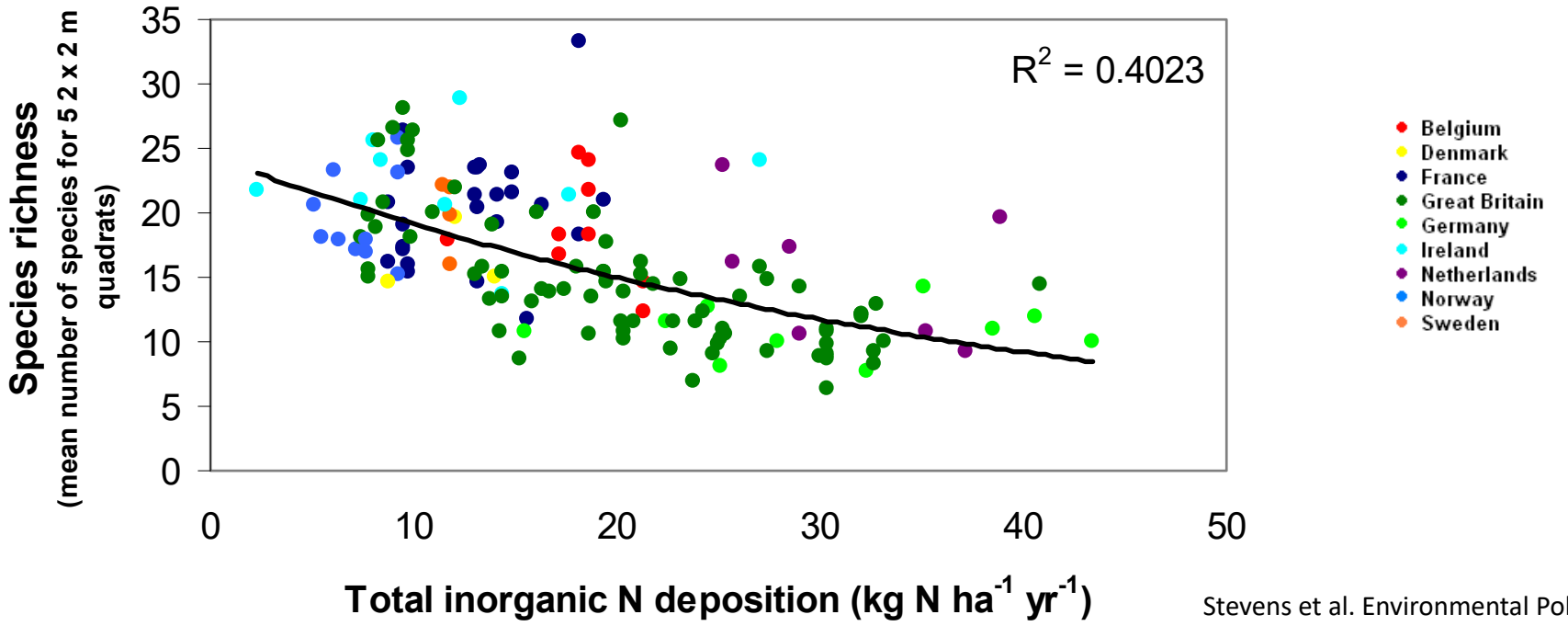
Recovery from nitrogen deposition? A European perspective

Carly Stevens

Lancaster Environment Centre

Lancaster University

Impacts on species richness



Stevens et al. Environmental Pollution, 2010

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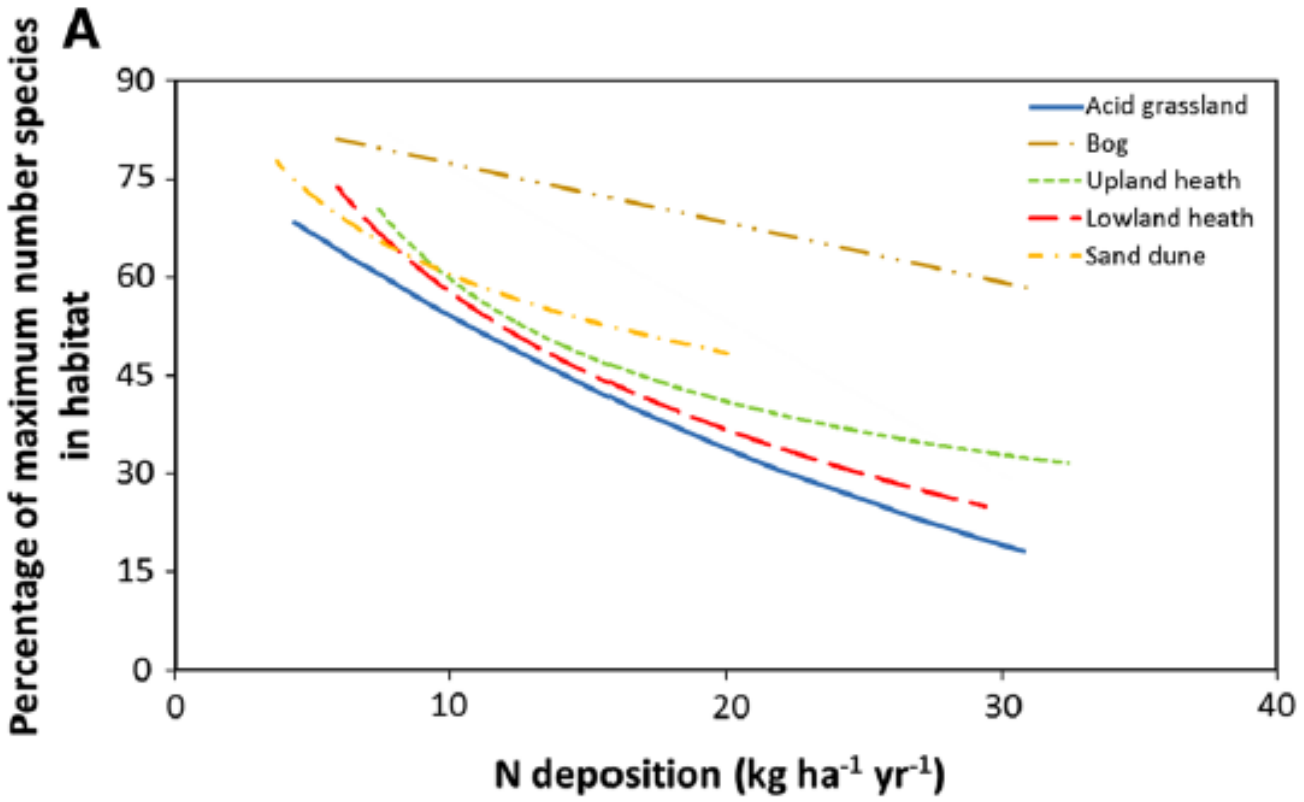
Impacts on species richness



Field et al., 2014 Ecosystems

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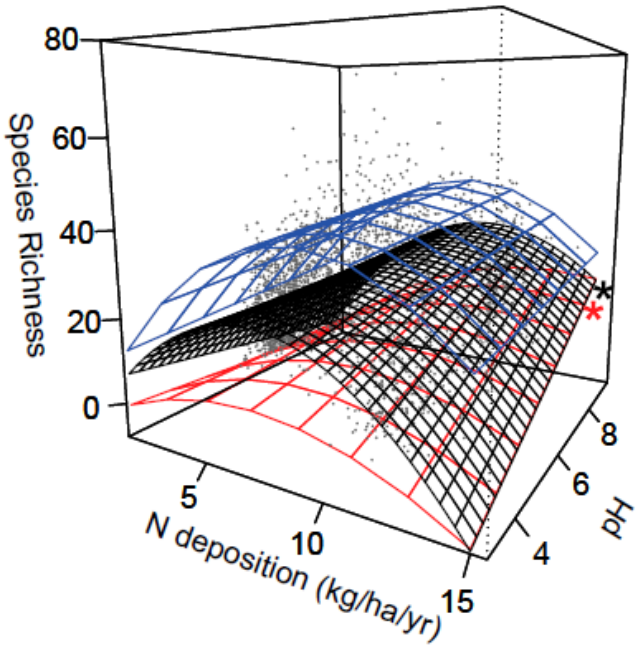
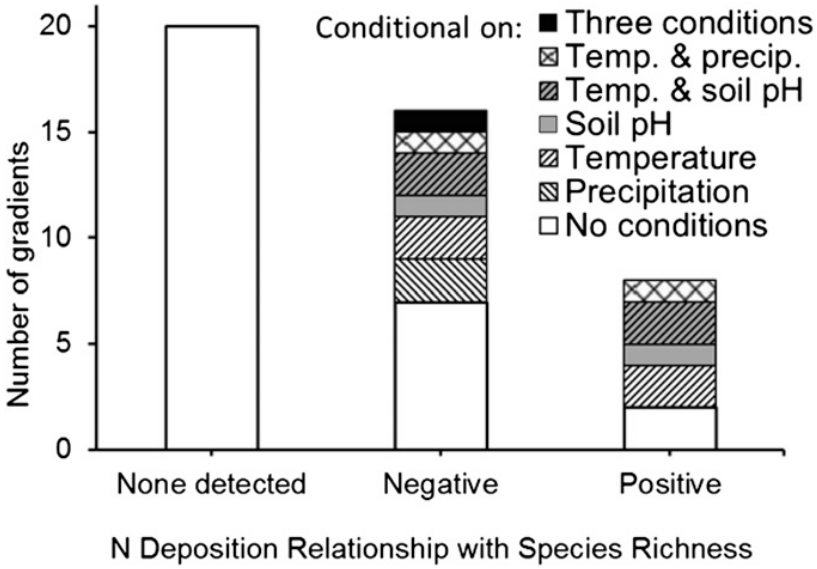
Impacts in US habitats





Simkin et al., 2016 PNAS

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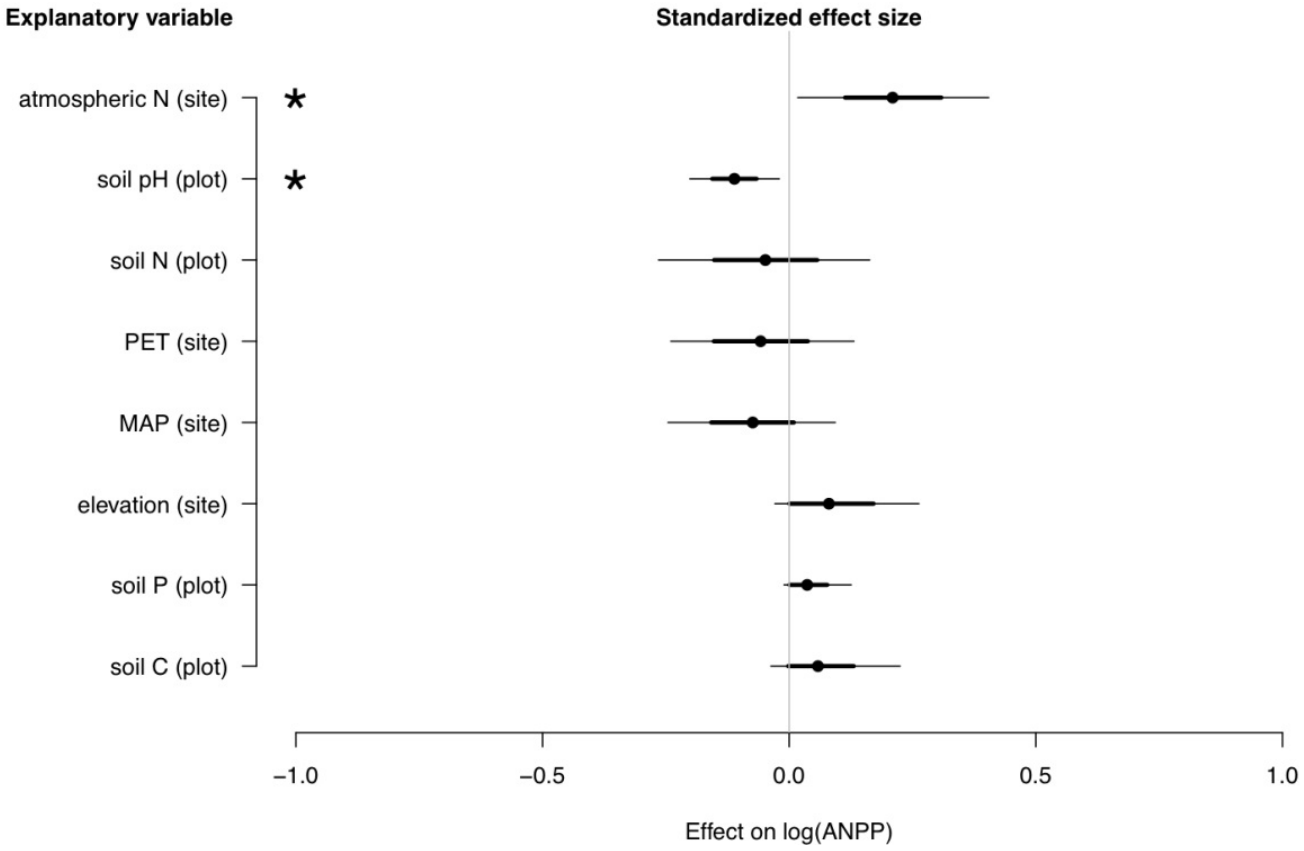
The importance of N deposition



Stevens and Lind et al. 2015 Ecology

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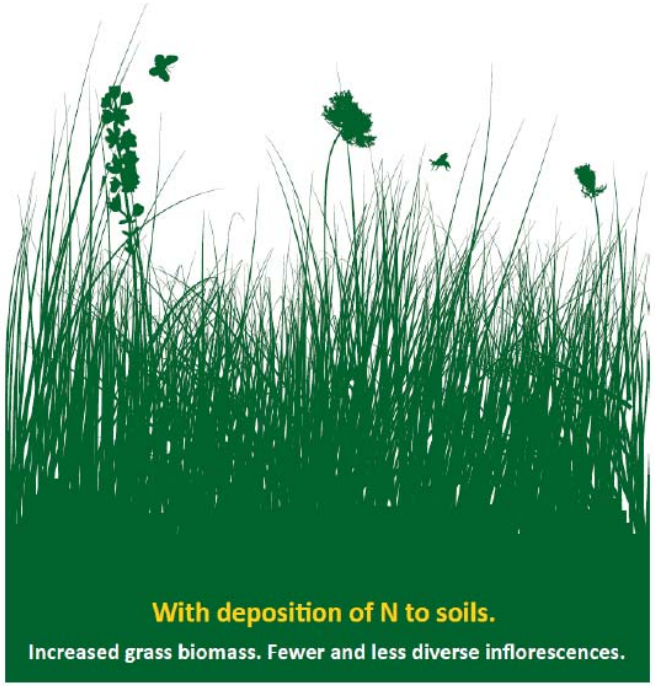
Impacts on higher trophic levels

- Impacts mediated by changing species composition and plant traits



David et al (Submitted)
Arthropod-Plant interactions

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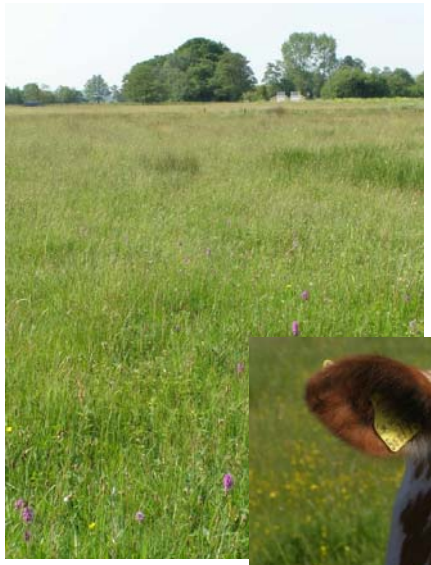
Is recovery possible? Tadham Moor



- Neutral grassland in Somerset, SW England
- *Cynosurus cristatus-Centaurea nigra* grassland
- Traditionally managed
- Floods regularly in winter
- Soil pH 6-6.5
- Peat soil
- Background deposition 21 kg N ha^{-1} yr^{-1}

Stevens et al., 2012 Plant &Soil

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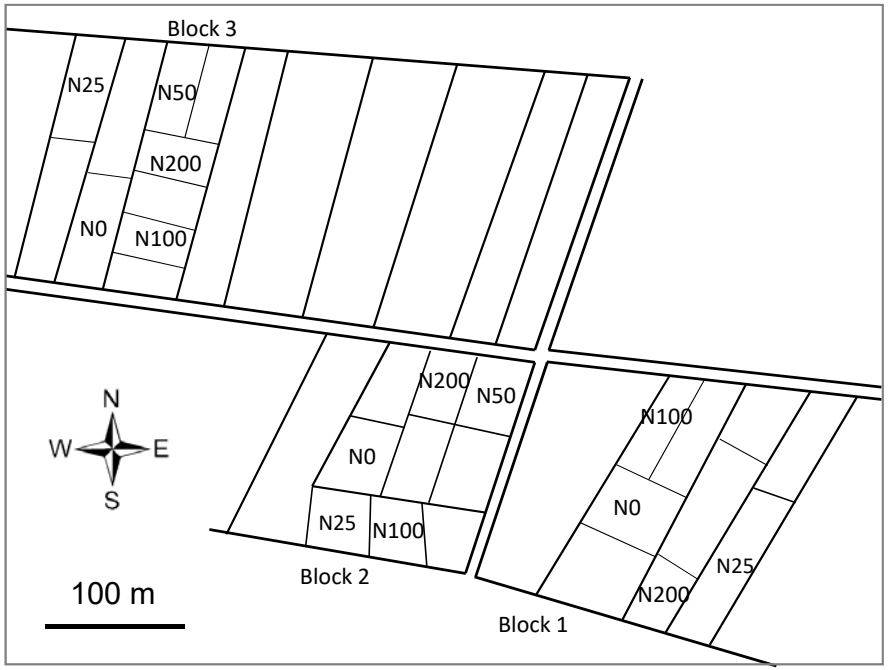
Methods



- Established 1986
- 3 replicate blocks
- 5 treatments – 0 25, 50 100, 200 kg N ha^{-1} yr^{-1}
- Field-scale plots
- 2009 Plots resurveyed to assess recovery - 15 years after cessation of N additions
- Species composition, biomass and soils assessed

Stevens et al., 2012 Plant &Soil

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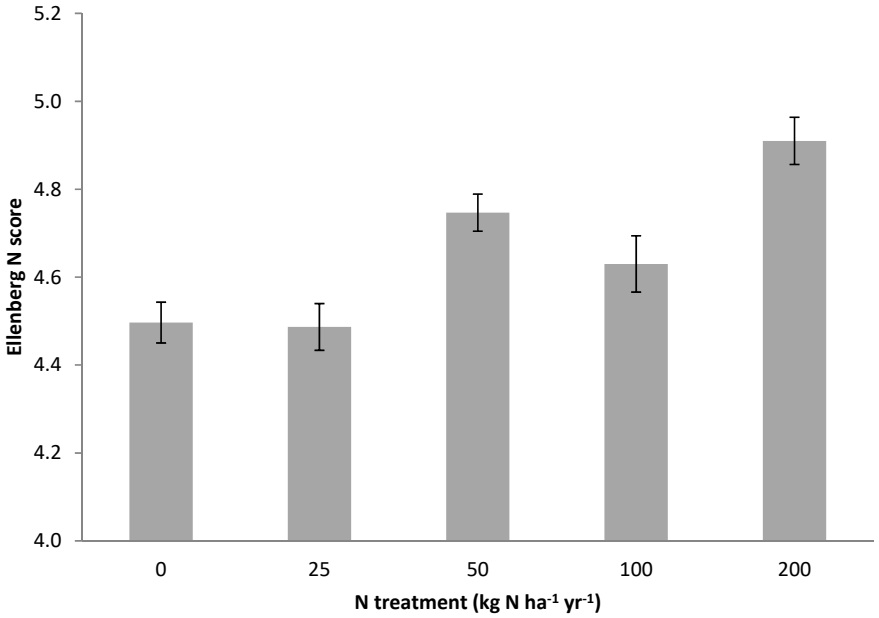
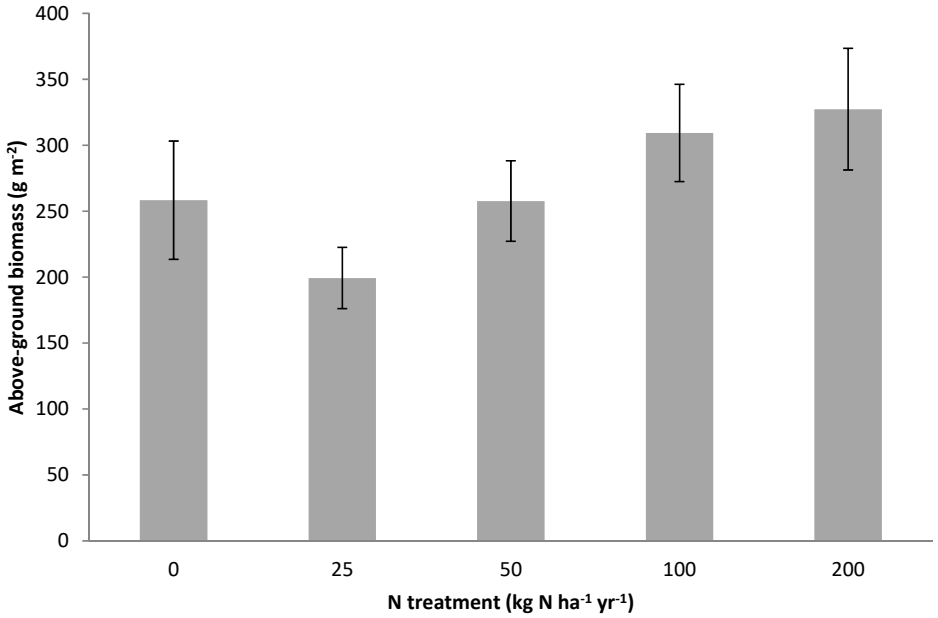
Results





Stevens et al., 2012 Plant &Soil

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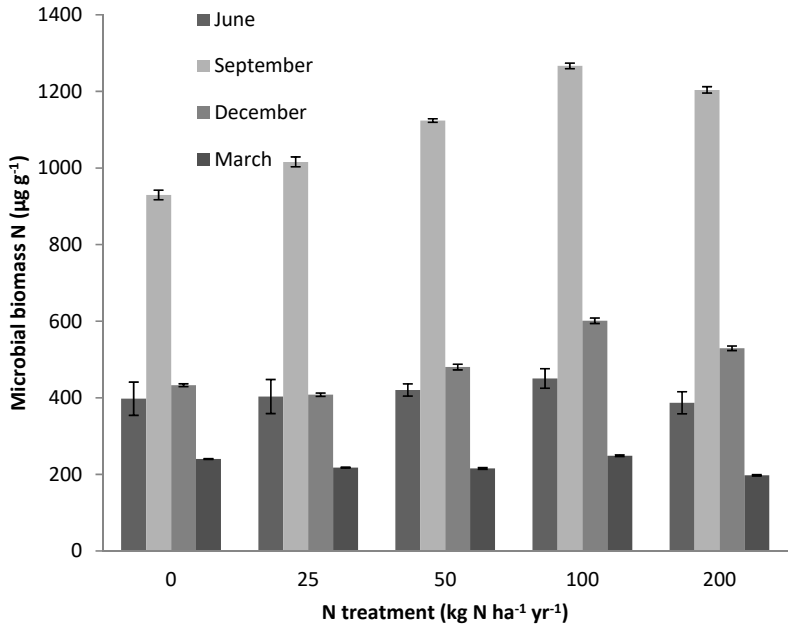
Results

- KCl ammonium ↑100N
- KCL nitrate –
- TON –
- Microbial biomass N ↑100N
- Total %N ↑ 25, 50, 100, 200N



Stevens et al., 2012 Plant &Soil

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Recovery?

- Review of 36 studies
- Majority suggest vegetation will be slow to respond
- Below-ground communities and soil processes also slow
- Soil chemical properties respond more quickly
- Continued critical load exceedance a major barrier to recovery

Stevens, 2016 Biological Conservation

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Recovery potential?

- 15 years after the cessation of N addition there are still clear differences in the vegetation
- Trajectories of vegetation change appear to differ in some plots suggesting that they are not becoming more similar
- Difficult for species lost to get back into the sward
- No decline in competitive species and biomass still differs
- Chemistry still differs – takes a long time to change.
- Could alternative stable states be reached?

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Management to promote recovery

Broad habitat	Management method	Potential to reduce N deposition impact or aid recovery	Strength of evidence
Broadleaved, mixed and yew woodland & (natural) coniferous woodland	Grazing and Browing	Medium	2
	Litter removal	High	1
	Thinning or harvesting	Low	2
	Burning	Low	3
Neutral grassland	Grazing	Medium	3
	Cutting	Medium	2
	Liming	Medium	3
	Introduction of hemi-parasitic species	High	2
	Hydrological management	Low	3
	Carbon addition	Medium	3
	Turf stripping	Low	3
Calcareous grassland	Grazing	Medium	3
	Cutting	Medium	2
	Sheep folding	?	3
	Glycophosphate control of *B. pinnatum*	Low	2
Acid grasslands	Grazing	High	1
	Burning	Low	3
	Liming	Medium	3
	Cutting	Medium	2
Dwarf shrub heath	Turf stripping	High	2
	Rotavating	Low	2
	Grazing	Medium	2
	Cutting	High	1
	Burning	High	2
Fen, marsh and swamp	Grazing	Low	3
	Cutting	High	2
	Burning	Medium	3
	Hydrological management	Medium	3
	Topsoil removal	Medium	3
Bogs	Hydrological management	Medium	3
	Burning	?	3
Coastal dunes and slacks	Grazing	Medium	2
	Cutting	Medium	2
	Burning	?	3
	Hydrological management	Medium	3
	Turf stripping and topsoil removal	Medium	3
	Dune mobilisation	High	2
Other coastal habitats	Grazing	Medium	3
	Cutting	?	3

Jones et al. 2017 Biological Conservation

Innovative management options

- Sheep folding
  - Potential to remove N
  - Labour intensive but traditional practice
- Litter removal
  - Traditionally used for animal bedding
  - Probably only lowland English woodlands
  - Potential to remove N
  - Negative impacts on soils unknown

Jones et al. 2017 Biological Conservation

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Conclusions

- There are clearly impacts of N deposition that have been detected in a wide range of habitats
- Recovery seems to be very slow but does occur, at least partically in some habitats
- In other habitats recovery does not seem to occur
- Reducing levels of N deposition to low enough levels is key to recovery
- Active management could be used to promote recovery

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