IUCN guidelines as well as being appropriately licensed by the relevant statutory bodies.

Projects already planned or in progress are shown in Table 4. Where these overlap with, or are adjacent to, Important Freshwater Areas it would be valuable to assess for each location:

(a) which ***additional*** habitats could be protected, added to or created at each site other than the main project focus

(b) which freshwater Species of Conservation Concern are helped by the project and any ***additional*** species which could be helped by modest additional works. For example, at a location where a fish pass is being installed, could floodplain peatlands be restored or Floodplain Wetland Mosaic habitat improved?

Table 4. Water and wetland management projects already planned or in progress in the project area where extra work could potentially help additional habitats or species

Name	Location	Comments
Martin Sandford, SBIS	Wangford and Pushford	Historical sites
	Blackbourn Valley	Suffolk WT landscape enhancement
	Note also projects outside this area eg. Great Fen, Little Ouse Headwaters…etc	
Matt Jones, Norfolk WT	Around Thompson Common	Pingo restoration including proposed ghost pingo recreation at Watering Farm
Martin Bowes, Anglian Water	Thompson water	WEG bid submitted for water soldier removal and habitat enhancement
	Thetford	WEG town council – structures (fish pass)
	Little Ouse (Gasthorpe)	WEG Little Ouse Headwaters Project. Structure removal and river restoration.
	Around The Black Bourne river	Suffolk WT interest – habitat enhancement
	Lark River	Volunteer led river restoration
	Little Ouse – just south of Thetford	BTO WEG habitat enhancement
	Around the R. Wissey	Anglian Water surface water priority area
Sue Chambers and Maria Regondon, EA Fisheries and Biodiversity	Thetford Horse Meadows SSSI	Water level management plan (ongoing)
	Thompson Water SSSI	Water soldier clearing and water quality monitoring
	Little Ouse	River restoration works – some done, ongoing. Eel passes, several in area James Dyke has details.
	Cavenham and Icklingham Heaths SSSI	Water level management plan, Temple weir works 2010, more ongoing. Also signal crayfish in this area trapped by angling club.
Iain Perkins, MOD	Madhouse SSSI, Waterhouse unit	6th year of 12 year management plan of pingo restoration and surveying with FHT
Nick Dickson, BFER Scheme Development Manager		Projects not part of BFER
	Cockley Cley	Potential access improvements
	North Pickenham	Possible new area for access and creates link to old railway walk to Swaffham
	R. Gadder between Whittington and Oxborough	Helen Blower (EA), river restoration planned (Oxborough section done)
	Pashford Poors	Restoration proposed by IDB (surface stripping to lower ground level)

Appendix 1. List of freshwater species of conservation concern found The Brecks National Character Area

Taxon Name	Common Name	Taxon Group
Agabus labiatus	A diving beetle	Invertebrate - beetle (Coleoptera)
Agabus uliginosus	A diving beetle	Invertebrate - beetle (Coleoptera)
Agabus undulatus	A diving beetle	Invertebrate - beetle (Coleoptera)
Agabus (Gaurodytes) melanarius	A diving beetle	Invertebrate - beetle (Coleoptera)
Agabus biguttatus	A diving beetle	Invertebrate - beetle (Coleoptera)
Anabolia brevipennis	A caddis fly	Invertebrate - caddis fly (Trichoptera)
Anaciaeschna isoceles	Norfolk Hawker	Invertebrate - dragonfly (Odonata)
Anasimyia interpuncta	A hover fly	Invertebrate - true fly (Diptera)
Anguilla anguilla	European Eel	Vertebrate - fish
Apium inundatum	Lesser Marshwort	Plant - Flowering plant
Arvicola terrestris	European Water Vole	Vertebrate - mammal
Augyles hispidulus	A variegated mud beetle	Invertebrate - beetle (Coleoptera)
Austropotamobius pallipes	White-clawed Freshwater Crayfish	Invertebrate - crustacean
Badister (Baudia) dilatatus	A Ground beetle	Invertebrate - beetle (Coleoptera)
Bagous glabrirostris	An aquatic weevil	Invertebrate - beetle (Coleoptera)
Bagous limosus	An aquatic weevil	Invertebrate - beetle (Coleoptera)
Bagous lutosus	Miry Sloth Weevil	Invertebrate - beetle (Coleoptera)
Bagous lutulentus	Horsetail Sloth Weevil	Invertebrate - beetle (Coleoptera)
Bagous puncticollis	An aquatic weevil	Invertebrate - beetle (Coleoptera)
Baldellia ranunculoides	Lesser water-plantain	Plant - Flowering plant
Bembidion (Actedium) pallidipenne	A ground beetle	Invertebrate - beetle (Coleoptera)
Bembidion (Bembidion) quadrimaculatum	A beetle	Invertebrate - beetle (Coleoptera)
Bembidion (Bembidion) quadripustulatum	Scarce Four-dot Pin-palp	Invertebrate - beetle (Coleoptera)
Bembidion (Notaphus) obliquum	A Ground beetle	Invertebrate - beetle (Coleoptera)
Bembidion (Testedium) bipunctatum	a ground beetle	Invertebrate - beetle (Coleoptera)
Bembidion (Trepanes) octomaculatum	A Ground beetle	Invertebrate - beetle (Coleoptera)
Beris clavipes	Scarce Orange Legionnaire	Invertebrate - true fly (Diptera)
Beris fuscipes	Short-horned Black Legionnaire	Invertebrate - true fly (Diptera)
Berosus luridus	A scavenger water beetle	Invertebrate - beetle (Coleoptera)
Blysmus compressus	Flat-sedge	Plant - Flowering plant
Bracteon argenteolum	Silt Silver-spot	Invertebrate - beetle (Coleoptera)
Bufo bufo	Common Toad	Vertebrate - amphibian
Calamagrostis stricta	Narrow Small-reed	Plant - Flowering plant
Campyliadelphus elodes	Fine-leaved Marsh Feather-moss	Plant - moss
Carex acuta x elata = C. x prolixa	Sedge	Plant - Flowering plant
Carex appropinquata	Fibrous Tussock-sedge	Plant - Flowering plant

Carex diandra	Lesser Tussock-sedge	Plant - Flowering plant
Carex echinata	Star Sedge	Plant - Flowering plant
Carex elata	Tufted-sedge	Plant - Flowering plant
Carex lasiocarpa	Slender Sedge	Plant - Flowering plant
Catabrosa aquatica	Whorl-grass	Plant - Flowering plant
Cercyon bifenestratus	A scavenger water beetle	Invertebrate - beetle (Coleoptera)
Cercyon granarius	A scavenger water beetle	Invertebrate - beetle (Coleoptera)
Ceutorhynchus querceti	A beetle	Invertebrate - beetle (Coleoptera)
Chaetarthria seminulum s. lat.	A scavenger water beetle	Invertebrate - beetle (Coleoptera)
Chaetarthria simillima	Chaetarthria simillima	Invertebrate - beetle (Coleoptera)
Chamaemelum nobile	Chamomile	Plant - Flowering plant
Chara aculeolata	Hedgehog Stonewort	Plant - stonewort
Chara curta	Lesser Bearded Stonewort	Plant - stonewort
Chara rudis	Rugged Stonewort	Plant - stonewort
Chartoscirta elegantula	A shore bug	Invertebrate - true bug (Hemiptera)
Clemnius decoratus	a diving beetle	Invertebrate - beetle (Coleoptera)
Cobitis taenia	Spined Loach	Vertebrate - fish
Coenagrion pulchellum	Variable Damselfly	Invertebrate - dragonfly (Odonata)
Colobaea bifasciella	A snail-killing fly	Invertebrate - true fly (Diptera)
Colobaea distincta	A snail-killing fly	Invertebrate - true fly (Diptera)
Comarum palustre	Marsh Cinquefoil	Plant - Flowering plant
Contacyphon pubescens	A marsh beetle	Invertebrate - beetle (Coleoptera)
Cottus gobio	Bullhead	Vertebrate - fish
Cyperus longus	Galingale	Plant - Flowering plant
Cyphon pubescens	A marsh beetle	Invertebrate - beetle (Coleoptera)
Dactylorhiza incarnata subsp. ochroleuca	Early Marsh-Orchid	Plant - Flowering plant
Dolichopus cilifemoratus	A long-headed fly	Invertebrate - true fly (Diptera)
Dolichopus lineatocornis	A long-headed fly	Invertebrate - true fly (Diptera)
Dolichopus notatus	A long-headed fly	Invertebrate - true fly (Diptera)
Dolichopus plumitarsis	A long-headed fly	Invertebrate - true fly (Diptera)
Donacia impressa	A reed beetle	Invertebrate - beetle (Coleoptera)
Donacia thalassina	A reed beetle	Invertebrate - beetle (Coleoptera)
Drosera rotundifolia	Round-leaved Sundew	Plant - Flowering plant
Drupenatus nasturtii	A water-cress weevil	Invertebrate - beetle (Coleoptera)
Dryops anglicanus	A long-toed water beetle	Invertebrate - beetle (Coleoptera)
Dryops auriculatus	A long-toed water beetle	Invertebrate - beetle (Coleoptera)
Dryops griseus	A long-toed water beetle	Invertebrate - beetle (Coleoptera)
Dryops similaris	A long-toed water beetle	Invertebrate - beetle (Coleoptera)
Dytiscus dimidiatus	A great diving beetle	Invertebrate - beetle (Coleoptera)
Eleocharis acicularis	Needle Spike-rush	Plant - Flowering plant
Elodes minuta	A marsh beetle	Invertebrate - beetle (Coleoptera)
Enochrus nigritus	A scavenger water beetle	Invertebrate - beetle (Coleoptera)
Enochrus quadripunctatus	A scavenger water beetle	Invertebrate - beetle (Coleoptera)
Ephemerum recurvifolium	Strap-leaved Earth-moss	Plant - moss
Epipactis palustris	Marsh Helleborine	Plant - Flowering plant

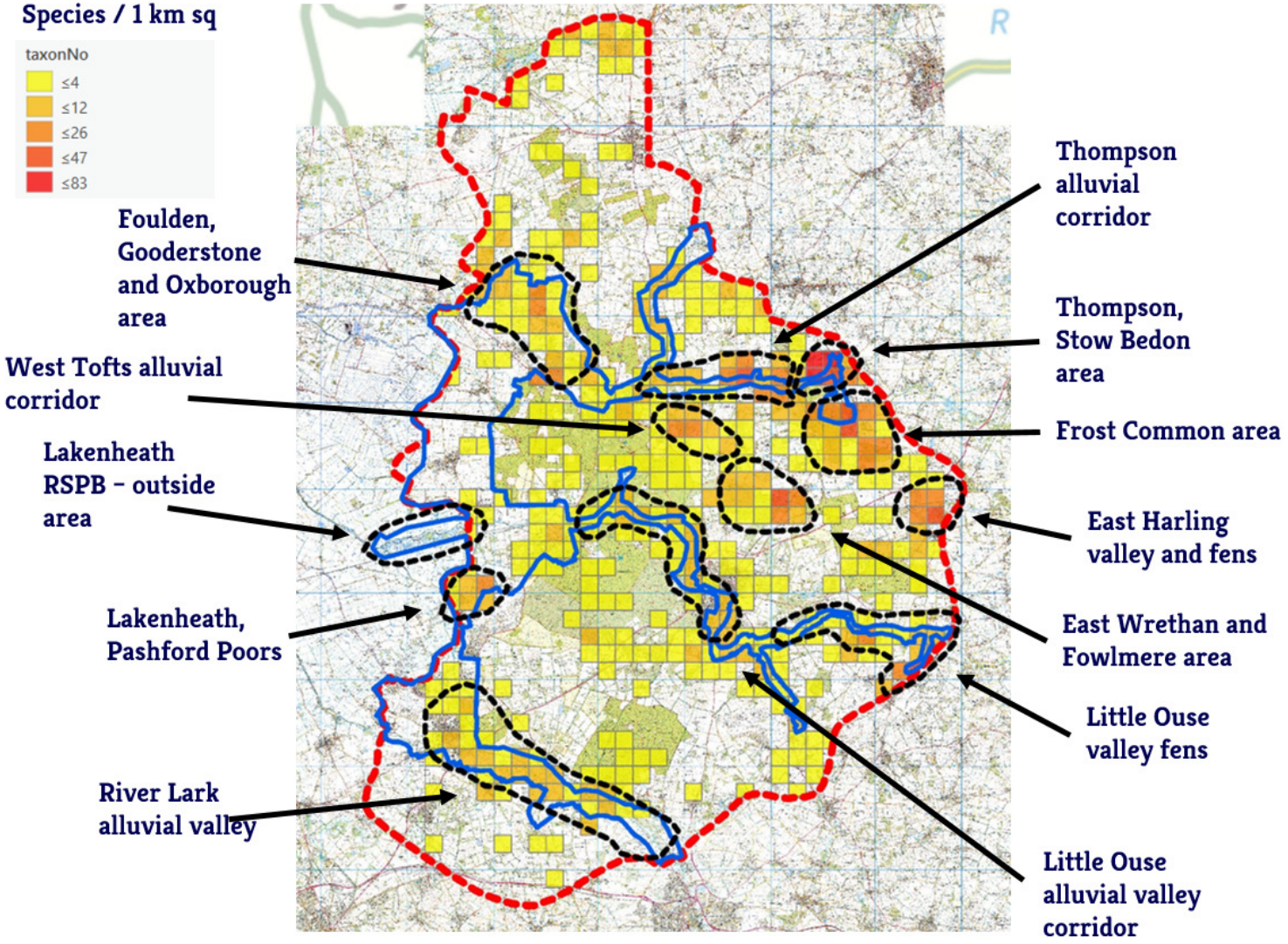
Eriophorum angustifolium	Common Cottongrass	Plant - Flowering plant
Erioptera nielseni	A crane fly	Invertebrate - true fly (Diptera)
Eubria palustris	Water Penny Beetle	Invertebrate - beetle (Coleoptera)
Georissus crenulatus	A scavenger water beetle	Invertebrate - beetle (Coleoptera)
Gnypeta rubrior	A rove beetle	Invertebrate - beetle (Coleoptera)
Gonomyia bifida	A crane fly	Invertebrate - true fly (Diptera)
Groenlandia densa	Opposite-leaved Pondweed	Plant - Flowering plant
Grypus equiseti	Horsetail Weevil	Invertebrate - beetle (Coleoptera)
Gymnetron beccabungae	A weevil	Invertebrate - beetle (Coleoptera)
Gymnetron veronicae	Brooklime Gall Weevil	Invertebrate - beetle (Coleoptera)
Gymnetron villosulum	A weevil	Invertebrate - beetle (Coleoptera)
Gyrinus aeratus	A whirligig beetle	Invertebrate - beetle (Coleoptera)
Gyrinus paykulli	A whirligig beetle	Invertebrate - beetle (Coleoptera)
Gyrinus suffriani	A whirligig beetle	Invertebrate - beetle (Coleoptera)
Haliplus mucronatus	An algivorous water beetle	Invertebrate - beetle (Coleoptera)
Hebrus (Hebrus) pusillus	A Sphagnum bug	Invertebrate - true bug (Hemiptera)
Helius pallirostris	A crane fly	Invertebrate - true fly (Diptera)
Helochares obscurus	A scavenger water beetle	Invertebrate - beetle (Coleoptera)
Helochares punctatus	A scavenger water beetle	Invertebrate - beetle (Coleoptera)
Helophorus strigifrons	A scavenger water beetle	Invertebrate - beetle (Coleoptera)
Helophorus granularis	A scavenger beetle	Invertebrate - beetle (Coleoptera)
Helophorus longitarsis	A scavenger beetle	Invertebrate - beetle (Coleoptera)
Helophorus nanus	A scavenger water beetle	Invertebrate - beetle (Coleoptera)
Hercostomus fulvicaudis	A long-headed fly	Invertebrate - true fly (Diptera)
Hercostomus plagiatus	A long-legged fly	Invertebrate - true fly (Diptera)
Holocentropus stagnalis	A caddis fly	Invertebrate - caddis fly (Trichoptera)
Hottonia palustris	Water-violet	Plant - Flowering plant
Hydaticus seminiger	A scavenger beetle	Invertebrate - beetle (Coleoptera)
Hydraena palustris	A small water beetle	Invertebrate - beetle (Coleoptera)
Hydrocharis morsus-ranae	Frogbit	Plant - Flowering plant
Hydrochus angustatus	A scavenger water beetle	Invertebrate - beetle (Coleoptera)
Hydrochus brevis	A scavenger water beetle	Invertebrate - beetle (Coleoptera)
Hydrochus crenatus	A scavenger water beetle	Invertebrate - beetle (Coleoptera)
Hydrochus elongatus	A scavenger water beetle	Invertebrate - beetle (Coleoptera)
Hydrochus ignicollis	A scavenger water beetle	Invertebrate - beetle (Coleoptera)
Hydrocotyle vulgaris	Marsh Pennywort	Plant - Flowering plant
Hydrophilus piceus	Great Silver Water Beetle	Invertebrate - beetle (Coleoptera)
Hydroporus elongatulus	a diving beetle	Invertebrate - beetle (Coleoptera)
Hydroporus glabriusculus	a diving beetle	Invertebrate - beetle (Coleoptera)
Hydroporus neglectus	a diving beetle	Invertebrate - beetle (Coleoptera)
Hydroporus scalesianus	a diving beetle	Invertebrate - beetle (Coleoptera)
Hygrotus (Coelambus) novemlineatus	A beetle	Invertebrate - beetle (Coleoptera)
Hygrotus (Coelambus) parallelogrammus	A beetle	Invertebrate - beetle (Coleoptera)
Hygrotus decoratus	A beetle	Invertebrate - beetle (Coleoptera)
Hygrotus nigrolineatus	a diving beetle	Invertebrate - beetle (Coleoptera)

Ilybius subaeneus	A diving beetle	Invertebrate - beetle (Coleoptera)
Laccornis oblongus	a diving beetle	Invertebrate - beetle (Coleoptera)
Lampetra fluviatilis	River Lamprey	Vertebrate - fish
Lampetra planeri	Brook Lamprey	Vertebrate - fish
Lejogaster tarsata	Lejogaster tarsata	Invertebrate - true fly (Diptera)
Lestes dryas	Scarce Emerald Damselfly	Invertebrate - dragonfly (Odonata)
Libellula fulva	Scarce Chaser	Invertebrate - dragonfly (Odonata)
Limnebius aluta	A small water beetle	Invertebrate - beetle (Coleoptera)
Limnebius papposus	A scavenger beetle	Invertebrate - beetle (Coleoptera)
Limnephilus binotatus	A caddis fly	Invertebrate - caddis fly (Trichoptera)
Lutra lutra	European Otter	Vertebrate - mammal
Lysimachia thyrsiflora	Tufted Loosestrife	Plant - Flowering plant
Microvelia buenoi	A lesser water-cricket	Invertebrate - true bug (Hemiptera)
Moerckia hibernica	Irish Ruffwort	Plant - liverwort
Molophilus bihamatus	A crane fly	Invertebrate - true fly (Diptera)
Molophilus corniger	A crane fly	Invertebrate - true fly (Diptera)
Myrica gale	Bog-myrtle	Plant - Flowering plant
Natrix helvetica	Grass Snake	Vertebrate - reptile
Nemoura dubitans	A stonefly	Invertebrate - stonefly (Plecoptera)
Neoascia interrupta	A hover fly	Invertebrate - true fly (Diptera)
Neomys fodiens	Eurasian Water Shrew	Vertebrate - mammal
Neophytobius muricatus	A weevil	Invertebrate - beetle (Coleoptera)
Nitella flexilis sensu lato	Smooth Stonewort	Plant - stonewort
Nitella mucronata	Compact Stonewort	Plant - stonewort
Notaris scirpi	A weevil	Invertebrate - beetle (Coleoptera)
Noterus crassicornis	A burrowing water beetle	Invertebrate - beetle (Coleoptera)
Notidobia ciliaris	A caddis fly	Invertebrate - caddis fly (Trichoptera)
Nymphoides peltata	Fringed water lily	Plant - Flowering plant
Odontomyia tigrina	Black Colonel	Invertebrate - true fly (Diptera)
Oecetis furva	A caddis fly	Invertebrate - caddis fly (Trichoptera)
Oenanthe fistulosa	Tubular Water-dropwort	Plant - Flowering plant
Oenanthe lachenalii	Parsley Water-dropwort	Plant - Flowering plant
Omophron limbatum	Omophron limbatum	Invertebrate - beetle (Coleoptera)
Omphiscola glabra	Pond Mud Snail	Invertebrate - mollusc
Oodes helopioides	A Ground beetle	Invertebrate - beetle (Coleoptera)
Orthonevra brevicornis	Orthonevra brevicornis	Invertebrate - true fly (Diptera)
Orthonevra geniculata	Orthonevra geniculata	Invertebrate - true fly (Diptera)
Oulimnius major	A beetle	Invertebrate - beetle (Coleoptera)
Oulimnius troglodytes	A beetle	Invertebrate - beetle (Coleoptera)
Oxycera morrisii	White-barred Soldier	Invertebrate - true fly (Diptera)
Oxycera pygmaea	Pygmy Soldier	Invertebrate - true fly (Diptera)
Oxyethira distinctella	A caddis fly	Invertebrate - caddis fly (Trichoptera)
Paracymus scutellaris	Paracymus scutellaris	Invertebrate - beetle (Coleoptera)
Parhelophilus consimilis	Parhelophilus consimilis	Invertebrate - true fly (Diptera)
Parnassia palustris	Grass-of-Parnassus	Plant - Flowering plant
Pedicularis palustris	Marsh Lousewort	Plant - Flowering plant

Pelenomus quadricorniger	Pelenomus quadricorniger	Invertebrate - beetle (Coleoptera)
Pelophylax lessonae	Pool Frog	Vertebrate - amphibian
Petromyzon marinus	Sea Lamprey	Vertebrate - fish
Thyselium palustre	Milk parsley	Plant - Flowering plant
Phalacrocera replicata	Phalacrocera replicata	Invertebrate - true fly (Diptera)
Pherbellia griseola	Pherbellia griseola	Invertebrate - true fly (Diptera)
Phylidorea abdominalis	A crane fly	Invertebrate - true fly (Diptera)
Physcomitrium eurystomum	Norfolk Bladder-moss	Plant - moss
Pilaria fuscipennis	Pilaria fuscipennis	Invertebrate - true fly (Diptera)
Pinguicula vulgaris	Common Butterwort	Plant - Flowering plant
Pisidium pseudosphaerium	A pea mussel	Invertebrate - mollusc
Potamogeton coloratus	Fen Pondweed	Plant - Flowering plant
Potamogeton gramineus	Grass-leaved pondweed	Plant - Flowering plant
Potamogeton gramineus x lucens = P. x angustifolius	Long-leaved Pondweed	Plant - Flowering plant
Potamogeton praelongus	Long-stalked Pondweed	Plant - Flowering plant
Potamophylax rotundipennis	A caddis fly	Invertebrate - caddis fly (Trichoptera)
Psacadina verbekei	Psacadina verbekei	Invertebrate - true fly (Diptera)
Pseudanodonta complanata	Depressed (or Compressed) River Mussel	Invertebrate - mollusc
Ranunculus flammula	Lesser Spearwort	Plant - Flowering plant
Ranunculus penicillatus subsp. penicillatus	Stream Water-Crowfoot	Plant - Flowering plant
Renocera striata	Renocera striata	Invertebrate - true fly (Diptera)
Rhantus frontalis	a diving beetle	Invertebrate - beetle (Coleoptera)
Rhaphium lanceolatum	A long-headed fly	Invertebrate - true fly (Diptera)
Riccia cavernosa	Cavernous Crystalwort	Plant - liverwort
Riolus subviolaceus	A riffle beetle	Invertebrate - beetle (Coleoptera)
Salix repens	Creeping Willow	Plant - Flowering plant
Salmo trutta	Brown trout	Vertebrate - fish
Scarodytes halensis	a diving beetle	Invertebrate - beetle (Coleoptera)
Sciomyza simplex	Sciomyza simplex	Invertebrate - true fly (Diptera)
Segmentina nitida	Shining Ram's-horn snail	Invertebrate - mollusc
Senecio aquaticus	Marsh Ragwort	Plant - Flowering plant
Sialis nigripes	An alderfly	Invertebrate - alderfly (Megaloptera)
Silene flos-cuculi	Ragged-Robin	Plant - Flowering plant
Sium latifolium	Greater Water-parsnip	Plant - Flowering plant
Sparganium natans	Least bur-reed	Plant - Flowering plant
Stellaria palustris	Marsh Stitchwort	Plant - Flowering plant
Stenolophus teutonus	Stenolophus teutonus	Invertebrate - beetle (Coleoptera)
Stratiomys potamida	Banded General	Invertebrate - true fly (Diptera)
Stratiomys singularior	Flecked General	Invertebrate - true fly (Diptera)
Tachys (Paratachys) bistriatus	A Ground beetle	Invertebrate - beetle (Coleoptera)
Tachyusa coarctata	Tachyusa coarctata	Invertebrate - beetle (Coleoptera)
Tanysphyrus ater	An aquatic weevil	Invertebrate - beetle (Coleoptera)
Telmaturgus tumidulus	A fly	Invertebrate - true fly (Diptera)
Thaumastoptera calceata	A crane fly	Invertebrate - true fly (Diptera)

Thelypteris palustris	Marsh Fern	Plant - fern
Thryogenes scirrhosus	A weevil	Invertebrate - beetle (Coleoptera)
Tournotaris bimaculatus	A wetland weevil	Invertebrate - beetle (Coleoptera)
Tricholeiochiton fagesii	A caddis fly	Invertebrate - caddis fly (Trichoptera)
Trichostegia minor	A caddis fly	Invertebrate - caddis fly (Trichoptera)
Triglochin palustre	Marsh Arrowgrass	Plant - Flowering plant
Triturus cristatus	Great Crested Newt	Vertebrate - amphibian
Utricularia minor	Lesser Bladderwort	Plant - Flowering plant
Vanoyia tenuicornis	Long-horned Soldier	Invertebrate - true fly (Diptera)
Veronica scutellata	Marsh Speedwell	Plant - Flowering plant
Vertigo (Vertigo) moulinsiana	Desmoulin's Whorl Snail	Invertebrate - mollusc

Appendix 2. Map of Important Freshwater Areas in The Brecks overlain on the current Brecks Fen Edge and Rivers landscape boundary



Key

Brecks Fen Edge and Rivers Landscape Partnership project area boundary (shown by fine blue line)