Long-Term Large-Scale Project

Net primary productivity

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Model testing

- The N14CP ecosystem model calculates NPP over space and time for different vegetation types, producing predictions for 5x5 km grid cells (c 10,000 for the UK as a whole).
- We compared the model predictions with 825 estimates of NPP based on peak biomass measurements for grass, peat and shrubs, and from data for tree growth, litterfall etc. Many of the data came from JA Milne et al (Grass and Forest Science, 2002).
- Average values from individual plot measurements agreed reasonably with average modelled values (Table 1), but there were no significant correlations among results for individual sites.
- We standardised* the NPP values by vegetation type to create a single response variable. This varied significantly ($p<0.001$) with cumulative N deposition (obtained from the model in Poster 1), in line with model predictions (Figure 1).

* *Each measured NPP value was divided by the average for the vegetation type.*

Bracken phytometry

- Plant productivity is a key process for C and nutrient fluxes.
- Measuring (NPP) in many semi-natural ecosystems is difficult, but bracken is not affected much by herbivory or repeated cutting, so is suitable for a snapshot NPP survey (Figure 2).
- We hypothesised that N pollution has led to ecosystems being P- rather than N-limited, and thus that NPP would be correlated with soil organic-P but not with soil total N/C.
- The results (Figure 3) were surprising, showing no relationship of NPP with organic P stock, but significant relationships with soil K and Mo stocks.
- Potassium, like N, makes up a substantial proportion of plant tissue and is susceptible to loss. Molybdenum makes the most efficient nitrogenase co-factors, and so may have limited pre-industrial N fixation.
- Essential elements other than N and P may limit productivity.

Table 1. Average observed semi-natural NPP (gC m^{-2} a^{-1}) compared with values estimated with the N14CP ecosystem model.

	n	Obs	N14CP
Grassland	*184*	**424**	**311**
Shrubs	*393*	**382**	**422**
Peatlands	*98*	**414**	**270**

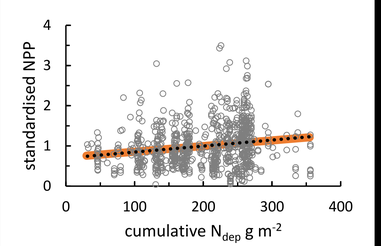

Figure 1. Standardised NPP vs. cumulative Ndep. Dotted black line is the regression, full orange line is the model prediction.

Figure 2. Above-ground biomass harvested from 1 m^2 plots in late July / early August

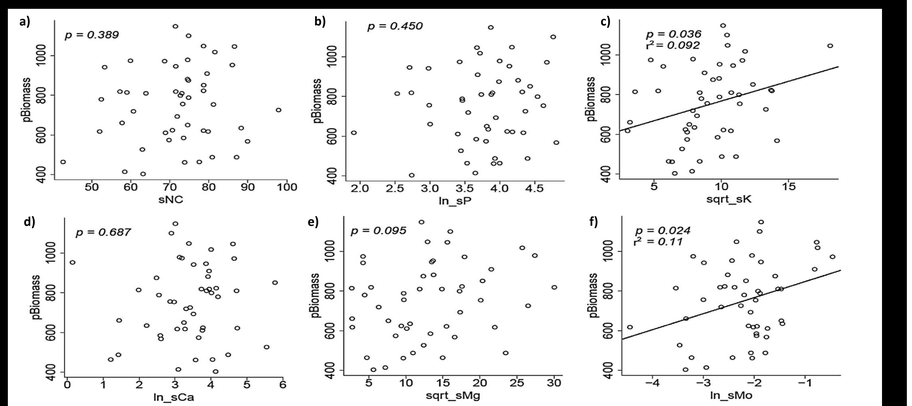

Figure 3. Relationship of above-ground biomass (g m^{-2}) with a) soil total N/C, mg g^{-1}; b) ln(soil organic P stock), c) soil K $stock^{0.5}$, d) ln(soil Ca stock), e) Mg $stock^{0.5}$, f) ln(Mo stock). Stocks are all expressed in g m^{-2}.

Conclusions

- N14CP provides reasonable predictions of NPP at large scales and how it depends upon fertilisation by atmospheric N deposition.
- Variation in NPP within a single habitat is related to nutrient availability. For bracken, the limiting nutrient seems to be neither nitrogen nor phosphorus, but potassium.

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Peat

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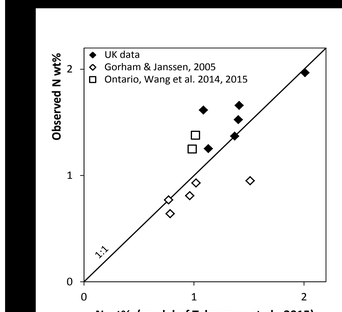
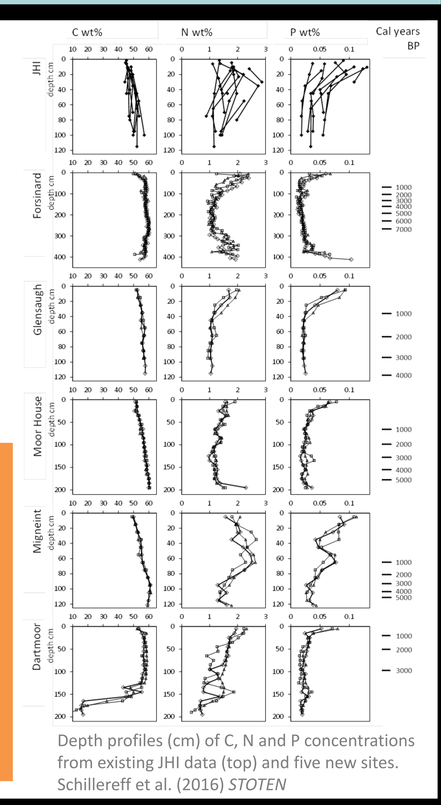
Long-term (4000-10000 years) macronutrient concentrations and accumulation rates are reported from 15 ombrotrophic bogs along a N-S gradient across the UK.

Cores from five new sites sub-sampled at 10 cm intervals, measured for C & N (EL analyser) and P (colorimetrically) and dated with ^{14}C.



Predicted N concentration from P concentration and MAP (Toberman model) shows good agreement with new UK and global observations

Integrating long-term nutrient concentrations into the Toberman (2015, *BGC*) regression model reveals an association between N, P and MAP. This is consistent with a key role for P in biological fixation of N & C and/or a common source (plant material, bird faeces)



Depth profiles (cm) of C, N and P concentrations from existing JHI data (top) and five new sites. Schillereff et al. (2016) *STOTEN*

Conclusions

- Surface P enrichment (2.4x) is a consistent feature; N elevated at top of some cores. Plant recycling to minimise nutrient limitation in operation, external supply (biological debris, dust) unquantified
- Long-term C, N and P accumulation rates are 25.3±2.2, 0.70±0.09 and 0.018±0.004 g m^{-2} yr^{-1} (mean±SE), similar to global values
- Nutrient budgets estimate long-term N-fixation rate of 0.8 g m^{-2} yr^{-1}

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