PhD Project Title: Developing a trait-based approach to understand *Sphagnum* responses to hydrological stress in the context of peatland restoration

SUMMARY:

Large-scale and fast-paced peatland restoration interventions currently happening across the UK are only going to lead to successful outcomes if they increase the capacity of degraded blanket bogs to withstand future threats such as climate change, but also invasive species, wildfires or pollution. This capacity reflects resilience thresholds that relate to the re-establishment of feedbacks between production, decomposition, and eco-hydrology, which remain poorly characterised for blanket bogs.

PROJECT BACKGROUND:

Peatlands are the Earth's most efficient terrestrial carbon store, regulate water and climate, and support unique biodiversity, but their degradation compromises the delivery of all those benefits. In the UK, the cool, wet climate supports a globally rare peatland type: blanket bogs. Most UK blanket bogs have been degraded by human activities and unprecedented efforts to restore them are currently underway, particularly in Scotland. There are still considerable uncertainties about the trajectories of recovery of restoration areas in the context of climate change.

In many bogs, *Sphagnum* mosses are disproportionately important in regulating feedbacks associated with resilience. Despite often being lumped together as a key genus, individual *Sphagnum* species differ in their physiological and morphological traits. Interspecific differences in traits affect decomposition rates, water retention strategies and habitat preferences. At the finer scale, species also have niche preferences along micro-topographic positions (e.g. pools, lawns, hummocks), and respond differently to restoration, with some species becoming abundant while others fail to re-establish. Between and within species, trait variability could play a role in tolerance limits, including in the way *Sphagnum* species respond to localised stress events (e.g. drought) and restoration.

This project will aim to understand the eco-hydrological triggers of stress responses and recovery in *Sphagnum* and will benefit from access to a range of sites spread along climate and topographical gradients found in the "Flow Country" of North Scotland, a site of global significance.

RESEARCH QUESTIONS:

1. Do *Sphagnum* species exposed more regularly to water stress exhibit physiological and metabolic adaptations absent from species exposed to wetter conditions?
2. Are there key thresholds/barriers in local edaphic conditions and landscape features that need to be overcome to facilitate *Sphagnum* recovery following degradation?
3. Can *Sphagnum* stress and recovery be remotely monitored effectively?
4. How do *Sphagnum* species provenance (wet/dry climate) and combinations (single vs mixed species) alter response to restoration?

METHODOLOGY:

This PhD will take advantage of the climatic gradient across the Flow Country with long-term annual rainfall averages ranging from 3000 mm yr-1 in the west to <800 mm yr-1 in the east. There are several restoration sites of varying ages spread along the climate gradient and adjacent degraded/reference areas from which the project will be able to establish baselines and trajectories of change. The project will undertake a field campaign to collect and measure traits from a range of *Sphagnum* species found across those gradients of climate and condition, and contribute to a new global *Sphagnum* trait initiative, with which it will be possible contextualise findings for species that have a circumboreal distribution.

Within the Flow Country, 67,000 ha of open blanket bog were afforested with non-native conifers during the 1960-80s. Many areas have subsequently been targeted for "forest-to-bog" restoration. In recent years, the restoration techniques have been developing fast, and there is currently a gap in our understanding of how these techniques perform and of their cost-effectiveness. Over selected areas, we will combine vegetation surveys, drone surveys and remote sensing to identify key relationships between *Sphagnum* cover, landscape features and soil properties and identify stress/recovery thresholds/barriers for *Sphagnum*.

Finally, the project will allow us to design a replicated *Sphagnum* re-introduction trial at RSPB's Forsinard Flows NNR on the bare peat areas resulting from techniques such as ground smoothing or deep mulching. There, we will compare the cover, plant traits and greenhouse gas emissions between different treatments and relate them to local edaphic variables.

TRAINING

A comprehensive programme will be provided comprising both specialist training and generic transferable and professional skills. The student will have access to a range of training opportunities within each of the project partner organisations, but also through SAGES (www.sages.ac.uk).

The student will form a core part of the Leverhulme Leadership Award "Blanket Bog Resilience" team and the ERI's "Carbon, Water & Climate" theme, attending regular meeting with the relevant postdocs, PhD students and collaborators. In addition, the student will join the "Flow Country Research Hub", a network of >60 organisations involved in peatland research in the north of Scotland, which will give further opportunities for training and non-academic skills development.

All essential and medical training (e.g. first aid training) relating to fieldwork will be provided. Fieldwork in the north of Scotland can be challenging, involving carrying kit over difficult terrain in sometimes cold and wet conditions, and often with the company of midges. We would expect the student to have some outdoor experience and enjoy spending time in remote, isolated areas.

ACADEMIC QUALIFICATIONS:

We expect an undergraduate degree (minimum 2:1) in a relevant field (e.g. biological, environmental sciences) or equivalent. English language requirement: IELTS score must be at least 6.5 (with not less than 6.0 in each of the four components). Other, equivalent qualifications will be accepted. Full details of the University's policy are available online.

ESSENTIAL ATTRIBUTES

- Strong interest in peatland research
- Experience of field-based research
- Good written and oral communication skills
- Full clean driving license
- Due to the field work requirements associated with this PhD, it will be necessary for the candidate to be based in Thurso, Scotland for the duration of the PhD.

DESIRABLE ATTRIBUTES

- Botanical interest, taxonomic identification skills
- Laboratory experience

KEY REFERENCES:

Hancock, M.H., Klein, D., Andersen, R. and Cowie, N.R., 2018. Vegetation response to restoration management of a blanket bog damaged by drainage and afforestation. Applied Vegetation Science, 21(2), pp.167-178.

Konings, W., Boyd, K.G. and Andersen, R., 2019. Comparison of plant traits of sedges, shrubs and Sphagnum mosses between sites undergoing forest-to-bog restoration and near-natural open blanket bog: a pilot study. Mires and Peat, 23, pp.1-10.

Lees, K.J., Artz, R.R., Khomik, M., Clark, J.M., Ritson, J., Hancock, M.H., Cowie, N.R. and Quaife, T., 2020. Using Spectral Indices to Estimate Water Content and GPP in Sphagnum Moss and Other Peatland Vegetation. IEEE Transactions on Geoscience and Remote Sensing.

SUPERVISORS:

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Dr Rebekka Artz, James Hutton Institute.
Dr Neil Cowie, Royal Society for the Protection of Birds.
Dr Jens-Arne Subke, University of Stirling.

ADDITIONAL INFORMATION:

Eligibility: To be eligible applicants must have no restrictions on how long they can stay in the UK (with some further constraint regarding residence for education).

Note: EU, EEA and Swiss citizens who are entering the UK on or after 1 January 2021 will need a Tier-4 visa in order to live and study in the UK. All those who are living in the UK before 31 December 2020 must apply for either pre-settled or settled status in order to remain living in the UK after 30 June 2021.

Funding: This project is funded through a Leverhulme Leadership Award to Dr Andersen and will include stipend and fees at RCUK rates for 42 months. The funding does not cover international fees but international applicants are welcome to apply and discuss their application ahead of submission with the lead supervisor. The successful candidate will start between at the latest in October 2021 (to be agreed with student).

Deadline for application: 06/04/2021

Interviews expected week starting 19/04/2021

For information, contact roxane.andersen@uhi.ac.uk