Long-term macronutrient stoichiometry of UK ombrotrophic peatlands

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Introduction

- Peatlands represent a globally-important store for carbon (C), nitrogen (N) and phosphorus (P) and ombrotrophic bogs (where nutrient input is almost exclusively via atmospheric deposition) across northern latitudes make a significant contribution
- Surprisingly few published studies investigating the patterns of and controls on the long-term (centuries to millennia) accumulation, cycling and stroichiometry of C, N and P in ombrotrophic peatlands: Sweden (Damman 1978 *Oikos*), Indonesia (Weiss et al. 2002 *GeCA*) and North America (Gorham and Janssons 2005 *Wetlands*; Wang et al. 2014 *ERL*; 2015 *GBC*)
- Despite the importance of ombrotrophic peatlands as a wetland ecosystem across Britain, a UK perspective on long-term nutrient cycling has not previously been obtained

Key research objectives

- Report the first data on long-term macronutrient stoichiometry and accumulation rates in ombrotrophic peats across Britain
- Examine whether surface enrichment of N and P is present and consider evidence that biological recycling is primary driver (conventional view)
- Conduct a comparison of UK trends with the few existing, comparable datasets worldwide

Data and methods

- Triplicate cores (95 - 417 cm length) from five sites along a N-S gradient were sub-sampled at 10 cm intervals
- Bulk density and loss-on-ignition values were determined. C and N were measured on an Elementar Vario-EL analyser, P measured colorimetrically using a scalar continuous flow analyser
- Fifteen 14C ages (three per site) were obtained by AMS from NRCF
- C, N and P data were also compiled for ten existing profiles (<120 cm deep, 3-5 discrete samples) extracted as part of the National Soil Inventory of Scotland

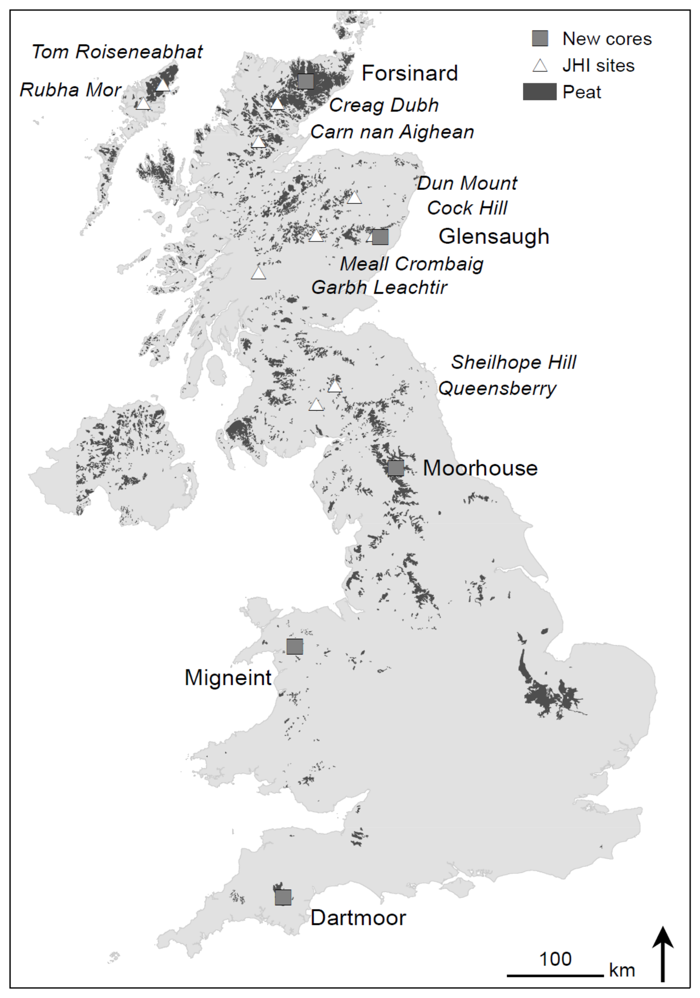

Figure 1. Sampling locations.in relation to the distribution of peat (including fen peat)

C:N:P stoichiometry of UK peats

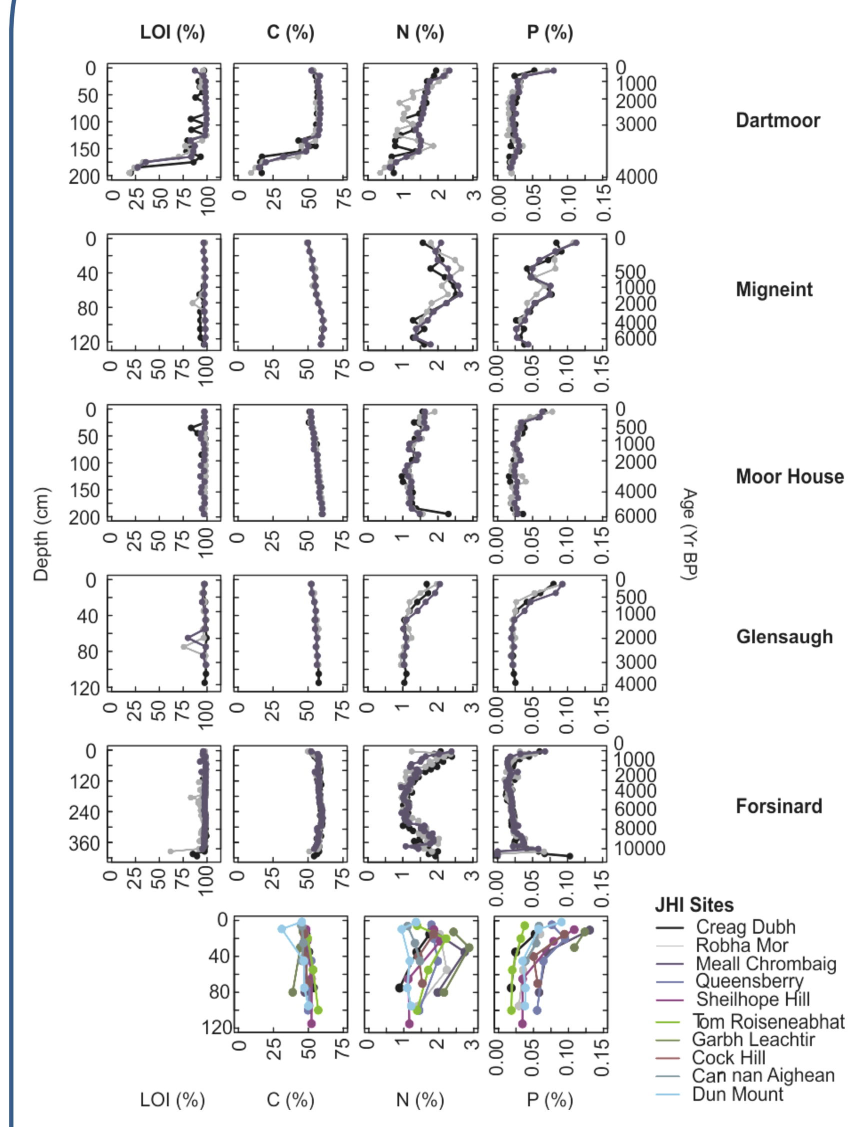

Figure 2. Depth profiles of LOI, C, N and P concentrations

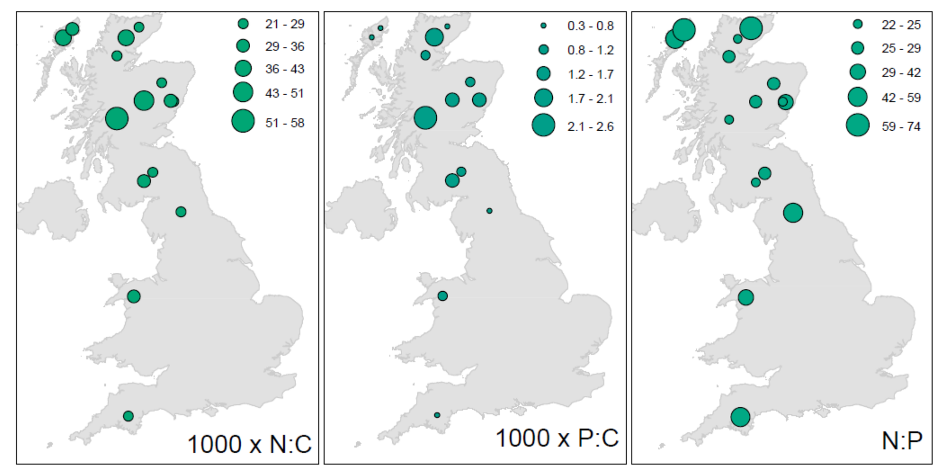

Figure 3. Spatial variation in C:N:P stoichiometry across the UK

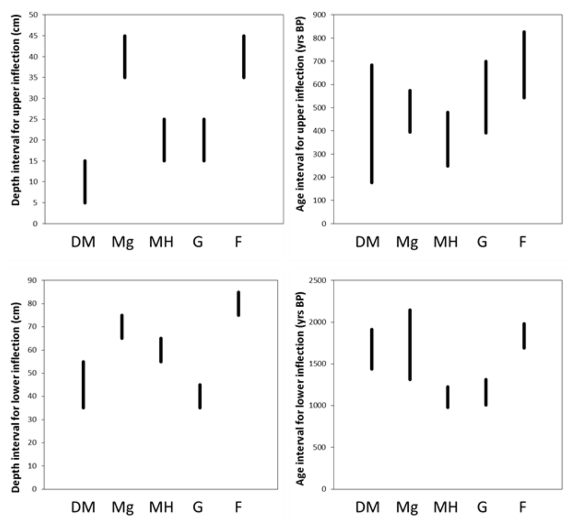

Figure 4. Depth and age intervals at which an inflection towards higher N and P is recorded

- Excluding zones presumably reflecting basal soil/fen, N and P concentrations (and stoichiometric ratios) were stable through the early and mid-Holocene
- Surface enrichment of P is observed at all sites (0-20cm = 2.4x higher than 20-120 cm), consistent with those few existing case studies, and ten of the 15 sites exhibit maximum N in the surface layers
- Profile inflections show greater between-site consistency for age than for depth, behaviour that could be explained by variable external supply (dust?) alongside translocation in plants - further research is warranted
- Holocene average accumulation rates of carbon, nitrogen and phosphorus are 25.0 ± 0.74 gC m^{-2} yr^{-1}, 0.64 ± 0.024 gN m^{-2} yr^{-1} and 0.015 ± 0.001 gP m^{-2} yr^{-1}, similar to values reported elsewhere

Comparison with global sites

Table 1. UK and global stoichiometry and accumulation rates

Location	N:C	P:C	N:P	C accumulation (gC m^{-2} y^{-1})	N accumulation (gN m^{-2} y^{-1})	P accumulation (gP m^{-2} y^{-1})
UK (mean)	0.0294 ± 0.0022	0.00086 ± 0.00016	44.4 ± 5.2	25.0 ± 0.7	0.64 ± 0.02	0.015 ± 0.001
Québec[2]	0.0258	0.00051	50	22.7	0.57	0.015
Ontario[3]	0.0303 ± 0.0005	0.00075 ± 0.00001	46.4 ± 0.9			
Minnesota[6]	0.0154	0.00050	30.8	26	0.4	0.013
Québec[6]	0.0175	0.00045	38.8	27	0.55	0.014
Maine[6]	0.0170	0.00034	50.0	37	0.47	0.0093
Newfoundland[6]	0.0123	0.00021	58.2	37	0.46	0.008
Labrador[6]	0.0153	0.00034	45.0	24	0.36	0.0081

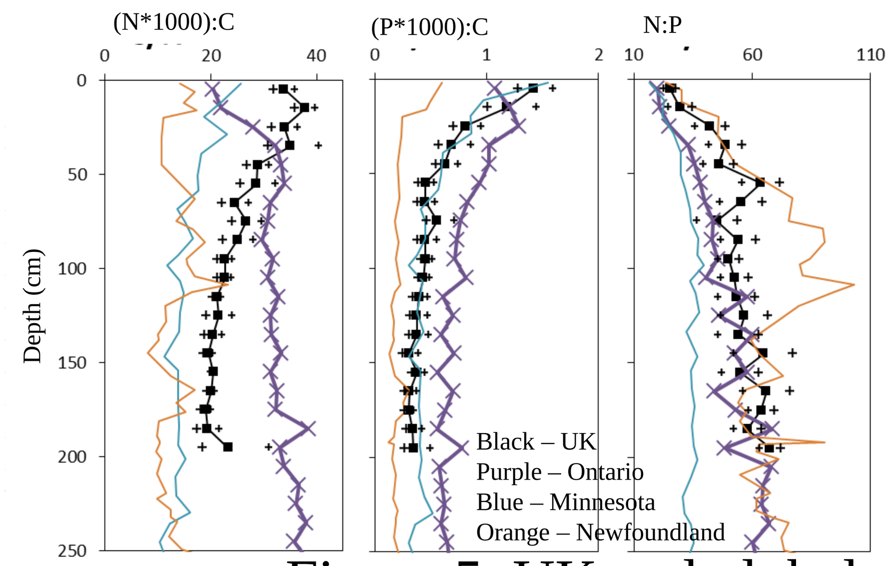

Figure 5. UK and global stoichiometric profiles

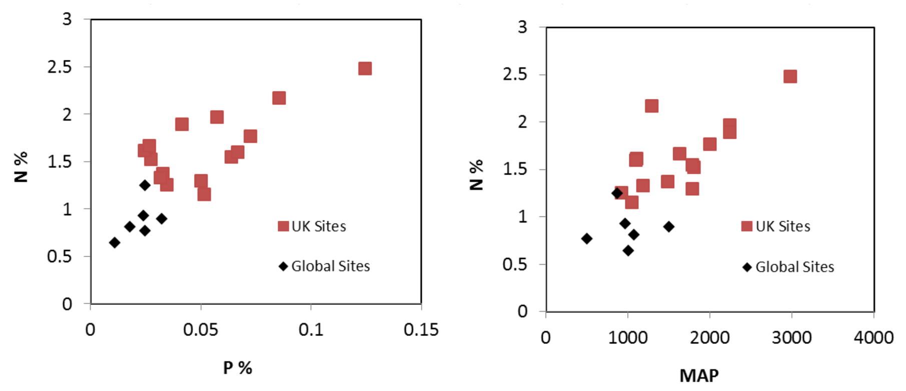

Figure 6. UK and global relationship of P% and MAP with N%

A multiple regression model examining the interaction of N% with P%, MAP and MAT (following Toberman et al. 2015 *Biogeochemistry*) reveals both P ($c1 = 0.32$, $p = 0.0046$) and MAP ($c2 = 0.31$, $p = 0.033$) exert statistically significant effects on N concentrations over large temporal (centuries to millennia) and spatial (inter-hemispheric) scales.