

# 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)



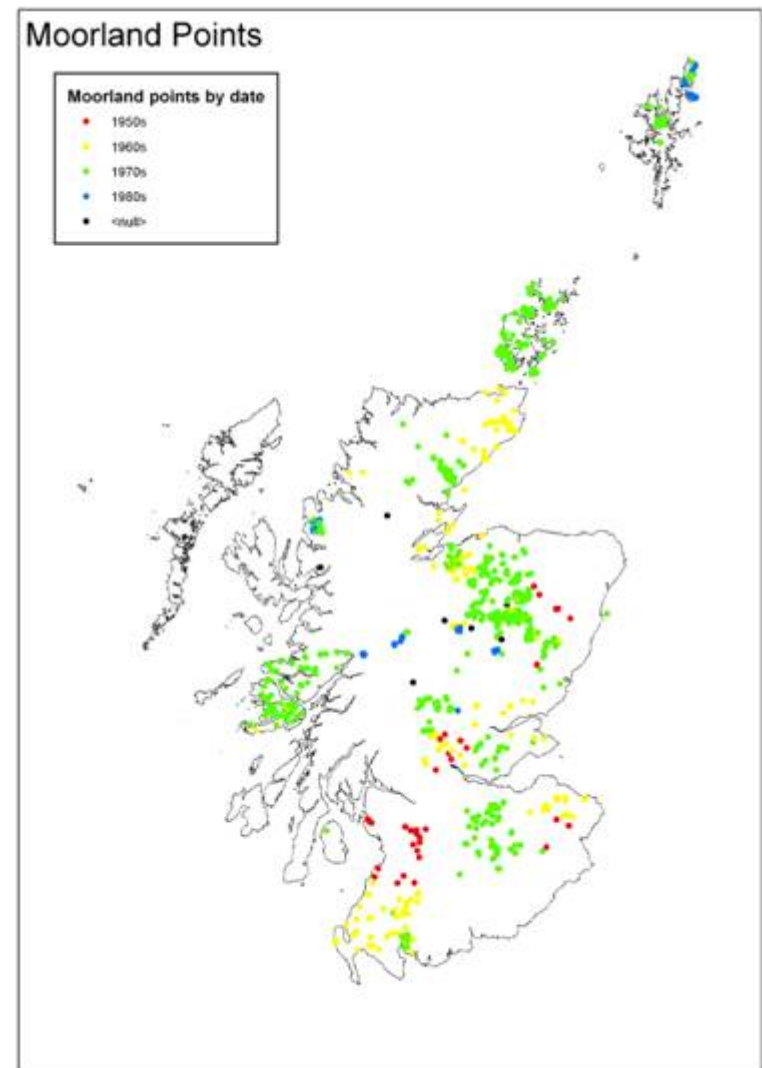
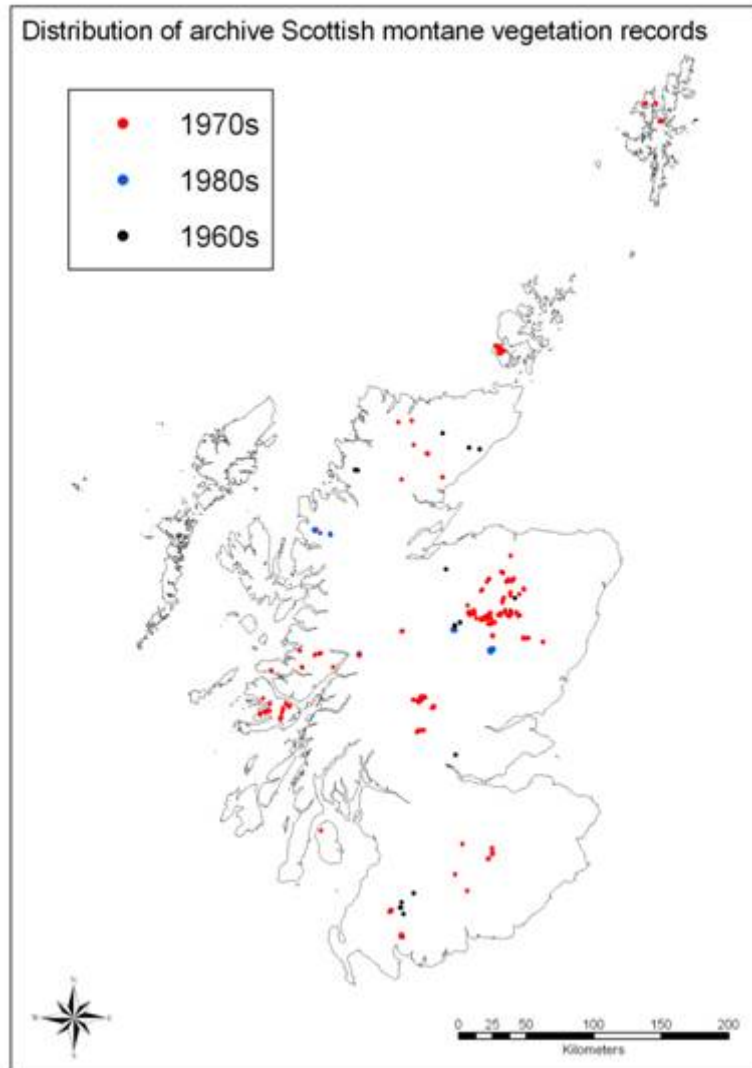
# The 'Birse and Robertson' dataset

- 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

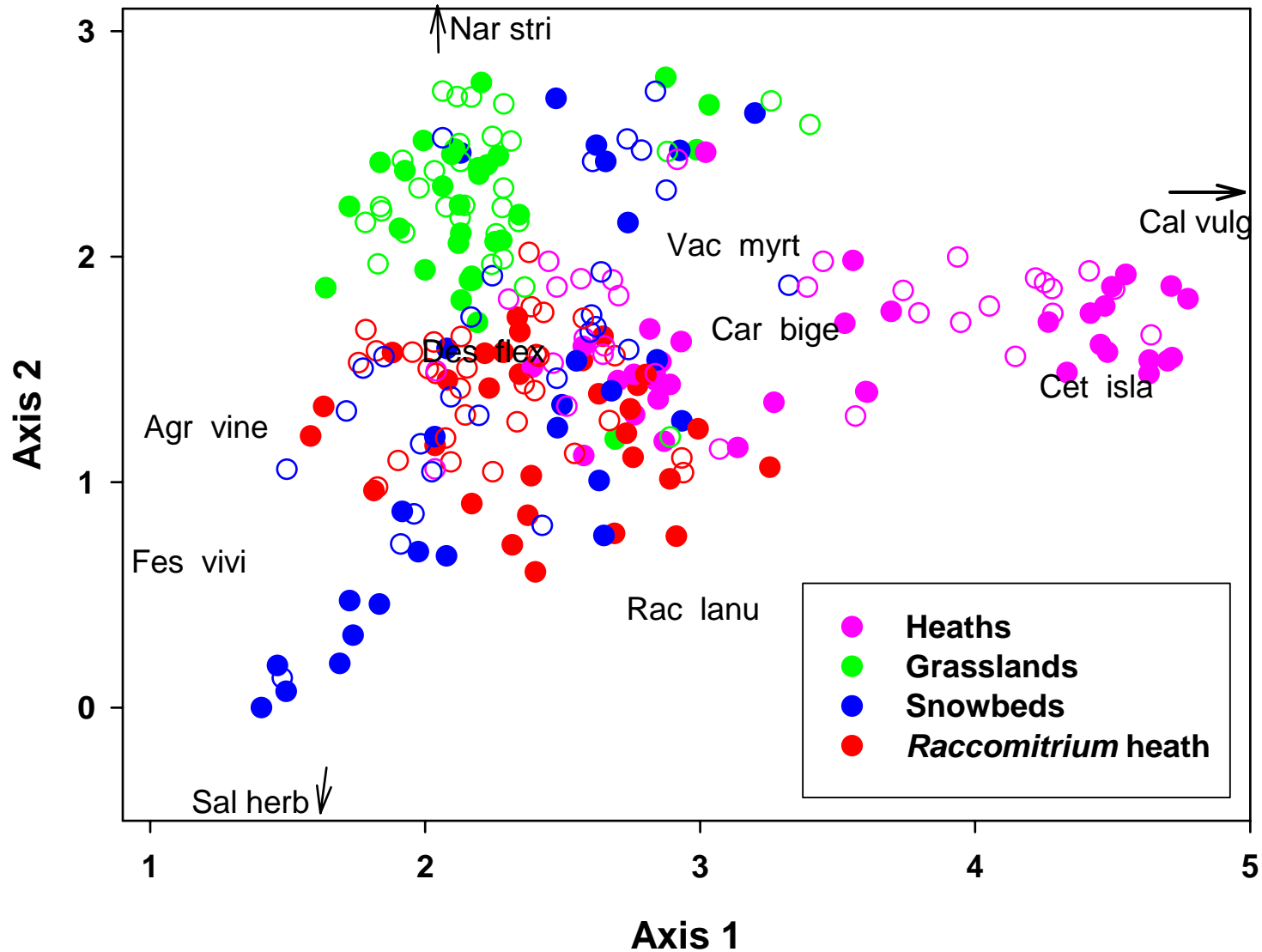


# Can we detect change over 30 years?

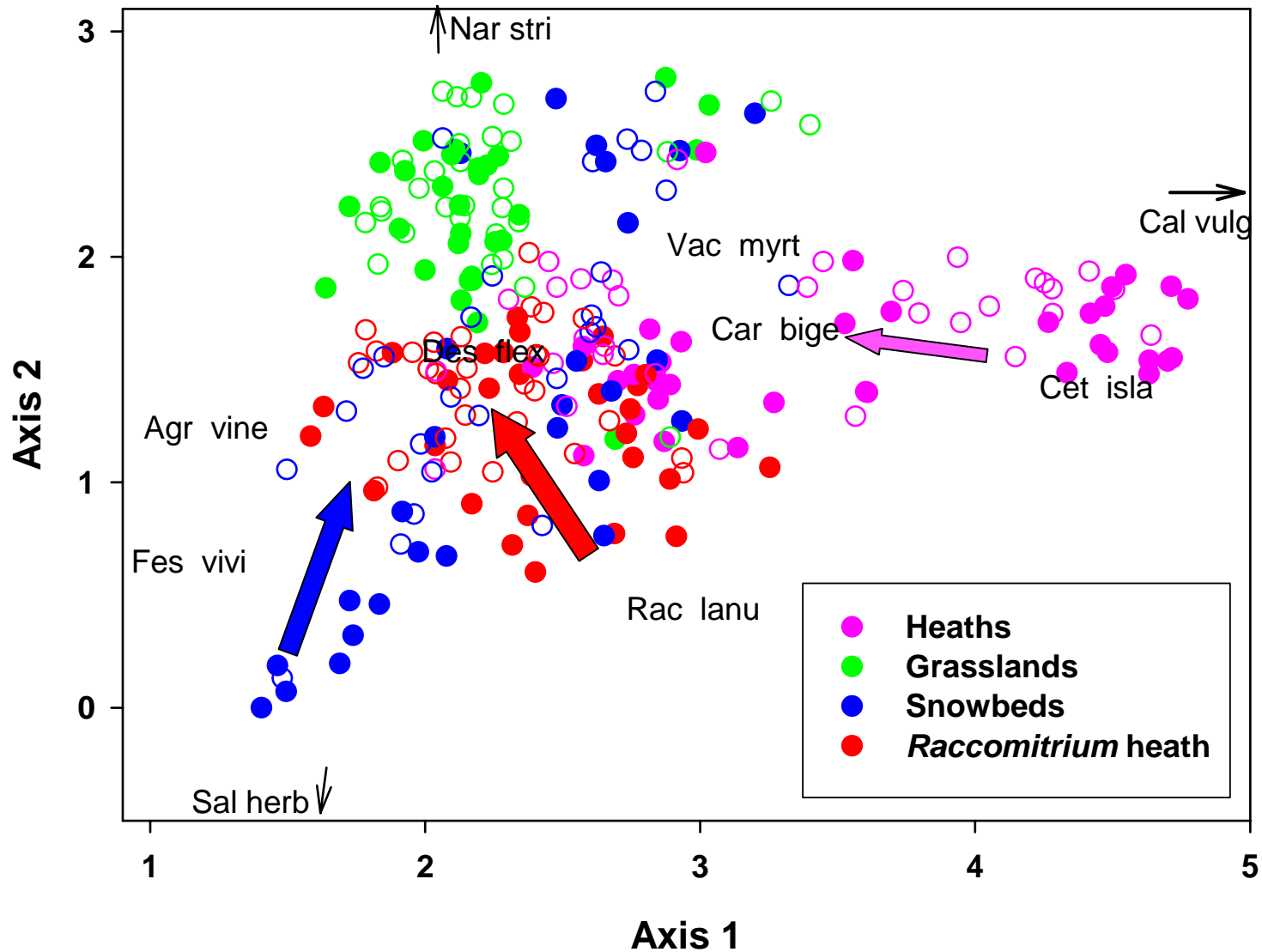
- Yes
- Different degrees of change in different habitat types
- Greatest change in moss heaths and snowbeds
- Smaller changes in dwarf shrub heaths and grasslands



# Vegetation change - all habitats



# Vegetation change - all habitats



## Linking vegetation change to drivers

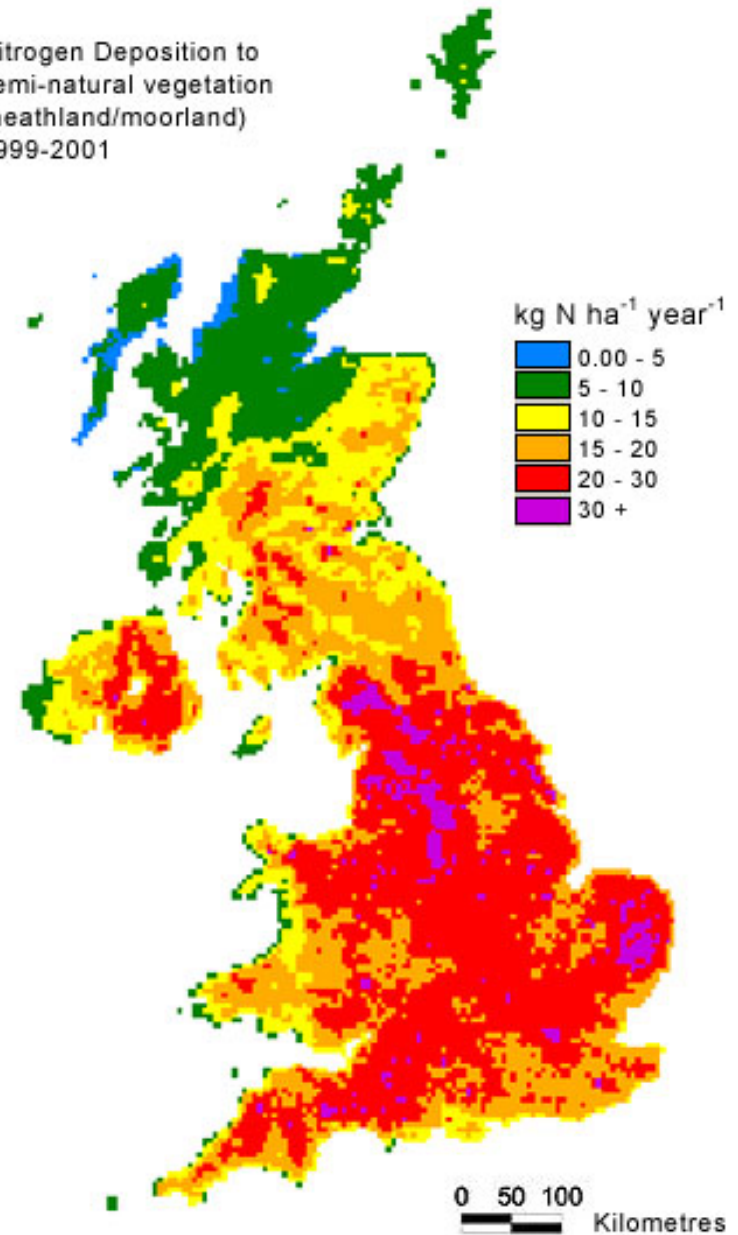
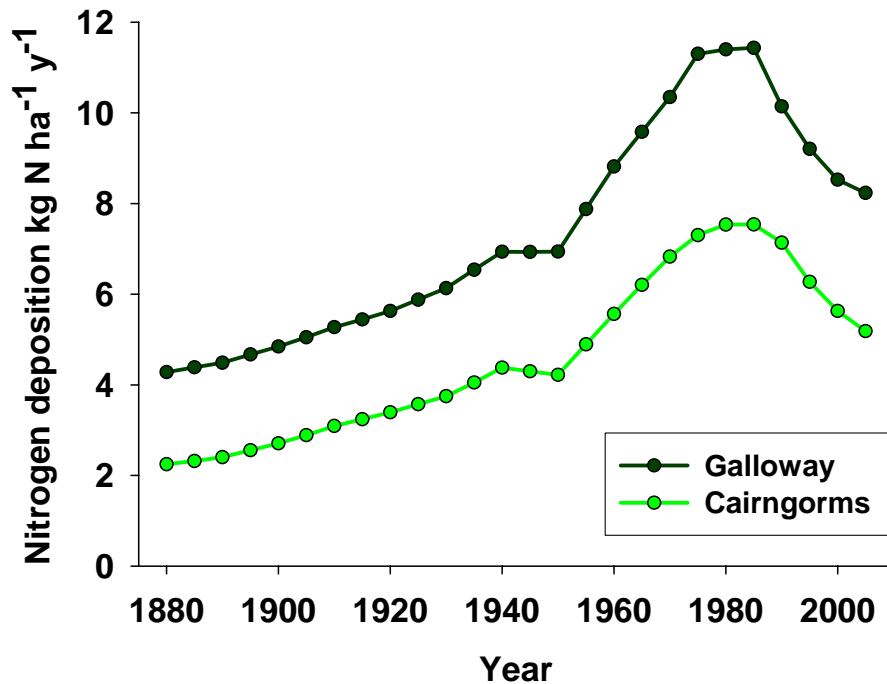
- How do we determine which drivers are responsible for observed changes?
- Is there sufficient data available to show how driver impacts have changed through time?



# Nitrogen deposition

Nitrogen Deposition to semi-natural vegetation (heathland/moorland) 1999-2001

### Nitrogen deposition - historical trend

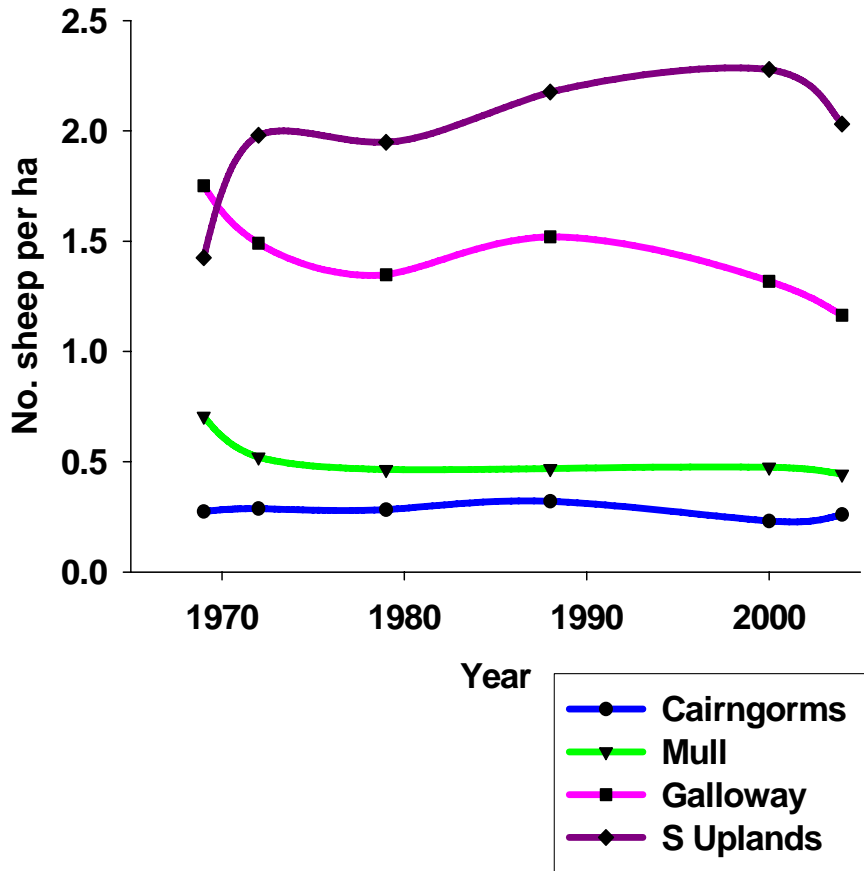


Map data CEH, from UK Air Pollution Information System [www.apis.ac.uk](http://www.apis.ac.uk)

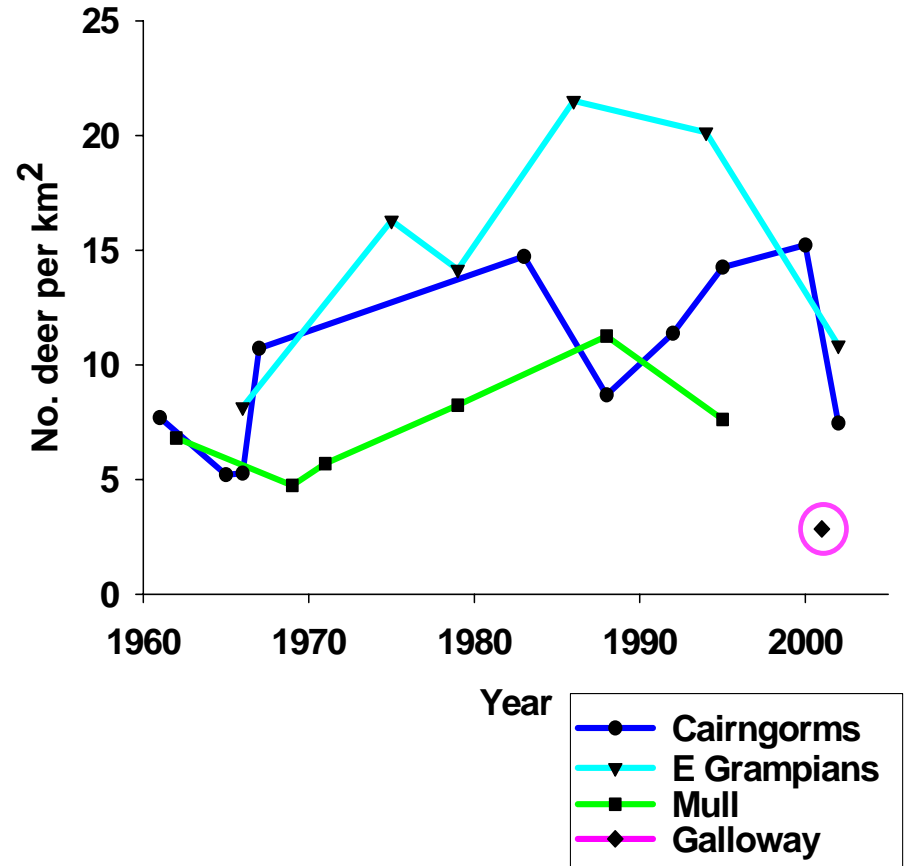


# Grazing

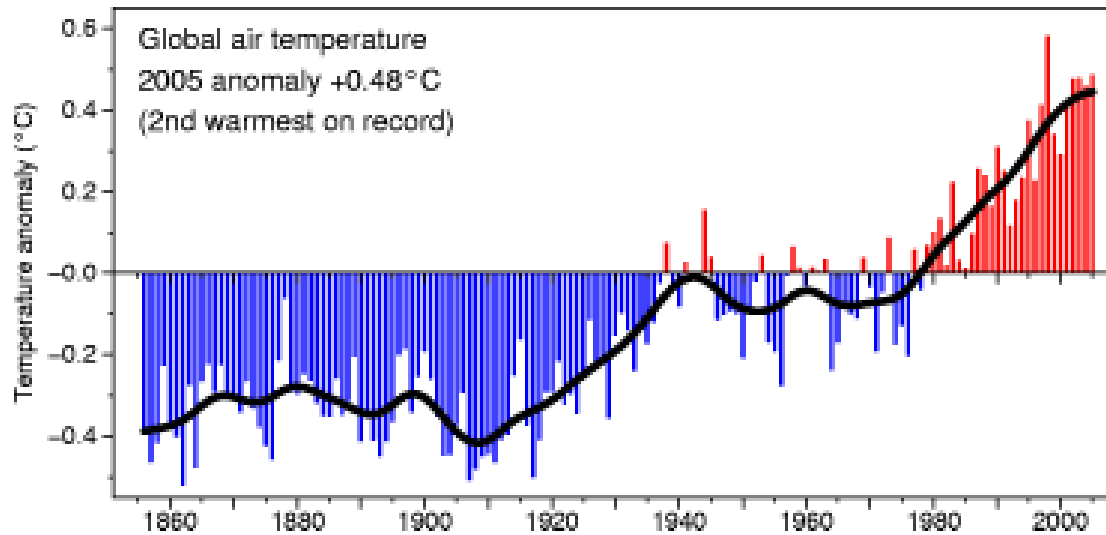
Sheep density - Agricultural census data



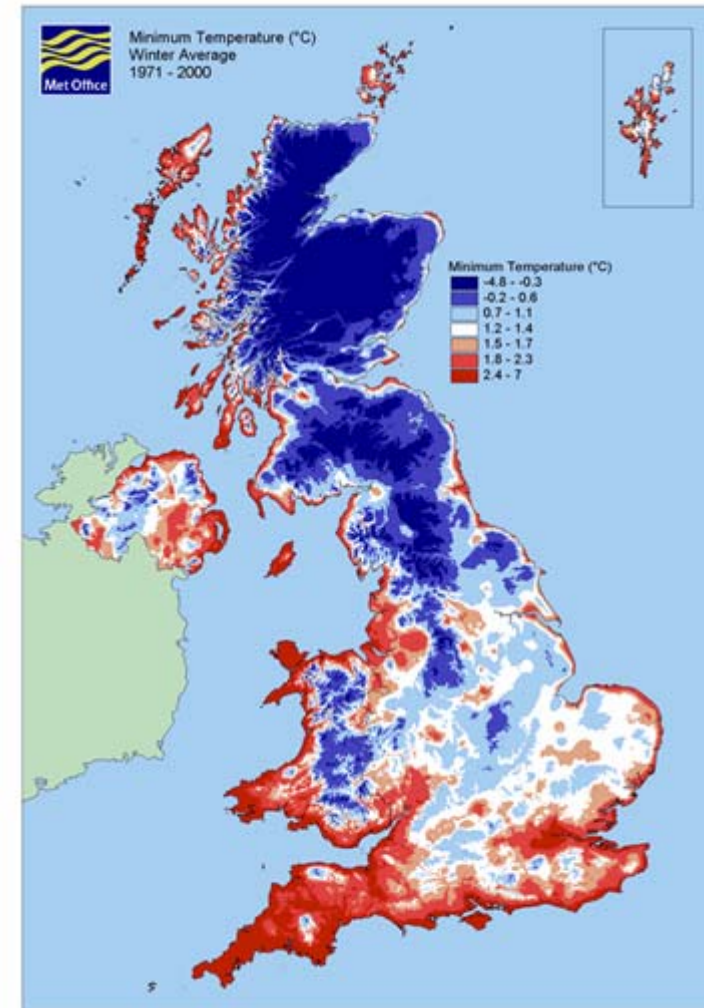
Deer density - DCS area counts



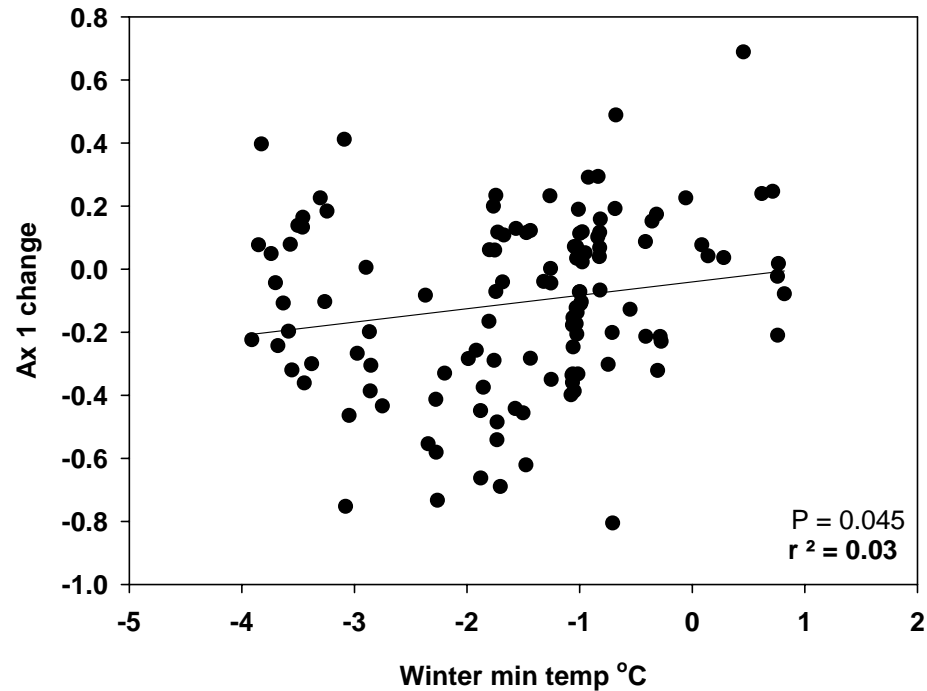
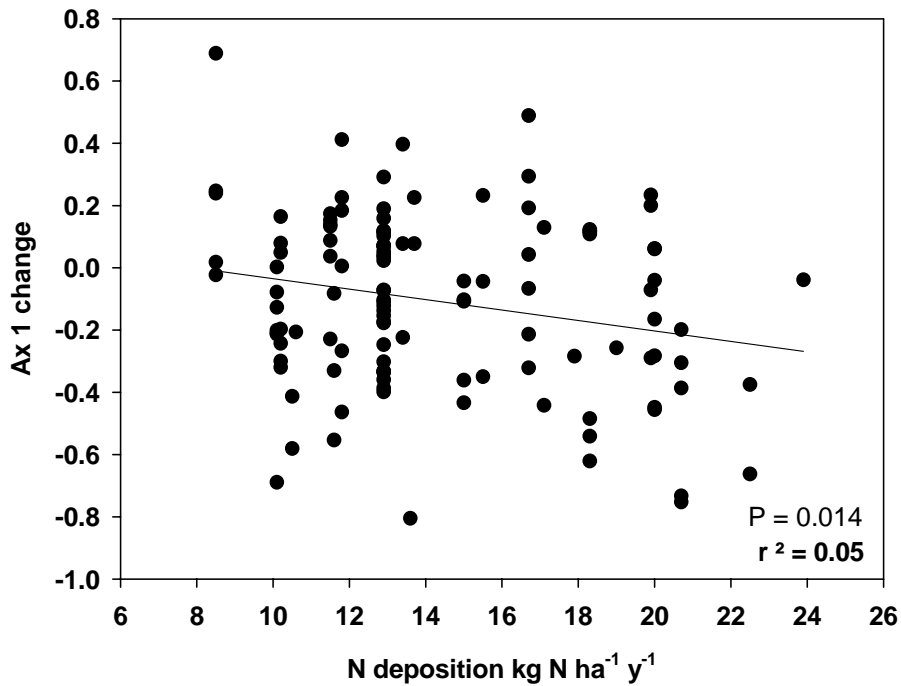
# Climate



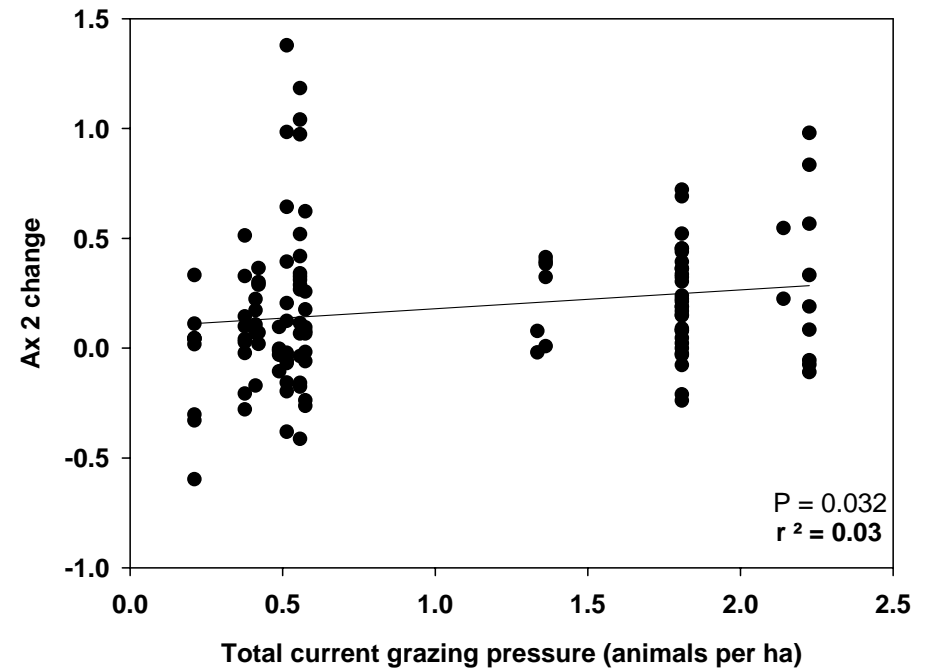
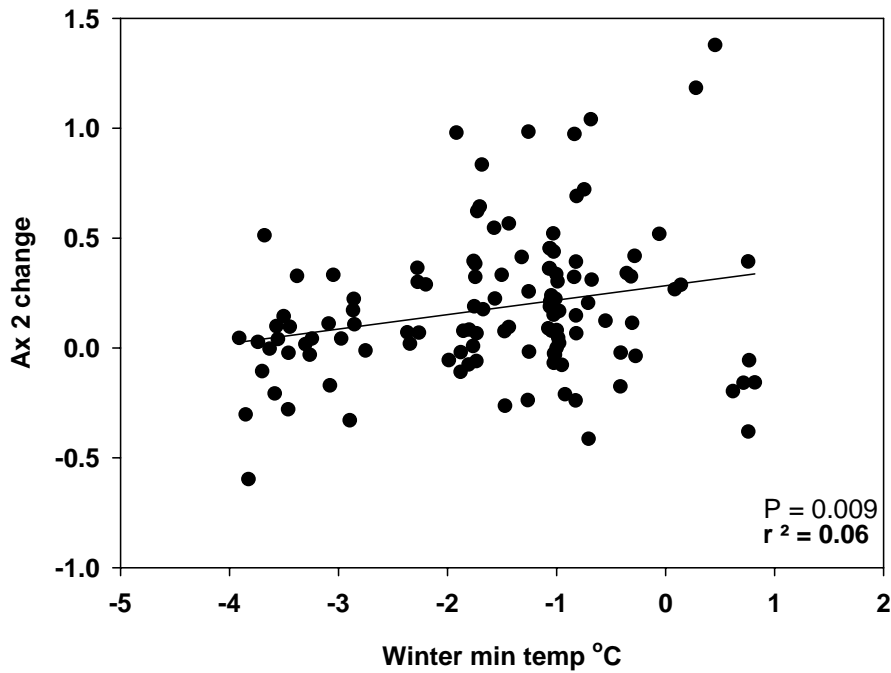
Central England temperature  
anomaly ca. + 1°C for 2002-05



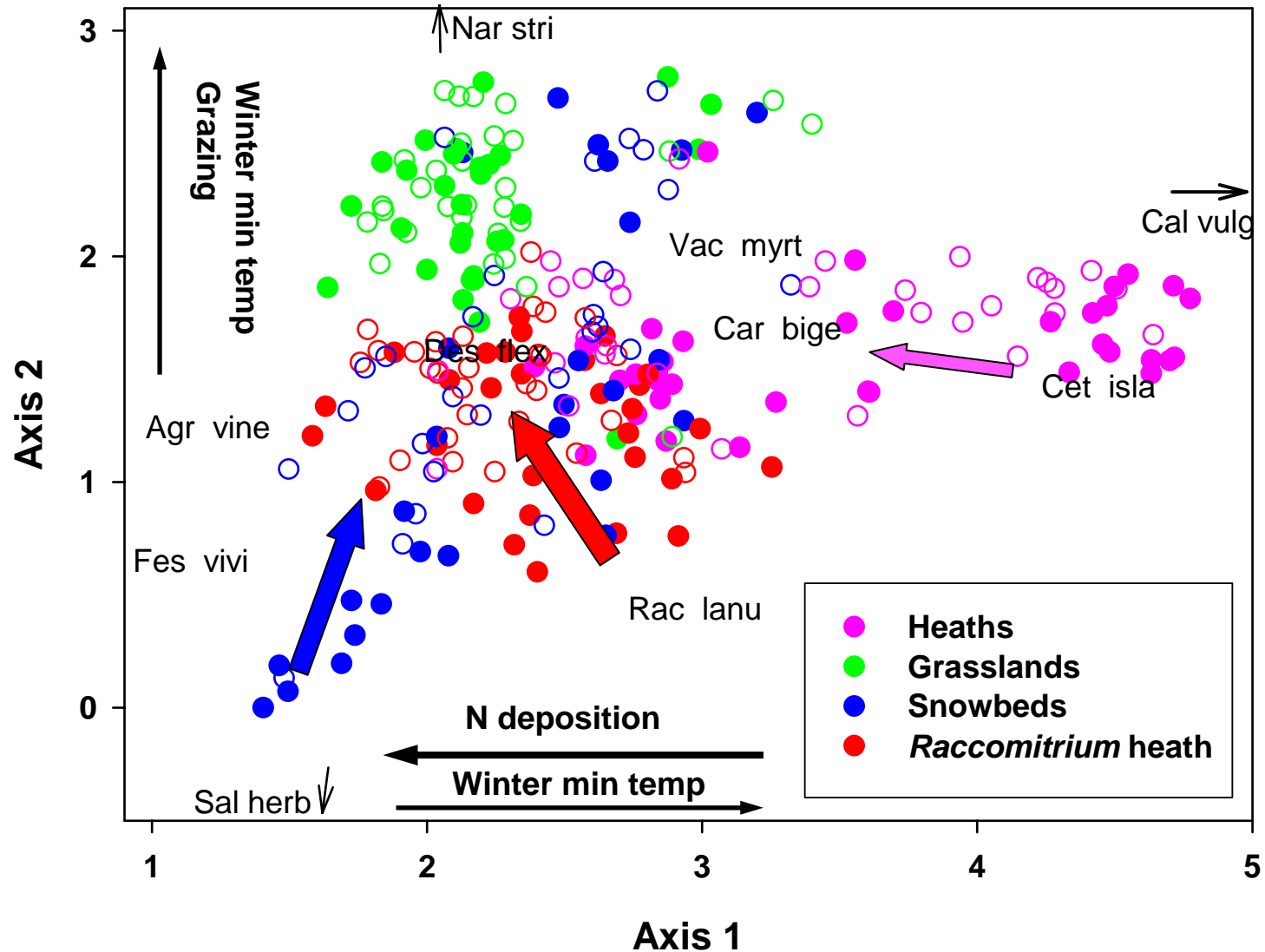
# Drivers vs vegetation change: Axis 1



# 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



# Acknowledgements

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