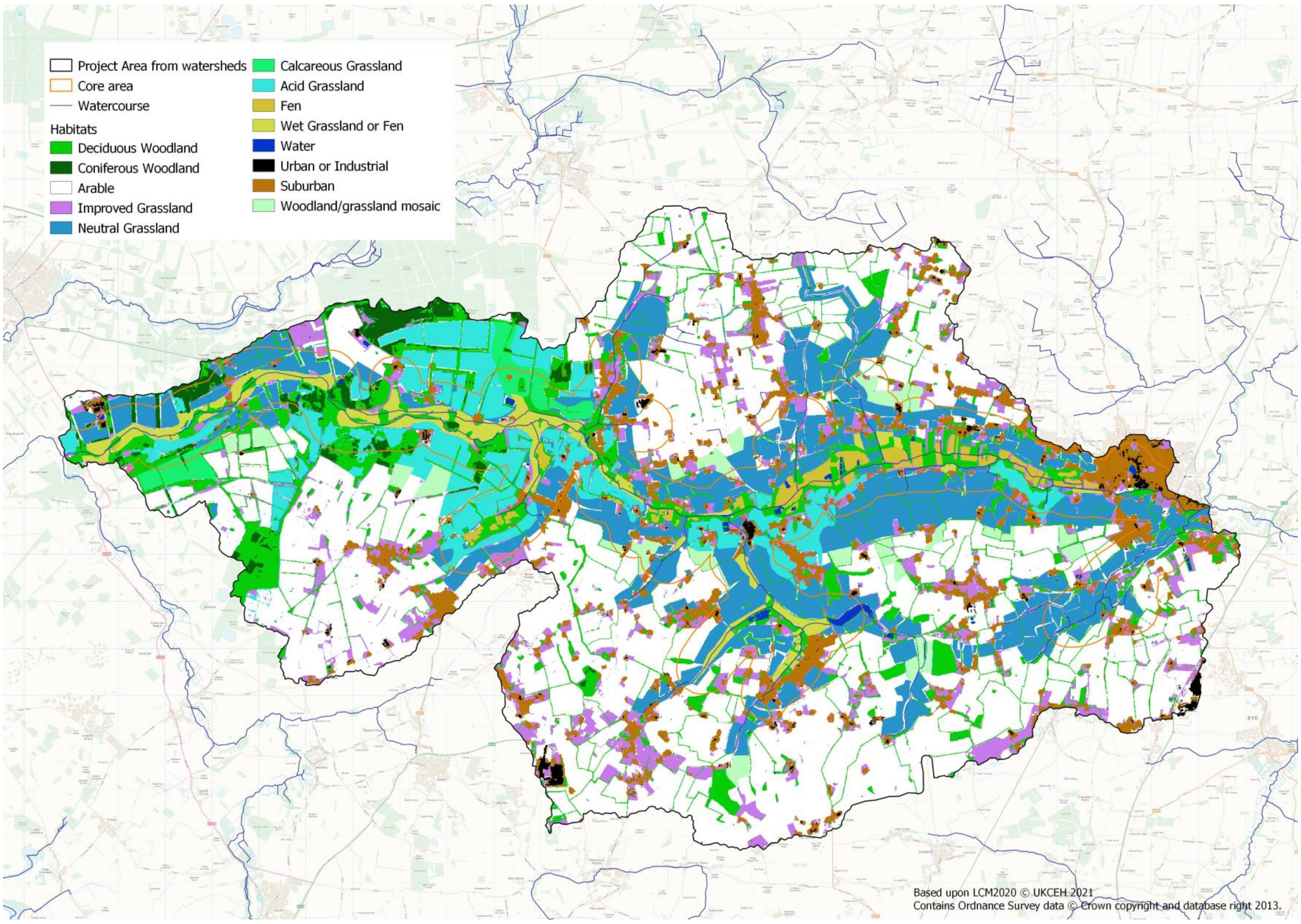
A Vision for Landscape Recovery in the Upper Waveney and Little Ouse Valleys



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October 2022

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Report commissioning

This report was funded by Natural England and commissioned by Suffolk Wildlife Trust to gather and interpret information on the natural capital assets of the landscape between Diss and Knettishall. It forms as part of the evidence gathering for a wider project in development, investigating the potential for linking priority sites within this landscape through habitat corridor and larger site restorations. The origins of the project go back to early discussions between Gareth Dalgleish, Stephen Rothera and the Suffolk Wildlife Trust around developing landscape scale recovery in the upper Waveney and Little Ouse catchments.

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Acknowledgments

We are grateful to the Steering Group and to Sam Hanks of Suffolk Wildlife Trust for their support and guidance in the preparation of this report. Martin Sandford, Sam Neal, Matt Jones, Sam Brown, Ellie Beach and Tim Holt-Wilson all provided invaluable information and Arthur Rivett provided many of the photographs.

NATURAL ENGLAND

Suffolk Wildlife Trust

Contents

1 Summary

This study was funded by Natural England and commissioned by Suffolk Wildlife Trust to gather information on the natural assets of the landscape between Diss and Knettishall. It investigates the potential for restoring wildlife sites and reconnecting them through new habitat corridors and expansion of existing sites. It proposes a new Vision for nature-based land management accommodating farming and promoting other benefits to society, such as management of water flows, reduced loss of sediment, nutrient and carbon from the land, and better access to nature.

The outcomes are tested by modelling using the new Environmental Benefits from Nature tool (EBN). This tool is not specifically designed for a catchment scale exercise involving significant land use change, so the results should be treated with caution.

The Vision (Section 2) is for a landscape where human activity thrives in sympathy with recovered nature. There is no timescale set for achieving the Vision; it provides the framework for long term nature recovery in the project area.

The methods for translating this Vision into reality are described (Sections 3 and 4). The project area is divided into the Core Area – the floodplains of the headwaters of the Little Ouse and Waveney Rivers – and the Wider Area, which encompasses the valley flanks up to the watershed. No assumptions about landowner intent or current land use are made – all land is considered equally, reflecting only its potential for contributing to a new nature- based landscape.

Mapping and analysis has been conducted for two scenarios – current land use, and a future Vision. The aim within this Vision is not wholesale rewilding. Productive but much less intensive farming will remain across much of the project area.

The context for the work is described. Section 5 outlines the conservation history of the area, describing the original rich mosaic of valley habitats which characterised the two headwater areas. The role of nineteenth century Enclosure in the fragmentation of wetlands and improvement of land for agriculture, along with the drainage and nutrient enrichment this brought, was followed by the further impact of twentieth century agricultural intensification. Over-use of ground and surface water resources are described. Recent efforts to restore habitats and species and re-connect wildlife sites are documented. This review makes clear the need for a new landscape Vision to restore nature in the project area.

Section 6 focuses on the rivers, describing their critical importance to nature recovery. The relationship between changing land use and deterioration of river quality is outlined, particularly the increased siltation and nutrient loads. The direct impacts of over-engineering watercourses are highlighted. Current ecological condition of the rivers, which varies from Bad, to Poor, and at best, Moderate status, is reviewed. The benefits of land use change in reversing deterioration are summarised. There have been projects to restore degraded river channels in the area, but these have been modest in scope and are in need of renewal. Restoration of channel morphology and water quality are key to the Vision.

Maps present the data sets which were used to develop the Vision (Section 7). These data sets are: designated conservation sites; soil type; agricultural land class; ponds; watercourses, and current habitats. Current habitat was based on published land cover types, supplemented by local knowledge and data supplied by the partners. Together with the contextual information, this evidence base

directed where wildlife would best recover, providing greatest connectivity and indicating the land uses and soil types that will most effectively restore nature.

Most of the suggested habitat modification is within the Core Area, but there are three key elements which extend well into the Wider Area: hedgerows, sediment management and ponds.

Section 8 describes delivery of the Vision through working with nature. The primary focus is re-establishing grassland mosaics with scrub and woodland across the catchment. Reconnecting fens within the Core Area is a second key strategy. Expansion of these habits will reduce the area of cropland and improved grassland, although both will remain in the project area.

In the coming uncertain decades of climate disruption, the Vision is as much about creating opportunities for wildlife to colonise, adapt and change, as it is about re-establishing or restoring pre-existing habitats. It is about building resilience to environmental adversity.

Delivery of the Vision will be a long-term undertaking, involving significant commitment by individuals and organisations, and requiring both guaranteed government support and private investment.

Any final scheme will include an array of landowners, each with differing preferences and constraints operating on their land. Implementation will therefore be through a series of options from which landowners can choose. The menu of habitats and options will deliver substantial nature recovery, going beyond Stewardship and ELMS (Environmental Land Management Scheme), having a minimum standard which delivers some or all of:

- Substantive improvement in habitat condition.
- Habitat re-creation.
- Recovery of species populations or assemblages, such as pollinators.
- Transformative farm practice, where crops and grazing are sustained within a productive landscape but where farm nature has recovered.

Section 8.2 outlines the kinds of measures which can deliver on the following themes, which will also be needed to implement the Vision:

- Carbon release and carbon sequestration.
- Nutrient and silt management.
- Restoration and management of water resources.
- The role of woodland, scrub, wood-pasture and trees.

The benefits of a catchment-wide approach are described, linking land use change in the valleys, on the slopes and across the watershed with river channel restoration and reconnection to the floodplain. This will produce greatest benefits for water resource management, nutrient reduction and water quality, ensuring nature recovery is maximised. Catchment-wide improvements will bring wider economic benefits through tourism, recreation and access to nature.

The results from the Environmental Benefits from Nature (EBN) analysis are described. Results underestimate the natural capital uplift produced by the Vision. The EBN tool is designed for small sites not landscapes which leads to several issues described in the report. Hence the results are interpreted with caution. Even so, the results show:

- Overall, substantial biodiversity net gains and an increase in ecosystem services.
- Significant improvements in erosion protection, water quality regulation, pollination, pest control, aesthetic value, education, interaction with nature and sense of place.
- Moderate improvements in flood protection and carbon storage.
- A small decrease in agricultural production.

2 Vision

The Vision was developed by the project team with input from the Steering Group and wider consultees.

A landscape where human activity thrives in sympathy with a recovered nature. It contains the full range of habitats characteristic of the headwaters of the Waveney and Little Ouse Rivers. This nature-enriched landscape re-makes the link between the Broads and the Brecks natural areas, connecting the habitats and species of each. It remains an essentially agricultural landscape, retaining historical boundaries and patterns. The valley slopes are a mosaic of open heath, grassland, scrub and woodland. In the floodplain, dynamic and varied rivers with good water quality flow through peatlands with fens and wet woodland, and in areas of silt and clay soils there is wet grassland with water-filled ditches. In the wider landscape, regenerative farming practices provide space and connectivity for wildlife, and rebuild soil structure and carbon stores. In this landscape, field hedgerows, margins and ponds are restored, lost populations of typical species rebuilt, and pollinators and other invertebrates are abundant in the flower-rich fields. Water, sediment and nutrients are held on the agricultural land and restored water tables ensure carbon is retained in peat stores. Fens, woods and scrub remove more carbon from the atmosphere. The landscape will help mitigate climate change, while the habitats and species will be more resilient to face the challenges the future will bring.

3 Introduction

3.1 The project

This report describes the work to build a detailed and ambitious Vision for nature recovery in the upper Waveney and Little Ouse valleys. In it, we define the scope of the project and set the context by outlining the complex landscape history of the area and the environmental issues that have impacted on the rivers and the internationally important wetlands that border them. To address these issues and deliver a very different vision for the future, we used a wide range of data sources to develop a map showing the potential for modifying current land uses, providing a radical uplift for nature while retaining a largely farmed landscape.

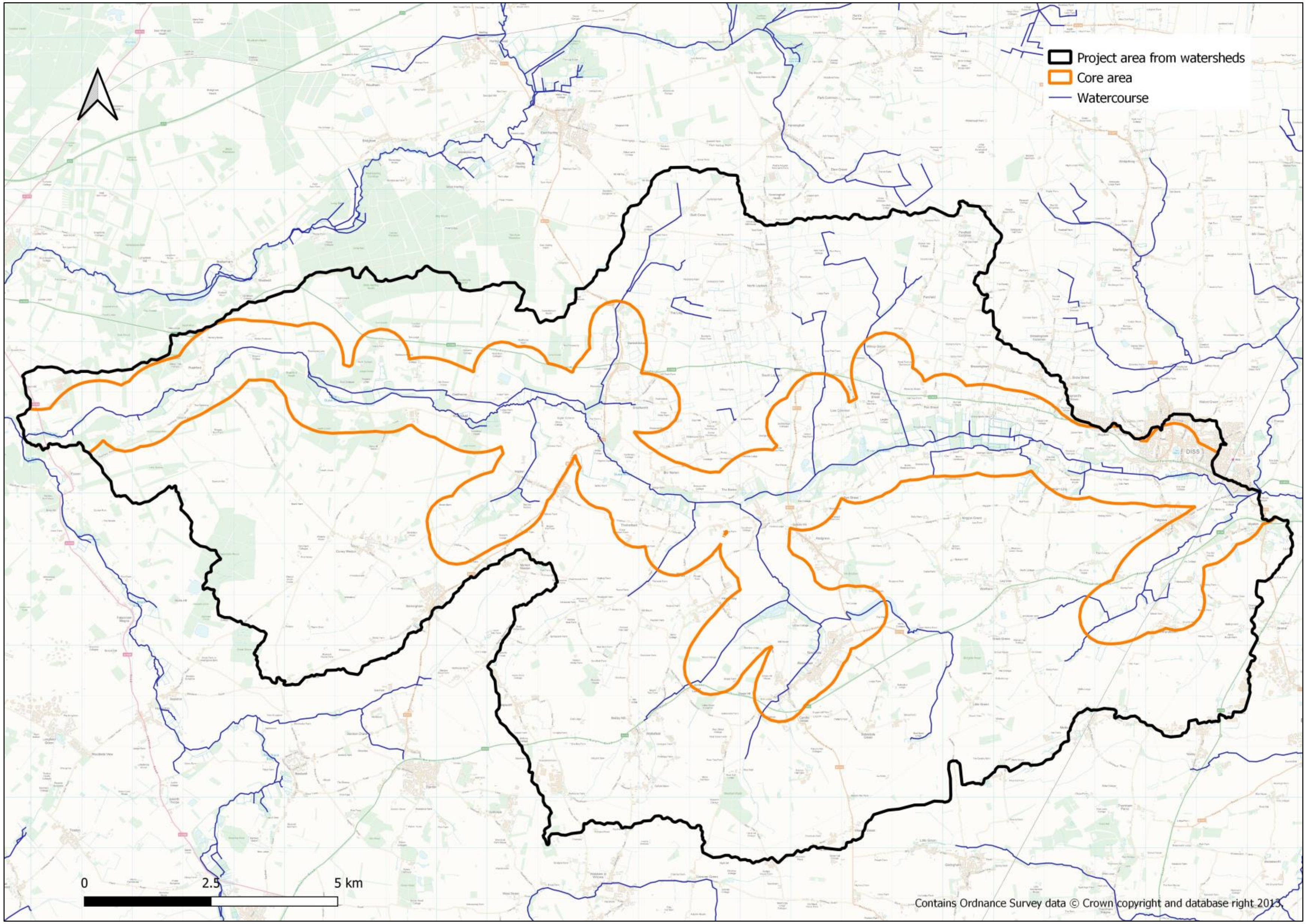
3.2 The project area

Our proposals cover the headwater catchment areas of the Waveney and Little Ouse rivers, from Diss to close to Thetford, including their significant tributaries (Figure 1). The main river channels mark, for the most part, the county boundary between Norfolk and Suffolk, rising back-to-back from sources separated only by the very low gravel ridge that carries the B1113 road, and flowing away to the east (Waveney) and west (Little Ouse). The two rivers occupy a contiguous shallow valley landscape characterised by very low channel gradient, an underlying chalk aquifer and complex surface drift geology. The lack of any significant topographic boundary means there is a continuity of habitats and environmental conditions across the area, and the headwaters of the two rivers can be considered as a single unit for landscape and species recovery purposes. In terms of character, the project area provides a link between two of the great ecological landscapes of East Anglia – the Broads to the east and the Brecks to the west. The project area shows characteristics of both of these natural areas and should be considered transitionary between them.

3.3 Core and Wider Project Areas

The land under consideration has been divided into a “Core Area” close to the rivers and tributaries, surrounded by a “Wider Area” which aligns with the river catchments. The outer boundary shown on Figure 1 is therefore the watersheds of the two rivers. The Core Area of the valley (5,445 ha) is defined by the occurrence of deep peat and peaty soils, surrounded by a 500m buffer. The bordering Wider Area includes the transitions from peat to sand on the valley sides, extensions along the major tributaries and links to other large areas with landscape restoration potential, giving a total project area of 21,595 ha. The Core Area has the highest potential for nature recovery/biodiversity gain and carbon storage. It includes 44 sites designated for their international, national and locally important habitats and species. However, it is important that this Core Area is not considered in isolation from the surrounding catchments included within the Wider Project Area, which has an additional 31 designated sites, although none of international importance.

Figure 1 Location of the Core and Wider Project Areas



3.4 Current scenario and future vision

Mapping and analysis has been conducted for two scenarios: current land use and a future Vision encompassing significant land use change while maintaining a predominantly farmed landscape. The aim within this Vision is not large-scale rewilding – this landscape has been farmed for centuries[1]. We have assumed in our planning that productive but much less intensive farming will remain across much of the project area.

3.5 Land ownership

The vision mapping is focussed on the land's potential for nature recovery and takes no account of land ownership or preceding land use. It covers an area which includes a diversity of landowners and land management practices. It is not intended to be prescriptive – landowners might consider adopting some, all, or modifications of, the suggested changes in future.

[1] Barnes, G. & Williamson, T. 2022 *A Brief History of Land Use and Land Management in the Upper Valleys of the Waveney and Little Ouse.* Unpublished Report to Suffolk Wildlife Trust, Ashbocking.

4 Scope

4.1 Constraints and limitations

The report is based on an analysis of available data, either already in the public domain or licenced for use in this project. Some corrections have been made based on the authors' detailed knowledge of the area, and we have used the recent additional mapping of parts of their area by the Little Ouse Headwaters Project (LOHP), but no field-based survey has been undertaken. Some inaccuracies will inevitably be found when looking in detail at the mapped data. Ground-truthing and correction of the maps is expected to form part of the planning and implementation phase of the project.

4.2 Application of the Environmental Benefits from Nature Tool

The Environmental Benefits from Nature (EBN) tool[2] has been used to estimate the biodiversity gain resulting from changes in land use. This tool is not specifically designed for a catchment scale exercise involving significant land use change, so the results should be treated with caution.

Improvements to the rivers themselves are likely to be underrepresented in the current version because the assessment is based largely on morphological features and does not account fully for water quality improvements.

Further details are given in Appendix 1.

[2] Smith, A.C., Baker, J., Berry, P. M., Butterworth, T., Chapman, A., Harle, T., Heaver., Hölzinger, O., Howard, B., Norton, L.R., Rice, P., Scott, A., Thompson, A., Warburton, C. and Webb, J. *Environmental Benefits from Nature (EBN) Tool*. Natural England Joint Publication JP038. Natural England, Peterborough.

5 Conservation History of the Project Area

5.1 The habitats of the project area

In their upper reaches, the valleys of the rivers Waveney and Little Ouse hold the largest remnants of 'valley fen' habitat in lowland England. This rare habitat is characterised by peat deposits fed by nutrient-poor, alkaline water rising from a chalk aquifer. The deep peat soils support a mosaic of wetland plant communities including many rare species that are restricted to these unusual conditions. Alder and willow carr woodland sometimes replaces the open fen under drier conditions or where land-use practices have lapsed. In places, more acidic sandy ridges project into the peat and support damp, heathy vegetation. Beyond the peat, on the valley sides, sandy deposits support drier heathland, acid grassland or birch-oak woodland. Where the chalk bedrock is closer to the surface, neutral or chalk grassland develops while further up the slopes, meadow and woodland on boulder clays contribute further to the complex of habitats that formerly supported an exceptionally rich variety of wildlife.

5.2 19th Century fragmentation and isolation

The habitats and landscapes of the area have been subject to constant change since they were first assembled after the final glaciation. At first change was entirely natural as the habitats adapted to changing climate and to the evolution of the physical landscape. It was, inevitably, the intervention of people which wrought the greatest changes[3] at a rate which nature could not keep pace with. The extent and continuity of the valley fens and their associated habitats, including the two rivers at their core, has been eroded over many centuries, with immense impacts on the quantity and quality of wildlife they support. Although extensive changes pre-dated the 19th Century, until then most of the valley floor land was held in common and grazed, cut

This view of Redgrave and Lopham Fen in the 1960s gives an impression of the open expanses of wetland wilderness that occupied much of the valley floor until the 1840s.

[3] Barnes, G. & Williamson, T. 2022 *A Brief History of Land Use and Land Management in the Upper Valleys of the Waveney and Little Ouse.* Unpublished Report to Suffolk Wildlife Trust, Ashbocking.

for thatching materials, and dug for peat for domestic fuel. At the start of the Century, only a quarter of the land was in private ownership and converted to pasture.

By 1840, however, Parliamentary enclosures had brought an abrupt end to the open expanses of commonly held fens; each newly allotted land parcel was enclosed by ditches to improve drainage, or by hedges on drier land. Critically, for their survival, the enclosure awards set aside the wettest of the valley fens as a ‘poors allotments’ or ‘fuel allotments’ to allow the local poor to continue to use them as a fuel source.

5.3 Drainage and nutrient enrichment

Although the setting aside of land for the poor ensured the physical survival of some fens, they became fragmented and isolated within a more heavily drained, though still largely pastoral, valley floor. In the wider catchment, over 70% of the land was already in arable, albeit of a much less intensive nature, and far less inimical to wildlife, than modern arable farming. It would, however, have increased silt run-off into the rivers at a time when increasingly efficient underdrainage was also having negative effects on water levels in the fens. This period also saw some changes in the river courses, with some meandering sections straightened and canalised. The owners of newly enclosed riparian land were also obliged to keep the river ‘well scoured’ although the manual removal of vegetation and sediment would have had far less impact on wildlife than modern mechanised methods. Later in the 19th Century, the widespread use of imported fertilisers enriched both fens and rivers – in 1851, for example, the Euston Estate was using 2 cwt/acre of fertilisers, mostly imported guano[4].

5.4 20th Century intensification

The impacts of agricultural practices in the wider catchment on the remnant fens and the largely pastoral land between them, changed tempo and scale in the 20th Century. World War II and its aftermath increased demand for home-produced food, and technical innovation in farming methods provided the means to meet it. Pastures were ploughed as arable replaced livestock farming. Although arable increased to over 80% regionally, in places becoming viable immediately adjacent to the rivers, the greatest impacts came through more effective land drainage, increased mechanisation and the increasingly heavy use of inorganic artificial fertilisers and pesticides. Field size increased, hedgerows and pasture were lost, and the quality and quantity of water available to the valley fen remnants and their specialist species declined.

5.5 The double whammy

Coinciding with the post-war peak in agricultural intensification, a major new threat to the viability of the valley fens came not from farming but from over-use of groundwater, which is often the life blood of these fens. The prime example was a public water supply borehole sunk into the chalk aquifer

[4] Williamson, T. 2-13 *The Little Ouse: aspects of the history of a river.* Report to the Little Ouse Headwaters Project. https://readmore.lohp.org.uk/sites/default/files/archive/rural_history/UEA%20History%20of%20the%20Little%20Ouse%20Dec%202013.pdf Downloaded 01/07/21

adjacent to the largest intact block of valley fen – the 127 ha of Redgrave and Lopham Fen. From the late 1950s to 1999 it drew up to 3,500 cubic metres of water a day from the chalk aquifer. Worsened by increasingly frequent summer droughts, the site was desiccated. Many of its rarest wetland species were lost, while others hung on by a thread. Concern remains that abstraction from aquifer and surface waters remains at levels which continue to drain the life from the wetlands of the Core Area. If water resources continue to be used in this way, it could compromise restoration of nature in the floodplain. A comprehensive review of all abstractions and their impact on the Core Area wetlands is needed.

Recognition of the national and international importance of the area's valley fens came only as their wildlife was being lost. Redgrave and Lopham Fen was designated as Wetland of International Importance (Ramsar site) 1991, a National Nature Reserve two years later. In 2005, along with the fens at Blo' Norton, Market Weston, Hopton and Thelnetham it became a Natura 2000 site (Special Area of Conservation) in recognition of the internationally significant areas of chalk fen dominated by both Great Fen-sedge beds and Purple Moor-grass meadows.

Despite this recognition of the value of a few individual sites, the outstanding importance of the area's wildlife as a whole received less attention than that of Breckland immediately to the west and Broadland to the east. These larger areas have benefitted from more significant funding for special sites and the wider farmed landscape, most notably through the establishment of Environmentally Sensitive Areas (ESAs) in 1987. This important designation did not cover much of the short stretch of the Little Ouse valley that provided a corridor linking the Brecks and Broads ESAs and supported habitats typical of both of these larger areas, as well as some unique in their own right.

5.6 Bigger, better and more joined up

Until the start of this century, Redgrave and Lopham Fen, the smaller fen fragments designated as SSSI in the Little Ouse catchment, and a few County Wildlife Sites such as Roydon Fen near Diss[5], were the only remnants of the area's formerly rich fen wildlife receiving any conservation attention.

The rapid decline at Redgrave and Lopham Fen and smaller near-by fen remnants was halted by 1999 with the completion of a landmark restoration project involving relocation of the public water supply borehole and restoration of environmental conditions suitable for fen regeneration. The two decades since have seen a slow but progressive return from the brink of many of the special fen species - a recovery increasingly challenged by summer droughts.

Even after hydrological and ecological restoration, the small size and isolation of the sites left them vulnerable to the impacts of surrounding land use – particularly agricultural water abstraction and land drainage - and to continuing loss of species. As highlighted by the 2010 Lawton Report, *Making Space for Nature*, areas such as these need to be 'bigger, better and more joined-up' to retain their special wildlife.

The first moves to reconnect them and rebuild a wetland corridor for wildlife along the river began 20 years ago. A community project, the Little Ouse Headwaters Project (LOHP), was established with the long-term aim of linking the fen remnants in the upper reaches of the Little Ouse valley. One of its main

[5] Managed by Suffolk Wildlife Trust as a nature reserve.

early funding sources, the Transnational Ecological Network (TEN) project, aspired to reconnect wetlands from Brandon Creek on the Little Ouse to St. Olaves on the Waveney[6]– a very similar vision to our current one but greater in extent.

Over the last 20 years, progress towards the TEN project's vision for the upper Waveney and Little Ouse valleys has been positive but limited in extent (Figure 2).

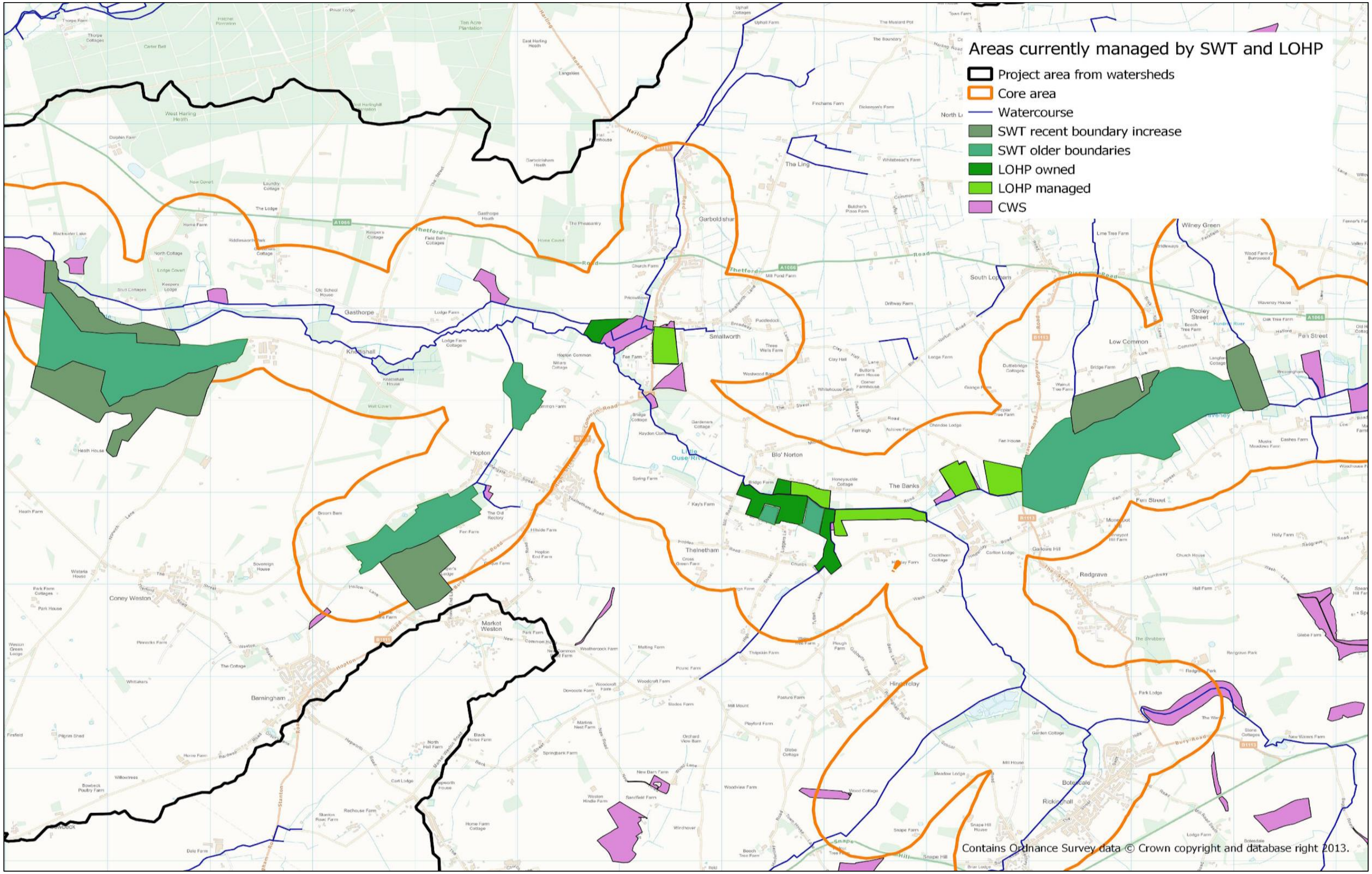
The Little Ouse headwaters emerged as the area where it has come closest to realisation. Increasingly working in partnership with SWT, the LOHP has acquired, by purchase or long lease, 15 parcels of land comprising 77 hectares along the upper 5 km of the river. These include most of the SSSI and County Wildlife sites not already in conservation management. To link these areas, fen habitats are being restored on fields acquired on the deep peat soils. Fields on more sandy or alluvial soils are being restored to more wildlife-rich, heathy grassland and meadow respectively. Critically, these linkages form a much more joined-up area in which nature can move and thrive. It links with Redgrave and Lopham Fen to the east, reconnects Thelnetham and Blo' Norton Fens with Hinderclay Fen, and stretches as far west as Garboldisham (Figure 2). The LOHP area also supports a network of public and permissive footpaths which are enjoyed by local people and visitors alike.

Beyond the immediate headwaters of the Little Ouse, work to reconnect the remnant fens and their associated habitats offers enormous potential for biodiversity restoration but has been much more limited in extent. Suffolk Wildlife Trust took on the restoration management of 169 ha of Knettishall Heath, including river-side wetlands, in 2012. More recently, they have almost doubled the extent of their Market Weston Fen reserve. However, these important sites, together with Hopton and Bugg's Hole Fens on the Little Ouse and Roydon Fen on the Waveney, remain essentially isolated from other wetlands. SSSIs currently occupy 8.6% of the Wider Project Area and County Wildlife Sites a further 1.3%. Within this project's Core Area on the valley floor peat, these figures rise to 13.9% and 2.8% - in all cases far below the Government's commitment to protect 30% of the land area to reverse biodiversity loss by 2030.

The rivers of the Little Ouse and the Waveney have also seen changes in management to restore biodiversity in the last decade. The rivers formerly meandered through the valley fens, forming an integral part of their ecosystems. But more than two centuries of land management designed to remove water from the area as fast as possible has radically changed their channels and flows and disconnected them from their floodplain fens and meadows. Recent in-channel restoration works have improved habitat diversity and self-cleaning, reducing silt deposition and obstruction by emergent reeds. However, while successful, these were undertaken only on limited and isolated stretches and some parts continue to be overwhelmed by incoming silt. The potential remains for much more extensive, joined-up improvements, ranging from further in-channel work to re-meandering of canalised sections to slow flows and reduce downstream flood risk. The critical importance of river condition impacting wildlife and their central role in restoration of the Core Area is explored further in the next Section.

[6] Norfolk and Suffolk County Councils 2003. TEN Vision

Figure 2 Increases in connectivity and area of sites managed for nature in the headwaters of the Waveney and Little Ouse Rivers.



6 Rivers in the Landscape

6.1 Land use and the river

Changes in catchment land use, land drainage, and intensification of farming practices over many years have led to increased loss of sediment (soil) and associated nutrients (principally nitrogen and phosphorus) from the land to the rivers. The loss of soil can be clearly seen during times of high flow, when the river water becomes brown and turbid. This was clearly shown for instance on the Thelnetham Brook by Andrew Adams[7]. In addition, land drainage via ditches and the long-established practice of under-draining arable land, together with bare soils at certain times of year, results in rapid transfer of rainwater from land to river. This produces two problems - water does not percolate down through the soils to refill the underground aquifer, and large volumes of water leaving the land contribute to flooding further downstream.

6.2 Impacts of over-engineering on the rivers

The Little Ouse in flood and laden with silt at Thelnetham Ford

The upper reaches of both the Waveney and Little Ouse have been significantly physically modified over a period of several hundred years. Parts of their channels have been straightened, and increased dredging during the last century for land drainage (although not carried out in recent years) has resulted in over-deepened and widened channels, with little habitat diversity. The dredged material forms embankments in places, cutting the rivers off from their floodplains and fens. Lowering of the riverbed has resulted in loss of gravel substrates, important habitat for a range of aquatic invertebrates and spawning fish[8].

In combination with abstraction of groundwater, the river dredging, by widening the channel and reducing the already low gradient, created slower flows within the river channel leading to an increase in fine sediment deposition on the riverbed. With reduced flow velocity, emergent aquatic vegetation spreads across the channel, with growth encouraged by high nutrient levels in the sediment and water. Slow in-channel flows and excessive plant growth in turn result in depletion of dissolved oxygen, which adversely impacts all aquatic life.

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[7] Adams, A (2022) *Little Ouse Headwaters Project River Survey: Little Ouse and Thelnetham Brook*. Report to LOHP

[8] Margaret Phillips recorded in 2012: *Personal histories* – Little Ouse Headwaters Project. Downloaded from https://readmore.lohp.org.uk/archive/personal-histories on 01/07/2022

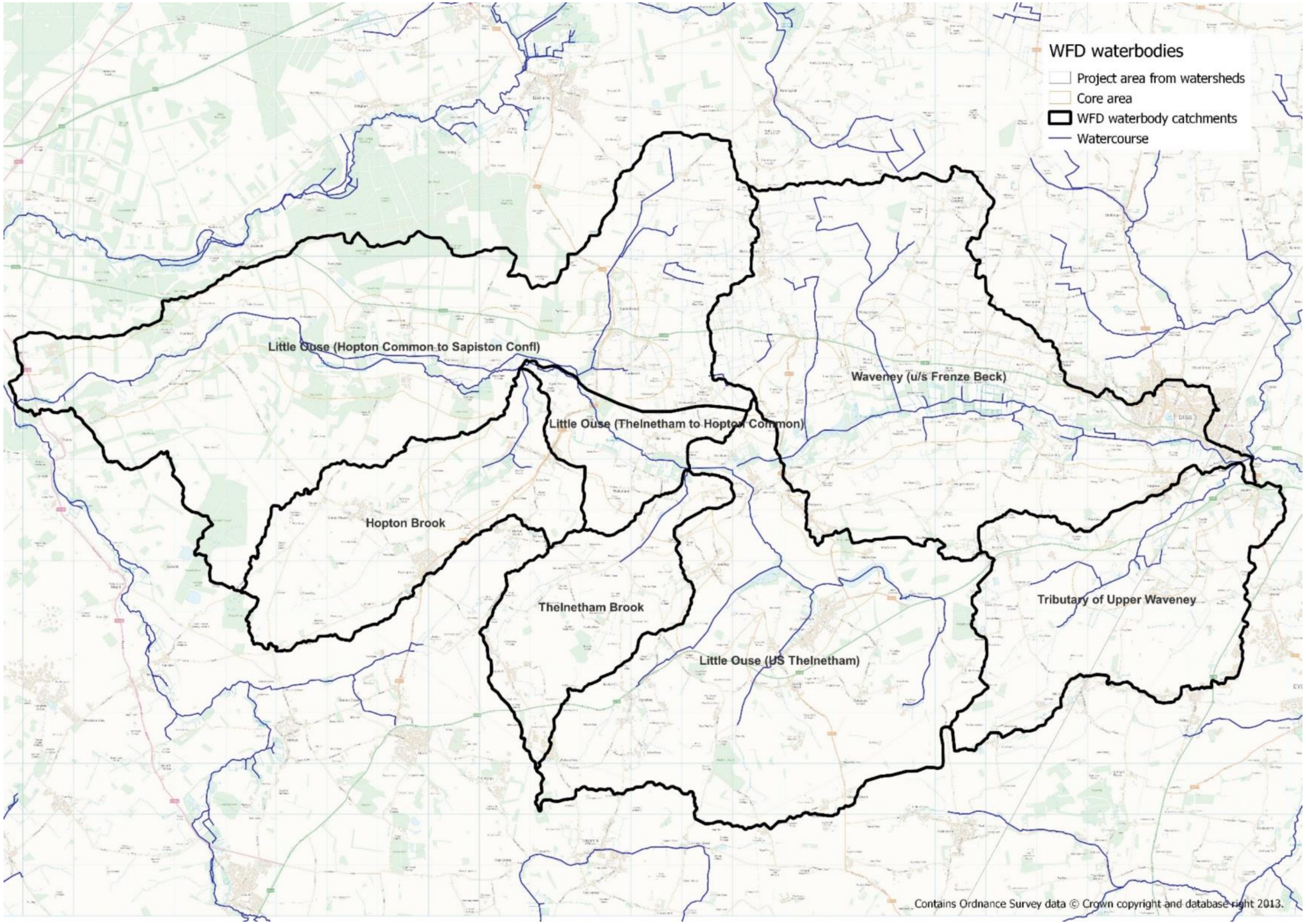
6.3 Ecological condition

Current assessments of ecological status for the Waveney and Little Ouse under the Water Framework Directive Regulations (WFD) are shown in Table 1. Within the project area each river is divided into "water bodies" (Figure 3) with an individual assessment of status. None of the water bodies in the project area currently achieve the target of Good Ecological Status. The pressures thought to be responsible for this are also shown in Table 1. It is notable that, despite much similarity in land use and environmental conditions across the catchments of the water bodies, there is some variation in the pressures identified, particularly when comparing the Waveney and Little Ouse, and the reasons for this merit further investigation. The WFD assessments may not fully reflect all the pressures acting on the ecology of these rivers – for example there is no direct measure of sediment reaching the river channel, and no ecological standard applied for nitrate in the water. The assessment of phosphate in these rivers may also under-estimate the full extent of nutrient enrichment, as the rivers will receive phosphorus bound to soil particles as well as that dissolved in water. Clearly, raising our rivers to Good Ecological Status is an urgent, all-embracing task for the responsible bodies such as the Environment Agency, but in this work there is a role for all land managers and agencies.

Table 1 Current status of WFD water bodies within the project area and pressures identified as contributing to failure to achieve good status (Environment Agency 2019 results)

Water body	Ecological status	Pressures
Little Ouse		
Thelnetham Brook (tributary)	Moderate	Abstraction and flow, physical modification, ammonia, dissolved oxygen, phosphate, chemicals
Upstream Thelnetham	Bad	Abstraction and flow, physical modification, fine sediment, ammonia, dissolved oxygen, phosphate, chemicals
Thelnetham to Hopton Common	Poor	Abstraction and flow, physical modification, fine sediment, ammonia, dissolved oxygen, chemicals
Hopton Brook (tributary)	Moderate	Physical modification, dissolved oxygen, phosphate, chemicals
Hopton Common to Sapiston confluence	Moderate	Abstraction and flow, physical modification, dissolved oxygen, phosphate, chemicals
Waveney		
Upstream Frenze Beck	Moderate	Dissolved oxygen, chemicals
Tributary of Upper Waveney	Moderate	Phosphate, chemicals

Figure 3 Water Framework Directive water bodies within the project area



6.4 Benefits of land use change for the rivers

It was not within the scope of this project to quantify the impact on river water quality and ecological status of the proposed land use changes in the Vision. However, changing from arable to permanent low input grassland or woodland in targeted locations should significantly reduce the loss of sediment and nutrients to the river, improving water quality.

Land use change would also affect the rate of loss of surface water to the rivers. The rivers depend on groundwater to maintain their base flow, with surface water entering after rainfall events. With current catchment land use there is a relatively "flashy" flow regime - levels in the rivers rise comparatively rapidly after rain, and the sediment load in the water visibly increases. Land use change could slow this flow into the river by retaining more water on the land, increasing recharge to the below-ground aquifer, and reducing the transport of sediment into the river channels.

6.5 Reversing the impacts of over-engineering

Small scale river channel restoration projects in the Little Ouse have already demonstrated that in-channel flows can be improved, and habitat diversity re-introduced[9], but, without wider catchment changes, issues with sedimentation and poor water quality will remain. River channel restoration on a larger scale than so far achieved would help reconnect the rivers to their floodplains, restoring natural processes, allowing sediment to be deposited on land rather than in the river channel. This would slow the flow of floodwater downstream, reducing flood risk in the lower parts of the catchments. Climate change predictions suggest more extreme rainfall events will become more frequent, so increasing flood storage capacity in the upper reaches of the river offers a nature-based solution to flooding issues well beyond the project area.

River channel restoration on the Little Ouse in 2013 reduced silt deposition by narrowing the channel to increase flow velocity

[9] Holmes, N. T. H. 2013 Little Ouse Headwaters pilot restoration project. Report to the Little Ouse Headwaters Project. Downloaded from https://readmore.lohp.org.uk/sites/default/files/archive/report_pdfs/Little_Ouse_in-channel_Restoration_Project_2013.pdf on 01/07/2022

7 Creating a Vision for Landscape Recovery

7.1 Mapping

We used a variety of mapped/spatial data sources to examine the factors influencing current land use and the opportunities and constraints they present for landscape recovery. In this section we describe these information sources and how we used them to build a vision map for the area's nature recovery potential. All the maps are presented in Section 7.3 and are available in A3 format at https://www.suffolkwildlifetrust.org/recovering-nature-headwaters-little-ouse-and-waveney-rivers.

7.1.1 Data sources

The mapping exercise was undertaken with QGIS software.

There is no single fully accurate, field-scale source of land use/habitat data currently available. Our baseline habitat mapping is adapted from the Centre for Ecology and Hydrology (CEH) Land Cover Map 2020 10m raster data set (LCM)[10]. This data is generated from reflected light spectrum analysis which results in a degree of inaccuracy in identifying different vegetation types. Key issues for this project were (1) that it showed virtually no fen in the project area, with only a small fraction of Redgrave and Lopham Fen being represented, and (2), there was a fair degree of inaccuracy in the classification of arable and improved grassland. While this project was in progress, Natural England's Living England Habitat Map was released (April 2022)[11] - while achieving greater accuracy than the LCM data it is based on, this has the acknowledged issue of over-representing neutral, acid and calcareous grassland. Due to the timing of its publication, we have not incorporated the Living England map.

Using the authors' local knowledge and some aerial imagery, the baseline map was manually adapted to increase accuracy. Mapping of different types of grassland from remotely obtained data is particularly problematic; almost all of the grassland in the study area is, or has been, agriculturally improved at some point in recent times but there is room for debate over the correct classification of any particular field, particularly when it is deemed to have recovered to a semi-natural state after the cessation of re-seeding, agrochemical inputs or regular maintenance of field drainage.

In terms of other information which helps in the classification of habitats there is data for most of the designated sites and there is more recent habitat mapping undertaken by LOHP, but in the wider countryside information is very limited.

7.1.2 Developing the Vision map

The main decisions regarding the Vision map (Figure 10) were based on the authors' local knowledge and experience in the fields of habitat management, water resources and ecology. We took into

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[10] Habitat mapping: Morton, R.D.; Marston, C.G.; O'Neil, A.W.; Rowland, C.S. (2021). Land Cover Map 2020 (10m Classified Pixels, GB). NERC EDS Environmental Information Data Centre. https://doi.org/10.5285/35c7d0e5-1121-4381-9940-75f7673c98f7

[11] *Living England: From Satellite Imagery to a National Scale Habitat Map* https://naturalengland.blog.gov.uk/2022/04/05/living-england-from-satellite-imagery-to-a-national-scale-habitat-map/

consideration the existing designated sites and land in conservation management in the project area, soils and agricultural land class data, areas suitable for fen or wet grassland restoration and existing land use. Our map therefore provides a more detailed coverage of the project area than Natural England's National Habitat Network (NHN) map. However, virtually all the land we identify for land use change falls into one of five categories in the NHN mapping: Restorable habitat, Fragment action zone, Network enhancement zone 1, Network enhancement zone 2 and Network expansion zone.

It was clear from looking at the existing habitats (Figure 9) where some land use changes would be most beneficial in terms of creating a wider continuous corridor of non-arable habitats. While the corridor of grassland, woodland and fen is narrow along the entire length of the river valleys, there is a conspicuous pinch point in the parishes of South Lopham, Blo' Norton, Redgrave, Hinderclay and Thelnetham. Given the important fragments of valley fen found in these parishes, providing a buffer to these fens and increasing connectivity and overall area is a priority.

The majority of the suggested habitat modification is within the Core Area but there are three key elements which extend well into the Wider Area:

- **Hedgerows** - The modification of the existing hedgerow network over the entire project area is an acknowledgement of the known biodiversity value of high-quality hedgerows, both for supporting a large number of species and their use as corridors connecting other habitats within the catchments and beyond. While no extra hedgerows have been added to the landscape vision map, the intention in the restored landscape would be to make significant improvements to the existing hedgerows primarily by letting them grow taller and wider and allowing some trees to become standards. This does not, of course, preclude the establishment of additional hedgerows.
- **Sediment management** - The creation of grassland buffers along all major tributary ditches will reduce sediment and nutrient runoff into ditches. Any remaining sediment inputs from road surface runoff and arable fields connected to the upstream ditch network should be removed by sediment traps.
- **Ponds** - The restoration and creation of ponds across the whole project area is vital for connectivity of aquatic habitats and species. There is evidence that ponds are also of benefit to terrestrial species, including many farmland birds.

7.2 Supporting information

7.2.1 Designated sites (Figure 4)

Some of the sites on this map have multiple designations. This is difficult to show clearly at the scale used, the complete designations for these sites are as follows:

- Redgrave and Lopham Fen: SSSI, RAMSAR, SAC, NNR
- Blo' Norton and Thelnetham Fens: SSSI, SAC
- Breckland Forest: SSSI, SPA
- Breckland Farmland: SSSI, SPA
- Fakenham Wood and Sapiston Great Grove: SSSI, Ancient woodland
- Westhall Wood and Meadow: SSSI, Ancient woodland

- Burgate Wood: SSSI, Ancient woodland
- Brockley Wood: CWS, Ancient Woodland
- Calke Wood: CWS, Ancient Woodland
- Roydon Fen: CWS, LNR

7.2.2 Soils (Figure 5)

The soils map, based on the 1983 Soil Survey[12], is indicative of the boundaries between major soil types. It was used, along with local knowledge, to identify areas where the highest returns in terms of wildlife recovery, water storage and carbon capture could be achieved in the shortest time frame.

7.2.3 Agricultural land classes (Figure 6)

Our map is based on the Natural England's 2010 1:250 000 Series Agricultural Land Classification map for the East Region[13].

Consideration was given during the mapping process to areas with higher agricultural value - where possible, Grade 2 land was left in arable production. This was largely practical with two exceptions where arable reversion of small areas of Grade 2 land was desirable to achieve a corridor with maximum wildlife value and an effective buffer to the river-side wetlands:

- On the Waveney, the fields in Wortham and Redgrave on the south side of the valley.
- On the Little Ouse in Blo' Norton, South Lopham, Redgrave and Hinderclay where arable fields create a pinch-point in the corridor.

7.2.4 Water in the landscape (Figures 7 and 8)

Ponds

The pond mapping only covers Norfolk as we could find no comparable data for Suffolk. It is, however, reasonable to assume that similar densities of ponds will be found across the Suffolk side of the project area.

Pond numbers shown on the 2014 (Figure 7a) Ordnance Survey map are 32% lower than on the 1955 map (Figure 7b) - a very significant reduction in the area of wetland habitat available for wildlife in the farmed countryside[14]. However, impacts on wetland wildlife are much greater than these data suggest because most of the surviving ponds have suffered from a lack of management and become overgrown and shaded by trees.

While potential pond restoration and creation locations have not been mapped, we feel that the benefit of increasing the density of ponds with open water, and at least the south side being unshaded

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[12] Soil Survey 1983. *Soils of England and Wales*: (in six map sheets at 1:250 000 scale). Ordnance Survey, Southampton.

[13] Natural England 2010. Agricultural Land Classification map, Eastern Region (ALC008) http://publications.naturalengland.org.uk/publication/127056?category=5954148537204736 downloaded 07/2022.

[14] : Alderton, E. 2017 *"Ghost ponds" : Resurrecting lost ponds and species to assist aquatic biodiversity conservation.* PhD thesis, University College, London. https://discovery.ucl.ac.uk/id/eprint/1571783/1/THESIS_revised%20for%20PDF.pdf Downloaded 01/07/22

by trees and scrub, would have significant benefits in creating a connected landscape for aquatic plant and animal species.

This can be very successfully achieved by the restoration of overgrown and 'ghost' ponds[15] which has the benefit of recovering species from the buried seed bank. Alternatively, new ponds can be created. Increasing the number of managed ponds produces a significant wildlife benefit at relatively low cost.

Rivers, tributaries and main ditches

Figure 8 is based on OS OpenData[16], shows the main water courses within the project area and has the stretches of river where straightening of the channel is most obvious marked for meander restoration. The section marked immediately to the west of Wortham Ling is the original river channel. The suggestion here would be to reinstate the old channel, with the new cut being used in high flow events. Suggested sites of sediment trap ponds on the main ditches are also marked, although these could be placed in other locations with the same benefit achieved.

7.2.5 Current Habitats (Figure 9)

This map, based on the UKCEH 2020 Land Cover Map[17], shows the current land cover, as far as can be achieved in a desk study using both available data and local knowledge.

7.3 The maps

The project maps are presented in the following series of Figures, described above.

[15] Norfolk Ponds Project -Downloaded from www.norfolkfwag.co.uk/norfolk-ponds-project/ on 01/07/22

[16] Watercourse data: OS OpenData. Contains Ordnance Survey data © Crown copyright and database right 2021.

[17] Morton, R.D.; Marston, C.G.; O'Neil, A.W. & Rowland, C.S. 2021. Land Cover Map 2020 (10m classified pixels, GB). NERC EDS Environmental Information Data Centre. (Dataset). https://doi.org/10.5285/35c7d0e5-1121-4381-9940-75f7673c98f7, downloaded 01/07/2022.

Figure 4 Designated sites within the project area

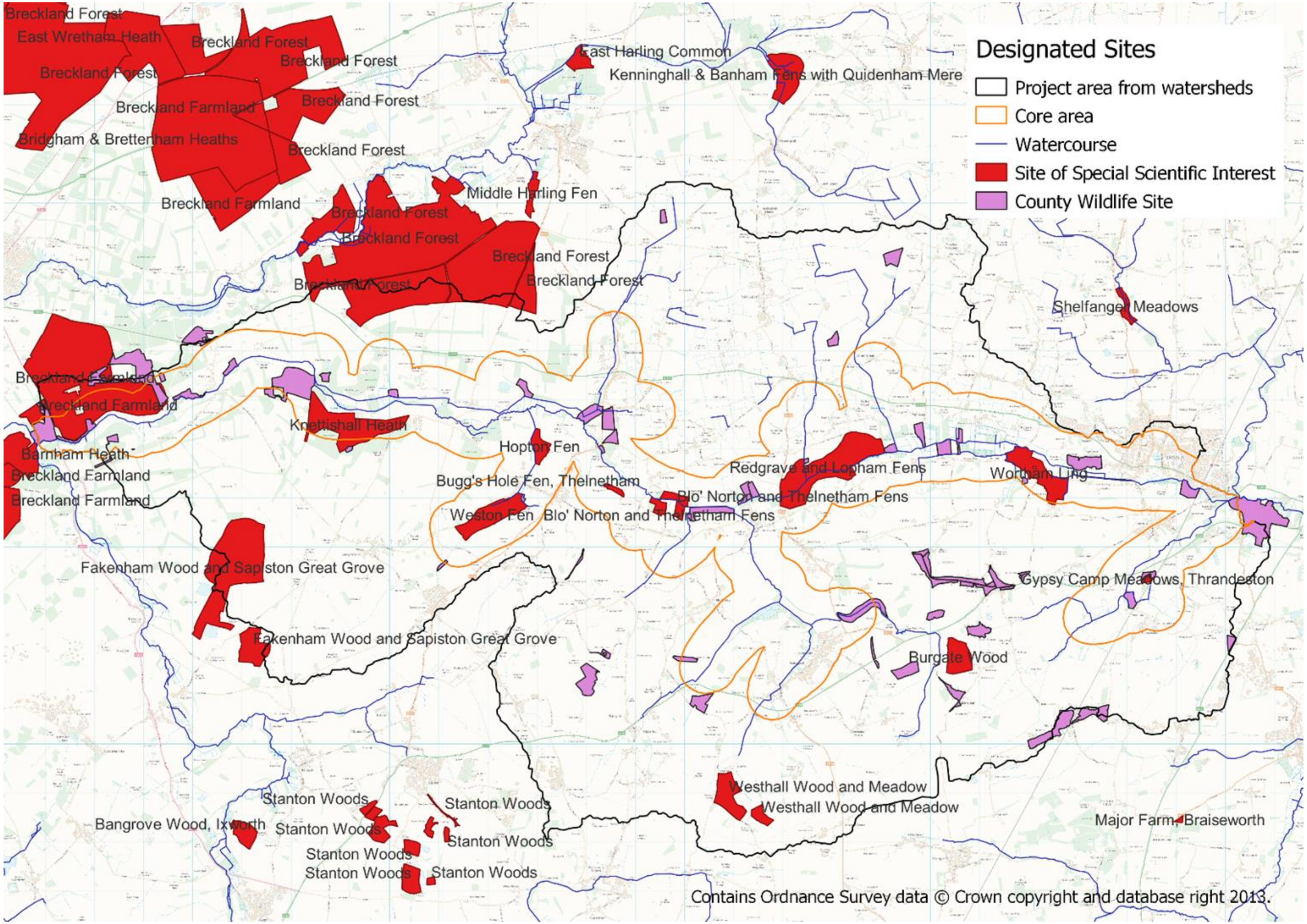
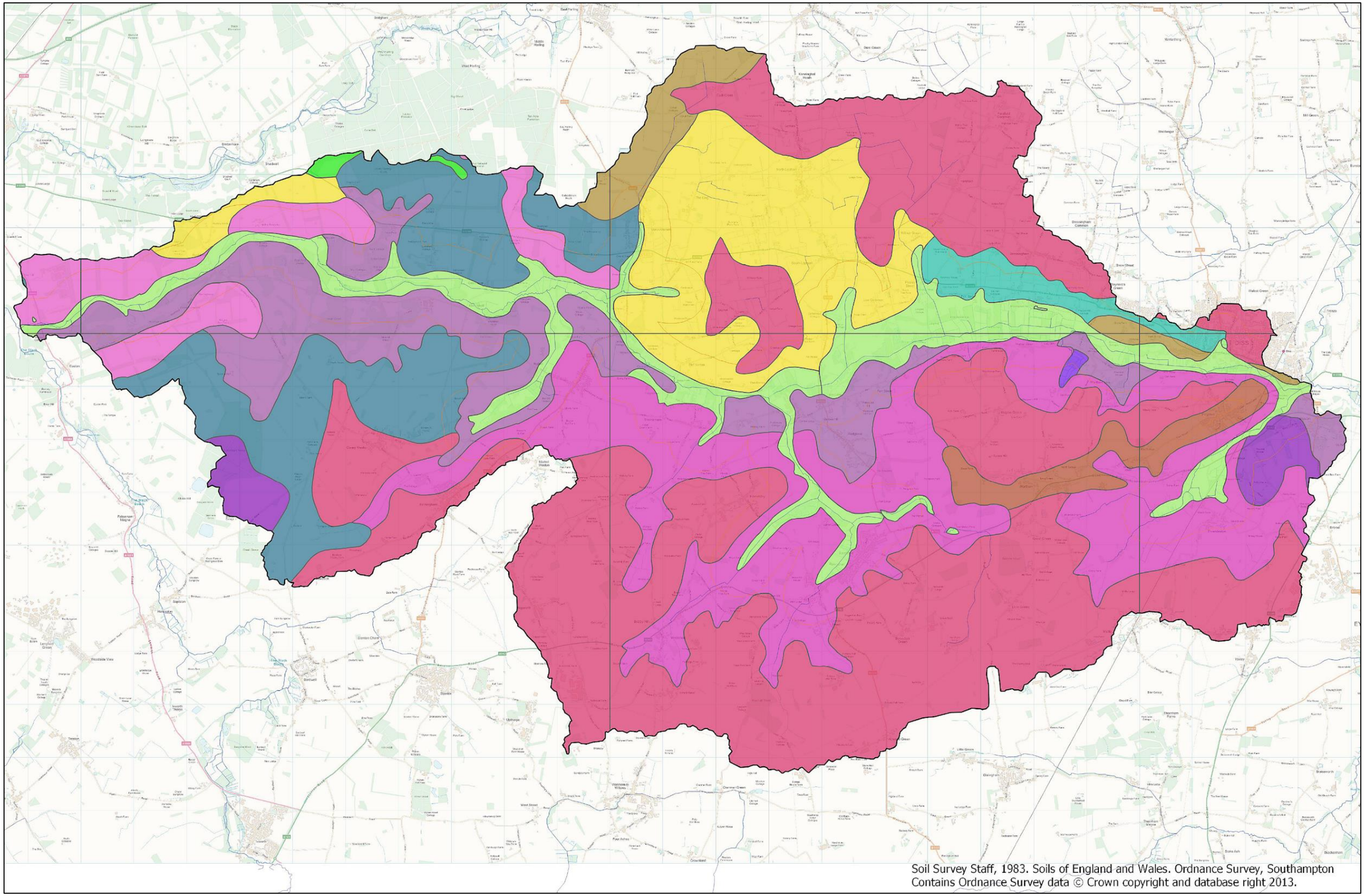


Figure 5 Soil types within the Wider Area. Based on the 1983 Soil Survey (Ordnance Survey) map (legend next page)



Legend for Soil Map (Figure 5)

- Project area from watersheds
- Core Area
- Watercourse

Soil Type

- associated with similar but non-calcareous soils
- associated with similar clayey soils.
- Sandy soils with a peaty or humose surface horizon.
- Some coarse and fine loamy soils with slowly permeable subsoils and slight seasonal waterlogging.
- Some coarse loamy soils with slowly permeable subsoils and slight seasonal waterlogging.
- Some deep sandy soils affected by groundwater.
- Some deep well drained coarse loamy and sandy soils.
- Some similar deeper sandy soils, often in an intricate striped pattern.
- Some similar fine or coarse loamy over clayey soils. Some deep well drained coarse loamy over clayey, fine loamy and sandy soils.
- Some slowly permeable non-calcareous clayey soils.
- Some very acid soils with bleached subsurface horizon especially under heath or in woodland.
- Widespread small scale polygonal soil patterns.

Figure 6 Agricultural Land Classification within and close to the project area

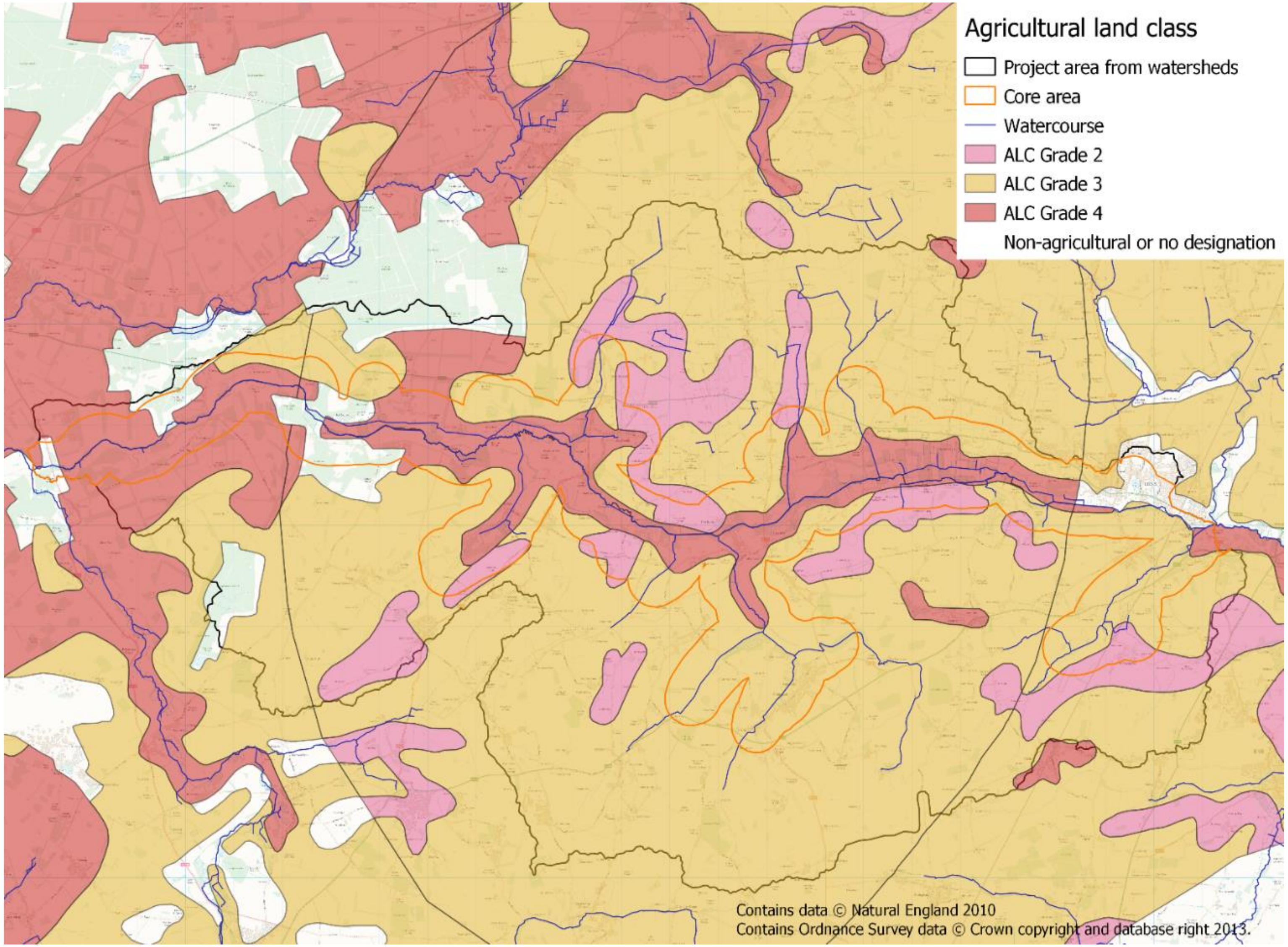
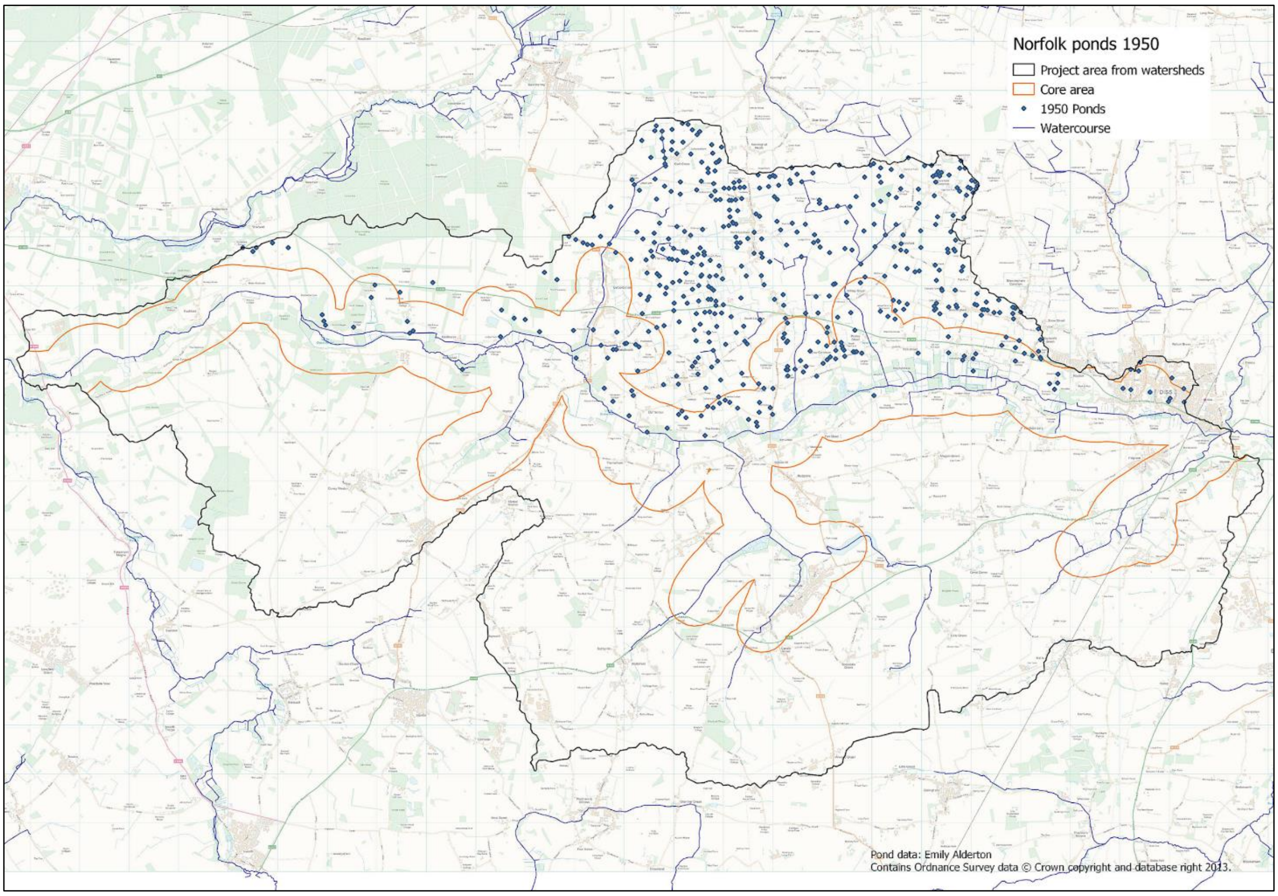


Figure 7 Location of ponds within the Wider Project Area in 1950 (top) and 2020 (bottom)



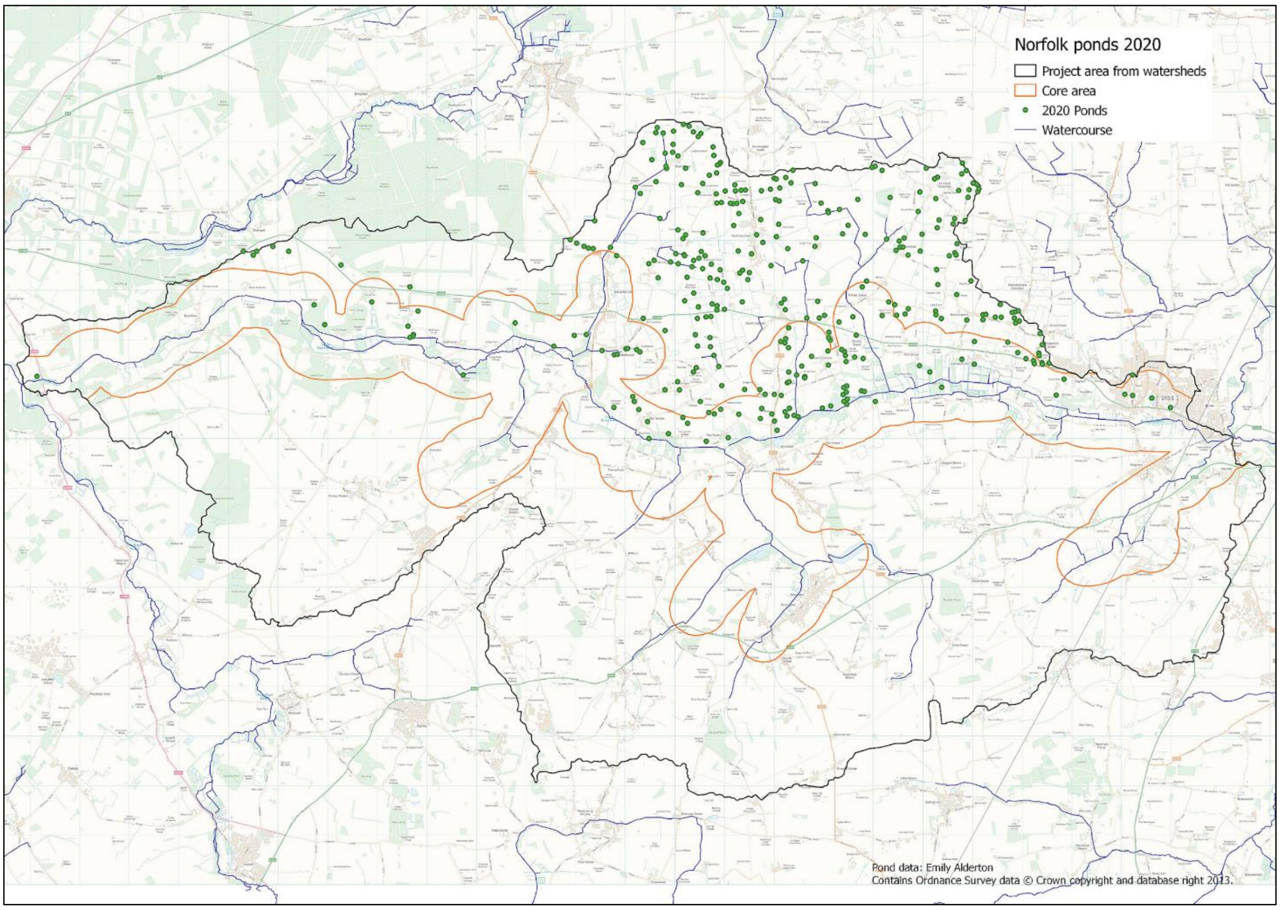


Figure 8 Watercourses within the Core Area showing potential restoration works

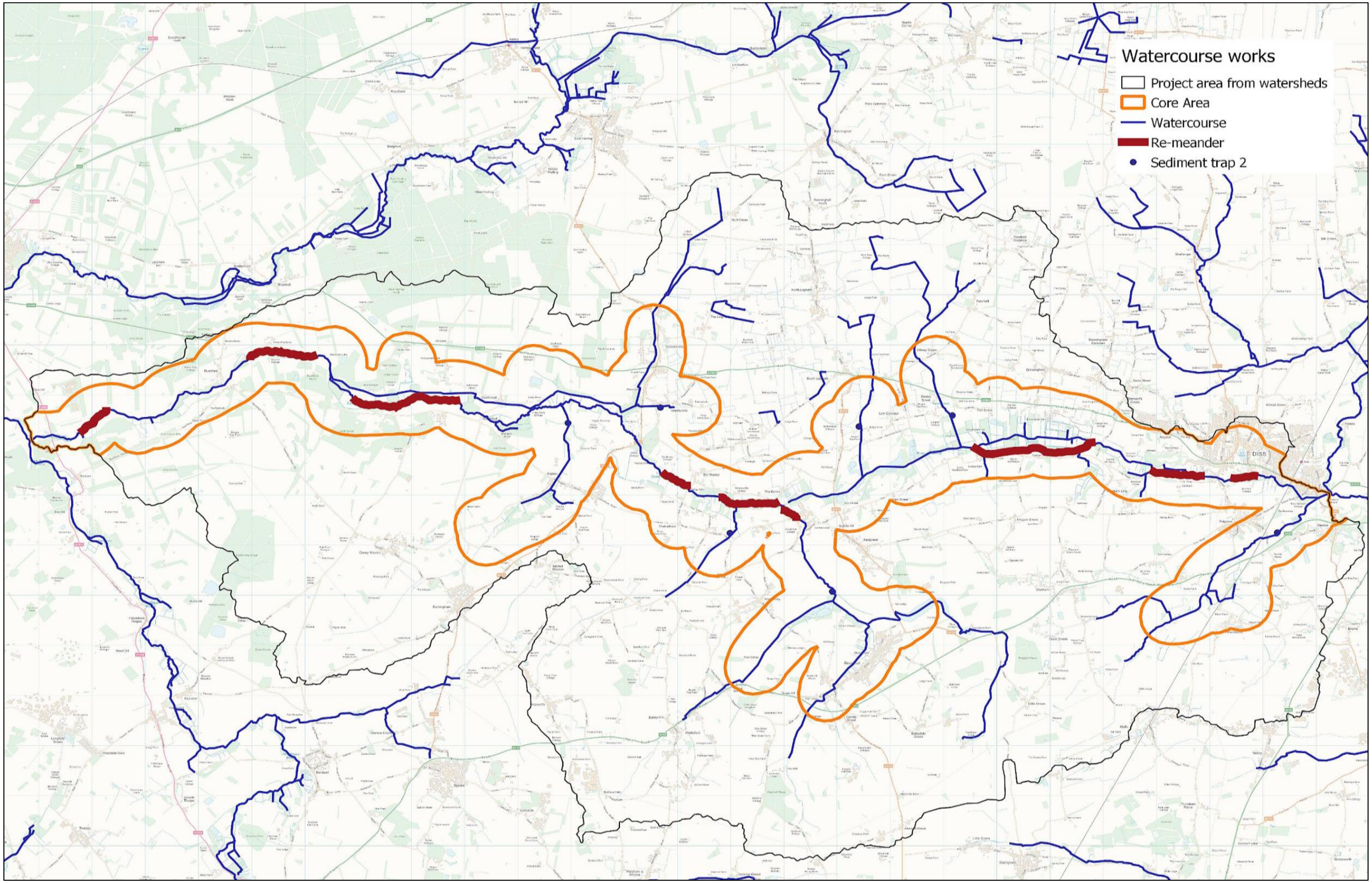


Figure 9 Current broad habitat types within the project area

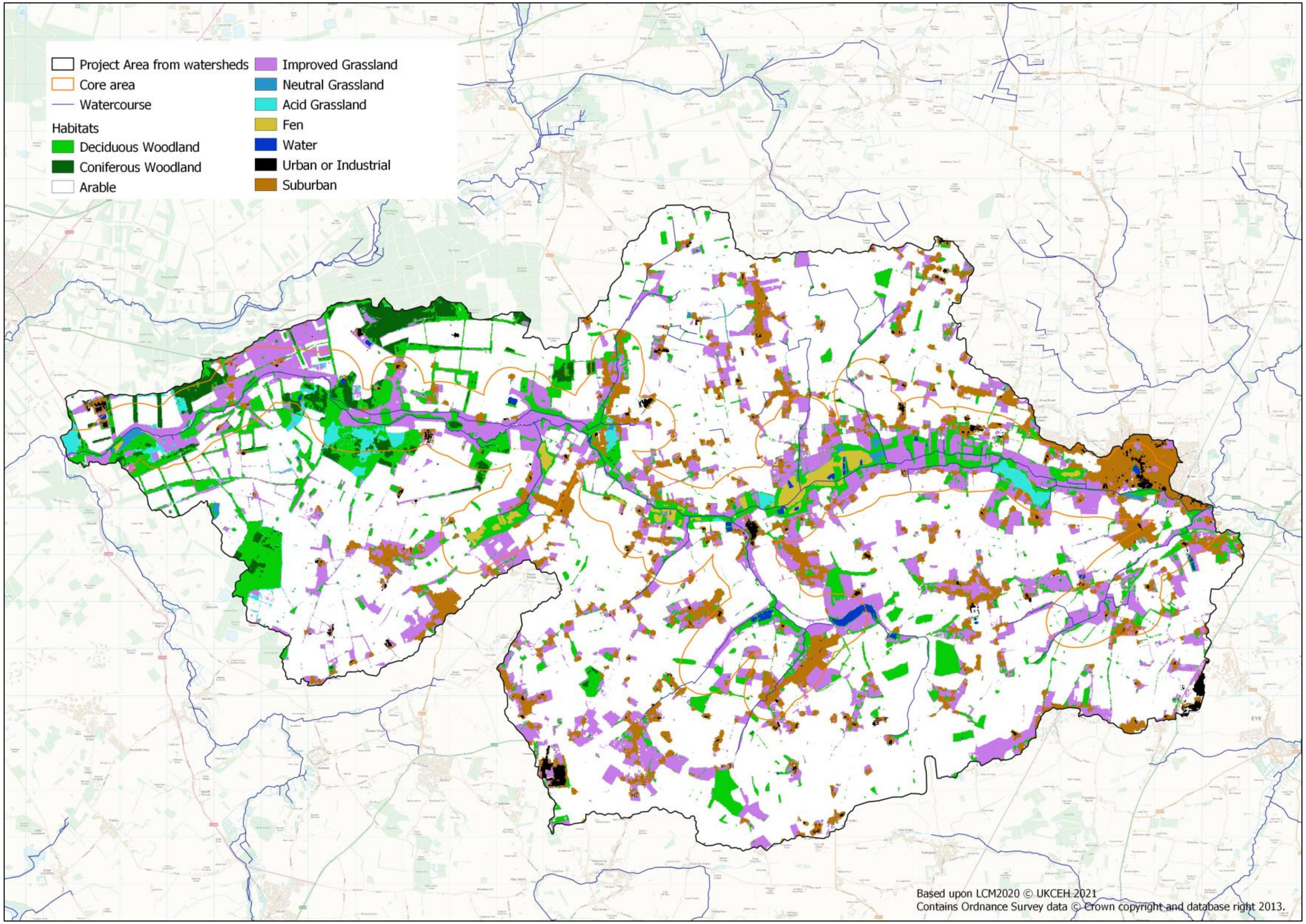
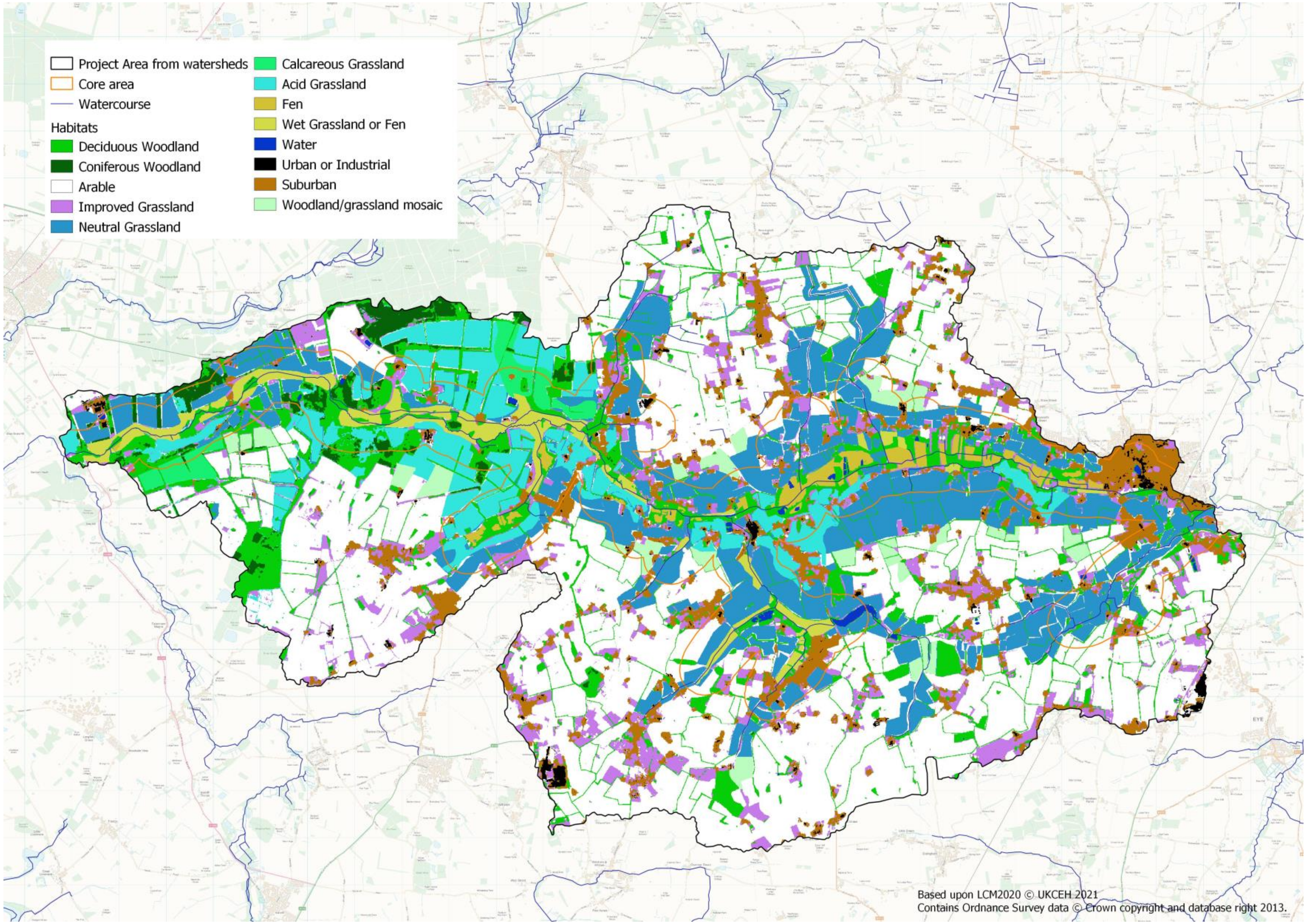


Figure 10 Vision Map for future habitat recovery within the project area



8 Vision for Habitat Recovery

8.1 Working with nature

The benefits of nature-based solutions to tackle the interlinked biodiversity and climate crises we face have been well documented, as has the rapid loss of habitats and species in our lowland landscapes[18] (see examples at end of section). The recovery of nature and the ecosystem services it provides is at the heart of this ambitious vision.

The main focus of our vision for the landscape is on returning a significant area to extensively managed, low input, wildlife-rich grassland mosaics interspersed with scrub and trees. By grassland, we mean permanent grass which becomes increasingly rich in species over time. This grassland is mown for late summer hay or grazed. It would not be heavily fertilised or cut for silage. There are three pressing reasons for this:

First, the well-documented loss of lowland grassland to intensively managed arable and agriculturally improved grassland, particularly in the second half of the 20th Century, resulted in very significant declines in many plant and animal species dependent on these habitats. An estimated 97% of lowland grassland was lost between the 1930s and 1980s, leaving only 2% with a high diversity of species[19]. Restoring areas of semi-natural grassland, whether acid, calcareous or neutral, will benefit many species while supporting low-intensity food production from grazing animals.

Secondly, low input grasslands increase and stabilise the store of soil carbon in comparison to intensive arable production.

The final main beneficiary of an increase in grassland within the catchment would be the river. Semi - natural grassland will add a fraction of the sediment and nutrient runoff to the ditch system in comparison with arable land. Grassland has a greater year-round ability to intercept and store rainfall than arable, leading to less flooding and increased recharge of the aquifers. This is one of the reasons why our vision includes grassland strips that continue from the Core Area, following the major ditches into the Wider Area.

On peat soil in the Core Area, reverting some of the improved grassland to fen reconnects fen fragments and at the same time has substantial benefits for carbon storage[20]. There are several sites within the Core Area where this has already occurred. At Webbs Fen, Thelnetham, former species-poor and dry grassland has been reverted to developing fen by raising water levels and removing trees and

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[18] Environment Agency, Chief Scientist's Group. (2022). Working with nature. https://www.gov.uk/government/publications/working-with-nature

[19] Hayhow DB, Burns F, Eaton MA, Al Fulaij N, August TA, Babey L, Bacon L, Bingham C., Boswell J., Boughey K.L., Brereton T., Brookman E., Brooks D.R., Bullock D.J., Burke O.,Collis M., Corbet L., Cornish N., De Massimi S., Densham J., Dunn E., Elliott S., Gent T., Godber J., Hamilton S., Havery S., Hawkins S., Henney J., Holmes K., Hutchinson N., Isaac N.J.B., Johns D., Macadam C.R., Mathews F., Nicolet P., Noble D.G., Outhwaite C.L., Powney G.D., Richardson P., Roy D.B., Sims D., Smart S., Stevenson K., Stroud R.A., Walker K.J., Webb J.R., Webb T.J., Wynde R. and Gregory R.D. 2016. *State of Nature 2016*. The State of Nature partnership.

[20] R Gregg, J. L. Elias, I Alonso, I.E. Crosher and P Muto and M.D. Morecroft (2021) Carbon storage and sequestration by habitat: a review of the evidence (second edition) Natural England Research Report NERR094. Natural England, York.

scrub. Scrapes have been created and light grazing started. The grassland is slowly turning back to fen, connecting surrounding parts of the established Thelnetham Fens. More species-poor grassland areas at nearby Parkers Piece and Oak Tree Fen are also reverting to fen following localised lowering of ground levels by removal of degraded dried out peat, raising of water levels by blocking small ditches, and management by low intensity grazing. Restored fen can take time to develop. Plants may colonise from the buried seed bank or from adjacent sites. First to arrive are typically the tall and more competitive species that respond well to raised water levels and relaxation of management, such as reed, a variety of rushes and tall bulky fen herbs. Smaller, more uncommon fen species take more time and may require the nutrient levels in the soils to be reduced and the fen become less dominated by tall species. Maintaining management such as grazing and/or cutting is vital to ensure the fen develops plant species richness. Actions that may accelerate the process of fen restoration include turf stripping to remove the competitive grass sward and accumulated soil nutrients, and scooping out shallow pools and scrapes which allow aquatic plants and animals to enrich the biodiversity of the fen habitat.

The vision also includes two grassland swathes that extend out from the Core Area which are not associated with the main ditch network:

- An area of acid and calcareous grassland extends north from the Gasthorpe area up to the SSSI/SAC boundary at Harling Forest. This creates a broad continuous connection from the Little Ouse valley into Breckland and the Thet valley. There is great potential for relatively quick reversion to a semi-natural grassland on these thinner soils.
- On the south side of the Waveney in Redgrave and Wortham, the neutral grassland extends south of the Core Area to provide a generous corridor and a good buffer for the valley floor fens.

Figure 11 summarises the changes in area of different habitats that would occur if the vision was fully realised. It should be noted that this only represents the total area under each habitat and does not therefore reflect other gains for biodiversity and ecosystem services that would result from increased connectivity of habitats, improvements to water quality, and adoption of best environmental practices within the area of cropland.

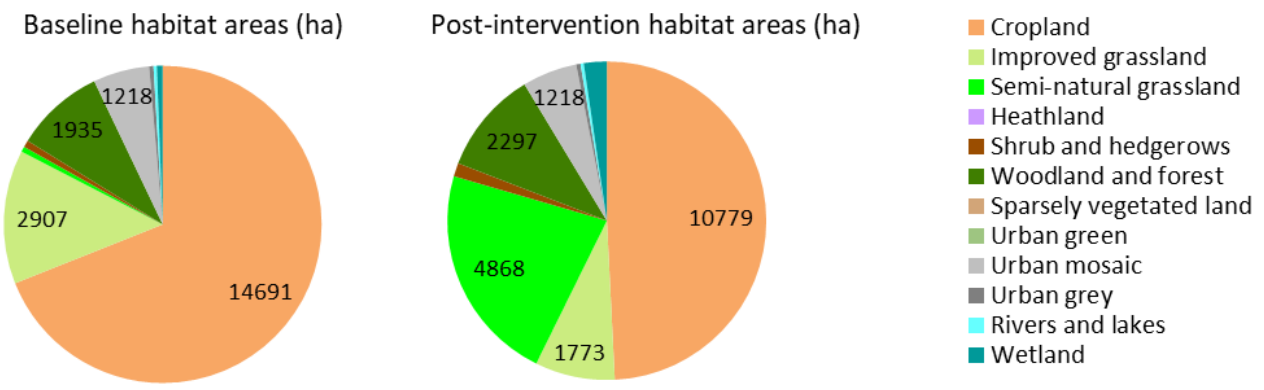


Figure 11 Changes in habitat areas achievable through the Vision. Contains data from CEH licence number 1616.

It is important to understand that in the coming uncertain decades of climate disruption, the Vision is as much about creating opportunities for wildlife to colonise, adapt and change, as it is about re-establishing or restoring pre-existing habitats. It is about building resilience to environmental adversity.

Habitats with potential for restoration in the project area

©Arthur Rivett

Short, herb-rich fen (above and below)

©Helen Smith

©Helen Smith

Sedge (*Cladium mariscus*) beds

©Arthur Rivett

Wet, rushy meadows with wide hedges and hedgerow trees

©Arthur Rivett

Neutral meadow grassland with wide hedges and scattered scrub

©Helen Smith

Yellow Meadow Ant hills in chalk grassland

Acid grassland with wide hedgerows including standard trees

Heathland

Examples of the many species likely to benefit from less intensive agricultural management in the project area (Red text indicates species assessed as being at risk of extinction in Britain, photo credits and sources are on the following page).

Near Threatened: Common Toad. Decline approaching 30% over 10 years[1].

Red Listed: Yellowhammer.[2] 58% decline in 50 years.

Vulnerable: Green-winged Orchid. 32% decline 1970-2000.[3]

Endangered: Wall Brown. 70% decrease in distribution 2010-2019.[4]

Vulnerable: Hedgehog. Decline of at least 46% over 13 years.[5]

Red Listed: Lapwing. 54% decline in 50 years, with lowland areas and SE England worst affected.[6]

[1] Foster, J., Driver, D., Ward, R. & Wilkinson, J. 2021.*IUCN Red List assessment of amphibians and reptiles at Great Britain and country scale*. Report to Natural England. ARC report. ARC, Bournemouth. (Photo. Credit Helen Smith)
[2] BTO *Bird trends* downloaded from https://app.bto.org/birdtrends/species.jsp?year=2018&s=yelha July 2022. (Photo. Credit)
[3] Stroh, P.A., Leach, S.J., August, T.A., Walker, K.J., Pearman, D.A., Rumsey, F.J., Harrower, C.A., Fay, M.F., Martin, J.P., Pankhurst, T., Preston, C.D. & Taylor, I. 2014. A Vascular Plant Red List for England. Botanical Society of Britain and Ireland, Bristol. (Photo. Credit Arthur Rivett)
[4] Fox, R., Dennis, E. B., Brown, A. F. & Curson, J. 2022. *A revised Red List of British butterflies***.** Insect Conservation and Diversity. https://doi.org/10.1111/icad.12582 (Photo. Credit Arthur Rivett)
[5] Mathews F. & Harrower C. 2020. *IUCN – compliant Red List for Britain's Terrestrial Mammals*. Assessment by the Mammal Society under contract to Natural England, Natural Resources Wales and Scottish Natural Heritage. Natural England, Peterborough ISBN 978-1-78354-485-1. (Photo. credit Gaudete, CC BY-SA 2.5 <https://creativecommons.org/licenses/by-sa/2.5>, via Wikimedia Commons).
[6] BTO *Bird trends* downloaded from https://app.bto.org/birdtrends/species.jsp?year=2019&s=lapwi July 2022. Photo. credit Arthur Rivett.

8.2 Delivering the Vision

Delivery of the Vision will be a long-term undertaking involving significant commitment by a wide range of individuals and organisations, requiring both guaranteed government support and private investment.

In addition, the Vision map presented in Figure 10 is indicative and would benefit from additional survey and ground truthing. A revision following collection of the required data should be programmed for 5-10 years.

8.2.1 Implementation through a habitat menu system

The Vision foresees a broad series of habitats and gradations between them. It is not possible to be prescriptive about the plant and animal communities which will assemble in any given location. Nature is not easily corralled into pre-determined formations and communities. The project has taken a landscape, rather than field scale approach, which envisages wide sweeps of habitats being assembled and shaped by management of natural processes. Following on from this report, an Implementation Plan to turn the Vision into reality will be developed.

It is anticipated that any scheme will include an array of landowners, each with differing preferences and constraints operating on their land. Not all landowners will want, or be able to commit to, full recovery to the highest level of the Vision. It is important that the scheme allows for different levels of implementation, and that it includes all who want to see nature flourish on their land.

Implementation will therefore depend on the development of a series of options from which landowners can choose as they develop the submission for their land holding. This will allow a practical scheme to be developed which can be implemented rapidly within a landscape unit and is sustainable in the long term, with a view to perpetuity.

The menu of habitats and options must still deliver substantive nature recovery. It should go well beyond the weaker elements of the current Stewardship offer or its successors, having a minimum standard which delivers some, or all of:

- Substantive improvement in habitat condition.
- Habitat re-creation.
- Recovery of species populations or assemblages, such as pollinators.
- Transformative farm practice, where crops and grazing are sustained within a productive landscape but where farmland nature has recovered.

8.2.2 Carbon release and carbon sequestration

Release of carbon to the atmosphere is the key driver for climate change. Sources from fossil fuels are well documented and publicised, but less well considered in policy or public forums is the role of land management in releasing carbon. There are a number of **sources** of carbon release arising from rural land:

- Drying out and degradation of peat. This arises mostly from drainage of valley floodplain peat, of which there is a substantial volume in the project area.
- Loss of soil carbon. Modern farm practices, such as regular tilling (including to establish grass leys) and replacement of organic fertiliser with mineral inputs, are the main cause.
- Intensive livestock farming, which releases methane.
- Use of fossil fuels and the high carbon footprint of modern land management practices and rural lifestyles.

The project area in its current condition and methods of management is therefore likely to be a significant source of carbon emission. Delivery of the Vision should ensure the project area becomes a carbon sink, helping to mitigate climate change. Key carbon policies which will be part of the Implementation Plan include:

- **Rewetting peatland**. Raising the water table should stop further release of carbon. Even better, raising the level to within 10cm of the ground surface should allow new peat formation and carbon sequestration. Rewetting peatland also has direct benefits for nature recovery. In addition, there is a potential income stream from registering peat-forming lands for carbon credits[21].
- **Carbon positive farming**. Where land is maintained as arable, moving to farm practices that rebuild and enhance soil carbon will increase carbon storage and at the same time improve soil structure and water retention, all with associated benefits for nature recovery.
- **Habitat carbon**. Development of non-peatland habitats that sequester carbon from the atmosphere will be promoted in the Implementation Plan. Trees, hedges and scrub will be important, with young trees in the vigorous growth stage being most efficient at removing carbon. Short to medium rotation coppiced habitats should be favoured, especially if arisings go to sustainable fuelwood uses, with parkland, scrub and grassland mosaics also being wildlife rich

[21] Carbon credits: Wikipedia Downloaded from https://en.wikipedia.org/wiki/Carbon_credit on 01/07/22

alternatives with good carbon storage potential. Tree planting will not be promoted on heath, wetland or grassland habitats of high value for nature (see below). There is evidence that other habitats such as wet grassland can also be effective at storing carbon[22].

- **Farm livestock** present more difficult issues. Grazing is an important tool in nature recovery, with extensive grazing in particular one of the main mechanisms for creating shifting mosaics of scrub and grassland. However, the project should seek to support a move away from intensive livestock production towards integrated and extensive livestock management.
- **Reducing carbon footprint**. In all submissions to the scheme, landowners should be supported to demonstrate how participation will reduce the carbon footprint of managing the land. This should not be onerous; a large part of reducing carbon will be from reduced intensification of landholding management. Additional reductions will result from measures to increase carbon sequestration. An important element will be deliberate, specific actions to reduce the carbon footprint of a land holding that go further than de-intensification.

8.2.3 Nutrient and silt management

The land in East Anglia has been subjected to significant increases in nutrients, from the air (atmospheric nutrients, mostly nitrogen, washed down by rain) and by direct agricultural application as fertiliser[23]. High nutrient levels are detrimental to nature because they feed vigorous and competitive plant species, causing vegetation to become dense, rank and species poor. Valley sites are particularly affected because most catchment nutrients are routed through them via surface water. The issue is made worse by sediment movement from land to the rivers. This is especially so during storms when overland flow, helped by compacted surfaces, roads and ditches, sweeps silt from the land into the river. Sediment creates turbid water, smothers aquatic wildlife and chokes the channel. Its role as a carrier of nutrients also worsens the problem of eutrophication in rivers and floodplains. Traditional in-field water management and an excessively “flashy” surface water regime are the main causes of excessive flushing of sediment and nutrient into the rivers.

Nature recovery in the Little Ouse and Waveney valleys must address nutrient and sediment release from the land. The Implementation Plan will therefore include the following types of measure:

- **Measures to slow the flow of surface waters** across the fields and into watercourses throughout the catchment. Actions would include removal of bare-land farm practices, in-field management of silt generation and reduced drainage intensity. Judicious siting of tree planting, hedges or

[22] De Deyn, G. B., Shiel, R. S., Ostle, N. J., McNamara, N. P., Oakley, S., Young, I., Freeman, C., Fenner, N., Quirk, H. and Bardgett, R.D., 2011. Additional carbon sequestration benefits of grassland diversity restoration. Journal of Applied Ecology, 48: 600-608. (besjournals.onlinelibrary.wiley.com/doi/pdfdirect/10.1111/j.1365-2664.2010.01925.x)

[23] E.g. (1) Hicks, W. K., McKendree, J., Sutton, M. A., Cowan, N., German, R., Dore, C., Jones, L., Hawley, J. and Eldridge, H. 2022. A comprehensive approach to nitrogen in the UK. WWF-UK. wwf.org.uk/sites/default/files/2022-02/WWF_Comprehensive_Approach_to_N_Final.pdf
(2) Caporn, S., Field, C., Payne, R., Dise, N., Britton, A., Emmett, B., Jones, L., Phoenix, G., Power, S., Sheppard, L. & Stevens, C. 2016. Assessing the effects of small increments of atmospheric nitrogen deposition (above the critical load) on seminatural habitats of conservation importance. Natural England Commissioned Reports, No. 210.
(3) For local gaseous ammonia data see UKEAP: National Ammonia Monitoring Network at uk-air.defra.gov.uk/data/non-auto-data?uka_id=UKA00496&network=namn&s=View+Site

permanent habitat strips would reduce overland silt and nutrient movement. The outcome would be to retain water on the land rather than rapid conductance to water courses, and to keep nutrients and silt on the land where they belong.

- **Reduced nutrient applications**: fields which are to remain in productive agriculture should have in place enhanced nutrient reduction strategies which ensure applications are wholly balanced with crop offtake. Reduction of crop area within the project area as a whole will allow reduction of nutrient application at the landscape scale.
- **Nutrient stripping measures**: in some places, turf stripping to remove accumulated nutrients or enhanced cropping of herbaceous habitats to increase offtake will be beneficial. Prior to return to semi-natural habitats, ex-arable land would benefit from unfertilised cropping. In floodplain locations, regularly cut and cleared wetland buffer strips alongside water courses, could intercept transmission of sediment and nutrients to ditches and rivers.

8.2.4 Restoration and management of water resources

The principal habitats of the floodplain and the valley margin are dependent on maintenance of a high water table throughout the year. Keeping water levels high depends on reliable inputs to the valley and limiting losses of water out of the system. Maintaining inputs and limiting losses both currently face challenges.

In the headwaters of the Waveney and Little Ouse, a significant proportion of water inputs come from groundwater, stored after the winter recharge period and released to feed the valley during spring and summer. In addition to climate change two factors reduce the amount of groundwater discharging to the valley:

- **Direct removal by abstraction**, for industrial, agricultural and public water supply uses.
- **Land drainage**. Efficient land drainage intercepts rain which would otherwise infiltrate through the soil to the aquifer. Instead of filling the stores, this water is transferred to rivers to flow out of the catchments. Over-deepened ditches and rivers directly drain the aquifer by lowering the level to which groundwater flows, pulling it far below ground surface levels.

As a consequence of both processes, groundwater supplies are depleted and inputs to the valley diminished. There has been no landscape-scale quantification of this depletion and no mapping of the impact on specific areas of the headwaters. However, when specific aquifers or abstractions have been examined in the area, such as at Redgrave and Lopham Fen (Section 5.5), significant and widespread impacts have been demonstrated.

Loss of water from the valley systems has increased enormously over the last 100 years. Improved in-field under-drainage and the heavy engineering of arterial ditches and the rivers, has lowered the regional drainage level and directly impacted wetland water tables. The rivers no longer simply remove surface water and floods, they permanently drain down the peat mass and valley wetlands.

These issues are likely to be acting in combination. Until they are addressed, wider nature recovery and carbon management outcomes will be compromised.

To address these issues, the Implementation Plan will include the following measures:

- Wherever practical and feasible, **restore arterial ditches and river channels** to drain only excess valley water during times of flood, recreating a more naturally functioning river with dimensions and sinuous courses more appropriate to the head of a catchment.
- Wherever feasible, **reduce in-field drainage** so that water is retained and can infiltrate downwards to the aquifers.
- On small watercourses and ditches, **utilise water control structures** to regulate flows and reduce excessive drainage where full restoration is not practical or feasible.
- Promote a **comprehensive review of abstractions** and removals that might affect groundwater inputs to the valley and take action on activities which have significant impacts.

8.2.5 The role of woodland, scrub, wood-pasture and trees

Woodland, scrub and single large trees (in hedges, open land or wood-pasture) have well understood benefits for nature, and also for carbon sequestration as described above. All forms of woodland and trees will play an important role in nature recovery in the headwaters area.

However, the amount conservation organisations and landowners spend on clearing trees and scrub from open habitats shows the degree to which self-sown trees can also be a problem. Dense stands of trees can rapidly transform species-rich open habitats to species-poor secondary woodland, making the habitat unsuitable for specialist invertebrates and plants. Woodland also makes fundamental changes to soils and peat, making the site unsuitable for the original habitats. It can take decades to restore wooded-over land to the previous open habitat.

Early successional woodland – open scrub in mosaic with grassland – is of very high value for wildlife but there is a fine balance between valuable habitat and poor secondary woodland. If very large areas are available for nature management, rolling mixtures of young scrub and open habitats are of great value, but this requires larger areas and partnership approaches to management across land ownership boundaries. It also requires some skill and judgement in terms of knowing when to intervene in the succession, where, and to what degree. While this kind of "process management" should be an opportunity promoted by the scheme, the practicalities can be difficult and need careful consideration.

To resolve the tension between the benefits of woodland, scrub and trees and potential problems or enclosure of open habitats, the Implementation Plan will take the following approach:

- New woodland and scrub in the project area will focus on connecting current woodlands, thickening existing hedges, establishing new hedges and linear strips of woodland (especially along historic boundaries), and allowing woodland to develop on land that has little prospect of developing high quality open habitats.
- In areas of former arable or intensive grassland, with little value for nature at the start of the scheme, grassland and scrub mosaics will be favoured. The wildlife benefits of bare land restoration are especially high in the early stages of woodland succession but rapidly diminish after canopy closure. Maintaining open mosaics of scrubby vegetation is therefore an important

prescription. These shifting mosaics would ideally be managed by grazing, with occasional direct intervention by scrub removal if the mix of scrub and open habitat is out of balance.

- Areas of existing value as open habitat, or areas which could be easily restored to open habitats, will not be put forward for wooded habitats. If the parcel is large enough, even these areas might benefit from allowing hedges or scrub lines to mature and spread a little. Open habitats typical of the valley which have priority over wooded habitats include:
    - Wetlands such as fens, wet grassland, sedge beds and species-rich rush meadows.
    - Heathland.
    - Acid grassland.
    - Species-rich neutral grasslands and meadows.
    - Chalky grasslands.
    - Pollinator habitat and flower-rich headlands and field margins.

8.2.6 The issue of wet woodland in fens

The Vision map (Figure 10) could indicate wider clearance of secondary woodland to recover more fen. Carr woodland growing in fens in the headwaters area is almost all secondary woodland, accumulating in the period since active management of the fen resource by local communities started to decline. This new woodland presents a dilemma for land managers. The valley fen over which it grew is now especially rare and where it remains as open habitat is protected by national and international designations. In these areas of carr woodland on deep peat, groundwater seepage may still occur, and the remnants of rare fen flora and fauna can still be found, so will respond rapidly to woodland clearance. If the water table can be maintained at the surface, new peat should accumulate and store carbon once trees are removed.

Since much of this recent wet woodland occurs in SSSIs or County Wildlife Sites, this is a high priority for restoration to fen and this has been an active policy for most conservation organisations, with substantial investment over recent decades. However, there are factors which limit the scope of fen restoration by tree clearance. Wet woodland is a valuable habitat in its own right, and floodplain alder woodland is also an SAC Feature habitat, just like the fen over which it likes to grow. In addition, the perceived wisdom of extensive tree clearance at this time of carbon management, and the public response to cutting down any tree no matter how necessary, means significant clearance requires careful and long-term discussion with local communities.

The resource requirements of woodland clearance and subsequent sustainable management of open habitat are high and have limited the area cleared in recent years. However, Nature Recovery, including joining up isolated fragments and creating larger, more viable management units with economies of scale, should be one of the benefits of implementing the Vision. New land management economics should emerge. Consequently, we have not factored these considerations into our recommendations.

In conclusion, the current Vision map includes more woodland on potential fen than is ecologically desirable, but the scope of this document does not allow fine-scale planning of which areas of woodland should stay and which go. This requires detailed site investigation (not all woodland would yield high quality fen), discussion with regulators and local communities, and long-term planning.

This is a good example of where the preferences and resources of individual landowners will determine the appropriate balance of habitats for individual sites, addressed through the menu system of implementation (Section 8.2.1). Where a site is SSSI or SAC, Natural England will have a regulatory input, as will the Forestry Commission. It may be possible to balance clearance in one area with wet woodland establishment elsewhere on wet peat sites of no existing value, although, even then, the option of restoring such sites to wet fen should be considered.

8.3 Benefits of a catchment-wide approach

The Vision of reconnecting and enriching nature in the project area, including comprehensive restoration of the rivers as the life blood of the upper Waveney and Little Ouse valleys, requires a partnership involving the diverse community of landowners, organisations and individuals who manage these catchments. The connection of the land-managing community in a new catchment wide collaboration will be at the heart of delivering this Vision.

To derive maximum benefit, a holistic approach to landscape recovery is required, encompassing the whole of the catchment. This must link land use change in the valleys, on the slopes and across the watershed with river channel restoration and reconnection to the floodplain. A catchment scale approach to improving water quality will benefit not only the in-river biodiversity, but also help protect the internationally important valley fens from inundation with poor quality water during times of flood. Increasing water retention in the headwaters will increase aquifer recharge and mitigate flood risk.

It should also be noted that landscape-scale changes of the type suggested here can bring additional and significant economic benefits to the area in the form of increased tourism. These benefits have been successfully realised in other landscape-scale restoration projects[24]. The diverse and quiet countryside proposed in our Vision offers the potential to greatly expand the length of circular footpaths, create new bridle and cycle ways and support an expanded and thriving network of accommodation, pubs and farm shops.

[24] E.g. Tree, I. 2019. *Wilding : The Return of Nature to a British Farm*. Pan Macmillan, UK.

Appendix 1: Results of the Environmental Benefits from Nature Analysis

A.1 Introduction

The Environmental Benefits from Nature tool (EBN) was developed by Natural England from its predecessor the Eco-Metric, the first version being released in July 2021. It utilises a combination of open-source data, figures calculated from field recording and the outputs from the Biodiversity Metric (BM).

Data is entered into the spreadsheet for before and after scenarios of a project, and outputs are calculated using built-in equations that capture the increases or decreases to ecosystem services and biodiversity net gain of a set of land use changes.

A.2 Issues using the Environmental Benefits from Nature tool on a catchment scale

The authors would like to make it clear that this EBN analysis should not be compared to any other EBN analysis of different areas, as the limitations of a desk study mean the results shown will underestimate the natural capital uplift of the proposed landscape changes.

The Environmental Benefits from Nature tool (EBN) is designed for use on a small site or farm scale, this leads to several issues when trying to use it on a larger scale:

- Many of the categories required cannot be completed using open-source data on this scale, the inability to fill all the categories leads to low confidence in 11 of 18 areas of interest in the results overview table.
- The EBN is designed to be delivered in conjunction with the Biodiversity Metric 3.0 (BM), in itself a tool to estimate biodiversity net gain (BNG) in field or small site-based projects. The BM uses data from field recording to generate numerical outputs in the form of biodiversity units. The recording is designed to give an accurate assessment of the physical state of the rivers, ditches and hedges on site and hence their ability to support wildlife. Obviously for a desk-based study this was not an option and doing so over the whole project area could take years. The assessment of the current state of hedges and rivers within the study area is based on local knowledge of the area and extremely limited field observation.

The raw data in terms of areas of habitat, hedge lengths, river and ditch lengths used in the BM and EBN has been generated either by the modification of available data sets such as the CEH land cover vector data or, in the case of hedgerows and rivers, manual calculation using aerial imagery overlaying the CEH land cover vector map to sample a known area.

We have achieved more accurate habitat mapping than was openly available, but obviously, as no fieldwork was undertaken, there will be some degree of error, and this inevitably passes into the BM and EBN. For this reason, the results of the EBN should be taken as indicative and not an absolute reflection of what would be achieved with the proposed land habitat changes.

A.3 Results overview

Given the limitations of the data collection described above, in this desk study a conservative approach was adopted when making assumptions about the extent of change to landscape features, such as hedgerows and rivers, that might be realised were the Vision to be implemented. For example, in the river quality and hedgerow quality categories, we only made an increase of one category unit within the BM. In practice, it is likely that there would be greater changes, so the outputs should be assumed to underestimate the likely gains from the proposed landscape scale changes. Also, there is no capacity within the biodiversity metric or EBN to take account of improvements resulting from surface water quality measures, such as sediment traps on the tributary ditches. We would expect greater improvement in water quality within the catchment than shown by the EBN if these measures, and other land use changes, were adopted.

A selection of the results where a significant change is seen are presented below and they show that there would be:

- Significant improvements in erosion protection, water quality regulation, pollination, pest control, aesthetic value, education, interaction with nature and sense of place.
- Moderate improvements in flood protection and carbon storage.
- A small decrease in agricultural production.

A.4 Potential impacts on ecosystem service flows: whole area

Figure A.1 Change in total score after each time period compared to baseline before development/intervention

Whole area	. year	10 year	30 year	Confidence
Food production	↘	↘	↘	🟠
Wood production	→	→	→	🟠
Fish production	→	→	→	🟠
Water supply	→	→	→	🔴
Flood regulation	↗	↗	↗	🔴
Erosion protection	↗	↗	↗	🔴
Water quality regulation	↗	↗	↗	🔴
Carbon storage	↗	↗	↗	🟠
Air quality regulation	→	→	→	🟠
Cooling and shading	→	→	→	🟠
Noise reduction	→	→	→	🟠
Pollination	↗	↗	↗	🔴
Pest control	↗	↗	↗	🔴
Recreation	→	→	→	🔴
Aesthetic value	↗	↗	↗	🔴
Education	↗	↗	↗	🔴
Interaction with nature	↗	↗	↗	🔴
Sense of place	↗	↗	↗	🔴

Change in average score per hectare

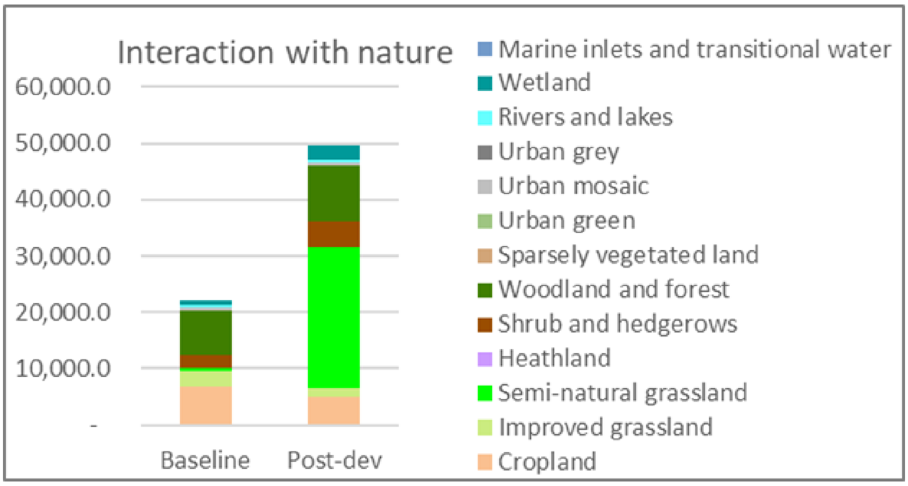
Large decrease (more than -2.5 points out of 10)	↓
Decrease (-0.25 to -2.5 points out of 10)	↘
Minor change (-0.25 to 0.25 points out of 10)	→
Increase (0.25 to 2.5 points out of 10)	↗
Large increase (more than 2.5 points out of 10)	↑

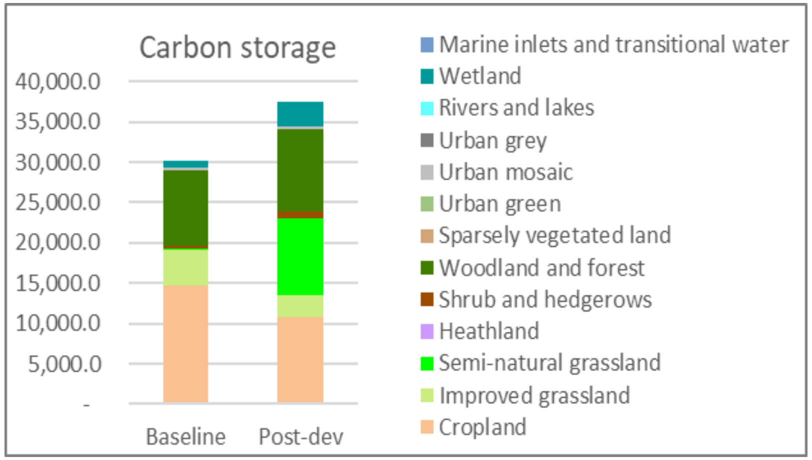
In Figure A.1 the arrows indicate the direction and magnitude of the change in scores at three points in time after the development or intervention. They do not take account of the cumulative impact up to that time. There is no significant difference shown in the outcomes over the 30-year period, but, in reality, we would expect to see a cumulative change as habitats recover and change over time.

A.5 Ecosystem services by category

The standard interpretation chart outputs of the EBN are designed to show the increase or decrease in benefit of the proposed project to a range of ecosystem services. They also aim to show which habitats are driving the change. There are 18 charts in the complete EBN; those showing significant change between our current and restored landscape scenarios are shown below (Figure A.2). The units are ecosystem service scores assigned by the EBN from the data entered. Note that the scale is different in each chart.

Figure A.2 The influence of different natural capital assets on baseline and post-development scores for a range of ecosystem services (N.B. charts continue on following pages)

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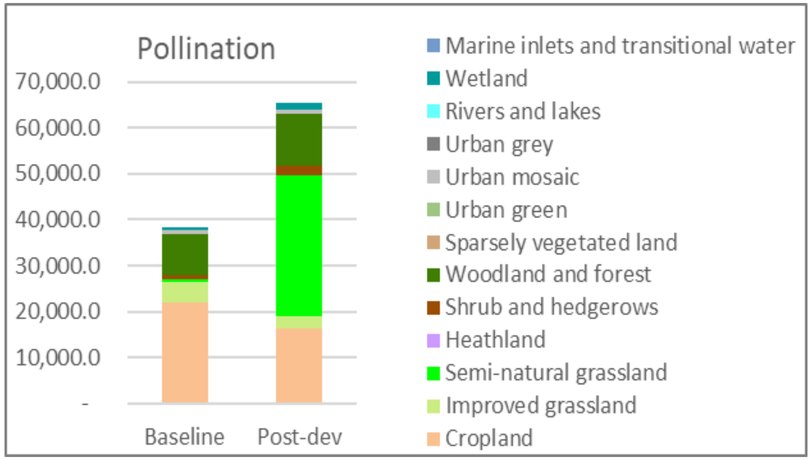
35,000.0
30,000.0
25,000.0
20,000.0
15,000.0
10,000.0
5,000.0
-
Baseline
Post-dev
Marine inlets and transitional water
Wetland
Rivers and lakes
Urban grey
Urban mosaic
Urban green
Sparsely vegetated land
Woodland and forest
Shrub and hedgerows
Heathland
Semi-natural grassland
Improved grassland
Cropland


Pollination
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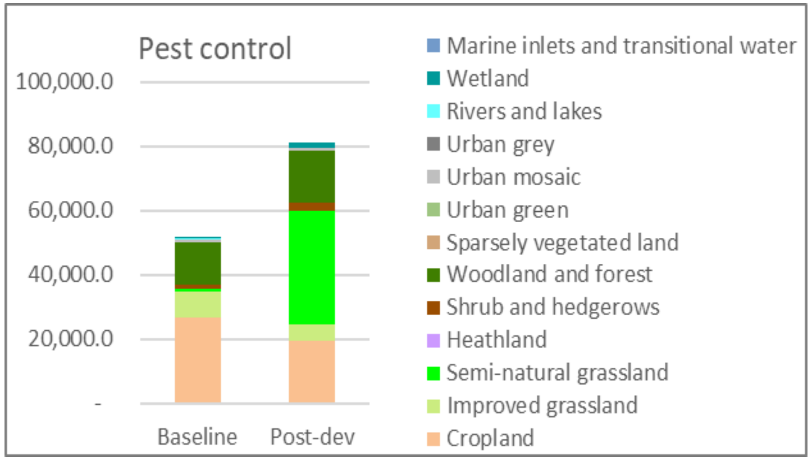
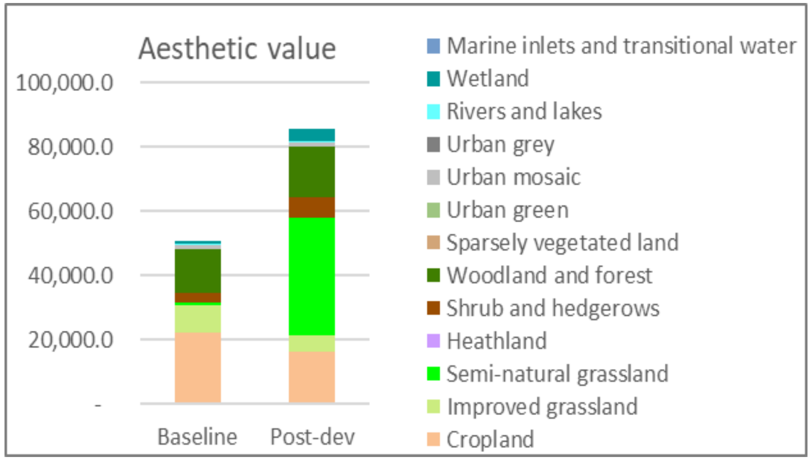
60,000.0
50,000.0
40,000.0
30,000.0
20,000.0
10,000.0
-
Baseline
Post-dev
Marine inlets and transitional water
Wetland
Rivers and lakes
Urban grey
Urban mosaic
Urban green
Sparsely vegetated land
Woodland and forest
Shrub and hedgerows
Heathland
Semi-natural grassland
Improved grassland
Cropland


Pest control
100,000.0
80,000.0
60,000.0
40,000.0
20,000.0
-
Baseline
Post-dev
Marine inlets and transitional water
Wetland
Rivers and lakes
Urban grey
Urban mosaic
Urban green
Sparsely vegetated land
Woodland and forest
Shrub and hedgerows
Heathland
Semi-natural grassland
Improved grassland
Cropland


Aesthetic value
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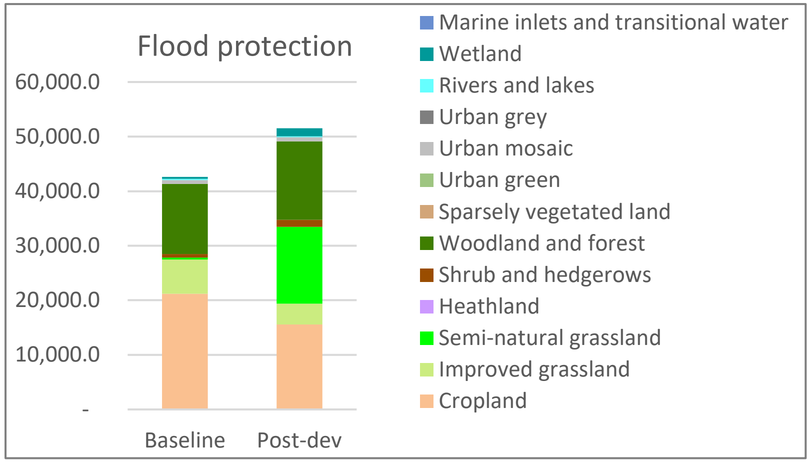
80,000.0
60,000.0
40,000.0
20,000.0
-
Baseline
Post-dev
Marine inlets and transitional water
Wetland
Rivers and lakes
Urban grey
Urban mosaic
Urban green
Sparsely vegetated land
Woodland and forest
Shrub and hedgerows
Heathland
Semi-natural grassland
Improved grassland
Cropland


Flood protection
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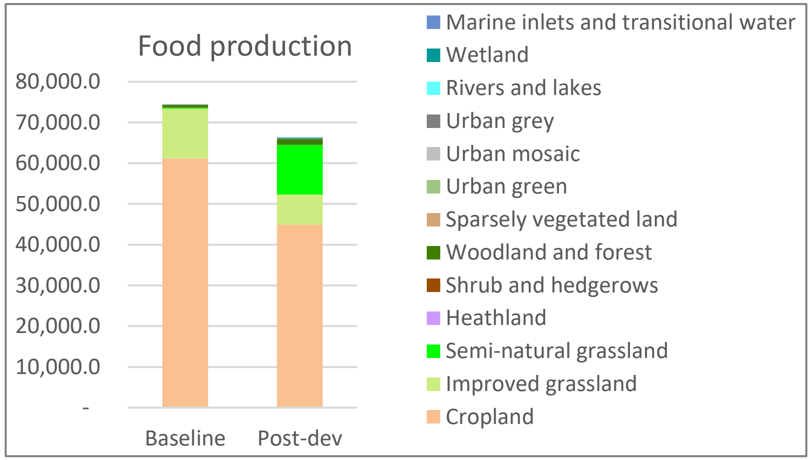
40,000.0
30,000.0
20,000.0
10,000.0
-
Baseline
Post-dev
Marine inlets and transitional water
Wetland
Rivers and lakes
Urban grey
Urban mosaic
Urban green
Sparsely vegetated land
Woodland and forest
Shrub and hedgerows
Heathland
Semi-natural grassland
Improved grassland
Cropland


Food production
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70,000.0
60,000.0
50,000.0
40,000.0
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20,000.0
10,000.0
-
Baseline
Post-dev
Marine inlets and transitional water
Wetland
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Urban green
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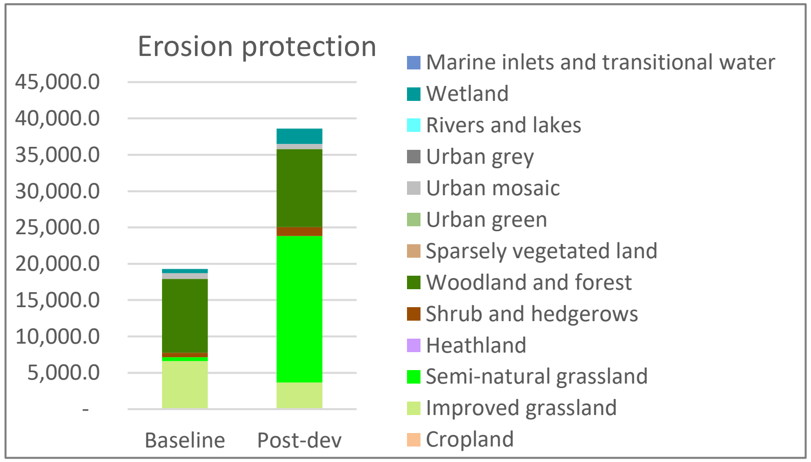
Erosion protection
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35,000.0
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Baseline
Post-dev
Marine inlets and transitional water
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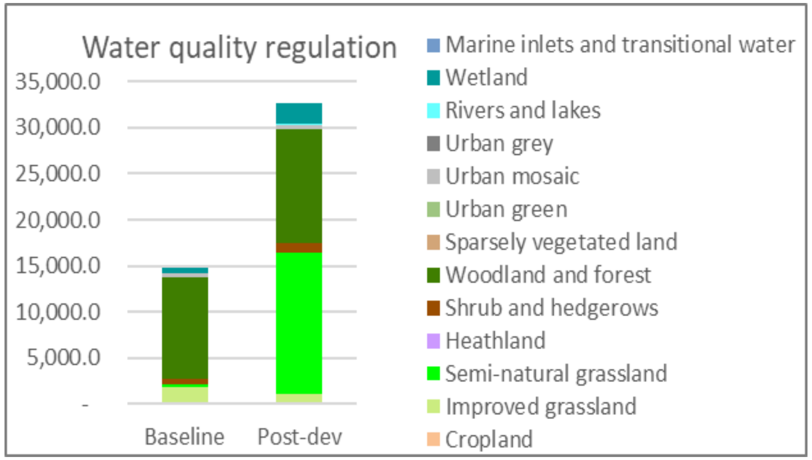
Water quality regulation
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30,000.0
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Baseline
Post-dev
Marine inlets and transitional water
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Improved grassland
Cropland

A.6 Conclusions

Even with the limited data that could be used in this incomplete version of an EBN analysis, the overall result shows that implementation of the Vision would bring a substantial biodiversity net gain and an increase in ecosystem services within the project area.

This is unsurprising given the large-scale land use modifications suggested. Given the limitations of the EBN approach and available data, the exact increase in both benefits is still uncertain, but increasing confidence in the results would require a very significant investment in ground truthing and fieldwork.

Were the analysis to be carried out on a field or farm scale, on current arable land within the Core Area, we would expect the relative gains to be higher and the degree of confidence in the results to be significantly greater.