The only constant is change:

using archive data to explore drivers of change in heathland communities over the last 30 years

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Why study change?

- Information on past change puts current situation in context
- Aids prediction of future changes by refining models and improving understanding
- To inform management planning

What drives change?

- Management (or lack thereof)
  - Grazing
  - Burning
  - Successional change

- Pollution
  - Nitrogen deposition
  - Acid deposition (S & N)
  - Ozone

- Climate change
  - Temperature
  - Precipitation (and duration of snow cover)
  - Wind speed (exposure)

What are the potential impacts of these drivers?

Management impacts

- Majority of heaths maintained by burning, grazing, cutting
- Long history of experimental studies of management
- Lack of management – invasion by scrub & trees
- "Overgrazing" – suppression of shrubs, fragmentation & increased grass dominance

Pollution impacts

- Acidification and nitrogen pollution well studied
- Decreased soil pH, build up of N stocks, nitrate leaching
- Loss of herb species
- Loss of bryophyte & lichen species
- Increased frequency & severity of heather beetle attacks
- Heather out-competed by grasses esp. *D. flexuosa* & *M. caerulea*

Climate change impacts

- Relatively little experimental evidence yet
- Impacts difficult to predict, both direct and through species interactions
- Effects most clearly seen in high altitude heaths (less management)

In general:

- Shifts in community boundaries?
- Reduction in montane specialists?
- Increase in 'lowland' species in upland areas?

Heathland-specific predictions

- Earlier & greater flower production
- Faster growth rates & increased productivity
- Reduction in the length of the 'Heather cycle'?
- Increase in frequency of pest outbreaks
- Heather better competitor against Bracken in drought conditions
- Movement from wet to dry heath
- Increased fire risk
- Changes in nutrient cycling

Interactions

Likelihood of interactions between all 3 main drivers:

N & climate change:

- N increases sensitivity to drought
- Temp & moisture alter soil N-cycling

N & management

- Intensive management limits N build up
- Grazing may amplify N effects

Climate change & management

- Will management practice change with increasing drought?
- Management to allow or restrict species change?

What evidence do we have of driver impacts?

Evidence for change in the UK

- UK scale surveys (CS2000) - wide variety of habitats but may lack power to detect habitat specific changes
- ECN - detailed but small number sites/habitats
- Species distribution data - useful but doesn't show community change
- Individual site monitoring – local scale data

Archive data

- Detailed high-quality records of vegetation composition
- Large sample size
- Wide geographical coverage
- Goes back to 1960's and earlier

BUT must have:

- Original data collection protocol
- Sufficient data for re-location

Scottish vegetation datasets

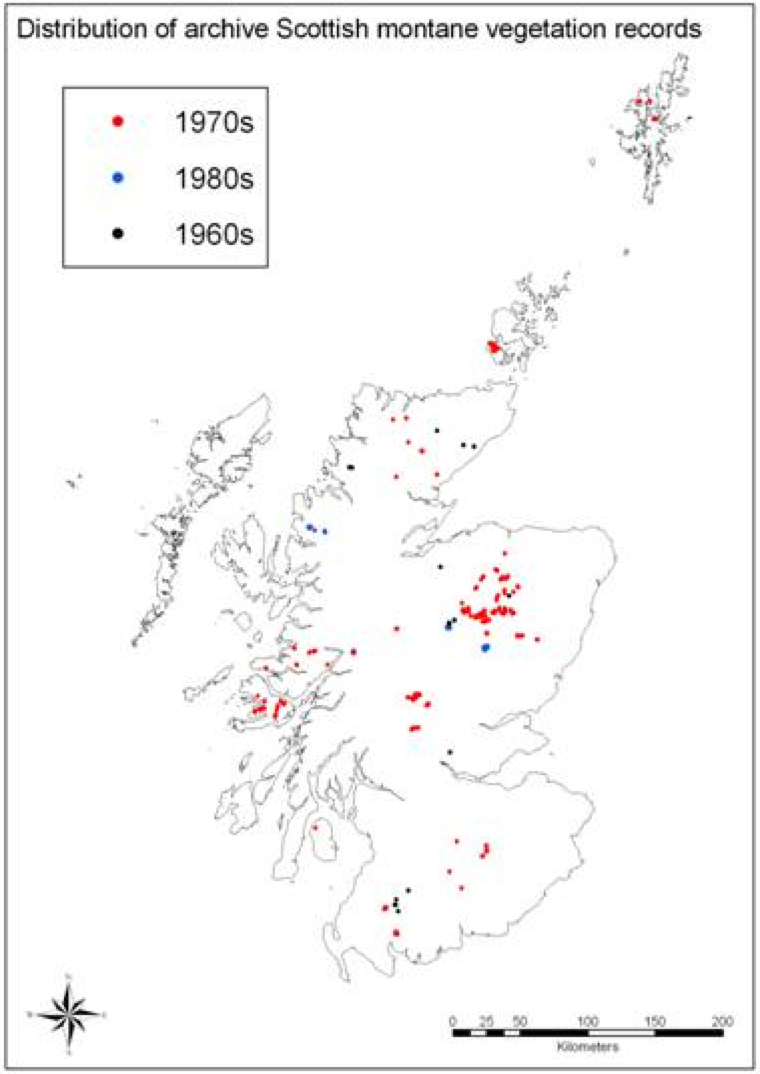
- Two vegetation datasets available, collected by:
- Birse & Robertson (Macaulay Institute) ca. 1950's-1980's
- McVean & Ratcliffe (NCC) ca. 1950's-1960's

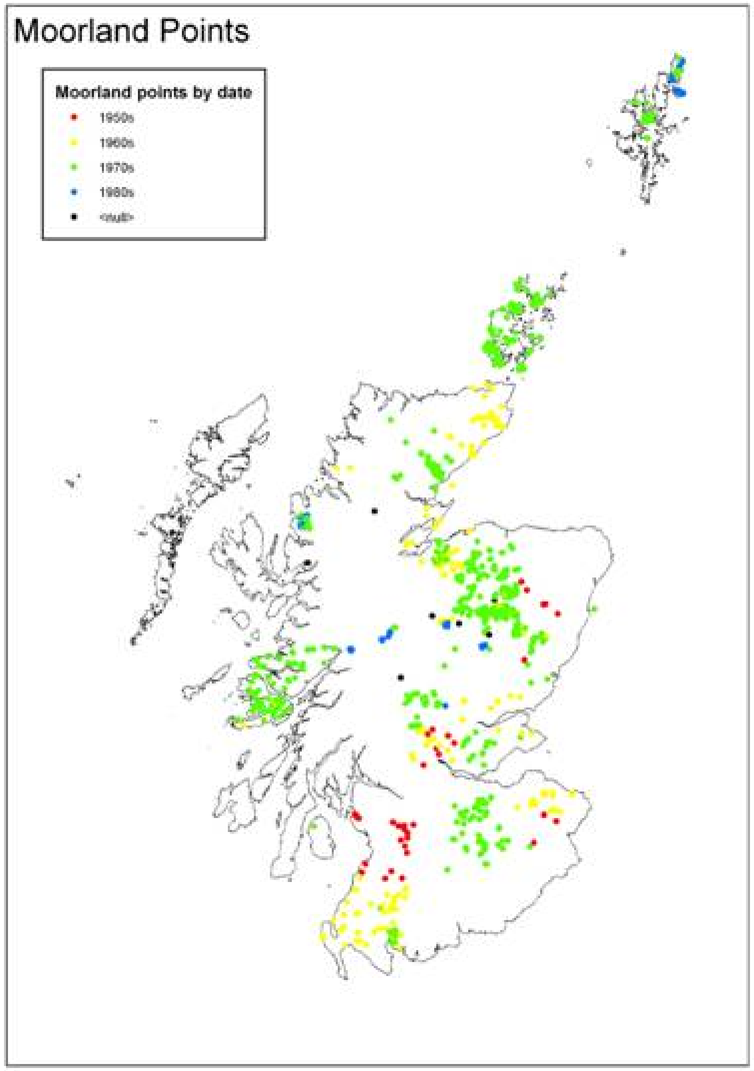
(NERC/SNH funded PhD starting 2007)

The 'Birse and Robertson' dataset

- Covers several habitat types:
  - Oroarctic (alpine) (677)
  - Moorland (1950)
  - Woodland (1241)
  - Wetland (456)
  - Maritime (302)
  - Grasslands (2000+)

Geographical distribution





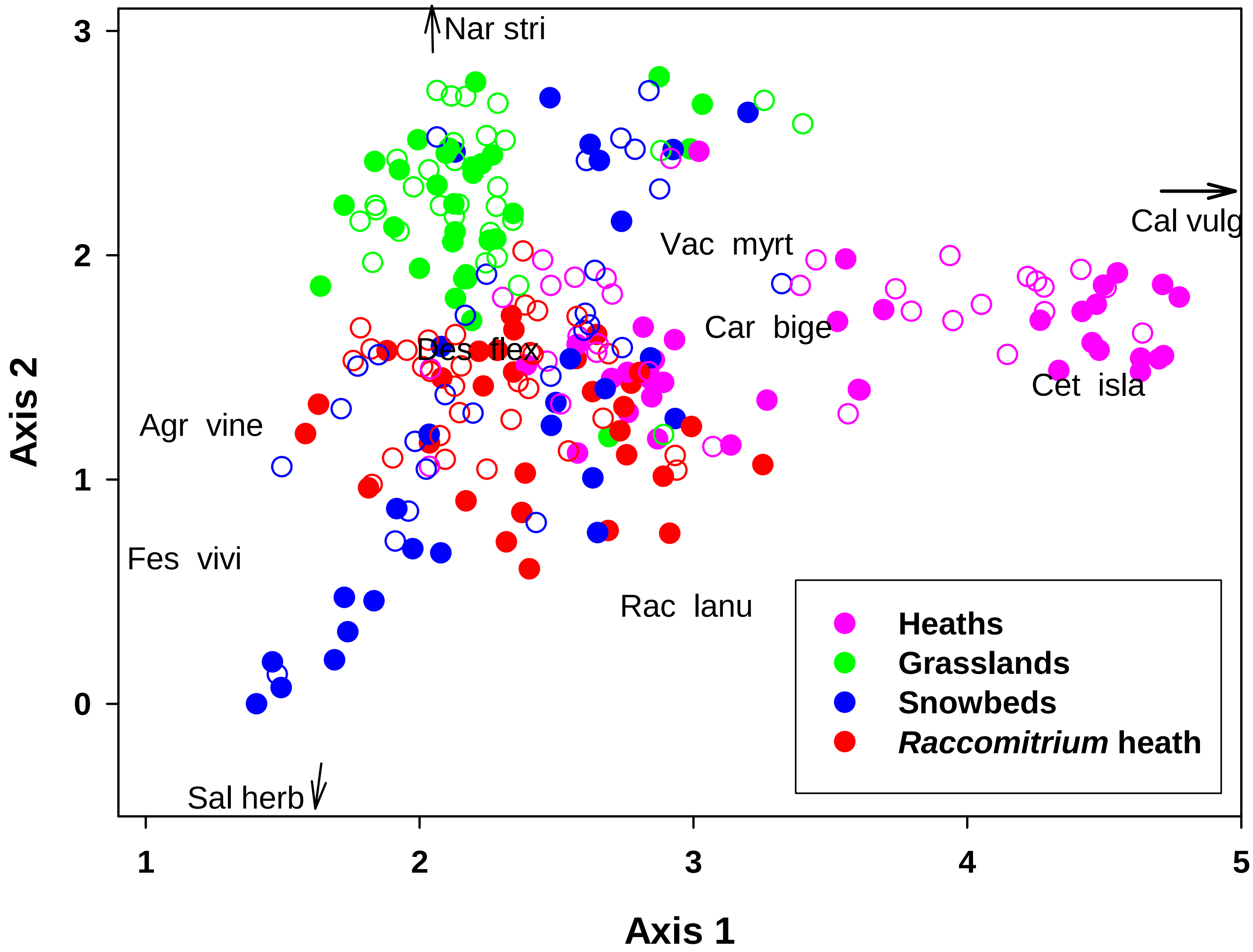
Results of the re-survey

- Focus on alpine heathland communities
- 135 plots resurveyed during 2004-5
- 3 contrasting areas: Cairngorms, Mull, Southern Uplands & Galloway

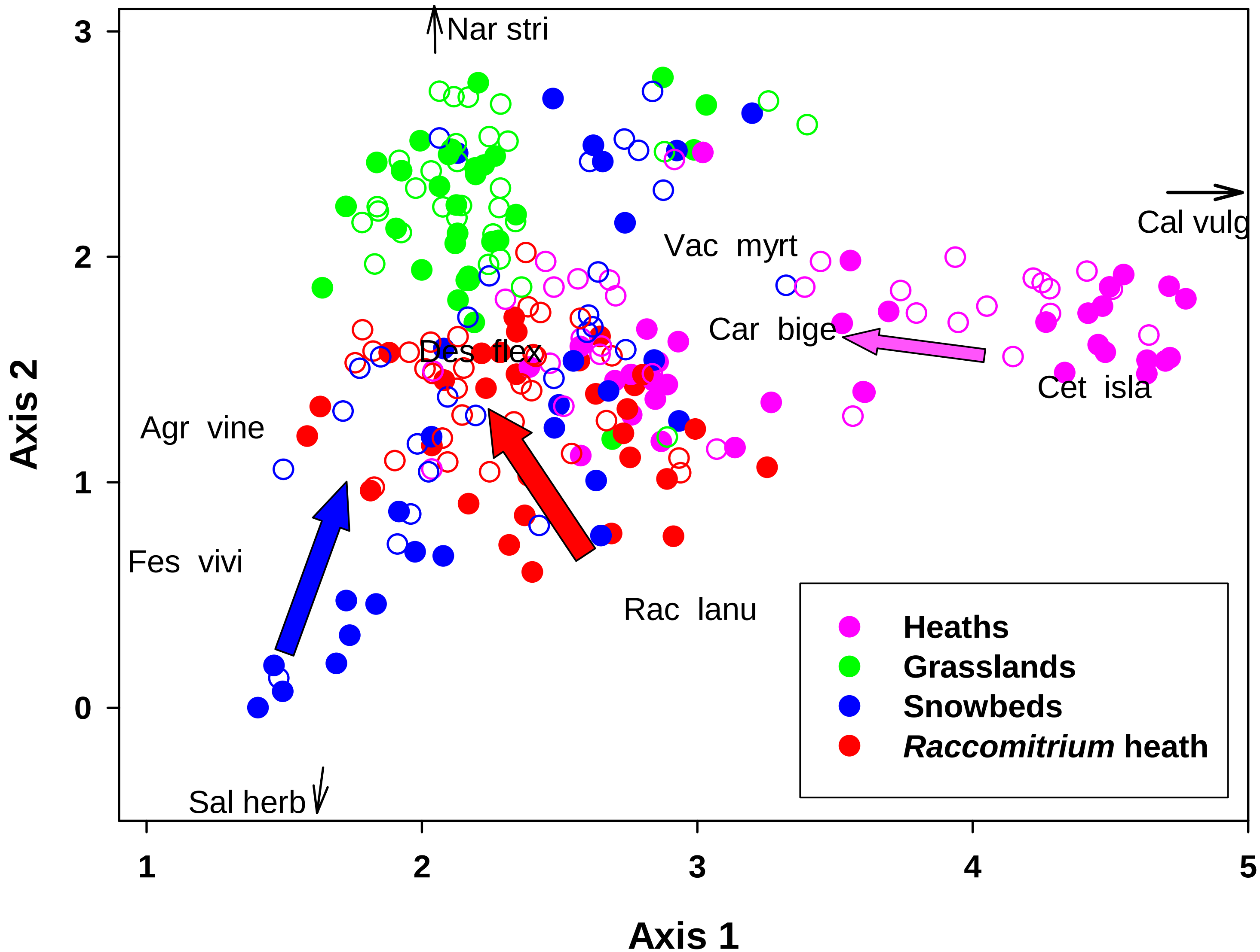
Can we detect change over 30 years?

- Yes
- Different degrees of change in different habitat types
- Greatest change in moss heaths and snowbeds
- Smaller changes in dwarf shrub heaths and grasslands

Vegetation change - all habitats



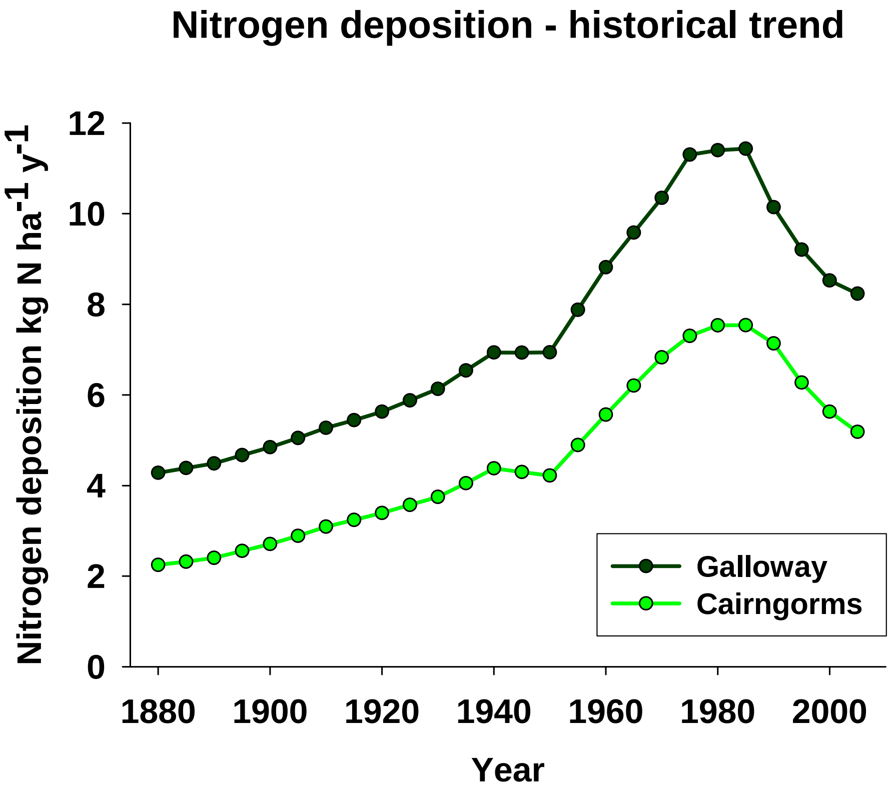
Vegetation change - all habitats

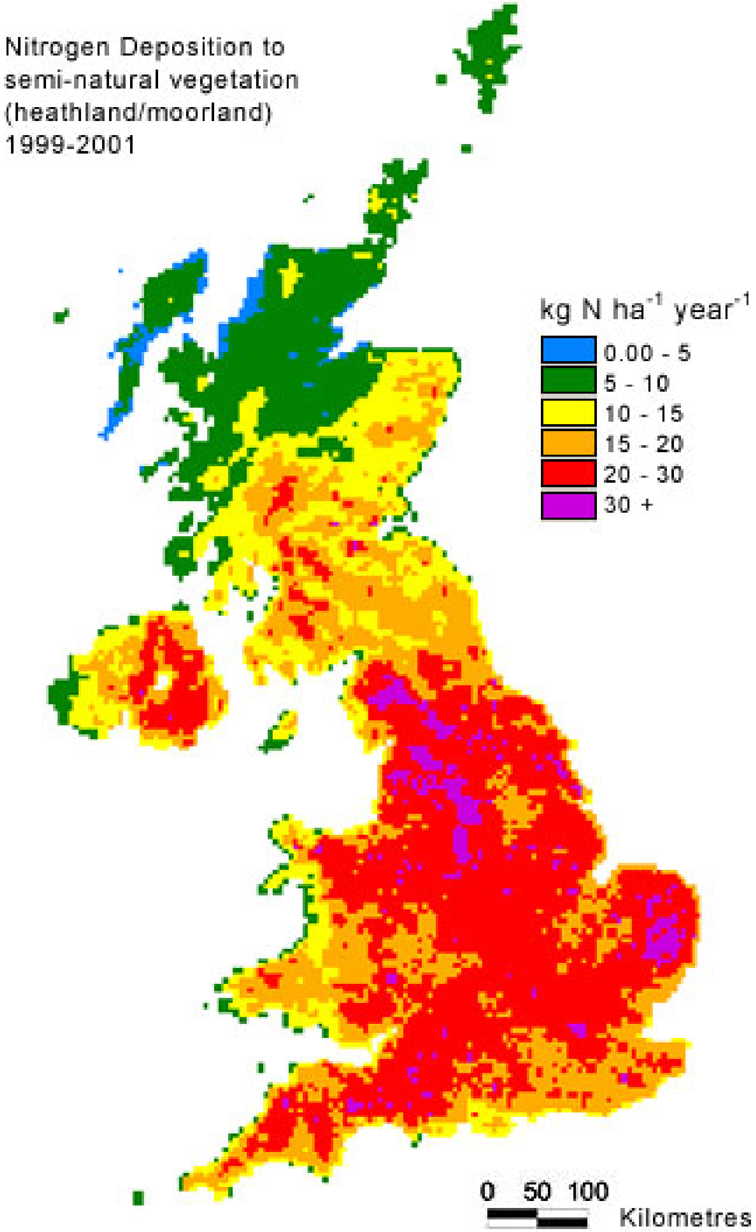


Linking vegetation change to drivers

- How do we determine which drivers are responsible for observed changes?
- Is there sufficient data available to show how driver impacts have changed through time?

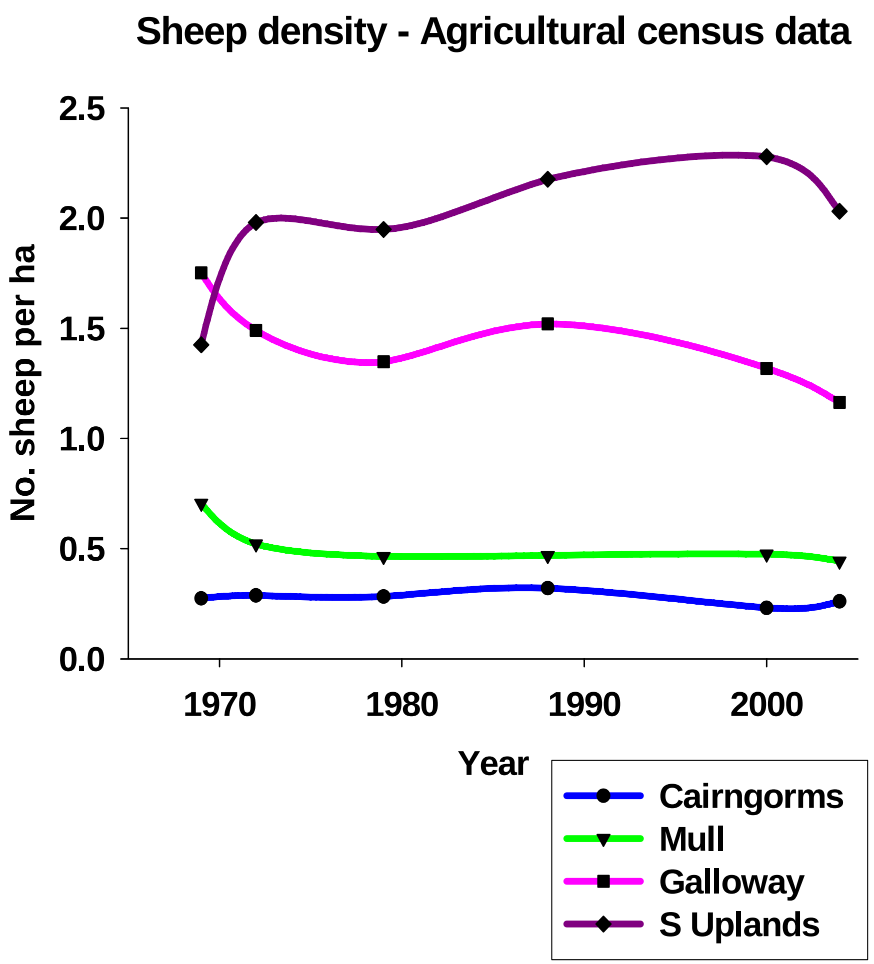
Nitrogen deposition

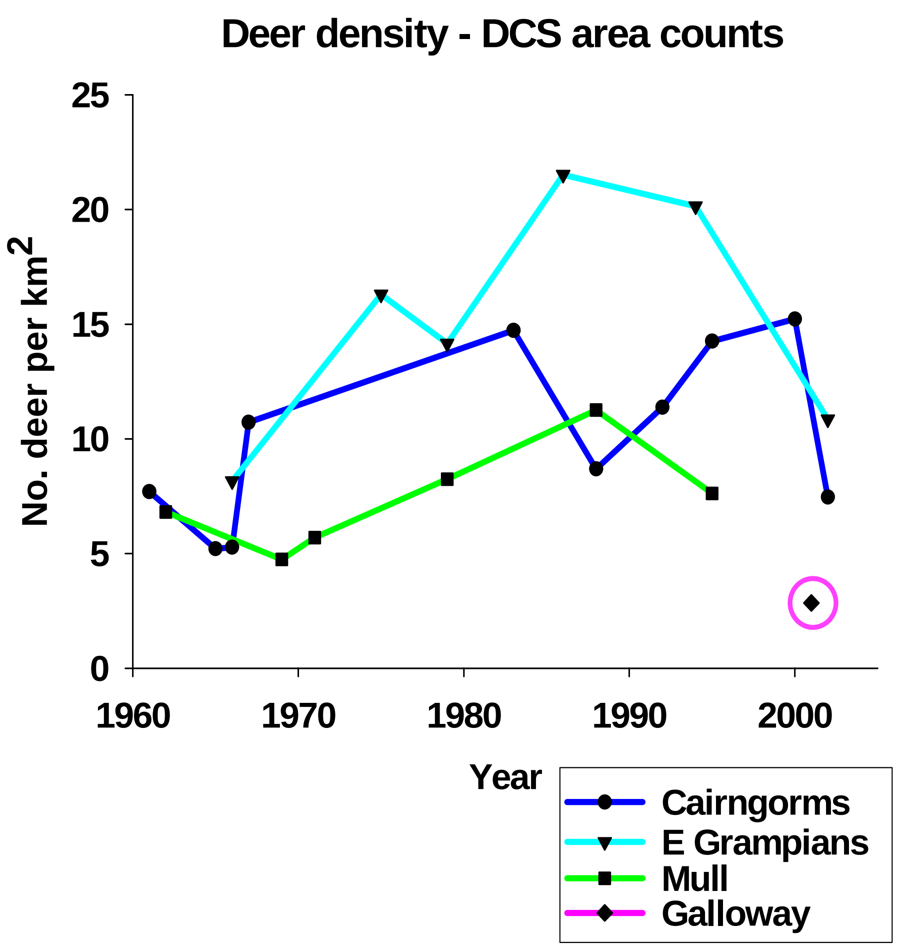




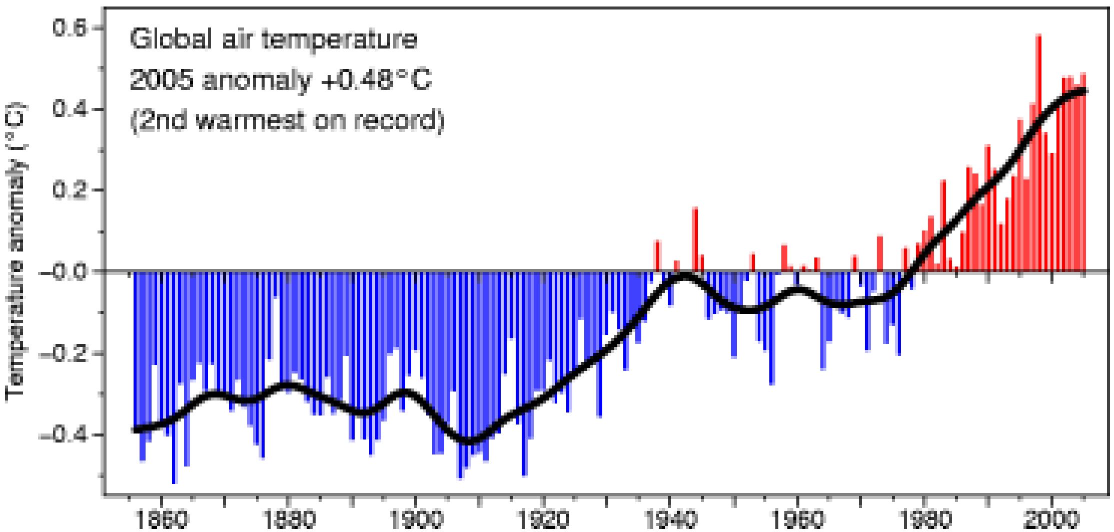
Map data CEH, from UK Air Pollution Information System www.apis.ac.uk

Grazing

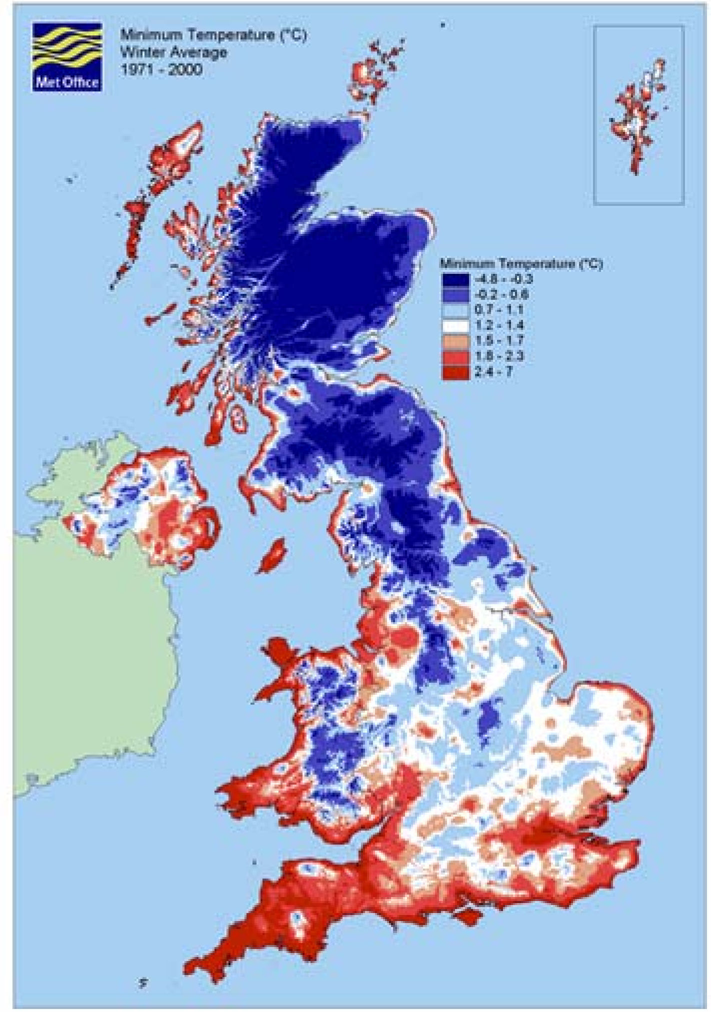

Sheep density - Agricultural census data
No. sheep per ha
2.5
2.0
1.5
1.0
0.5
0.0
1970
1980
1990
2000
Year
Cairngorms
Mull
Galloway
S Uplands


Deer density - DCS area counts
No. deer per km2
25
20
15
10
5
0
1960
1970
1980
1990
2000
Year
Cairngorms
E Grampians
Mull
Galloway

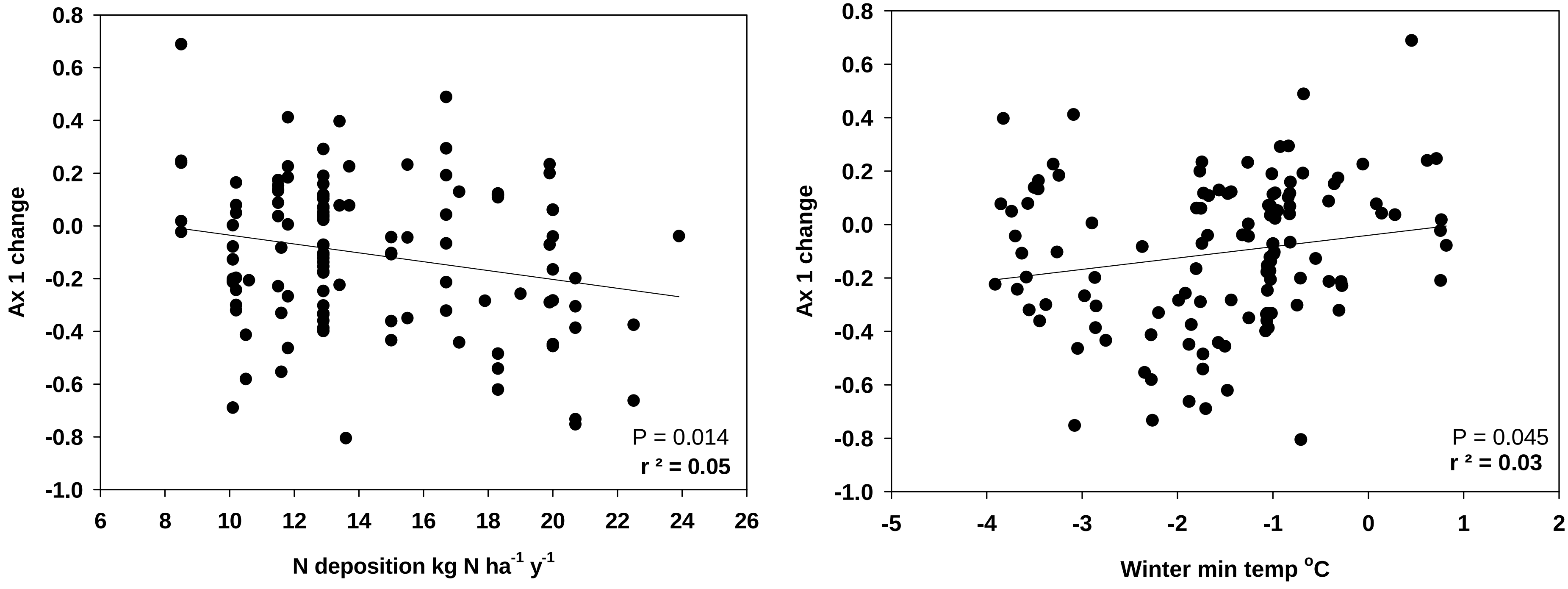
Climate



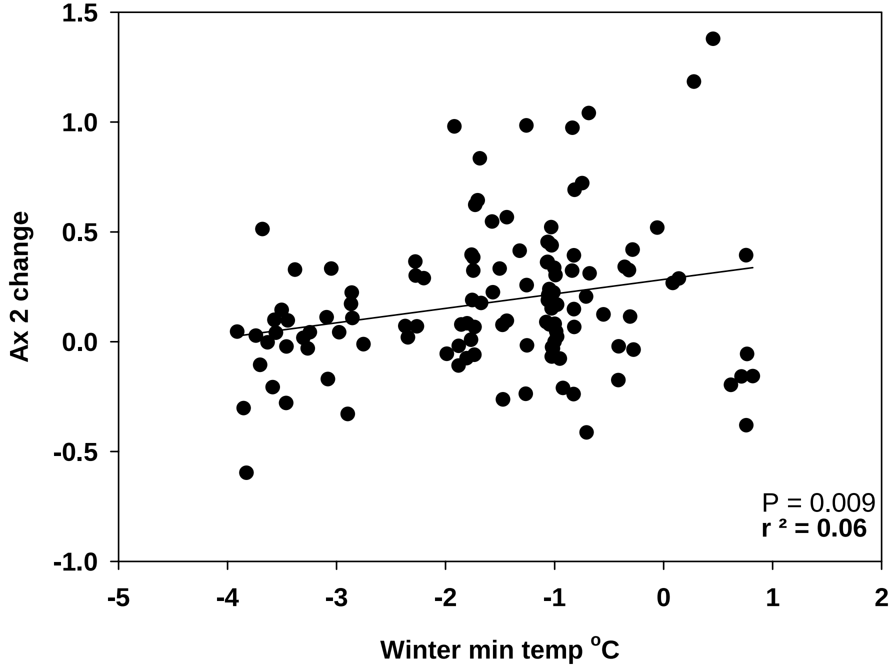
Central England temperature anomaly ca. + 1°C for 2002-05

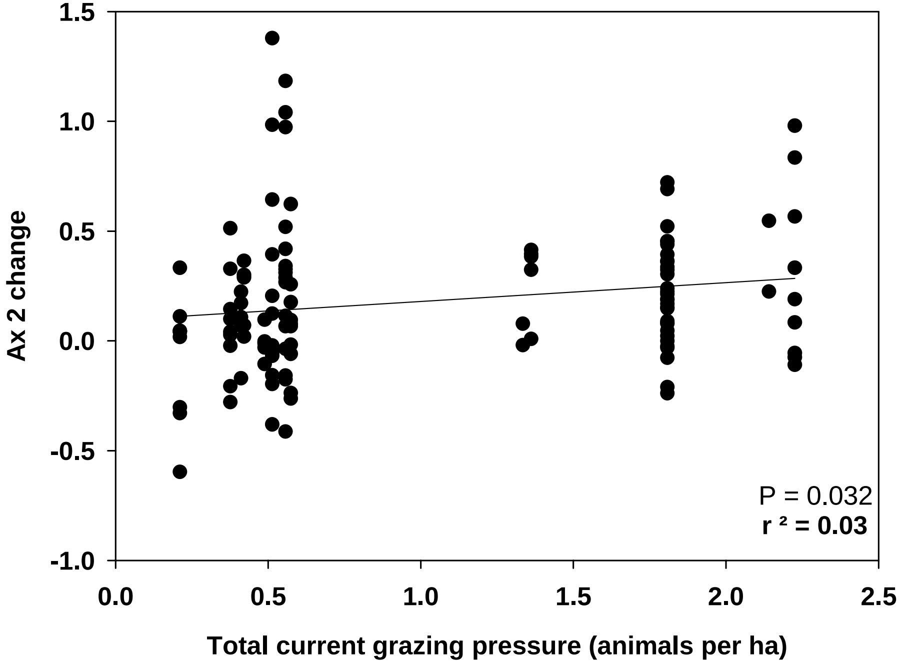


Drivers vs vegetation change: Axis 1

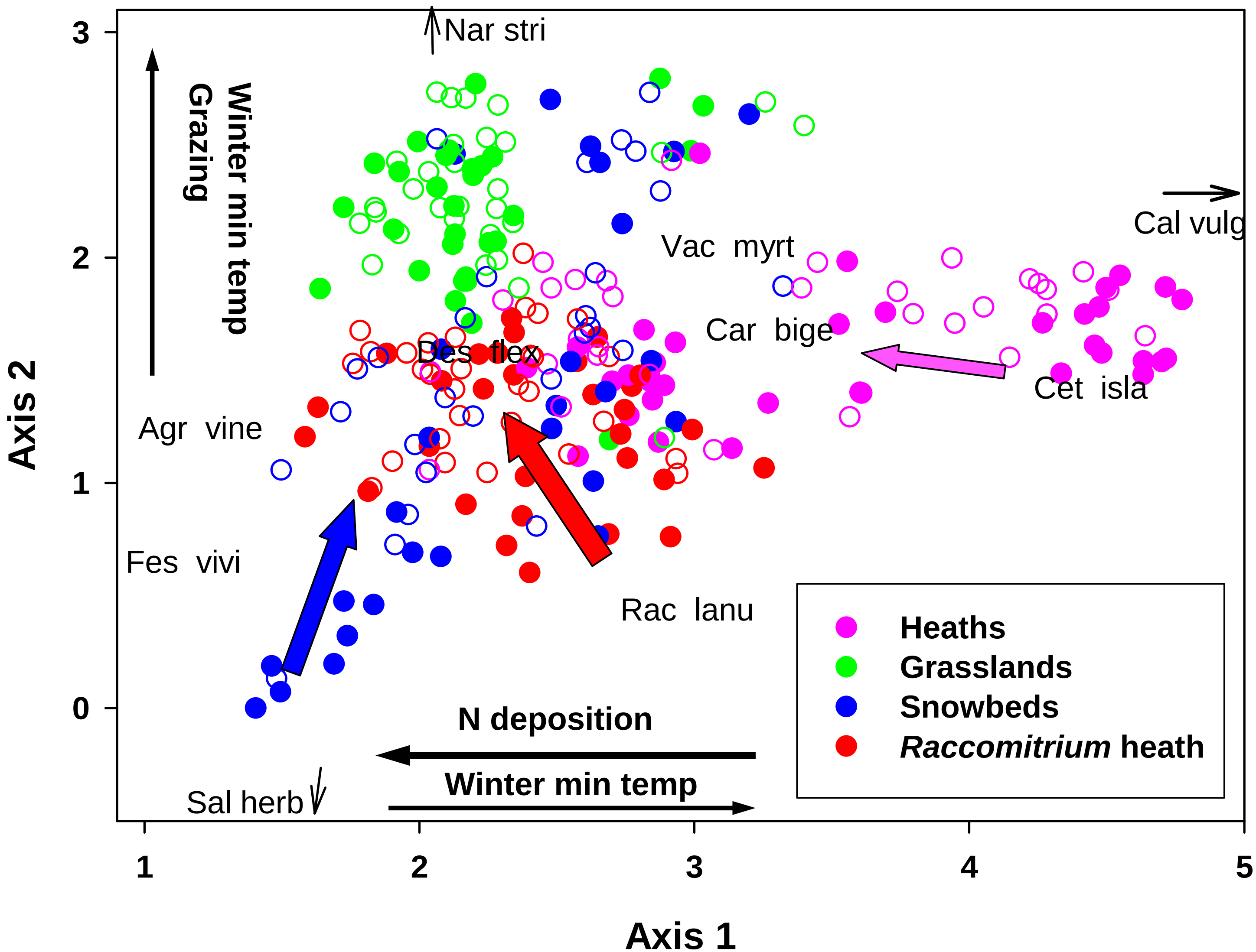


Drivers vs vegetation change: Axis 2





Vegetation change - all habitats



Conclusions

- Archive data – valuable record of past community composition
- Despite limitations can detect vegetation change over past 40 years
- Vegetation change results from multiple drivers and complex interactions
- N deposition and climate change signals detected in alpine vegetation
- More work to explore species responses

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