

Ecological effects of air pollution

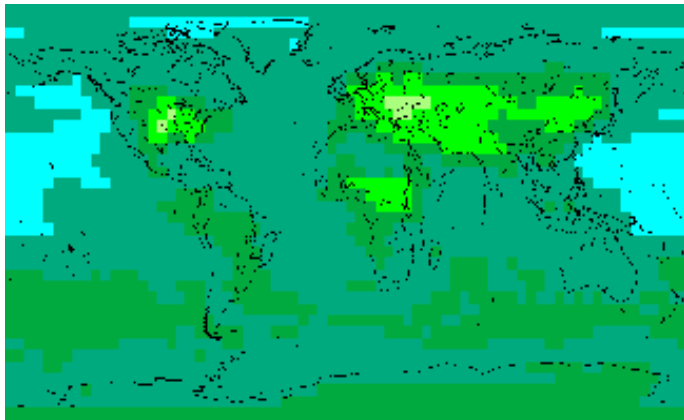
Bridget Emmett

Centre for Ecology and Hydrology

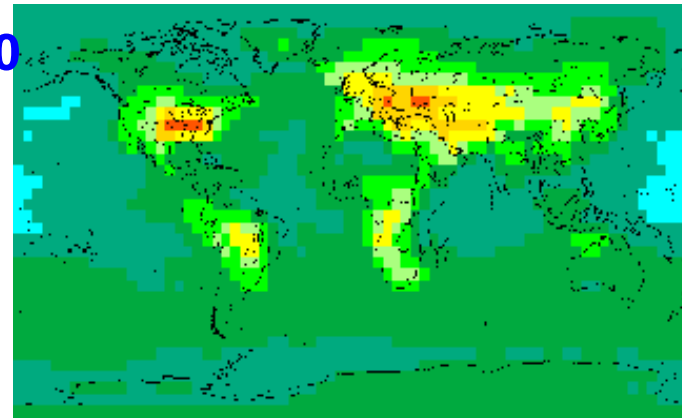


Ozone

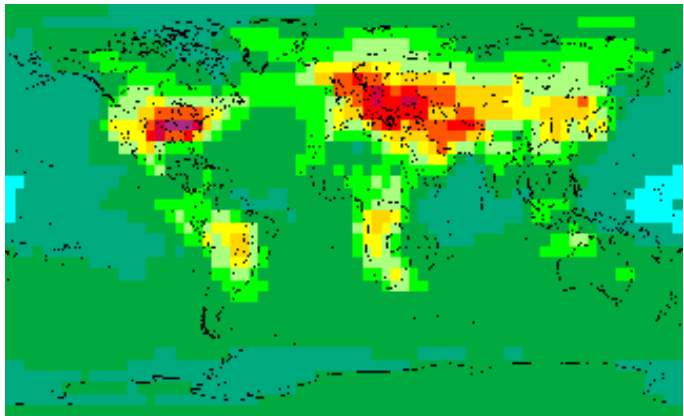
1860



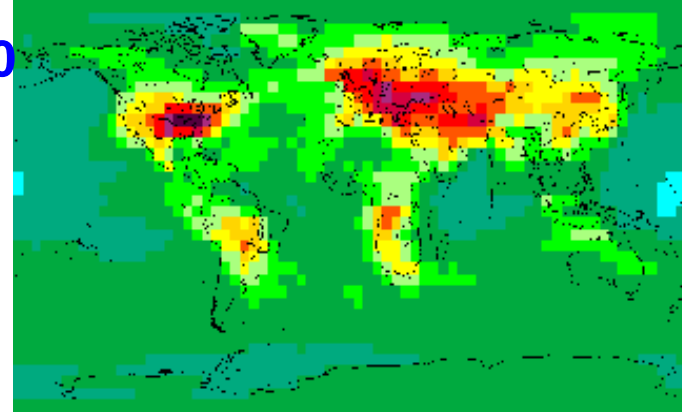
1950



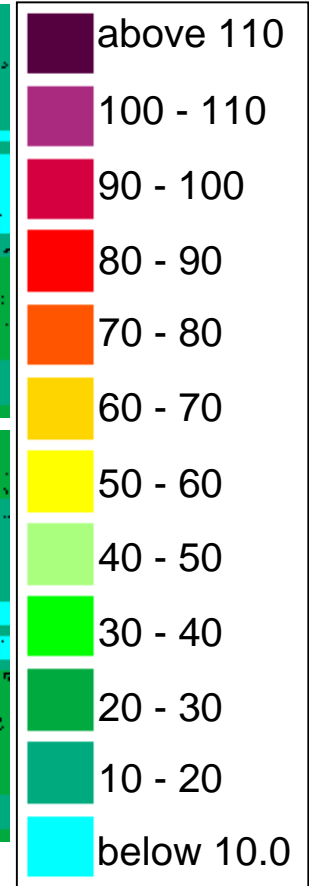
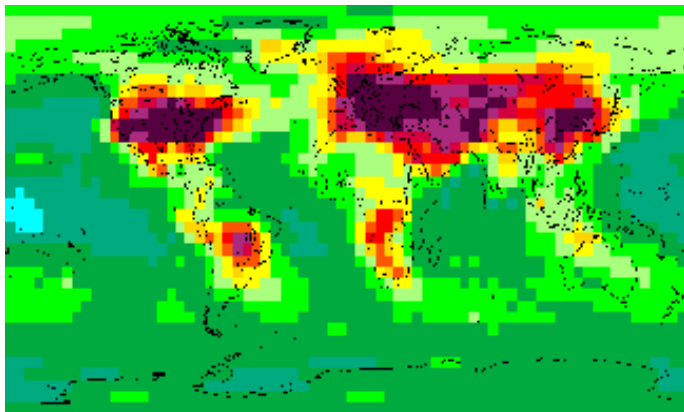
1970



1990



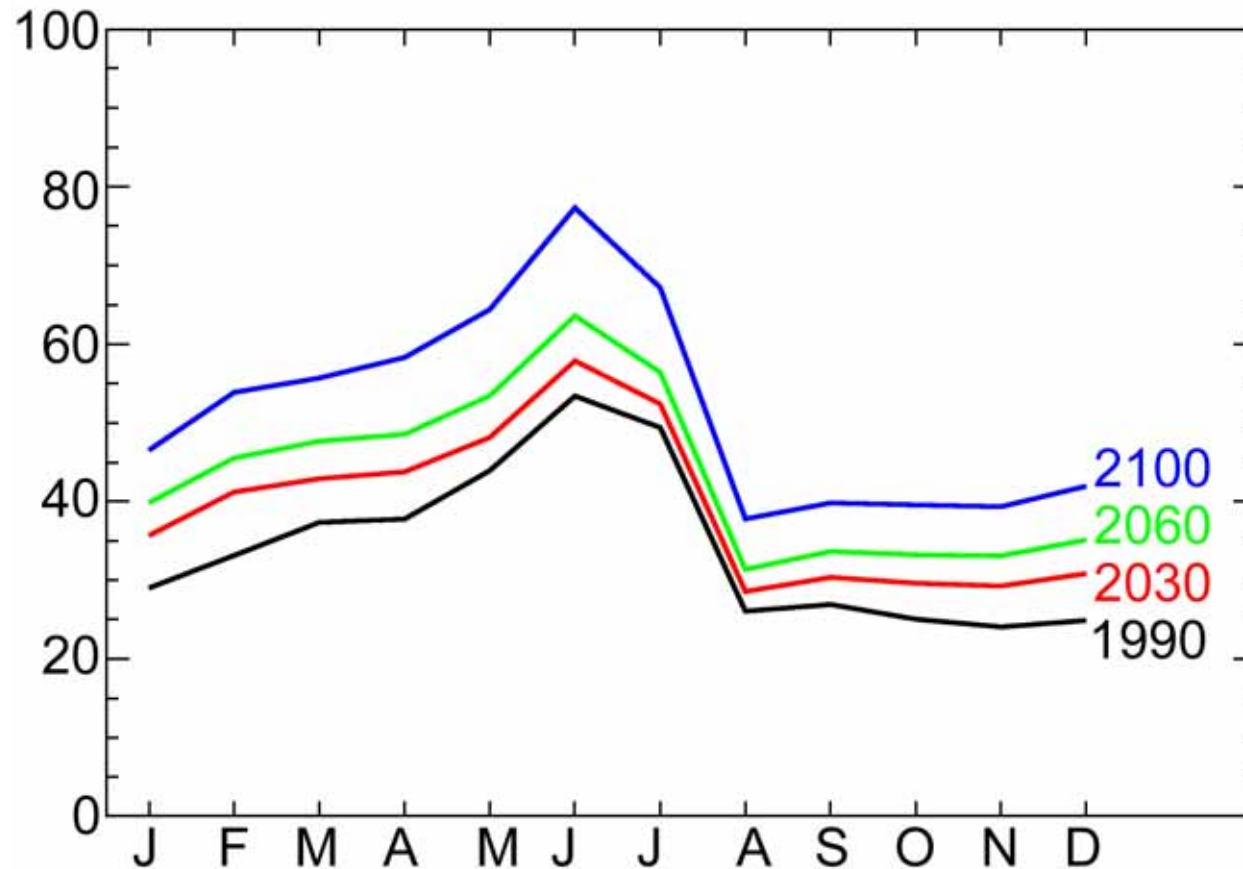
2100



Ozone – a pollutant on the increase

July data supplied by the UK Meteorological Office from the STOCHEM model.

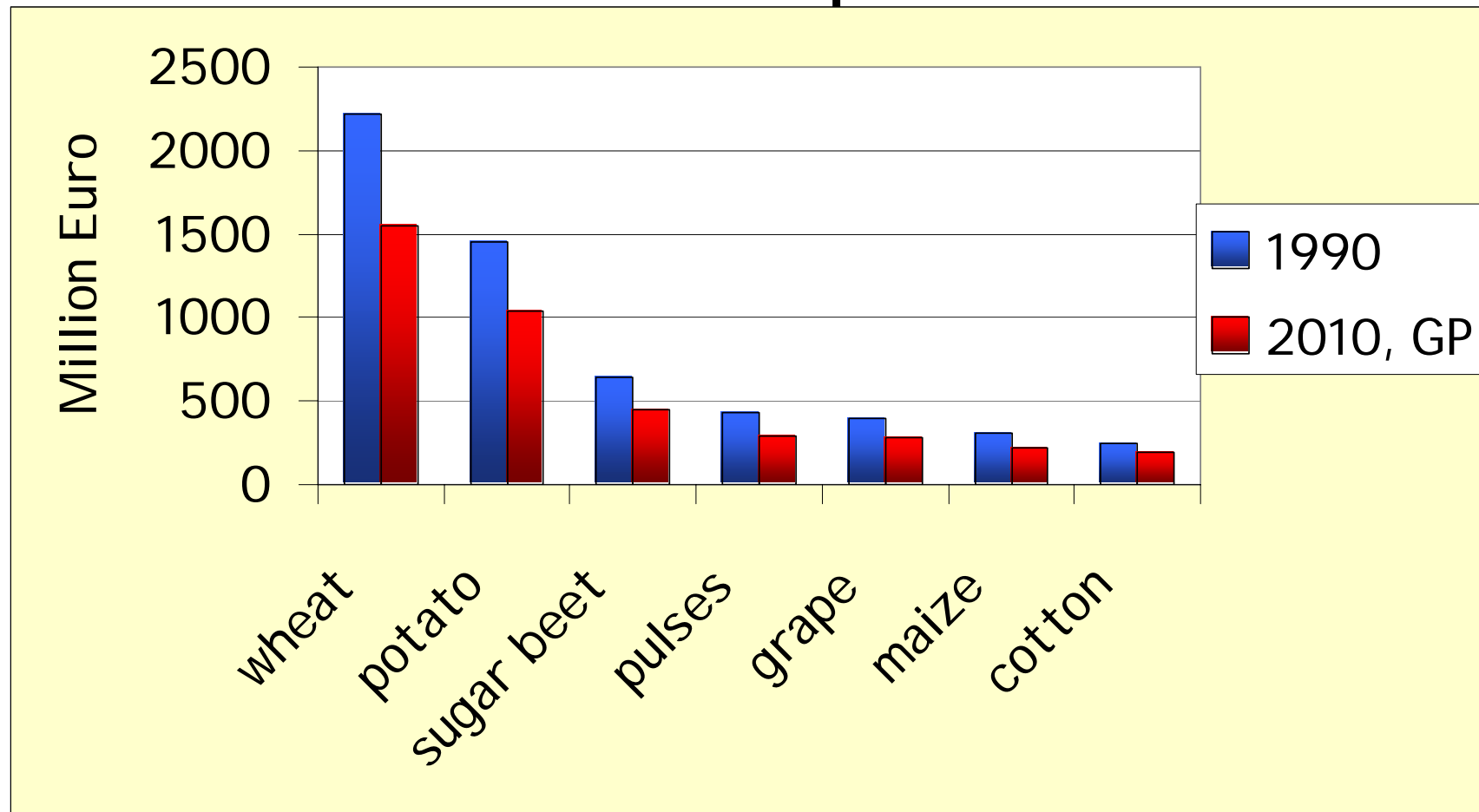
Model predictions of ozone concentrations for the next 100 years (STOCHEM Model)



Effects on yield quality for the horticultural industry

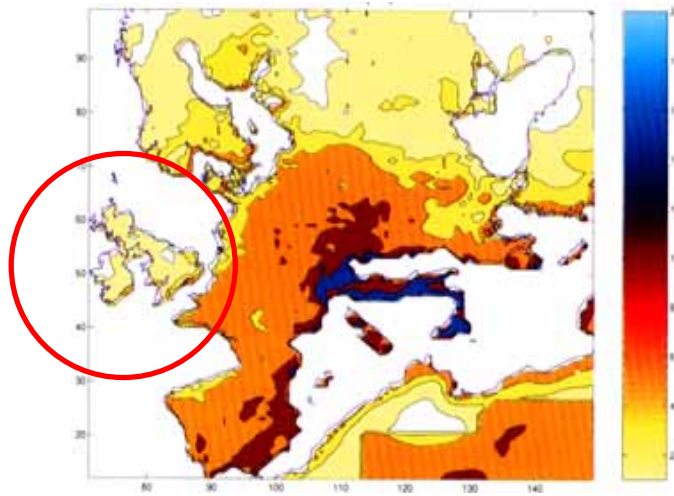


This leads to estimated large economic losses across Europe

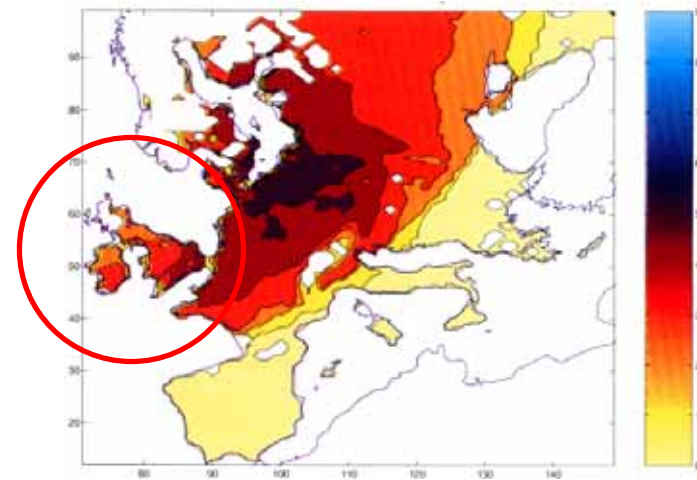


But are we under-estimating effects and their location?

AOT40 for crops



Stomatal fluxes to wheat (nmol O₃ m⁻² s⁻¹ (June))



Are native plant species sensitive to ozone damage?

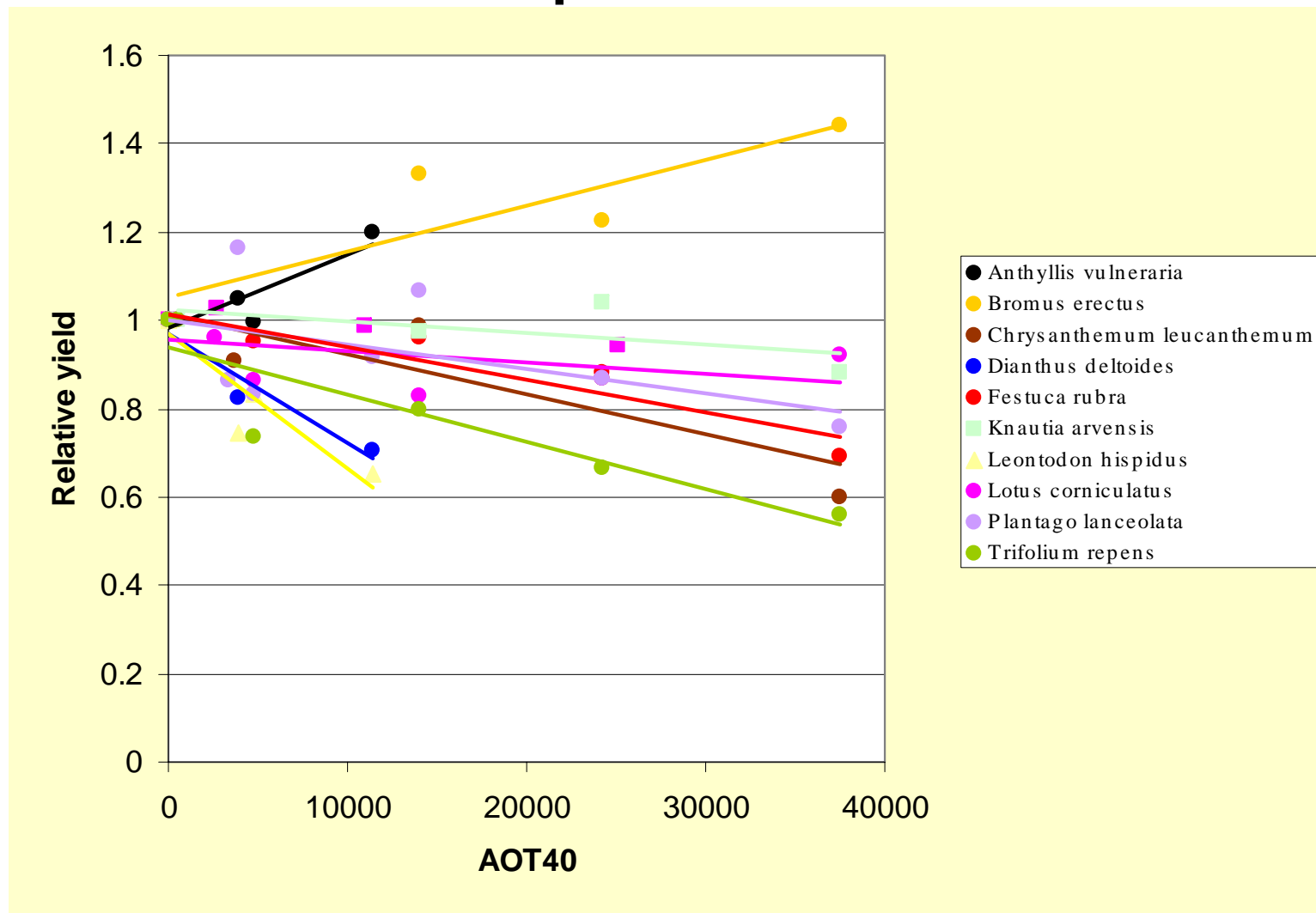
Potentilla erecta



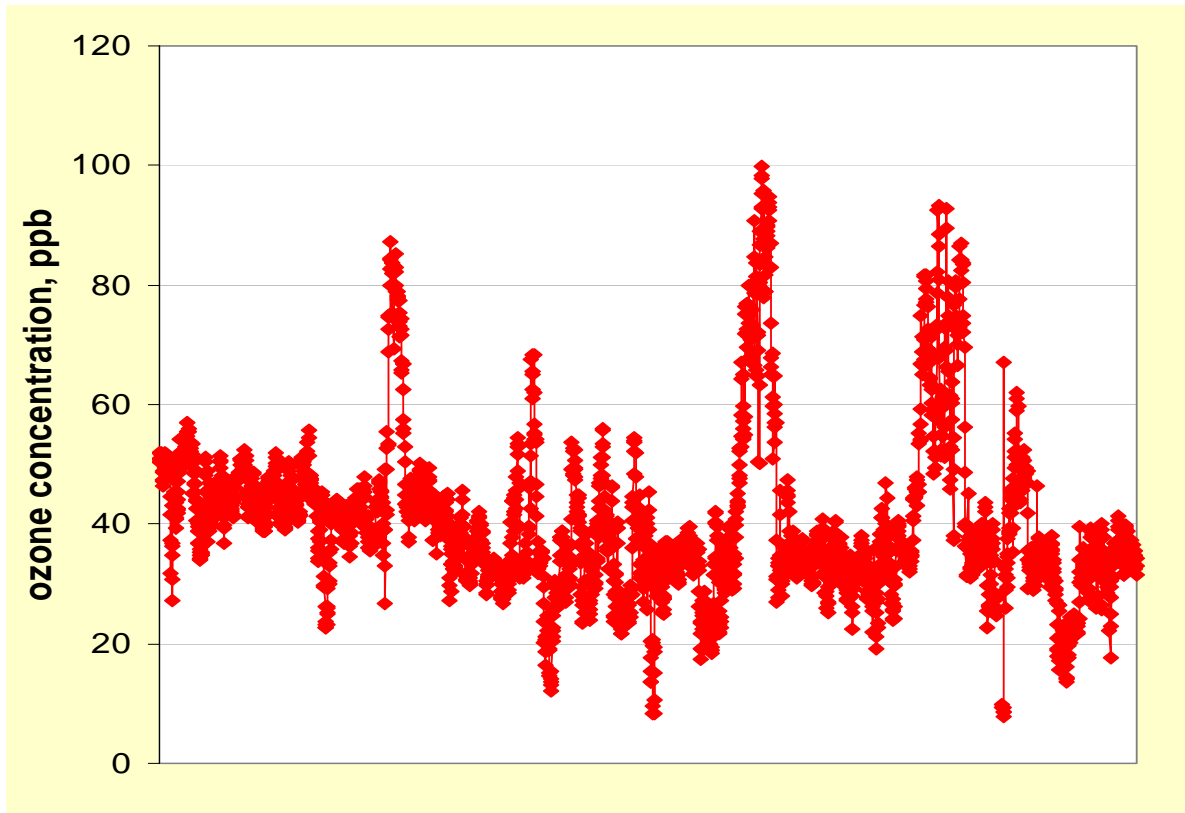
Carex echinata



Differential responses by native species



Ozone concentrations are a particular concern in mountain areas



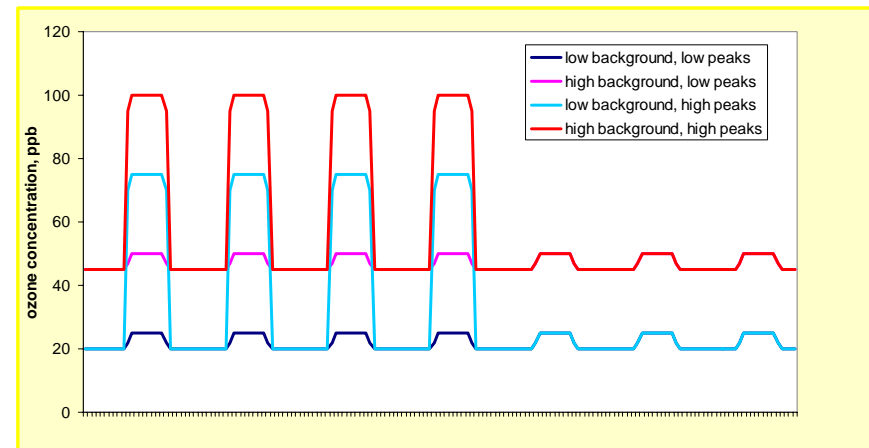
Snowdon:

Data from May
to August 2003

High
background

Peaks of up to
100ppb

A new problem is the change from high peaks to high background concentrations





Nitrogen

Sources of Nitrogen

Transport



Agriculture



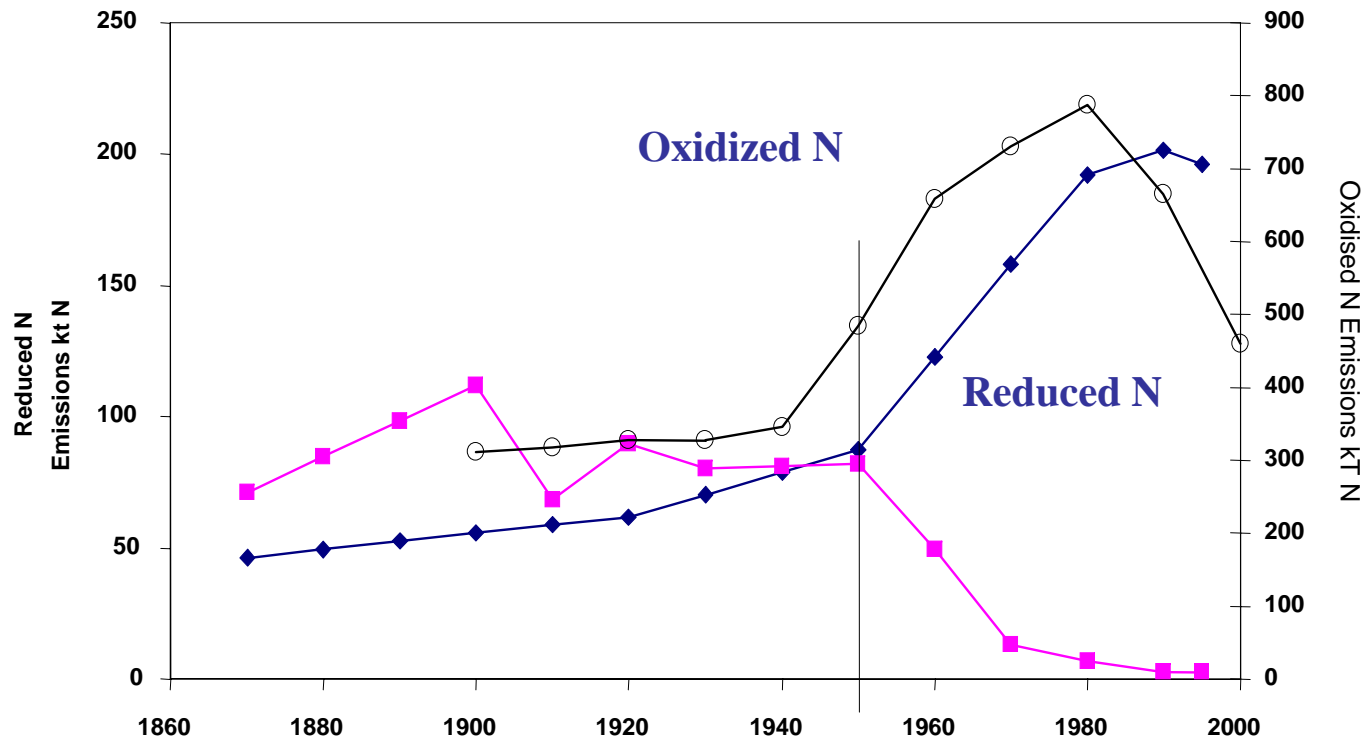
Energy and
Fertilizer production



Sewage



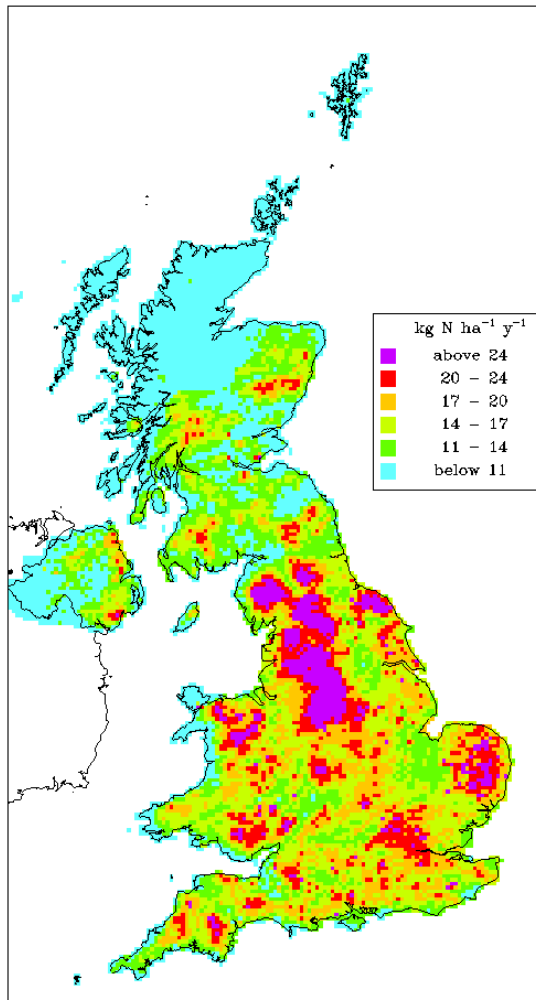
UK emissions



- ◆ Agriculture (animals)
- Domestic coal combustion
- NO_x emissions

N deposition in the UK (David Fowler CEH)

Annual N deposition 2001



Wales?

- average of 20 kgN/ha/yr (or 2000 cowpats/ha/yr!)
- can be > 50 kgN/ha/yr near to pig or chicken units

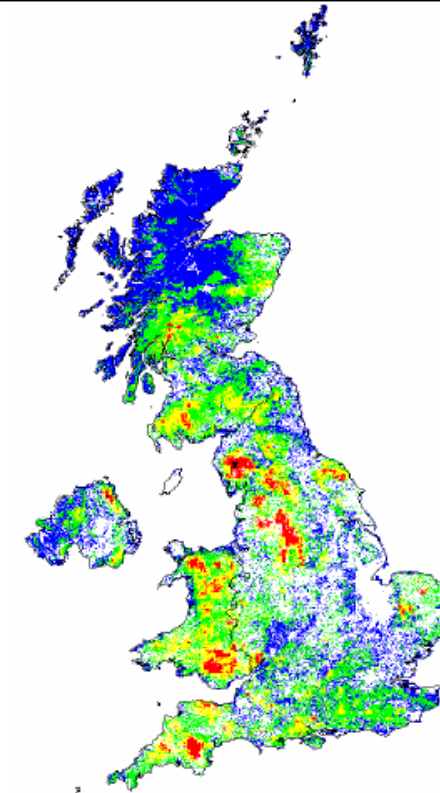
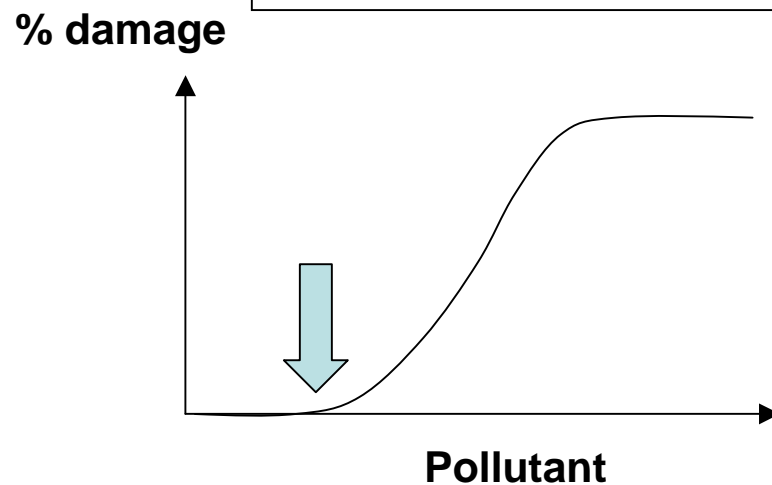
EFFECTS

Emission	Pollutant	Target
NO _x	O ₃ , PAN photochemical smog	human health / crops / materials / radiative forcing (+'ve)
NO _x , NH ₃	deposited acidity	Acidification of terrestrial & freshwater systems / materials
NO _x , NH ₃	aerosols	climate radiative forcing (-'ve) / human health
NO _x , NH ₃	deposited Nitrogen	Eutrophication of terrestrial and freshwater systems / carbon sequestration

Effects-based approach to assessment and policy

Nitrogen Critical Load Map 2003

Critical load concept



Implications for terrestrial systems?

(Jane Hall et al. CEH)

Habitats at risk from acidity:

- 73% in 1995-97
- 60% in 1999-01
- 47% by 2010



and for nitrogen enrichment.....

(Jane Hall et al CEH)

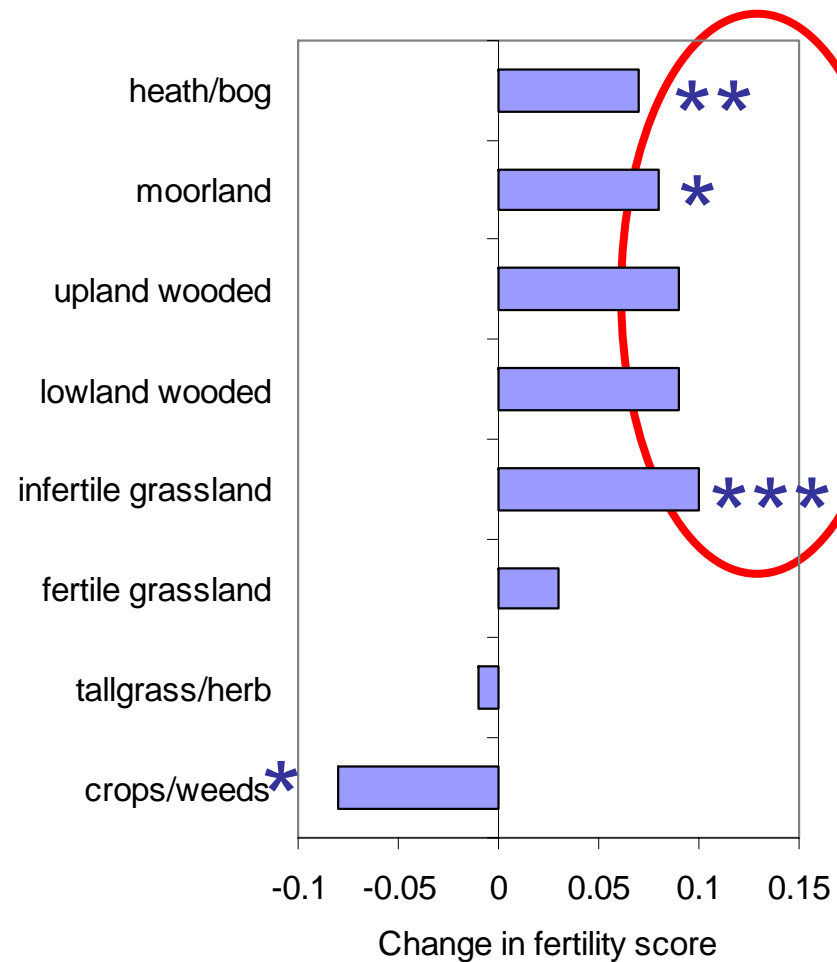
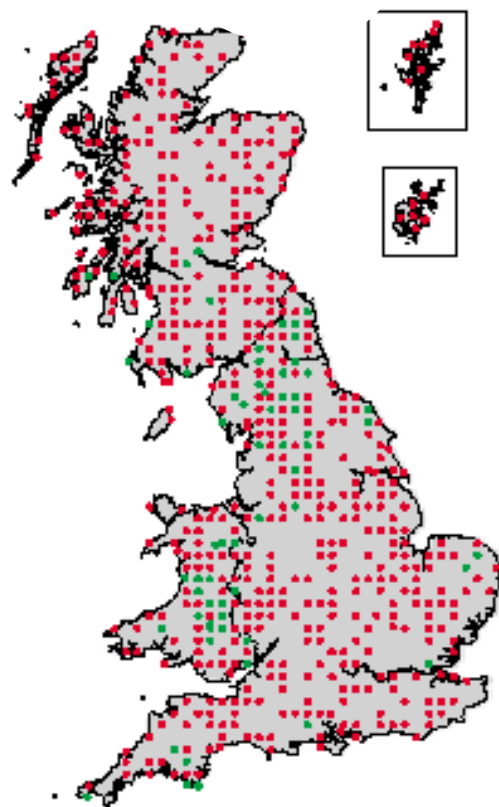
- 65% in 1995-97
- 59% in 1999-01
- 49% by 2010



Evidence of change?

Countryside Survey 1990 - 98

Countryside Survey
www.CS2000.org.uk

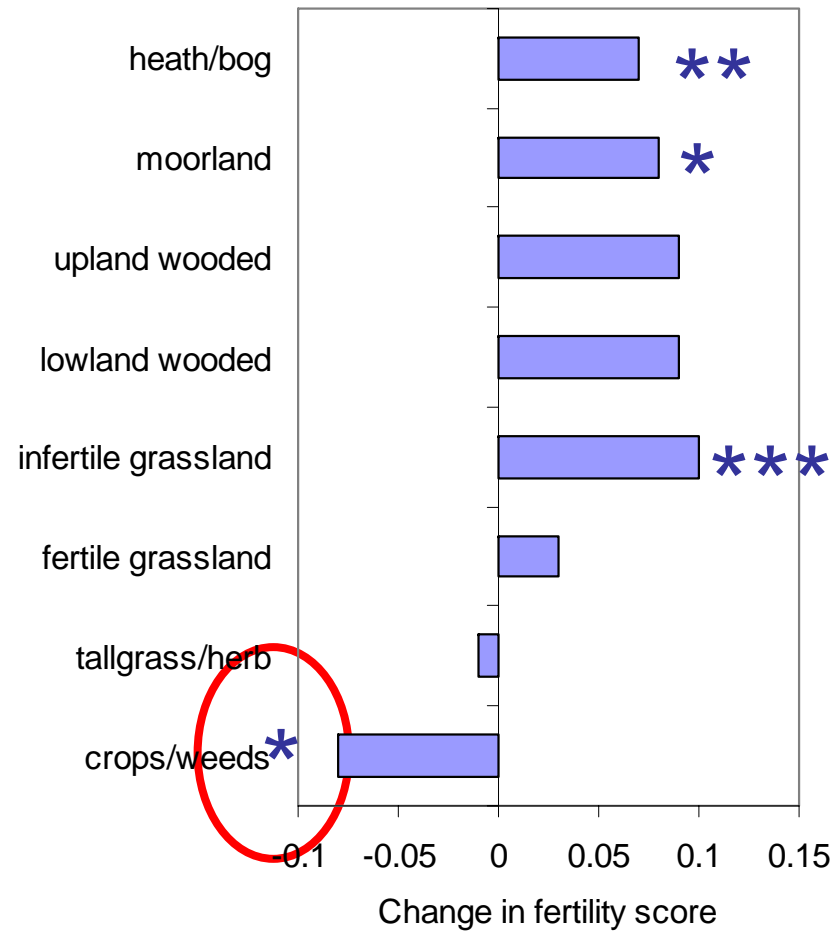
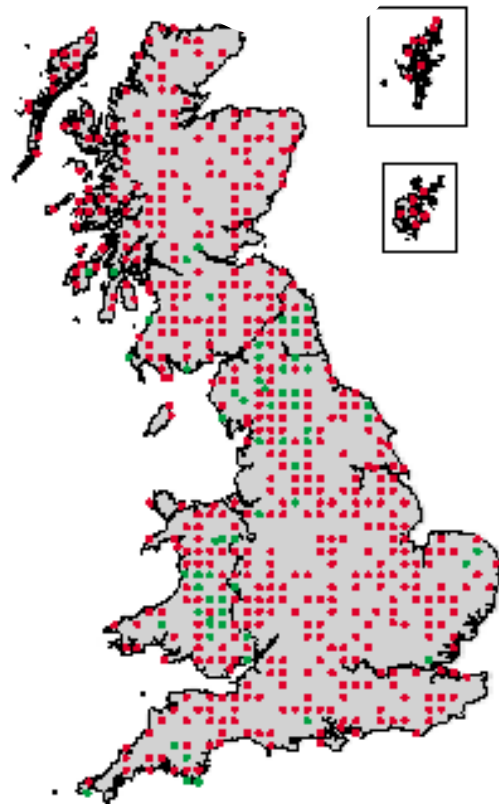


An increase in species with high 'N fertility' score in low nutrient habitats

Evidence of change?

Countryside Survey 1990 - 98

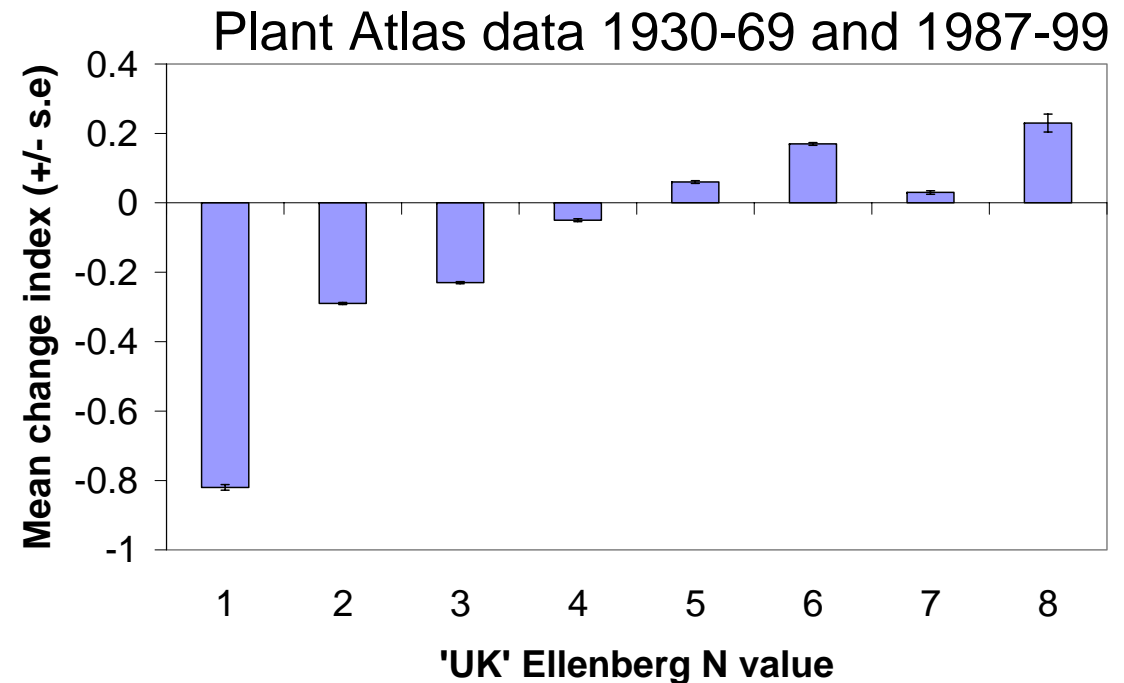
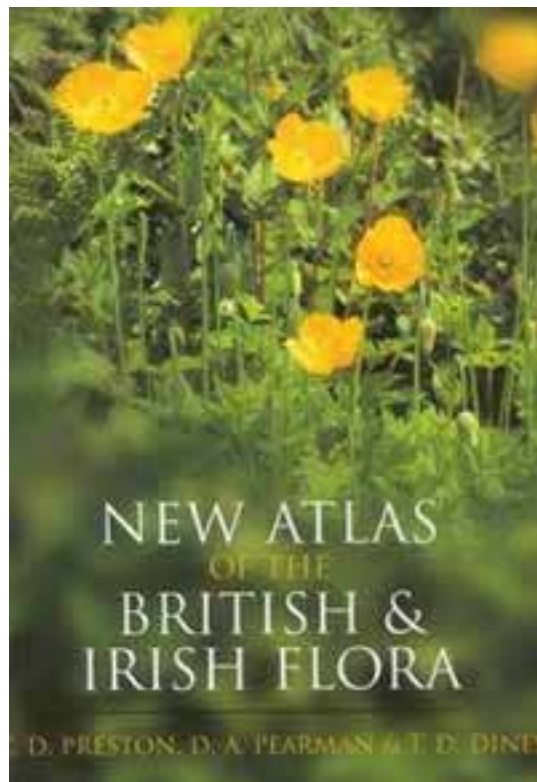
Countryside Survey
www.CS2000.org.uk



....but a decrease in crop systems due to reduced fertiliser use

A 2nd independent source of UK-wide evidence of species change

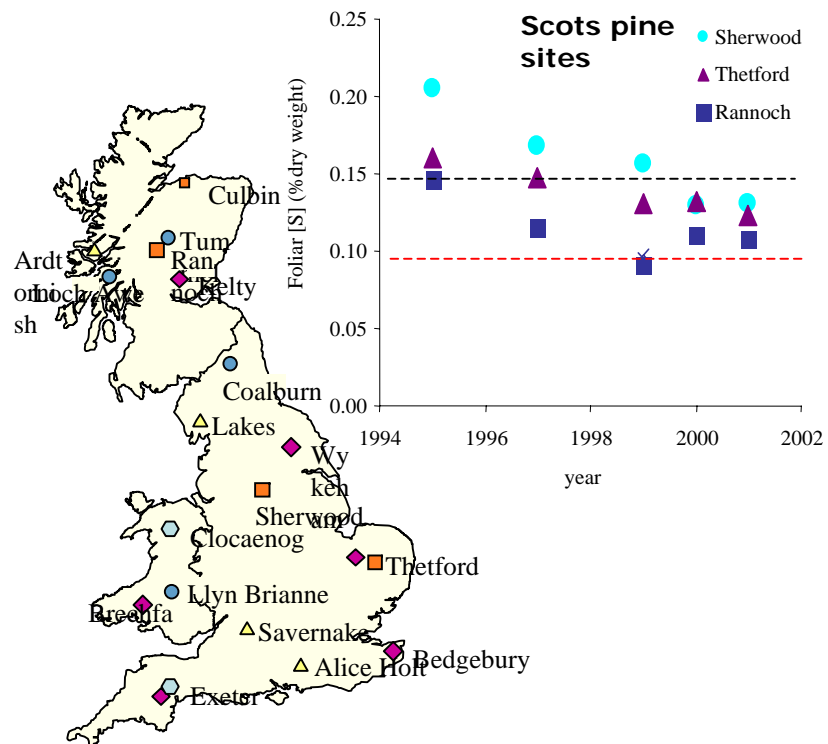
New Plant Atlas of the British and Irish Flora. (Preston et al. 2002)



And habitat specific surveys...

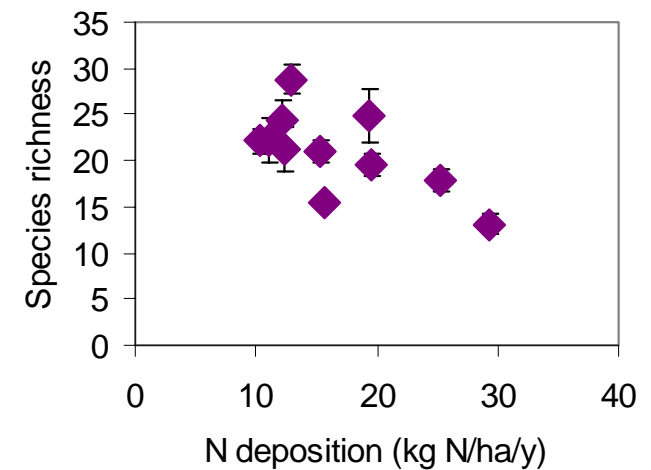
Forests

(Mark Broadmeadow Forest Research)



Sand dune systems

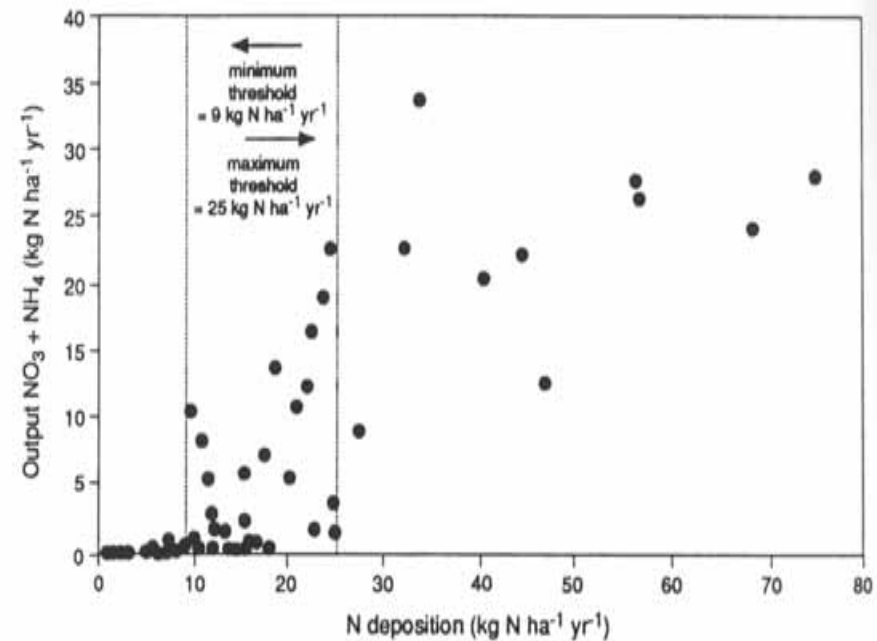
Laurence Jones (CEH)



Impacts on rivers and lakes?

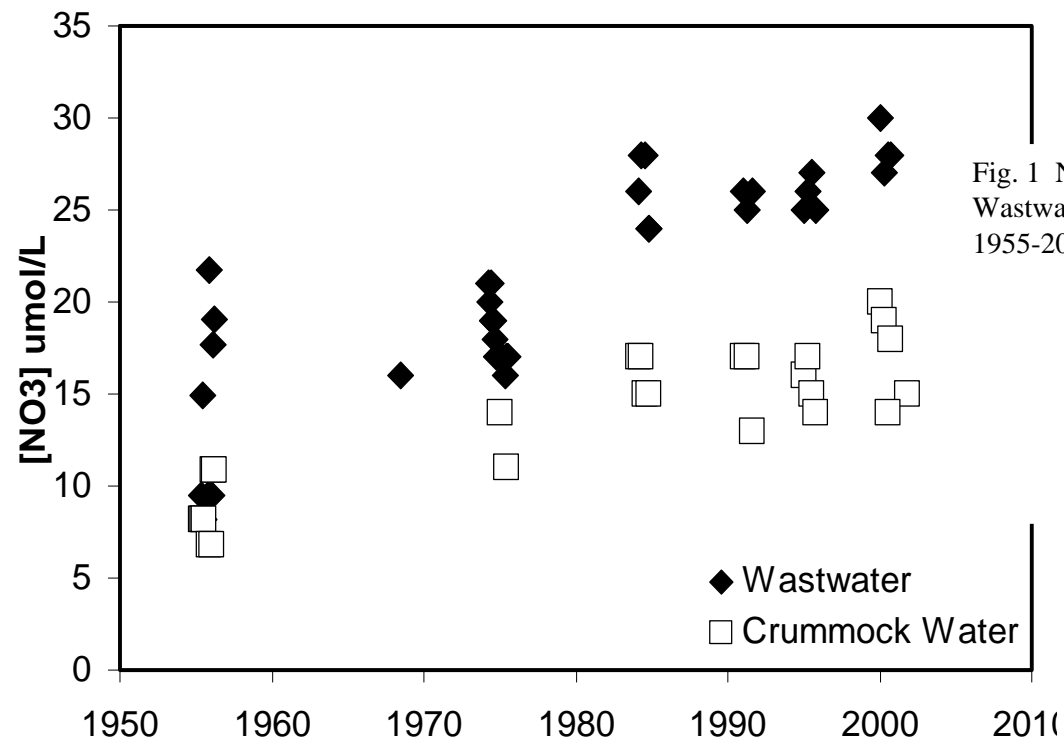


Dise and Wright 1995

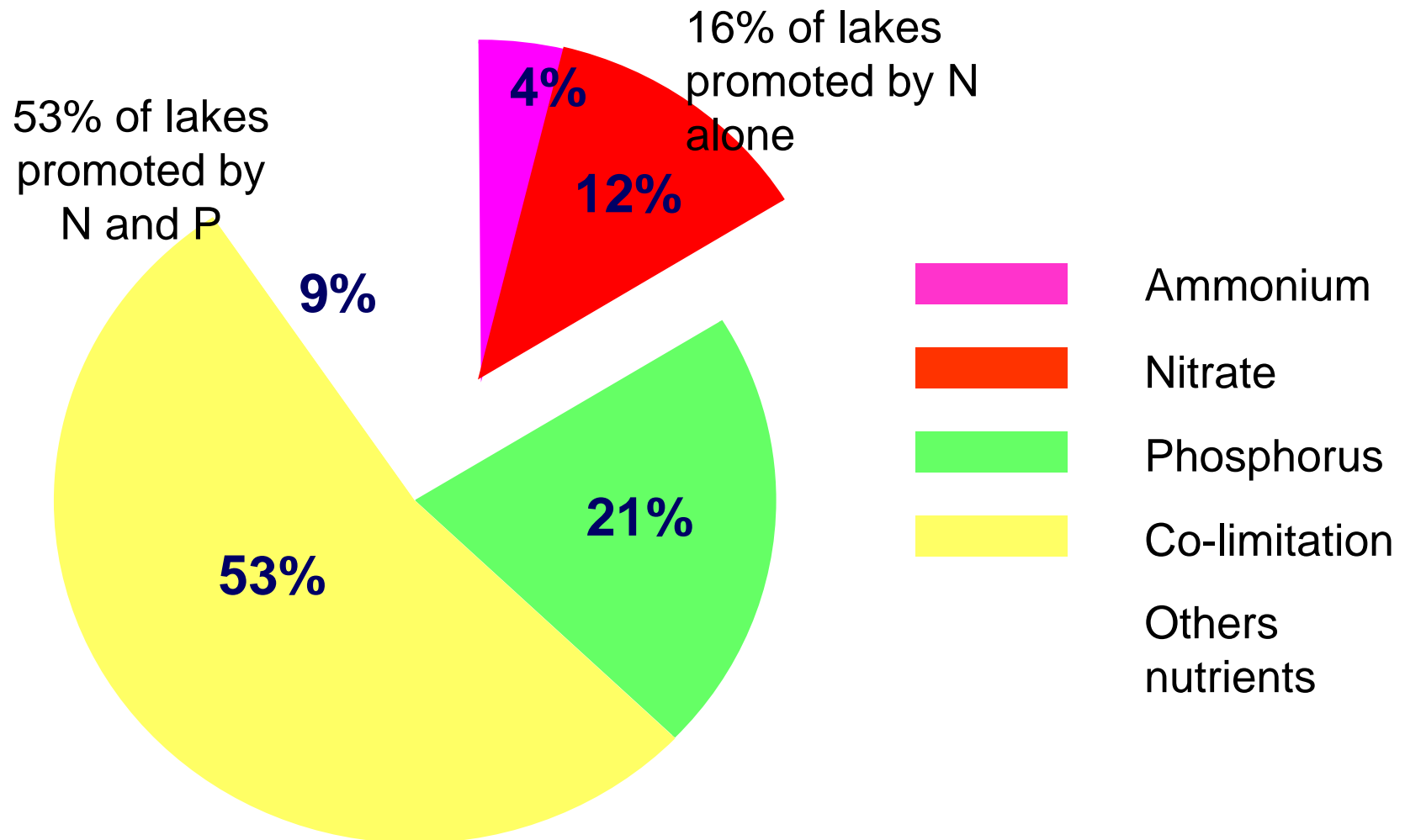


Can we see this trend in the UK?

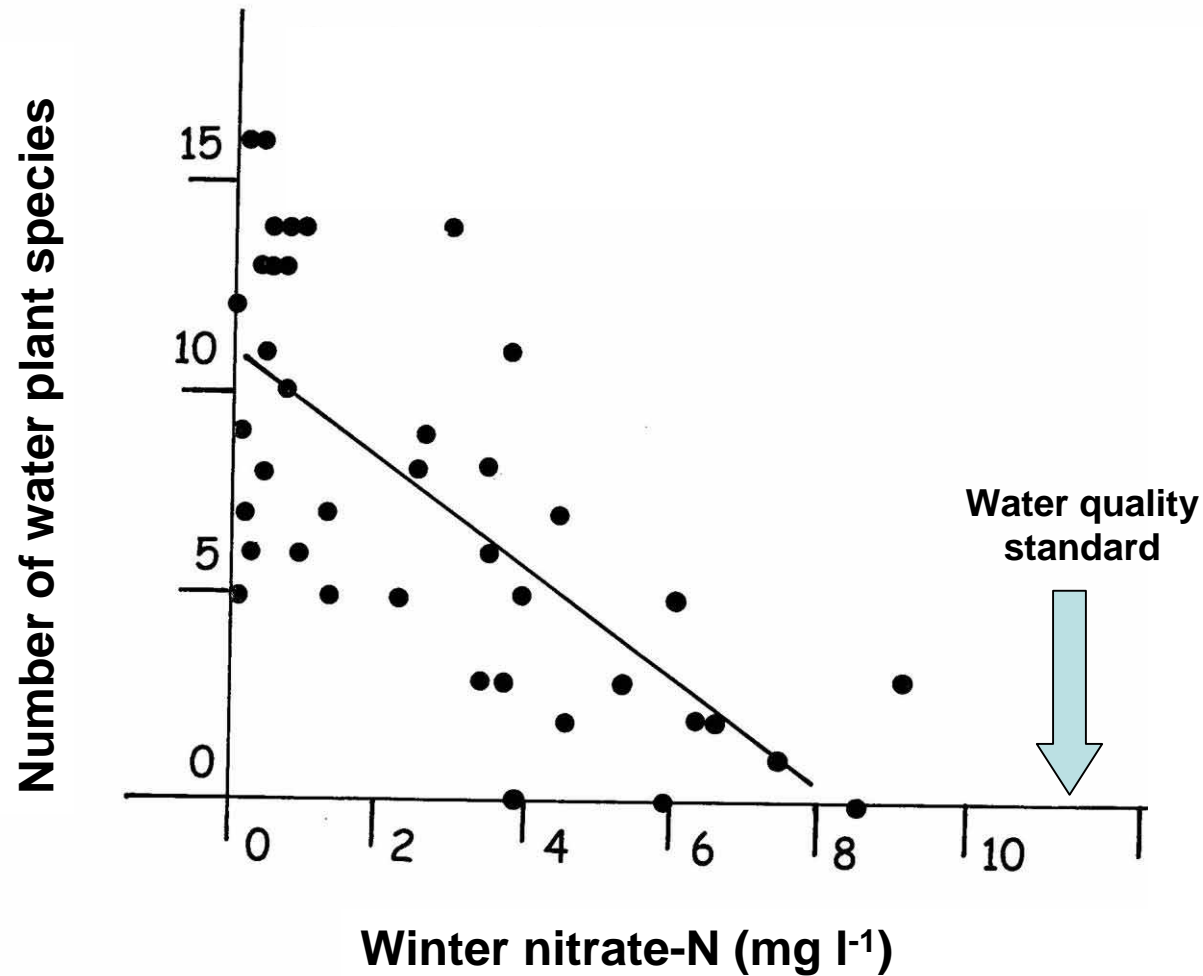
(Ed Tipping CEH)



65% of upland lakes studied found to increase algal productivity with N addition (Stephen Maberly CEH)



N also causes loss of freshwater plant diversity..

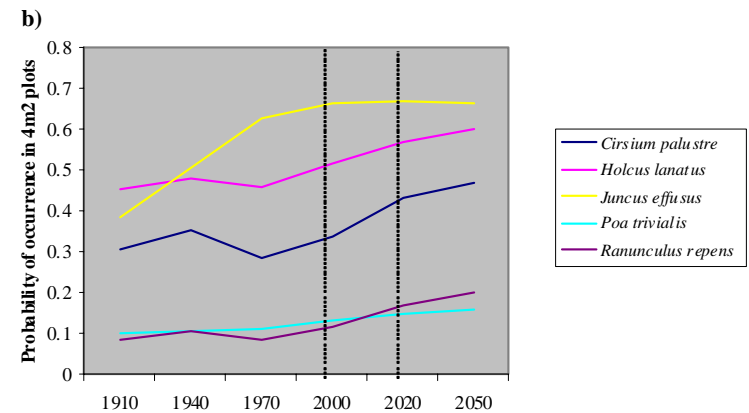
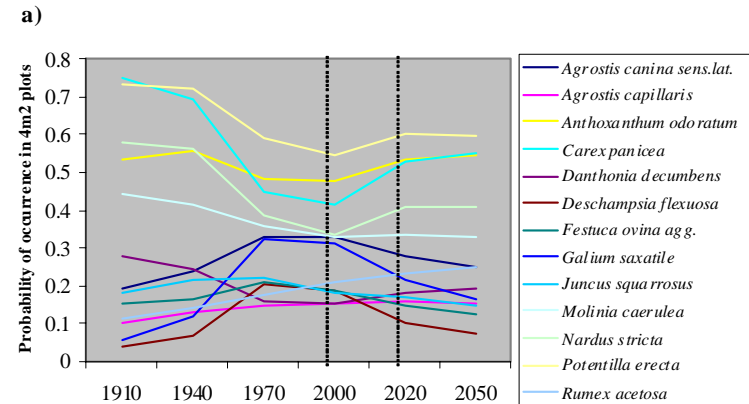
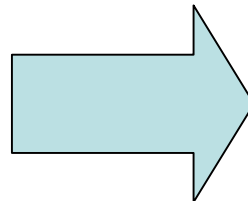
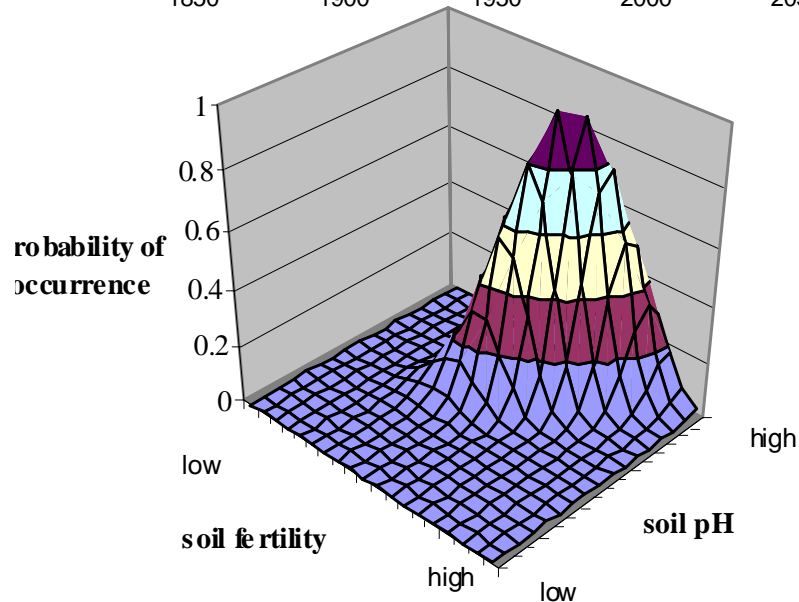
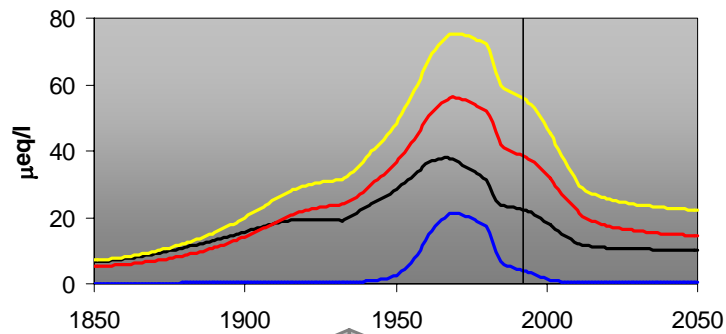




How will air emission policies
change impacts in the future?

What will happen and when? International requirement now for dynamic modelling

Inorganic aluminium

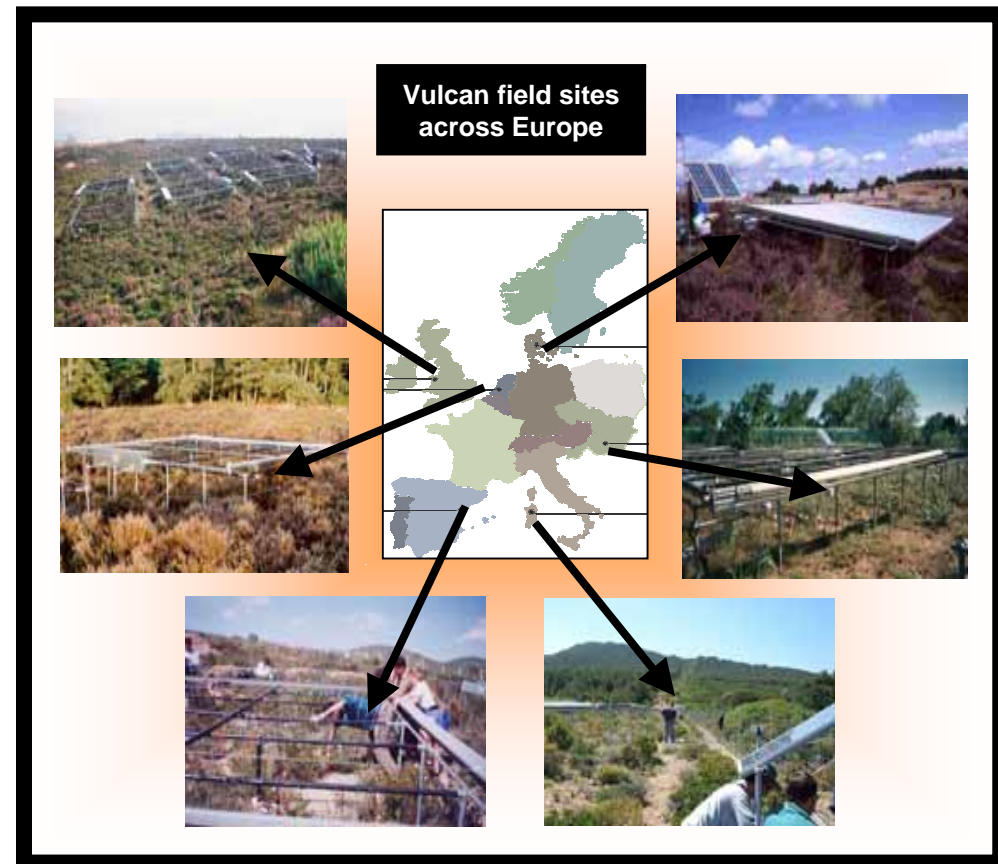




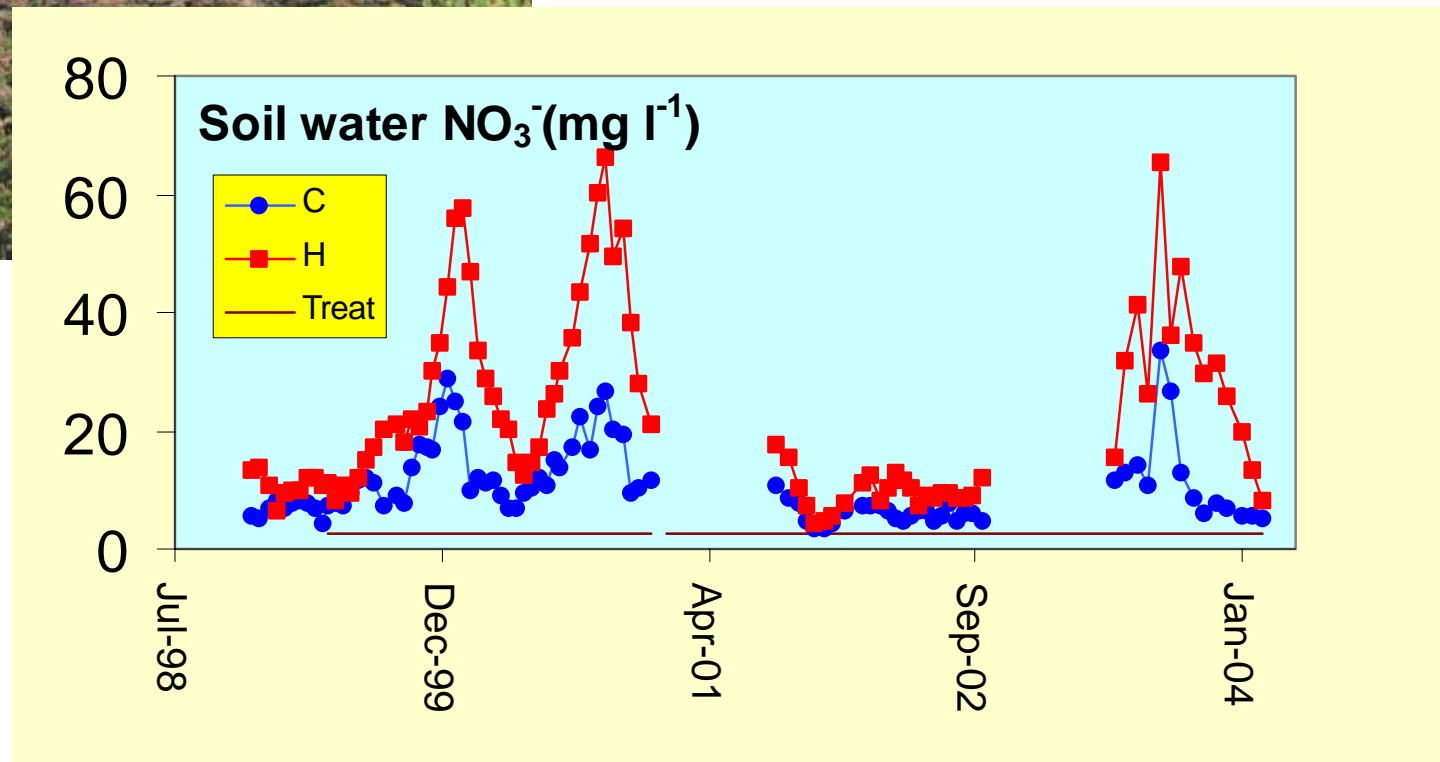
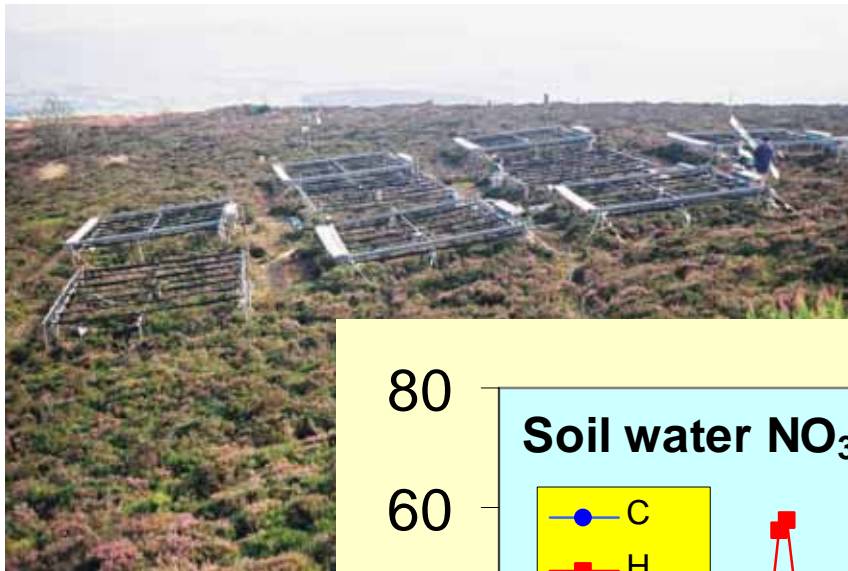
Interactions with climate change and management?

Possible areas of concern

- Ozone and NO_x are greenhouse gases
- Climate change causes release of pollutants from the soil
- Effects are more than additive e.g. increased pest and diseases attack
- Grazing effects response to N deposition
- Effects on C sequestration
-etc etc



What evidence do we have?



Conclusions

- Air pollution is having real and measurable effects on semi-natural systems in the UK
- Air pollution does not act in isolation and interactions with climate change and management have to be considered.
- New dynamic modelling tools are now being developed with EU partners to understand trends and forecast future changes

Why should we care?

- We are losing biodiversity (damaging soils and waters)
- Ozone and NO_x contribute to climate change
- We will fail international commitments
- It costs us money!

- What can we do? – limited other than cutting emissions