Peatland mapping

The James Hutton Institute

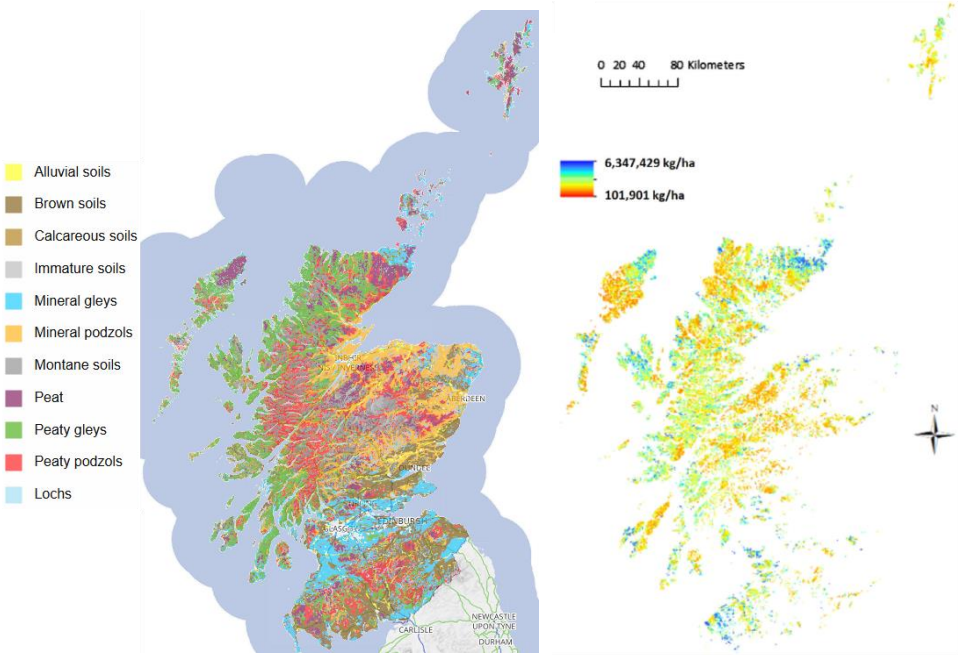
Matt Aitkenhead, Ciaran Robb, Fraser Macfarlane, Malcolm Coull, Margaret McKeen, Doug Wardell-Johnson, Dave Miller, Mohamed Jabloun, Mostafa Tavana, Keith Matthews

Peat extent mapping

Peat mapping in Scotland has been done previously within the National Soil Map of Scotland (Scotland's Soils - soil maps) with mixed map units at 1:250k and by Aitkenhead & Coull (2019) at 100 metre resolution.

Current work uses Scottish Soil Database's National Soil Inventory of Scotland (>20k values for soil C, ~1600 values for Bulk Density (BD)). A machine learning (ML) model was used to link C & BD to spatial covariates and predict both variables in a 10 metre grid at 5 cm depth intervals.

C and BD together can provide carbon stock estimates; C > 30% for a thickness of >50 cm identifies peat. Profile depth was estimated using 10 metre depth or BD > 1.6 g cm^{-3}, whichever came first.

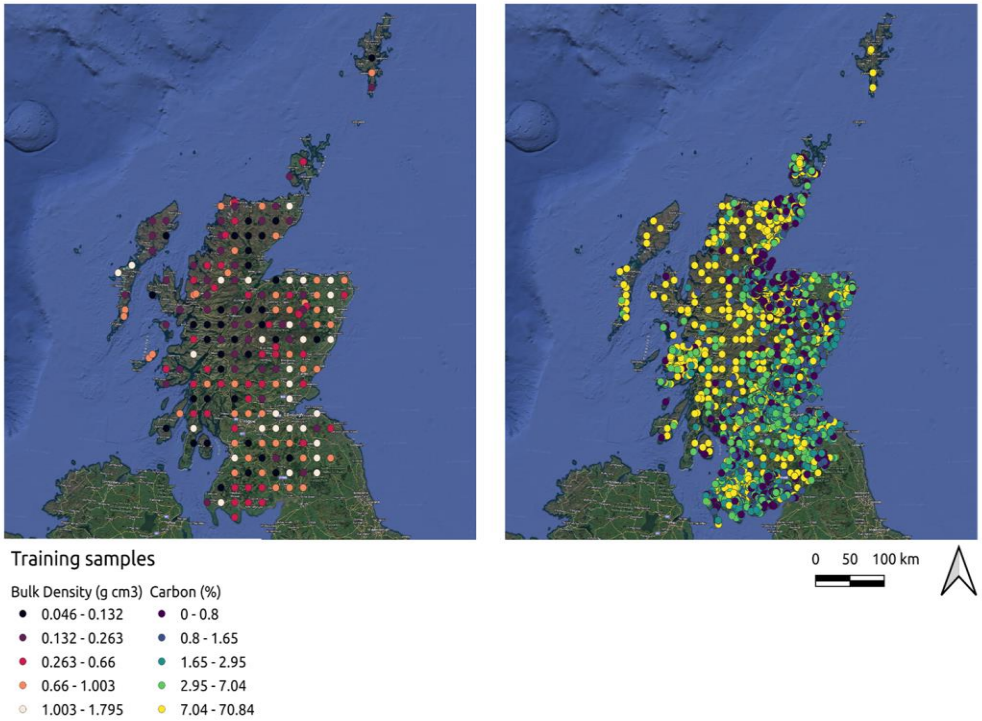


Spatial covariates and modelling

A total of 81 spatial covariates plus depth were used to generate the ML model:

- Topography (12 variables derived from digital elevation map)
- Climate (24 variables, mean monthly rainfall and temperature 1990-2020)
- Soil type (13 variables, dominant soil class)
- Geology (12 variable, reclassed from BGS parent material mapping)
- Land cover (9 variables, reclassed from UKCEH LCS2020)
- Remote sensing (11 variables, individual bands from Sentinel-2 2020 imagery)

Covariate values at each sample location extracted and used to develop model, which can then make predictions of C & BD at any location where covariate values exist.



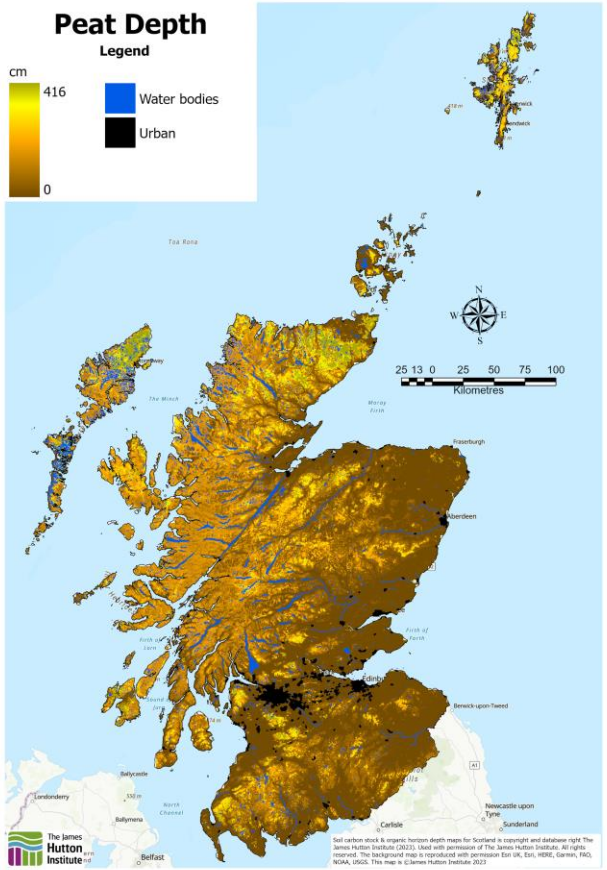
Peat extent & carbon stock

The James Hutton Institute

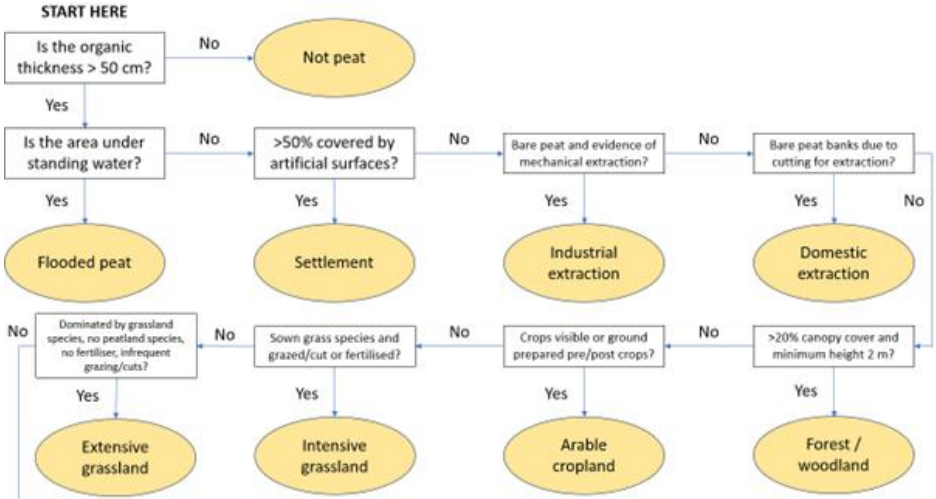
Organic horizon thickness and total carbon stock predicted at 10 metre grid. Some artefacts exist due to the resampling of coarser climate data.

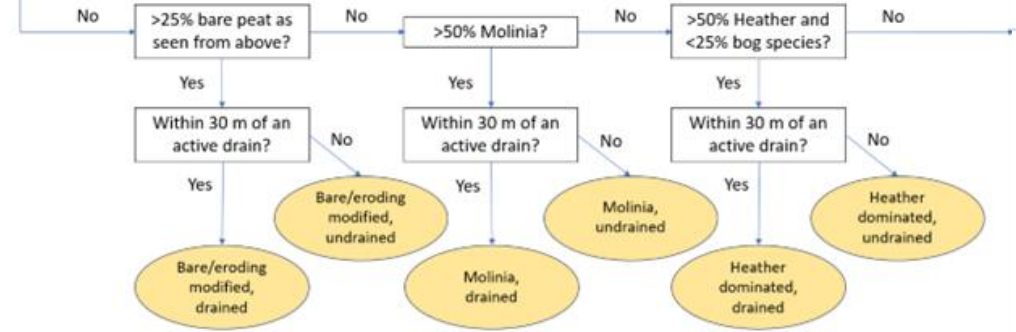
Mapping overall agrees with previous mapping and provides more spatial resolution than before. Peat depth is underestimated on forest soils and for deeper soils (there is a shortage of data points on deep peat due to challenges with sampling). C stock total/local estimation agrees with previous work, identifying more carbon-rich non-peat soils than previous mapping.

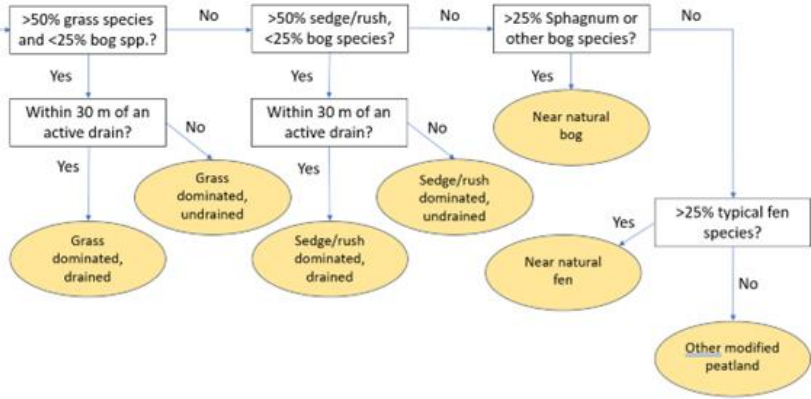
Current work focusing on integrating data from Forest Research, which provides data from several hundred sample points on organic soils within forested areas.



Peat condition mapping: the classes







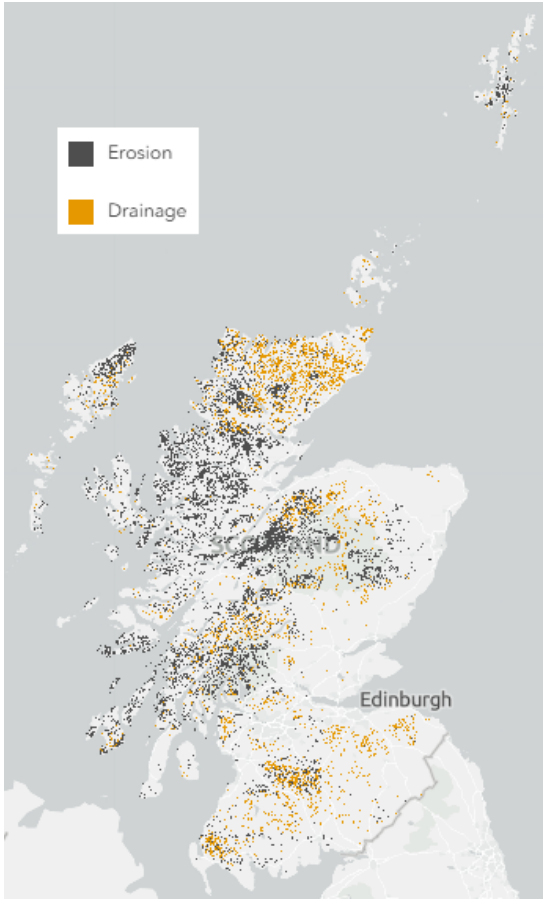
Discussions between JHI, UKCEH, SRUC, NIEA and other organisations have produced agreement on definitions and a working flow diagram of peatland condition classes. While not yet adopted for inclusion within the UK GHG inventory process, this can be considered the UK 'working version' (Rebekka Artz has a version with some additional classes being discussed but not yet finalised – please refer to her for further details).

These are the definitions used in the current work.

Peat condition mapping: spatial datasets

Before we can determine peatland condition class and associated emissions, we first need to determine the area of peatland in Scotland, then identify areas where erosion is present and/or the peat has been drained - these are major factors in classifying peat as 'degraded'. Further details on these datasets can be found on the project storymap at Land Use Transformations.

- Underlying datasets to determine peatland extent: Bulk Density, Carbon Concentration, Soil Profile Depth (Robb)
- Identification of Degradation Features: Drainage & Erosion (Macfarlane)
- Determination of condition class using land use and land cover datasets:
  - Land Cover Map 2021 (LCM) (UKCEH)
  - Scottish Integrated Administration and Control System (SIACS) (SGRPID)
  - Land Cover Map 1988 (LCS88) (MLURI/James Hutton)
  - National Vegetation Classification (NVC) (JNCC)
  - National Forest Inventory (NFI) (Forest Research)
  - National Geographic Database (NGD) (Ordnance Survey)



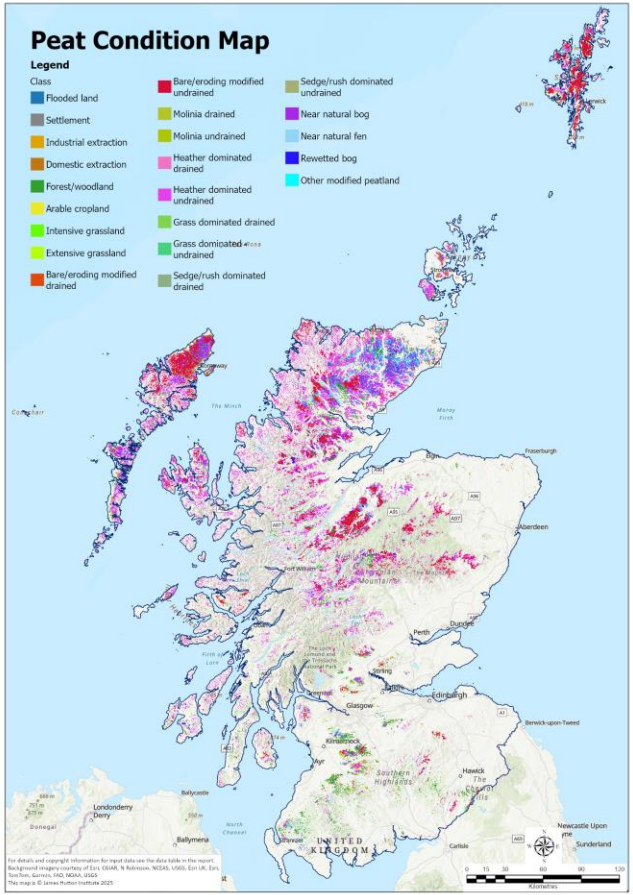
Peat condition mapping: output

Each of the datasets listed on the project storymap at Land Use Transformations was assessed in terms of the evidence it provided for or against individual peatland condition classes. These datasets were not developed specifically with these condition class definitions in mind, and so interpretation was required to determine how they aligned with these definitions.

Accuracy assessment with 500 points selected at random: 83.4% correct identification of condition class. Majority of misclassification is between functionally similar condition classes with same emission factors.

Publications for soil C/BD and drainage/erosion mapping:

- Macfarlane, F., Robb, C., Coull, M., McKeen, M., Wardell-Johnson, D., Miller, D., Parker, T.C., Artz, R.R.A., Matthews, K., Aitkenhead, M.J., 2024. A deep learning approach for high-resolution mapping of Scottish peatland degradation. European Journal of Soil Science 75(4), e13538. https://doi.org/10.1111/ejss.13538.
- Robb, C., Aitkenhead, M., Macfarlane, F., Matthews, K, resubmitted to EJSS. Soil property, carbon stock and peat extent mapping at 10 m resolution in Scotland using digital soil mapping techniques.

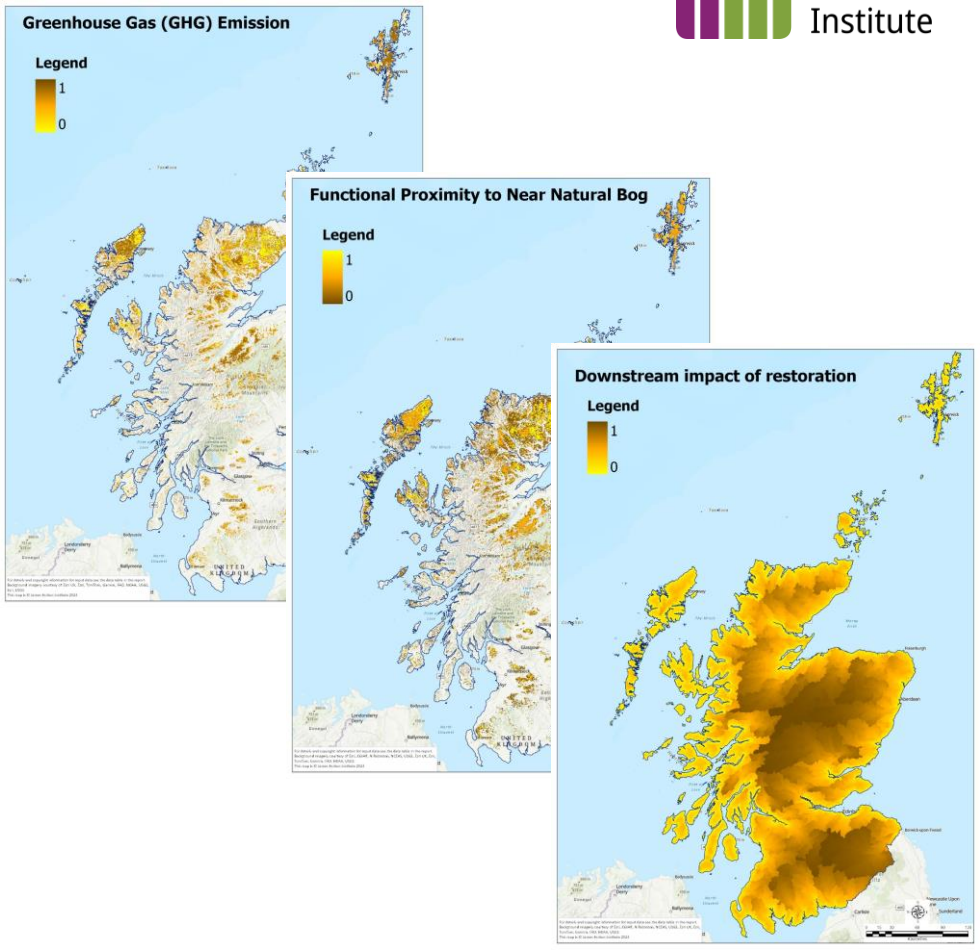


Restoration prioritisation: method

Published in 2014 (WISE booklet v2 Nov 2013 reduced size.pdf), the original WISE concept was designed to provide a decision support tool for identifying where peatland restoration would be most desirable by a range of stakeholder groups. The work was not able to produce some of the datasets that were identified as important in relation to peatland restoration, due to data shortages and computational processing restrictions.

The goal of the current work is to expand on the original WISE concept, with updated datasets and a framework for integrating and analysing these in a manner that goes beyond reliance on small numbers of stakeholders with very different opinions from one another. Datasets were a mix of existing data and those derived using expert opinion/knowledge.

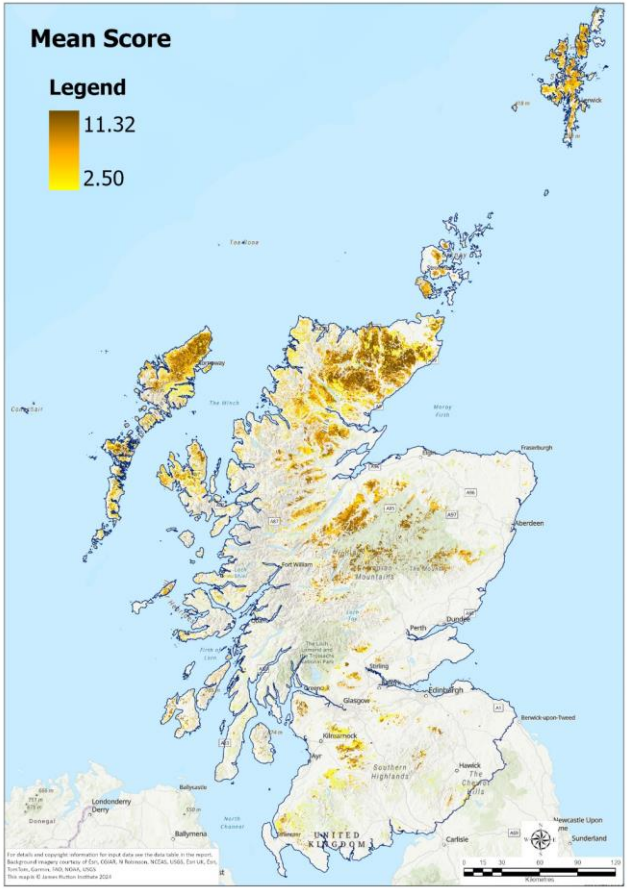
100 random virtual stakeholders were generated with random weighting preference for each of the 25 spatially explicit factors used. Mapped scorings for each virtual stakeholder were combined to identify areas with consistently high scorings (i.e. 'it doesn't matter who you ask, these locations should be prioritised').

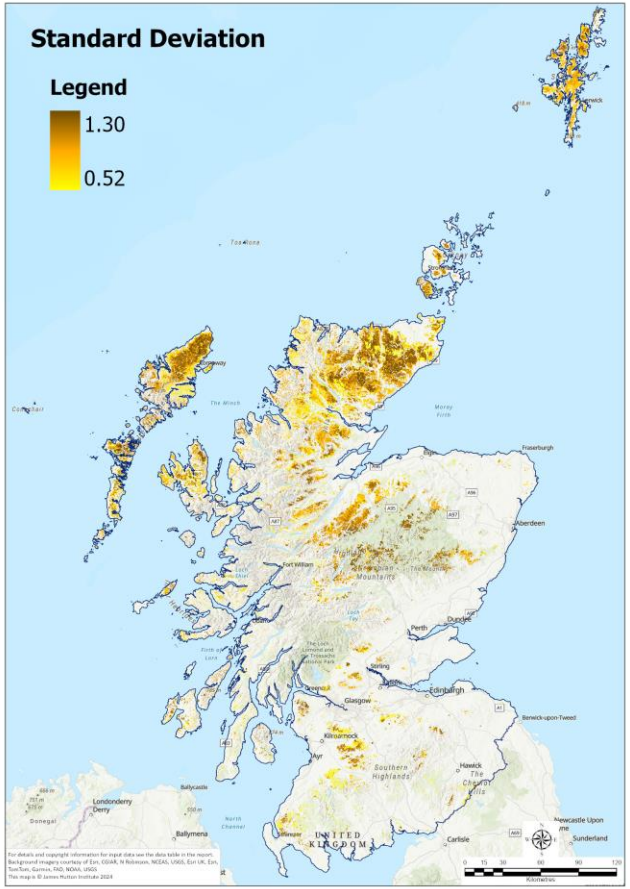


Restoration prioritisation: outputs

Locations with a high mean value and a low or medium variance are likely to be of interest as potential restoration sites. These sites exist across Scotland, but the largest areas are:

- in the Monadliath Mountains
- Loch Ericht and Loch Rannoch
- on and around the Bhlaraidh Wind Farm west of Loch Ness
- the large area of peatland north and west of Loch Glass
- south-west of Ben Armine
- across Shetland generally
- around the head of Loch Reasort on Lewis and Harris
- around the Flow Country
- across the areas of peatland south of Glasgow





The James Hutton Institute

Thank you

For queries contact matt.aitkenhead@hutton.ac.uk

Scottish Government
Riaghaltas na h-Alba
gov.scot

SEFARI

Athena Swan Silver Award
GENDER CHARTER
Stonewall LGBTQ+ INCLUSIVE EMPLOYER SILVER AWARD 2024
THE KING'S AWARDS FOR ENTERPRISE 2023 SUSTAINABLE DEVELOPMENT
We are a Living Wage Employer
disability confident EMPLOYER
UKAS TESTING 7541
UKAS INSPECTION 7541
nqa ISO 9001 QUALITY MANAGEMENT
nqa ISO 14001 ENVIRONMENTAL MANAGEMENT