HM Government – Written evidence (NSD0042)

Submitted by Department for Environment, Food and Rural Affairs (DEFRA)

Introduction

The government welcomes the Committee's inquiry into Nature-based Solutions (NbS) and their role in tackling climate change. The government recognises the crucial role of NbS for climate change mitigation and adaptation and is already developing, supporting and implementing NbS domestically, for example by providing funding for woodland expansion and peatland restoration, and internationally through its International Climate Finance. The upcoming Net Zero Strategy will set out our plans for reducing emissions across the economy, including how we will use NbS to support decarbonisation.

NbS are defined by the International Union for the Conservation of Nature as 'actions to protect, sustainably manage, and improve and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits. For the purpose of this Inquiry, when referring to NbS for climate change, we are referring to actions which both reduce greenhouse gas (GHG) emissions and help us to adapt to the impacts of climate change, while providing wider societal benefits.

Nature is a core theme of our COP26 Presidency. There is no viable pathway to net zero emissions that does not involve protecting and restoring nature on an unprecedented scale. If we are serious about mitigating climate change, adapting to its impacts, and holding temperature rises to 1.5 degrees, we must change the way we use and look after our land and water, and the ecosystems and biodiversity upon which all life depends.

The COP26 Nature Campaign aims to drive forward two main areas of action:

1. Global action to protect and restore forests and critical ecosystems.
2. Global transition to sustainable agriculture and land use.

Achieving action in these two areas is dependent on increased mobilisations of public and private finance or nature and shifting existing flows towards 'nature positive' investments, with the understanding that nature is imperative for improving the quality of climate action and finance.

This is underpinned by enhanced political commitments on nature and NbS and the need for increased engagement and action from a wide range of actors and stakeholders.

1. **What is the potential scale of the contribution that nature-based solutions can make to decarbonisation in the UK?**

    a) **Which ecosystems are most relevant to the UK for nature-based solutions, and which have the largest potential to sequester carbon or reduce emissions?**

1.1 Nature-based solutions can play a key role domestically in responding to the threat of climate change, alongside ambitious action and mitigation in other sectors. Tree planting is a key contributor to nature-based carbon sequestration and the UK's woodlands currently sequester the net equivalent of 16 $MtCO_2e$/year (ca. 4% of the UK's gross emissions). Peatlands are the UK's largest category of terrestrial carbon store, but currently are net emitters of GHGs due to the degraded state of many of them. Restoration can reduce these emissions and may in the long-term turn peatland back into a net carbon sink.

1.2 Sustainable forest management sequesters carbon by growing biomass more rapidly on average than unmanaged forestry, providing timber that continues to store carbon while in use. This also reduces GHG emissions across other sectors (particularly construction) by replacing materials which have high emissions associated with production and remaining use of fossil fuels. Harvesting residues and purpose grown forest biomass can also provide a feedstock for bioenergy production, which may become important in generating negative emissions if bioenergy with carbon capture and storage is implemented at scale.

1.3 In addition to providing climate change mitigation, targeted woodland creation and tree planting can help both biodiversity and human society adapt to the effects of climate change, through:

i. Helping to provide flood resilience.
ii. Reducing the urban heat island and providing shade for recreation through urban and peri-urban planting.
iii. Reducing the impact of climate change on the freshwater environment particularly for species such as salmon that are vulnerable to an increase in water temperature, through riparian planting providing shade.
iv. New woodlands provide stepping stones and potential corridors for wildlife to adapt to the changing climate.

1.4 Defra is also exploring the potential for NbS beyond trees and peatland, including in soils generally, blue carbon habitats, including saltmarshes and other vegetation, such as hedgerows. This evidence gathering work will feed into our broader Net Zero policy proposals and priorities.

b) How much of the UK's 'hard-to-mitigate' emissions can be offset by NbS? How much of the UK's land and exclusive economic zone (EEZ) coastal areas would need to be managed to achieve this, and what level of investment would be required?

1.5 Nature-based solutions are important for compensating for GHG emissions in hard to fully decarbonise sectors, like transport[1]. While commercial offsetting of emissions may include the storage of carbon in ecosystems, it should not be an alternative to decarbonisation. It is also

[1] Decarbonising Transport: A Greener, Better Britain 2021. Department of Transport. Decarbonising Transport – A Better, Greener Britain (publishing.service.gov.uk)

important that carbon offsetting approaches[2] are selected which are suitable for local habitats and wildlife.

1.6 Defra is currently assessing the amount of land needed to achieve our net zero target, including using NbS, while delivering on wider environmental and economic outcomes. The work is spatially explicit and connects social, physical, economic and ecological evidence. This spatial prioritisation analysis will enable us to manage trade-offs, to achieve multifunctional land use and assess the amount of land required for our net zero and other targets, as well as the level of investment needed.

1.7 Woodland creation and peatland restoration have the strongest evidence base, are the most advanced carbon offsetting approaches in the UK and already have certification standards that enable them to be used for offsetting in the UK. A recent Environment Agency report found that woodland creation and upland peatland restoration have the highest national abatement potential of more than 10 $MtCO_2e$/yr carbon dioxide equivalent reduction/removal in the UK and lowland peatland restoration has a high national abatement potential of 5-10 $MtCO_2e$/yr.

1.8 There are important issues to be considered with regards to the need for productive forestry using fast growing species to provide long term significant carbon sinks and products of value to society and the need to address broader environmental challenges, such as biodiversity loss, with naturally regenerated mixed native woodlands. Native woodlands offer diverse benefits and may, for a given land area, eventually generate similar or greater average stocks of carbon, but will show slower rates of removals initially than commercial species and management and, in the long term, as the native trees mature, their carbon removal rate slows compared to a replanted plantation. It is important that when woodland creation is used as an NbS, opportunities to support wildlife recovery are taken and that productive woodlands are truly multi-functional, supporting environmental, social and economic objectives, as set out in the UK Forestry Standard.

1.9 Other ecosystems could sequester smaller amounts of carbon and at much slower rates, but Defra is actively exploring their potential (Annex 1a). The available evidence indicates that soils sequester approximately 1 $MtCO_2e$/yr although healthy soils deliver a range of ecosystems services and could unlock further emissions savings across agricultural systems in particular. The protection, restoration and sustainable management of certain coastal 'blue carbon' habitats, such as saltmarsh and seagrass, could provide cost-effective NbS with carbon sequestration benefits (Annex 1b), alongside benefits for biodiversity, climate adaptation and resilience. 38% of UK waters are in Marine Protected Areas, covering the majority of saltmarsh and seagrass habitats. Our focus is now on ensuring these are effectively protected.

[2] https://assets.publishing.service.gov.uk/media/60cc698cd3bf7f4bcb0efe02/Achieving_net_zero_-_a_review_of_the_evidence_behind_carbon_offsetting_-_report.pdf

In the UK, the coastal environment does not currently contribute to carbon accounting and reporting due to a lack of appropriate data, but we continue to build the evidence base to help inform this (for further information see Question 2). Removals occurring in the seas surrounding the UK are not included in UK carbon targets.

1.10 While there is uncertainty in the amounts that other ecosystems could store either in their vegetation and / or in their soil, their protection, management or restoration could contribute to climate mitigation whilst providing many other benefits for biodiversity and humans well-being.

1.11 Defra has also been exploring the potential in mineral soil, and is taking a natural capital approach to improving soil health by developing a range of actions that consider soil as part of an ecosystem, balancing the need for improved food production and protecting the environment. Encouraging the uptake of sustainable soil management practices for agriculture and other sustainable land uses that improve soil health will in turn underpin a range of environmental, economic and societal benefits, including, food production, biodiversity, carbon storage and flood mitigation.

c) How do the costs and benefits (including co-benefits), of implementing NbS compare to other techniques for offsetting 'hard-to-decarbonise' sectors?

1.12 Assessing the costs and benefits of NbS and their co-benefits is difficult, however we know they are likely to have a high return (see Annex 2 for some examples). Costs and benefits are closely dependent on the location and characteristics of the habitat, as well as on the details of site management. While, there is currently limited information on the costs of implementing and benefits from many NbS, with inconsistencies between what is included in and excluded from such assessments, many of the hard to monetise benefits (such as aesthetic or well-being benefits from nature) mean that NbS have even greater value than currently captured.

1.13 Decarbonisation must be a priority across all sectors, however, for those that are hard to decarbonise an EA review on carbon offsetting approaches found that woodland creation, upland peat management and planting trees and hedgerows outside of woodland all cost £100 or less per tCO_2e[3], based on the lifetime cost of reductions or removals. Avoided nature-loss and nature-based sequestration are more cost-effective than technology-based removal bioenergy with carbon capture and storage (BECCS) and direct air carbon capture and storage (DACCS)[4].

[3] Achieving Net Zero carbon emissions: a review of the evidence behind carbon offsetting - GOV.UK (www.gov.uk)

2. What major scientific uncertainties persist in understanding the effects of nature-based solutions and affect their inclusion in carbon accounting, and how can these uncertainties be addressed?

a) How reliable are the estimates of the quantity of greenhouse gas emissions reduction or sequestration by nature-based solutions, as well as the duration and reliability of storage?

2.1 There are a number of knowledge and evidence gaps that contribute to uncertainty about the effectiveness of NbS for climate mitigation and adaptation and their co-benefits. This is partly due to the site-specific nature of NbS, their management and their potential, leading to difficulties of extrapolating from an often-limited number of site studies to calculating wider effectiveness[4]. However, there is sufficient evidence to suggest they are often more cost-effective than more engineered alternatives, particularly when accounting for co-benefits. Specific uncertainties, many of which Defra is actively working to gather further evidence on, include:

i. Limited number of quantitative long-term emissions studies[5], especially for different types and conditions of peatland, some carbon-rich coastal and marine habitats, that means estimates of removals and their development through time is uncertain.
ii. Resilience of NbS to climate change. Climate change will impact directly and indirectly on ecosystems and will affect their ability to sequester carbon dioxide. For example, carbon fertilisation may speed tree growth, while warmer temperatures may increase other potential GHG emissions and methane from rewetted peat and carbon dioxide from soils.
iii. The permanence of woodland carbon stores, given risks of introduced pests and disease[6] and peatland carbon stores in a changing climate with less rainfall and longer dry periods, but more intense rainfall events.
iv. How sustainably produced timber will be used in the future, thus the scale/longevity of ongoing storage in harvested wood products and reduced emissions in other sectors through product substitution.
v. Effectiveness of adaptation actions for species and ecosystems.[7]
vi. Difficulty of capturing and verifying all the non-monetary benefits of NbS for climate change, especially those relating to human well-being (such as recreation and health benefits) and biodiversity.
vii. How to realise synergies between NbS for climate change and co-benefits and minimise trade-offs.[8,9,10]

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[4] Stafford et al., 2021. www.britishecologicalsociety.org/nature-basedsolutions

[5] Evans et al., 2017. https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1904111135_UK_peatland_GHG_emissions.pdf

[6] Coomes et al.,, 2021. In Stafford et al., 2021. www.britishecologicalsociety.org/nature-basedsolutions

[7] Berry, P. and Brown, I. (2021) National environment and assets. In: The Third UK Climate Change Risk Assessment Technical Report [Betts, R. A., Haward, A.B. and Pearson, K.V. (eds.)]. Prepared for the Climate Change Committee, London.

[8] Cambridge Econometrics (2020) Economic costs and benefits of NbS to mitigate climate change. Report for RSPB. https://www.camecon.com/wp-content/uploads/2021/03/The-economic-costs-benefits-of-nature-based-solutions_final-report_FINAL_V3.pdf

[9] Seddon, et al., 2020. Understanding the value and limits of NbS to climate change and other global challenges. Philosophical Transactions of the Royal Society B: Biological Sciences, 375(1794), 20190120

[10] Defra 2021 The effectiveness of NbS for climate change mitigation and adaptation in the UK

viii. Uncertainties in the effectiveness of NbS outcomes in different locations or ecosystems can be addressed by having a clear baseline and standardised measuring techniques and indicators, underpinned by appropriate long-term monitoring.[11] (see Question 6).

b) How reliable are the estimates of the quantity of greenhouse gas emissions reduction or sequestration by nature-based solutions, as well as the duration and reliability of storage?

2.2 Restored peatland takes decades to reach its full potential and many UK peatlands, having been degraded through historic management, are currently a source of emissions. Peatland restoration preserves the carbon stored in them, reducing emissions, and delivers the suite of ecosystem services associated with healthy peatlands. Woodlands and trees may take 40-50 years to reach their full sequestration potential, depending on the type of woodland established. They make a long-term contribution both to carbon storage and adaptation. Disturbances, such as wildfire, can affect both ecosystems, whilst pests and diseases might affect woodland stores and erosion the peatlands.

2.3 Estimation of removals and risks of reversal are based on historic measurements. Under a hotter, drier climate removal mechanisms may alter substantially. Traditional approaches to woodland management and selection of planting stock (species and seed origins) may no longer provide the level of removals expected, with difficult cultural discussions around selection of species and cultivars for future climates.

2.4 The accuracy of estimates of the quantity of GHG emissions reduction or sequestration by NbS will depend on:

i. The spatial scale of interest. Certainty is improved where projects across the country are considered instead of with individual projects.
ii. The timescale of assessment. Certainty is improved where assessments are made over the course of a carbon budget period rather than a given year because changes in carbon stocks are impacted by the interannual variability in weather conditions and other natural disturbances. Even at a national scale and averaged over a number of years (conditions where uncertainties are expected to be the lowest) impact uncertainties are still likely to be of the order of at least a few tens of percent. Storage of carbon in natural ecosystems is subject to reversal, both as a result of future changes in climate, land management and natural disturbances, such as plant disease, flooding or fires.
iii. Estimates of GHG emissions reduction or sequestration can be improved by measurements based on repeated assessments of fluxes, not stocks.
iv. The carbon stock(s) affected by the specific NbS. It is easier to track changes in above ground biomass than in soil carbon stocks, as changes are much smaller in relative terms in the latter.
v. Current carbon budget accounting and the current GHG inventory could include NbS, such as salt marsh restoration, as additional opportunities to

[11] Seddon, et al., 2020. Understanding the value and limits of NbS to climate change and other global challenges. Philosophical Transactions of the Royal Society B: Biological Sciences, 375(1794), 20190120

store carbon. Additionally, the developing evidence base of some of these NbS project types under UK conditions could assist in their inclusion.

c) Which bodies should be involved in establishing an agreed evidence base to inform best-practice techniques for restoring peatlands?

2.5 Bodies should include: Defra, Natural England, Joint Nature Conservation Committee, Devolved Administrations, NERC and BBSRC institutes such as the Centre for Ecology and Hydrology, International Union for Conservation of Nature, Peatland Partnerships, Historic England, Environment Agency, Forest Research, Forestry Commission and Forestry England.

d) To what extent do we understand the capacity of the oceans and coastal ecosystems to sequester greenhouse gases through NbS?

2.6 Certain marine and coastal habitats, such as saltmarsh, seagrass and mangroves, can capture CO_2 as organic carbon and store it in their biomass and surrounding sediments. These "blue carbon" habitats are particularly important through the long-term removal of carbon, with secure storage on decadal to century timescales[12]. Their protection, restoration and sustainable management could provide a cost-effective NbS. However, we do not yet have sufficient data to accurately quantify the baseline and potential contribution of coastal habitats to emissions reductions in the UK. We continue to build the evidence base on blue carbon habitats to help inform future, robust GHG reporting and accounting.

2.7 Based on recent data, the potential contribution of saltmarsh and seagrass to annual UK emissions reductions is estimated to be modest due to their small area: carbon sequestration from UK saltmarsh is estimated to be around 0.24 Mt CO2/yr, and seagrass 0.022 Mt CO2/yr[13]. Whilst saltmarsh restoration has been shown to achieve relatively high rates of GHG removals per unit area, the challenges of coastal squeeze and sea level rise could affect the permanence of this habitat. Seagrass restoration sequestration rates vary, however overall suggest a net removal. We have good evidence that restoration of coastal habitats can provide a wide variety of other benefits alongside carbon storage, the value of which can be considered when deciding on which NbS to employ in any area

2.8 For marine sediments, additional carbon emissions reductions through management is uncertain and the level of savings will depend on highly localised properties and processes, as well as related trade-offs if activity is displaced.

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[12] IPCC, 2019

[13] Ruth Parker, Lisa Benson, Carolyn Graves, Silke Kröger, Rui Vieira (2020) Carbon stocks and accumulation analysis for Secretary of State (SoS) region, Cefas Report for Defra project ME5439, (http://randd.defra.gov.uk/Document.aspx?Document=15118_Blue_Carbon_Stocks_Fluxes_FINALREPORTv6.pdf). Please note that the sequestration rates do not represent "net" carbon fluxes – i.e, these are accumulation rates of Particulate Organic Carbon.

3. What frameworks already exist for the regulation and financing of NbS?

3.1 The application of NbS is regulated through a range of domestic legislation and regulatory codes:

i. For woodland creation as a NbS the Woodland Carbon Code (WCC) provides a voluntary UK-domestic standard for woodland carbon projects (limited to woodland creation). This builds on the robust regulatory framework for forestry, such as the UK Forestry Standard and includes Environmental Impact Assessment (EIA) screening or notification applying to all projects of more than 2 hectares across England. These forestry regulations also apply to woodland removal which ensures NbS are managed in the correct way mandating a felling licence be issued by the Forestry Commission before trees can be removed as part of the sustainable forest management cycle. Permanent removal (i.e. deforestation) is regulated through Environmental Impact Assessment and consent is only likely to be agreed to meet biodiversity objectives (I.e. open habitat restoration).

ii. There are also a range of marine regulations and decision-making processes, alongside wider policy, which protect and enhance NbS across the marine environment including marine licencing and marine planning and management measures, for example Marine Protected Areas.

iii. The Peatland Code regulates peatland restoration as a NbS in the UK.

iv. Section 1 of the Agriculture Act 2020 sets out purposes for which Ministers can give financial assistance to landowners and land managers for the implementation of NbS. These include a range of environmental objectives and programmes to improve the productivity of agricultural activities.

3.2 There are a range of dedicated public funding streams for NbS across various sectors, including:

i. Of the £640 million of the Nature for Climate Fund, we intend to commit over £500 million to support tree planting and woodland creation through a number of delivery mechanisms, including the recently launched England Woodland Creation Offer, the Community Forests programme, funding for the Northern Forest and new Woodland Creation Partnerships in Northumberland and Cornwall.

ii. Peatland restoration is being funded through the Nature for Climate Peatland Grant Scheme promoting restoration at a landscape scale through multi-objective projects

iii. The £80 million Green Recovery Challenge fund is designed to help environmental organisations start work now on projects across England to restore nature and tackle climate change, including NbS projects for trees, peat, soil and marine.

iv. Defra recently announced 27 new schemes which will benefit from the new £10 million Natural Environment Investment Readiness Fund, which includes a number of successful projects in both the terrestrial and marine environment.

v. The Environment Agency has spent £20 million of flood and coastal erosion funding since 2015 (in addition to the dedicated £15m natural flood management pilot programme) on natural flood management elements of wider flood defence schemes. There will be future funding for natural flood

management in the £5.2bn flood and coast programme running from 2021-27. The Government Policy Statement on Flooding and Coastal Erosion commits to double the number of government funded projects which include nature-based solutions to reduce flood risk.

vi. A key new stream will be the three new Environmental Land Management schemes: the Sustainable Farming Incentive, Local Nature Recovery, and Landscape Recovery. Environmental Land Management will pay farmers for delivering public goods, with more choice and control for farmers, and a greater focus on outcomes and the main practices and interventions that support them. The Sustainable Farming Incentive will be open and accessible to all farmers, to achieve important environmental outcomes across the whole countryside. Local Nature Recovery will pay for actions that deliver local environmental priorities and Landscape Recovery will support the delivery of landscape and ecosystem recovery through long-term, large-scale change projects.

3.3 We recognise that public funding alone will not be sufficient to deliver investment at the scale required to meet our ambitious goals for Net Zero and nature recovery. In the Green Finance Strategy, government called on the private sector to mobilise expertise and capital to deliver green investment at the requisite scale. Government has a key enabling role, not least in setting clear investment signals, including through stable, long term statutory targets and goals. We are also committed to building the policy frameworks to enable and incentivise investment in the technologies, sectors and activities that need to grow. Government can also support through carefully targeted public funds and other measures to stimulate innovation, capacity building and project pipelines, to stimulate and accelerate the development of new markets. Current activities include:

i. Developing a roadmap for scaling up high integrity markets that deliver investment for climate, nature and people. We have called for a multi-sector coalition, drawing on expertise from across the environment, land use, business, finance sectors to develop an initial blueprint, through the Financing UK Nature Recovery initiative. We look forward to hearing their ideas in the autumn 2021.

ii. Taking account of the international experience and the development of clear rules for participation in voluntary carbon markets, including the work of the Voluntary Carbon Markets Integrity initiative, which is supported by the UK COP26 Presidency.

iii. Building the nature-based project pipeline through our Green Recovery Challenge Fund, Natural Environment Investment Readiness Fund (NEIRF) and Big Nature Impact Fund. The NEIRF and Impact Fund will test new models of investible nature projects by providing technical assistance and capacity-building support and provide a return on investment by capturing the value of carbon, water quality, biodiversity and other benefits provided by natural assets.

iii. Supporting the development of project pipelines including through the Woodland Carbon Guarantee, which provides up to £50m and helps accelerate woodland planting and scale up the domestic carbon market for woodland carbon sequestration and storage through the Woodland Carbon Code. Options to extend the scheme to help reduce carbon emissions

through peatland restoration are being explored, as outlined in the England Peat Action Plan.

a) What can be learned from the implementation of the Woodland and Peatland Codes for the regulation and financing of NbS?

3.4 The WCC and Peatland Code are the most mature standards in the UK for supporting the development of carbon markets for NbS, with both Codes sharing a project and carbon registry via the UK Land Carbon Registry. The WCC is the quality assurance standard for woodland creation projects in the UK and generates independently verified carbon units. It is internationally recognised for high standards of sustainable forest management and carbon management and is endorsed by the International Carbon Reduction and Offset Alliance, the global umbrella body for carbon reduction and offset providers in the voluntary market. The WCC took two years to develop and was initially piloted in 2011. It has recently reached the landmark of having 1,000 registered projects. In developing the Code, the following key points have become apparent:

i. Investors and project developers value the status of having been developed by and continuing to be administered by Government.
ii. Some project developers see the robust framework (Project Design Document including additionality requirements, third-party project validation and verification and carbon registry) as a barrier to engaging with the Code.
iii. Investors value the robust framework associated with the Code, which has gained it an international reputation as a high-quality carbon standard.
iv. Investors value 'charismatic carbon', specifically the wider benefits (or ecosystem services) of WCC projects and a robust, quantitative framework for quantifying those benefits would enhance market value.
v. The prices paid to landowners were typically low, leading to relatively low project registration numbers, particularly in England. The introduction of the Woodland Carbon Guarantee changed this, demonstrating the value of Government intervention in supporting the development of nascent markets.
vi. Recent stakeholder engagement sessions have showed that the WCC is accessible and industry would welcome similar approaches to 'new' nature-based carbon markets.

3.5 As a certification standard, the Peatland Code provides assurances for carbon market buyers. Though the Peatland Code exists it can be difficult to prevent similar mechanisms marketing carbon benefits, which aren't as robust and regulated coming to market. Making the Peatland Code as attractive as possible to buyers and sellers contributes to ensuring buyers come to the right place and Defra has been investing in a number of updates to the Code.

3.6 The process of implementing the Peatland Code identified options for future progression which Defra outlined in the England Peat Action Plan and are reflected in future plans. For example, the recent Crichton Carbon report on the Peatland Code implementation for Snowdonia National Park outlined a

number of areas for improvement such as, improving awareness and education by producing more targeted communications particularly aimed at land managers and owners, providing greater flexibility over timescales in order to allow for better integration with agri-environment schemes.

3.7 Learning from both the Woodland Carbon Code and Peatland Code will be key for informing the potential development of Codes for other habitats, including those proposed for prototyping and testing under the Natural Environment Investment Readiness Fund.

b) Are there good examples of NbS already being undertaken in the UK or elsewhere, and what can we learn from them?

3.8 A host of exemplary examples of NbS in practice can be found on the programme and fund websites described below with details on impacts, insights and lessons learned.

i. Across the UK, there are over 300 projects that have been validated under the WCC. These projects cover over 15,000 hectares and will sequester almost 6 $MtCO_2$. There are a range of case studies on the WCC website.
ii. The Peatland Code Projects and IUCN UK Peatland Programme sites include a range of examples of NbS projects in practice.
iii. Projects awarded under the Green Recovery Challenge Fund and Natural Environment Investment Readiness Fund include:
    - Green Recovery Challenge Fund first round decisions, December 2020
    - Green Recovery Challenge Fund second round decisions, July 2021
    - Innovative nature projects awarded funding to drive private investment.
iv. The Environment Agency's Restoring Meadow, Marsh and Reef (ReMeMaRe) initiative is working to restore our estuarine and coastal habitats to benefit people and nature.
v. Natural England are also leading the LIFE Recreation ReMEDIES project, which aims to restore seagrass and habitat in five Special Areas of Conservation.

3.9 The Environment Agency has undertaken collaborative projects with the US army corps of engineers and the Rijkswaterstaat national organisation in the Netherlands to write international natural and NbS guidelines which are to be published in September 2021. Working with these same partners Defra have developed two 'Engineering with nature atlases', which showcase examples of NBS globally[14][15].

3.10 Earlier this year, the government announced 25 local places that will benefit from the £200m Flood and Coastal Resilience Innovation Programme. This programme will provide £150m, for six years, to trial a wide range of different innovative actions that improve their resilience to flooding and coastal erosion, including NbS.

[14] EWN | NNBF (dren.mil)
[15] EWN | An Atlas (dren.mil)

3.11 The Government's £15 million natural flood management programme[16], dedicated to natural flood management measures across England, has helped further develop the evidence base around working with natural process to reduce flood risk. Information on the approach and evaluation of these projects can be found here.

c) How should a hybrid public-private financing model be regulated? How should any carbon offsetting markets be regulated to ensure that they prioritise and support well-designed and effective NbS?

3.12 An approach is needed that supports the private investment required to meet our environmental ambitions whilst ensuring integrity in delivering against our climate commitments. There will be respective roles for the public and private sectors here. Defra is engaged with industry leaders from business, finance, land management and environment sectors through the Financing UK Nature Recovery coalition to understand how to scale up effective markets in environmental services, including how to ensure these markets have environmental and financial integrity.

3.13 The government will consider the coalition's recommendations report in autumn 2021, alongside work underway by the Taskforce for Scaling Voluntary Carbon Markets and the Voluntary Carbon Markets Integrity initiative to inform requirements for ensuring quality and integrity for nature-based carbon crediting schemes.

3.14 We are clear that our work to meet our climate targets should also support our ambitions to meet our other environmental targets as much as possible, such as our new landmark target to halt the decline in nature by 2030. Regulation can be an important tool to enable this and reduce the impact of any potential trade-offs.

d) How can we ensure that the carbon accountancy is science-based, robust, and consistent across NbS?

3.15 Effective and consistent carbon accounting will be necessary to ensure that organisations can incorporate NbS initiatives within their science-based targets, as one means of addressing their residual emissions. Recognising the scientific uncertainties outlined, there are a number of steps that need to be taken and work is underway to develop these. These include the following elements, many of which are being considered as part of our work on accelerating environmental markets:

i. Continuing to build the evidence base, such as on calculating the carbon savings or storage potential of various nature-based approaches.
ii. Supporting the development of robust and cost-effective data collection and monitoring, reporting and verification (MRV) processes for nature-based initiatives.
iii. Ongoing development and strengthening of standards and codes for various NbS, ensuring consistency in quality assurance.

[16] Use nature-based solutions to reduce flooding in your area - GOV.UK (www.gov.uk)

iv. Applying robust technical solutions to issues such as additionality and permanence across various nature-based approaches.
v. Ensuring required inventories or registries are in place to effectively record and track carbon units.

3.16 As outlined above, the WCC is an excellent example of an internationally accredited, robust approach to carbon accountancy for nature-based approaches which will be drawn from in the development of ongoing policies. For example, recognising potential future reversals arising from loss of trees to fire, pests or disease, the WCC builds in a conservative accounting principle or 'buffer' and requirements to replace during the lifetime of the agreement. As outlined above, we will continue to explore options to ensure environmental and accounting integrity.

4. Who are the key stakeholders for the implementation of NbS in the UK? How can stakeholders' expertise and concerns inform the incentives and requirements for implementing NbS?

4.1 UK landowners, land managers, independent and government bodies and NGOs across the UK are vital to the shaping of and implementation of NbS across the country. There are many ways Defra ensures stakeholder's expertise and concerns inform the incentives and requirements set for implementing NbS. These include joint programmes and initiatives, advisory groups and testing new policies with stakeholders as part of policy development.

4.2 To inform NbS policy in the peat sector, Defra works closely with a range of stakeholders including Natural England (NE), the EA, regional Peatland partnerships, Green Finance institutions to fund peat projects, landowners, land managers and NGOs including the Wildlife Trust and RSPB.

4.3 Defra draws on the expertise of partners to inform projects. For example, Defra commissioned a consortium led by Newcastle University to conduct social research into the implementation of the England Peat Action Plan which ensured maximum impact of the plan[17].Defra has also formed a Lowland Agricultural Peat Task Force, a consortium of landowners, NGOs, land managers and charities which are providing recommendations on how to shape policy to responsibly manage our lowland farmed peat soils whilst maintaining productivity.

4.4 In the forestry sector, Defra draws on expertise from NGOs including the Forest Canopy Foundation and Forestry and Environmental Land Partnerships to inform not only the requirements for implementation, but also to ensure the effective delivery of interventions and the ongoing maintenance/management needed to secure the benefits. The WCC also embeds stakeholders in its ongoing development through the WCC Advisory Board supporting its Executive Board.

[17] https://eprints.ncl.ac.uk/file_store/production/268895/628AA5ED-5ACC-4B59-AFD9-D1488C9C63BE.pdf

4.5 Defra also draws from a wide range of stakeholders to shape, inform and implement NbS for flood risk management including: landowners and land managers, Internal Drainage Boards, Local Authorities, water companies and NGO's, such as the Wildlife Trust, Rivers Trusts and the National Trust. Defra recently completed research[18] looking at the enablers and barriers to the delivery of natural flood management projects, the report sets out the wide range of stakeholders involved in the delivery of NFM. These findings are now informing the Government's approach to NbS for flood and coastal erosion risk management.

a) How can farmers (including tenant farmers) and land managers be supported in their deployment of NbS by policy and legislative frameworks?

4.6 Section 1 of the Agriculture Act 2020 provides Ministers with powers to provide financial assistance for a range of environmental improvements to incentivise and help farmers, landowners and tenant farmers deploy NbS across their practices and land.

4.7 As set out in 3.2 part vi, agricultural policy will be set out in the three new Environmental Land Management schemes. These schemes will be fully introduced by 2024, starting with the rollout of the Sustainable Farming Incentive in 2022. We will maintain current average levels of investment in farming of £2.4 billion per year in England over the life of this Parliament. All funding released from reductions in Direct Payments will be re-invested into delivering new schemes, primarily schemes that provide environmental and climate outcomes.

4.8 As detailed in the Agricultural Transition Plan update[19] published in June 2021, over this Parliament, we envisage spending 30% of the funding released for environment, climate and animal health and welfare outcomes on farm-level actions such as the Sustainable Farming Incentive. The remainder will be spent on locally tailored initiatives (such as through Local Nature Recovery and Countryside Stewardship) and landscape-scale interventions (such as Landscape Recovery and Nature for Climate projects). By 2028, we currently expect spending to be evenly split across farm-level, locally tailored, and landscape-scale investment. We will keep these allocations under review as we progress through the transition and learn more about the demand for and outcomes and value for money from each scheme.

4.9 We want our new schemes to enable farmers and land managers to combine revenue from both public and private sector funding, wherever this can unlock a wider range of benefits, or lead to better overall environmental outcomes. To support this, as well as providing government schemes, we are developing and promoting private markets for high-quality ecosystems and the services they provide (See 3.3 above).

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[18] Factors enabling or preventing natural flood management projects - GOV.UK (www.gov.uk)

[19] Agricultural Transition Plan: June 2021 progress update - GOV.UK (www.gov.uk)

b) Are there examples of projects which have engaged with stakeholders and local communities to implement NbS successfully, and what can we learn from them?

4.10 As set out above Defra undertakes a wide range of projects alongside stakeholders both in shaping and delivering policies. For example, there are case studies for over fifty projects Defra delivered with stakeholders as part NbS for Natural Flood Management.[20]

4.11 The Nature for Climate Fund resources the community forests and the New Woodland Creation Partnership projects based around NbS. The community forests are locally led projects that focus on supporting urban and peri-urban regeneration in some of the most deprived areas, delivering multiple social, economic and environmental outcomes. In addition, the Northumberland and Cornwall Local Authorities under the New Woodland Creation Partnership projects have a specific focus to develop locally backed, natural capital approaches to tree planting, leveraging private finance and delivering the right trees, in the right places, for the right reasons, as well as to develop innovative new market mechanisms for NbS.

4.12 The EA's Restoring Meadow, Marsh and Reef (ReMeMaRe) initiative works to restore our estuarine and coastal habitats to benefit people and nature. It works collaboratively with partners and is supported by a Partnership Group, made up of a variety of environmental organisations, all of which have an interest in leading and delivering the restoration of England's estuaries and coasts. The initiative has highlighted that by working collaboratively with partners, we can achieve far more for people and wildlife.

5. How should implementation of NbS be integrated with other government policies for landscapes and seascapes, for example, agricultural, forestry, and land-use planning policies?

5.1 The 25 Year Environment Plan sets out how we will improve the environment over a generation. It enables us to mainstream NbS across government policies for landscapes and seascapes. Government is actively using NbS in the fight against climate change and integrating them across our sectors. For example, we have aligned our England Trees Action Plan with the England Peat Action Plan to deliver a joined up approach to land use and management. The £640 million Nature for Climate Fund will support the delivery of these Plans to maximise the potential of trees and peat as NbS.

5.2 Under the Local Nature Recovery Strategies (LNRS), the new system of spatial strategies for nature, opportunities for habitat creation and improvement will consider the potential for NbS, to support the delivery of a broad range of policies, including biodiversity net gain, local planning processes, and future schemes that reward environmental land management.

5.3 The National Planning Policy Framework sets out that planning policies and decisions should contribute to and enhance the natural and local environment

[20] Working with natural processes to reduce flood risk - GOV.UK (www.gov.uk)

by recognising the benefits from natural capital, including those from the best and most versatile agricultural land.

5.4 The use of marine NbS also plays a crucial role in the protection, restoration and management of the UK's marine environment. Through our comprehensive network of Marine Protected Areas and their management approaches we are already using nature to deliver improvements in our seas. In addition, the UK Marine Strategy[21] is vital in achieving the Government's vision for 'clean, healthy, safe, productive and biologically diverse ocean and seas' and our climate change objectives. This provides the framework for monitoring, assessing and taking measures to achieve and maintain Good Environmental Status (GES) in our seas. Effectively managing the pressures on the marine environment to deliver GES can in turn support the capacity of marine ecosystems to adapt and build resilience in response to a changing climate.

a) How could solutions implementation contribute to the UK's goals surrounding biodiversity, the preservation of nature, and adaptation to climate change?

5.5 With limited land available in the UK for NbS it is critical to seek approaches that deliver the best solutions for nature and achieve a wider range of policy ambitions. Defra are applying this strategy across all sectors. For example, the Environment Agency (EA) use NbS as part of flood schemes which are shaped to deliver co-benefits, including habitat creation and carbon offsetting.

5.6 Restoring our natural habitats will help communities to adapt to climate change risks, for example, through natural flood management or urban cooling, as well as helping to support the resilience of ecosystems to climate change. Improving the condition and diversity within, and connectivity between, our wildlife habitats will help species survive in their existing locations and allow them to move towards more suitable climates where necessary.

5.7 The second National Adaptation Programme (NAP) sets out how we will address climate risks in England from 2018 to 2023. This also includes a dedicated chapter on the natural environment and seeks to address risks set out in the second Climate Change Risk Assessment published in 2017. This includes risks to natural capital including terrestrial, coastal, marine and freshwater ecosystems, soils and biodiversity, and flooding and coastal change risks to communities, businesses and infrastructure. NbS offer an important role in tackling some of these risks. The third CCRA Independent Assessment launched on 16 June 2021 by the Climate Change Committee (CCC) highlights the growing risks to the UK from climate change, as well as opportunities[22]. This evidence, alongside the CCC's statutory advice, will inform the third CCRA Government Report due in early 2022. Together, these

[21] https://moat.cefas.co.uk/introduction-to-uk-marine-strategy/

[22] Independent Assessment of UK Climate Risk - Climate Change Committee (theccc.org.uk)

will inform an ambitious third NAP, which will lay out further Government ambitions to mobilise and implement NbS.

5.8 Additionally, the England Tree and Peat action plans recognise woodlands and peatlands as two of the largest natural climate regulating ecosystem types which the Government's climate change and biodiversity obligations require to be sustainably managed. Much of the remaining peatland resource in England is on protected sites, and therefore restoring the hydrology to protect carbon stores is also an essential step in bringing such sites to a favourable condition and providing habitats for rare species. Appropriately located, these ecosystems can also buffer and connect existing wildlife sites, increasing the adaptive capacity of our landscapes, as well as contributing to wider societal objectives, such as water quality improvement or increased resilience to flooding. That is why the government is introducing Local Nature Recovery Strategies to help local people and organisations target protection and investment in nature.[23]

5.9 The Environment Bill will also play a key role in achieving the biodiversity goals for England in the Government's 25 YEP. The Bill requires a new, historic legally binding target to be set to halt the decline in species abundance by 2030. Habitat loss and fragmentation is consistently identified as a major driver of species loss, both globally and at home. It is for this reason that the 25 YEP commits to restoring or creating 500,000 hectares of wildlife rich habitat, and to improving the condition of existing habitats on protected sites. Furthermore, in September 2020 the Prime Minister committed to protecting 30% of our land and sea by 2030 to support the recovery of nature. NbS that involve the restoration or creation of ecosystems, and the habitats they support, therefore offer significant co-benefits for biodiversity.

5.10 The UK also has domestic legislative obligations, for example, under the Conservation of Habitats and Species Regulations 2017, to bring a range of habitats into favourable status. Not all habitat management or restoration will provide significant carbon benefits (upland and lowland heathland for example), although they will provide other benefits for people, such as recreation and amenity. Biodiversity policy, therefore, requires complementary investment in ecosystems elsewhere.

b) Which ongoing governmental plans, policies, and strategies are relevant to NbS, and can they be better coordinated? For example, are the Nature for Climate Fund and associated targets for peatland and forestry restoration designed so as to support NbS?

5.11 Government recognises the need to ensure all plans, policies and implementation contributing towards restoring habitats and promoting NbS are well-coordinated and integrate adaptation from conception.

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[23] Vanbergen, A.J , Heard M , Breeze T , Potts S G and Hanley N. 2014. Status and Value of Pollinators. Research report for Defra; IPBES. 2019. Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Brondízio, E. S., Settele, J., Díaz, S., Ngo, H. T. (eds). IPBES secretariat, Bonn, Germany. 1144 pages. ISBN: 978-3-947851-20-1

5.12 The England Tree Action Plan, published in May 2021, publicly committed to at least treble tree planting rates in England by the end of this Parliament, with an intention to spend over £500m to deliver the goal. The commitment of the England Trees Action Plan to improve the condition and increase the extent of woodland habitats, such as protected sites and irreplaceable ancient woodlands offers opportunities for NbS, such as building their resilience to climate change and to pests and diseases, as well as developing the tools needed to ensure the environmental benefits gained through woodland management are secured for future generations. The new England Woodland Creation Offer will also target new woodland to maximise their potential as NbS through a system of additional contributions for woodlands that provide important habitat, riparian buffers for water quality and flood risk mitigation and landscape benefits.

5.13 Through the England Trees Action Plan we commit that our trees and woodlands will form a core part of the Nature Recovery Network, by providing important habitats themselves, as well as connecting other wildlife rich habitats. Establishing new native woodland has made the greatest contribution to the increase in priority habitats in recent years, and we will continue to improve the condition and increase the extent of our most precious woodland habitats, such as protected sites and irreplaceable ancient woodlands. This will contribute to the global goals to be agreed at the Convention on Biological Diversity in 2021.

5.14 The England Peat Action Plan has been developed to support peatland restoration as a NbS, with strong links to trees policy and the Forestry Commission. For example, across both the Tree and Peat Action Plans, there is a commitment to develop UK Forestry Standard Practice Guidance to minimise damage to peaty soils. Peatland restoration is currently being delivered through the Nature for Climate Peatland Grant Scheme (2021-2025). The scheme design promotes restoration at a landscape scale through multi-objective projects, contributing to the aims of the Nature Recovery Network, 30x30 and net zero. From 2025, we expect restoration to be delivered through the Sustainable Farming Incentive, Local Nature Recovery and Landscape Recovery schemes. The Lowland Agricultural Peat Task Force will develop recommendations for the responsible use of peat soils by summer 2022, exploring necessary changes to landscape-scale water management and innovative approaches, such as paludiculture.

5.15 The government's policy statement on flooding and coastal erosion risk management sets out our approach to natural food management. The Environment Agency's flood risk strategy gives further detail on how this will be delivered. They are clear that we will continue to strengthen links and ensure natural flood risk management can do more to deliver multiple benefits for carbon, nature, water quality and more.

5.16 The 25 Year Environment Plan commits the government to improving the condition of our protected sites and to creating or restoring 500,000 hectares of wildlife-rich habitat in England, as part of a Nature Recovery Network.

5.17 Last year the government announced further funding for nature. Our Nature for Climate Fund will provide significant funding for the creation, restoration and management of woodland and peatland habitats. Government's Green Recovery Challenge Fund, which has recently been doubled to a total of £80 million, will kick-start a pipeline of nature-based projects to restore nature, tackle climate change and connect people with the natural environment.

5.18 Healthy soils should be a priority outcome for our new environmental land management schemes in England, and to help achieve our commitment to sustainably managed soils by 2030, we are already taking action to support land managers and farmers to achieve sustainable soil management. Firstly, we are focusing on soil in two of the first standards to be rolled out under the Sustainable Farming Incentive scheme next year – the Improved Grassland Soils and Arable and Horticultural Soils standards. Recently published details on the Sustainable Farming Incentive set out what sustainable farming actions farmers will be rewarded for to improve soil health, such as the introduction of herbal leys and the use of grass-legume mixtures and cover crops

5.19 Furthermore, as part of our environmental land management schemes, over the next four years we will establish at least 10 Landscape Recovery projects to help us restore wilder landscapes, with a focus on large-scale sites. The government's guidance on Catchment Sensitive Farming already provides advice and incentives for NbS to reduce water and air pollution,[24] and this approach is critical to the government's agricultural transition plan.[25] Our farmers and land managers will play a crucial role in the national effort to reach Net Zero and our policies will help them do that. Our new environmental land management schemes will help deliver on Net Zero and our schemes will also make a significant contribution to the goals of the 25 Year Environment Plan.

c) Should incentives for NbS be included in future Agri-environment schemes, and if so, how?

5.20 Maintaining and enhancing the natural environment is essential to future farming policy. The UK is moving away from the Common Agricultural Policy and towards a system which will pay farmers to improve the environment and reduce carbon emissions which will include a range of NbS. The heart of future agricultural policy will be the three components of Environmental Land Management, the details of which have been set out in 3.2 vi. Overall, these schemes will include incentives for actions with a strong focus reducing GHG emissions, expanding our carbon sequestration potential across the English landscape, and be crucial in tackling climate change.

5.21 New schemes are designed to enable farmers and land managers to combine revenue from both public and private sector funding, wherever this

[24] https://www.gov.uk/guidance/catchment-sensitive-farming-reduce-agricultural-water-pollution
[25] https://www.gov.uk/government/publications/agricultural-transition-plan-2021-to-2024

can unlock a wider range of benefits, or lead to better overall environmental outcomes.

6. How should nature-based solutions be planned and monitored at the national level?

6.1 To increase confidence in the evidence on NbS we need high quality baseline data before measures are installed, followed by a commitment to long-term monitoring to demonstrate the benefits. This requirement can draw data from some existing schemes, such as those that assess habitat quality, such as Natural England's Priority Habitats Inventory (PHI), which also contains data from other field surveys and Natural England's designated sites database.

6.2 Defra has also been piloting the Natural Capital Ecosystem Assessment (NCEA), a new approach to monitoring that will – for the first time – give a whole systems view of the environment, providing much higher resolution data, more frequently and more consistently. NCEA will be an essential tool in understanding NbS effectiveness. We also continue to invest in novel technologies, such as artificial intelligence and machine learning technologies, to improve our overall understanding of changes in land use and quality.

a) What measuring reporting, and verification requirements should be put in place to determine the degree of success of nature-based solutions? Which techniques and technologies are best suited to accomplishing robust monitoring?

6.3 The UK already has measuring, reporting and verification requirements to determine the degree of success of some aspects of NbS, for example, the 25 YEP[26], Peatland Code assessment methods[27]However, we need to ensure monitoring continues over the long-term in order to demonstrate the full effectiveness and multiple benefits of NbS and learn how to maximise synergies and manage trade-offs.

6.4 Consistent techniques and technologies for measuring, monitoring and verification are required to enable comparison between NbS outcomes. So, investment is needed to assess what are appropriate measures and indicators[28] , identify the gaps and collect long-term monitoring data.This should include aspects of NbS that are less frequently measured (e.g. sociological), often due to the difficulty in establishing robust measures and those associated with adaptive capacity which are less well understood[29].

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[27] Evans et al. 2017 https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1904111135_UK_peatland_GHG_emissions.pdf

[28] Raymond, et al., 2017. An Impact Evaluation Framework to Support Planning and Evaluation of NbS Projects. Report Prepared by the EKLIPSE Expert Working Group on NbS to Promote Climate Resilience in Urban Areas. Centre for Ecology & Hydrology, Wallington, United Kingdom. https://www.eklipse-mechanism.eu/apps/Eklipse_data/website/EKLIPSE_Report1-NBS_FINAL_Complete-08022017_LowRes_4Web.pdf

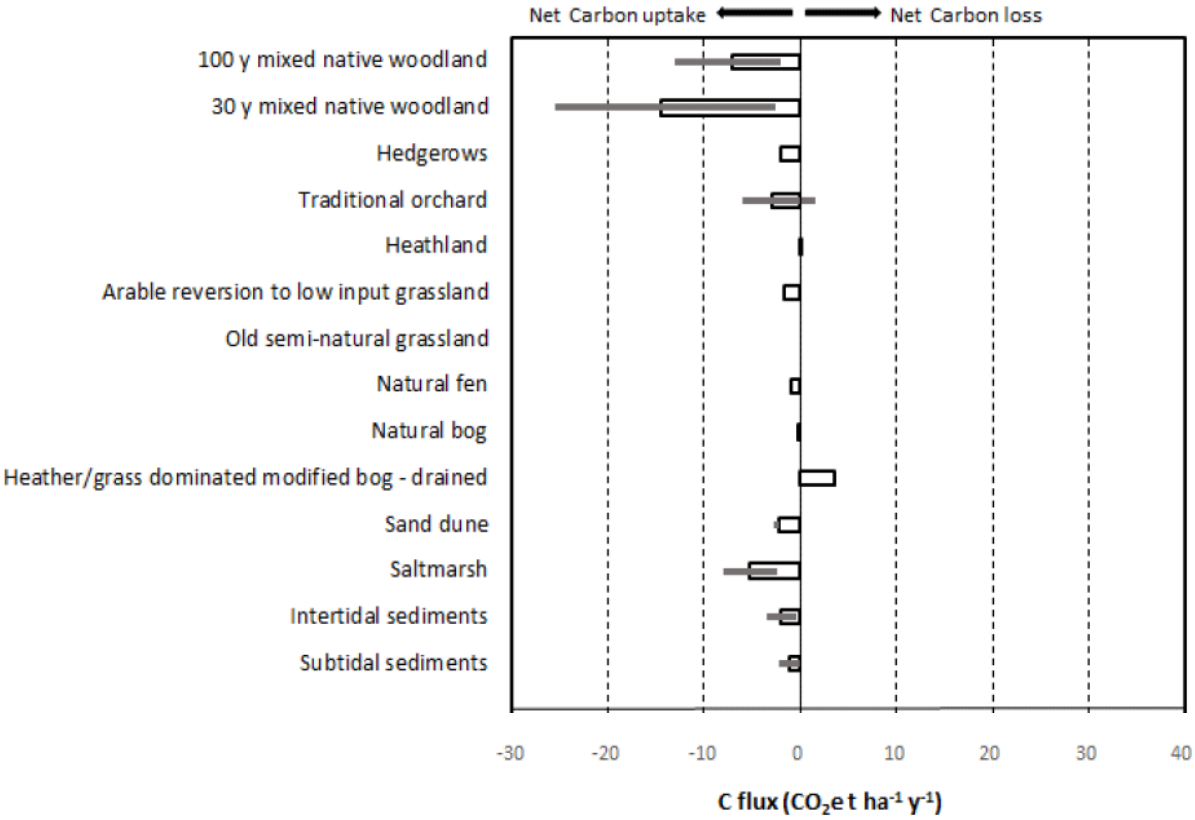
[29] Seddon, et al., (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. Philos. Trans. R. Soc. B Biol. Sci., 375

6.5 Climate adaptation is locally specific, making it very difficult to monitor in a way also relevant at the national scale. Good principles, such as having clearly stated climate change outcomes, interim targets to ensure the achievement of desired outcomes, indicators specific to climate change vulnerability/adaptation and reduction in impact/hazard/vulnerability are required.

6.6 Furthermore, activity data that are sufficiently robust to establish national estimates and, if needed, for individual projects are required, for example, to ensure fungibility of carbon units from NbS into carbon-trading schemes covering a wide range of sectors. A combination of techniques, from site measurements (flux chamber or eddy flux covariance to measure fluxes, inventory of stocks) to remote sensing to facilitate the spatialisation of results is probably needed to obtain the best results on GHG fluxes.

15 September 2021

Annex 1a: Carbon flux in contrasting habitats using representative and best available data. A negative value indicates sequestration, positive values are emissions. The grey bars indicate the likely range of values across sites where this is available. From: 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 (2nd edition) Natural England Research Report NERR094. Natural England, York.



Annex 1b: Estimates of the mitigation potential of selected nature-based solutions

Habitat	Carbon sequestration	Reference
Woodland		
New woodland 23,200 ha per annum for 40years	3.3 $MtCO_2$/yr, take until 2070 to reach that peak	Stafford et al., 2021
Planting 30,300ha per annum	2 $MtCO_2$/yr by 2030	CCC in Stafford et al., 2021
Nature-friendly woodland creation	44-71 MtCO2e by 2030	WWF-UK and RSPB (2020)
Nature-friendly woodland creation	143-224 MtCO2e by 2050	WWF-UK and RSPB (2020)
Reforestation assuming **all**	153.05 MtCO2e /yr30.	Griscom et al., Suppl.

[30] This amount is not constrained by costs, but it is constrained by a global land cover scenario with safeguards for meeting increasing human needs for food and fibre. We allow no reduction in existing cropland area, but we assume grazing lands in forested ecoregions can be reforested, consistent with agricultural intensification and diet change scenarios. This maximum value is also constrained by excluding activities that would either negatively impact biodiversity (e.g., replacing native non-forest ecosystems with forests) or have carbon

UK grazing lands can be reforested where it has no negative impact on biodiversity or the climate		Mat.
Peatlands		
Peatland Restoration	Saved emissions of 2-19 t C/ha/yr	Dunn et al. In Stafford et al., 2021
Peatland Restoration	Cumulative emissions reduction 23-34 MtCO2e by 2030	WWF-UK and RSPB (2020)
Peatland Restoration	Cumulative emissions reduction 63-122 MtCO2e by 2050	WWF-UK and RSPB (2020)
Peatland Restoration	5.76 gMtCO2e yr-1	Griscom et al. Suppl. Mat.
Restoring at least 50% of upland peat & 25% of lowland peat by 2050	Reduce emission by 5 Mt CO2	CCC, 2020
Heathland		
Natural afforestation of upland heaths	+3 t.CO2/ha/yr	Alonso et al. In Stafford et al., 2021
Freshwater		
Ponds	5.21 t.CO2/ha/yr (one study – can also emit GHGs)	Spray et al. In Stafford et al., 2021
European lakes	2.20 t.CO2/ha/yr	Spray et al. In Stafford et al., 2021
Lakes with > 100 micrograms P/litre	3.67 t.CO2/ha/yr	Spray et al. In Stafford et al., 2021
Coastal		
Sand dune (no habitat loss 2000-2060)	7.63 Mt CO_2 in total between 2000 and 2060	Beaumont et al., 2014
Saltmarsh (no habitat loss 2000-2060)	9.93 Mt CO_2 in total between 2000 and 2060	Beaumont et al., 2014
Machair (no habitat loss 2000-2060)	1.3 Mt CO_2 in total between 2000 and 2060	Beaumont et al., 2014
Saltmarshes	3.81 tCO2/ha/yr 1st 20 years	Burden et al., 2019 in Cam Econ, 2020
Saltmarshes	2.35 tCO2/ha/yr 20-50 years	Burden et al., 2019
Saltmarshes	2.38 tCO2/ha/yr 50-100 years	Burden et al., 2019
Saltmarsh - (restored)	2.46 – 4.66 t CO_2/ha/yr organic carbon accumulation rate	Parker et al. 2021
Marine		
Intertidal sediments - mud	3.06 (± 0.37) tCO2/ha/yr	Parker et al. 2021
Seagrass	3.15 (± 0.70) tCO2/ha/yr *(non-UK - summary estimate temperate, N. W. Atlantic sites)*	Parker et al. 2021
Kelp (biomass)	0.271 (± 0.015) Mt CO2e	Parker et al. 2021

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Annex 2: Examples of estimated costs and benefits of NbS. NB no study will capture the full value of the NbS action undertaken.

Habitat	Costs and Benefits	Benefit Cost Ratio	Reference
Woodland restoration		2.79	Cambridge Econometrics, 2020
Peatland restoration		4.62	Cambridge Econometrics, 2020
Wetland restoration	Flood protection benefits £17,750/yr or £37/ha/yr48		Cambridgeshire, Peh et al, 2014
Wetland restoration	Costs can outweigh benefits		Eftec, 2015
Wetland restoration		1.3 - 9 50	Faivre et al., 2017
Managed realignment		1.4	EEC, 2015
Salt marsh restoration		low cost 1.31; medium 0.59; high 0.24. NB many benefits not included, nor operational costs	Cambridge Econometrics, 2020

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