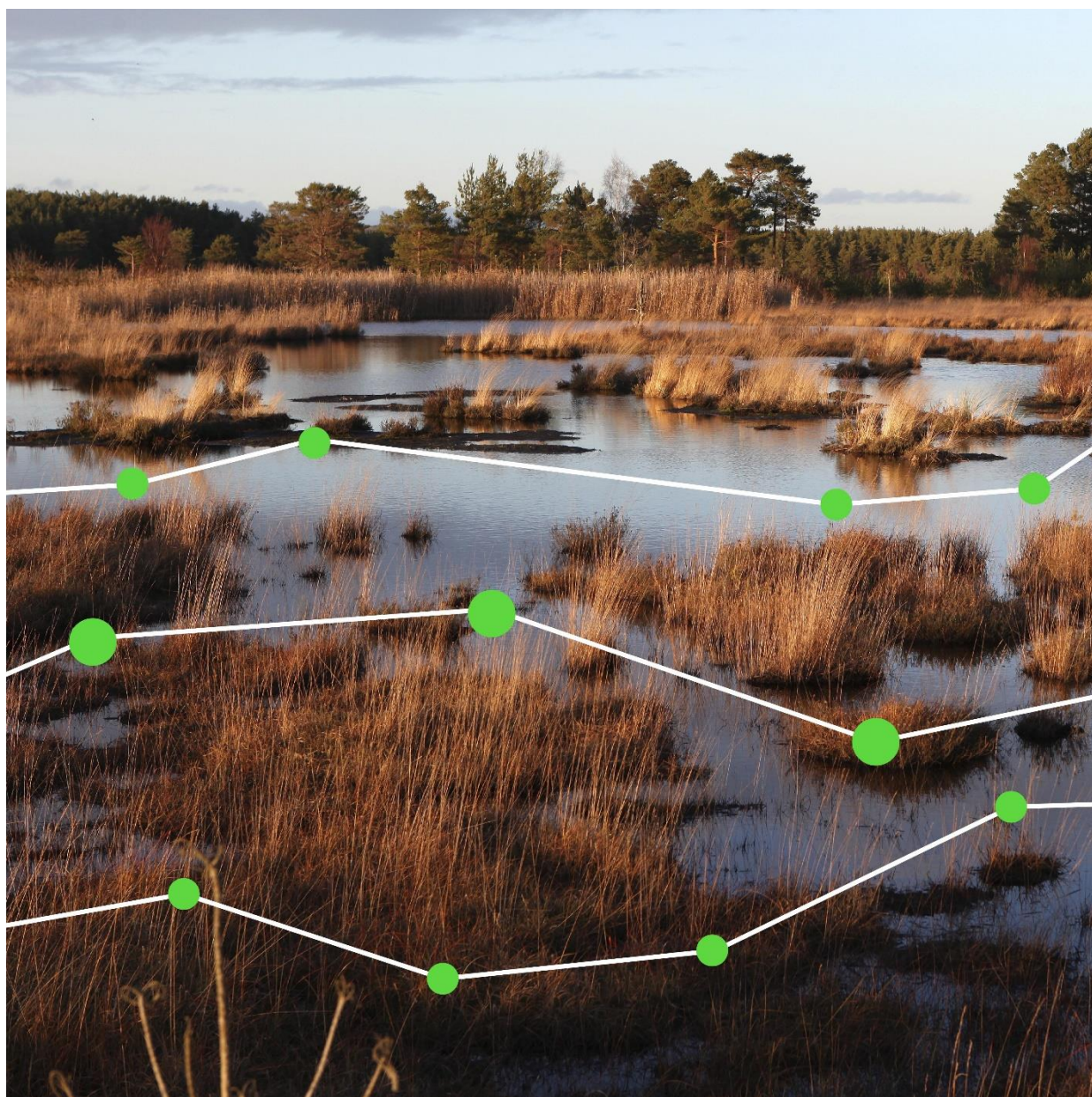


# Nature Returns

Summary Report  
March 2025



nature  
returns



HM Government

A partnership of government departments,  
charities and organisations working together  
to build the evidence for Nature-based Solutions  
to climate change and biodiversity loss.



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# Executive Summary

The Nature Returns programme aims to pilot and research Nature-based Solutions for climate change at the landscape scale, enabling better decision-making by policymakers, land managers and investors. This report summarises the key findings and learning outcomes from the first four years of the programme, largely funded by HM Treasury's Shared Outcomes Fund.

Through the programme, over 800 hectares (ha) of habitat were created or restored, 16km of hedgerows planted and 2.5km of water courses improved at six Local Partnership Projects (LPPs) across England. Over 95,000 trees and shrubs were planted and the process of natural colonisation of woodland and scrub started in other areas. Going forward these sites will allow the development of biodiversity and carbon stores to be monitored, building on high quality baseline monitoring. Collaboration and community engagement was an important element of the LPPs' work, with more than 400 volunteer days recorded.

Scientists at Natural England and the Royal Botanic Gardens, Kew enhanced understanding of carbon storage in various habitats such as hedgerows, grasslands, and woodlands:

- Using a series of locations where habitat creation took place in the past, soil carbon stocks were found to be significantly higher in old grasslands compared to new grasslands, with the rate of carbon accumulation decreasing over time.
- A study of adjacent grasslands and native broadleaved woodlands of similar age and soil type found that woodland carbon was substantially higher because of the carbon in the trees – soil carbon was similar.
- Mycorrhizal fungi are key mediators of carbon storage. Mycorrhizal communities were mapped across habitats at Wakehurst, Sussex and found to correlate with soil carbon stock. Some mycorrhizal fungi can be used as indicators of soil carbon.
- New techniques have been developed, particularly a) a non-destructive method for measuring carbon in woody biomass including hedgerows and scrub, b) LIMMMA multifunctional land use platform - extrapolating, scaling up, and engaging with uncertainty, c) a toolkit to better estimate tree biomass and carbon compared to existing techniques, and d) methodology for in situ measurements of carbon dioxide and methane fluxes across different sites and habitats.

Experts from the Environment Agency and the Forestry Commission worked with the LPPs to understand opportunities and challenges regarding green finance options, developing blended finance models that best support Nature-based Solutions. This has resulted in the development of catchment-scale blended funding processes and recommendations for creating a government-led Community of Practice to support green finance initiatives. These models are crucial for mobilising resources and ensuring the long-term viability of Nature-based Solutions.

The practical implementation of Nature-based Solutions and nature recovery highlighted:

1. the importance of local knowledge and partnerships for effective implementation of Nature-based Solutions, alongside technical expertise.
2. flexibility and adaptability in project planning and execution being crucial for addressing unforeseen challenges, including as a result of weather extremes.
3. the need for longer funding cycles and consistent support from government bodies to improve the chances of good outcomes in programmes of this sort.

Nature Returns has demonstrated the potential of Nature-based Solutions to contribute to achieving Net Zero and nature recovery whilst providing multiple benefits to society. It has also shown that investment into nature would need to become a normal part of our economy, rather than a separate strand of 'nature finance', if it is to drive landscape-scale planning and delivery of Nature-based Solutions for climate change adaptation and mitigation.

Going forward the priorities for the programme include an increased emphasis on Nature-based Solutions for climate change adaptation, application of the lessons learnt in the context of the forthcoming Land Use Framework for England and repeat monitoring of plots to measure changes in carbon and biodiversity.

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# Summary Report

## Introduction

Nature-based Solutions (NbS) address societal challenges in ways that benefit both people and biodiversity. For climate change, this includes creating and restoring habitats to reduce greenhouse gas emissions and implementing adaptation measures, including natural flood management and shading. However, significant evidence gaps limit the potential of species-rich habitats, such as grasslands, wetlands, scrub, hedgerows, and diverse woodlands, to contribute fully towards Net Zero.

Understanding factors that promote or hinder NbS adoption and nature recovery in varied landscapes is crucial, including blending private finance with government funding to accelerate uptake and delivery on the ground.

The Nature Returns programme addressed these challenges by piloting approaches to NbS for climate change. The programme was led by Natural England (NE) in partnership with the Environment Agency (EA), Forestry Commission (FC), and Royal Botanic Gardens (RBG), Kew, with sponsorship from the Department for Environment, Food and Rural Affairs (Defra) and the Department for Energy Security and Net Zero (DESNZ) and funding from HM Treasury's Shared Outcomes Fund and Defra's Net Zero Research and Development budget.

A central component of the programme's 'learning by doing' approach was the creation and restoration of over 800ha of habitat by six Local Partnership Projects (LPPs) across England. Scientists at Natural England have researched carbon sequestration and storage in different habitats across the LPPs, establishing baselines for longer-term study to track the effectiveness of NbS for climate change mitigation. Research by RBG, Kew, using their Wakehurst Living Laboratory, has enhanced understanding of ecological processes, developed methods to measure carbon and biodiversity, and contributed to the development of tools for land use decision-making (in collaboration with Royal Holloway, University of London, University of Sussex and Imperial College London). Partners at the EA and FC have supported LPPs in blending funding for environmental outcomes and developing sustainable funding plans. This work has provided significant insights into habitat restoration, collaboration, and the multiple benefits of this work for people and nature.

Nature Returns has contributed to Government priorities, including Net Zero, the Environmental Improvement Plan (EIP), the National Adaptation Programme, the Green Finance Strategy, England Trees Action Plan, Peat Action Plan, the Plan for Water and the development of the Land Use Framework.

This Summary Report builds on the previously published Interim Report\*, summarising lessons learned and research findings from October 2021 to March 2025.

\*Available via [Natural England's Access to Evidence site](#)

# Sites

## Local Partnership Project Sites

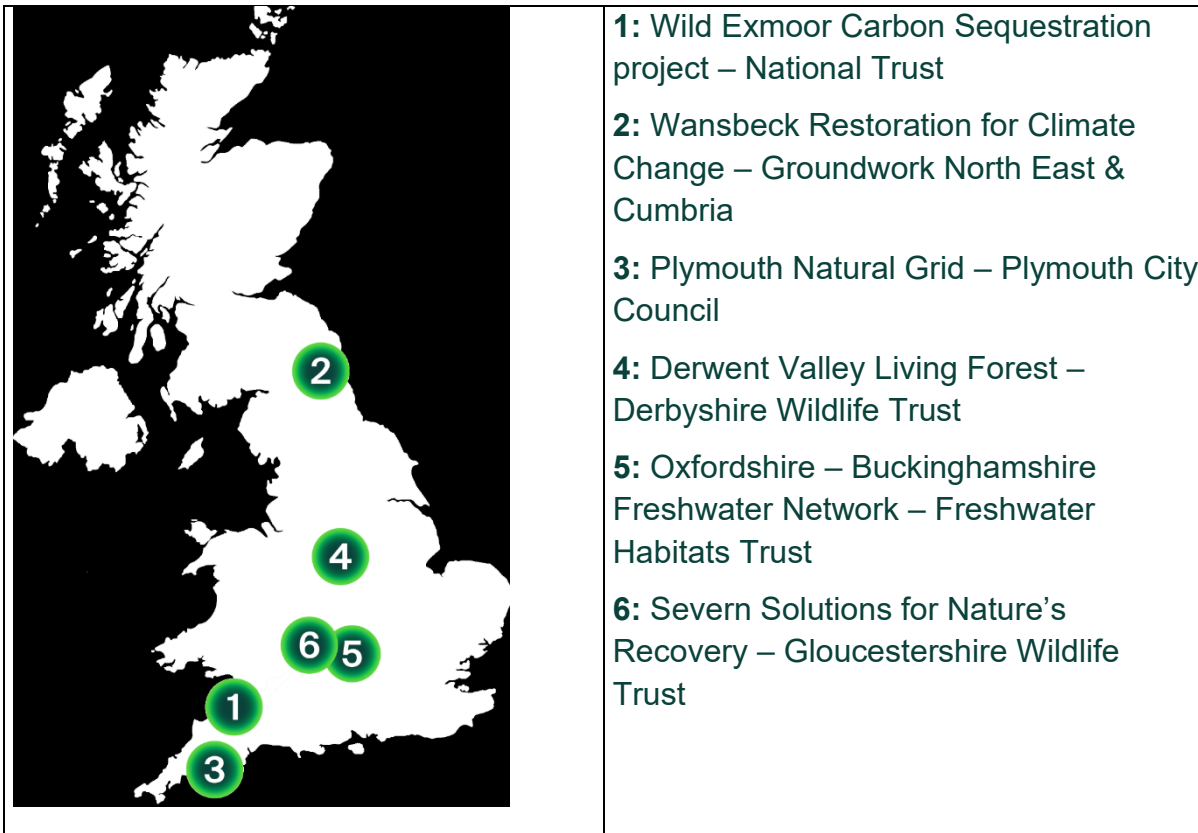


Figure 1. Location of Nature Returns LPP sites (see Annex for full descriptions)

As part of their grant award all six LPP sites agreed to maintain habitats and allow access for future monitoring for a period of 10 years, running through to 2034/35.

To provide a baseline, NE’s Nature Returns field team took measurements of soil carbon at 0-15 and 15-30 cm depth, species composition and structure of vegetation, estimated carbon in trees, seasonal flux of carbon dioxide and methane and carbon in hedgerows and scrub using our published [field survey methodology](#). Further measurements were taken by some of the LPPs.

## Kew Wakehurst’s Living Laboratory

Kew’s site at Wakehurst in Sussex is a flagship site for in-depth scientific studies and has been utilised by Nature Returns to undertake high resolution research into carbon & GHG gas flux in different habitats, to better understand the mechanisms underpinning this both above and below ground. It has also been a testbed for the development of new methods, including using Lidar and genomic techniques.



Figure 2. Kew scientists in action at Wakehurst. Photo credit: Jim Holden © RBG Kew

## Additional Sites



Figure 3. Location of Nature Returns chronosequence sites across England.

In addition to the core sites an additional series of sites were used to compare existing habitats of different ages forming 'chronosequences'. There was a focus on grasslands at different stages ranging from pre-restoration to 100+years. Some of these sites also had mixed woodlands and other habitats.

Further sites were used for testing the new Lidar method for measuring hedgerow structure and carbon.

## Habitat creation summary

Habitat type	Area/length (Ha/m)
Mixed/native woodland	145.77
Fen	11.12
Floodplain grassland	8.80
Floodplain wetland mosaic	72.72
Upland heath	45.55
Lowland heath	98.00
Ponds/Open water	7.39
Orchard	6.80
Peatland/peaty pockets/blanket bog	70.20
Riparian woodland	0.60
Coastal saltmarsh	0.26
Mixed scrub	103.52
Species rich/ semi-natural grass	93.43
Wood Pasture (including natural regeneration)	189.39
Hedgerow (m)	15,996.00
Watercourse (m)	2,489.00

## Lessons Learned

### Overarching lessons

Restoring semi-natural habitats within mixed landscapes with a variety of different land uses can contribute to Net Zero and biodiversity targets, at the same time as delivering a wide range of other benefits. Nature Returns provides well evidenced examples of this and has improved the scientific evidence base to support decision-making and prioritisation.

Delivering for biodiversity and climate at a landscape scale depends on a range of factors including both practical and technical expertise, local knowledge and good partnerships. Funding is more effective if sites have sufficient time to plan and the flexibility to adjust as opportunities and constraints become clearer. Private finance can make an important contribution but is challenging for many local partnerships and the incentive to engage with it is relatively low at the moment. Engaging with private funding opportunities takes dedicated time and resources.

There is a growing need to plan for extreme weather events. The Nature Returns programme has been impacted throughout by extremes of wet and dry conditions. Habitat creation and restoration, and surveying, has become more challenging and required additional planning for contingency measures as a result.

## The practicality of nature-based solutions

### What works on the ground

The work of the Nature Returns LPPs clearly demonstrated a number of practical requirements for effective delivery of NbS:

#### **1. It is essential to know the environment you are working in**

This was key and ensured that the work being considered was appropriate and achievable for the locality. All our LPPs understood the areas they were working in and partnered with other landowners and land managers who could add further local knowledge. For example, to plan the creation of scrapes within floodplains it was important to understand where water would collect naturally to maximise the impact of these works.

#### **2. Relationships should be prioritised from the outset**

Developing relationships with the landowners and securing their buy-in at an early stage was essential where work was taking place on third party land. A good example of this was that Groundwork's LPP had a strong relationship with the Forestry Commission, and this allowed them to identify and include a new opportunity that wasn't part of their original proposal (blanket bog restoration on a former conifer plantation). Conversely, Freshwater Habitats Trust's LPP suffered in their first year of habitat creation as landowners who had initially shown interest withdrew, which significantly impacted their ambitions.

Working on a programme with multiple partners allowed LPPs to connect to other organisations and form networks. Through activities such as regular forums and site visits, the projects experienced the breadth of work taking place across the programme and benefited from sharing ideas, knowledge and learning.

#### **3. There are many ways to use communication and engagement to support work on the ground, which should be tailored to the project**

LPPs found success through a range of different approaches, such as: dedicated 1-2-1 site visits with landowners to build support and understand their requirements; visits to similar projects to show stakeholders what change could look like; hosting events to bring communities together and share messages with them; campaigns like the Freshwater Habitats Trust's GroWet where stakeholders could be involved in delivering projects (in this case growing on rare wetland plants at risk of local extinction for re-introduction back into the landscape).

#### **4. Delivering multiple benefits is possible with well targeted interventions within a landscape**

The LPPs have delivered a range of other benefits in addition to those for carbon and biodiversity. Interventions that allow some farming practices to continue have proven popular, with wood pasture being an element of four of the six Nature Returns LPP sites. This allows grazing to continue and requires minimal actual reduction in the grazable areas. Leaky dams have proven to be effective in reducing peak flows in watercourses – Plymouth City Council’s LPP measured a 12% reduction in the first year after installing leaky dams in the Seaton Valley (Puttock *et al.* 2024).



Figure 4. Wye leaky dam at Derwent Living Forest. Photo credit Daniel Blake.

## **5. Flexibility, adaptability and contingency are key**

Whilst the LPP grants necessarily required advance agreement of scope and targets, this incorporated a degree of flexibility given the ‘piloting’ nature of the work. This has allowed the projects to incorporate new opportunities, such as the integration of blanket bog restoration within Groundwork’s LPP in the first year, which had not been anticipated. Having contingency plans in place enabled the National Trust’s LPP to make adjustments to delivery when the presence of waxcap fungi (a conservation priority) impacted their heathland creation ambitions in the first year, ensuring they were still able to deliver habitat works to a similar extent.

## **6. Funding and support mechanisms can help or hinder delivery**

Delays in funding, resulting from following the required procurement processes, combined with the inability to transfer funding between years, reduced what could be achieved in the first year of habitat delivery. Longer funding cycles than

government typically allow would deliver better results and value for money. Advice and support from Arms Length Bodies (NE, EA, FC) supports better outcomes but consistency in staffing and good local links are important.

## Partnership projects by numbers

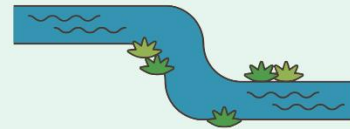
Over  
95,000 trees,  
tree and  
scrub whips  
planted



More than 400  
volunteer days  
contributed



16 km of hedgerows planted and 2.5 km of watercourse  
improvements



20 jobs and  
apprenticeships  
supported

28 educational  
outreach events



Over 800 hectares of habitat created  
or restored, which is over 1,100  
football pitches



## What works for green finance: funding Nature-based Solutions

Nature Returns' engagement around green finance focused on supporting the supply-side delivery of habitat restoration. The learning and recommendations below are based on our experience of working directly to support this supply-side, and through independent research contracts. All research reports are available on the [Investing in Nature](#) page of the [Nature Returns digital hub](#).

### 1. Supply-side programme and business development support is necessary

Developing programmes to access blended or green finance requires time and support, as there are no standard models available - each project must create a tailored approach. Since green finance is still emerging, securing private investment is challenging, especially for early-stage business development, which typically lacks private funding and needs government backing. For instance, Derbyshire Wildlife Trust used part of their Nature Returns grant to begin creating a funding model with Triodos Bank for NbS.

To address these challenges, a process for enabling catchment-scale blended funding was developed with three Nature Returns local project partners. This process involves organisations collaborating to identify a key issue, determine suitable interventions, and then build a delivery and funding plan. The approach emphasises ongoing, hands-on learning and development. Continued collaboration with these partners is helping refine the process, demonstrating the need for sustained support as new funding models and strategies are tested and implemented.

### 2. Continued support for green finance training and development is necessary

ICF Consulting was commissioned to assess the existing green finance resources and identify gaps related to blended funding. The assessment revealed that staff in partner organisations, as well as within EA, NE and FC, are still learning about blended funding, its implementation, and necessary governance structures. Resources are currently dispersed across various platforms, including SharePoint sites and general websites like the Green Finance Institute's [Hive](#) or Ecosystem Knowledge Network's [site](#). ICF's report highlighted that users seek more accessible resources, such as guidance, templates, case studies, legal agreements, and financial models, but want direct support navigating setting up programmes to attract private money. To address these needs, ICF have recommended options for addressing these gaps, including the creation of a government-led Community of Practice that builds on existing platforms while addressing identified gaps.

### 3. Businesses need clear reasons to input finance into nature recovery

Voluntary nature markets currently focus on carbon credits, driven by the UK's 2050 Net Zero target, which provides clear incentives for businesses to engage, as customers and investors value these efforts. This creates demand for carbon credits, offering the market longevity essential for long-term offset projects. However, for other ecosystem services like biodiversity, water quality, or green

space, the reasons for business engagement are less clear. Our research indicates that compulsory markets, like Biodiversity Net Gain (BNG), could drive quicker action and higher prices, as businesses will seek the most cost-effective ways to comply with regulations, such as onsite biodiversity gains. Although BNG, introduced in 2024, may not live up to expectations for offsite units, it could still minimise negative biodiversity impacts from development.

Despite the Woodland Carbon Code operating since 2011, voluntary carbon prices remain low at around £23/tonne CO<sub>2</sub>e, compared to £40–£80/tonne CO<sub>2</sub>e under the UK Emissions Trading Scheme and £120/tonne CO<sub>2</sub>e in government valuations. It is uncertain whether market prices will rise to reflect carbon's true value, but if they do this could influence land use and reduce public funding reliance. While some businesses support nature philanthropically, this is insufficient for large-scale recovery. Long-term investment depends on businesses recognising their impact on nature. A national framework like the Taskforce on Nature-related Financial Disclosures could guide companies in aligning operations with environmental goals.

**Full paper: [Buyers of Ecosystem Services in Voluntary Markets](#)**

#### **4. Nature markets need high integrity mechanisms**

For businesses to engage with nature markets, trust in the integrity of the credits they purchase is essential to avoid greenwashing. Research from the Nature Returns programme shows that UK voluntary carbon credits trade at significantly higher prices (£26.85 per tonne CO<sub>2</sub>e) compared to international markets (\$6.37 per tonne CO<sub>2</sub>e), reflecting the high integrity of UK standards like the Woodland Carbon Code and Peatland Code. To expand nature markets, more high-integrity mechanisms are needed across various ecosystem services. Institutional investors also require reliable, credit-assured financial products offering economic return, low transaction costs, and real environmental impact, with risks properly managed (North Star Transition, 2023).

**Full report: [UK Carbon Prices](#)**

#### **5. Nature markets need clear rules and regulations**

High integrity comes with a higher degree of complexity. Clear rules and regulations around blended finance and nature markets can give confidence to both the supply and demand side that what they are doing is effective. For example, clear guidance on stacking and bundling of ecosystem services will help suppliers value activity appropriately. Buyers can then be confident that what they buy is genuinely contributing to environmental improvements.

#### **6. Examples and evidence about what works can drive further development**

Suppliers need guidance on approaching blended finance to plan effectively and secure long-term income for nature recovery. However, the emerging green finance sector causes uncertainty about engaging with ecosystem markets and selecting appropriate agreements. This results in suppliers relying on traditional funding sources, such as grants, and struggling to pursue alternative funding. A low-risk

appetite on the supply side stems from concerns over the impact on their livelihoods.

## **7. Supply of benefits from nature cannot be piecemeal**

For nature recovery to be effective, large-scale action is required, with landowners working together to deliver sufficient outcomes to meet demand. This approach ensures that customers seeking carbon credits, for example, can procure enough supply. [Research](#) co-commissioned by the National Innovation Centre Rural Enterprise (NICRE) and Natural England in the Wansbeck Catchment emphasised the importance of strategic planning and policy to address both environmental and social challenges. This study found that improving access to greenspace could save £2.1 billion annually in health costs as physical activity increased in those spaces. NICRE conducted workshops in the Wansbeck Catchment to support this research.

# **The value of nature-based solutions for climate change**

## **Carbon and biodiversity**

Nature Returns sought to improve the evidence base on the efficacy of Nature-based Solutions for climate change mitigation, focusing on the contribution of under-studied habitats to Net Zero. Using our six LPP areas, Kew Wakehurst's Living Laboratory and additional sites, our science teams at Natural England and the Royal Botanic Gardens, Kew have collected a significant amount of empirical data over the past three and a half years (2022-2025), summarised in the below infographic. The [field survey methodology](#) for measuring carbon stock, sequestration rate and biodiversity of each habitat via a range of methods including soil coring, vegetation surveys, gas flux measurements, woodland surveys and 3D scanning of scrub and hedgerow is available on Natural England's [Access to Evidence](#) website.

Analysis of our extensive datasets has led to the following headline findings:

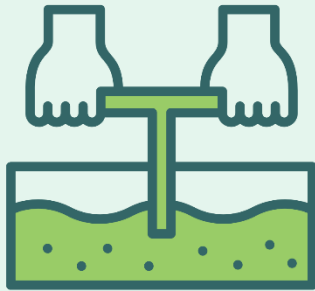
### **1. 3D scanning using LiDAR offers improved methods for estimating hedgerow carbon**

Hedgerows offer vital nature-based benefits, including carbon storage, but predicting their carbon stock is challenging due to the highly varied age and management. 3D LiDAR scan studies measure hedgerow volume (using 3D pixels). We found this is a better predictor of carbon than hedge height, a commonly used proxy for assessing hedgerow carbon in the UK landscape. Our research shows that carbon stocks in hedgerows are highly variable, ranging from 25 to 130 t C ha<sup>-1</sup>. These levels can be comparable to those found in some UK woodlands.

**Methods paper: [A non-destructive method for estimating hedgerow biomass](#)**  
**Data: [Terrestrial LiDAR derived point clouds and quantitative structure models for Kew Wakehurst](#)**

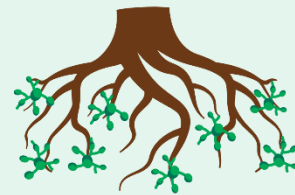
# Research by numbers

48 hours drone flying time  
travelling 2,200km



2,533 soil samples

6,540 root  
and soil  
DNA  
extractions



900 microscope  
slides of mycorrhizal  
roots



1,500 kg hedgerow sampled



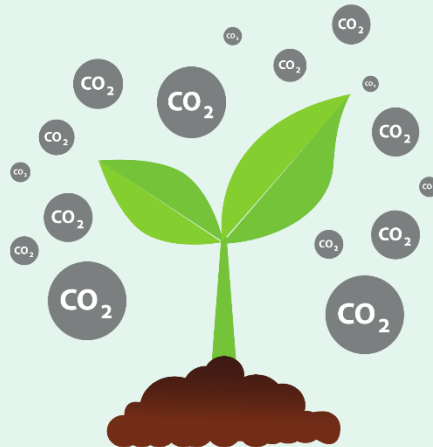
5,600 trees and shrubs  
scanned in 3D



248 plant  
species  
identified



3,496 m<sup>2</sup> quadrats surveyed for  
vegetation species diversity



405,629 Gas flux readings

## 2. Creating species-rich grassland can take up significant amounts of carbon over decades, whilst supporting plant communities of high conservation value

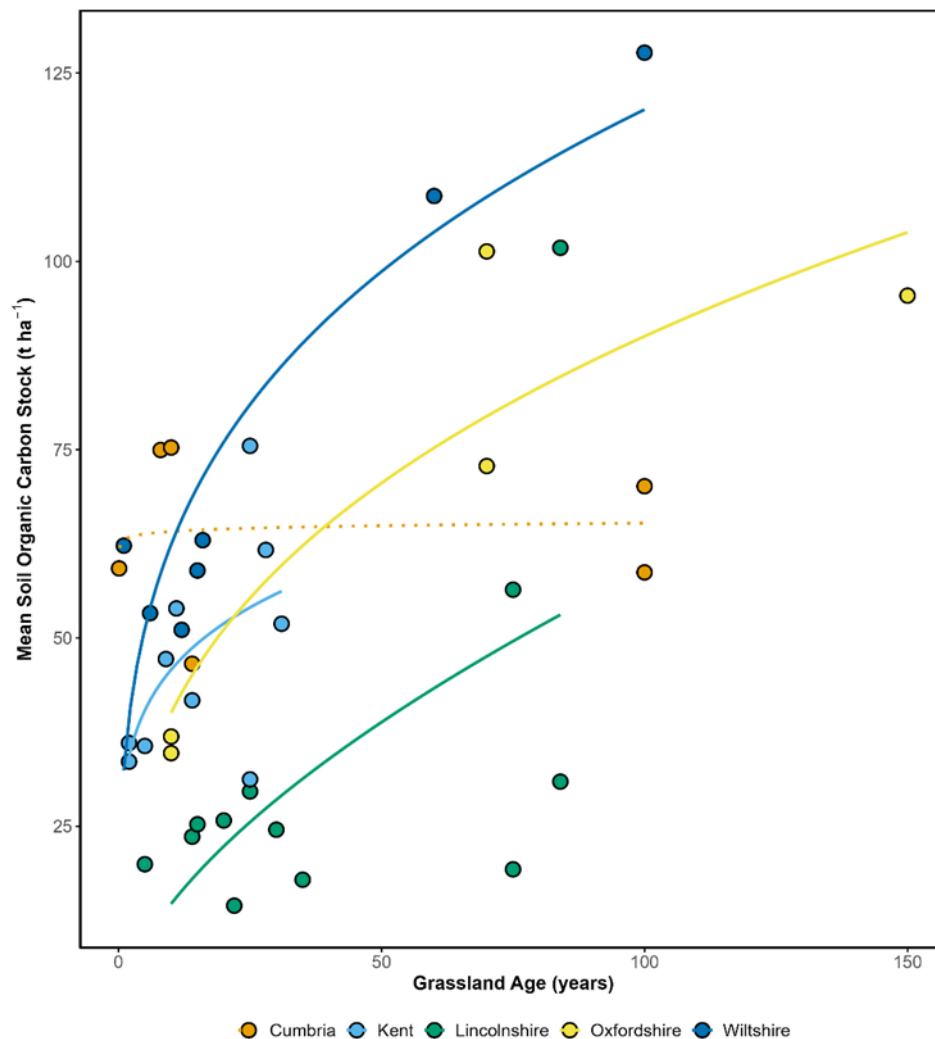


Figure 5. Carbon stocks increase with grassland age. Solid lines show statistically significant increase in carbon stock with increasing age. The single dotted line shows the one site where there was not a statistically significant increase.

Across five chronosequence sites, Natural England scientists found that soil carbon is generally higher in older grasslands, indicating long term sequestration. However, the rate of increase declined over time and was highly variable between sites, dependent upon the initial carbon stock, as well as soil texture (particularly clay content) and mean annual rainfall. Plant community composition changed with age, from faster growing ruderal species in younger grasslands to higher proportions of stress tolerant species in older grasslands, which are often the most important for conservation.

**Full paper: [Semi-natural grasslands as a nature-based solution for climate change mitigation: An assessment of carbon and plant communities across age gradients](#)**

### **3. Whilst grasslands do sequester and store carbon, they do not sequester carbon as quickly as woodlands**

Comparing established semi-natural woodlands and grasslands at the same sites, on similar soils, showed comparable soil carbon stocks and substantial additional carbon stocks in the wood of the trees. Research at Wakehurst found that the greatest soil carbon stocks were in broadleaved and less densely planted conifer woodlands compared with other habitats.

**Full report: [How do neighbouring grasslands and woodlands compare in their potential role as nature-based solutions? \(in progress, summary available on request\)](#)**

### **4. A small number of old trees can account for most of the tree carbon in a woodland**

Research at Kew found that 50% of the total above ground carbon was stored in only 3% of trees, which were the oldest and largest trees. Protecting veteran trees and ensuring younger trees grow to maturity is therefore important for maintaining forests as significant carbon stores as well as supporting biodiverse habitats.

### **5. Soil mycorrhizal fungi are carbon mediators**

Ectomycorrhizal (EM) fungal community composition emerged as a fine-scale reliable predictor of soil carbon stocks (Suz *et al* 2022). In particular, EM composition and foraging traits explained variation in carbon storage even after accounting for soil chemistry, topography, and tree cover. Soil carbon stocks can be predicted by specific soil fungal communities; scientists at Kew identified several potential ectomycorrhizal species that indicated higher soil carbon stocks at landscape scale, including *Russula ochroleuca* and *Lactarius tabidus*. *Russula ochroleuca* is a generalist species, widespread in both broadleaf and conifer-dominated forests across the UK and Europe. Consequently, integrating the presence of widespread and host generalist indicator species into carbon stock predictions could help differentiate between low- and high-quality woodland sites, regardless of forest-type, and therefore help improve national predictions of soil carbon stocks and land-management decisions. These results highlight the potential for integrating fungal biodiversity into national soil monitoring frameworks to improve the spatial accuracy of carbon estimates and inform woodland management.

**Full paper: [Ectomycorrhizal composition and traits predict soil carbon at the landscape scale](#)**

### **6. Greenhouse gas (GHG) fluxes are highly variable and change through space and time**

Analysis of data from instantaneous measurements of carbon dioxide and methane flux, collected by NE scientists at our LPP sites, showed high levels of variability in grasslands. To date there have been few studies making comparative measurements at different sites. Grasslands can take up or emit significant amounts of carbon at different times, depending on season, temperature and soil water content. The relationship between photosynthesis and soil respiration is

important for carbon dioxide - high rates of soil respiration associated with high temperatures can exceed rates of uptake by photosynthesis. There are also differences between and within sites related to soil and vegetation characteristics. Emissions of methane, a potent greenhouse gas, can vary with small scale differences in soil water. Greenhouse gas surveys at Kew's Wakehurst site showed that soil moisture and soil temperature are drivers of carbon flux in hazel coppice woodlands. Analysis is continuing to assess the implications for how to better manage emissions.

**Full paper: Carbon dioxide and methane flux in grasslands ([draft available on request](#))**

### **7. Some under-studied habitats, including hedgerows, scrub, trees outside woodland and floodplain mosaics, have good potential as Nature-based Solutions for climate change**

LPP sites found it relatively straightforward to increase trees and shrubs in the landscape through planting hedgerows, creating wood pasture and promoting the growth of scrub. These measures offer the potential to increase carbon and biodiversity through subtle land use change, allowing food production to continue. Our work also shows the importance of protecting carbon that is stored in localised spots within a landscape, such as old trees and flood plain mosaic habitats.

**Case study: Wood Pasture, Lessons Learned and Implications for Policy ([draft available on request](#))**

## **Other benefits including community engagement**

Interventions by each LPP were primarily intended to test potential Nature-based Solutions for climate change mitigation; however, despite the limited scale of individual projects, the Nature Returns programme has been able to demonstrate how Nature-based Solutions can provide other benefits for people, nature and the wider environment.

- All of the LPPs have offered opportunities for local communities to engage with nature, with over 7,000 people engaged in activities or volunteering in total (including over 400 days of volunteer time) and likely associated positive [impacts on people's health and well-being](#). The projects have also provided opportunities for upskilling and had local economic benefits, supporting 20 jobs and apprenticeships across the partner organisations.
- Nature Returns LPPs created or restored over 800 ha of habitat, and restored 16km of hedgerows, directly improving biodiversity locally and contributing to the government's 2023 Environmental Improvement Plan targets.
- Many of the LPPs were in catchments where flooding has been an issue in recent times. They have delivered elements of natural flood management (NFM) including woodland and wood pasture creation, installing leaky dams within watercourses, lower banks to improve the connection of watercourses to the floodplain, and the creation of scrapes within the floodplain to better store floodwater. Some of the LPPs have directly assessed the impact of interventions on peak flow rates, for example [Plymouth City Council](#). This has

the potential to reduce downstream flooding, directly attributed to NFM interventions.



Figure 6. Volunteers scything and raking at Pea Pits Copse, within National Trust's Buscot and Coleshill Estate. Photo credit: Freshwater Habitats Trust

- Anecdotal evidence from the Groundwork LPP highlights the biosecurity and livestock welfare benefits of improving hedgerows and boundary features, reducing contact between stock in neighbouring farms and providing shade and shelter.

Whilst the programme has not focused on collecting data around wider impact, the work delivered by the LPPs is likely to deliver a wide range of other well-documented benefits, including:

- reductions in soil erosion, through the increase in tree cover
- improved drought resilience, through increased soil water retention
- improved water quality, with new bogs filtering and purifying water
- increase in pollinator populations, and associated food security benefits

# Resources for the future

## New techniques

### A non-destructive method for estimating hedgerow biomass

Hedgerows provide many ecosystem services in agricultural settings and support biodiversity. One under-explored service is storage of carbon in woody biomass. We have developed a [method](#) for measuring hedgerow volume based on the internal structure using ground-based laser scanners and carbon analysis techniques developed throughout the programme. This method enables large-scale estimation of carbon held within hedgerows.

### LIMMMA multifunctional land use platform - extrapolating, scaling up, and engaging with uncertainty

The [LIMMMA platform](#), developed by our partners at the University of Sussex, is designed to bring empirical evidence concerning the changing functions and values of multifunctional land use into rapid and effective use. It enables specialists and non-specialists to consider diverse data sources in one integrated platform and support bespoke analysis and decision-making.

LIMMMA has built on the data collected through Nature Returns, and can integrate ecological, social, and economic data to visualise and analyse the benefits and trade-offs of different NbS.

Drawing on insights and key themes from the Nature Returns empirical studies, and specific case studies of contemporary policy and planning initiatives, we demonstrate the potential of utilising the LIMMMA platform to help to address some of the key challenges to nature recovery in the UK, such as:

- Accelerating progress in nature recovery policy formulation by making emergent scientific data available in a timely and accessible format with uncertainties and assumptions visible
- Examining the implications of this evidence for land use change options at multiple spatial scales alongside evidence from other sources
- Providing flexibility to add diverse perspectives, knowledge and understanding of landscape function and value with potential to support multi stakeholder dialogue

### A toolkit to estimating tree biomass using allometric equations

Tree biomass is commonly estimated using allometric equations based on diameter at breast height (DBH) and tree height. However, a wide range of methods and equations exist, making consistent application challenging (Vorster *et al* 2020 and Holland *et. al.* 2024). We have compiled and standardised these approaches (including; Woodland carbon code (Jenkins *et al* 2018), Bunce (1968), BIOMASS (Réjou-Méchain *et al* 2017

and allodb (Gonzalez-Akre *et al* 2022)) for UK conditions into an accessible [R package](#) which help researchers and practitioners to compare results across methods.

## **Field survey methodology for comparative assessment of carbon and biodiversity**

Our [field survey methodology](#) has been taken up and used by a variety of projects across Natural England and gathered interest from a range of stakeholders also aiming to produce baseline carbon measurements in other land uses. By providing an approach to baselining carbon in different habitats that is scientifically robust, easily replicated and presented in an understandable way for different audiences, it will help fill key evidence gaps towards understanding the wider role that Nature-based Solutions, and other land management activities, can play in achieving Net Zero.

## **Baseline data**

Baseline data across both LPPs and additional sites of varying age and management history (chronosequence) will be published via Natural England's [Access to Evidence](#) site ([available now on request](#)). [Baseline biodiversity data](#) is available via the [National Biodiversity Network \(NBN\) Atlas](#) from Natural England's landing page.

Other Nature Returns data is deposited in [Zenodo](#) and code in [GitHub](#). Baseline data for Wakehurst's living laboratory is open access and available on request. The mycology data is accessible on [figshare](#) and tree LiDAR data on [Zenodo](#).

All academic papers will be open access.

## **Publications and Outputs**

A list of all Nature Returns publications, with links to online locations, can be found on the [Nature Returns website](#).

# Annex

## Site descriptions

### **National Trust, Exmoor**

Kipscombe Farm is part of the National Trust's Watersmeet Estate on the north-western edge of Exmoor. It is a rural, farmed setting on the north Devon coast.

The work undertaken through Nature Returns is part of the National Trust's ambition for the wider area to make it 'messier' by creating more of a mosaic of habitats across their estate.

The work at this site involved the creation of wood pasture areas, species rich grassland and heathland habitats. The areas identified for heathland creation also provide a significant and nationally important waxcap fungi presence. The heathland works were targeted to those areas where surveys indicated waxcaps were less likely to be present.

As part of their community engagement activities the National Trust hosted volunteer groups from Plymouth for a week in each of the last 2 summers, providing an opportunity for people from urban areas to experience a new environment, while building links with Plymouth City Council's project work.

### **Groundwork North-east & Cumbria, Northumberland**

Groundwork's LPP was centred around the National Trust's Wallington Estate in the upper Wansbeck catchment in Northumberland. This is an upland fringe farmed environment, approximately 25 miles north-west of Newcastle.

Groundwork worked with a number of landowners, building on a partnership established during the Local Nature Recovery Strategy pilot in Northumberland. They worked closely with the National Trust and their tenants, along with private landowners.

During the first year the project undertook work on five separate sites and the work involved a variety of interventions including wood pasture, woodland shelterbelts, riparian woodland, floodplain wetland mosaic and fencing along watercourses to improve the riparian habitat and reduce pressures from livestock. They installed leaky dams within the Harwood Burn, and reconnected the burn with its surrounding floodplain, and were able to begin work to restore blanket bog on an area of previously planted conifer plantation. During the second year further works within the Harwood Burn and its floodplain took place, as well as grip blocking at Catcherside and Rothley West Shield Farms to retain water within the landscape.

### **Plymouth City Council**

Plymouth City Council are working in partnership with the National Trust at several sites across the city. All of the sites are within the urban environment, and as a

consequence Plymouth City Council were able to incorporate a significant element of community engagement as part of their project.

Work in the first year of the project involved the installation of leaky dams on three watercourses within the Seaton Valley, which are surrounded by housing estates and prone to flash flooding. Other work included bracken bashing to remove and enable semi-natural grassland to re-establish, and the creation or restoration of wood pasture and broadleaved woodland and small areas of scrub and saltmarsh.

Second year work involved further wood pasture, floodplain wetland and semi-natural grassland, along with hedgerow restoration.



Figure 2. Planting trees for South Devon Community Forest, Plymouth's Natural Grid. Photo credit: Chris Parkes

## **Freshwater Habitats Trust**

Freshwater Habitats Trust worked with a number of private landowners throughout Oxfordshire and Buckinghamshire to restore or create wetland habitats. They also operate a community engagement initiative called GroWet where volunteers propagate and grow rare wetland before volunteer groups re-plant these in wetlands across the area.

Habitats targeted were fens where tree and shrub encroachment were impacting the status of these habitats. By thinning scrub and removing trees to expose the fen they were able to restore condition. They also worked across several holdings spreading species-rich 'green hay' to re-introduce wet grassland species and increase diversity across these sites. The final element of their work was the creation of wet grassland mosaic habitats. This involved the creation of new scrapes within floodplains to increase the ability of these sites to hold water.

## **Derbyshire Wildlife Trust**

Derbyshire Wildlife Trust worked across several sites throughout the River Derwent catchment, ranging from Derby in the south up to the high Peak District. They worked across their own reserves within the catchment, and also with private landowners including the Chatsworth Estate, and focussed primarily on creating the infrastructure to enable grazing on these sites to commence and promote natural regeneration.

Two of their sites are on the edge of Derby, including Allestree Park, and so a significant element of the project was targeted towards community engagement. This had the twin benefits of attracting volunteers to undertake some of the work, and by engaging communities it has been possible to promote understanding and ownership locally.

First year delivery included a wide range of habitats, including broadleaved woodland, scrub and grassland mosaics and species-rich grassland. As the majority of these sites will be allowed to regenerate naturally, the target habitats are predicted.

Second year delivery again focussed on natural regeneration, with work taking place across four new sites within the catchment and focussing on floodplain wetland mosaic and species-rich grassland, as well as developing a pipeline of sites where woodland habitats can be created.

## **Gloucestershire Wildlife Trust**

Gloucestershire Wildlife Trust's LPP focussed on the Hasfield Estate on the escarpment above the River Severn floodplain. They worked closely with the owners of the estate, with the intention of restoring traditional landscapes by creating wood pasture linking existing woodland patches.

In the first year they created wood pasture, traditional orchards and species-rich grassland, but experienced challenges due to a prolonged period of dry weather soon after the first planting season. This resulted in some of the grassland having to be replanted, and an intensive watering regime to ensure freshly planted trees survived.

The second year of delivery continued this work, with further wood pasture, scrub and species-rich grassland creation taking place, along with hedgerow restoration on tenanted land on the Hasfield Estate.

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# Glossary

Term	Definition
Biodiversity	The collection of all living things on Earth
Biodiversity Net Gain (BNG)	A development approach that ensures new developments leave the natural environment in a measurably better state than before, requiring a 10% increase in biodiversity value compared to pre-development levels.
Biomass	The total mass of an organism or organisms in a given area.
Carbon codes	Standards and frameworks used to ensure the quality and reliability of carbon credits, which represent the reduction, removal, or avoidance of greenhouse gas emissions.
Carbon dioxide (CO <sub>2</sub> )	A greenhouse gas with a chemical compound comprising one carbon atom and two oxygen atoms.
Carbon sequestration	The rate at which carbon is captured and stored from the Earth's atmosphere.
Carbon stocks/carbon storage	The amount of carbon that is stored within a habitat, object or system.
Chronosequence	A series of sites similar in characteristic that vary in age, enabling an assessment of change through time.
Emissions	The production and discharge of a substance. In this report, emissions refer to carbon dioxide and/or methane.
Environmental Improvement Plan (EIP)	England's first revision of the 25 Year Environment Plan. Sets out how each goal will be delivered.
Environmental Land Management Schemes (ELMS)	Government programs that pay farmers and land managers to enhance the environment while continuing to produce food.

Term	Definition
Flux	The difference between the rate of emissions to the atmosphere and the amount taken up by ocean or land masses.
Greenhouse gas (GHG)	Gases in the Earth's atmosphere that trap heat and contribute to climate change. The primary greenhouse gases described in this report are carbon dioxide and methane.
Local Nature Recovery Strategies (LNRS)	Agreed priorities for nature recovery and proposed actions in locations where it would make a particular contribution.
Methane (CH <sub>4</sub> )	A greenhouse gas containing one carbon atom and four hydrogen atoms. Methane is at least twenty-eight times more potent than carbon dioxide.
Mycorrhizal fungi	Fungi which are associated with the roots of a host species, creating a relationship which benefits both, in a process called 'symbiosis'.
National Adaptation Programme	A five-yearly plan that sets out actions for government and others to take, as required by the Climate Change Act 2008.
Natural habitat	An ecosystem where its natural processes have not been significantly impacted by human activities
Nature-based solution (NbS)	Actions that address challenges in society through the protection, sustainable management and restoration of natural and modified ecosystems. These actions benefit people and nature simultaneously.
Nature Recovery Network (NRN)	A government-led initiative in England aimed at creating a single, national network of wildlife-rich places.
Net Zero	Net zero emissions are achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced

Term	Definition
	by anthropogenic removals over a specified period. The UK has committed to achieving net zero by 2050.
Shared Outcomes Fund (SOF)	A funding initiative set up by HM Treasury to incentivise cross-departmental collaboration to address challenging policy areas.

nature  
returns



HM Government



Environment Agency



Forestry Commission

Royal Botanic Gardens  
**Kew**



Derbyshire Wildlife Trust



Freshwater Habitats Trust



Gloucestershire Wildlife Trust



GROUNDWORK  
CHANGING PLACES  
CHANGING LIVES



National Trust



PLYMOUTH  
CITY COUNCIL

Working together to build the evidence for nature-based solutions to climate change and biodiversity loss