IUCN National Committee United Kingdom

Peatland Programme

Peatlands and Development

Summary of key points

1. Development should be avoided where there is likely to be negative impacts directly or indirectly on a peatland. Examples of negative impacts are loss of biodiversity, loss of peatland habitat, loss of carbon, and breakdown of the water regulating and ecosystem services that peatlands provide. This also extends to damaged and degraded peatlands where the priority should be restoration.

2. Restoration plans should seek to deliver net gain in support of the 2040 Peatland Strategy targets for restoration and conservation. The climate, carbon and biodiversity impacts of the development should all be considered in this net gain calculation.

3. Where development is permitted it should follow good practice guidance issued by the relevant statutory and planning bodies covering construction, restoration and aftercare.

4. There is an urgent need for monitoring the impacts of development on both peatland biodiversity and function.

   This will:

   - Improve our understanding and provide the data needed to strengthen guidance and policy (for example the ambiguity around drainage impacts).

   - Demonstrate compliance with existing guidance and validate the claims made by developers around impacts, mitigations, and restoration efforts when they have been used in gaining permissions.

   - Improve our understanding of direct peatland habitat and functional losses, including cumulative impacts of multiple developments within a peatland, so that these can be taken into account in future planning cases and accurately reported in national accounting.

This monitoring should be undertaken by individuals with a competent knowledge of the complexities of peatland ecology and function. These ‘Peatland Protection Officers’ could be part of the local authority or of a third-party organisation funded by all industries that seek to develop on peatlands to avoid further stretching the existing limited local authority resources. Either way, they could advise planners, oversee active monitoring of developments that have been approved, gather the data needed for compliance cases and raise reports of non-compliance within the local authority.

© Simon Browne

1. Introduction: Planning policy context for development

Peatlands have long been acknowledged in land use planning and much of the existing development planning guidance recognises them as being important habitats, particularly for biodiversity. In recent years peatlands have gained further recognition for their role in water provisioning and climate regulation. The protection and restoration of peatland habitats is considered a vital nature-based solution to the twin crises of climate change and biodiversity loss, building resilience for both society and the natural world. This is evidenced, in terms of financial investment, by the commitments that devolved governments across the UK are making to restore damaged peatlands[1 2 3 4].

Peatlands experience development pressures from a range of sectors including renewable energy, transport and highways, extractive industries, housing developments, and other built infrastructure. These sectors may utilise one or a number of different development types:

- Linear developments, e.g., tracks and roads. These can be intended as temporary or permanent structures
- Deep excavations/extraction of material, e.g., borrow pits, quarries and other extractive industries such as peat extraction
- Hydrological engineering, e.g., hydro schemes which may divert water away from sensitive wetland and peatland areas or lead to permanent flooding and loss of habitat
- Urban expansion, e.g., housing developments, supermarkets
- Industry, e.g., space launch industry

All the above typically include building works and/or groundworks. Developments that are inappropriately located, designed and managed can have an adverse impact on peatland biodiversity and ecosystem function. Effective, strategic planning with robust development policies coupled with guidance aimed at safeguarding peatlands can deliver sustainable development whilst ensuring peatlands deliver their full contribution to the UK's climate and biodiversity obligations.

1.1 Policy

Policy concerning land use and development in the UK is largely a devolved matter but there are similarities in the regulatory approaches taken, partially around commitments to and legislation which protect peatlands.

1.2 Permitted development

Permitted development is a category of development that a landowner may undertake without seeking formal planning permissions, although often there is a requirement to notify the local authority and/or regulatory/statutory body 28 days before commencement. Relevant examples of such developments can be access tracks or agricultural sheds. There are however situations where usual permitted development rights may be curtailed or rescinded, such as if the proposed development is within a national park or protected habitat. It should be noted that in Scotland, permitted development rights have been updated to include peatland restoration (as set out in a restoration plan submitted with 28-day notification), but for the purposes of this briefing, the development referred to will be built development.

1.3 Formal planning

If a development is not eligible under permitted development rights, it is then subject to a planning application procedure where a decision to approve or deny will be made in the light of:

- Habitat and environmental protection legislation
- Evidence submitted by the developers (e.g., Environmental Impact Assessment, Carbon Calculator assessment)
- Governmental planning policy guidance (e.g., National Planning Frameworks, Peatland Strategies/plans)
- The comments of statutory regulatory and conservation bodies

In most applications, this decision will be made by the local authority, but in some situations may be referred to ministerial level or another specific body. For example, in the case of onshore wind turbines, in Wales a project with an output exceeding 10MW is referred to ministers, whilst in Scotland a project exceeding 50MW is referred to the Scottish Energy Consents Unit.

Habitat and environmental protections relating to peatland are broadly similar across the UK. All peatlands are considered to be a priority habitat for protection and conservation and any development must be carried out sensitively to avoid negative impacts. Some sites do however qualify for specific legal protections. These sites could be designated as SACs or SPAs (also known as Natura 2000 or European sites) which are protected under the EU Habitats and Birds Directives. Most of these sites are also designated as Ramsar sites as wetlands of international importance. Other sites may also be classified as NNRs, SSSIs or ASSIs where they are protected for their flora, fauna or geological interest. A list of protections and designations can be found in Appendix Table 1.

Planning policy for each nation is set out in National Planning Policy Frameworks (also known as Strategic Planning Policy Statements). These frameworks set out principles for development and land use and how they comply with current legislation. For example, a principle that development should protect and enhance biodiversity will emphasise or expand on the legal habitat protections but may also list under what circumstances exemptions may be sought. Policy themes detailed in these frameworks that relate to peatlands cover carbon, water, soil, biodiversity and nature, historic environment, climate change and flood resilience, renewable energy and sustainable development. However, how these themes are titled and expanded may differ between nations.

1.4 Guidance

Statutory bodies may also produce guidance for developers who seek to work on peatlands where permission has been granted. The purpose of this guidance is to help developers stay within the regulatory framework and minimise the impacts of their development.

Scotland, which has the UK's greatest extent of peatland cover, has experienced considerable expansion of development pressures on peatlands over the last 10 to 15 years, particularly from the renewable energy sector.

A number of Scottish planning measures have been introduced in response, including the publication of guidance for peatland management and mitigation, along with tools to aid decision making, such as the Carbon Calculator[5 6 7 8].

The Carbon Calculator in Scotland

The Carbon Calculator, first published in 2008, was commissioned by the Scottish government for use by onshore wind developers to account for the carbon impact across the full lifecycle of developments. It was designed to provide planning authorities with information on the extent to which impacts on peatland affect the carbon savings from a specific development, for consideration in assessing the development proposal. Carbon losses from peatland drainage and excavation, lost peatland cover and built infrastructure are accounted for and compared to carbon savings from reduced fossil fuel energy generation, to provide a payback time calculation. Developers may also include carbon emissions reductions from peatland restoration activities to mitigate losses and therefore reduce the payback time.

At present there is no set threshold for what is considered an acceptable payback time. There is no guidance to indicate how the calculation and supporting evidence submitted should be scrutinised or taken into account in the final decision; this is concerning as it is often cited as a key consideration in the decision to grant permission.

The Scottish Environment Protection Agency (SEPA) is the designated consultee for Calculator submissions, but it is unclear if or how an application audit would be triggered (e.g., project size/capacity or randomly), or how many have been audited. Industry are aware of this ambiguity[9], and so may be inclined to follow what could be deemed reasonable by following the example of previous applications, especially around areas of concern such as drainage. The decision to accept or reject a submitted payback time is made by the planning authority, but the lack of guidance or apparent scrutiny when dealing with sensitive carbon-critical habitat risks severely undermining the stated carbon benefits of the development[10]. Providing an advised payback period for the lifetime emissions of a development would provide planning authorities with a decision point on which they could either approve or refuse planning consent. This would increase the importance of accurately evaluating overall carbon emissions versus savings of a development on peatlands.

2. Impacts of development

The impacts of developing on peatlands are often varied, complex and interconnected, and can lead to a degradation in several of the ecosystem services for which they are valued and recognised. For example, a change in hydrology can directly and indirectly impact biodiversity, water quality, carbon storage, historical archive, peat stability and downstream habitat health. In some parts of the UK, good statutory guidance on how to reduce and mitigate for some of these impacts exists. However, sometimes incorrect assumptions which oversimplify or ignore the complexities of peat (no two peat bodies are the same) can nullify the effectiveness of the guidance and lead to exacerbated negative impacts as a result of development.

© Richard Lindsay

2.1 Biodiversity

Direct habitat/species loss - Peatlands are recognised as priority habitats under the UK Biodiversity Action Plan and much of the UK's peatland resource qualifies for designation under international, national and local site protection measures. Peatlands support important populations of rare and threatened species, many of which are restricted to peatland habitats[11]. Peatlands also include some of the UK's most species-rich sites[12].

Development impacts on biodiversity can occur through loss of or deterioration of habitat through physical incursion by materials and built structures, species disturbance and direct mortality e.g., through wind farm bird collisions. Sometimes a development proposal will argue that the footprint of the development, and therefore the affected area of peat-land, is small in the context of the local/national habitat resource. This framing of impact ignores the cumulative loss of habitat from multiple development proposals – only a few percent of loss is important in the context of a globally rare habitat type.

Indirect habitat/species loss - Adverse impacts can extend beyond the boundary of the development. Hydrological disturbance can have wide ranging consequences across the peatland hydrological unit (see section 2.3). Biodiversity impacts of development on peatlands can also extend to wider species populations than just those immediately present within a peatland. In a hydrologically connected landscape, a healthy peatland ensures the provision of good quality freshwater to downstream catchments supporting other freshwater habitats and species[13].

Disturbance, particularly to breeding, roosting or feeding birds, can result from human activity within an area. Whilst the impact may peak during construction, the continued presence of access tracks or other infrastructure can mean that species in previously remote areas may be vulnerable to increased levels of human activity[14]. For breeding birds, the 'edge effect' occurs when otherwise suitable habitat is avoided in areas adjacent to built infrastructure[15].

2.2 Climate and carbon

Peatlands are the UK's largest natural terrestrial carbon store and have a vital role in climate change mitigation and adaptation. The restoration of the UK's historically damaged peatlands is important to the UK's commitments to net zero and can form part of the nationally determined contributions as part of the Paris Climate Agreement. The UK's Climate Change Committee and the IUCN UK Peatland Strategy[16 17] call for 80% of UK peatlands to be restored to a 'natural state' by 2050 as part of the net zero target.

Development can impact on the functioning of peatlands through changes to hydrology and peat-forming vegetation, resulting in increased net greenhouse gas (GHG) emissions. Impacts of changes to hydrology at distances beyond the development can affect the carbon storage and sequestration capacity of the whole peat unit, rather than just the direct footprint of development.

2.3 Water

Peatlands are wetland ecosystems with water playing a huge role in both the diversity of life supported and the processes that underpin their function. Like all wetlands, a sustained change in water quality or quantity by natural or anthropogenic forces can dramatically alter the ecology, leading to changes in vegetation communities and biogeochemical processes.

© Iain Detrey

2.3.1 Quantity

In peatlands it is well demonstrated that a drawdown of the water table is directly correlated to increased greenhouse gas (GHG) emissions and changes in vegetation. In particular, a lowering of the water table can have long lasting consequences such as subsidence of the soil and development of erosion pathways and soil pipes; all of which have a string of consequences for peatland ecosystem function and, as such, the immediate impacts of drainage are often underestimated.

Drains do not simply act to reduce the water table either side of the drain. Rather, in sloping blanket peatlands, when the drain runs across the slope, it intercepts upslope water and prevents it flowing down the rest of the slope. This means that all of the slope below may receive less water from upslope than it would have otherwise done, effectively draining large areas of land downslope.

The construction of roads and tracks can have significant adverse effects on peatland hydrology[18]. So-called 'floating roads' are often used over deep peat in an attempt to reduce subsidence and prevent adverse impacts on the peatland. These are constructed over the peat, so the carriageway 'floats' on top. Evidence suggests[19] however, that floating roads can still dam the flow of water across and through a peat mass by blocking surface flow and compressing underlying peat. This can 'significantly alter habitat drainage regimes'[20]. The impact of floating roads on hydrology has been observed from satellites using InSAR radar which recorded around floating roads in Scotland a lowering in peatland surface height (as water tables decreased) on the downslope adjacent to the roads[21] .

Peatlands also play a vital role in the regulation of water flow. A number of studies (in the context of restoration and historic drainage features) have shown a clear link between the presence of peatland drains in uplands and a reduction in lag time and increased peak flow increasing the likelihood of downstream flooding. This is why peatland restoration is widely considered to be a form of natural flood management (NFM). In most cases development requires some form of drainage or redirection of water and, if not carefully considered, could risk a reduction in landscape/catchment resilience to storm events and increased downstream flood risk. Although the impact of one development may be assessed to have minimal risk, the cumulative impact of multiple areas of development within a catchment is likely to increase the risk of adverse impacts. Reducing water quantity within a peatland through drainage can also have knock-on effects on carbon storage, and this drainage effect can extend for hundreds of metres from the drain[22].

The effect of drainage features may also continue to grow over time as peat surrounding them collapses and the ground subsides, squeezing water out of the lower layers, making the drains and their effects wider as the peat consolidates. The lower water content of the peat will favour vascular plant species over mosses, increasing transpiration and drying the peat further. This extensive surface drainage can potentially stall or reverse carbon sequestration over the drained area[23].

2.3.2 Quality

Peatlands play a key role as regulators of water quality, which is often linked with their condition (a catchment with a large area of degraded peatland is likely to have lower water quality). This means that development on peatland, if not adequately considered, could have a significant detrimental impact on the quality of the water flowing out of that development, affecting both biodiversity and other water users. As already mentioned, in a hydrologically connected landscape this could have a detrimental impact on other habitats and species downstream in freshwater and estuarine habitats.

Another potential risk to consider is the impact development could have on drinking water quality. Around 72% of the UK's reservoirs are fed from peaty catchments and over 28 million people consume water from peaty catchments[24]. Healthy peatlands produce high quality water that needs little treatment. Degradation and disturbance of peat is often accompanied by increases in dissolved and particulate organic carbon loads which increase treatment costs, as they can react in the treatment process to produce toxins, thus necessitating further treatment steps. This is already predicted to be an issue of increasing importance as degradation of poor condition peatland is likely to increase as climate change progresses[25], but development runs the risk of enhancing this loading either during or after construction, e.g., if a change in hydrological regime triggers erosion pathways.

Areas of peatland around former industrial centres also have a legacy of pollution, where heavy metals and other pollutants have been locked into the peat. If disturbed, or if the peat begins to erode as a result of development, there is the risk that these pollutants become mobile and impact on water quality[26].

2.4 Archive

The waterlogged and anaerobic nature of peatland environments results in the exceptional preservation of archaeological and paleoenvironmental remains. Destruction of peat will of course lead to the direct loss of any archaeological or paleoenvironmental information preserved within the peat. Any process which leads to a reduction in the levels of saturation or to the quality of the water itself within a peatland, can impact negatively on the long-term survival of the archaeological and paleoenvironmental record[27].

2.5 Peat stability

Peat is geotechnically unpredictable due to its high water content (it's not unusual for peat to have a lower solid content than milk). Generally, it can be characterised as being highly compressible and having low tensile strength[28]. This can make it prone to failure when loaded, under-cut, following a change in hydrological conditions or even as a result of vibration from a passing vehicle[19]. The high water content and properties of peat also mean that its strength is likely to vary temporally, between seasons or even rainfall events, as well as spatially across the landscape. Because of this, many traditional measures of soil strength (such as the shear vane test) can be misleading for construction on peat[6].

There is a misconception that degraded peat, such as that subject to past drainage, will be stronger due to consolidation increasing its bulk density. However, peat that has experienced degradation in this way can be more likely to fail if there is a sudden change in hydrology or after intense rainfall, due to shrinkage, fissures and chances of preferential flow between the peat and the bedrock[29].

Peat Stability and Climate Change

Due to their unpredictability, developments sited on peat must often include a stability risk assessment. Given the link between geotechnical properties and hydrology, and considering the predicted changes in UK rainfall patterns due to climate change[30], it could be argued that these should also consider the medium to long term risks of prolonged droughts followed by intense rainfall events.

Under these conditions peat slopes with degraded peat or compromised hydrology are likely to fail, experiencing peat slides or 'bog bursts'. This happened in 2003 in the Shetland Islands, where heavy rain following a prolonged dry period seeped through peat fissures and lifted it from the underlying bedrock[31].

In the Republic of Ireland, there have been several peat slides attributed on many occasions to the construction of tracks causing changes in the landscape hydrology. The most well-known would be the Derrybrien bog slide, also of 2003, where the construction of a renewable energy project caused an estimated 450,000m^3 of peat to catastrophically fail, having devastating impacts on the landscape and downstream aquatic ecosystems[29].

3. Other considerations for peatland development

Where development is not able to avoid peatland, impacts should be avoided or minimised through mitigation measures, direct reinstatement, and the restoration of the development footprint and/or wider peatland areas.

3.1 Pre-development

Developments on peatland often include mitigation measures to limit damage from the construction operation and decommissioning stages and to offset any unavoidable loss of habitat, carbon emissions, or peat damage. Mitigation measures are set out as part of the planning process, prior to development.

Development permission may be granted on the basis that the site in question is no longer considered to be 'active' or is too degraded, fragmented, or damaged to be meaningfully repaired. Indeed, this forms part of current guidance in some parts of the UK[32], but it could be argued that this principle is flawed and ignores advancements in the practice of peatland restoration. Mainly, the threshold at which a site can be considered irretrievable is either set too low or is poorly and vaguely defined, creating room for interpretation. The field and practice of peatland restoration has advanced greatly in the past 10 to 15 years and there are now numerous examples in which sites in various states of degradation, from bare and eroding uplands to formally afforested peatlands, have been returned to functional, peat-forming, biodiverse habitats[33 34 35].

Recent projects like the Winmarleigh Carbon Farm have even demonstrated that former lowland bog, drained and converted to grazing pasture with no remnant peatland vegetation, can once again support bog vegetation[36]. Of course, the level of input varies greatly with each of these examples, but they underline that the assumption that a site is beyond restoration should be challenged, and not doing so could in fact deny the opportunity for restoration and its associated benefits. This is particularly relevant when governmental targets for peatlands, biodiversity and carbon emissions are considered which extend beyond the protection of good sites and seek to restore damaged and degraded sites. Many of the impacts of development on peatlands discussed will also extend to damaged peatlands and can result in their further deterioration rather than their improvement.

3.2 Reinstatement

Developments will often involve some level of excavation and disturbance. The impacts of this have already been discussed, but in most cases, this peat is later reinstated or reused in restoration. Uses of excavated peat for restoration within a development site are often limited. Guidance exists to ensure reuse is done in accordance with good practice and to minimise extraction and waste.

The disturbance of peat can have a number of negative impacts, and the assumption that it can be easily reinstated ignores the complexity of peatland structure and function. The limitations of using peat for restoration can result in excess peat being classified as waste material, making it both costly to safely remove and process, along with a significant carbon cost (174 kg CO_2 per cubic metre of peat[37]).

Peat is reinstated when it is returned to where it was removed or used around the built development. It is often assumed that the impact of this is minimal as the peat is returned, but this is not the case. Peat structure is an important element of how (for bogs in particular) hydrology is regulated, and any disruption permanently degrades this regulation. The result of this is that it is unlikely to maintain saturation without further consideration to its hydrology and this therefore runs the risk of carbon loss through oxidation and erosion. Secondly, the loss of the natural structure can in some cases make the peat mass unstable, increasing the likelihood of erosion and slippage and posing a hazard if used to backfill deep excavations at depth (e.g., borrow pits).

An important consideration for using peat in both restoration and reinstatement is that the process is time critical. If the excavated peat is allowed to dry out it can suffer shrinkage, cracking and eventually become hydrophobic. This is likely to have a detrimental impact on the restoration or reinstatement outcome.

3.3 Restoration

Peatland restoration can be used as part of a development proposal, either within the development area, or in other areas as part of a mitigation package to essentially offset the GHG losses from the development. However, restoration as mitigation for a development on peatland does not always contribute to the national restoration target, particularly in the following scenarios:

a. International and UK climate change accounting rules do not allow inclusion of emissions reductions from restoration of peatlands which were damaged after 1990. Emissions arising from new developments on peatlands are included, however. Therefore, a development on peatland that causes an increase in carbon loss results in a net loss to the UK GHG account, even if the site is restored afterwards. There may be other biodiversity and hydrological reasons in support of restoring the peatland, but not from a carbon budget perspective.

b. Some developments seek to mitigate emissions arising from development on peatlands by restoring historically damaged peatlands either within the development site or elsewhere; these **are** eligible for inclusion in national carbon accounting. Such mitigation can make the development itself carbon neutral but cancels the opportunity for peatland restoration emissions savings earmarked for the national carbon account. This is significant when considered in the context that 80% of the UK's peatlands are degraded and emit over 23 million tonnes of carbon dioxide every year[38]. Furthermore, restoration associated with developments risks removing the most recoverable and cost-effective peatland restoration sites from the available peatland restoration pool (the low hanging fruit), leaving more expensive, difficult, and risky restoration projects to deliver national carbon reduction targets.

© Montgomeryshire Wildlife Trust

4. Recommendations

4.1 Regulation and compliance

Where planning for development on peatlands is granted, it should be clearly demonstrated how all relevant planning policies (for carbon, water, biodiversity, historic environment, and soils, etc.) have been consistently tested and applied in the application process. Following this, there is a need for formalised and long-term compliance monitoring of developments that are permitted and constructed on peatlands. This is especially true where restoration works have been included as part of the planning permission to increase biodiversity value or reduce carbon impacts. Achievement of these claims needs to be rigorously evidenced through baseline and long-term monitoring, with a process for enforcement if they are not.

Given the intricacies and complexities of peatland ecology, monitoring and regulation of these claims requires a certain level of technical knowledge. A 'Peatland Protection Officer' role could be created within local authority ecology teams to advise and oversee monitoring and compliance. However, to avoid placing further strain on already stretched local authority resources, this role or something similar could also sit within a third-party organisation that would be funded jointly by all those who develop on peat habitats. It would have the joint purpose of both ensuring that all guidance and conditions are complied with during the construction phase, and providing continued monitoring of the site and subsequent validation of restoration and mitigation claims post-construction in the medium and long term. Either solution would also ensure that, where existing guidance is robust, it is implemented well.

As part of a new compliance and validation framework, action should be taken to standardise the reporting of environmental impacts across industries. A 2018 study examined the EIAs of 21, >50MW wind farms across Scotland and found multiple inconsistencies in how the impacts and data were reported across different projects[39]. These included differences in how impacts were defined, how habitat loss was evaluated and reported and how site data (e.g., peat depth and vegetation surveys) were gathered and reported. This creates a barrier to attempts to evaluate the cumulative impact of developments. All baseline, impact and restoration data collected should also be made open source (although anonymised), to allow for national reviews of development effects around biodiversity, climate and hydrology.

© Ian Thomas SEPA

4.2 Guidance

Whilst the importance and value of peatland habitats is recognised in all nations of the UK, there is disparity in how evolved the guidance is in different regions. For example, published guidance on geotechnical stability issues and waste peat management exists in Scotland but appears absent in other parts of the UK. There is also a need to be holistic in peatland development guidance, emphasising the ecosystem value of peatlands and not simply the carbon value. Peatlands, as intact, functioning, dynamic and living environments, are what enable the carbon store to accumulate and remain.

There is also a need to better reflect the complexity and importance of hydrology and hydrological changes in existing guidance. This is particularly true where assumptions are made about the areas affected by drainage alterations. For example, in Scotland the technical guidance for the Carbon Calculator recommends figures for drainage extent should be primarily based on site study (without giving guidance on how to do this).

Values used in the Calculator should also be logical - at present they don't always appear to be, e.g., if extent of drainage is assumed as 10m, it is not logical to assume that the effects of drainage reversal would be beyond 10m. Values that are incompatible, unverified and not reasoned undermine the overall accuracy of the carbon assessment which has become critical in the decision making process for siting developments on peatlands. Guidance and tools should be developed to allow developers to easily make site specific measurements and assessments of hydrology both before and after a development. This will aid the application of other guidance and tools (e.g., the Carbon Calculator), provide decision makers with more accurate information and help to verify effectiveness of mitigation and restoration strategies.

4.3 Research

The UK is a leader in peatland research, and this is aided by many strong links between academic, NGO and industrial partners. With the growth of peatland developments in recent decades, there is now ample opportunity for further research into both the impacts of developments and the effectiveness of current policy aims and implementation. By making use of new and more accessible techniques and methodologies to assess the impacts of development, both spatially and temporally, some of the most contentious and ambiguous issues (e.g., drainage, tracks, reinstatement, biodiversity) can be addressed. The synthesis of this knowledge would therefore not only provide much needed new information to improve policy, but also move arguments between different viewpoints to a more conciliatory position.

One important area to develop is the tools available to developers and planners for assessing impacts on peatland habitats. This is especially true around ecohydrology, as water underpins all peatland function and drainage, and rewetting effects are critical to the accuracy of the Carbon Calculator. DigiBog Hydro is a tool funded by NERC and developed by researchers at the University of Leeds in partnership with the Yorkshire Peat Partnership, and can simulate drainage and rewetting effects over an area of bog[40]. Exploring if this tool can easily be integrated into the development process, and with the Carbon Calculator, would be useful.

Iain Detrey: info@iucn.org.uk
www.iucn-uk-peatlandprogramme.org
@iucnpeat

Endnotes

1. DEFRA, 2021. Nature for people, climate and wildlife, GOV.UK. Link
2. NatureScot, 2020. Peatland Action Project. Link
3. Welsh Government, 2020. Welsh Government launches National Peatlands Action Programme to help lock in carbon and reinvigorate vital habitats. Link
4. DAERA, 2022. Northern Ireland Peatland Strategy 2022-2040. Link
5. Scottish Government, SNH, SEPA, 2017. Peatland Survey. Guidance on Developments on Peatland, online version only. Link
6. Scottish Government, 2017. Peat Landslide Hazard and Risk Assessment, Second Edition. Link
7. Scottish Government, 2012. Assessment of peat volumes, reuse of excavated peat and minimisation of waste: guidance, Second Edition. Link
8. Scottish Government, 2018. Carbon calculator for wind farms on Scottish peatlands: factsheet, Second Edition November. Link
9. Mills, A., Massey K., Trinick, M., 2021. Carbon-rich soils, deep peat and priority peatland habitat: Expert views on project level assessment. Link
10. Smith, J., Nayak, D.R. and Smith, P., 2014. Wind farms on undegraded peatlands are unlikely to reduce future carbon emissions. Energy Policy, 66, pp.585-591. Link
11. Douglas, D.J., Jones, P.S., Crosher, I., Diack, I. and Littlewood, N., 2019. Peatland Biodiversity. IUCN UK Peatland Programme, Edinburgh. Link
12. Jowit, J., 2009. Fen-tastic: National Trust reserve opens its trove of secrets, The Observer. Link
13. Martin-Ortega, J., Allott, T.E., Glenk, K. and Schaafsma, M., 2014. Valuing water quality improvements from peatland restoration: Evidence and challenges. Ecosystem Services, 9, pp.34-43. Link
14. Birdlife International, RSPB., 2003. Windfarms and birds: an analysis of the effects of wind farms on birds, and guidance on environmental assessment criteria and site selection issues. Report by BirdLife International to the Council of Europe, Bern Convention on the Conservation of European Wildlife and Natural Habitats. Link
15. Pearce-Higgins, J.W., Stephen, L., Langston, R.H., Bainbridge, I.P. and Bullman, R., 2009. The distribution of breeding birds around upland wind farms. Journal of Applied Ecology, 46(6), pp.1323-1331. Link
16. Committee on Climate Change, 2020. The sixth carbon budget: the UK's path to net zero. Link
17. IUCN UK Peatland Programme - UK Peatland Strategy 2018-2040. Link
18. Williams-Mounsey, J., Grayson, R., Crowle, A. and Holden, J., 2021. A review of the effects of vehicular access roads on peatland ecohydrological processes. Earth-Science Reviews, 214, p.103528. Link
19. Grace, M.R., Dykes, A.P., Thorp, S. and Crowle, A., 2013. The impacts of tracks on the integrity and hydrological function of blanket peat. Report for Natural England. Link
20. SNH, 2015. Constructed tracks in the Scottish Uplands, Second Edition. Link
21. Marshall, C., Bradley, A.V., Andersen, R. and Large, D.J. 2021. Using peatland surface motion (bog breathing) to monitor Peatland Action sites. NatureScot Research Report 1269. Link
22. Holden, J., 2005. Peatland hydrology and carbon release: why small-scale process matters. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 363(1837), pp.2891-2913. Link
23. Impacts of Artificial Drainage on Peatlands, 2014. IUCN UK Committee Peatland Programme Briefing Note No. 3 Link
24. Xu, J., Morris, P.J., Liu, J. and Holden, J., 2018. Hotspots of peatland-derived potable water use identified by global analysis. Nature Sustainability, 1(5), pp.246-253. Link
25. Xu, J., Morris, P.J., Liu, J., Ledesma, J.L. and Holden, J., 2020. Increased dissolved organic carbon concentrations in peat-fed UK water supplies under future climate and sulfate deposition scenarios. Water Resources Research, 56(1), p.e2019WR025592. Link
26. Shuttleworth, E.L., Evans, M.G., Hutchinson, S.M. and Rothwell, J.J., 2015. Peatland restoration: controls on sediment production and reductions in carbon and pollutant export. Earth Surface Processes and Landforms, 40(4), pp.459-472 Link
27. Geary, B.,Bermingham, N., Chapman, H., Charman, D., Fletcher, W., Fyfe, R., Quatermaine, J., Van de Noort, R., 2010. Peatlands and the Historic Environment. IUCN UK Peatland Programme, Edinburgh. Link
28. Warburton, J., 2020. 'Peat hazards: compression and failure.', in Geological hazards in the UK: their occurrence, monitoring and mitigation. London: Geological Society, pp. 243-257. Engineering geology special publications. Link
29. Lindsay, R. and Bragg, O., 2005. Wind Farms and Blanket Peat - a report on the Derrybrien bog slide. Derrybrien Development Cooperative Ltd. Link

30. Met Office, 2021, UK Climate Projections: Headline Findings, Link

31. Dykes, A.P. and Warburton, J., 2008. Characteristics of the Shetland Islands (UK) peat slides of 19 September 2003. Landslides, 5(2), pp.213-226. Link

32. NIEA., 2012. NIEA, Natural Heritage, Development Management Team Advice Note Active Peatland and PPS18. Link

33. Cris, R., Buckmaster, S., Bain, C. and Bonn, A.(Eds.), 2011. UK Peatland Restoration—Demonstrating Success. IUCN UK National Committee Peatland Programme, Edinburgh. Link

34. Andersen, R., Farrell, C., Graf, M., Muller, F., Calvar, E., Frankard, P., Caporn, S. and Anderson, P., 2017. An overview of the progress and challenges of peatland restoration in Western Europe. Restoration Ecology, 25(2), pp.271-282. Link

35. Artz, R., CEH, C.E., Crosher, I., Scott-Campbell, M.H.R.M. and Peter, M.P.M., 2019. The State of UK Peatlands: an update. Commissioned report: IUCN UK Peatland Programme's Commission of Inquiry on Peatlands. Link

36. Lancashire Wildlife Trust, 2020. Pioneering Winmarleigh carbon farm is fighting climate change. Link

37. Lindsay, R., 2010. Peatbogs and carbon: a critical synthesis to inform policy development in oceanic peat bog conservation and restoration in the context of climate change. University of East London, Environmental Research Group. Link

38. Evans, C., Artz, R., Moxley, J., Smyth, M.A., Taylor, E., Archer, E., Burden, A., Williamson, J., Donnelly, D., Thomson, A. and Buys, G., 2017. Implementation of an emissions inventory for UK peatlands (pp. 1-88). Centre for Ecology and Hydrology. Link

39. Wawrzyczek, J., Lindsay, R., Metzger, M.J. and Quétier, F., 2018. The ecosystem approach in ecological impact assessment: Lessons learned from windfarm developments on peatlands in Scotland. Environmental Impact Assessment Review, 72, pp.157-165. Link

40. University of Leeds, 2023, About DigiBog. Link

Appendix

Table 1 Statutory designated sites for nature protection in the UK adapted from the Thompson Ecology Environmental Handbook Chapter 8 (https://www.thomsonec.com/thomson-environmental-handbook/). E = England, W = Wales, S = Scotland, NI = Northern Ireland.

Site Type	International Protection	National Protection	Description
Ramsar Sites (All)	Ramsar Convention	In E & W, have the same protection as SPAs and SACs by policy.	Wetlands of international importance supporting wildfowl and other important species.
Special Protection Areas (SPAs) (All)	Birds Directive	Regulations derived from the Habitats Directive	Sites that support rare, vulnerable or large numbers of regularly occurring migratory bird species. SPAs are part of a network of European sites known as Natura 2000.
Special Areas of Conservation (SACs) (All)	Habitats Directive	Regulations derived from the Habitats Directive	High-quality conservation sites which make a significant contribution to conserving habitats and species threatened in Europe as a whole. Part of the Natura 2000 Network.
Sites of Special Scientific Interest (SSSIs) (E, W & S)	None, unless also designated Ramsar, SPA or SAC	Wildlife & Countryside Act and CRoW Act	Representative samples of British habitats forming a national series aimed at maintaining the present diversity of wild plants and animals in Great Britain.
Areas of Special Scientific Interest (ASSIs) (NI)	As above	The Environment (Northern Ireland) Order 2002	Areas of land that have been assessed as having the highest conservation value in Northern Ireland.
National Nature Reserves (NNRs) (E, W & S)	None	National Parks and Access to the Countryside Act 1949; Wildlife & Countryside Act and CRoW Act	Areas managed for study or research into flora, fauna, geological or physiographical interest, or for preserving features of special interest. Owned or leased by Natural England, bodies approved by them, or managed under agreement with landowners/ occupiers.

Statutory Nature Reserves (Nature Reserves (NR) & National Nature Reserves (NNR)) (NI)	None	The Nature Conservation and Amenity Lands (Northern Ireland) Order 1985	Two tiers of nature reserve; NNRs are the top tier, representing sites of national importance, and NRs, which are of lesser importance but are primarily managed for nature conservation.
Local Nature Reserves (LNRs) (E, W, S)	None	National Parks & Access to the Countryside Act 1949; local planning documents and policies	Concentrated in or around urban areas where a policy of using LNRs to promote conservation education has been pioneered. LNRs have local as opposed to national importance for nature conservation and the local authority must consult with the relevant SNCO before designation.
Local Nature Reserves (LNRs) (NI)	None	The Nature Conservation and Amenity Lands (Northern Ireland) Order 1985; Local planning documents and policies	An area of land, designated by a district council, for the purposes of nature conservation or the study of wildlife or both.