Evaluating Upland Blanket Peatland Restoration in Cumbria

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Agenda

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Introduction

Peat

Peat is a type of **organic matter** that forms in **wetland** environments.

Usually defined as **≤65% organic carbon** content.

Peat is mainly composed of **decayed** or **decaying plant material**, often that of *Sphagnum* mosses.

Blanket Peatlands

- Blanket peatlands (i.e., **blanket bogs**) are a type of wetland characterised by the presence of **deep peat** (~30 – 50cm).
- They typically form on **gently sloping hillsides** (~5° gradient) or **plateaus**.
- Blanket bogs can be found in cool, wet, **boreal** and **temperate climates**.
- **~13%** of the world's blanket bogs are in the **UK**.

Blanket Peatlands & Carbon (the Positives)

- Peatlands are the **largest terrestrial carbon store** on the planet (~550 – 612 billion tonnes).
- In the UK, blanket peatlands store **~3.12 billion tonnes** and sequester **~5.5 millions tonnes** of carbon per year, equivalent to **~1%** of the UK's total annual **GHG emissions**.
- Blanket peatlands play a crucial role in **regulating climate** – For centuries, they have had a **net cooling effect** on climate.

Blanket Peatlands & Carbon (the Negatives)

- **90%** of the known extent of blanket bogs in the UK are categorised as **poor condition**.
- This is due to **cutting**, **overgrazing**, **burning,** and excessive **draining**.
- UK blanket peatlands emit **~24 million tonnes** of carbon per year, representative of **~7%** of the UK's total annual **GHG emissions**.
- Blanket peatlands are switching to having a **net warming effect** on climate.

What's Being Done?

Peatlands are now included in **UK climate policies** and **commitments** through **restoration targets**:

- **Climate Change Act** – Provisions for the protection and restoration of peatlands as a nature-based solution to the climate crisis.
- **Peatland Code** – Voluntary code to encourage the restoration of peatlands through funding from the private sector.
- **Peatland Strategy** – Sets out the UK governments plans to restore and protect peatlands.
- **Peatland Restoration Fund** – Provides financial support for peatland restoration projects in England (particularly upland blanket bogs).
- **Biodiversity Action Plan** – Describes the UK governments commitments to protecting and enhancing biodiversity through the restoration of peatlands.

How's it Going?

UK peatland restoration targets are **not being met**:

1. Scottish government committed to restoring a total of **50,000 hectares** of peatland **by 2020** – Only **25,000 hectares** were rehabilitated.
2. Scotland is committed to restore **250,000 hectares** of peatland **by 2030** – They have so far achieved **57,000 hectares**, a rate of **5,675 hectares** per year.
3. England is less than halfway to achieving its **2025 goal** of funding and restoring **35,000 hectares** under the Nature for Climate Fund.
4. Wales is only delivering **660 hectares** per year – **Three times less** than they need to be in order to reach their **2050 net zero target** of **45,000 hectares**.
5. Northern Ireland is only **just getting started**…

What's Wrong?

1. Monitoring and Evaluation – There is a **lack of primary data** into the **effectiveness** of peatland restoration as a **nature-based solution** to the climate crisis – Only **surface response** knowledge.

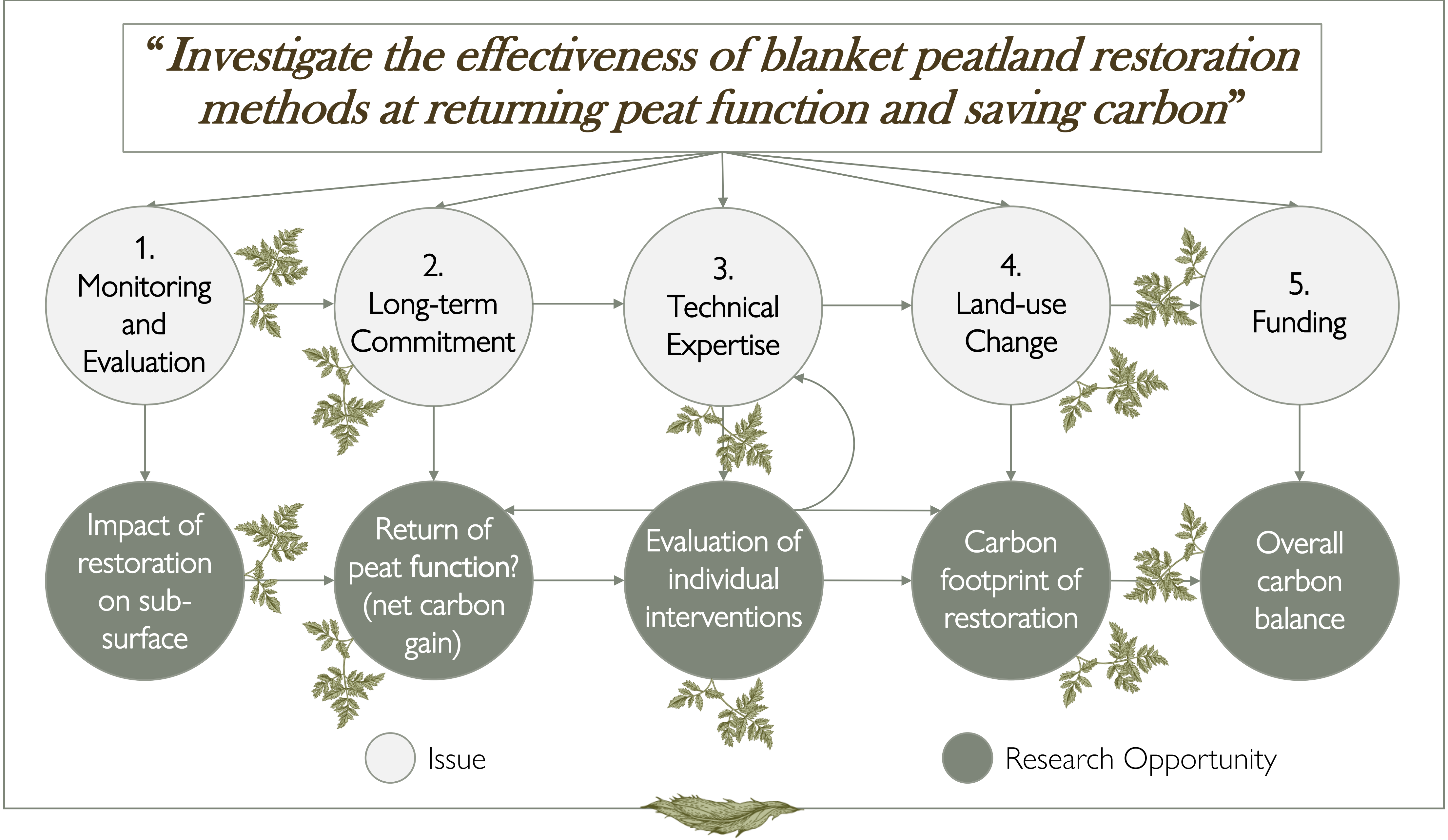
2. Long-term Commitment – Most peatland restoration projects aim to **'cap' emissions** from degraded peatlands (**net zero**). Successful restoration should return peat **function** (i.e., **net carbon positive**).

3. Technical Expertise – Peatland restoration requires **specialised knowledge** and **skills.** There are a **limited pool** of **professionals**.

4. Land Use – Peatlands are often **privately owned** and used for **agriculture** and **forestry**.

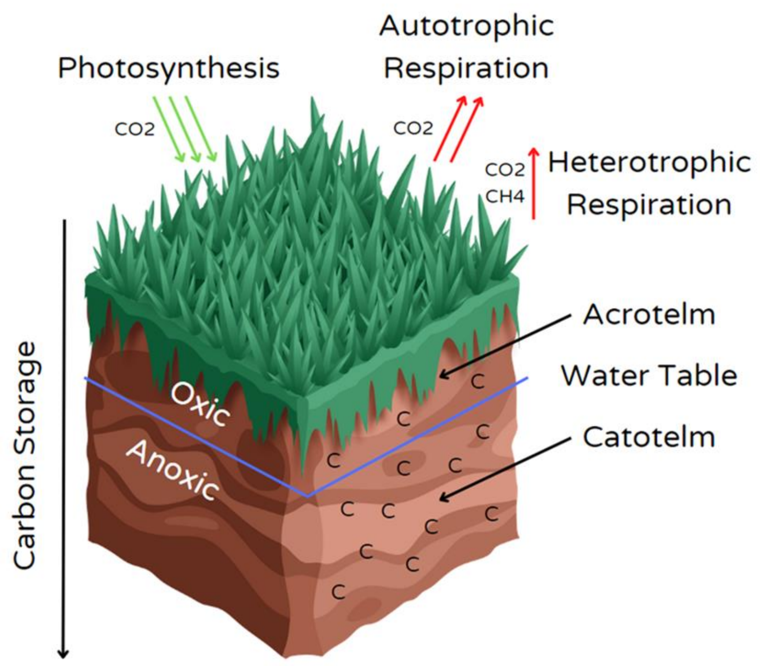
5. Funding – There is **limited funding** available for peatland restoration in the UK. This is further exaggerated by the **accessibility of sites** (i.e., the need for **helicopters**) and **un-certainties** in **data**.

Research Opportunities


"Investigate the effectiveness of blanket peatland restoration methods at returning peat function and saving carbon"
1. Monitoring and Evaluation
2. Long-term Commitment
3. Technical Expertise
4. Land-use Change
5. Funding
Impact of restoration on sub-surface
Return of peat function? (net carbon gain)
Evaluation of individual interventions
Carbon footprint of restoration
Overall carbon balance
Issue
Research Opportunity

Peat Function

- Peat **function** is **governed** by the physical **structure** of the sub-surface peat.
- **Pore networks** control:
  - 1. **Hydraulic conductivity** – which **limits decomposition** and **regulates solute transport**.
  - 2. **Biogenic gas movement** – **release pathways** to the atmosphere as **GHGs**.
- **Root structure** also controls **hydraulic conductivity** and **biogenic gas movement** – monocot roots can act as **release pathways** for **GHGs**.



Research Goals

1. Investigate the impact of blanket peatland restoration interventions on **sub-surface peat structure** over a **sufficient timescale**.

2. Evaluate to what extent blanket peatland restoration achieves a **return** (or **mimicking**) of **natural peat structure** (i.e., **function**).

3. Assess whether **alternative restoration interventions** result in **different outcomes**.

4. Incorporate the **carbon costs** (or **carbon footprint**) of conducting blanket peatland restoration into the **overall carbon savings** achieved.

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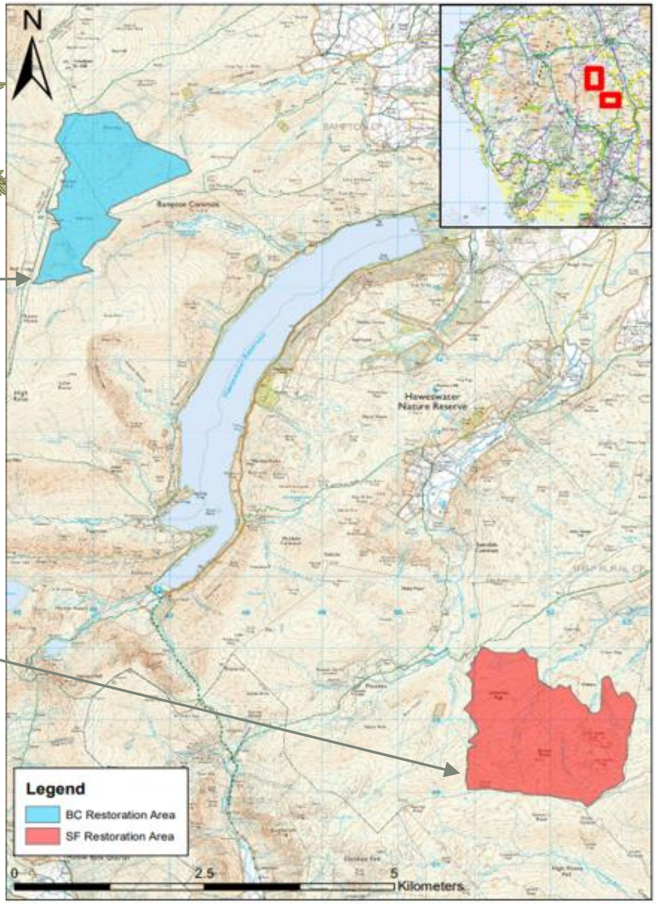
University of Cumbria | Eco-I North West | European Union European Regional Development Fund | NORTHERN POWERHOUSE | BARKER & BLAND LTD

Methodology

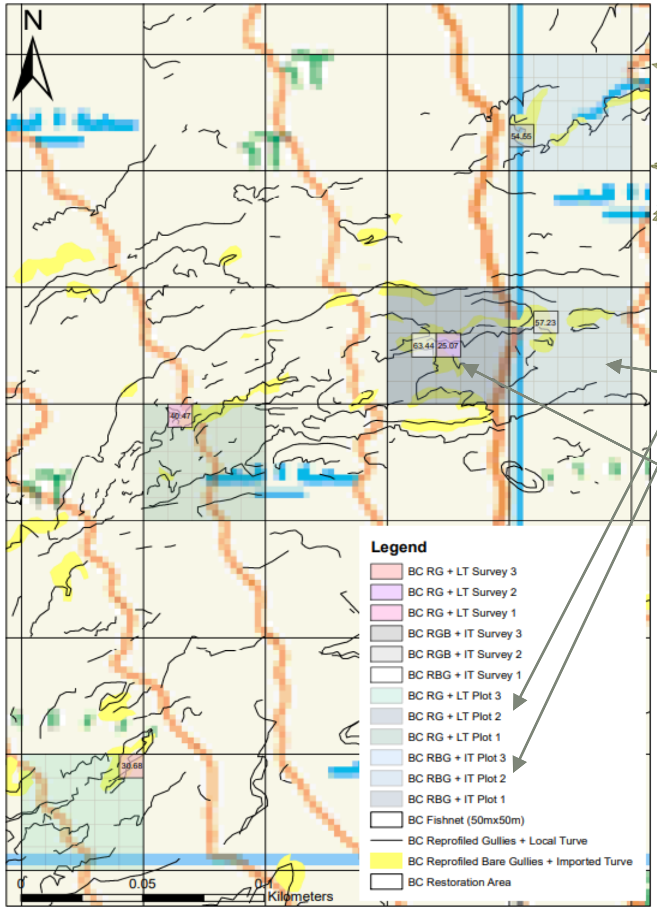
Study Sites (So Far)

- **Bampton Common (BC)**: (central Grid Ref: NY 4559 1547) – areas of **degraded** and **restored** blanket bog present - **restored ~2018-2019**.
- **Shap Fells (SF)**: (central Grid Ref: NY 5063 0889) – areas of **near-natural** and **restored** blanket bog present – **restored 2020-present**.



More sites TBC!

Site Selection (GIS)



- Data on **two** alternative restoration interventions:
  1. Location and **length** of gully and hag reprofiling plus revegetation using **local turves**.
  2. Location and **area** of bare peat zones revegetated using **imported turves**.
- Top 3, 50m x 50m areas identified demonstrating maximum restoration effort for each intervention.
- Most representative 3, 10m x 10m plots selected for ground surveying in each area.
- Replicated for degraded (BC) and near-natural (SF) areas – Initial data provided from satellite imagery.

Site Selection (Ground Surveys)

- An **adapted JNCC (2009) condition criteria** approach – **2m x 2m surveys**.
- 18, 10m x 10m plots – total of **450 surveys**:
  - BC: 3 most **degraded**, 3 most representative **restored (local turve)**, 3 most representative **restored (imported turve)**.
  - SF: 3 most **near-natural**, 3 most representative **restored (local turve),** 3 most representative **restored (imported turve).**
- Most **representative (condition)** 10m x 10m plots selected.
- **Top two,** 2m x 2m **survey plots selected** for **core extraction.**

Peat Core Extraction

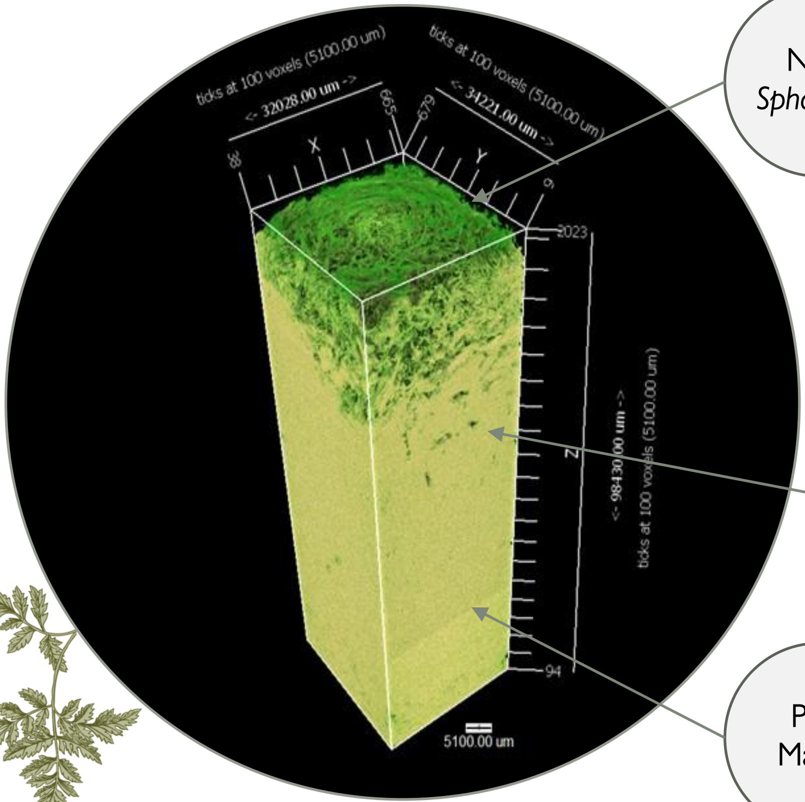
- (1) Degraded → (1) BC Bad Condition
- (8) Restored → (4) BC Old (>5yr) → (2) Local Turve; (2) Imported Turve
- (8) Restored → (4) SF New (<1yr) → (2) Imported Turve; (2) Local Turve
- (1) Near-natural → (1) SF Good Condition
- *(5) Restored - TBC* → *(1) TBC V. Old (>10yr)*
- *(5) Restored - TBC* → *(4) TBC Old (>5yr)* → *(2) TBC Brash Spread*; *(2) TBC Coir Logs*
- *(1) Pristine - TBC* | *(1) TBC Best Condition*

Advanced trimming method of peat core extraction!

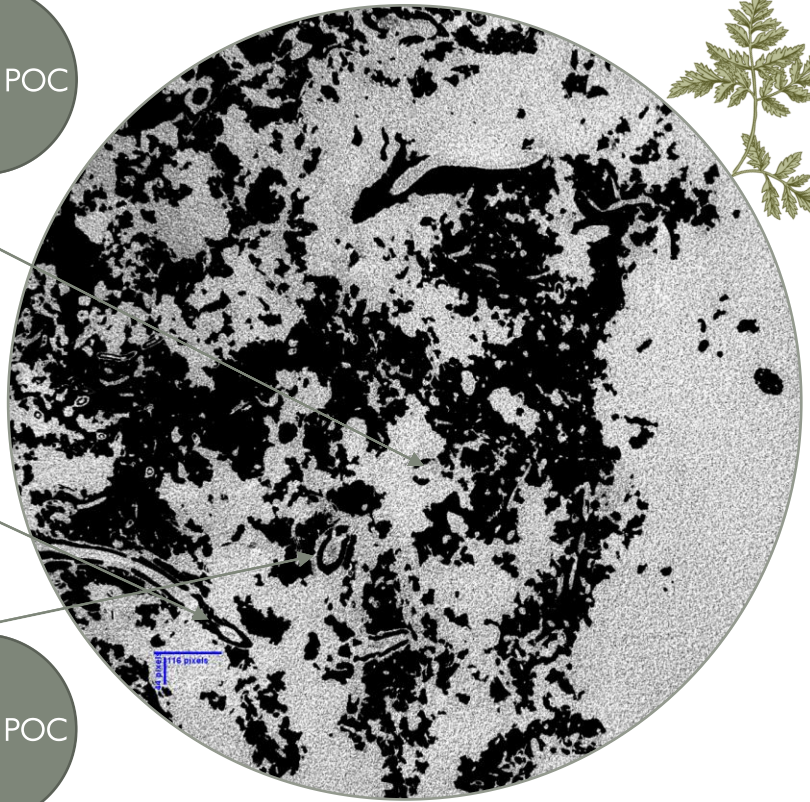
3D X-ray Micro-Computed Tomography

- 3D X-ray Micro-Computed Tomography (**μCT**) is a **non-destructive** imaging technique used to **evaluate** the **3D structure** and **composition** of environmental materials.
- The attenuation of X-ray energy enables the mapping of **density variations** within a sample.
- This study investigates at a **51μm** spatial resolution.

µCT Continued



- New *Sphagnum* → Carbon Sequestration
- Air Filled Pores → Gas Exchange (CO_2 & CH_4)
- Peat Matrix → Retarded Decay
- Water Filled Pores → DOC & POC
- Air Filled Roots → Gas Exchange (CO_2 & CH_4)
- Water Filled Roots → DOC & POC



Field & Laboratory Data Collection

Field measurements (assessed from the **surface – 30cm** depth at **5cm** increments):

1. pH.
2. Redox potential.
3. Soil temperature.
4. Other secondary datasets.

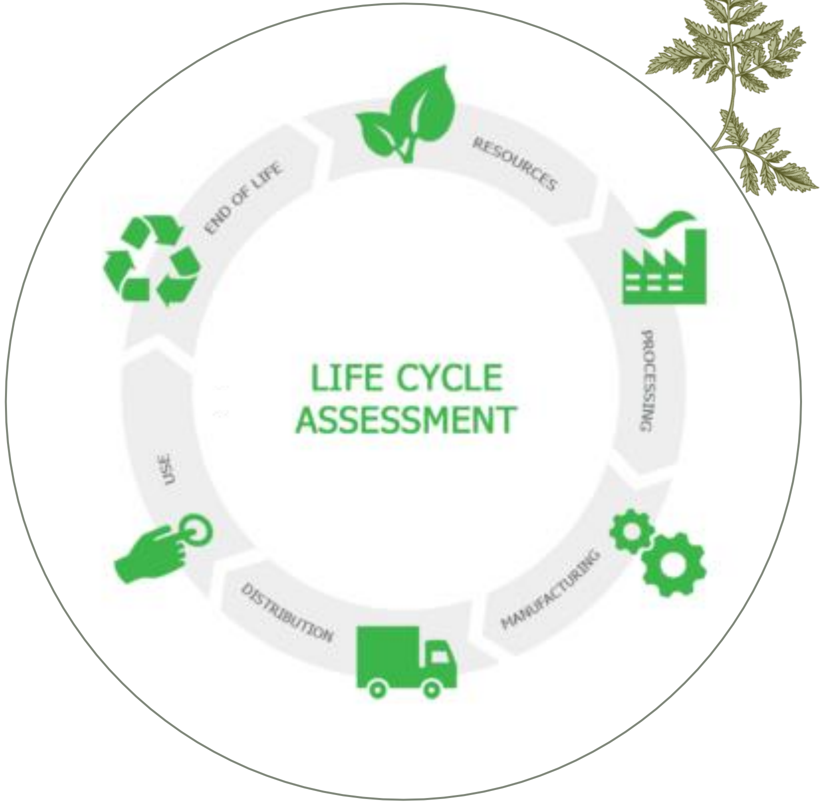
Laboratory measurements (assessed from **5cm – 25cm** depth at **5cm** increments):

1. pH.
2. Redox potential.
3. Moisture content.
4. Bulk density.
5. Organic carbon.
6. Von-Post humification.

Do variables link to peat structure (μCT)?

Carbon Costs of Restoration (LCA)

- Life Cycle Analysis (**LCA**) is a method used to assess the **environmental impact** of a **product** or **service**.
- Peatland restoration represents an '**event**', whereby **both** products and services are used.
- This investigation uses an **adapted LCA approach** to calculate the '**one-way**', **direct** and **indirect** emissions associated with implementing **various** blanket peatland restoration **interventions**.



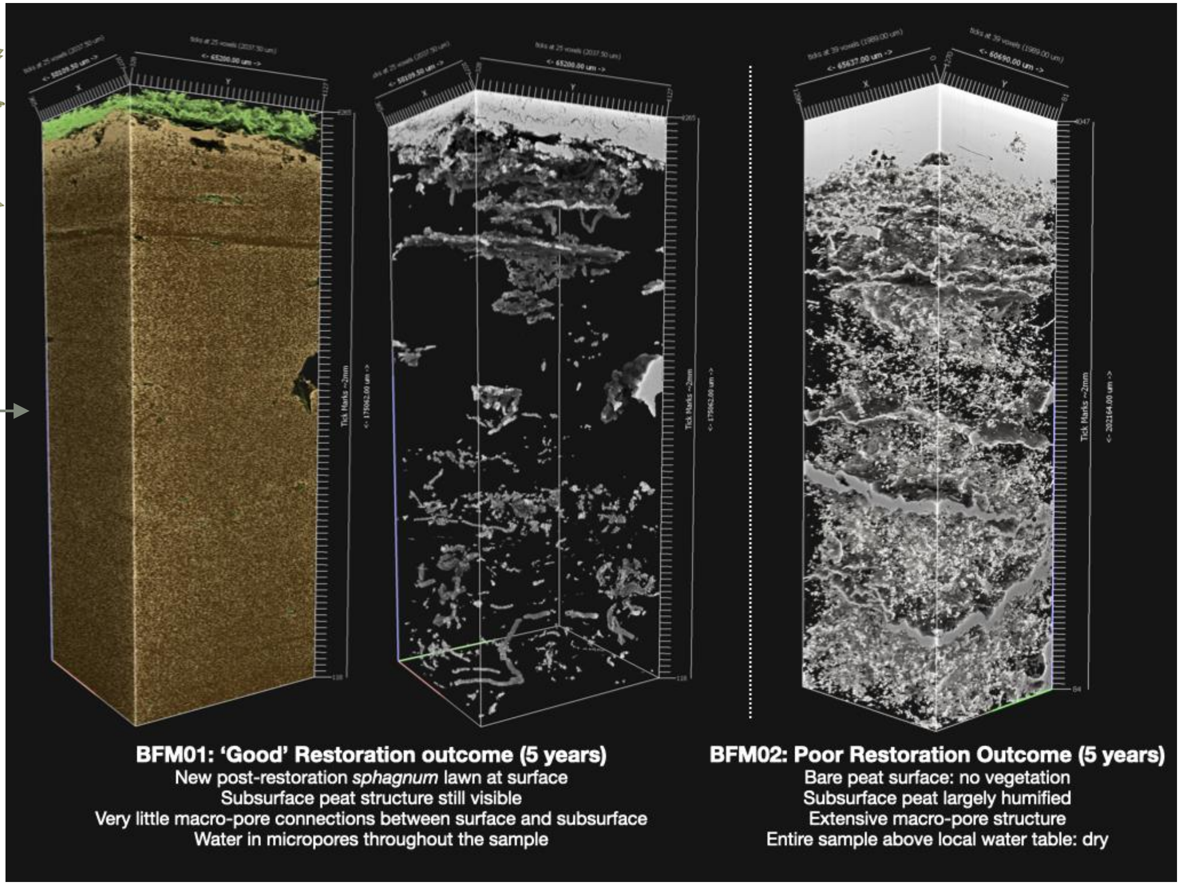
Current Findings

Adapted JNCC Surveys

	BC Local	BC Import.	SF Local	SF Import.	BC Deg.	SF NN
Species Richness Av.	4.87	4.57	5.81	5.93	3.64	7.24
Species Extent Av.	61.80	58.60	76.40	65.53	42.60	94.80
Number of Deg. Features Av.	4.15	3.80	3.76	3.85	4.88	2.96
Degradation Extent Av.	32.87	39.93	52.27	62.07	144.40	22.40
Remaining Extent Av.	28.93	18.67	24.13	3.47	-101.80	72.40

µCT

- **Complete assessment** of µCT for the project is **TBC**.
- Pilot study from Bolton Fell Moss reveals that there is a **significant difference** in **air filled pore space** between **successfully restored** and **un-successfully restored** peatland.
- µCT is a **valuable** tool for **evaluating** peatland restoration.



Field & Laboratory Datasets

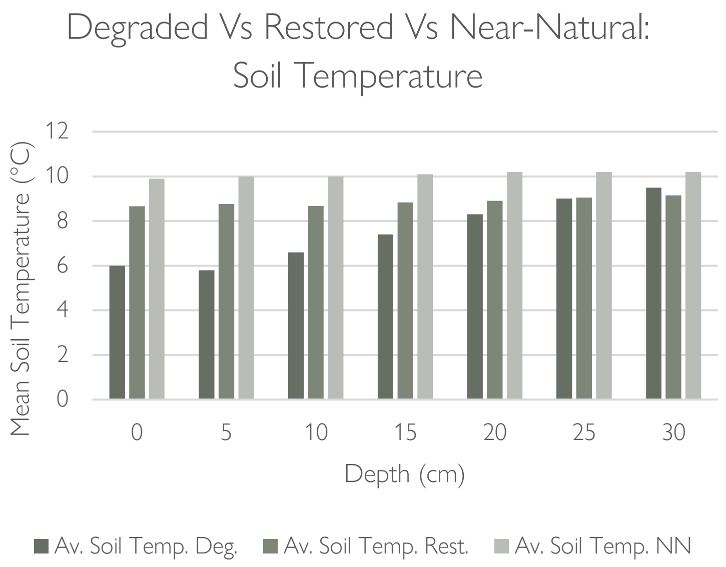
1. The **degraded** site demonstrated the **worst** findings for **soil temperature** (cool & variable), **pH** (very acidic), **redox potential** (oxidising), and **bulk density** (decreasing with depth).
2. The **near-natural** demonstrated the **best** findings for **soil temperature** (warm & stable), **pH** (correct acidity for *Sphagnum* growth), **redox potential** (less oxidising), **moisture content** (very wet), and **bulk density** (increasing with depth).
3. The **restored** sites demonstrated **variable** findings, **rarely** the **worst or best** for each variable assessed.

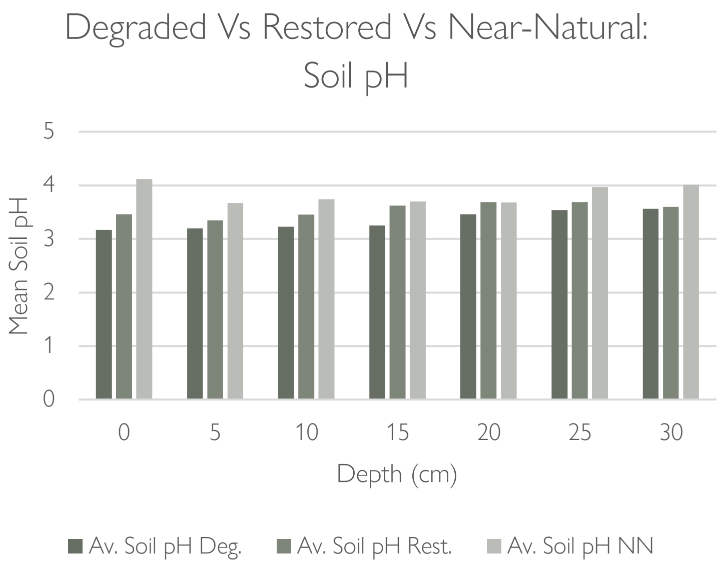
Sample Spectrum of 'Success' TBC:

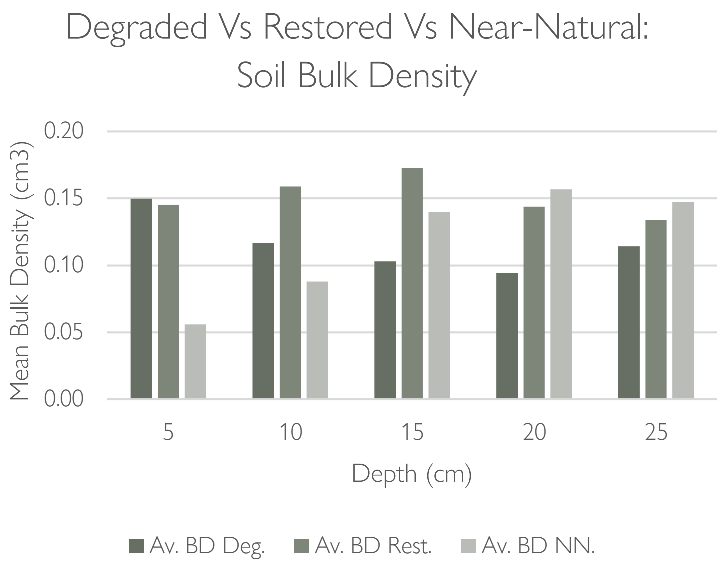
Worst → Best

Degraded | Restored (X) | Restored (Y) | Near-natural

Field & Laboratory Dataset Examples







Carbon Costs of Restoration (LCA)

Coir Logs

VS

Peat Bunds

Unit	GHG Emissions - Coir Log Intervention (CO_2equivalent)	GHG Emissions - Peat Bund Intervention (CO_2equivalent)	Total GHG Reduction (CO_2equivalent)	Percentage Reduction
Per Intervention	0.01529 Tonne	0.00076 Tonne	0.01453 Tonne	**95.0%**
Per Hectare (ha)	1.82 Tonne	0.0327 Tonne	1.79 Tonne	**98.3%**
Annually (Nationally - England)	1,303.68 Tonne	23.42 Tonne	1,280.27 Tonne	**98.2%**
Average Percentage Reduction = 97.2%				

Summary

What's Left to Achieve?

1. **Expand** study sites to include more **pristine, older,** and **diversely restored** examples.
2. **Complete µCT** analysis for each core sample.
3. **Connect** the completed **µCT analysis** with the **field** and **laboratory datasets** to **infer** the impact of **peat structure** on **peat function** – Can any of the **variables** work as a **proxy** for peat structure?
4. **Expand** the **LCA** to further blanket peatland restoration **interventions**, and:
   I. **Compare** the **carbon costs** of restoration to the **carbon benefits** (carbon sequestration rates) inferred through µCT.
   II. **Identify** the **impact** that the **carbon costs** of restoration have on the **overall carbon savings** reported from **projects** (carbon 'pay-back' time) using a case-study approach.

Conclusions (So Far)

1. The **sub-surface** of peat needs to be **investigated** post restoration if we are to **truly understand** the **effectiveness** of **restoration** on returning peat **function**.

2. **μCT** acts as an **effective tool** for **evaluating** the impact of restoration on **peat structure** and **inferring** the influence on peat **function** (carbon sequestration and storage).

3. The **carbon costs** of traditional blanket peatland restoration **interventions** are **significant**.

Thank you

(References available upon request)

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