

# *Implications of evergreen shrub advancement: The need for a more comprehensive view of Arctic shrubification*



UNIVERSITY OF  
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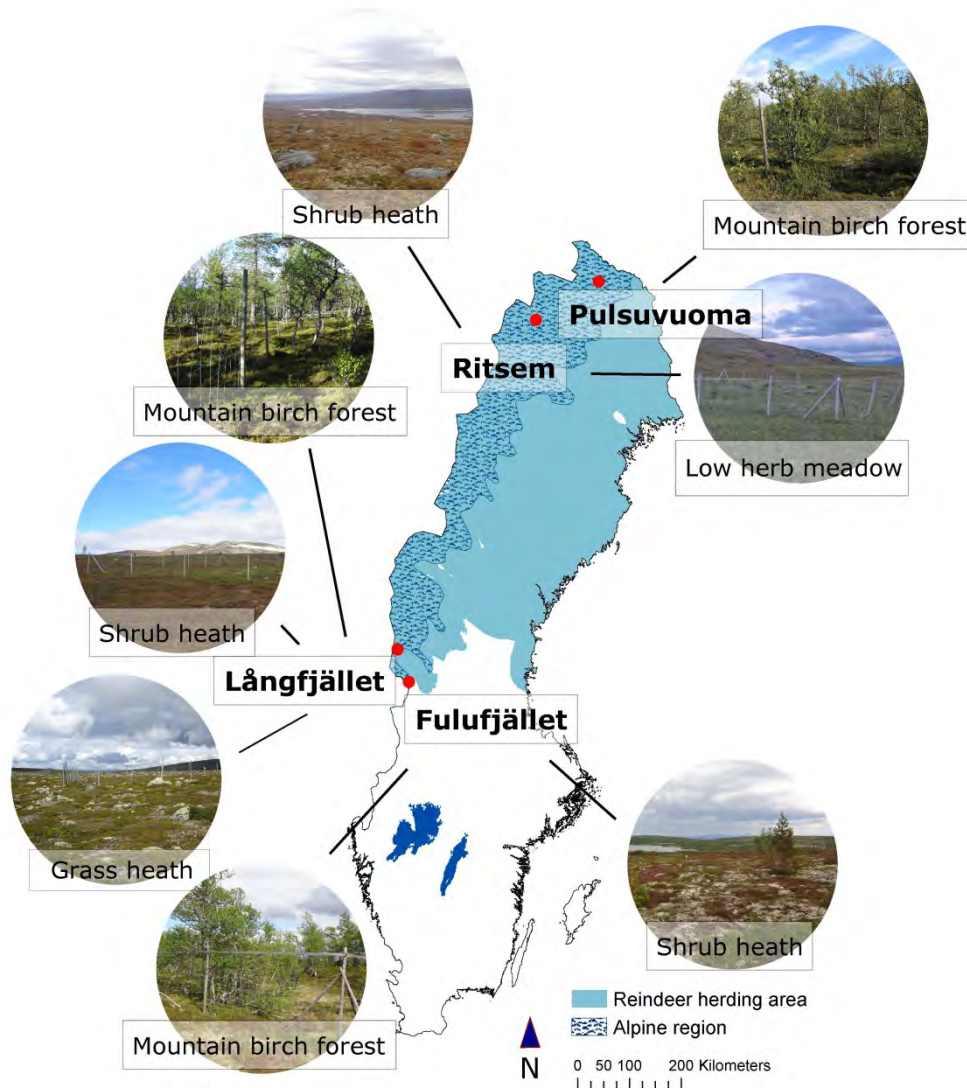


# Outline

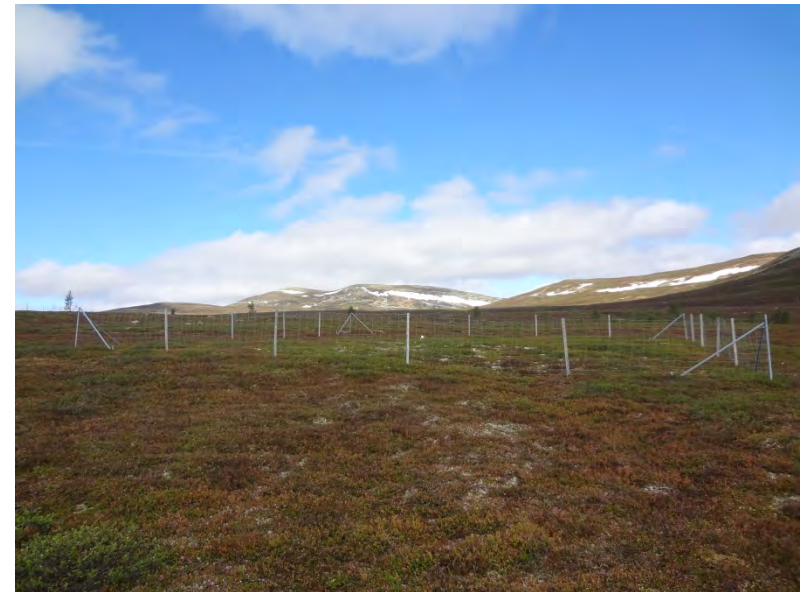
- A. Background: Herbivory and climate change in Swedish Scandes
- B. Have we ignored evergreen shrubs?
- C. Implications of evergreen shrub advancement



# Herbivory and climate change in Swedish Scandes



WWF-project:  
Three fenced plots (exclosures)  
Three open plots (ambient)  
Several sites and vegetation types  
Established in 1995

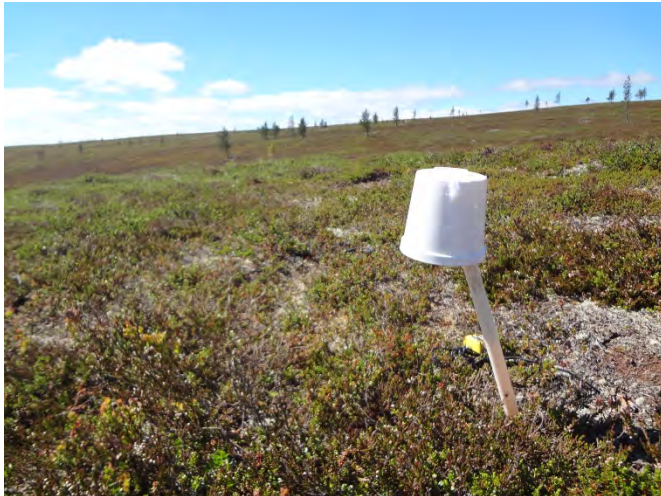




# Vegetation inventories

Cover and height of all species

Height, diameter and cover of trees and shrubs



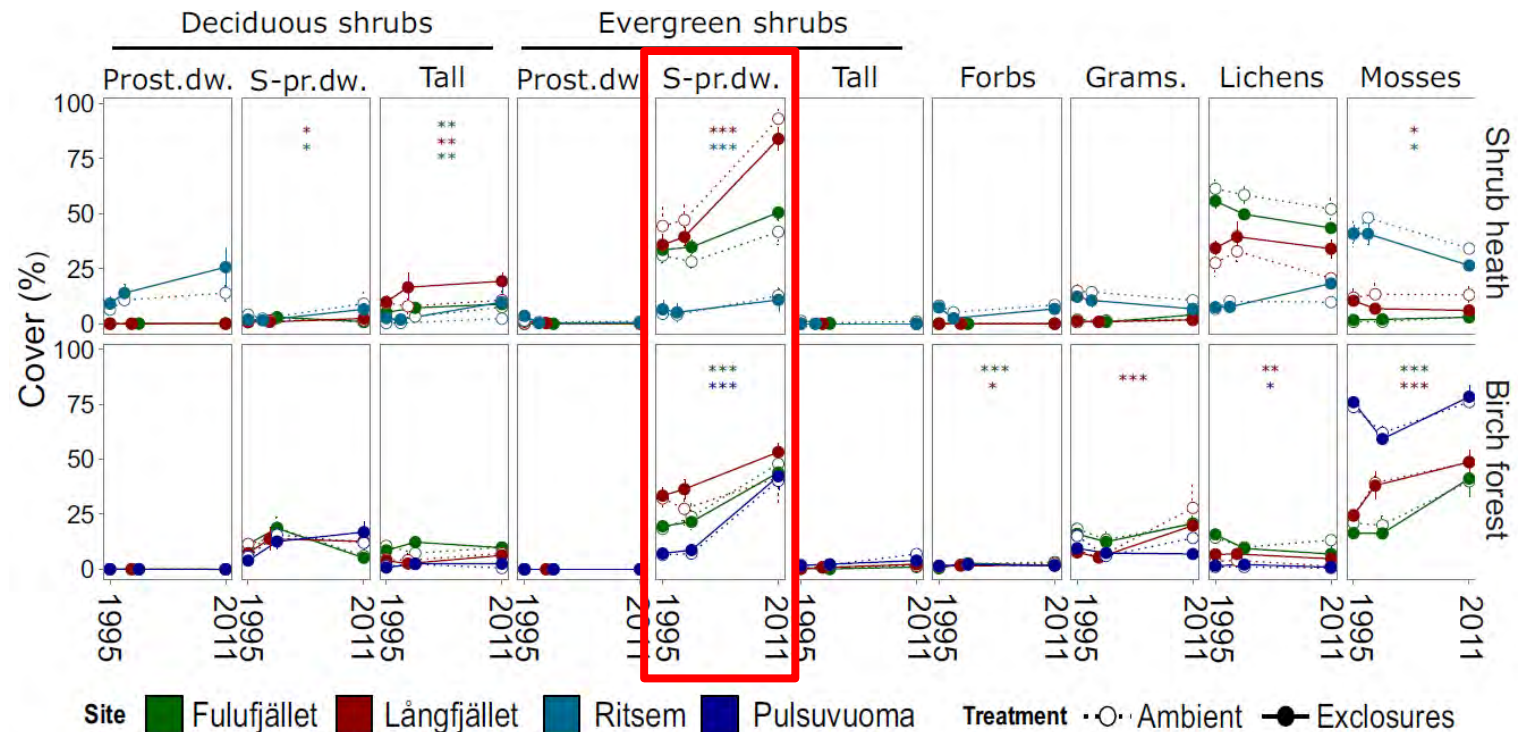
Soil and air temperatures logged in each plot





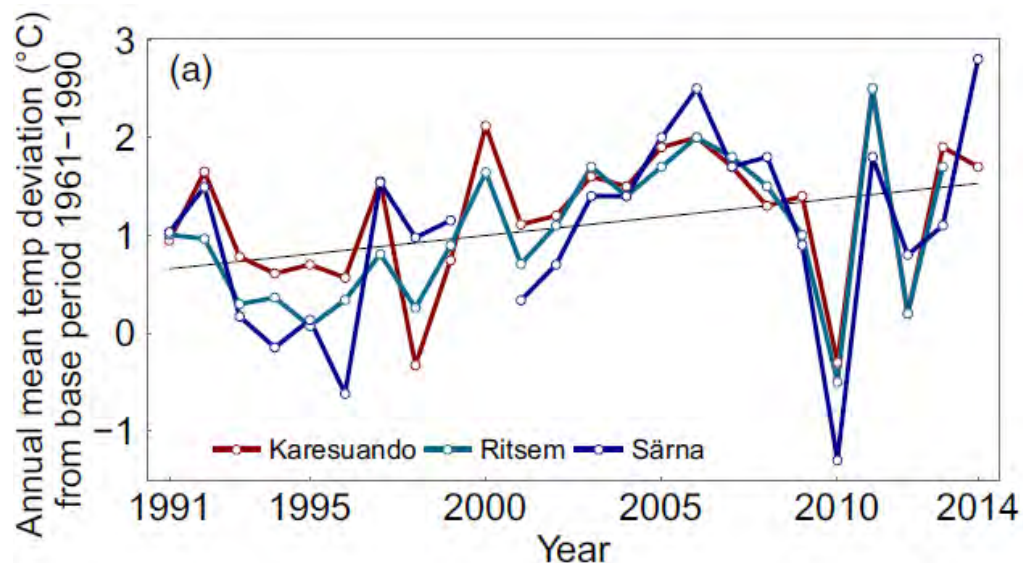
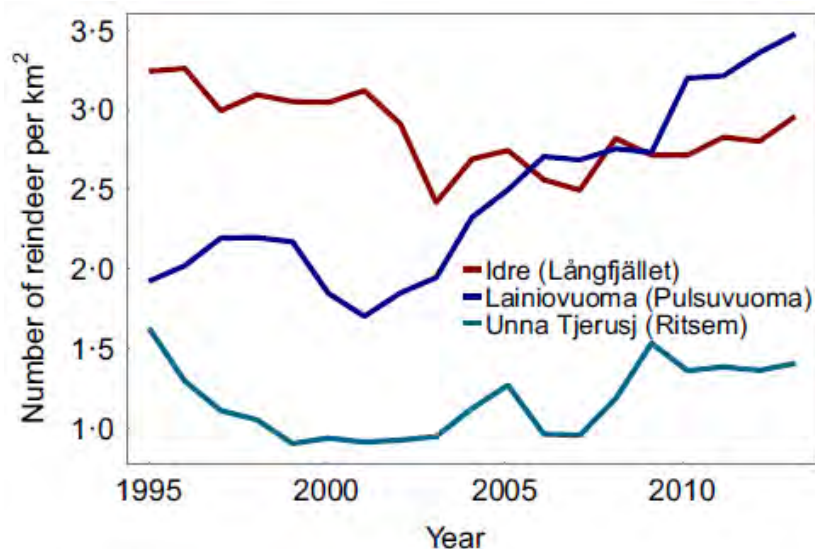
# Expansion of deciduous tall shrubs but not evergreen dwarf shrubs inhibited by reindeer in Scandes mountain range

Tage Vowles<sup>\*,1</sup>, Bengt Gunnarsson<sup>1</sup>, Ulf Molau<sup>1</sup>, Thomas Hickler<sup>2,3</sup>, Leif Klemetsson<sup>4</sup> and Robert G. Björk<sup>4</sup>



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## Environmental Research Letters

## LETTER

## Contrasting impacts of reindeer grazing in two tundra grasslands

Tage Vowles,<sup>1,3</sup> Cajsa Loveh  v,<sup>2</sup> Ulf Molau<sup>1</sup> and Robert G Bj  rk<sup>2</sup>

OPEN ACCESS

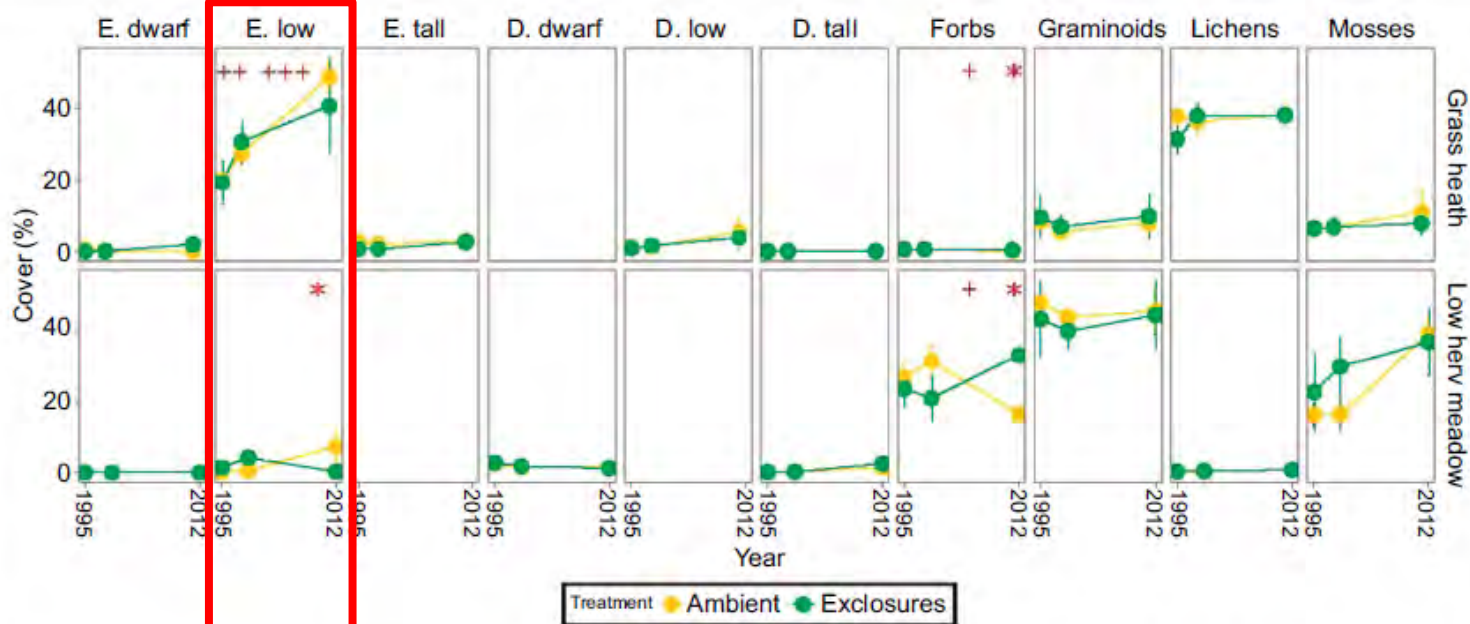


Figure 3. Mean percent cover (±SE) of each functional type at the two study sites, ambient plots in yellow and exclosures in green. + denotes significant time effects and \* significant treatment effects from pairwise t-tests with tukey adjustments. +  $P = 0.1 - 0.05$ , ++  $P = 0.05 - 0.01$ , +++  $P < 0.01$ , \*  $P = 0.1 - 0.05$ . Means are based on three plots per treatment everywhere except for the low herb meadow in 2012, where means are based on three plots for exclosures but only two for ambient plots.

# Environmental Research Letters



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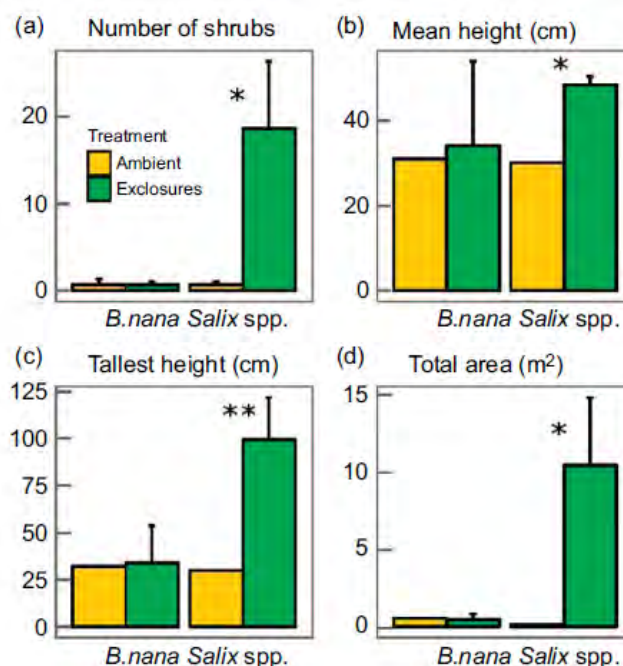


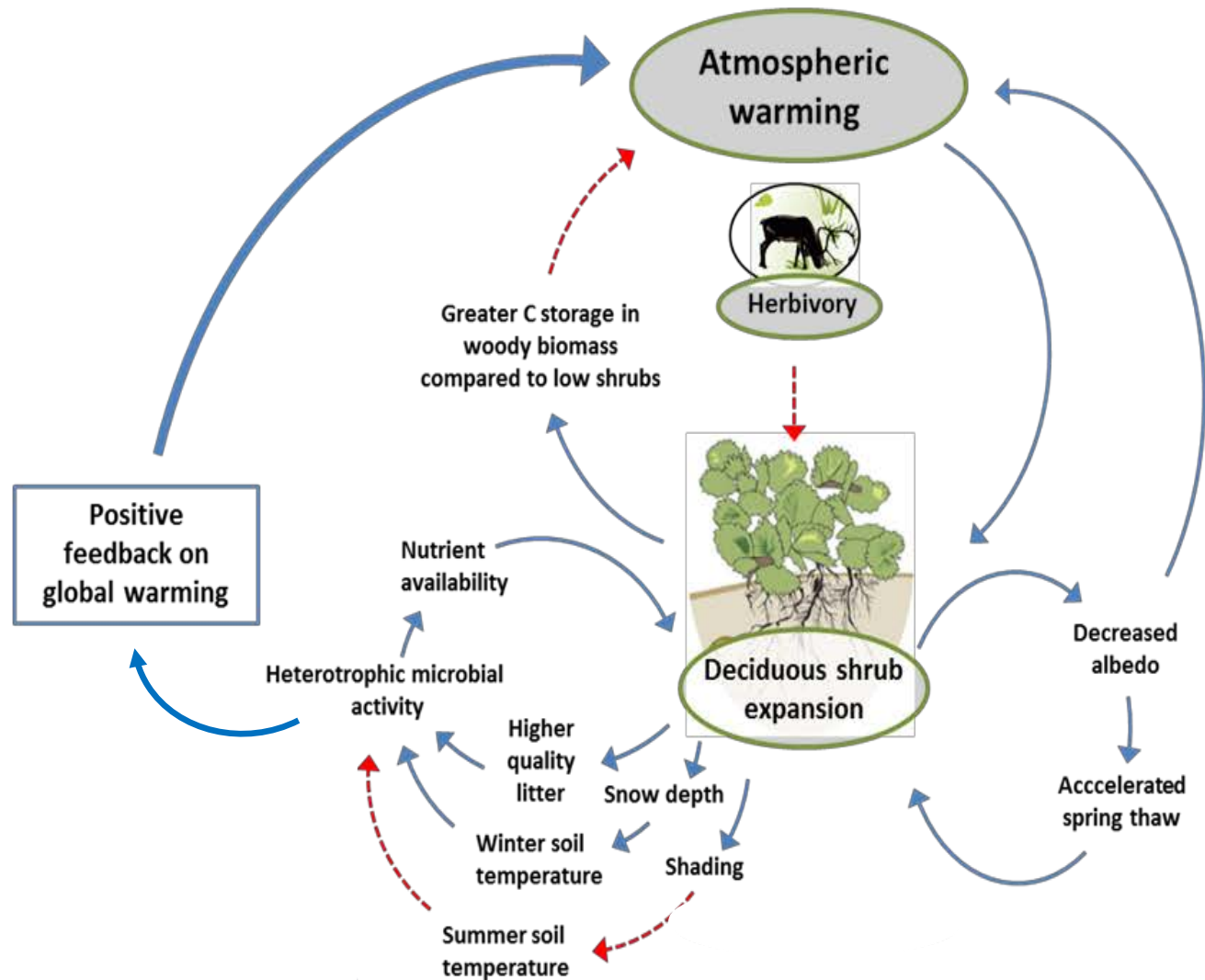
Figure 5. Results from shrub layer inventories of *Betula nana* and *Salix* spp. shrubs > 30 cm at the low herb meadow, showing means ( $\pm$ SE) of (a) number of shrubs, (b) mean height, (c) tallest height and (d) area cover in plot ( $n = 3$ ). Stars denote significant treatment effects. \*  $P = 0.1 - 0.05$ , \*\*  $P = 0.05 - 0.01$ , \*\*\*  $P < 0.01$ . Note that missing error bars mean that there was only one shrub above 30 cm, so no standard error could be calculated.



Low evergreen shrubs had increased dramatically in the majority of vegetation types studied and were either unaffected or positively influenced by grazing.

Tall deciduous shrubs too had increased, but to a lesser extent, and were negatively affected by grazing.

# The conceptual view on shrub expansion





# The increase of evergreen shrubs across the Arctic has been largely neglected in the shrubification literature

*The Holocene* 13,1 (2003) pp. 1–6

## Recent increases in species richness and shifts in altitudinal distributions of Norwegian spruce

Kari K

*Ecology*, 90(10), 2009, pp. 2657–2663  
© 2009 by the Ecological Society of America

Reports

Increased plant biomass in a High Arctic heath community

Global Change Biology

*Global Change Biology* (2009) 15, 1676–1684, doi: 10.1111/j.1365-2486.2009.01896.x

## Arctic alpine vegetation change over 20 years

SCOTT D. WILSON\* and C

nature  
climate change

LETTERS

PUBLISHED ONLINE: 8 APRIL 2012 | DOI: 10.1038/NCLIMATE1465

## Plot-scale evidence of tundra vegetation change and


Received: 24 November 2016 | Revised: 1 March 2017 | Accepted: 12 March 2017

DOI: 10.1111/gcb.13710

Sarah C PRIMARY RESEARCH ARTICLE

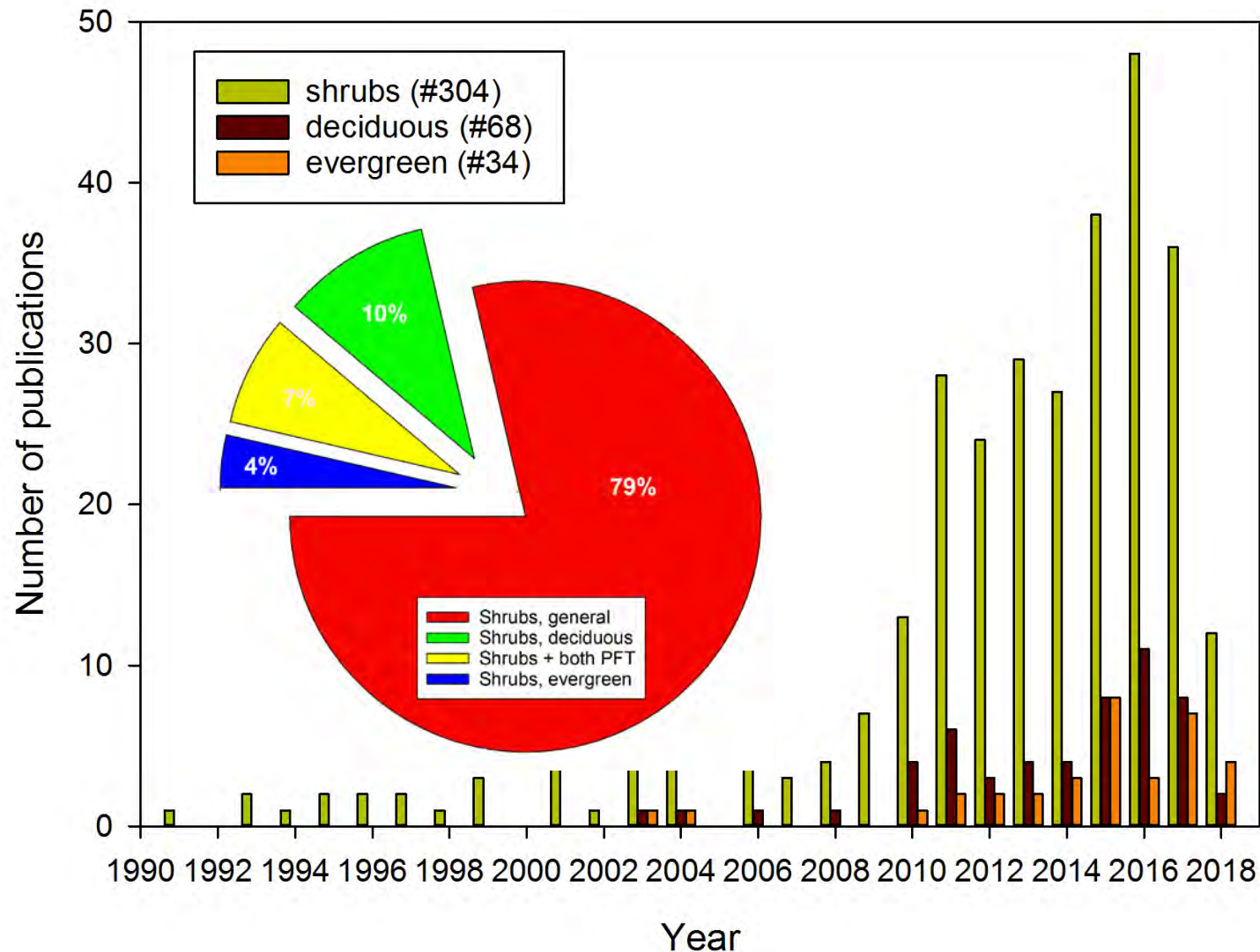
WILEY **Global Change Biology**

Open tundra persist, but arctic features decline—Vegetation changes in the warming Fennoscandian tundra

Katariina E. M. Vuorinen<sup>1</sup>  | Lauri Oksanen<sup>1,2</sup> | Tarja Oksanen<sup>1,2</sup> | Anni Pyykönen<sup>1,3</sup> | Johan Olofsson<sup>4</sup> | Risto Virtanen<sup>5,6,7</sup>

# The increase of evergreen shrubs across the Arctic has been largely neglected in the shrubification literature

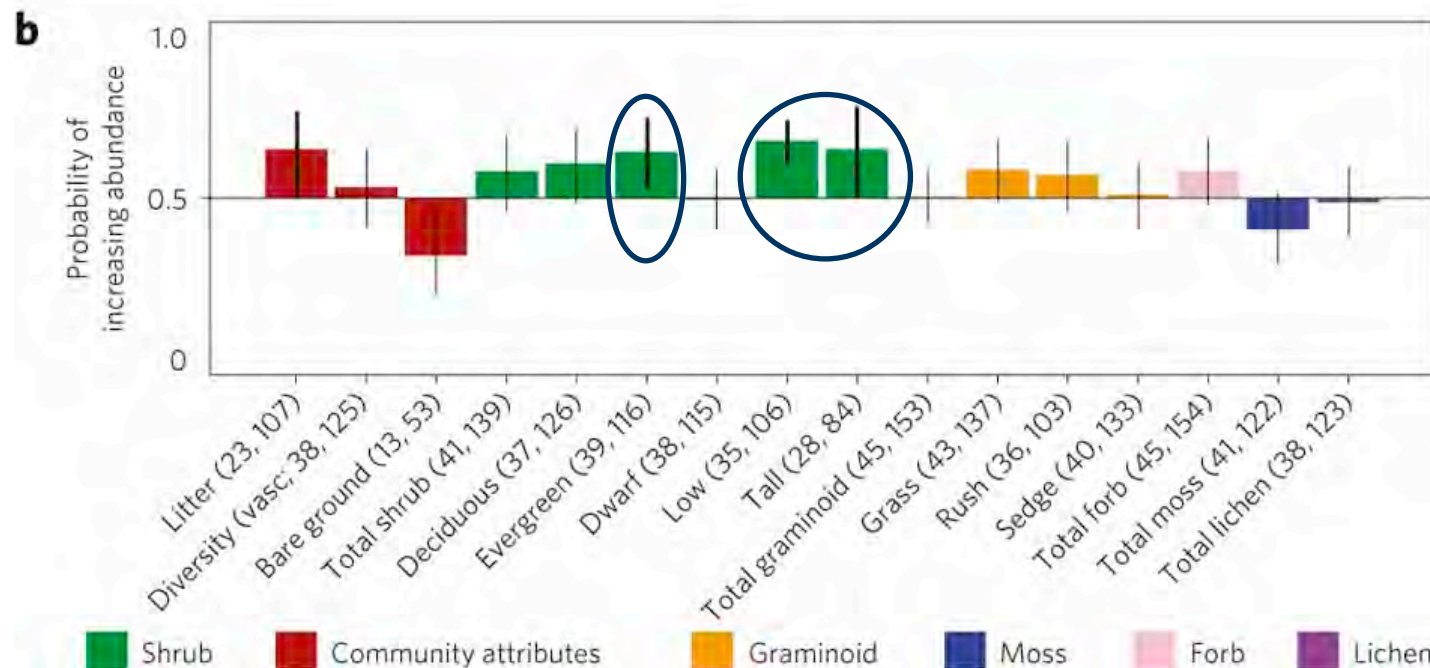
("shrub expansion" OR "vegetation change") **AND** (tundra OR arctic OR alpine) AND shrubs/deciduous/evergreen



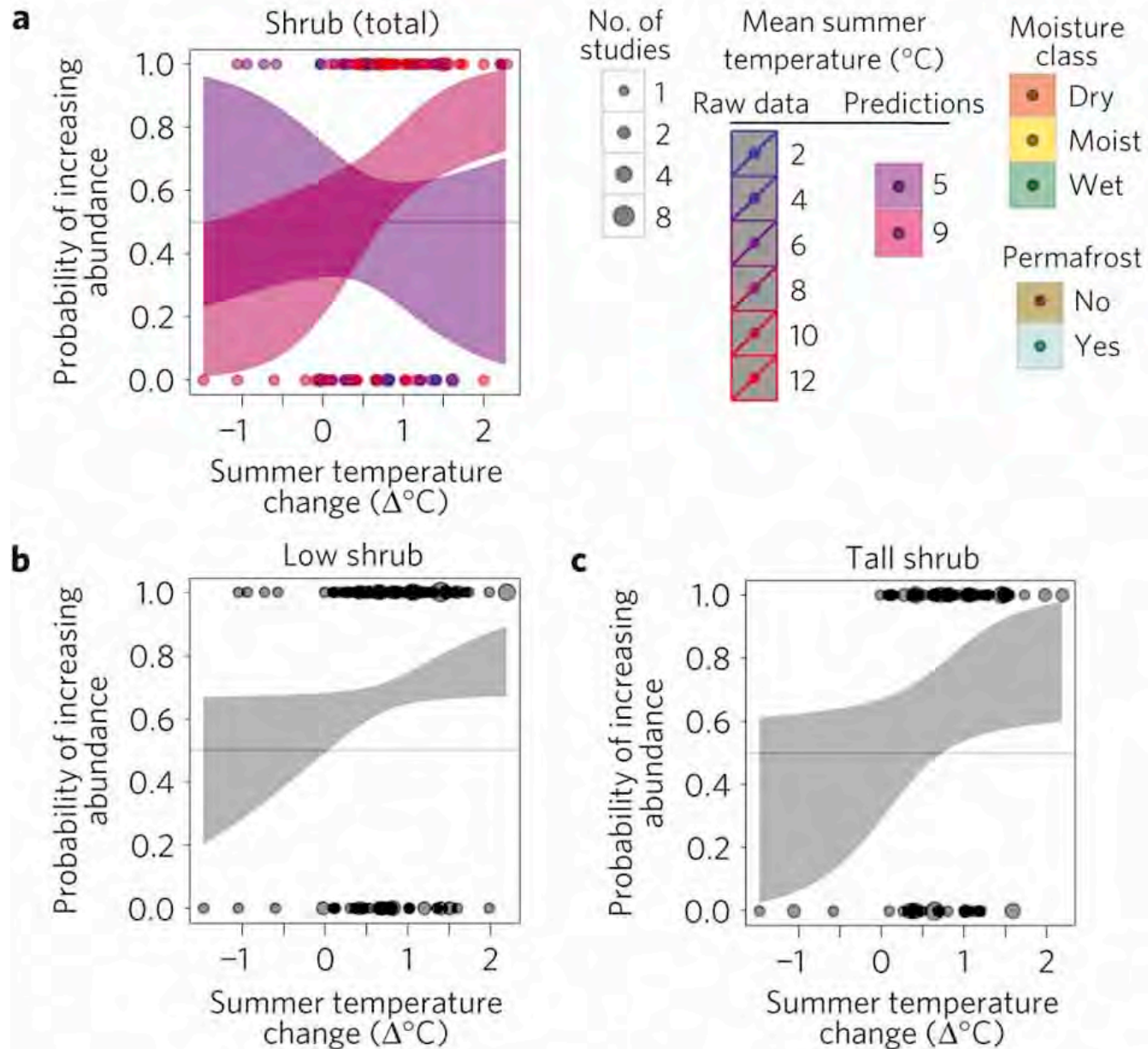


# Plot-scale evidence of tundra vegetation change and links to recent summer warming

Sarah C. Elmendorf, Gregory H. R. Henry, Robert D. Hollister *et al.*

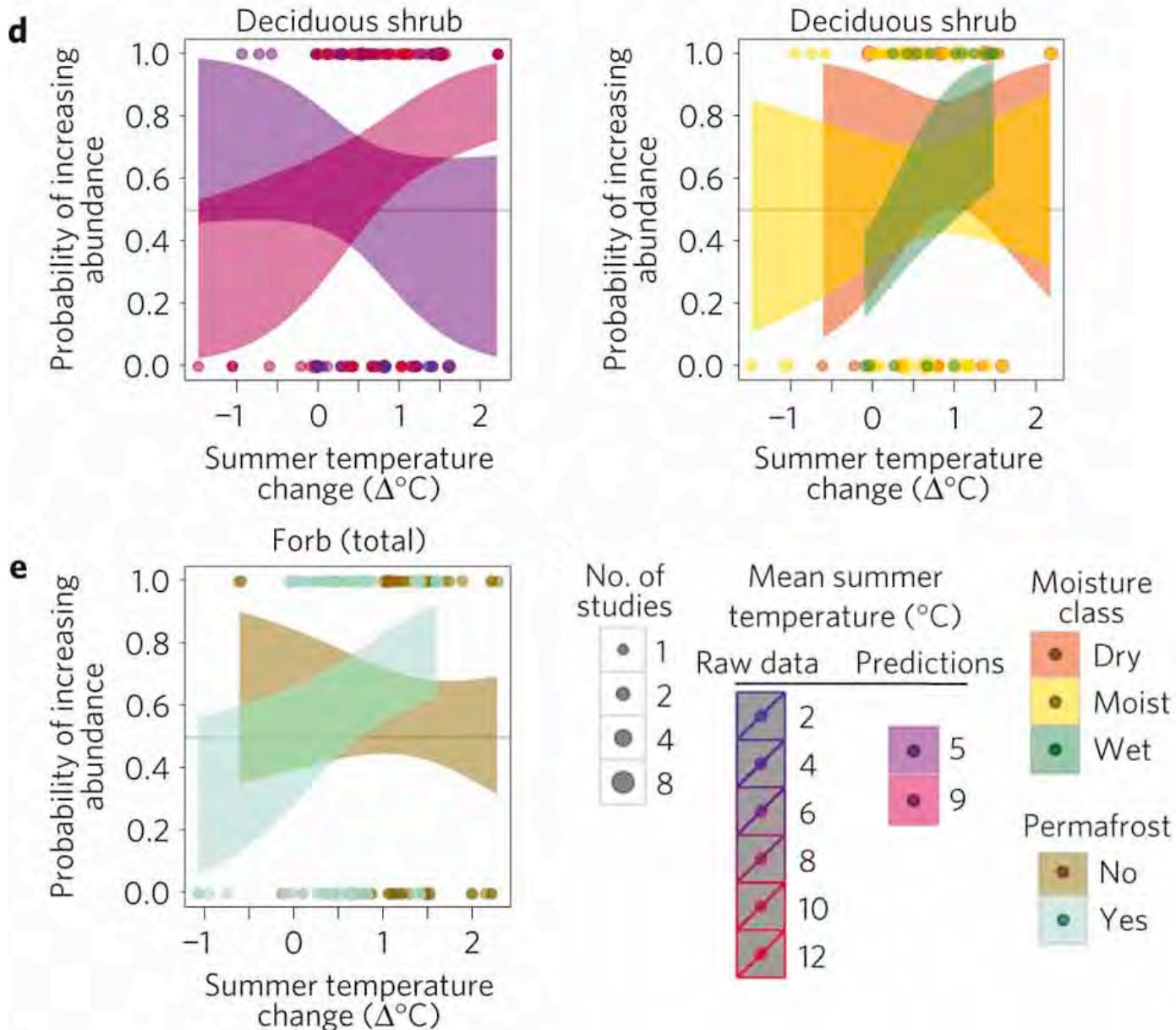


# Total shrub expands in sites that are already relatively warm





# Response dependent on the climate zone, the moisture regime and the presence of permafrost



# Deciduous vs evergreen shrubs in the Arctic



**Dwarf birches** (*Betula* spp.) or  
**Willows** (*Salix* spp.)

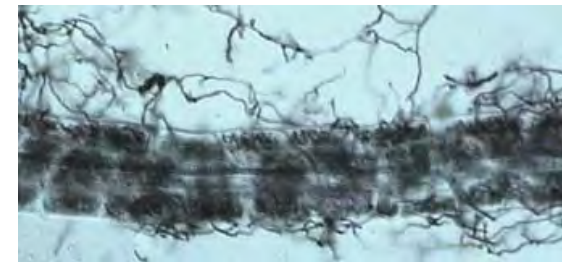
- + Albedo
- + Spring thaw
- + Summer shading

- Ectomycorrhiza



**Semi-prostrate shrubs** (*Vaccinium* spp., *Empetrum hermafroditum* etc.)

- + Allelopathy

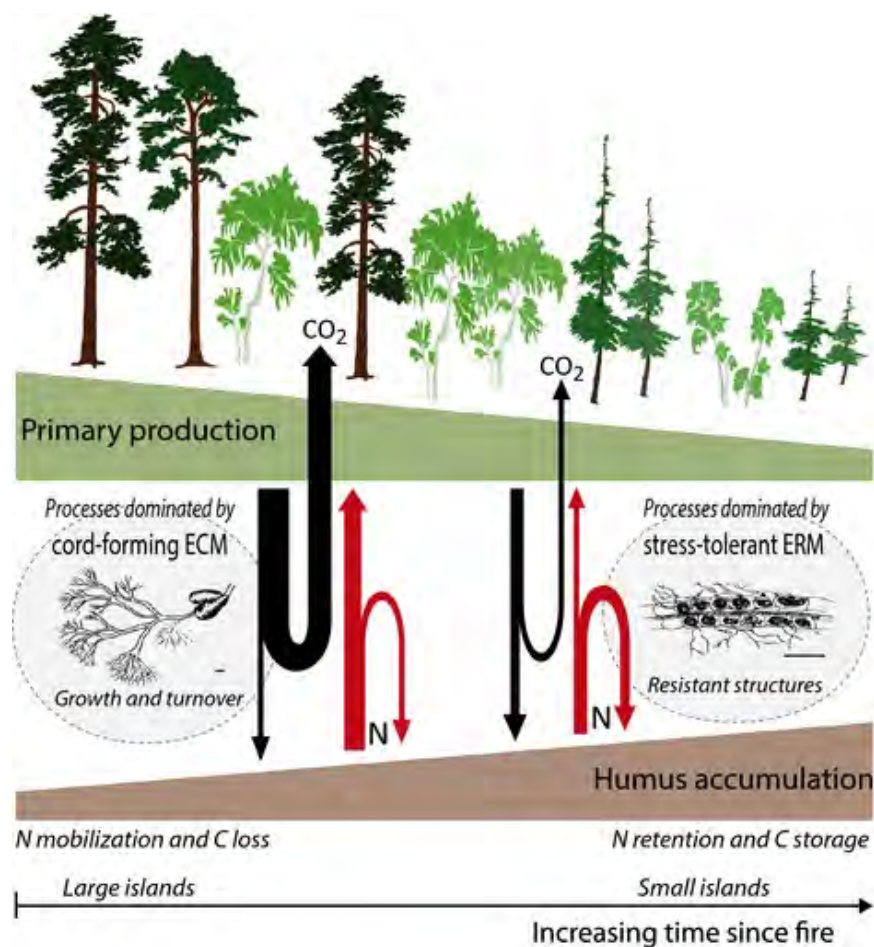


- Ericoid mycorrhiza



# Carbon sequestration is related to mycorrhizal fungal community shifts during long-term succession in boreal forests

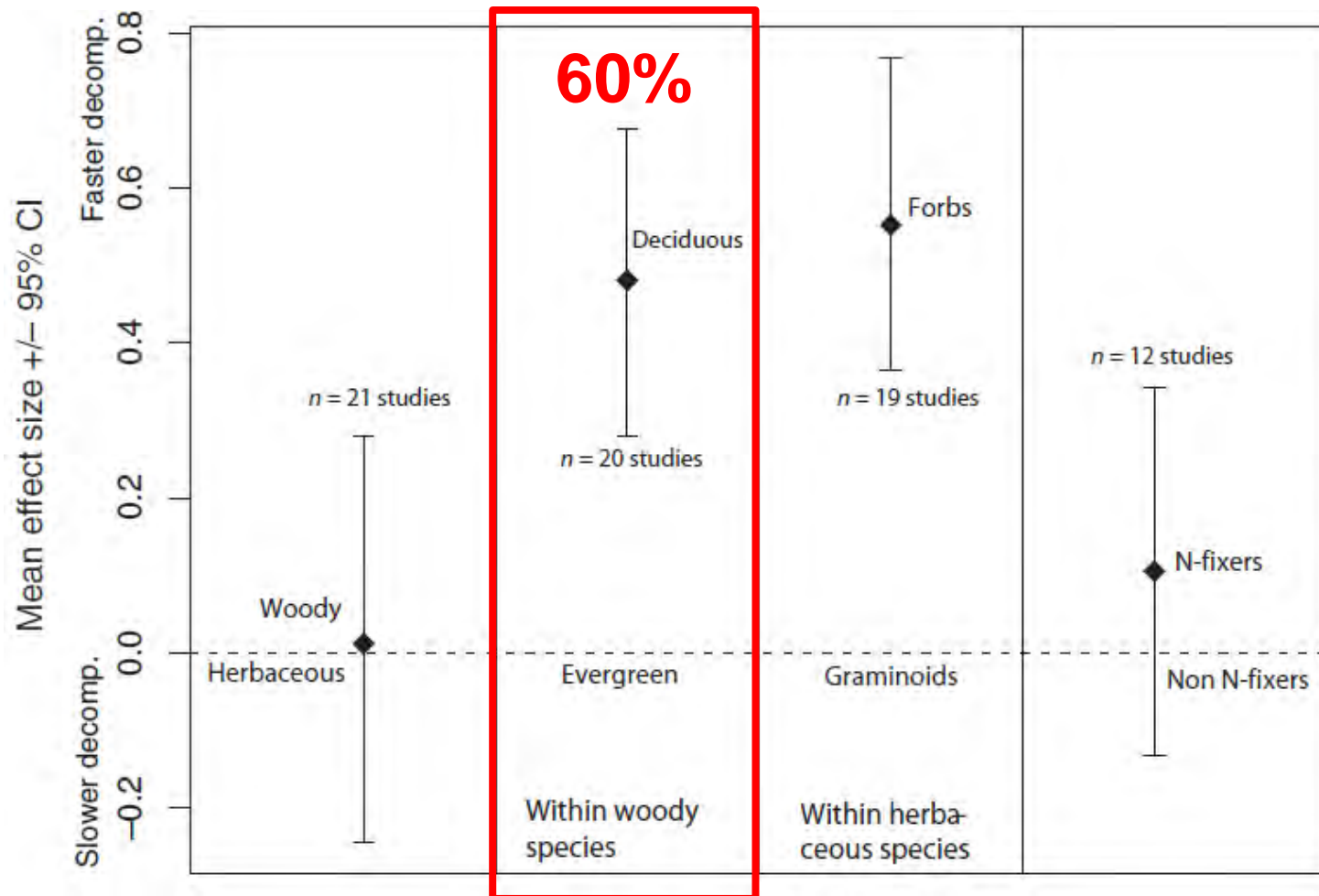
Karina E. Clemmensen<sup>1</sup>, Roger D. Finlay<sup>1</sup>, Anders Dahlberg<sup>1</sup>, Jan Stenlid<sup>1</sup>, David A. Wardle<sup>2</sup> and Björn D. Lindahl<sup>3</sup>



## LETTER

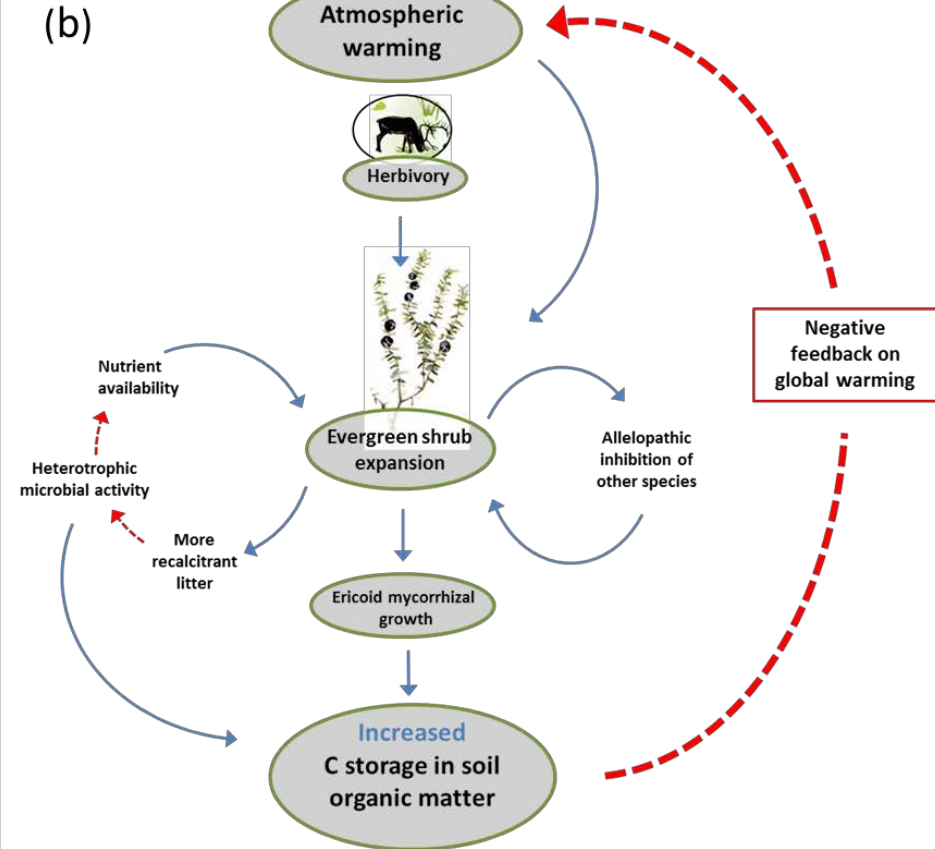
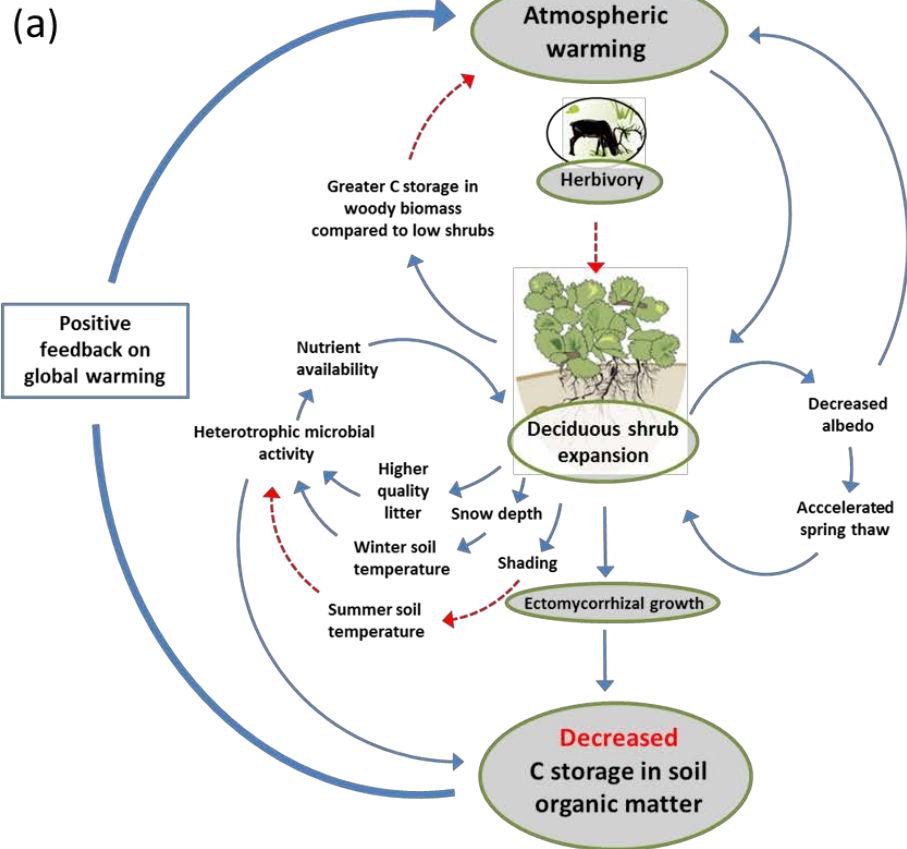
# Plant species traits are the predominant control on litter decomposition rates within biomes worldwide

William K. Cornwell,<sup>1\*</sup> Johannes H. C. Cornelissen,<sup>1</sup> Kathryn Amatangelo,<sup>2</sup> Ellen Dorrepaal,<sup>1</sup> Valerie T. Eviner,<sup>3</sup> Oscar Godoy,<sup>4</sup> Sarah E. Hobbie,<sup>5</sup> Bart Hoorens,<sup>1</sup>

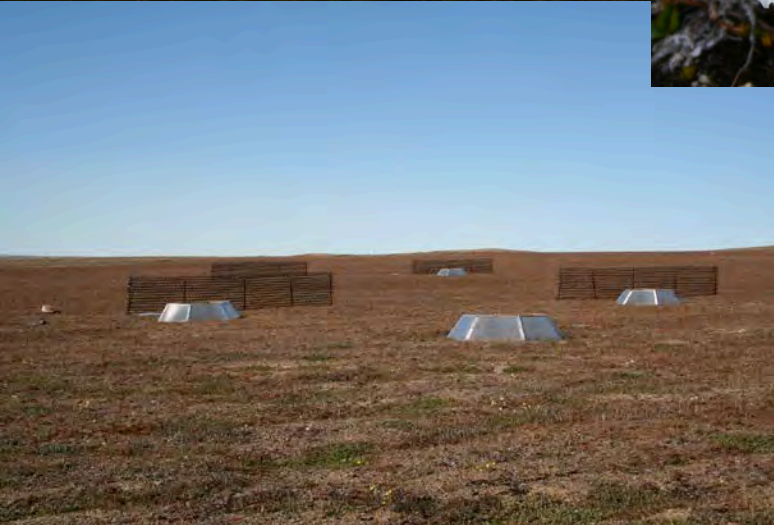




# The need for a more comprehensive view of Arctic shrubification



# Thank you very much for your attention!





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