



Ecosystem responses to herbivory and climate change along the Swedish mountains

Photo: Ulf Molau



UNIVERSITY OF
GOTHENBURG

Tage Vowles^{1,2} and Robert G. Björk¹

¹*Dept. of Earth Sciences, University of Gothenburg, Sweden*

²*Dept. of Biological and Environmental Sciences, Univ. of*



Outline

- i. Brief background
- ii. Grazing and vegetation change in the forest-tundra ecotone
- iii. Grazing and mycorrhizal production
- iv. Conclusion - other players in the arctic landscape

History

- During 1968-69, Olof Eriksson (Uppsala University) established four pairs of 160 m² plots (one open and one exclosure) for studying vegetation changes and plant growth after the release from mechanical damages and grazing of large ungulates (Eriksson et al., 1971).
- In 1995 WWF funded a long-term project “Dynamic and constancy of alpine communities”.



A Magnificent Mountain Landscape

(One of Sweden's national environmental quality objective)

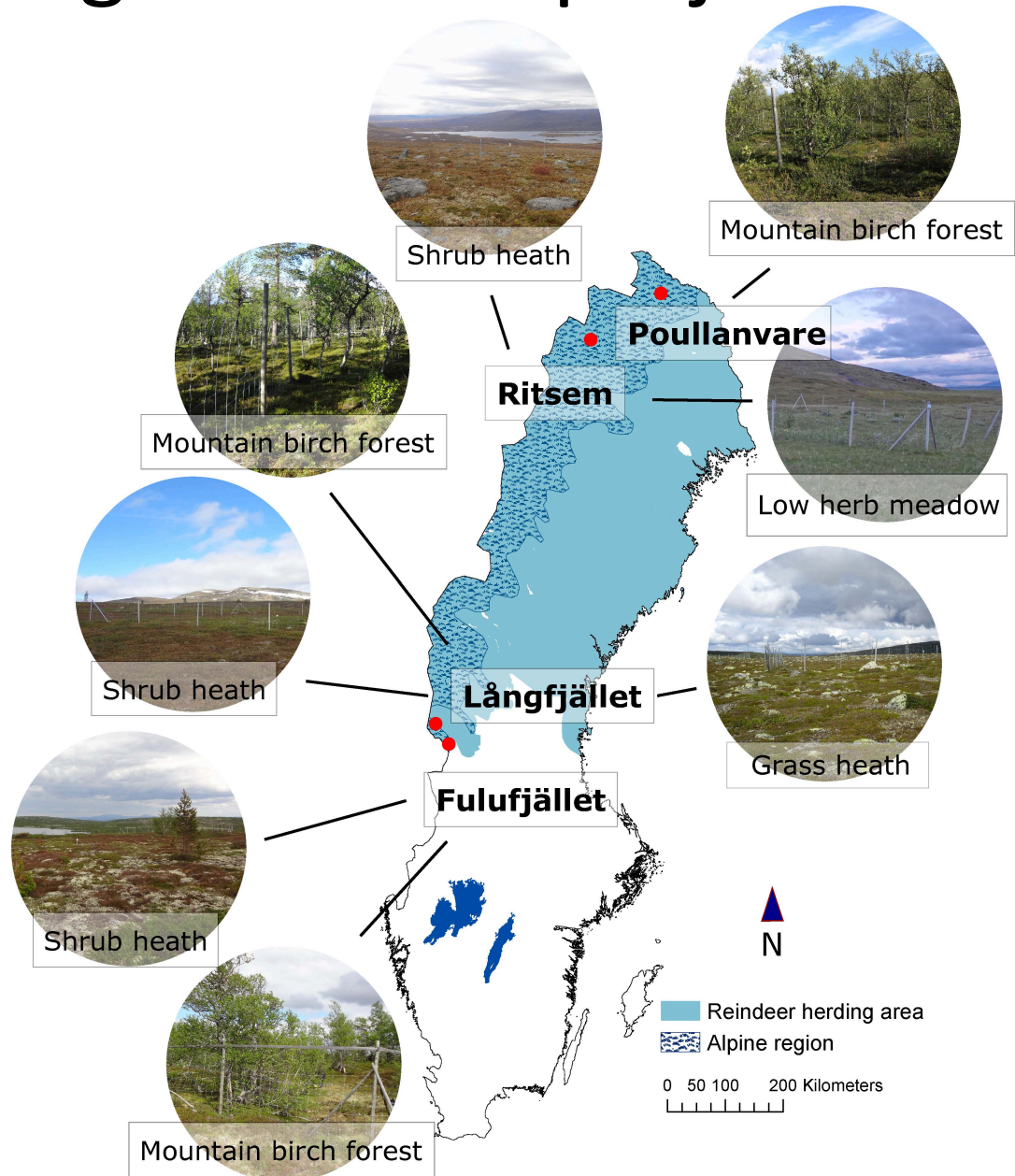
"The pristine character of the mountain environment must be largely preserved, in terms of biological diversity, recreational value, and natural and cultural assets (...) Continued reindeer herding (...) is needed to maintain an extensive mountain landscape, characterised by grazing (...) In addition, new research is needed to address (...) how current climate change will affect their natural values."



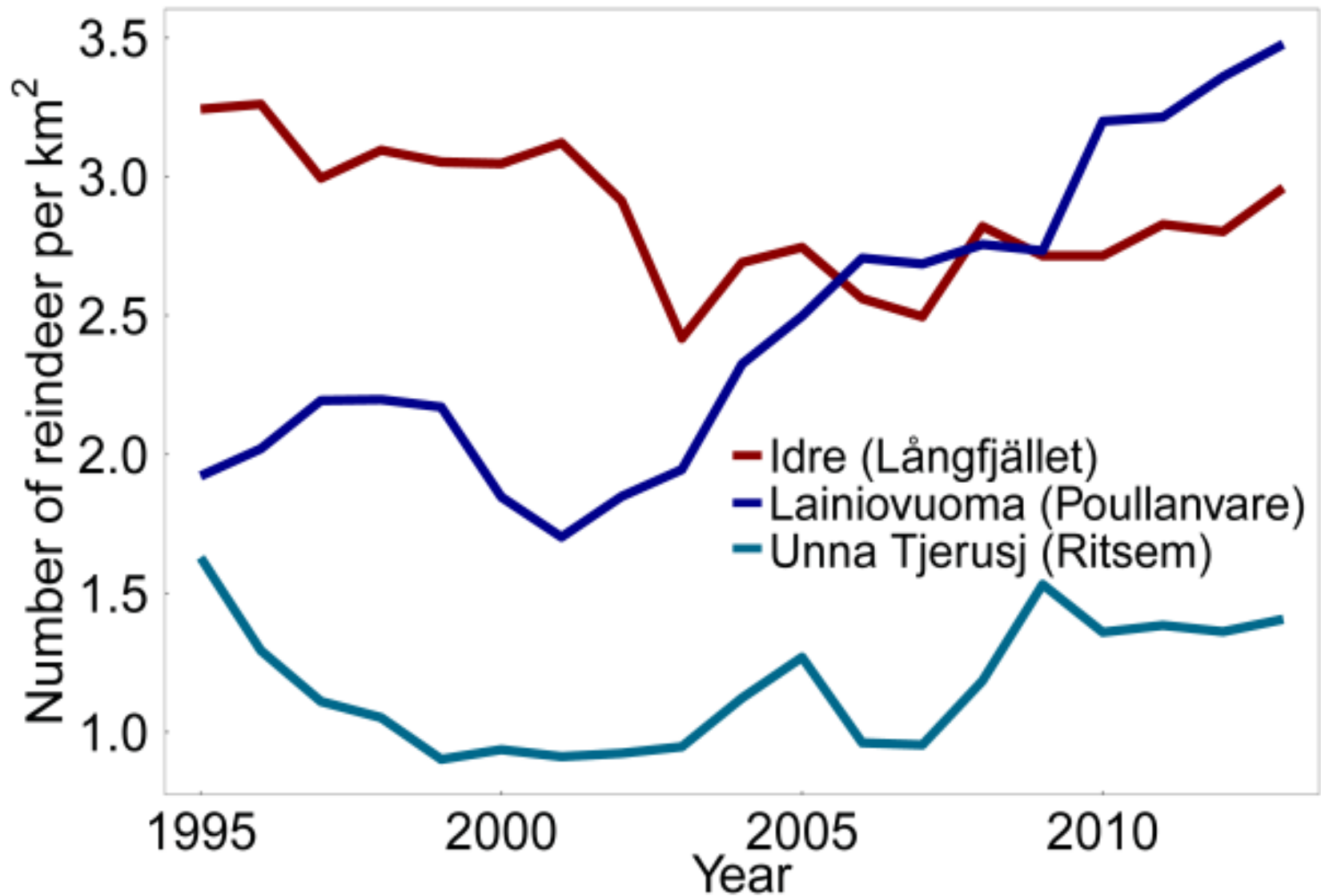
Swedish Environmental Protection Agency -

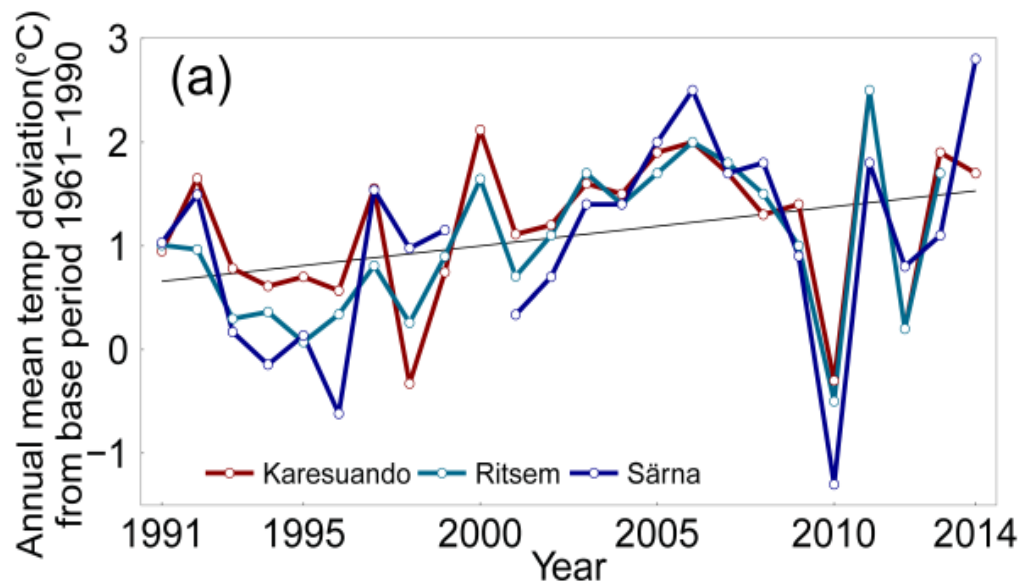
Revisiting the WWF project

- Established 1995
- Each site has:
3 C + 3 F
in the birch forest
on the alpine tundra
- Re-inventoried 1998/1999
and 2011/2012



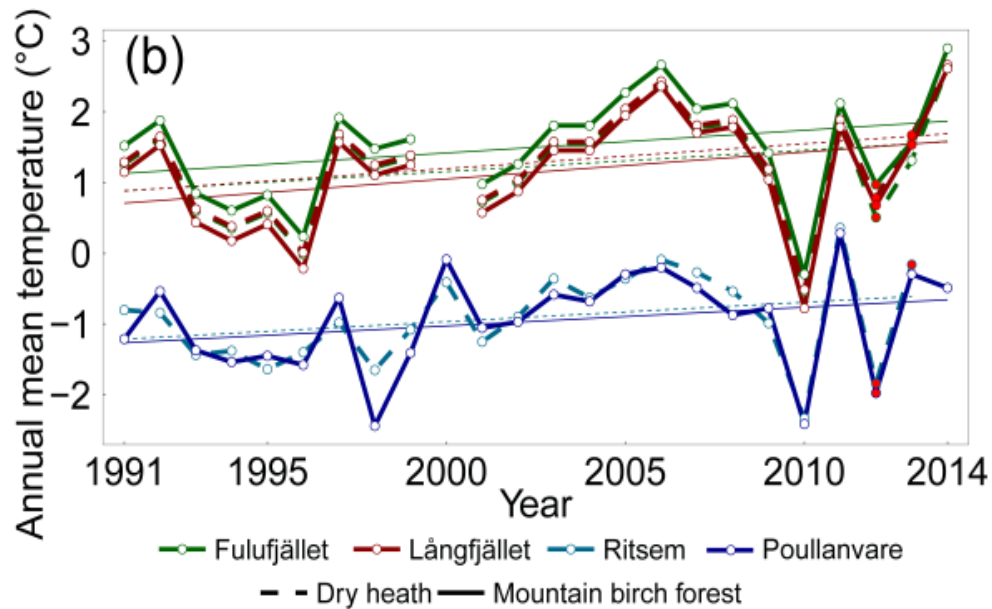
Reindeer densities





Annual mean temperature (AMT) deviation from the meteorological base period of 1961-1990 at the nearest SMHI meteorological stations to our sites.

AMT increased between 1991-2014 compared to 1961-1990 with 1.1-1.2°C!

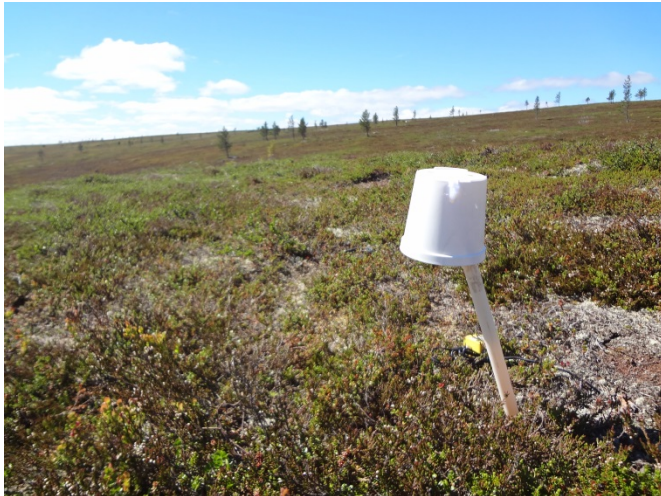
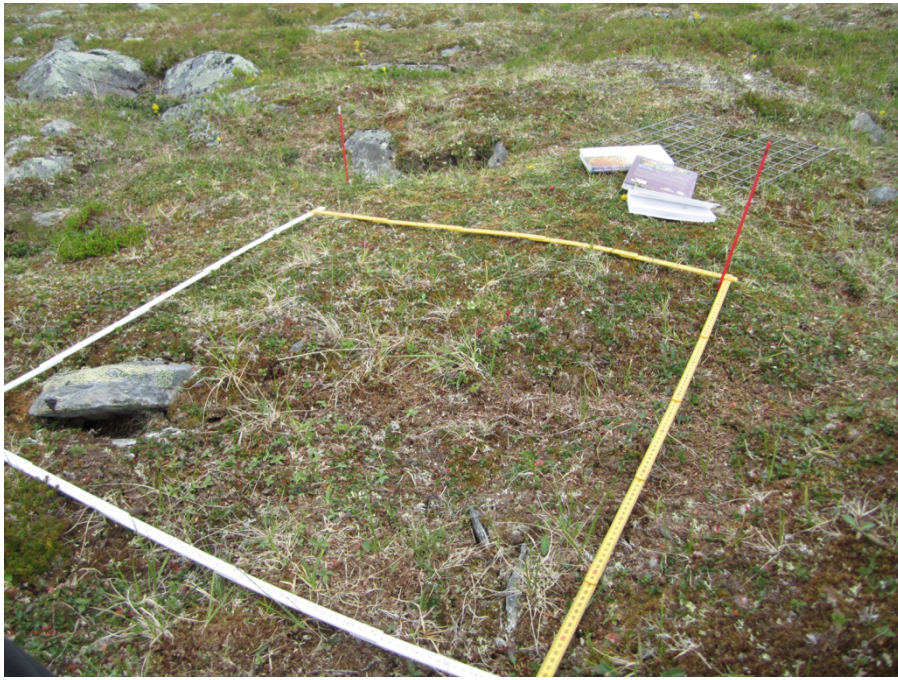


Annual mean temperature at the study sites. Observed temperatures are indicated with red dots, remaining years have been extrapolated using SMHI data from the closest meteorological stations.

Vegetation inventories

Cover and height of all species (field layer)

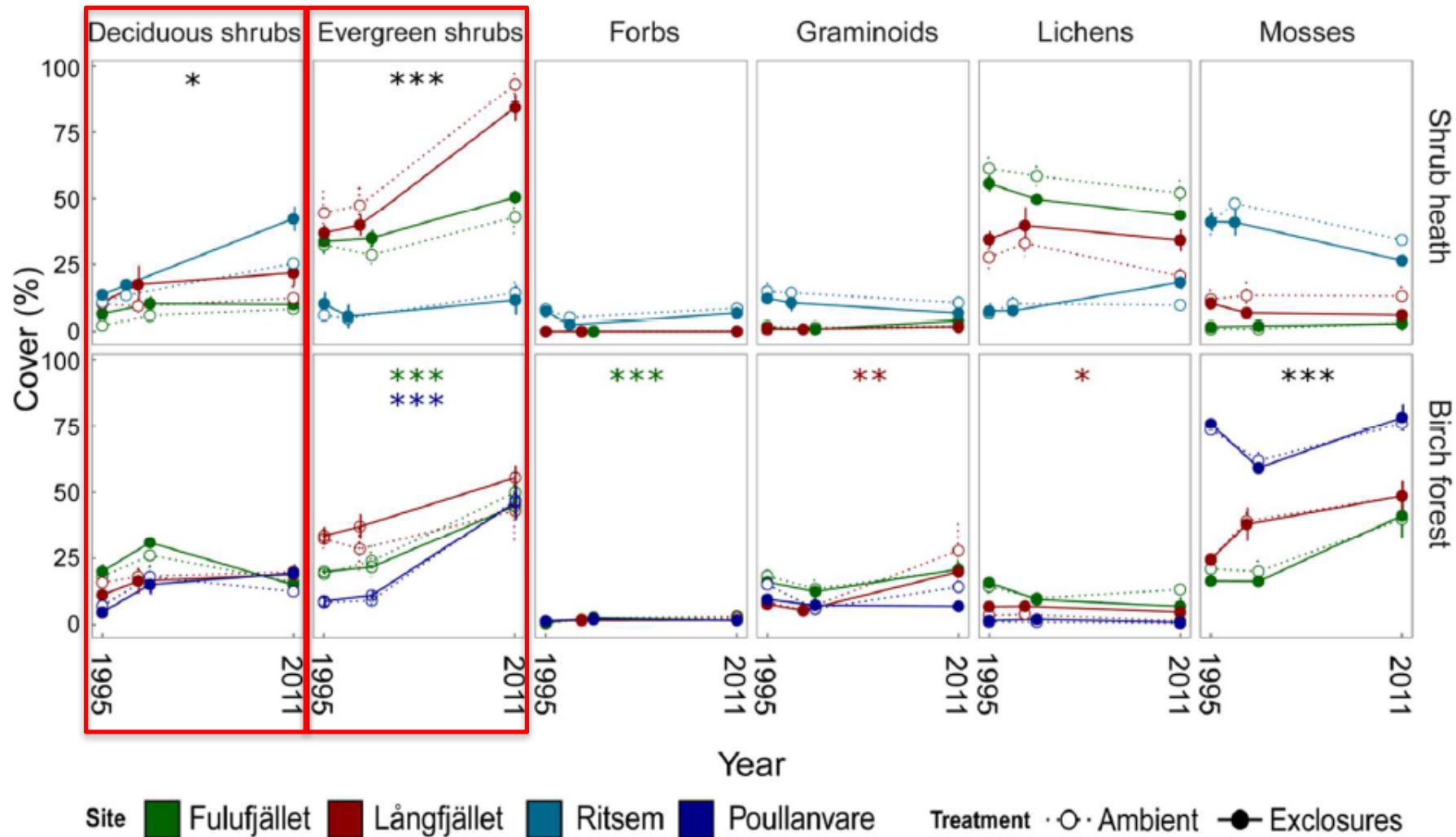
Height, diameter and cover of trees and shrubs (tree and shrub layer)



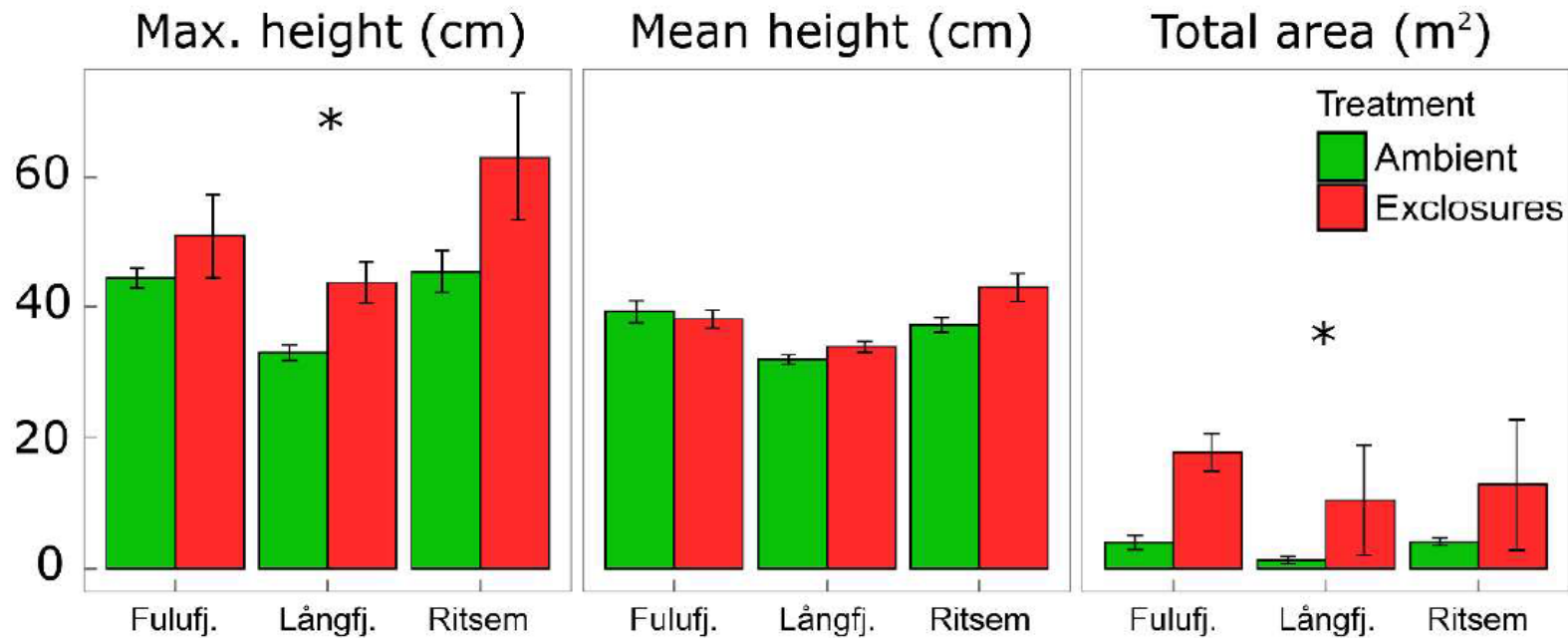
Soil and air temperatures logged in each plot



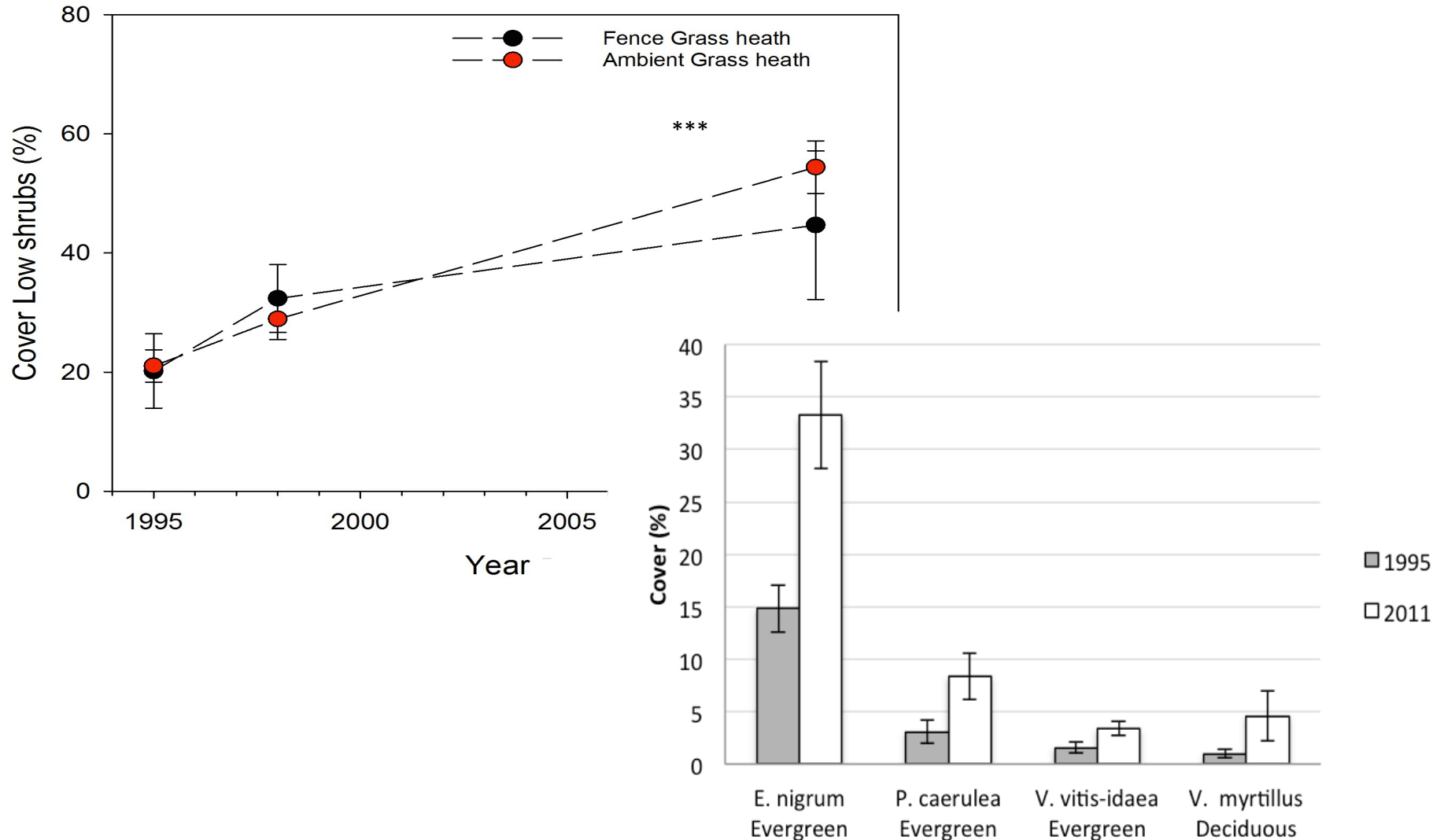
Shrub heaths/Birch forest after 16 years of reindeer exclusion – field layer



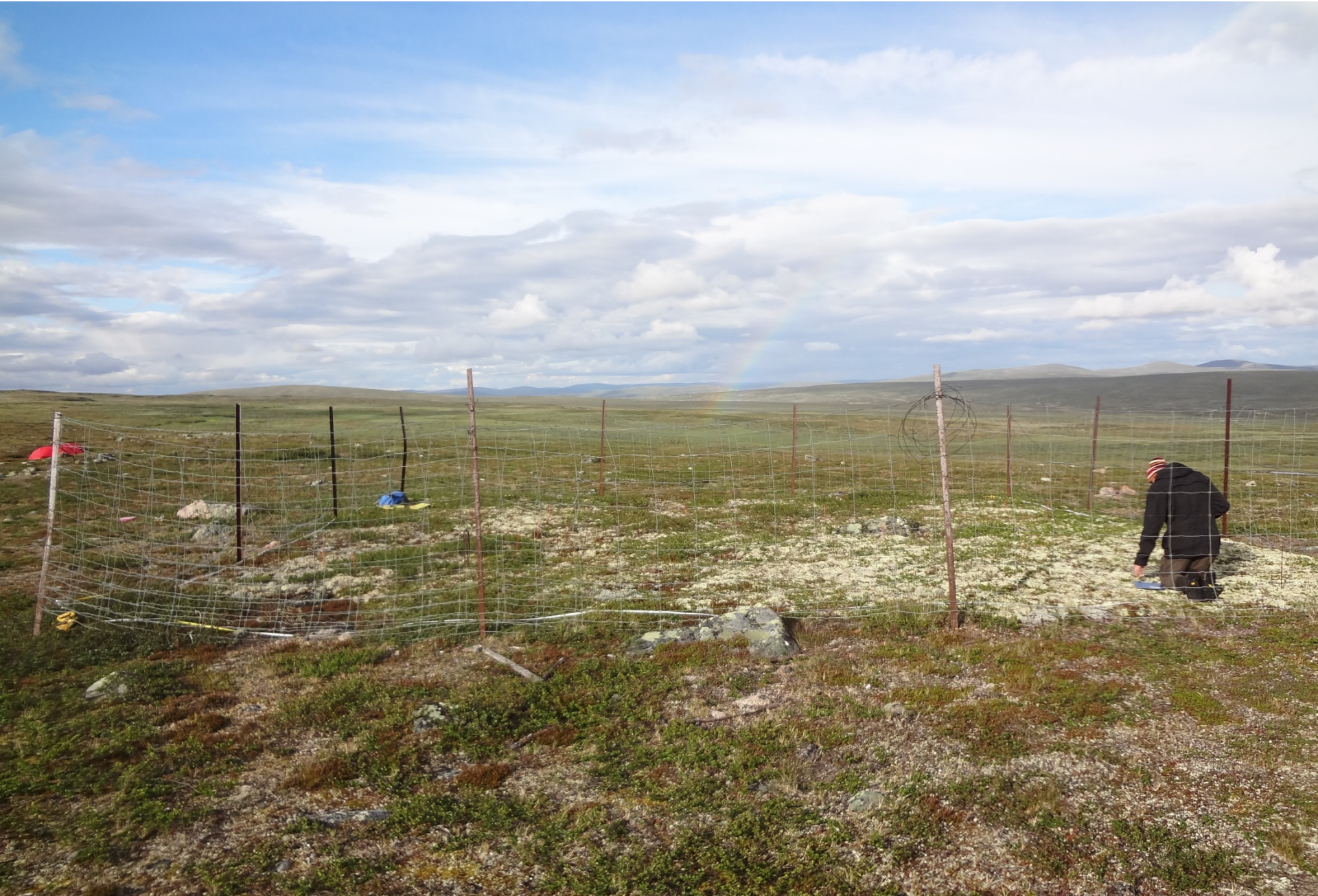
Shrub heaths after 16 years of reindeer exclusion – shrub layer



Grass heath after 16 years of reindeer exclusion at Långfjället



Shrub heath where reindeer have been excluded for 45 years



Meadow with low herbs where reindeer have been excluded for 17 years

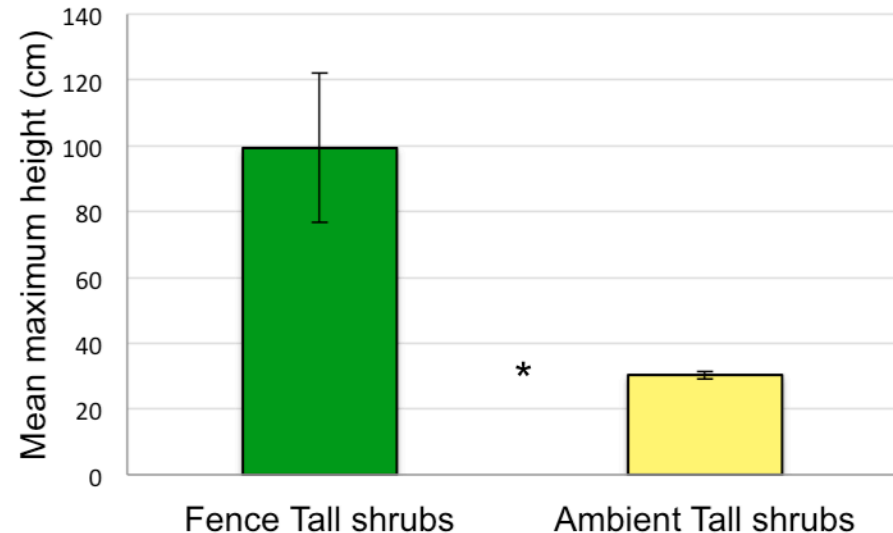
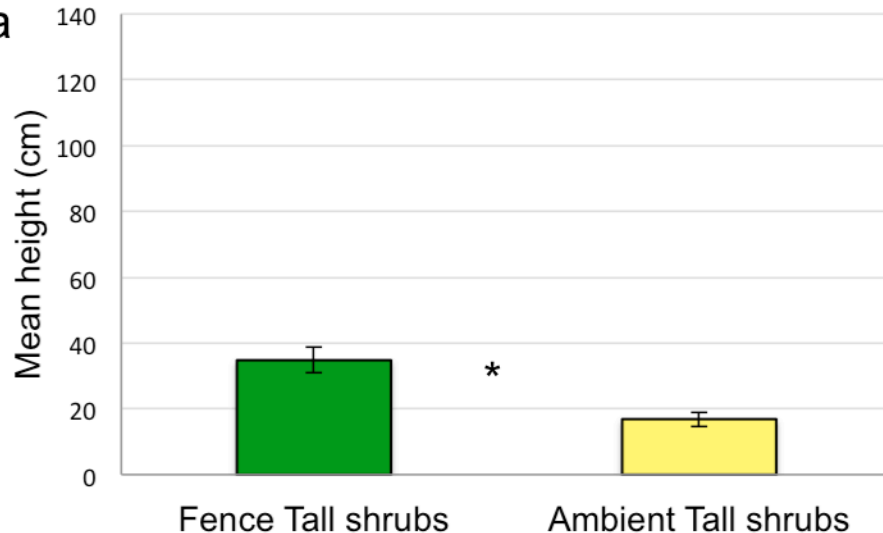


Meadow with low herbs after 17 years of reindeer exclusion at Ritsem

Mean height

Maximum height

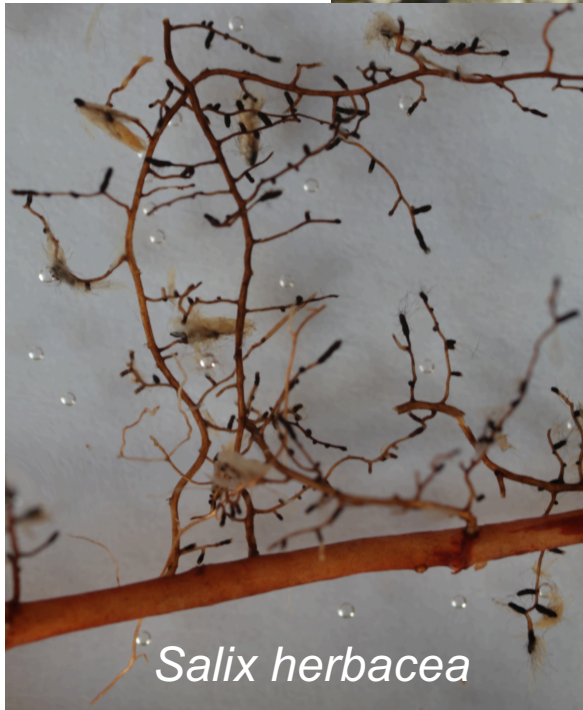
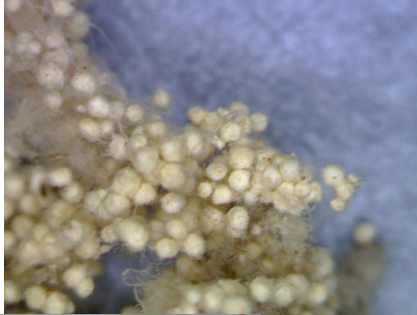
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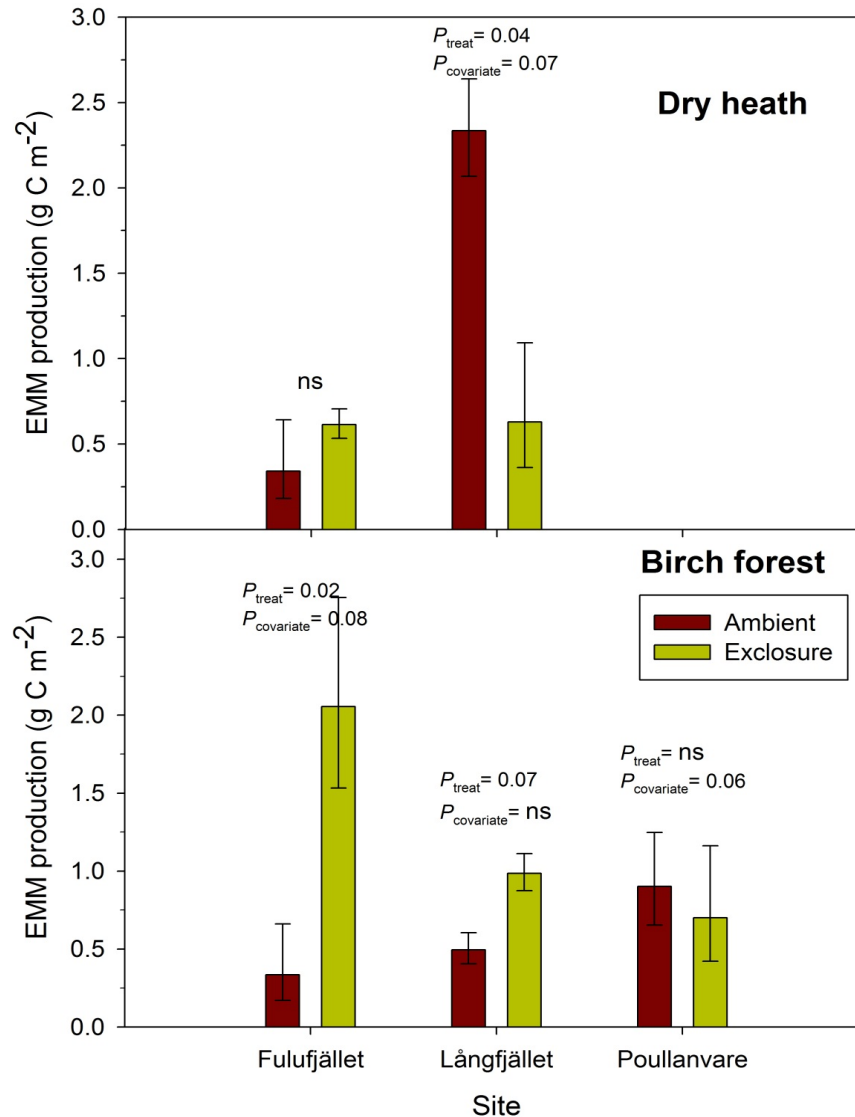
Mycorrhiza production and community dynamics



Salix herbacea



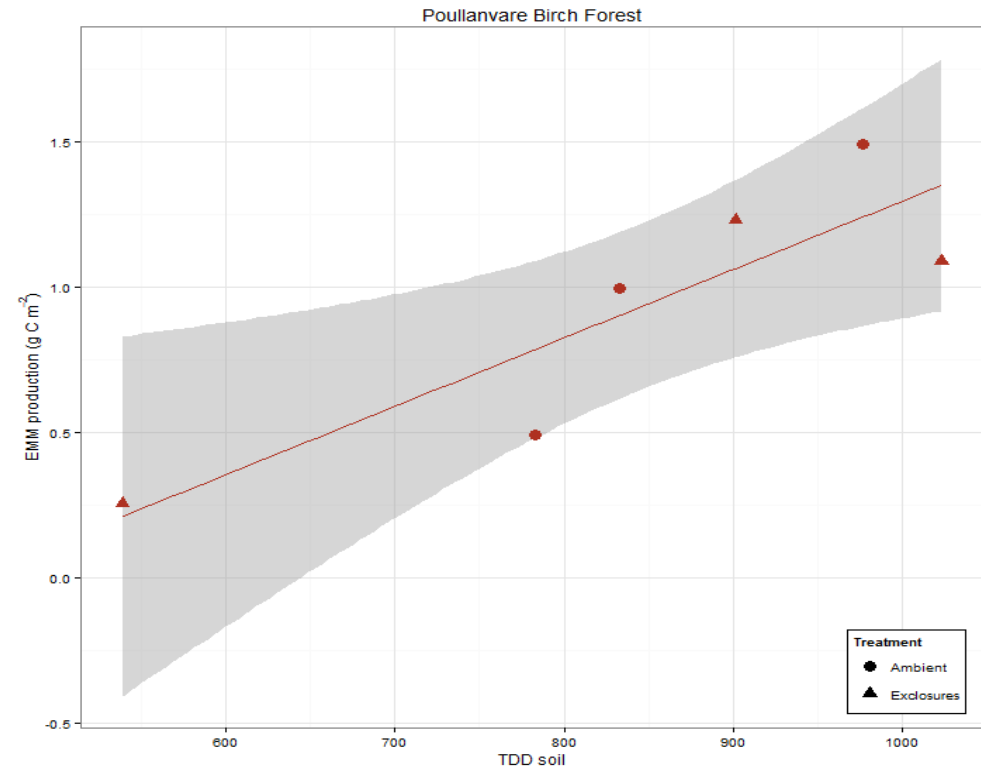
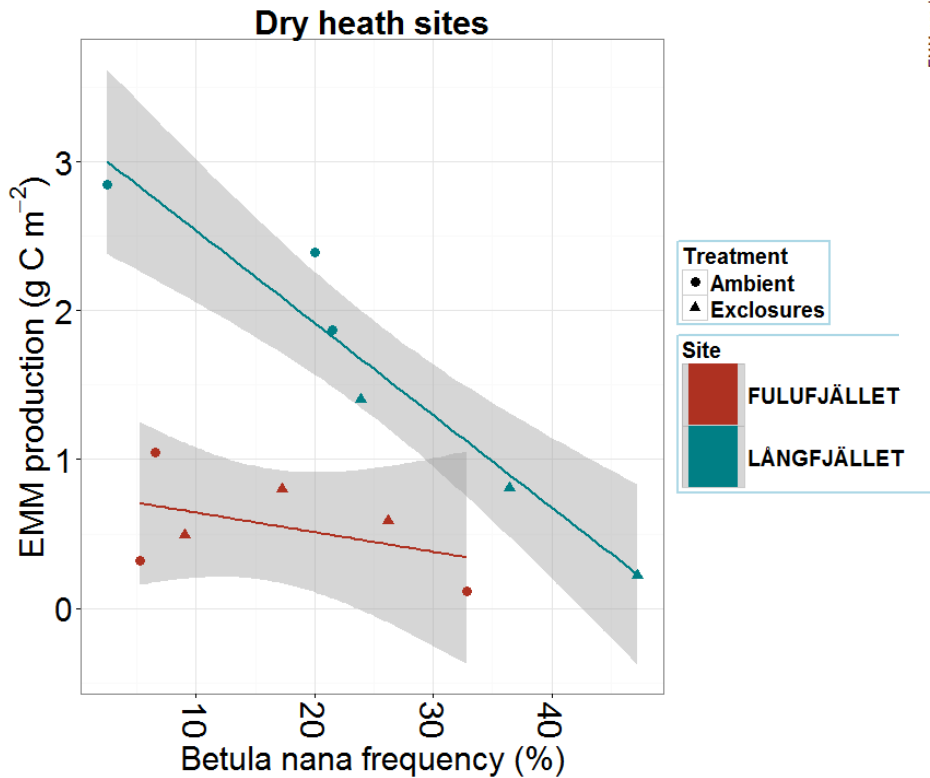
Mycorrhiza production and community dynamics



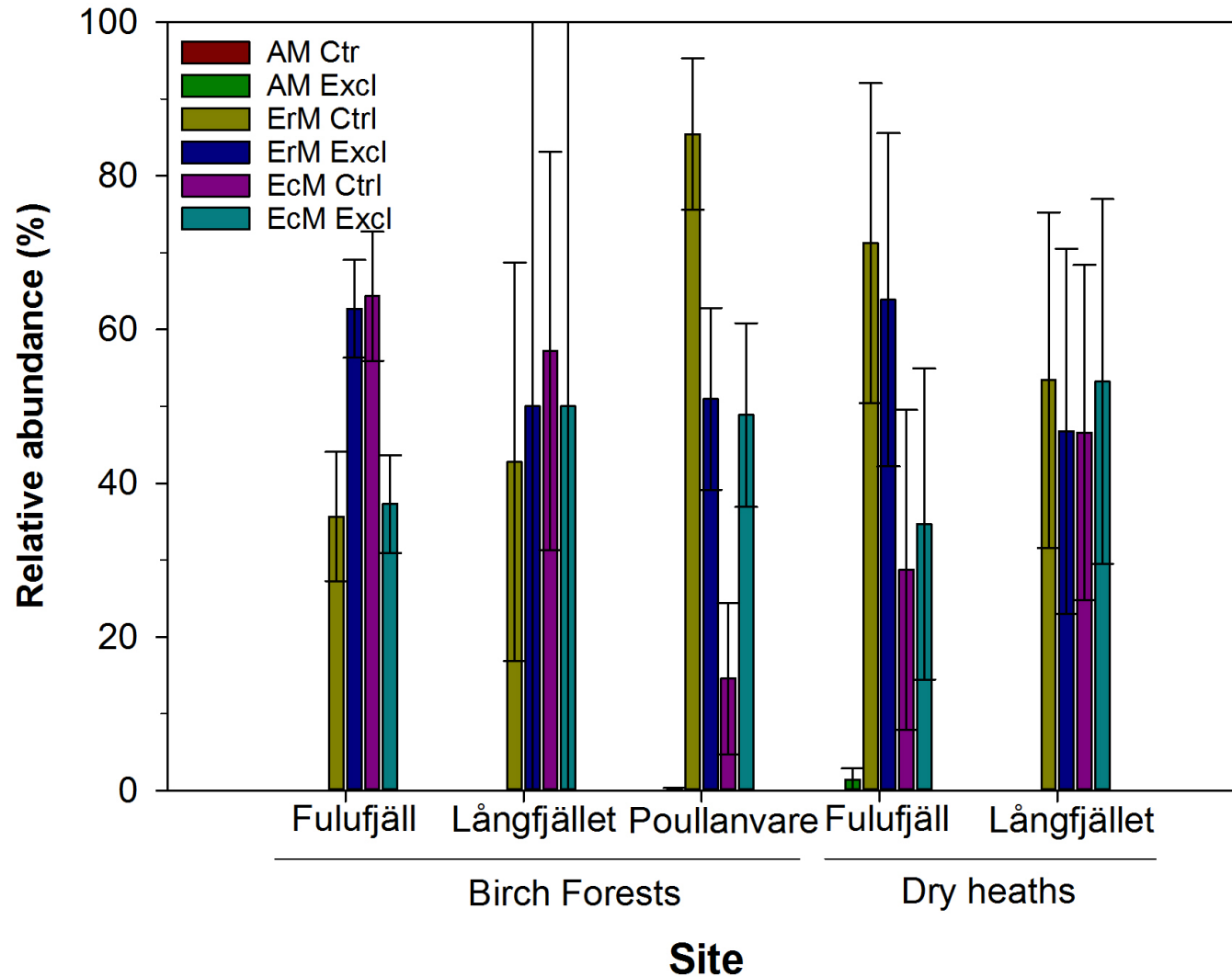
Covariates

- Mountain birch biomass
- Dwarf birch frequency
- Lichen cover
- Soil TDD

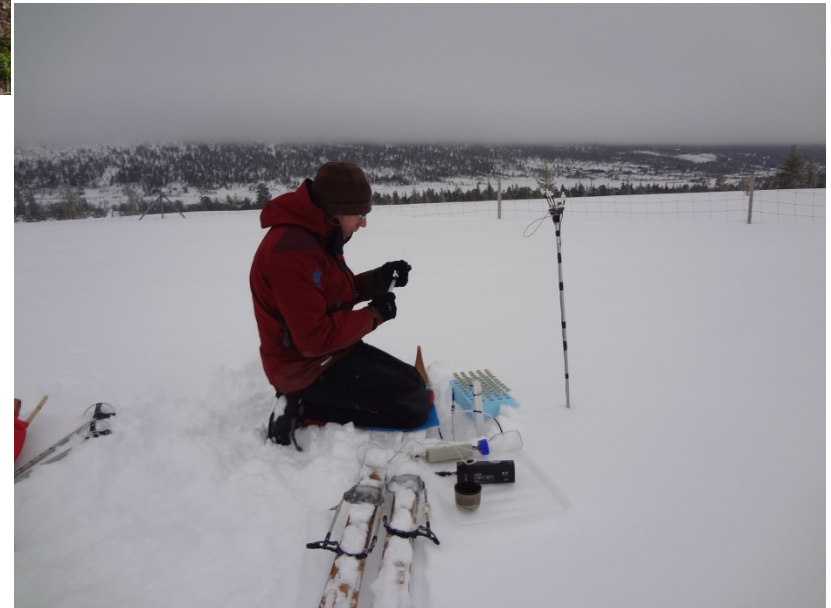
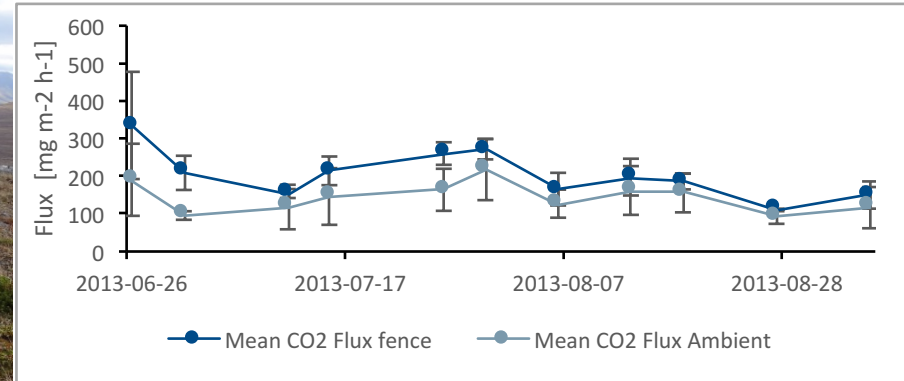
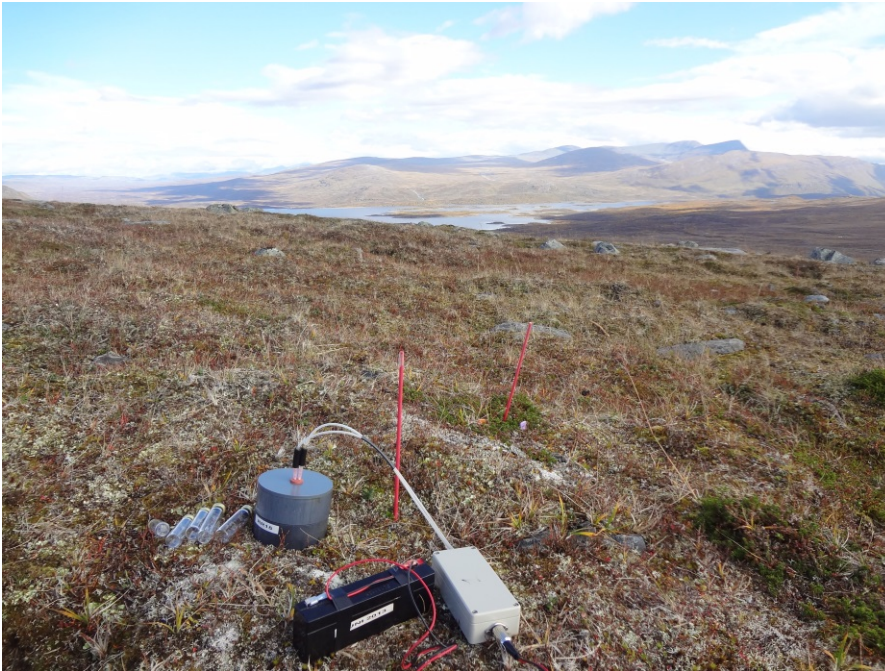
Mycorrhiza production and community dynamics



Mycorrhiza production and community dynamics



Greenhouse gas measurements

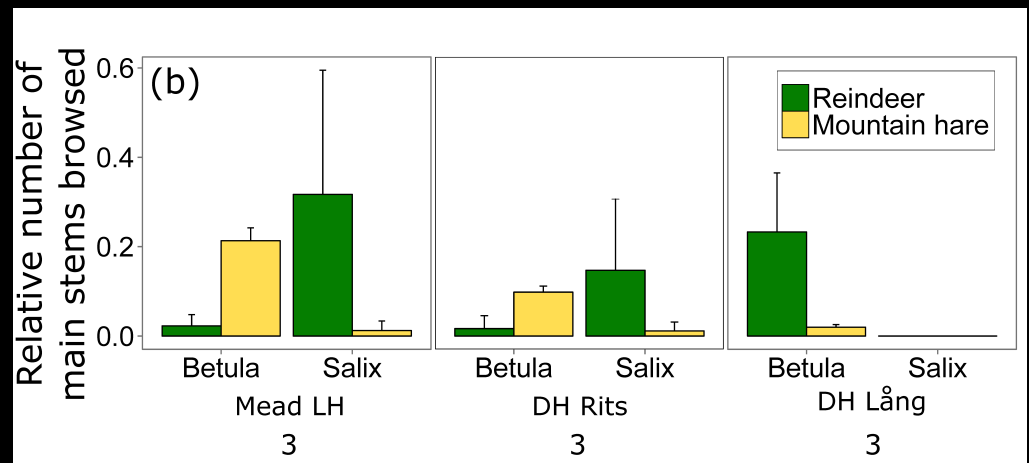


Conclusions

- Shrub expansion is occurring rapidly at the southern as well as the northern margins of the Scandes mountain range, both above and below the tree line.
- Tall, deciduous shrubs had benefitted significantly from grazing exclosure.
- Contrary to many previous studies, the greatest increases were seen in low evergreen shrubs and these were not influenced by grazing.

Conclusions cont.

- There was a great deal of variation in EMM production between sites and treatments and we propose that this variation is due to a number of site specific drivers.
- 16 years of grazing exclusion only showed indication of influencing carbon dynamics in the forest-tundra ecotone.
- Other players in the arctic landscape, that have been overlooked?



Acknowledgements!



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