

Impacts of climate change on the condition of calcareous grassland ecosystems

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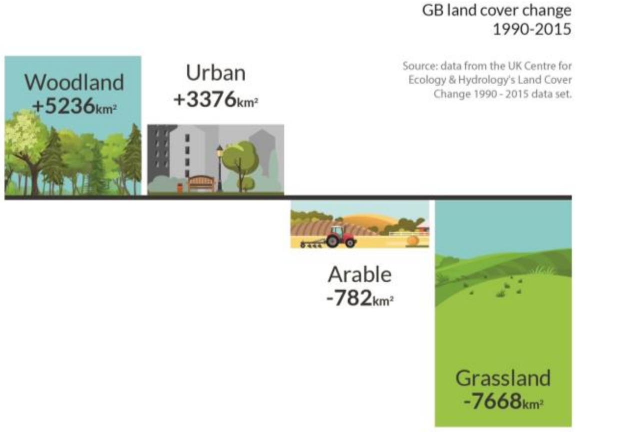
Grasslands

- Many values
  - Agricultural
  - Biodiversity
  - Cultural
  - Ecosystem services

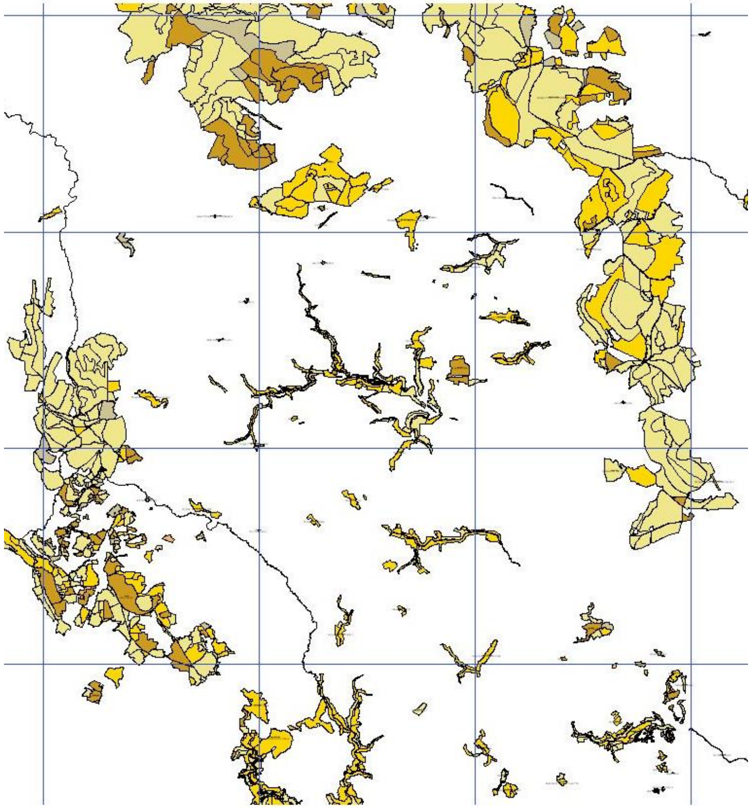
- Multiple threats
  - Land-use change
  - Abandonment
  - Global environmental change

- Climate change impacts poorly characterized



Common standards monitoring (CSM) & condition assessment

- Statutory protected areas
  - SSSI, SAC, SPA etc.
- Requirement for condition assessment
  - Standardised
  - Quick and easy
  - For protected sites
- Feature-based
  - Habitats
  - Species
  - Landforms



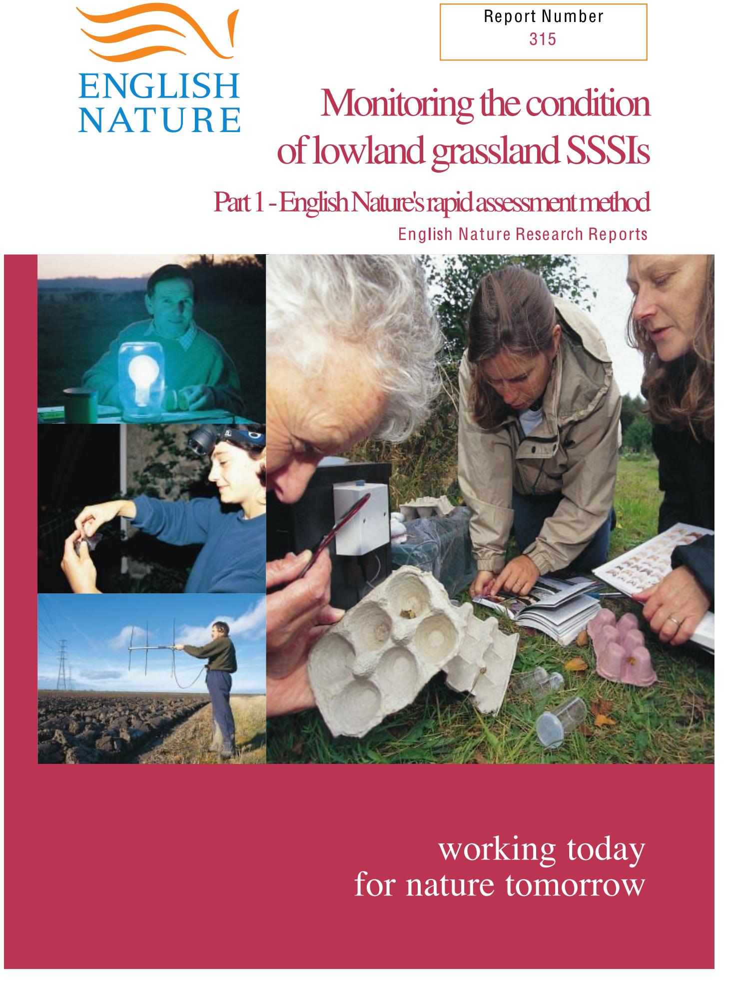
CSM attributes for ‘lowland’ grassland: rationale

- Attribute-based assessment
- Measure impacts of/ changes in
  - Nutrient status
  - Grazing/cutting regime
  - Disturbance
  - Hydrological conditions
- Instantaneous/ temporal measurements
- Climate change?

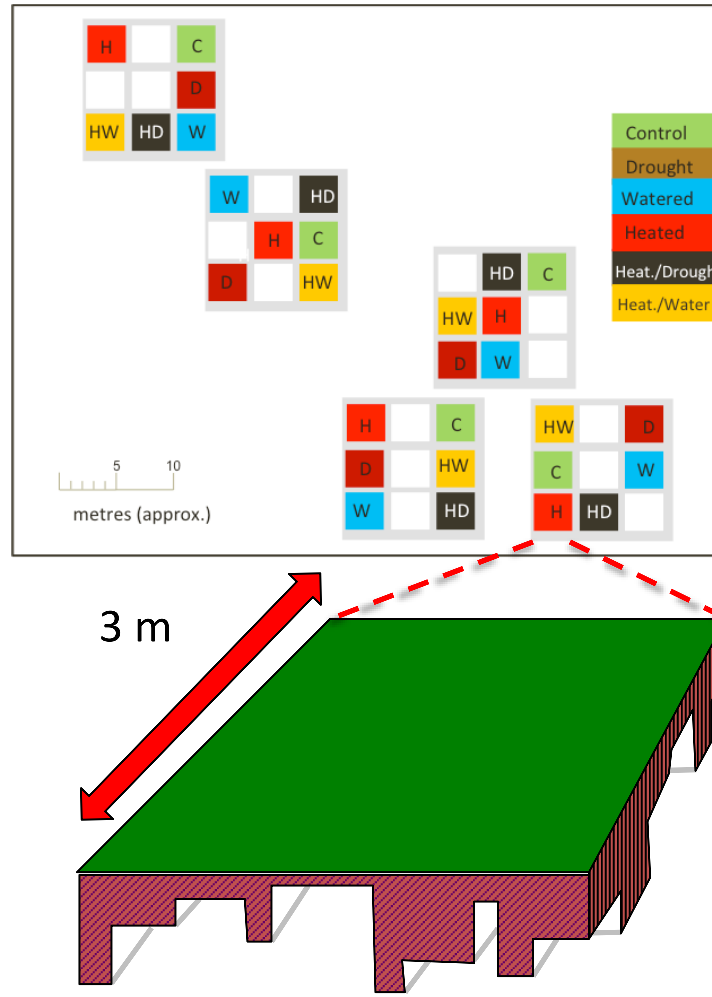
CSM attributes for 'lowland' grasslands

- Primary attributes
  - Extent
  - Grass:herb ratio
  - Positive indicator species
  - Negative indicator species
  - Indicators of local distinctiveness
- Secondary attributes
  - Sward height
  - Litter
  - Bare ground
- Four condition categories
- Trend qualifiers (optional)

- Impacts of climate on these attributes?



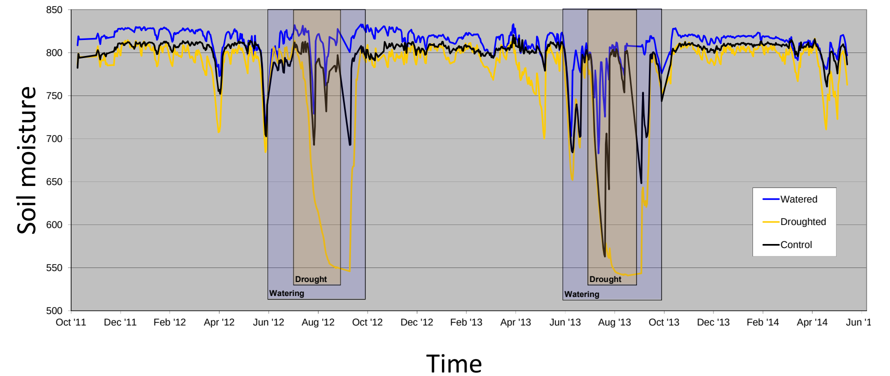
Buxton Climate Change Impacts Lab (BCCIL)



- Ancient sheep pasture
- Treatments for 27 years
- High species & genetic diversity
- Resistant to climate change

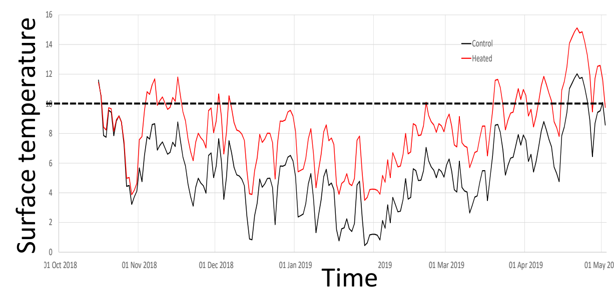
~ 40 plant spp.
500 > individuals

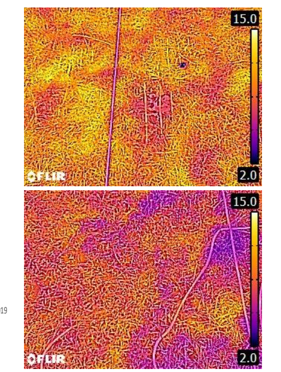
Drought



Heated

(+ 3 °C)



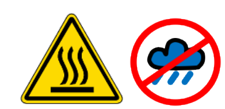


Watering

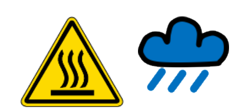
(+ 20%)

Control

Heated + Drought



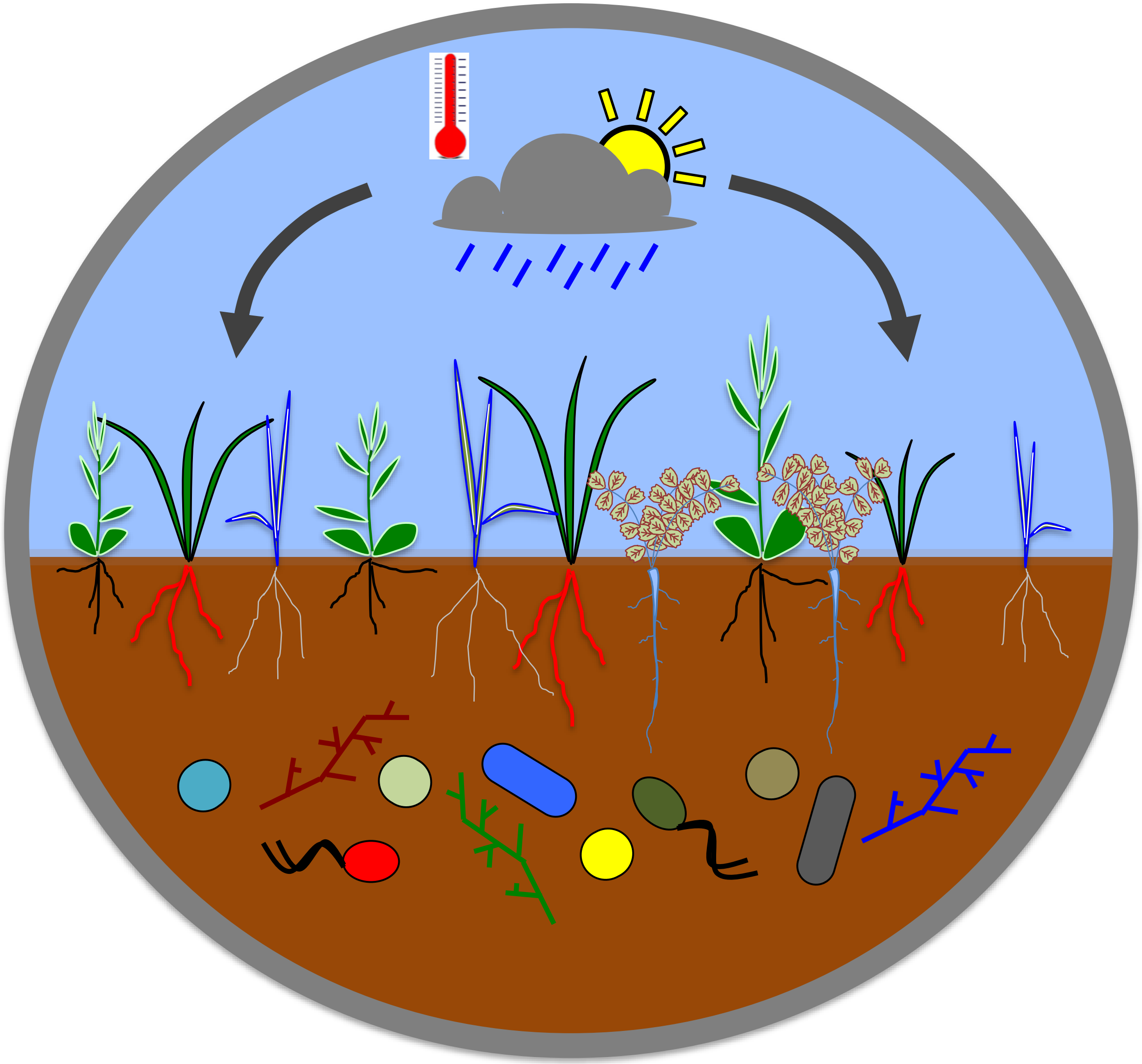
Heated + Watering



Direct and indirect impacts of climate change on grassland ecosystems

Drivers

Precipitation
Temperature
Light
CO_2



Biological Responses

*Community composition
*Evolution
(Selection)
(drift)
(Migration)
(Extinction)

Global Change Biology

Global Change Biology (2011) **17**, 2002–2011, doi: 10.1111/j.1365-2486.2010.02347.x

Soil heterogeneity buffers community response to climate change in species-rich grassland

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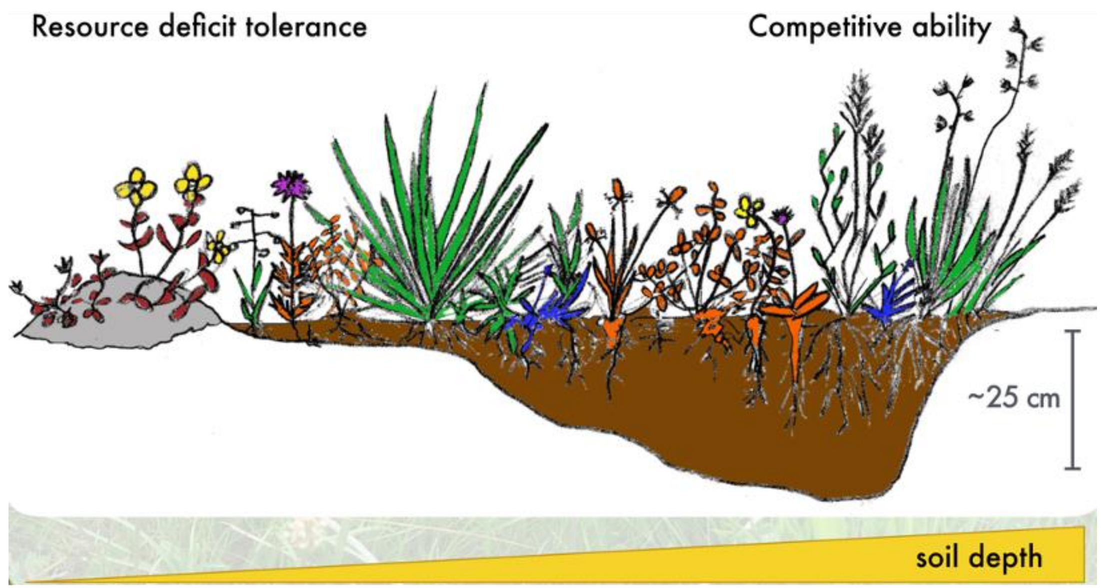
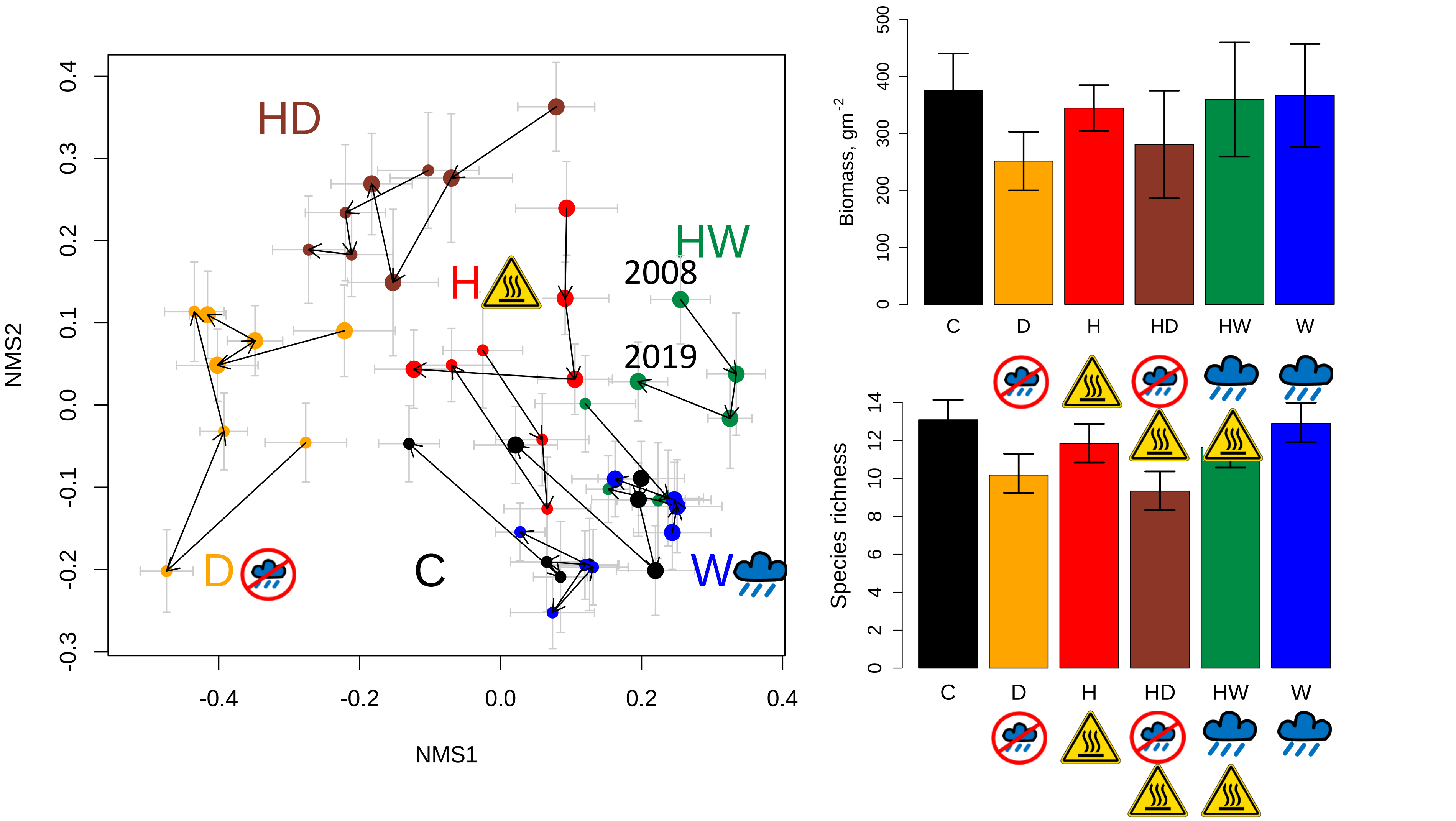
Abstract

Climate change impacts on vegetation are mediated by soil processes that regulate rhizosphere water balance, nutrient dynamics, and ground-level temperatures. For ecosystems characterized by high fine-scale substrate heterogeneity such as grasslands on poorly developed soils, effects of climate change on plant communities may depend on substrate properties that vary at the scale of individuals ($<\mathrm{m}^2$), leading to fine-scale shifts in community structure that may go undetected at larger scales. Here, we show in a long-running climate experiment in species-rich limestone grassland in Buxton, England (UK), that the resistance of the community to 15-year manipulations of temperature and rainfall at the plot scale ($9\,\mathrm{m}^2$) belies considerable community reorganization at the microsite ($100\,\mathrm{cm}^2$) scale. In individual models of the abundance of the 25 most common species with respect to climate



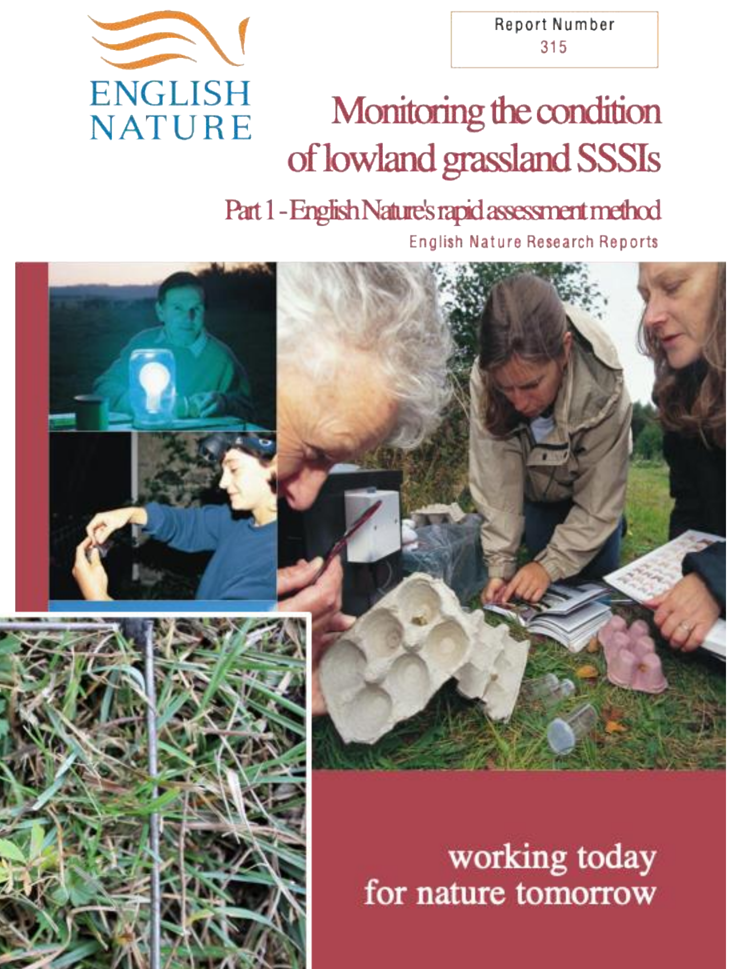
Climate change alters grassland structure, diversity and productivity



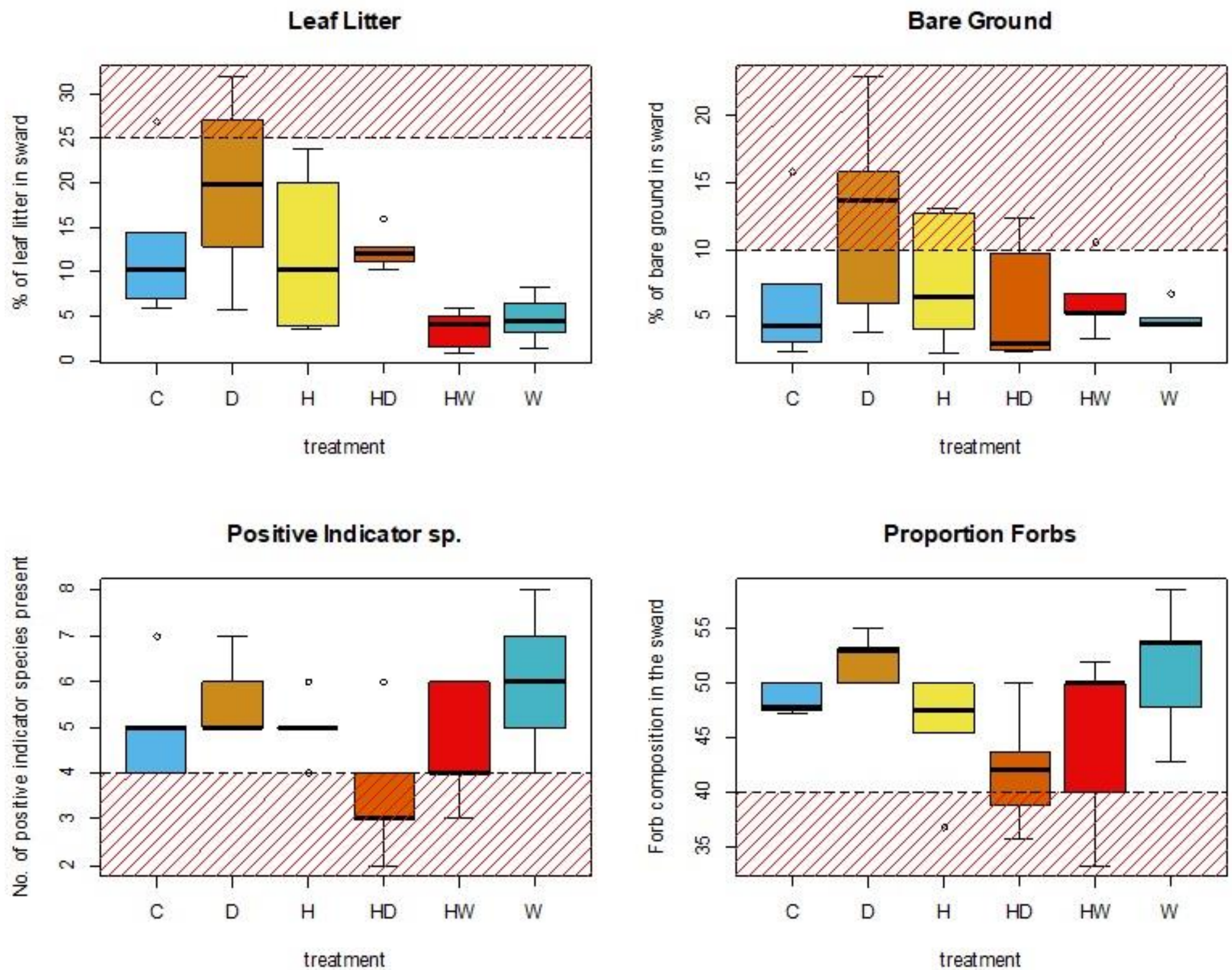
CSM condition assessment methods

- Primary attributes
  - Extent ✗
  - Grass:herb ratio ✓
  - Positive indicator species ✓
  - Negative indicator species ✓
  - Local distinctiveness ✗
- Secondary attributes
  - Sward height ✗
  - Litter ✓
  - Bare ground ✓

- **Spatial scale**



Climate treatments significantly affect CSM sttributes



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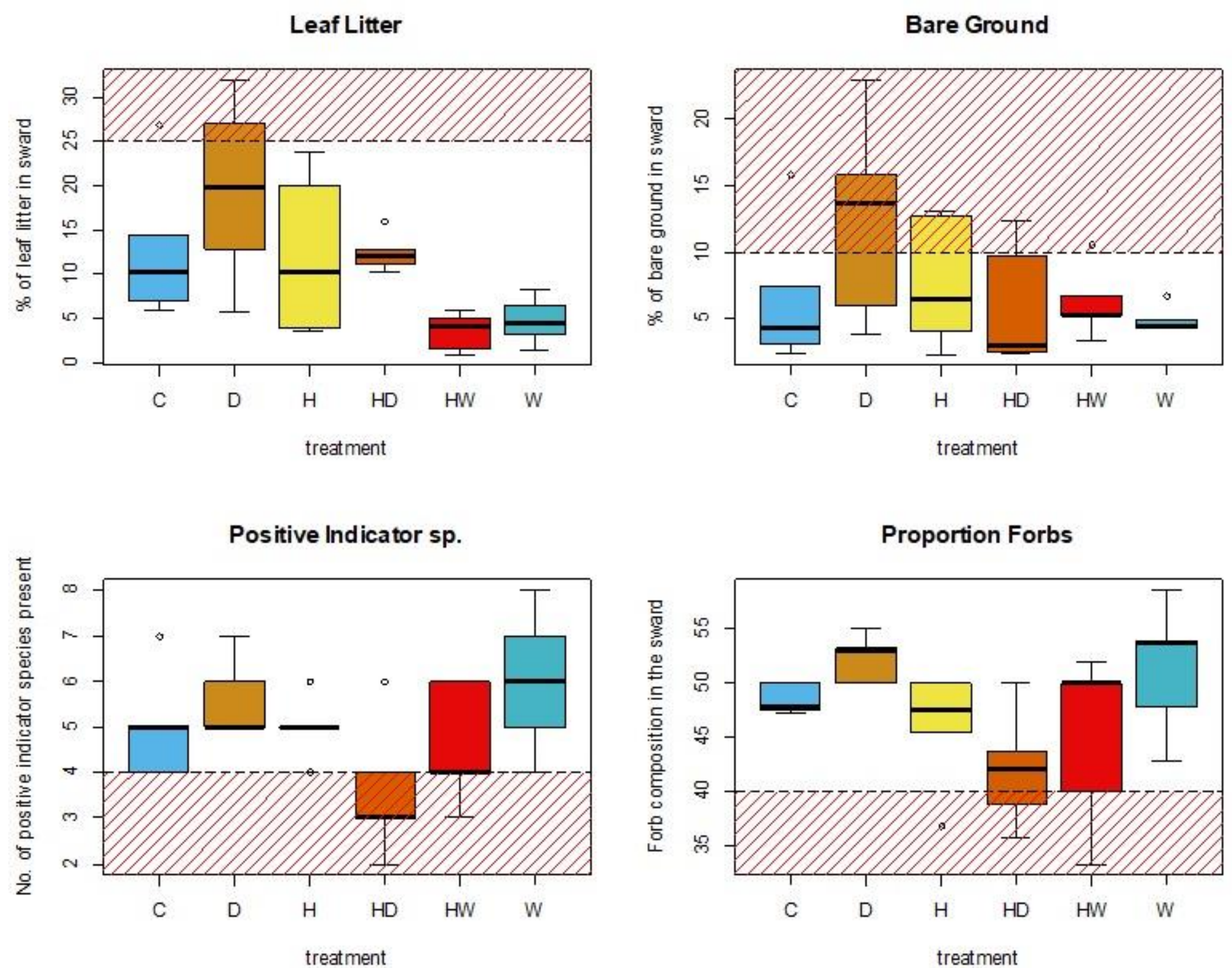
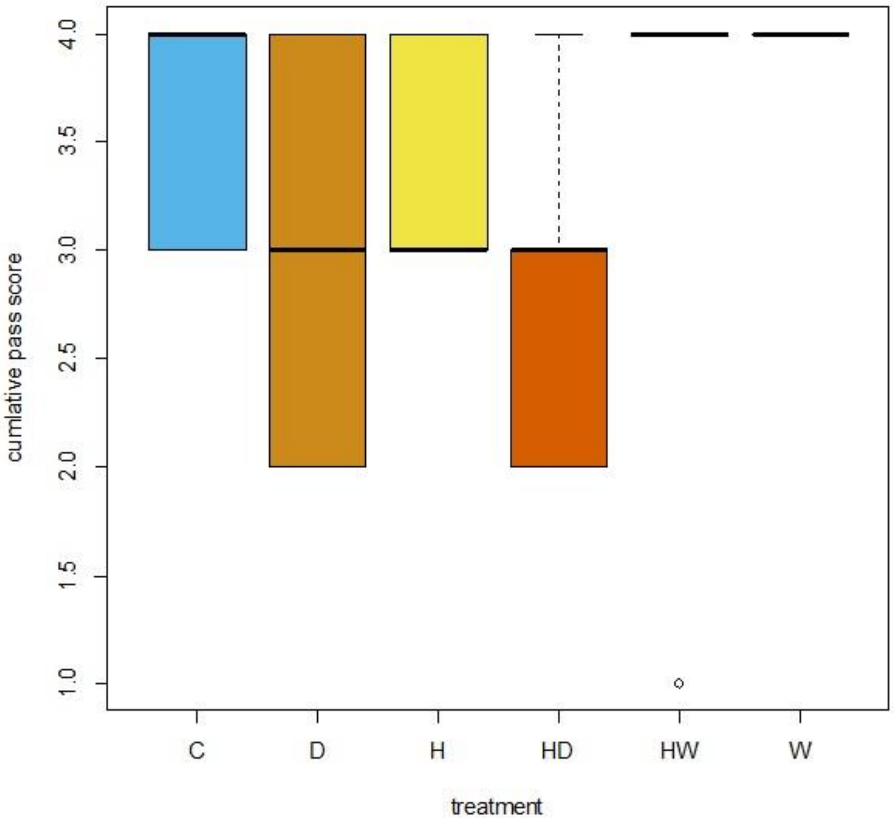
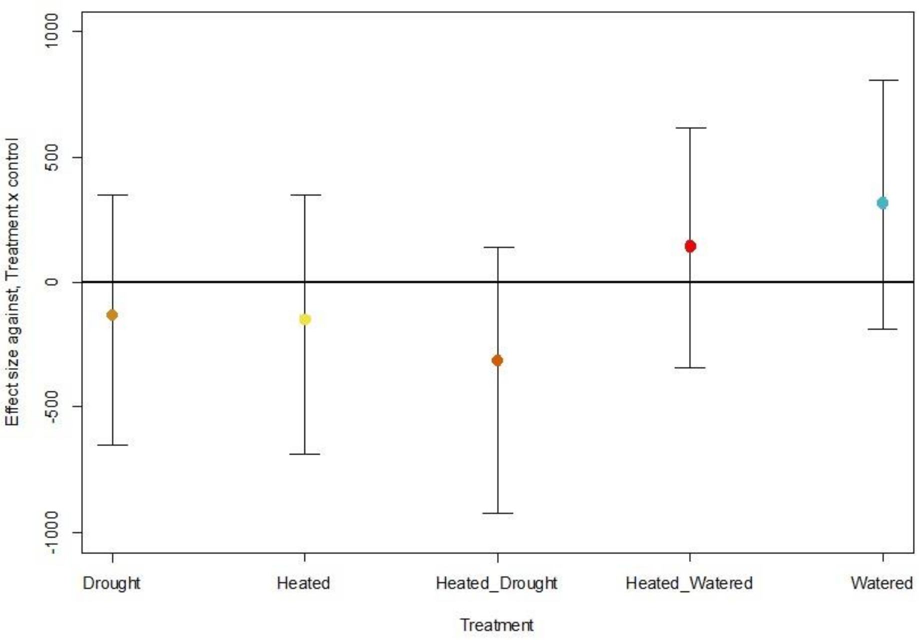
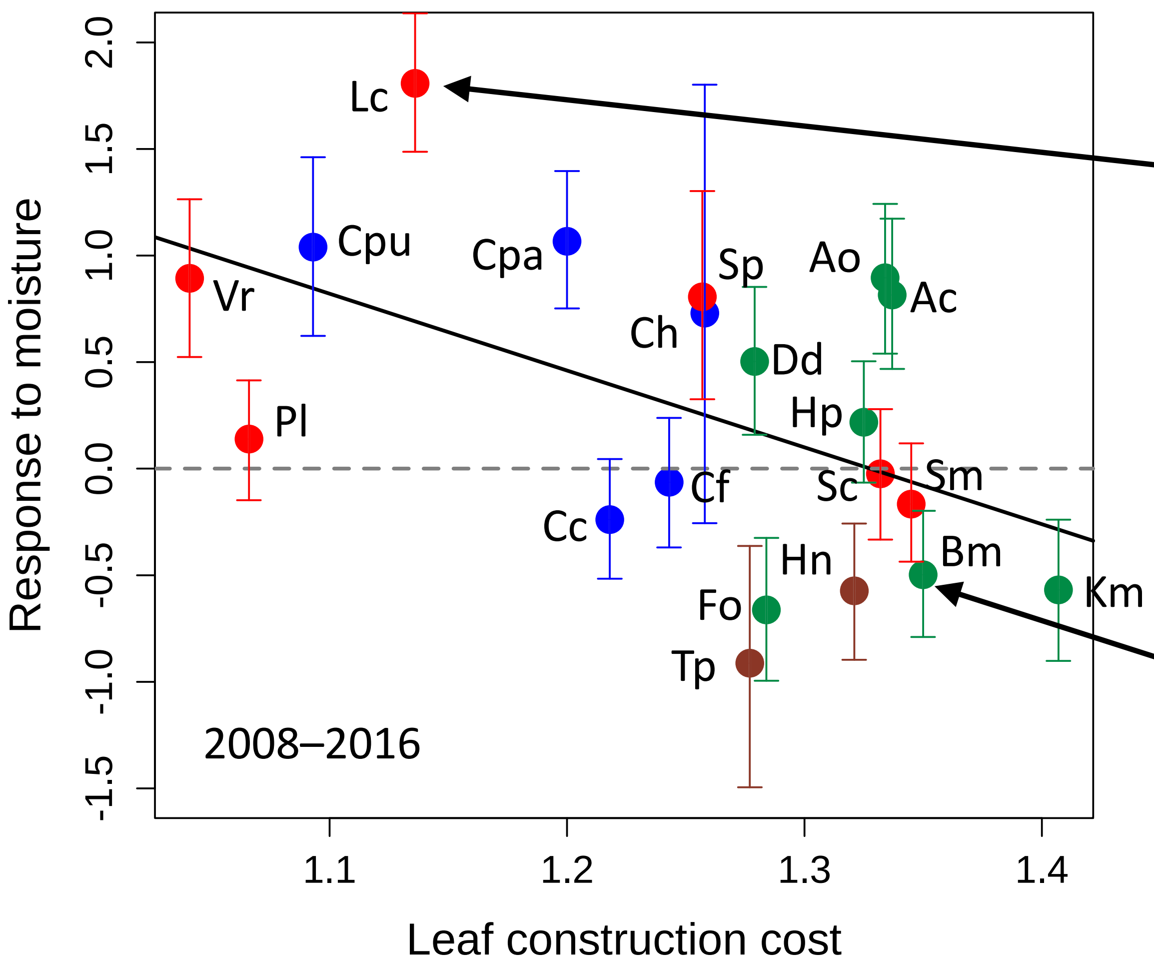


Overall condition doesn't capture climate impacts effectively

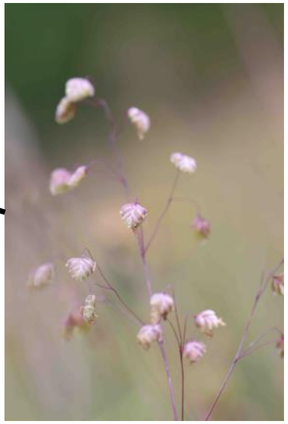




CSM attributes don't capture effects of climate-driven adaptive processes



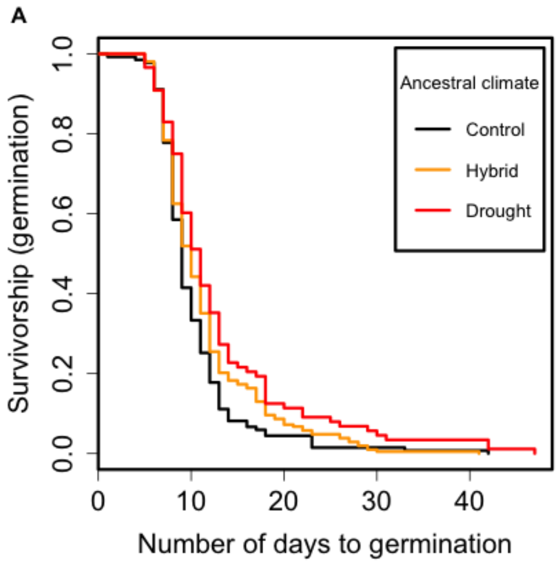
Lotus corniculatus

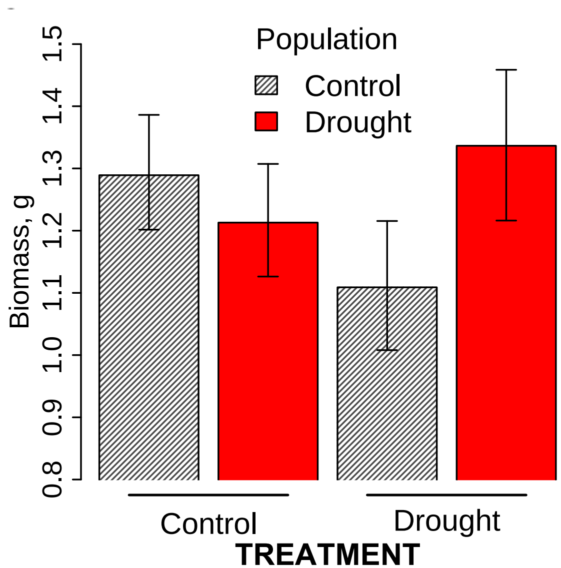


Briza media

Whitlock *et al*. in prep; Fridley *et al*. 2016

CSM attributes don’t capture effects of climate-driven adaptive processes





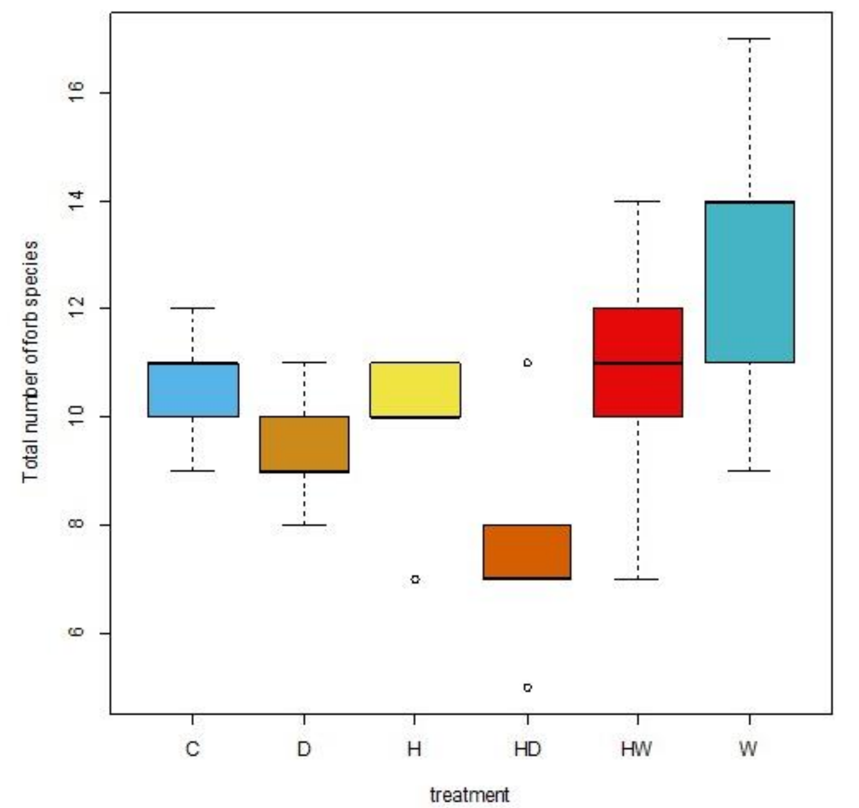
Festuca ovina

Trinder *et al.* 2020

NESS GARDENS

Possible solutions?

- Make better use of existing CSM data
  – Ecological information “summarized away”
  – ”Secondary” attributes?
- Consider additional attributes?
  – Species diversity?
  – Novel survey methods?



Conclusions

- Climate change influences CSM metrics
- Inconsistent effects on different attributes
- Climate induced adaptive processes are not represented
- Current CSM methodologies unlikely to capture climate impacts
- Solutions:
  - Better use of existing attribute data?
  - New attributes/ approaches?
- **Slope aspect topography is an ideal test bed!**

Thank you!

HSE UK
NSF-LTREB
STARS CDT

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