

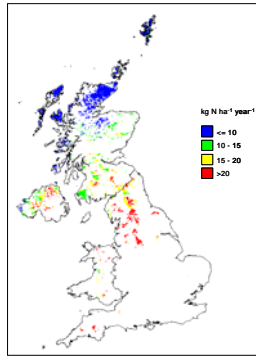
THE EFFECTS OF INCREASED ATMOSPHERIC NITROGEN ON OMBROTROPHIC BOG VEGETATION.

I. D. Leith, L. J. Sheppard, N. van Dijk, J. N. Cape & M. A. Sutton

Centre for Ecology and Hydrology Edinburgh, Bush Estate, Penicuik, Midlothian EH26 0QB, UK

Background

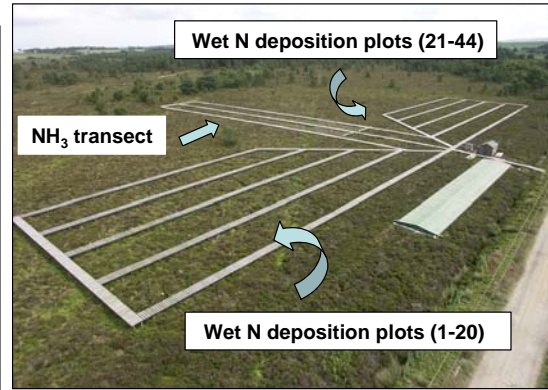
- Increased atmospheric nitrogen (N) deposition is a major threat to semi-natural vegetation in the UK.
- However, the impacts of the different forms of N (ammonia (NH₃) concentrations, oxidised and reduced N (as NH₄⁺ or NO₃⁻) in precipitation) on ombrotrophic bog vegetation, are less well known.
- In a unique field N manipulation facility, which mimics natural temporal exposure the impacts of dry (gaseous NH₃) deposition and wet N deposition were directly compared.
- N treatments with added P and K were also incorporated into the experimental design to evaluate their influence on N effects.



Total N deposition 2003-2005 overlaid on the bog habitat distribution of the UK.

Objectives

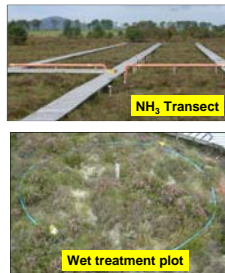
- Evaluate directly the relative importance of wet deposited reduced versus oxidised N and dry deposited NH₃ as drivers of the responses of semi-indigenous species to N.
- Quantify responses of keystone bog species e.g. *Calluna*, *Erica*, *Sphagnum* spp., moss and lichen species to known inputs of wet deposited reduced and oxidised N and dry deposited NH₃ under field conditions.
- Provide field evidence of the effects of quantified N deposition on a range of species and link to indicators of N uptake such as foliar N.
- Show how effects of N can be modified by interaction with other abiotic and biotic stresses.



Whim Bog N Manipulation Facility, Scottish Borders.

NH₃ fumigation

Using an automated computerised system, gaseous NH₃ was released along a 60 m transect over bog vegetation when the wind speed was > 2.5 m s⁻¹ and the wind direction was in the sector 180-215°. NH₃ concentrations were monitored using a series of passive NH₃ samplers positioned at distances of 1, 2, 4, 6, 8, 12, 16, 24, 32, 40, 60m and at a height of 0.1m above the vegetation along the transect and at background positions.

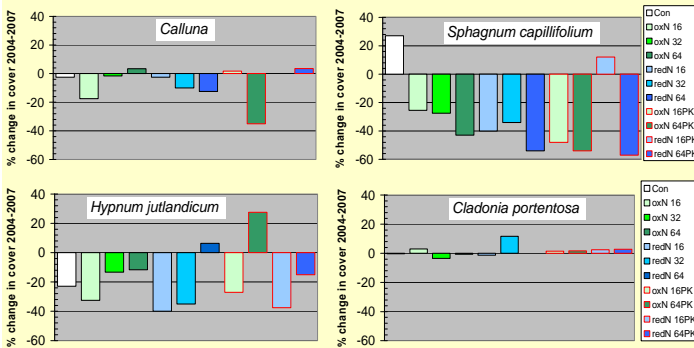


Wet N treatments

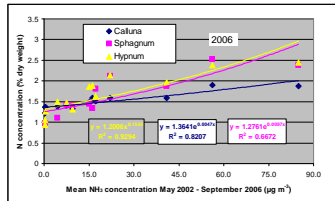
Using the precipitation collected from a 178 m² roof, 10 wet N treatments and a control treatment were automatically applied when there was sufficient precipitation and the wind speed was < 5 m s⁻¹. N was applied either as NaNO₃ or NH₄Cl at concentrations < 4 mmol. Additional P and K treatments were applied as K₂HPO₄ (N:P ratio 14:1) at 8 and 56 kg N ha⁻¹ y⁻¹. N was applied to the 44 treatment plots (plot area=12.5 m²) as fine droplets.

Treatment	N form	P & K added	Wet N degn. kg N ha ⁻¹ y ⁻¹	No. of replicate plots
CONTROL		No	8	4
oxN 16	NaNO ₃	No	Ambient + 8	4
oxN 32	NaNO ₃	No	Ambient + 24	4
oxN 64	NaNO ₃	No	Ambient + 56	4
redN 16	NH ₄ Cl	No	Ambient + 8	4
redN 32	NH ₄ Cl	No	Ambient + 24	4
redN 64	NH ₄ Cl	No	Ambient + 56	4
oxN+PK 16	NaNO ₃	Yes	Ambient + 8	4
oxN+PK 64	NaNO ₃	Yes	Ambient + 56	4
redN+PK 16	NH ₄ Cl	Yes	Ambient + 8	4
redN+PK 64	NH ₄ Cl	Yes	Ambient + 56	4

Species cover comparison (wet N treatments)

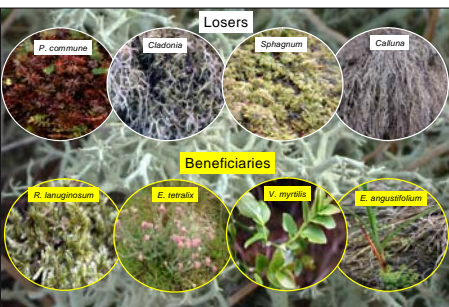
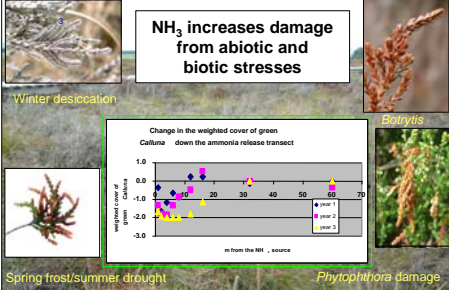


%N (Ammonia Transect)



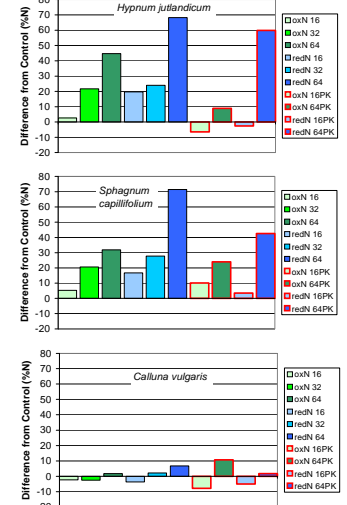
Catastrophic loss of keystone species with high NH₃ concentrations

Damage to Calluna



Impacts of enhanced N is species specific

%N conc. difference from control



Dramatic increase in *H. jutlandicum* in high NO₃⁻ + PK treatment and colonisation of nitrophytic lichens on the larch boardwalks.

Ammonia transect

- The impact of dry NH₃ deposition on vegetation is greater than wet N deposition (NH₄⁺ or NO₃⁻) on a per unit N input.
- High ammonia concentrations causes death of lichen, *Sphagnum*, moss species and *Calluna*.
- Continued loss of these species along transect at lower NH₃ concentrations with time.
- %N increases in *Sphagnum*, moss and *Calluna* with increasing NH₃-N deposition.
- NH₃ concentration increases susceptibility to abiotic and biotic stresses.

Wet N deposition (NO₃⁻ & NH₄⁺)

- No loss of species after 5 years of N treatment.
- High wet N deposition of NO₃⁻ and NH₄⁺ is now after 4 years of treatment starting to cause visible injury symptoms in *Sphagnum* and lichens.
- Effects of wet N (NO₃⁻ and NH₄⁺) greater on lower plants than vascular plants.
- The impact of NH₄⁺ on lower plants is greater than NO₃⁻ per unit N.
- Reduction in cover of *Sphagnum* and moss species but no large effect on *Calluna* with increasing NO₃⁻ and NH₄⁺ deposition.
- %N increased in moss and *Sphagnum*, but not in *Calluna*.
- Damage from abiotic and biotic stress is less pronounced in the wet treatments compared to dry e.g. spring frosts, pathogen attacks.

Wet N deposition (with additional P&K)

- Increase in *H. jutlandicum* cover in NO₃⁻ + PK but not in NH₄⁺ + PK.
- Increase in nitrophytic lichens in NO₃⁻ plus PK but not in the NH₄⁺ plus PK.
- Negative NO₃⁻ + PK interaction on *Calluna* cover.
- PK reduces %N in both the NO₃⁻ and NH₄⁺ treatments.

Contact: Ian Leith:
idl@ceh.ac.uk

