Nature Net Zero

Executive Summary

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NATURAL ENGLAND

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Foreword

The natural environment plays an important part in meeting our net zero target as healthy ecosystems, particularly forests, take up and store significant amounts of carbon in soils and trees. Large loss of habitats over the past century has resulted in a direct loss of carbon stored within them. Restoring these carbon-rich habitats for nature recovery will put back some lost biodiversity, with an added climate benefit including a critical contribution to achieving net zero.

The land based-sectors of the economy contain the main current mechanisms for removing greenhouse gases (GHG) from the atmosphere through tree growth and the establishment of natural habitats on agricultural land along with the restoration of degraded or lost habitat areas. Managing land to eliminate emissions and provide GHG removal is essential to deliver net zero.

Natural England's Nature Net Zero research looks through a nature recovery lens, to ask what is possible in carbon terms to help deliver net zero outcomes. It also asks what potential adjustments can be made to deliver greater carbon benefits through exploring changes to our delivery of support to land managers.

Climate change impacts the natural environment, which in turn affects the economy as people's lives are exacerbated by the degraded state of much of our natural environment. For example, degraded habitats at the coast and in river catchments increase flood risks from rising sea levels and heavier rainfall events. Restoring these habitats reduces risk to people and the knock-on increases in carbon emissions through property damage. Similarly incorporating natural areas within and on the edge of urban areas provides natural cooling and shade that lessen the risks of heatwaves & reduce the need for energy intensive solutions. The Dasgupta review (Dasgupta, P 2021) and the UK Natural Capital Accounts (ONS, 2023) demonstrate the economic value of the benefits that nature provides and show the wider economic potential that Nature-based Solutions offer at the same time as delivering Net Zero outcomes.

It is important to take a joined-up approach to climate change mitigation and adaptation, nature and the economy. This project has explored the most effective and most efficient locations to deliver enhanced biodiversity, climate mitigation and adaptation through restoration and creation of functioning ecosystems. It assesses the climate change risks for the main high carbon habitats in England. It seeks to answer:

- What habitats & ecosystems currently have the most natural carbon stores?
- Where are the best places to focus High Nature, High Carbon land management practices that increase carbon storage and sequestration?
- Which types of landscapes give the best results for increased carbon storage, sequestration & other net zero requirements?
- How will Climate Change impact on natural carbon stores in the future?
- What are the climate change risks to these habitats and locations and how can climate adaptation reduce those vulnerabilities?

Natural England commissions a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Contents

1. Aims

Natural England's Nature Net Zero (NNZ) research aims to assess the potential for England's ecosystems to deliver the greatest increase in biodiversity in ways that preserve carbon storage, increase carbon sequestration rates and reduce greenhouse gas emissions. The research seeks to identify the habitats and geographical locations that would make the best return on investment to deliver biodiversity targets and achieve long term functional recovery of "carbon in nature".

The study has four workstreams, each containing detailed analysis and mapping:

Part 1 – Carbon in semi-natural habitats. This quantifies carbon stored in, and sequestered by, semi-natural habitats.

Part 2 - Review of climate change impacts and risks in high-carbon habitats. This assesses the impacts of climate change on the mitigation value and adaptation potential of high carbon priority habitats.

Part 3 - Habitat Expansion for Carbon. This outlines the carbon outcomes associated with government targets for nature recovery, using five high-carbon habitat expansion scenarios.

Part 4 - Land use synergies & trade-offs when expanding habitats for carbon. This assesses the trade-offs and synergies between creating and restoring habitats for biodiversity, carbon storage and sequestration in terms of impacts on land use in England. It identifies principles for where good integrated delivery can achieve better outcomes.

2. A carbon-first approach to nature recovery

Climate change and biodiversity loss are closely linked problems and need to be tackled in an integrated way. Healthy ecosystems, particularly forests, take up and store significant amounts of carbon in soils and vegetation. Loss and degradation of habitat has resulted in a direct loss of stored carbon. However nature recovery can reverse some degradation, with an added climate benefit of increasing carbon stored in, and sequestered by habitats.

The land-based economy has a unique role to address climate change as it is responsible for the main current mechanisms for removing greenhouse gases from the atmosphere, notably through the establishment of natural habitats and carbon stores in soils and vegetation, including trees on agricultural land.

The impacts of climate change on the natural environment affect lives, property and the economy and are exacerbated by the degraded state of much of our natural environment. For example, degraded habitats at the coast and in river catchments increase the flood risks from rising sea levels and heavier rainfall events. Restoring these habitats reduces risk to people with the added benefit of reduced carbon emissions.

The Dasgupta review (Dasgupta, P 2021) and the UK Natural Capital Accounts (ONS, 2023) show the wider economic potential that Nature-based Solutions offer in delivering Net Zero.

3. Nature recovery ambitions and targets

Nature Recovery is an important government policy that has been strengthened through the Environment Act 2021, the Environmental Targets (Biodiversity) Regulations 2023, the updated 25 year Environment Improvement Plan (EIP) (DEFRA, 2023), the England Peat Action Plan (UK Government, 2021) and the '30 by 30' commitment[1], to protect 30% of land and sea for nature by 2030 along with halting the decline in species abundance by 2030, and then increase abundance by at least 10% to exceed 2022 levels by 2042. .

The headline nature recovery targets for this report are:

- By 2042, restore or create over 500,000 hectares of a range of wildlife-rich habitats outside protected sites.
- Increase tree canopy and woodland cover from 14.5% to 16.5% of total land area by 2050. This equates to 250,000 hectares, or 9,000 hectares per year.
- To restore 280,000 hectares of peatland in England by 2050.

These targets are accompanied by ambitious interim targets for habitat, woodland and peatland recovery by 2028.

These commitments for habitat creation and restoration offer significant opportunities for increasing carbon storage and sequestration.

The Nature Net Zero project looks through this nature recovery lens and asks what is possible in carbon terms for the agreed nature recovery work to deliver net zero outcomes and what potential adjustments to delivery mechanisms can be made to deliver greater carbon benefits. It focuses on habitats and ecosystems as these can be directly related to carbon and does not consider the species responses this might deliver.

[1] 30by30 on land in England: confirmed criteria and next steps - GOV.UK

4. How much carbon is already in England's semi-natural habitats?

The assessment of the individual scenarios is set out below and summarised in Table 1.

Part 1 has a rapid literature review, drawing extensively from Natural England's Carbon Storage and Sequestration by Habitat 2021 (Gregg and others (2021)). We used data from this review, alongside analysis of Natural England's peaty soils dataset, to derive typical carbon storage and sequestration estimates per hectare for most priority habitats and some non-priority habitats, taking account of the amount of the habitat that overlies deep or shallow peat.

We then estimated the total carbon stored in England's priority habitats and how this is distributed geographically and between different habitat types.

About 518 million tonnes of carbon is stored in England's priority habitats, of which deciduous woodland, blanket bog and upland heathland store about 76% of the national total.

We derived a 'top ten' list of 'high-carbon, high-nature' priority habitats to focus delivery of nature recovery targets through a carbon lens. These habitats account for 95% of all carbon stored in priority habitats in England:

1. Blanket bog – 114 million tonnes
2. Deciduous woodland – 231 million tonnes
3. Upland heath – 50 million tonnes
4. Coastal and floodplain grazing marsh – 24 million tonnes
5. Lowland raised bog – 20 million tonnes
6. Lowland fen – 14 million tonnes
7. Wood pasture and parkland (exc. other priority habitat) – 15 million tonnes
8. Lowland heath – 6 million tonnes
9. Coastal saltmarsh – 14 million tonnes
10. Upland flushes, fens and swamps – 4 million tonnes

We also examined the distribution of carbon in priority habitats. Table 1 below picks out some of the detailed findings.

Table 1. Carbon Storage in England's Priority Habitats - some key findings

Where is carbon in nature?	Total carbon stored in priority habitats	Proportion of English total
All English priority habitats	518 million tonnes	100%
Priority habitats in the SSSI network	215 million tonnes	41.5%

Where is carbon in nature?	Total carbon stored in priority habitats	Proportion of English total
Priority habitats in National Parks	126 million tonnes	24.3%
Priority habitats in National Landscapes (formerly Areas of Outstanding Natural Beauty)	136 million tonnes	25.8%
Priority habitats in the top five ‘carbon-rich’ upland National Character Areas (North Pennines, Yorkshire Dales, Dark Peak, Border Moors and Forests, Southern Pennines)	129 million tonnes	25%
Priority habitats in the top five ‘carbon-rich’ wooded National Character Areas (Cotswolds, High Weald, Low Weald, North Downs and Wealden Greensand)	42 million tonnes	8.1%

England’s priority habitats have an estimated net carbon sequestration rate of 7.3 million tonnes of carbon dioxide equivalent per year (t CO_2e y^{-1}). This is comprised of a total of 8.4 million tonnes sequestration by vegetation, offset by 1.1 million tonnes emission from oxidising and eroding soils, notably degrading peaty soils. The best evidence available has been applied here, but there is a caveat that, for many habitats, nationally consistent data has limitations and, for some habitats, data is absent.

Woodland and coastal saltmarsh habitats typically have net sequestration rates. Many peat-based priority habitats typically have net emission rates due to being in degraded condition. Land management measures such as re-wetting and changes in the type and extent of livestock grazing would rapidly reduce emissions while reversing or preventing degradation.

5. Climate risks and sensitivities

Part 2 looks at three climate change scenarios, defined as Representative Concentration Pathways (RCPs) (Met Office, 2018). The RCPs broadly match the following temperature change scenarios:

- RCP2.6: +1.6°C by 2081-2100
- RCP6.0: +2.8°C by 2081-2100
- RCP8.5: +4.3°C by 2081-2100

These suggest broad trends where summer weather is expected to be hotter and drier, whereas winter weather is expected to be warmer and wetter. As the warming projection increases, so does the intensity of the effect of climate change. For example, Figure 1 shows, in increasingly darker tones, the decreasing summer rainfall expected by 2100 for the three scenarios.

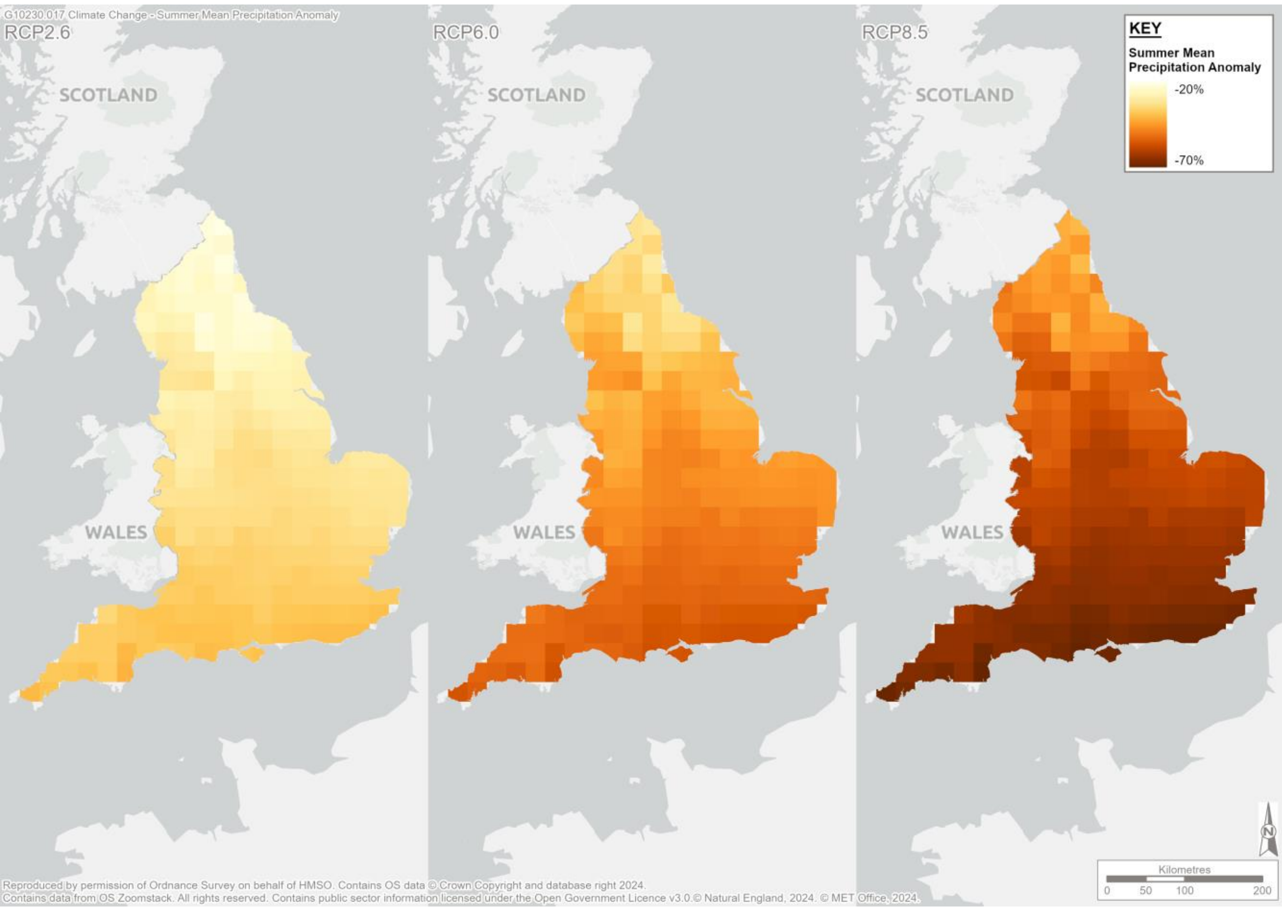

Figure 1. Summer mean precipitation anomaly for RCP 2.6 (+1.6°C by 2081-2100), RCP6.0 (+2.8°C by 2081-2100), and RCP8.5 (+4.3°C by 2081-2100) across England. Reproduced by permission of Ordnance Survey on behalf of HMSO. Contains OS data © Crown Copyright and database right 2024. Contains data from OS Zoomstack. All rights reserved. Contains public sector information licenced under the Open Government Licence v3.0 © Natural England, 2024. © MET office, 2024.

Priority habitats have varying sensitivity to climate change, as described by Staddon and others (2023). Sensitivity is ranked on a 1-5 scale, where 1 represents low sensitivity and 5 represents a very high sensitivity. This is assessed for habitats in good and degraded conditions. Degradation exacerbates habitats’ sensitivity to climate change, as shown in Table 2.

Degradation arises from pressures such as agricultural intensification, hydrological management, pollution, urbanization, invasive species establishment, changes in woodland management, and physical modifications such as engineering works (roads, rail, dams etc). These disrupt natural processes and reduce habitat functionality.

Restoration of good habitat condition, through removal of pressures and active habitat management, is an ‘early-win’ which can improve ecosystem health and resilience against climate change and other environmental challenges.

Table 2. Sensitivity of 'top ten' high carbon habitats to climate change (Staddon and others, 2023)

Habitat	Climate Change Sensitivity - Good Condition	Climate Change Sensitivity - Degraded Condition
Deciduous woodland	2	3
Wood pasture and parkland	2	3
Blanket bog	3	5
Lowland raised bog	3	5
Upland heathland (wet)	3	4
Coastal and floodplain grazing marsh	4	5
Coastal saltmarsh	4	5
Lowland fens	4	5
Upland flushes, fens and swamps	4	5
Lowland heathland	4	4

Each habitat type will experience specific pressures resulting from climate change. For wetland habitats, such as bogs, fens and floodplain grazing marsh, prolonged periods of lower water tables in the summer may lead to substantial changes in hydrological regime, and result in significant changes to vegetation composition and overall function.

Climatic pressures will vary across England. For example upland blanket bogs, upland heathland and upland flushes, fens and swamps on Bodmin Moor, Dartmoor and Exmoor are projected to experience a 50% reduction in summer rainfall by the 2080s (based on the RCP6.0 projection). This is likely to cause hazards such as wild fire and erosion resulting in rapid loss of carbon. The equivalent upland habitats in northern England, which represent over 90% of the English extent of blanket bog, will experience less change in this period - see Figure 2.

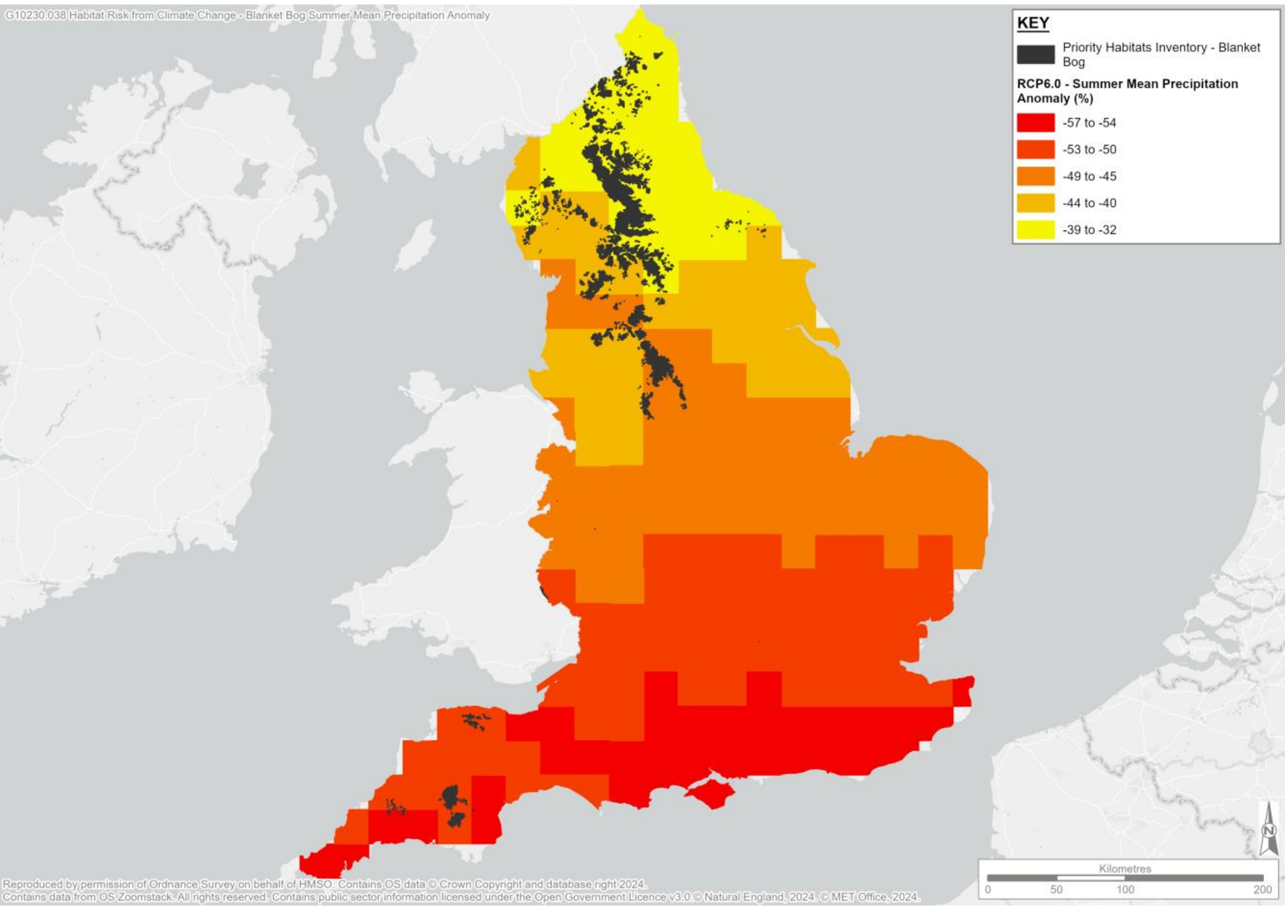

Figure 2. Location of blanket bog, showing the projected summer mean precipitation anomaly (%), highlighting areas in southwest England which may be impacted more by reduced summer rainfall. Based on RCP6.0 projection. Reproduced by permission of Ordnance Survey on behalf of HMSO. Contains OS data © Crown Copyright and database right 2024. Contains data from OS Zoomstack. All rights reserved. Contains public sector information licenced under the Open Government Licence v3.0 © Natural England, 2024. © MET office, 2024.

For coastal saltmarsh and grazing marsh, the pressure arises from expected rises in sea level and ‘coastal squeeze’ where the area between the sea and the shore gets smaller as the sea rises. Habitat loss would reduce carbon storage. On the other hand, allowing the development of new saltmarsh and grazing marsh on agricultural land affected by sea level rise offers rapid carbon benefits, particularly in terms of increased sequestration.

Lowland and upland heathland present unique challenges. Typically found on peaty and mineral soils, they hold large quantities of carbon. Drought and an increased risk of wildfire put the habitats at risk, with the possibility of wildfires burning underlying peat and causing subsequent release of carbon dioxide back into the atmosphere in a feedback loop for climate change (accelerating the temperature rise).

Deciduous woodland and wood pasture and parkland also may experience challenges. Although less vulnerable than wetland habitats, warmer and wetter winters may cause a proliferation in the number of pest species, resulting in increased disease and limiting natural regeneration of woodland where trees have died due to summer drought.

For all high carbon habitat types, management strategies will have to be employed to ensure that habitats are able to adapt to climate change pressures where possible, and appropriate measures taken where habitat types cannot adapt e.g. squeezed coastal habitats.

Management strategies to safeguard high-carbon habitats need to be habitat and location specific; considering habitats' ability to mitigate climate change through carbon sequestration and storage, their adaptive capacity and the climate-related pressures which may compromise their ability to function in the future.

Higher risk areas may need intervention sooner, using directed and bold approaches to restoration, rather than 'tweaking' current management strategies.

The Resist, Accept, Direct (RAD) Framework offers a technique for policy-makers and site managers to consider particular courses of action. Under RAD, strategic responses to climate change are described in terms of three broad categories: resisting climate transformation, accepting the transformation and continuing to manage as best one can, and directing the transformed system toward novel ecological conditions (Williams, 2024).

For example, the blanket bogs in the south west are more vulnerable to early and rapid loss of carbon store, so a 'Resist' approach would look to improve the habitats towards a wetter, good condition, with better sphagnum moss cover and manage local hydrology so that rainfall is retained for longer. A 'direct' approach would prioritise urgent landscape-scale action across a larger sub-catchment level, major re-instatement of natural hydrological pathways and bog restoration techniques, reduced grazing, increasing sphagnum moss cover by plug planting and spreading. So that winter rainfall is retained in the bogs for as long as possible to mitigate the effect of summer droughts. Thus, letting the bog become functional once again, so that it self-regulates as conditions change as natural ecosystem processes dominate.

6. Nature recovery and carbon

Part 3 is concerned with expansion of wildlife-rich habitats and associated carbon benefits. Natural England's Habitat Network Enhancement Zone 1 (NEZ1) and Fragmentation Action Zone (FAZ) were used as "areas of search" for nature recovery, consistent with the 'Lawton'[2] principles of 'bigger, better, more and more joined up' areas of priority habitat.

The carbon benefits of nature recovery were explored using five habitat scenarios, or trajectories for habitat creation and restoration:

- peatland habitats
- trees and deciduous woodlands
- coastal habitats
- grasslands and heathlands
- wetlands

For each scenario, the opportunity area consists of the maximum extent of land in the relevant Habitat Network NEZ1 and FAZ that is not already a priority habitat – see Table 3, Column 2.

The total carbon storage is the potential amount that would be held in store when all the habitats in the total opportunity area reach a steady and representative state. Similarly total carbon sequestration is the potential annual sequestration associated with this theoretical future state. For sequestration, a negative value means absorption of atmospheric carbon dioxide into vegetation and soils, whereas a positive value is a net emission of carbon dioxide to the atmosphere due to oxidisation or erosion of soils and decaying organic matter.

The total values for carbon storage and sequestration given in Table 3 do not account for the baseline 'pre-restoration' habitat so they cannot be used to quantify absolute increases in habitat carbon. More evidence is needed on the timescales over which created or restored habitats reach a steady state in terms of carbon storage and sequestration. As a proxy for decision-making, Table 3 includes the estimated timescales taken from the 'time to target condition' in the statutory biodiversity metric[3] to restore good habitat condition.

In almost all scenarios, habitat creation or restoration will result in a decrease of current carbon emissions. This decrease is beneficial and is called 'abatement' in circumstances

[2] https://www.gov.uk/government/news/making-space-for-nature-a-review-of-englands-wildlife-sites-published-today

[3] Statutory biodiversity metric tools and guides - GOV.UK

where carbon emissions are currently high and can be reduced to a lower level by specific actions.

Table 3. Scenarios for recovery of 'High Carbon High Nature' Habitats

Habitat Opportunity	Opportunity Area (hectares)	Total Carbon Storage t C	Total Carbon Sequestration t $CO_2e\ y^{-1}$	Timescale to Good Habitat Condition (years)
Scenario 1 – Maximum Peat	348,962	113,211,907	1,024,275	>30
Scenario 2 – Maximum Woodland	254,639	26,323,990	-890,704	>30
Scenario 3 – Maximum Coastal Habitats	119,306	29,048,715	-394,643	15
Scenario 4 – Maximum Grassland and Heathland	890,354	69,415,840	12,753	15 to 20
Scenario 5 – Maximum Wetland	155,799	26,174,239	225,675	12

In addition to nature recovery targets, the EIP also seeks ‘responsible management’ of lowland peat soils in agricultural use to significantly reduce carbon emissions associated with cultivation and drainage, practices which also erode soil depth and future productivity. The EIP states this would occur principally by re-wetting, although targets are not quantified in the EIP.

Part 3 identifies 203,000 hectares of lowland peat outside the Habitat Network, which would qualify for inclusion in this EIP aim. As lowland fen is one of the most carbon-dense habitat types, re-wetting measures would secure the current carbon store and abate the ongoing emissions currently associated with cultivation.

Part 3 presents a ‘Maximum Peat Plus’ scenario which includes the 349,000 hectares of peat-based areas in the Habitat Network (see Table 3 above) and the 203,000 hectares of lowland peat outside the Habitat Network that is the focus of the EIP’s aim of ‘responsible management’.

For each scenario, maps illustrate the spatial distribution of opportunity – for example Figure 3 shows the Maximum Peat Plus scenario in terms of Landscape Description Units[4] (LDUs), highlighting the 'top ten' in terms of area.

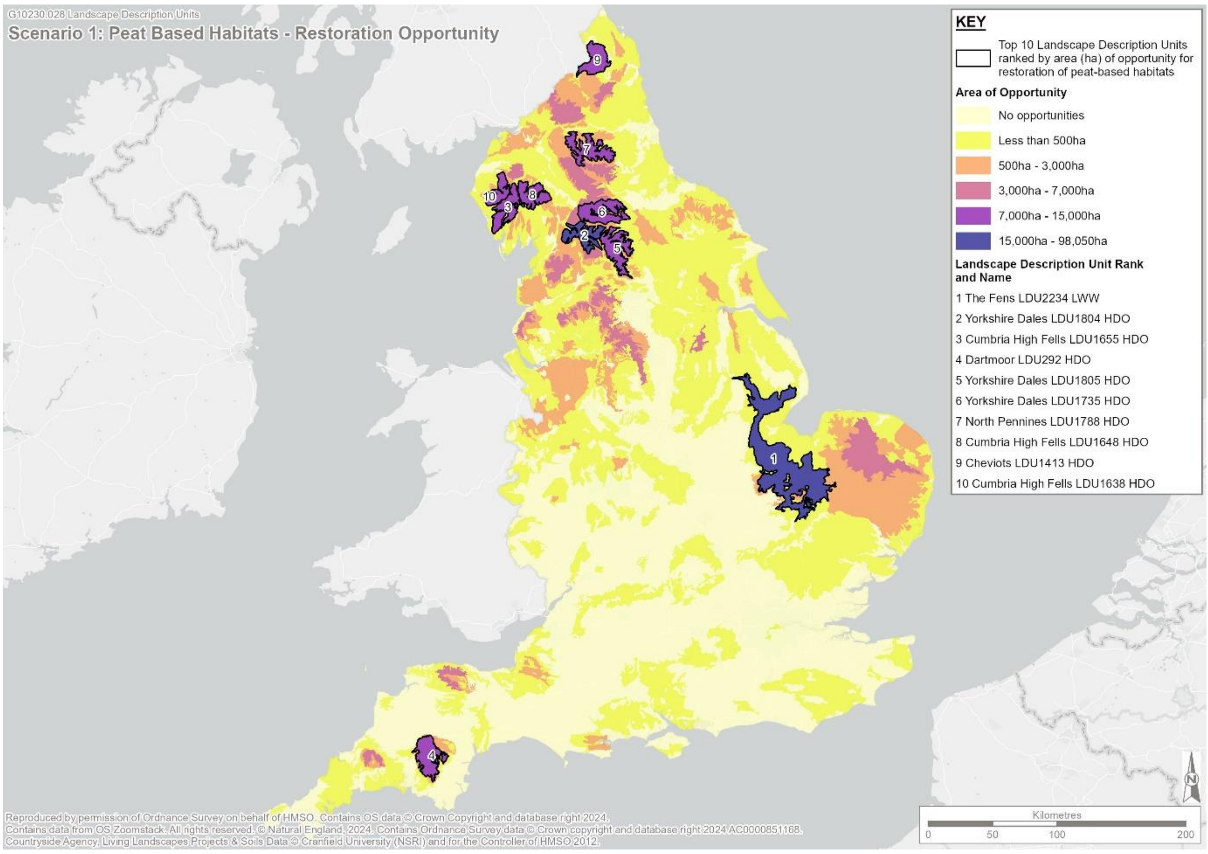

Figure 3.. **Maximum Peat Plus Scenario shown in terms of Landscape Description Units that have opportunity for restoration of peat, including the 'top ten' in area terms**

LDU's, of which there are about 3,000 in England, provide a more granular picture of the landscape than the 159 National Character Areas, and are more useful for targeting delivery of agri-environment and other nature recovery investment.

Part 3 includes detailed analysis of the extent of opportunity associated with each habitat expansion scenario. It includes a decision-makers matrix (at Table 34) which allows consideration of several factors that influence investment decisions:

[4] The Landscape Description Unit dataset is held by Natural England and is currently not available online. The Nature Net Zero Part 3 report provides details of how LDUs are classified.

- Extent of Opportunity – a large area offers opportunity to deliver against the legal target and provides a strong focus for research and knowledge-sharing effort
- Safeguarding of existing soil carbon stores – prevention of ongoing degradation of carbon-rich soils is key to meeting legal Net Zero targets
- Creating new carbon stores
- Creating habitats that will sequester atmospheric carbon as soon as possible
- Abatement of existing emissions at an early date
- Sensitivity to climate change – some habitats are particularly vulnerable, as set out at Part 2 of this research
- Timeframes to achieve good habitat condition

The difference in carbon outcome associated with different courses of action is significant. For example, the 500,000 hectare target for wildlife-rich habitat beyond peatland restoration could deliver between 41.5 million and 75 million tonnes of stored carbon, depending on what mix of habitats is created.

There is a major opportunity to deliver more for carbon and nature recovery. The government's nature recovery and land management targets understate the very considerable opportunity to safeguard and increase habitat carbon.
This could be addressed by:

- Protecting our carbon stores, making them more prepared for a future climate.
- Including more spatial direction towards creation of high-carbon wildlife-rich habitats at an ecosystem scale in key landscapes and areas.
- Setting out a carbon and nature approach to peat based ecosystems to deliver habitat restoration across significantly more of the 1.2 million ha of Peatlands in England.
- Clearer targeting on the locations that would be ideal for restoration and creation of new habitats to achieve both nature and carbon restoration at an ecosystem scale.
- Focussing the proposed restoration of peatland habitats (280,000 hectares) outside of protected sites onto areas adjacent to existing high quality areas. Our study finds that there is a total of 860,000 hectares of land that is already peatland habitat, often in degraded condition, or land that could be restored to peatland habitats from carbon-rich non-priority habitats.
- Recognising the 203,000 hectares of lowland agricultural peat soils that could be brought into 'responsible management' through a targeting approach for early improvement.
- Focussing the 500,000 hectare target for creating wildlife-rich habitats outside protected sites, on areas of habitat expansion. This will help to capture more opportunity for coastal and wetland habitat creation to reduce climate impact.
- Ensuring much more front-loaded delivery of high-carbon habitats that take several decades to achieve their ultimate carbon store, such as peatlands and deciduous woodland to support the Net Zero goal.

Early investment in expansion of high-carbon habitats will bring early benefit in terms of:

- rapid abatement of current emissions

- improved resilience of habitats to future unavoidable climate change
- slowing current habitat degradation and loss of peaty soils making restoration easier with lower costs when restoration does occur.
- delivery of other societal benefits such as improved resilience to flood, drought and improved water quality

To maximise carbon storage and sequestration benefits alongside nature recovery the research suggests the early focus should be on peatland restoration, woodland creation and saltmarsh creation, with resources prioritised in areas of greatest sensitivity to rapid climate change (see Part 2) and in Landscape Description Units where significant uplifts in habitat extent and connectivity are possible (see Part 3).

7. Land use synergies and trade-offs

Each scenario would involve local and landscape-scale changes in land use, so trade-offs with current land-uses and the ecosystem services they provide would be inevitable i.e. a win-lose situation. However these land use changes also provide opportunities for the enhancement of multiple ecosystem services (synergies), where increasing the supply of one service contributes to the enhancement of others i.e. a 'win-win' situation.

There are likely to be more trade-offs in terms of volume and value of food production (intensive meat and dairy and cultivated crops) in the lowlands as a result of habitat creation and restoration. That said, in certain of parts of the country such as the East Anglian Fens, prevailing agricultural practices may not be sustainable in their current form, due to fast diminishing soil resources, increasing costs of artificial drainage and climate change impacts increasing the costs of continuing a non-sustainable system..

Food production trade-offs in the uplands are also likely. Whilst perhaps lesser in terms of absolute volume and value, the effects on farm business margins and operational sustainability need to be recognised. The issue of food supply is further complicated by the extent of the UK's reliance on food imports.

In addition to increasing carbon storage and sequestration, the creation and restoration of habitats has the potential to increase the supplies of other ecosystem services such as flood mitigation, climate regulation, water quality and pollination. These synergies provide positive public benefits to society.

There is a finite amount of land in England, and the United Kingdom, and therefore multiple benefits need to be derived from it. The Government has committed to the production of a Land Use Framework to manage the multiple objectives of food production, carbon sequestration, restoring nature, and growing energy crops. Following consultation, the Framework is due to be published later in 2025.

The following useful principles were identified at Part 4 to maximise synergies and minimise trade-offs when planning for expansion of high-carbon habitats:

- Plan habitat creation at a landscape scale

- Explore and celebrate multi-functionality
- Adopt a ‘Place, People and Public value’ approach when introducing change
- Balance the use of Best and Most Versatile Land for food production with other ecosystem services it can deliver
- Develop a pathway for agricultural transition on deep lowland peats
- Avoid displacement of carbon
- Factor in climate changes over time
- Recognise that changes in land use are inevitable to meet net zero targets
- Recognise energy as part of the mix of rural land uses
- Recognise geographical variations in the impacts of climate change
- Embrace multifunctionality at farm and/or landscape scale

The concept of farming at ‘Maximum Sustainable Output’ (MSO), or perhaps more colloquially, the ‘sweet spot’ where outcomes for food and nature are optimised, is emerging. Part 4 provides some examples.

8. Recommendations

The work has identified a need for further action in the following areas relevant to Natural England’s Nature Net Zero programme:

- Better evidence on carbon storage and sequestration rates for a number of priority habitats where there are gaps in knowledge. Some of this research is already commissioned through Natural England’s Nature Returns programme.
- Better evidence on timescales for recovery of carbon storage and/or sequestration to inform decisions about when habitats will reach ‘good’ condition.
- Improvements to the Priority Habitat Inventory and Habitat Network maps to improve the habitat classifications within the data, notably in respect of Deciduous Woodland and Floodplain Wetland Mosaic, address out-of-date data and broaden the inventory to cover non-priority habitats on peaty soils that are capable of restoration to priority peatland types.
- A need to evolve our current priority habitat classifications system, which was largely developed in the 90’s, to be more adaptable for today’s priorities and fit for the future climate.
- Continued development of coastal habitat data using information from the Restoring Meadows, Marshes and Reefs (ReMeMaRe) initiative.
- Advocacy of the value of Landscape Description Units and their landscape character typologies as a means of targeting habitat and landscape recovery.

References

Dasgupta, P. (2021), The Economics of Biodiversity: The Dasgupta Review. Abridged Version.https://assets.publishing.service.gov.uk/media/6014329ce90e076265e4d9ba/Dasgupta_Review_-_Abridged_Version.pdf

https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review

Defra (2023) Environmental Improvement Plan – First Revision of the 25 year environmental improvement plan. Environmental Improvement Plan

Gregg, R, and others (2021) Carbon storage and sequestration by habitat: a review of the evidence (second edition) Natural England Research Report NERR094. Natural England, York. Carbon Storage and Sequestration by Habitat 2021 - NERR094

Met Office (2018) UKCP Science Overview Report UKCP18-Overview-report.pdf

UK Government (2021) England Peat Action Plan England Peat Action Plan

Office for National Statistics (ONS), released 27 November 2023, ONS website, bulletin UK natural capital accounts: 2023

Staddon, P.L. and others (2023) Re-evaluating the sensitivity of habitats to climate change. Natural England Commissioned Report NECR478. Natural England, York Re-evaluating the sensitivity of habitats to climate change - NECR478

Williams B.K. and Brown, E.D. (2024) Managing ecosystems with resist–accept–direct (RAD). In 'Methods in Ecology and Evolution' Volume 15 Issue 5. British Ecological Society Managing ecosystems with resist–accept–direct (RAD) - Williams - 2024 - Methods in Ecology and Evolution - Wiley Online Library