Does enhanced N deposition represent a threat to *Sphagnum* and thus the sustainability of Scottish peatlands?

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Peatlands

- Northern peatlands cover 2-3% of land surface
- Divided into 2 groups: **bogs** that only receive water and nutrients from the atmosphere and **fens** that also receive them from soil or run-off
- **Low nutrient availability**, especially nitrogen (N)
- Peatland ecosystems **accumulate peat**; the high water table and acidic, anaerobic conditions mean that the decomposition rate is lower than primary production
- The accumulation of peat **stores large amounts of carbon (C)** , the boreal peatlands have accumulated an estimated 455 Pg of C after last glacial period
- The formation of peat also locks up other nutrients, e.g. N
- Have **specialist plant species** that are adapted to these nutrient poor conditions; provide important habitats for many bird species

Nitrogen deposition

- Nitrogen naturally forms **part of the biogeochemical cycle**
- Natural sources include lightning and nitrification in the soil
- **Anthropogenic N fixation activities** generate additional N approximating to **70% of total N emissions**
- N emissions come mainly from combustion: transport, industry, energy production and agriculture
- Can be deposited as dry deposition or with rain as wet deposition
- The main forms in which N is deposited are nitrate (NO_3^-) and ammonium (NH_4^+)
- For bog ecosystems the critical load of N when negative effects start to appear has been estimated to be 5-10 kg ha^{-1} y^{-1}
- This is being exceeded in many parts of Europe

Sphagnum mosses

- Take up water and nutrient directly from rain
- *Sphagnum* mosses grow indefinitely from the top, decomposing from the lower parts at the same time making them the **main peat formers** in bogs
- **Store large amount of N** in slowly decomposing tissue making it unavailable for vascular plants
- Have morphological and physiological properties, which they use to **create nutrient poor and acidic conditions** that favour them
- Well adapted to the nutrient poor conditions and they have **low physiological tolerance of higher N** conditions
- Because *Sphagnum* mosses capture all the nutrients from the atmosphere and are sensitive to changes in nutrient balance they can be the **first indicators of changes in atmospheric deposition**

The effects of increased N on *Sphagnum* mosses and the C balance of peatlands

- Excessive N can cause **nutrient imbalance or even be toxic** to *Sphagnum*
- Early responses of *Sphagnum* have included increased growth but where N deposition exceeds demand a variety of negative effects, including **decreased growth**, may be observed
- Increased N can also possibly **increase decomposition** rates which together with decreased growth can **decrease the amount of peat and C that is being accumulated**
- The effects on *Sphagnum* are different in short-term and long-term, so far there is little information on the effects over the longer time frame
- When N deposition is too high *Sphagnum* can not take up all the N and more leaches to the roots of vascular plants; this leads to **changes in the vegetation composition** by increasing the amount of faster growing, N loving species and decreasing the amount of *Sphagnum*; this also leads to decreased peat and C accumulation

Aims of my research

1) Compare the effects of different forms and loads of N on the growth, decomposition and CO_2 fluxes of *Sphagnum* mosses

2) Produce information that can be used in management of bogs in Scotland to offset problems caused by N deposition

Results so far

- My results confirm that increased N **reduces length growth** but also that N **decreases decomposition rates** in *Sphagnum*
- Therefore my results so far are **contradictory concerning the C sink function of peatlands**

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