James Hutton Institute – Written evidence (NSD0028)

The James Hutton Institute is one of the Scottish Environment, Food and Agriculture Research Institutes, delivering research on agriculture, environment, food and land. Its response to the Call for Evidence on Nature-Based Solutions (NbS) has been collated by Institute experts in natural and social sciences. We have a track record in research on several types of NbS – especially relating to peatland management, forestry and catchment management – and across NbS design and implementation cycles, from on-the-ground design and implementation, to impact modelling, policy and governance.

1. **What is the potential scale of the contribution that NbS can make to decarbonisation in the UK?**

Which ecosystems are most relevant to the UK for NbS, and which have the largest potential to sequester carbon or reduce emissions?
The UK has many ecosystems characterised by high carbon stocks (e.g., peatlands, woodlands, upland organic and organo-mineral soils, salt marshes, seagrass beds) which, when degraded, can be significant sources of GHG emissions. Their restoration, and prevention of degradation, offers gains to other ecosystem services and biodiversity. Natural England has estimated carbon storage by habitat, and these figures could be refined further, e.g., by Aitkenhead and Coull 2020.

Small gains across common ecosystems should also be considered part of NbS. For example, grassland is an extensive crop and land cover type in the UK, often located on organo-mineral soils. Soil carbon is lost during ploughing when reseeding (Reinsch *et al.,* 2018), so its management should be adapted accordingly. Fertilisation of land to maintain animal productivity can result in emissions (methane, nitrous oxide) that negate gains in (soil) carbon. Increasing species diversity and incorporating legumes into grasslands can boost soil carbon (Fornara and Tilman, 2008; Lange *et al.,* 2015) and make grassland productivity more resilient to fluctuations in weather (Pakeman, 2014).

How much of the UK's 'hard-to-mitigate' emissions can be offset by NbS?
NbS contributions to net-zero targets should be viewed in the context of the challenge. NbS offer reductions versus current land management practices or historical degradation, rather than offsetting emissions from other sectors such as transport or housing. Examples with net offset potential are some carefully managed woodlands and, eventually (assuming a 5-to-20-year time horizon) restored peatlands. However, these offset potentials are uncertain under climate change, and may be reduced or negated by the more frequent cycles of drought and extreme rainfall, increased temperature and higher wildlife risks.

At the UK level, ambitious afforestation proposals made by the Climate Change Committee in its Sixth Carbon Budget are equivalent to c.1% of Business-As-Usual UK carbon footprint over the next 30 years. Complete restoration of all degraded peatland in the UK could provide a reduction of around 3% of the 2019 total UK carbon emissions - if success could be guaranteed.

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?

It is infeasible to use NbS to offset all 'hard-to-mitigate' emissions from UK land and EEZ coastal areas, with official estimates for total UK GHG emissions (2020) of 414.1 Million tonnes carbon dioxide equivalent (Mt CO_2e). Total emissions from LULUCF (Land Use, Land-Use Change and Forestry) in 2019 were 5.9 Mt CO_2e, including the sink from the forestry sector and net sources from grassland and peatland. Even with optimal woodland creation (most notably on high value agricultural land with low current soil carbon, Matthews *et al.* 2020), peatland restoration and sympathetic agricultural land management on all available land, there will be insufficient land available.

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

Focusing on peatland restoration, operational costs average £1,000 per hectare on average, and range between £100 and £10,000 (Glenk *et al*., 2020; Artz *et al.*, 2018), depending on accessibility, degree of degradation and technical challenges (e.g., terrain, previous land use). Resulting potential for emissions reductions is between 1.5 (least modified peatland) to 38 (cropland on peat) t CO_2e per hectare (~5.5 t CO_2e per hectare on area-weighted average; Evans *et al*., 2017). Published evidence suggests a positive benefit:cost equation on the basis of carbon emissions reductions alone (Moxey and Moran, 2014), and when some co-benefits (water quality, wildlife, landscape amenity) are considered (Glenk and Martin-Ortega, 2018). This evidence was sensitive to assumptions regarding costs and carbon pricing, and excluded the CO_2 emissions from the operations required to carry out restoration work. However, the benefits may be under-estimated when viewed against the newly developed 'mortality cost of carbon' (Bressler, 2021).

The potential benefits of NbS may be impaired by climate change, particularly via changing water availability. Higher temperatures will lead to greater water loss via evapotranspiration, whilst changes in rainfall variability (quantity, spatial and temporal distribution) will likely impact water availability for ecosystem function and human uses (i.e., private water supplies, Rivington *et al*., 2019). Increasing likelihood of droughts also threatens the resilience of ecosystems and their ability to function. Long-term changes in soil water balance must be considered, e.g., when planning woodland creation, species planted must be suited to future conditions.

Risks, timelines, costs and benefits vary between specific NbS. However, we expect NbS to offer significantly more co-benefits than non-NbS approaches such as Carbon Capture and Storage (CCS).

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

How reliable are the estimates of the quantity of greenhouse gas emissions reduction or sequestration by NbS, as well as the duration and reliability of storage?

For degraded peatlands, significant uncertainties exist relating to estimates of current levels of net emissions: investment in their monitoring is required for estimates with higher levels of confidence. There is also limited data on the variability of trajectories of reductions in emissions due to successful peatland restoration, and proportion of restoration projects that fail.

Scientific consensus is that undisturbed natural or near-natural peatlands function as carbon sinks under current climatic conditions. However, there is interannual variation, with near-natural peatlands being net-emitters during years with significant droughts. Increased frequencies of droughts and wildfires are significant and not fully quantified risks to almost all land-based NbS including peatland-restoration and woodland expansion. Research is needed to understand these risks. Future climate-related risk reinforces arguments for early implementation of restoration, to foster ecosystems more able to buffer against future climate change impacts.

Which bodies should be involved in establishing an agreed evidence base to inform best-practice techniques for restoring peatlands?
Development of an evidence base of best-practice techniques for restoring peatlands has been a transdisciplinary effort involving organisations from science, practice, society and policy. This process of shared learning benefits each group and collectively. That breadth of involvement should continue.

Many academic organisations provide underpinning scientific knowledge. Bodies developing practical techniques for restoration are conservation landowners and managers including the Wildlife Trusts, RSPB, Forest and Land Scotland, Forestry England, Natural Resources Wales, National Trusts, Plantlife; and volunteer groups supported by local authorities. Other stakeholders are statutory bodies, water companies and some government departments. In addition, the IUCN UK Peatland Programme has hosted formal reviews of the evidence base.

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

What can be learned from the implementation of the Woodland and Peatland Codes for the regulation and financing of NbS?
Our work on the Woodland Carbon Code (WCC) indicates its value as a framework to assess and issue carbon units from planting woods via carbon finance. However, the voluntary carbon market is inhibited by a lack of transparency due to a lack of available information about carbon prices agreed by forest developers, landowners and carbon buyers. The only publicly available carbon prices relating to WCC projects are from Woodland Carbon Guarantee actions in England. Barriers to uptake of the Peatland Code include a lack of information and awareness (Moxey *et al.*, 2021). These, and international initiatives, provide valuable insights to financing and regulating NbS.

Payment for Ecosystem Services (PES) schemes as such those applied to peatlands and woodlands, often target single services (e.g., carbon sequestration) so risk overlooking negative impacts (externalities) on other ecosystem services. Care in PES development and application is required to protect and improve multiple ecosystem services (Rivington *et al.*, 2018).

NbS is a relatively young concept, so it is important to learn lessons from work in closely related concepts and initiatives, such as the Ecosystem Approach (Waylen *et al.*, 2015a). For example, our work on green infrastructure identified potential interventions and practical techniques to inspire and improve NbS, and the need to attend to implementation, maintenance and evaluation, and not just design. These studies show achieving sustainability requires systemic change across multiple sectors, whilst involving the private sector does not substitute for the public sector, and indeed depends on regulatory frameworks.

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

The UK has a position of global leadership on carrying out successful peatland restoration. Well implemented restoration is, in conjunction with monitoring, enabling pioneering quantification of costs, benefits, effectiveness, and wider co-benefits and trade-offs. Getting the water table right is critical in achieving a net zero outcome; sites that are too dry or too wet continue to function as net carbon sources, albeit to a lower degree than in their unrestored state. Examples of good practice exist across the UK.

The wider multiple benefits of ecosystem restoration have been well recognised, highlighted by the UN Decade on Ecosystem Restoration initiative. Key elements for success include conducting restoration at scale, aiming for multiple benefits through co-construction with relevant local stakeholders and with long-lasting financial support.

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?

Safeguarding biodiversity is a criterion in IUCN Global Standard on Nature-based Solutions. NbS should be designed to avoid being detrimental to biodiversity or other ecosystem services (e.g., planting forests that reduce biodiversity), or local communities (e.g., to the detriment of livelihoods or amenity value). This should be a criterion for investments in carbon-offsetting, irrespective of badging as NbS. It is also important that the carbon costs of an intervention (e.g., installation of ground works, ongoing maintenance or management) are not overlooked in appraisals. Financing models should include costs for establishing a baseline, against which a scheme's target improvements can be measured, as well as for monitoring, evaluation and auditing (Yeluripati *et al*., 2018).

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

Ensuring consistency of carbon accounting across public and private instruments will benefit from collaboration e.g., for peatlands to ensure accounting of peatland emissions in the GHG Inventory (for UK UNFCCC submissions) aligns with the UK Peatland Code. Future work will benefit from establishment of a baseline, and trusted organisations to be involved in appraisal of evidence and verification. Such an organisation should be perceived as relevant, credible and legitimate (Sarkki *et al.*, 2015), entailing independence from those delivering NbS or benefiting from the services provided by NbS.

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?

Key stakeholders vary according to specific NbS, but can be appraised as:

i) Communities of place, i.e., in close proximity to an intervention.

ii) Communities influenced, e.g., visitors for recreation, those in sensory envelope of an intervention (sight, sound), downstream of a catchment-intervention.
iii) Communities of influence, e.g., public agencies and authorities, land managers, designers of NbS, investors in NbS.
iv) Communities of interest, e.g., technical, scientific and political interest in monitoring effectiveness and impacts of NbS.

Individuals may fall into one or more than one of those groups. Understanding stakeholder concerns can help identify barriers to adopting NbS (e.g., Bark *et al.*, 2021) informing targeting of regulation, subsidies and information. Meaningful stakeholder engagement should be incorporated early in any NbS proposals.

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

Post-CAP policies, such as the Environmental Land Management Scheme (ELMS), offer potential to ensure land managers are encouraged and enabled to deliver public goods. However, a fundamental expectation of good land stewardship should not require or depend on supplementary payments.

Many NbS may not immediately demonstrate effects (e.g., on biodiversity or flood risk) yet require maintenance (e.g., woodland management): such land uses typically face barriers to adoption, especially for tenant farmers. It will be important to attend to tenancy rights, and design schemes responsive to longer time horizons. A mixture of policy instruments (regulation, coupled with enforcement, incentives and advice) is required. Instrument selection must take account of justice and equity, ensuring that incentives are not deployed to unfairly benefit one group, or conflict with the polluter pays principle. Peer-to-peer learning and on-site demonstration can all be effective in helping land-manager understanding of opportunities, and advisory services on the specific challenges to applications for support.

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

Opportunities should be taken to learn from existing projects that embody some or all the principles and criteria of NbS. Studies of NbS in the UK, Europe and worldwide (e.g., river restoration in the Netherlands) offer insights on practical tactics for engaging with different stakeholder groups: doing so adds complexity and can slow planning, but are worthwhile investments for improving design and facilitating delivery in the longer-term (Blackstock and Richards 2007; Waylen *et al.*, 2015b). Fostering understanding amongst key stakeholders and wider communities will underpin long-term success.

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?

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

Habitat restoration to achieve NbS (e.g., native woods, catchments, peatlands and seagrass) will nearly always lead to biodiversity benefits. Other potential co-benefits are managing flood risk in the face of climate change. However, we note some habitats of high biodiversity value, for example chalk grassland, will need appropriate management and restoration to achieve biodiversity targets, without contributing significantly to NbS. Habitats such as peatland that are already in good condition may not offer further potential for abating emissions but may require management to maintain condition in the face of anticipated climate changes, even at an increase of 1.5°C. Thus, NbS for new benefits should not be the sole rationale for the management of habitats.

The timescale of benefits from NbS will vary, e.g., emissions savings from peatland restoration may be delivered relatively quickly, whilst biodiversity benefits may take longer to materialise.

NbS should avoid negative impacts on biodiversity, such as tree planting on species-rich grasslands. Inappropriate siting of tree planting can negatively affect ecosystem level carbon (Matthews *et al*., 2020); tree planting on a heathland reduces soil carbon by speeding up decomposition, which could take several decades to redress through carbon stored in tree growth (Friggens *et al*., 2020). Adverse impacts due to planting on peatland (Jovani-Sancho *et al*., 2021) could be more severe.

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?

The scope and resources of relevant policies and plans are generally not proportionate to the scope of the challenges. For example, the Nature for Climate Fund offers good prospects, but has only £10 million funding (by comparison, Scotland's Peatland Action funding has £22 million for 2021/22 alone, yet is still insufficient to deliver the mitigation required).

Alongside increasing funding for such initiatives, it is important to resource policy coherence, potentially aided by concepts such as Natural Capital. This must include 'non-environmental' sectors and departments such as transport, trade and treasury. Policy coherence can be hindered by pressures for short-term efficiency savings (Waylen *et al*., 2019a).

Lessons for coherence and coordination can be learnt from existing multi-functional landscape management initiatives, including Environment Agency's Catchment Based Approach (CaBA), and Scottish Government's Regional Land Use Pilots (2013 to 2016), and new Regional Land Use Partnerships (RLUPs).

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

Incentives for NbS can be very important but must reflect the above points about trade-offs and potential synergies. Incentives focused solely on carbon sequestration, without safeguards, risk perverse outcomes (e.g., inappropriately sited monoculture plantations risk net carbon loss, habitat destruction, exacerbation of droughts, increased wildfires). Additionally, policy design must carefully examine uncertainties accompanying estimates of current emissions and future potentials, especially regional variation.

Positive opportunities exist to enhance flood protection, habitat connectivity and reduce erosion risk. Incentives to encourage this should be based on spatial planning for multi-functionality. Suitable schemes can be based on either actions taken by managers, or 'by results', which have different needs for verification and implications for fairness (see Defra's trials on payments for results).

6. How should NbS be planned and monitored at the national level? *What measuring, reporting, and verification requirements should be put in place to determine the degree of success of NbS? Which techniques and technologies are best suited to accomplishing robust monitoring?*
Field-based evidence of emissions reductions is sparse. Currently it relies on models which are constrained by a lack of 'training' or 'validation' data. 'Earth Observations-based monitoring' offers potential, but the results are not yet sufficiently accurate for full operational use: more field-based observations are required to improve model reliability. Environmental monitoring requires significant resourcing to provide information at spatial and temporal resolutions sufficient to reliably verify the multiple consequences of NbS. Citizen science may sometimes help but is not a cost-saving shortcut. Additionally, there is often a mismatch between evidence collected and knowledge used in decisions (Waylen *et al*., 2019b) and perceptions of insufficient evidence block progress in catchment-based NbS (Bark *et al*., 2021) so future evidence collection should be informed by decision-making needs.

Our recent work for NatureScot on frameworks for planning and monitoring NbS, recommended the IUCN Global Standard for NbS, and its criteria and indicators. This standard is being adopted internationally. Uptake by the UK would promote best practice, reflect cutting-edge insights to NbS, and enable global comparisons of implementation and effectiveness.

Authors: *RJ Pakeman, KA Waylen, R Artz, A Gimona, P Ovando Pol, M Rivington.*

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