IUCN National Committee United Kingdom

Peatland Programme

Wildfire resilience: why rewetting peatlands must play a key role

Summary

- Peatlands have often been subject to significant land management interventions over lengthy timeframes. These activities have been shown to fundamentally alter both the biotic and abiotic components of the habitats. These alterations can dry the peat, reducing resilience to events such as wildfire.
- Climate change is likely to exacerbate both the frequency and severity of wildfires. High fuel loads from fire adapted vegetation may amplify the negative impacts. This has led to some advocating for a continuation of the use of burning as a management tool, following the lead of other countries such as the US, Australia and Spain. However, naturally arid systems where burning is used as a management tool are not an appropriate proxy for wetland systems. Burning is a recommended tool in North America to reduce peatland extent. Published research and anecdotal evidence from the UK suggests that intact and restored peatlands, where active management is absent or has largely ceased, have increased resilience to wildfire.
- Restoration of peatlands leads to improvements in water table height; this increases wetness and growth of key plants such as Sphagnum mosses, while naturally limiting the dominance of ericaceous shrubs and grasses which favour drier conditions and burn more readily.
- A water table which sits at or close to the peat surface limits the capacity of uncontrolled fires to burn into the peat layer and smoulder, leading to less severe fires which intact peatlands have been found to recover from relatively quickly.
- Wildfires are stochastic events and for this reason they may be difficult to study. When they do occur, baseline data may not be available for a given site, meaning before and after comparisons are not possible. However, where baseline data is available and there is a good understanding of land management history when wildfire occurs, sites should be prioritised for research funding.

Background

The IUCN UK Peatland Programme has a published position statement on burning as a land management tool; this remains current. This is a separate brief which addresses the role of peatland restoration and rewetting in managing wildfire risk on degraded peatlands, particularly those where past management activities may have increased or altered vegetation. Regulatory control of burning is in place in England and soon to be introduced in Scotland: there is therefore a presumption that the amount of prescribed burning taking place on upland habitats in these countries will decrease. This brief focuses on the future management of these areas following the regulatory reduction/cessation of prescribed burning management.

Introduction

We acknowledge that wildfire presents a risk; some elements of this risk may be real, and some may be perceived. Regardless of the nature of the risk, this uncertainty and the threat of wildfire must be addressed when discussing the restoration or management of degraded peatland sites. Areas of overgrown vegetation, particularly *Calluna vulgaris* and *Molinia caerulea,* represent a vulnerable increased fuel load. These increased fuel loads are largely the product of a long history of land management practices including grazing and burning[1]. Continuation of these land management practices promotes drier vegetation types on peat soils and, if these forms of land management decrease or cease, there is a risk that vegetation cover increases.

The type of the vegetation (species composition) and the character of the vegetation (density and height) may all be impacted by a change in land management. **There is confusion created by the generic terms 'moorland' and 'upland heath'. These terms describe a mosaic of habitats which may encompass peat and mineral soils, rather than a specific habitat type.** Here we are specifically discussing interconnected deep and shallow peat soil habitats – dry heath, wet heath, blanket bog and transition mires/fens, with a focus on blanket bog restoration.

Here, we review published evidence from both the UK and North America on peatland wildfires, along with observational evidence from restored UK sites. We discuss the role of rewetting in increasing peatland resilience to wildfire and discuss areas that will need to be addressed in transition periods between cessation of management and post-restoration recovery, to minimise wildfire risks and impacts.

The risk of wildfire

Historic burning management favours ericaceous shrubs or grasses[2]. These plants are 'fire adapted', which means that following burning they can regenerate rapidly.[2] Being fire adapted also means that they burn readily. Increasingly frequent drought periods due to climate change may lead to these increased areas of drier vegetation being at greater risk of accidentally or deliberately started wildfires.

Aerial image of the 2019 Caithness wildfire. © Paul Turner

Higher wind speeds increase risk of spread during a fire event, while slopes allow for fires to spread more rapidly. Unbroken vegetation monocultures that are no longer managed and left unrestored/in a degraded state allow fires to spread quickly

Where the peat is dry, cracking and oxidation occur, and wildfires may burn more easily into the deep peat layer – this occurred on Marsden Moor during a wildfire in 2023 (Figure 1). In areas where the peat was drier, outside of restoration areas on Marsden Moor, the wildfire was able to burn deeper into the ground, resulting in the loss of hundreds of years of peat accumulation and stored carbon. This meant that to extinguish the smouldering peat and prevent reignition, the peat had to be dug out and exposed and sat-urated with water, which was labour intensive work. Bring-ing the water table closer to the surface during restoration would provide a natural barrier to limit the ability of wildfire to burn into the deep peat layers, limiting carbon losses.

Figure 1: An area of deep burning peat below Marsden Moor. In order to prevent re-ignition of smouldering peat, these areas had to be dug out. (©. Divey-Matthews, National Trust).

Peatland restoration encompasses a variety of approaches. The most common active intervention is re-wetting through introduction of structures in the landscape to hold water, e.g., ditch blocks or bunds. This rewetting occurs as a mosaic in the landscape and a restored and recovering peatland will appear as a patchwork of wetter and drier areas.

A transition to wetter conditions across a whole site that would naturally limit the dominance and cover of drier plant species (e.g., heather/grasses) is likely to take a significant amount of time.

Smouldering from the Caithness wildfire © Paul Turner.

While restoration schemes are relatively new undertakings, studies of changes to vegetation after burning management has ceased highlight how changes are still recorded on bogs after more than 80 years.[2] Similar timeframes could be anticipated for restoration sites.

Wildfires can be hard to study because they are stochastic events that vary in their location, size, intensity and severity. It is also unlikely that pre-burn baseline data is available for all but the most well studied sites, given their sporadic occurrence. Fire impacts, therefore, are often extrapolated from studies of prescribed burns or overseas wildfires, but differences should be highlighted. Prescribed fires are smaller and more controlled in nature, with factors such as current and antecedent weather conditions playing an important role in the decision-making process around when and where to burn. Findings to support the use of vegetation burning as a wildfire management tool from overseas studies are frequently cited in press reports and even journal articles. However, they may be from non-peatland habitats (e.g., arid grasslands) and extrapolation from these studies may not be appropriate. While there are studies from North American peatlands that may be more comparable[3], it is important to acknowledge that different climatic and historic management conditions will exist. These differences mean that making comparisons to UK peatlands, to better understand responses to wildfire events, must be done carefully.

While the risk of wildfire in the absence of management may increase, it is also important to acknowledge that escaped muirburn or prescribed burns have significant correlation with incidence of wildfire, particularly in upland areas.[4,5] **Upland wildfires in England were also proportionally larger in area than in all other land cover classes over the period 2009-2021**.[5] Figure 2 highlights the seasonal occurrence of wildfires in terms of area burnt in England during 2009-21, with larger upland fires most prevalent in spring, coincident with permitted burning season and not obviously linked to the other widely reported sources of ignition such as recreational access or BBQs. This highlights the importance of training and due diligence in ensuring that any permitted prescribed burns are properly managed and regulated.

How rewetting and restoration may reduce wildfire impacts

Peatlands in an undegraded natural state have high water tables which sit at or near to the surface year-round. They support communities of specially adapted wetland plants, the most important of which are the *Sphagnum* mosses. By contrast, common heather (*Calluna vulgaris*) is a fire adapted species which prefers drier ground and readily regenerates in the post-burn period. Where burning is regular, *Calluna* is often the dominant species. In Canada, studies recommend controlled burning as a method of limiting or reversing paludification (the process by which organic matter is turned to peat as a result of waterlogging) by reducing growth of Sphagna to make peatlands more productive for forestry.[6,7]

Caithness wildfire of 2019 on area of brash tracks. © Paul Turner.

In the UK, this waterlogging favours Sphagna and reduces *Calluna* growth due to the increased wetness.[8] **Wildfires negatively impact the carbon sequestration abilities of peatlands, reducing carbon uptake by up to 35% in undamaged peatlands, and enhancing carbon emissions by up to 10% in already degraded peatlands**.[9] Although carbon uptake is a slow process, intact surface vegetation is vital in preventing losses from the existing carbon store.

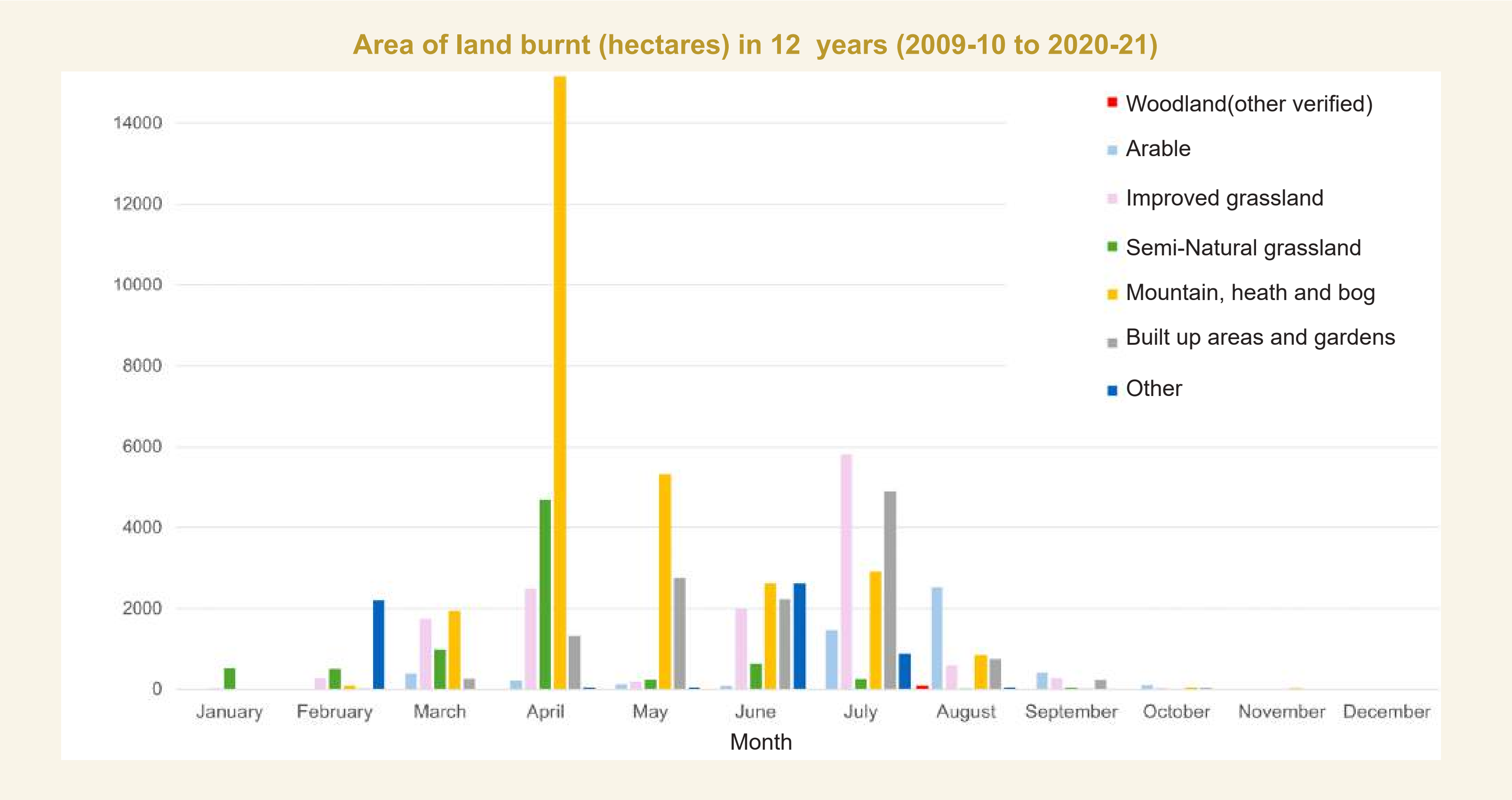


Figure 2. Area burnt (hectares) by wildfire incidents by land cover class in England over 12 years (2009-10 to 2020-21). Graph is based on data from the Forestry Commission.

A recent study from the Flow Country[10] looked at the response and resilience of peatland vegetation to a 2019 wildfire on areas which had been subject to differing management conditions. The site which had the longest history of activities which degraded the peatland (such as grazing, burning, drainage and peat cutting for fuel) suffered the most significant wildfire impacts. These impacts included almost complete consumption of the vegetation layer and smouldering into the deep peat layer, while larger hummocks supporting drier vegetation were observed to have deeper burn scars and charring.

Conversely, sites in 'no-burn' areas - in the main managed for conservation purposes and undergoing peatland conservation management or restoration where ericaceous shrub and graminoid growth was balanced with an abundance of Sphagna, and conditions were wettest - experienced the least damage. These findings are in line with studies from Canadian peatlands which found that intact, peat-forming wetlands experience decreased burn severities from wildfires.[11] Supportive of these findings, a further study from Canada found that intact bogs act as important wildfire refugia due to their high water tables, and as part of a heterogeneously patterned vegetation mosaic they can break up fuel loads.[12]

Roundhill Moss Fire 2022. © Tom Aspinall Moors for the Future Partnership.

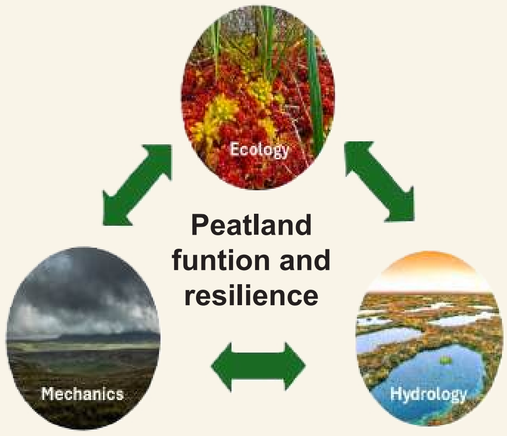
Wildfires were also seen in another UK study to be reduced in severity on the wettest site where Sphagna dominated, although it is important to note weather conditions differed significantly between study sites.[13] The dominance of Sphagna is common across the most resilient areas in studies. This emphasises that in restoration projects, it is important that rewetting is twinned with reintroduction of species which may have been lost, particularly the most significant peat-forming species with poor dispersal capabilities.

Rewetting and restoration of drained peatlands have been identified as effective measures to lower the risk of deep peat burns in Canada and northern Europe[14] and to mitigate the potential for high severity peatland fires in the UK.[15]

Rewetting and the (re-)establishment of *Sphagnum* mosses are necessary to convert a drained peatland into a system that maintains a high moisture content, limits water table declines, and is more resilient to wildfires.[14]

Interconnected processes are integral to resilience

The study from the Flow Country also highlighted the importance of the coupled process of 'bog breathing' whereby in healthy, intact peatlands, surface and water table patterns 'track' one another. This means that as water tables drop in the drier months, the bog surface contracts so that features such as pools remain permanent. Where land management interventions such as drainage have been undertaken, the surface and the water table can become dissociated from one another, meaning that pools and the surface may be more vulnerable to drying out.[10] Water deficits are expected to increase as a result of climate change, with water tables dropping even further in degraded peatlands, in turn leading to greater burn severity.[14] Where water tables drop, studies from North America have shown that vegetation regime shifts to shrub and grass vegetation increase in the post-fire recovery period.[16] A North American study also found that drying from drainage intensified burning effects and increased carbon losses ninefold compared to undrained peatlands: the equivalent of 450 years of peat accumulation.[3]



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Case Studies

Marsden Moor

In 2023, after a significant period of drought, Marsden Moor in West Yorkshire experienced seven wildfires, which burned approximately 10% of the 2000-hectare estate. Here we highlight photographic evidence of where restoration interventions and wet areas of *Sphagnum* mosses acted as firebreaks to limit the spread of the fire. The images in Figure 3 demonstrate consistency with the findings of the Flow Country study by Andersen et al., 2024. They also highlight the importance of *Sphagnum* in tackling wildfires and why replanting it is a key part of improving resilience.

Figure 3a. Blocked gully on Marsden Moor, showing clear delineation between burned and unburned areas along the gully block. © K. Divey-Mathews, National Trust.

3b. An area of wet Sphagnum on Marsden Moor – Wessenden valley area - that remained unburned in May 2023 fire. © K. Divey-Matthews, National Trust.

3c. Area around a leaky dam intervention where fire was halted on Marsden Moor. © Jason Hanks, Kirklees Council.

In the drier areas of the moor, the peat kept smouldering (see Figure 1). Kate Divey Matthews, Resilient Landscapes Project Officer at the National Trust also said,

"*One of reasons the fire kept smouldering in the peat for about 3 weeks was the warm dry weather, suggesting that a warming climate is going to increase the severity of wildfires*".

Dove Stone

In 2018, a wildfire near Stalybridge, England burnt around 1000 hectares of land. The fire started on neighbouring heather-dominated land, burnt onto Dove Stone Nature Reserve, and eventually slowed down enough to be stopped against a *Sphagnum*-filled gully located on United Utilities/RSPB land (Figure 4). It's important to note that the fire wouldn't have stopped by itself, but the change in vegetation from dry, heather-dominated peat on neighbouring ground, to wetter *Sphagnum*-dominated gullies on Dove Stone meant that the height and heat of the flames reduced sufficiently that humans were able to regain control of it.

Figure 4. Fire stops at wet gully edge in Dove Stone, England. © Jon Bird, RSPB.

The RSPB, who manage Dove Stone, aim to return the peatland to a more natural state, where vegetation height, fuel load and flammability are managed by restored hydrology and complexity of vegetation communities, including the dominance of *Sphagnum* mosses (Figure 5). *Sphagnum* retains moisture, in itself and in the peat soils below it, for far longer than heather and does not contain flammable oils like heather does.

"This does not mean that the bog will never be threatened by fire again - humans will always be a factor in fire risk, and climate change means that we are likely to face prolonged droughts which will make the peat vulnerable. The RSPB does not advocate a hands off approach, but rather working with nature as opposed to against it to make our upland landscapes more resilient to fire." – Kate Hanley, RSPB.

The RSPB approach to fire management at Dove Stone is three-fold:

- Land management which will move the site from dry towards wetter, with more complex vegetation communities.
- Active fire ranger team to educate the public about accidental fire starting and to provide a visible deterrent against deliberate fire starting.

Case Studies

- Active fire fighting alongside Fire and Rescue Services (on RSPB land, and on both NGO and privately owned moors at the invitation of FRS) using two Argocats and fogging units.

Figure 5. A *Sphagnum* hummock that survived burning on Dove Stone © Jon Bird, RSPB.

The Roaches

In August 2018, a wildfire occurred in the Roaches in the south-west Peak District. The fire burnt through a monitoring site of Moors for the Future Partnership, allowing photos to be taken before and after the event. Figure 6 illustrates the severe impact of fire on the heather-dominated plot, where the peat layer beneath the vegetation was severely impacted (Figures 6a and b).

Figure 6a. Heather-dominated plot before fire. © Tom Aspinall Moors for the Future Partnership.

6b. Heather-dominated plot after the fire. © Tom Aspinall Moors for the Future Partnership.

In contrast, the plot dominated by hare's tail cotton grass *(Eriophorum vaginatum*) and *Sphagnum* (approx. 50% Sphagnum cover was recorded on the site in a pre-fire vegetation survey) remained far more intact and appears to have protected the underlying peat from the fire (Figures 6c and d).

6c.*Sphagnum* and cotton grass-dominated plot before fire © Tom Aspinall Moors for the Future Partnership.

6d.Sphagnum and cotton grass-after the fire © Tom Aspinall Moors for the Future Partnership.

Whilst this is a localised example, Tom Aspinall from the RSPB said: "*Sphagnum remaining over peat following fires is something I have observed on many occasions in various locations*" (see Figure 7).

Figure 7a.*Sphagnum* hummocks that survived fire in Round Moss, Peak District in 2022 © Tom Aspinall, Moors for the Future Partnership.

7b. Burbage Moor, Peak District in 2023 © Tom Aspinall, Moors for the Future Partnership.

Recommendations

The IUCN UK Peatland Programme acknowledges that the risk of wildfire is a genuine concern for landowners and wider rural communities, particularly in the context of climate change where warmer, drier conditions may naturally exacerbate the incidence of wildfire. We do not advocate a ‘do nothing’ scenario, as abandonment of degraded peatlands will likely exacerbate issues: restoration and rewetting are key components of the management interventions which are needed in these degraded landscapes. Information, and in some cases, fire volunteers who can interact with the public in high usage areas may be needed to educate people on the risks of activities such as BBQ use. These sorts of initiatives can help reduce the likelihood of fires through carelessness, reducing wildfire risk during the transition period between abandonment of active management and recovery to a rewetted state.

Area of burning from the Marsden Moor fire. © Damien Cameron.

Cutting is widely used as a replacement for prescribed burning, to regenerate *Calluna* and to create firebreaks. However, cutting is a relatively new approach on bogs and as yet, the impacts of the frequency and timing of cutting, along with increased usage of vehicles, are poorly understood. There is the possibility of damage to the surface microtopography and key species, along with other physical impacts such as compaction and the creation of ruts. The use of cutting as a tool to manage fuel loads should therefore be carefully considered, as effects have not been well studied at this time. Policy makers seeking to mitigate wildfires should incorporate restoration and education into future planning.

Studies of wildfire are challenging due to the random nature of these events and the absence of baseline data for many sites. We also have a poor understanding of why some sites are more prone to severe wildfires than others, and work to investigate the drivers of this is needed. When fires occur on sites which have available baseline data, these should be prioritised for research funding to build the evidence base that will help to understand how we can better build resilience against altering climate scenarios.

It is vital that a greater understanding of UK peatland and wildfire interaction is built, as reliance on evidence from arid habitats is more likely to result in erroneous conclusions and consequent perverse outcomes in the longer term.

Roundhill Moss Fire 2022. © Tom Aspinall Moors for the Future Partnership.

References

1. Belcher CM, Brown I, Clay GD, et al. *UK wildfires and their climate challenges. Expert Led Report Prepared for the third Climate Change Risk Assessment*. 2021.

2. Lindsay R, Birnie R, Clough, J. *IUCN UK Committee Peatland Programme Briefing Note No. 8: Burning.* IUCN UK Peatland Programme. 2014.

3. Turetsky MR, Donahue WF, Benscoter BW. *Experimental drying intensifies burning and carbon losses in a northern peatland.* Nature Communications. 2011;2:514.

4. Holland JP, Pollock M, Buckingham S, Glendinning J, McCracken D. *Reviewing, assessing and critiquing the evidence base on the impacts of muirburn on wildfire prevention, carbon storage and biodiversity.* NatureScot Research Report 1302. 2022.

5. Forestry Commission. *Wildfire statistics for England: Report to 2020-21. 2021*. Accessed 02/10/2024 FC-Wildfire-statistics-for-England-Report-to-2020-21-.pdf (publishing.service.gov.uk).

6. Lavoie M, Paré D, Fenton N, Groot A, Taylor K. *Paludification and management of forested peatlands in Canada: a literature review.* Environmental Reviews. 2005;13:21–50.

7. Renard SM, Gauthier S, Fenton NJ, Lafleur B, Bergeron Y. *Prescribed burning after clearcut limits paludification in black spruce boreal forest.* Forest Ecology and Management. 2016;359:147–155.

8. Gimingham CH. *Calluna Salisb*. Journal of Ecology. 1960;48(2):455–483.

9. Wilkinson SL, Andersen R, Moore PA, Davidson SJ, Granath G, Waddington JM. *Wildfire and degradation accelerate northern peatland carbon release.* Nature Climate Change. 2023;13:456–461.

10. Andersen R, Fernandez-Garcia P, Martin-Walker A, Klein D, Marshall C, Large DJ, Hughes R, Hancock MH. *Blanket bog vegetation response to wildfire and drainage suggests resilience to low severity, infrequent burning*. Fire Ecology. 2024;20:26.

11. Whitman E, Parisien MA, Thompson DK, Hall RJ, Skakun RS, Flannigan MD. *Variability and Drivers of Burn Severity in the Northwestern Canadian Boreal Forest*. Ecosphere. 2018;9(2):e02128 .

12. Kuntzemann CE, Whitman E, Stralberg D, Parisien MA, Thompson DK, Nielsen SE. *Peatlands Promote Fire Refugia in Boreal Forests of Northern Alberta, Canada.* Ecosphere 2023;14:e4510.

13. Davies MG, Domènech R, Gray A, Johnson PCD. *Vegetation structure and fire weather influence variation in burn severity and fuel consumption during peatland wildfires.* Biogeosciences. 2016;13:389–398.

14. Granath G, Moore PA, Lukenbach MC, Waddington JM. *Mitigating wildfire carbon loss in managed northern peatlands through restoration.* Scientific Reports. 2016;6:28498.

15. Davies MG, Gray A, Power SC, Domènech R. *Resilience of temperate peatland vegetation communities to wildfire depends upon burn severity and pre-fire species composition.* Ecology and Evolution. 2023;13:e9912.

The International Union for the Conservation of Nature (IUCN) UK Peatland Programme exists to promote peatland restoration in the UK and advocates the multiple benefits of peatlands through partnerships, strong science, sound policy and effective practice.

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