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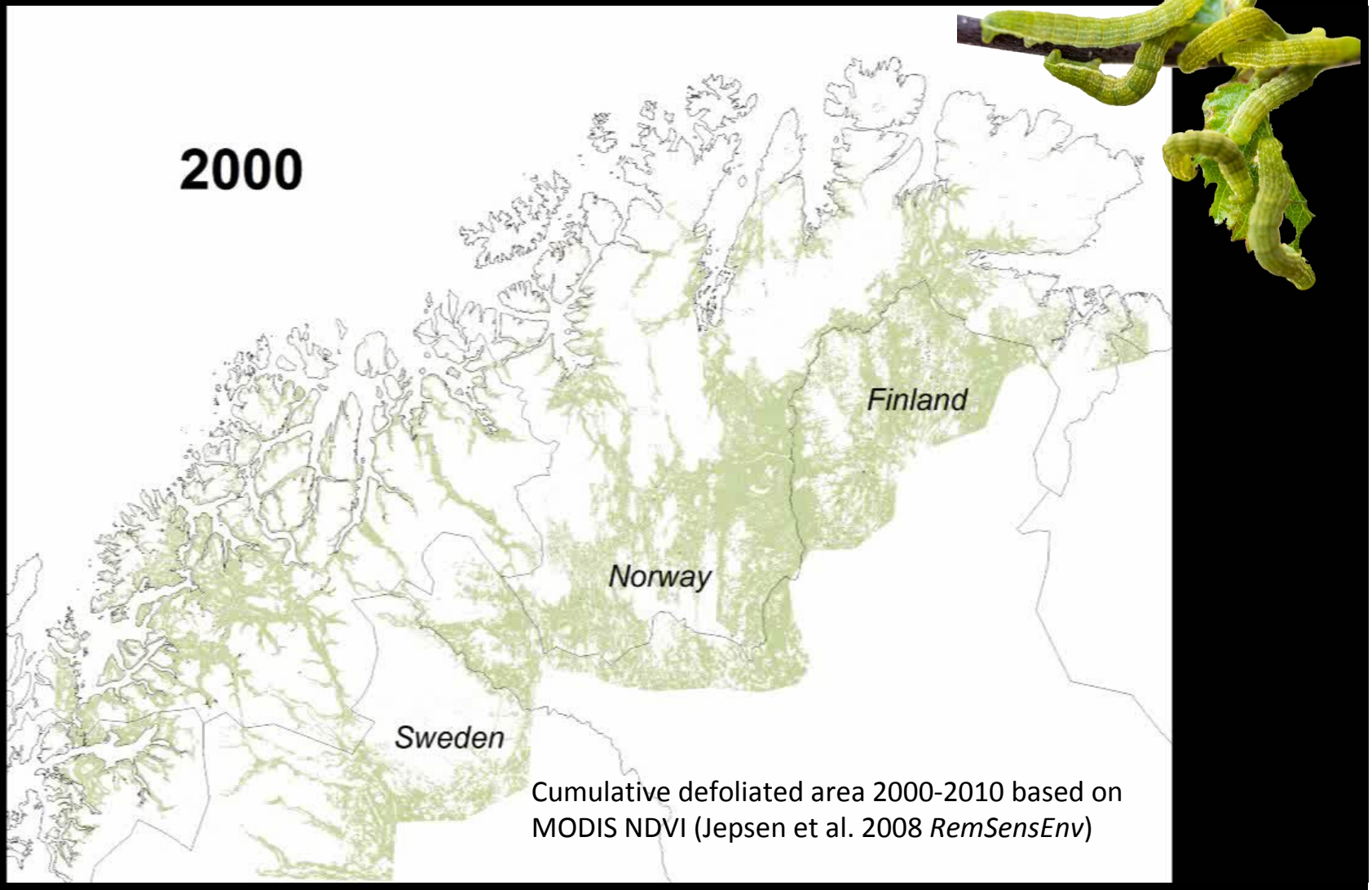
Photo: Moritz Klinghardt

10.000 km² of birch forest was affected by severe defoliation caused by geometrid moths during the 2000's



Cumulative defoliated area 2000-2010 based on MODIS NDVI (Jepsen et al. 2008 *RemSensEnv*)

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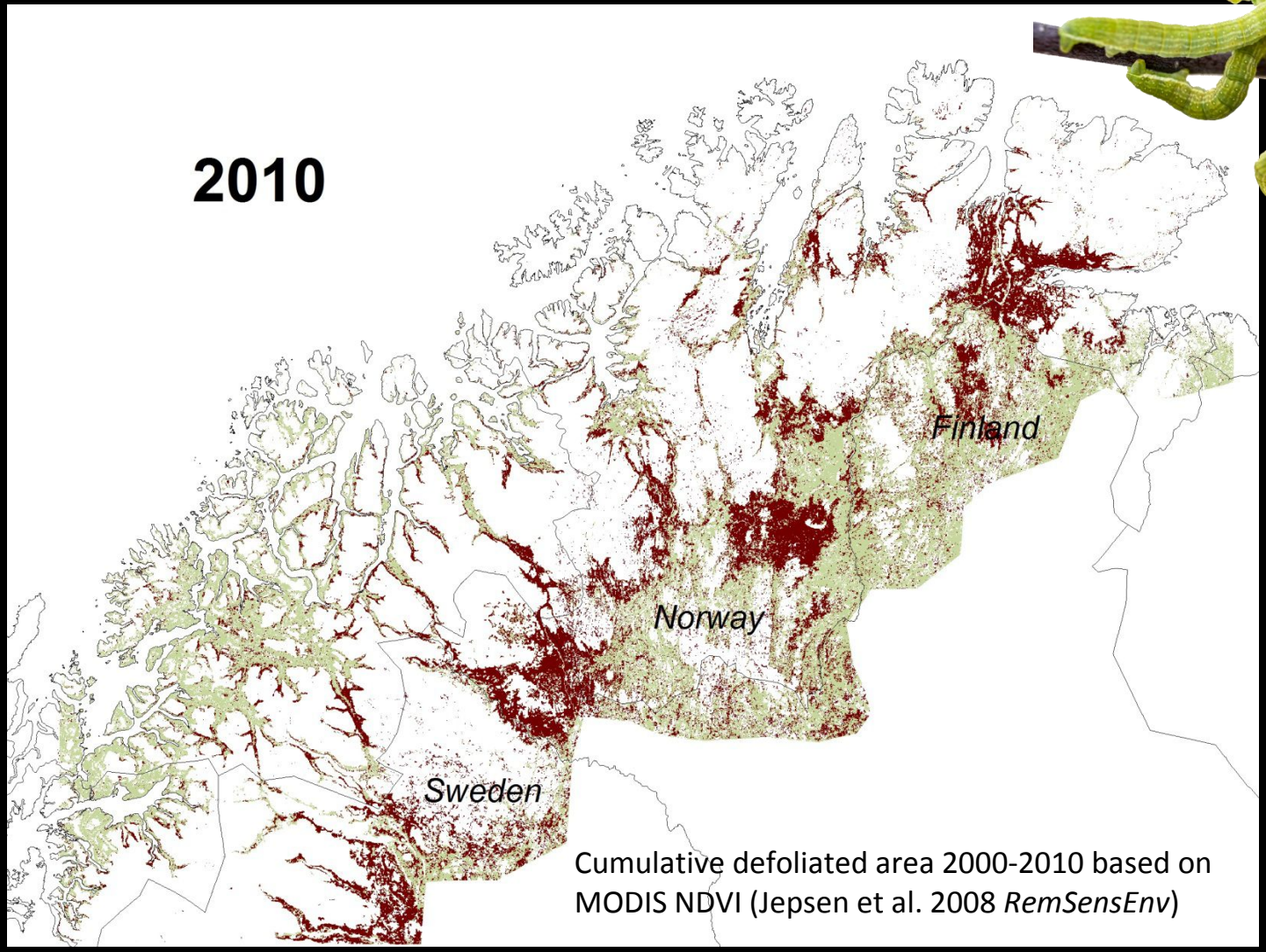
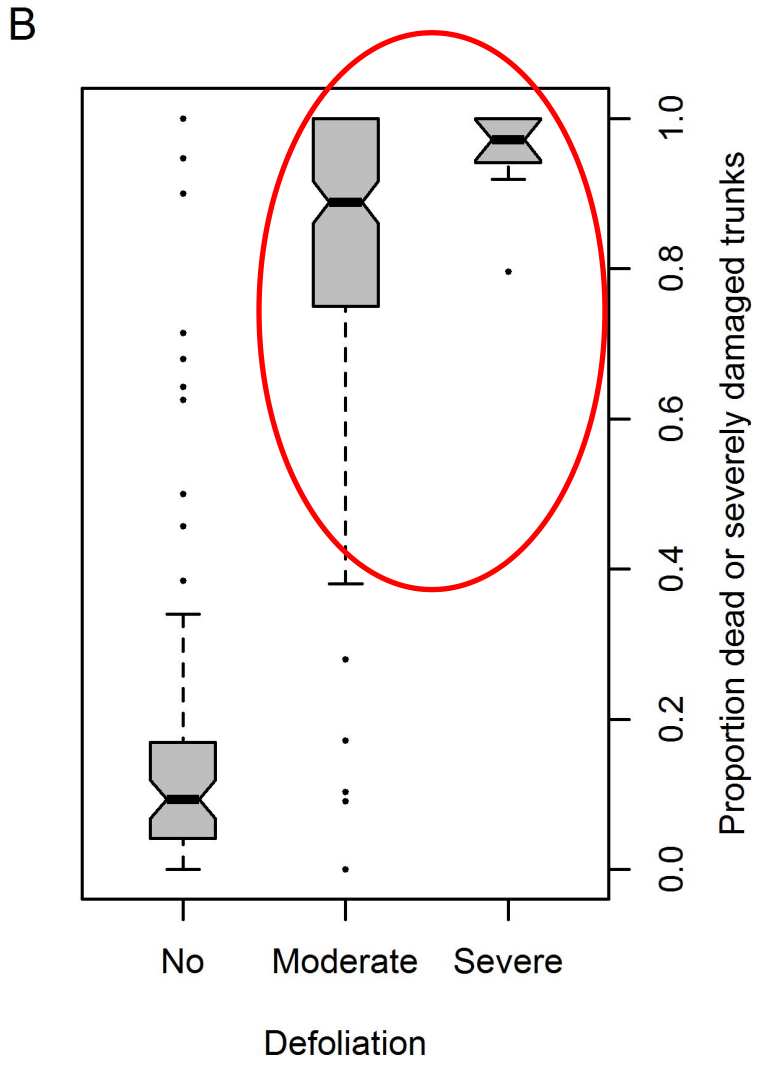


Cumulative defoliated area 2000-2010 based on MODIS NDVI (Jepsen et al. 2008 *RemSensEnv*)

Extended moth outbreaks cause forest mortality

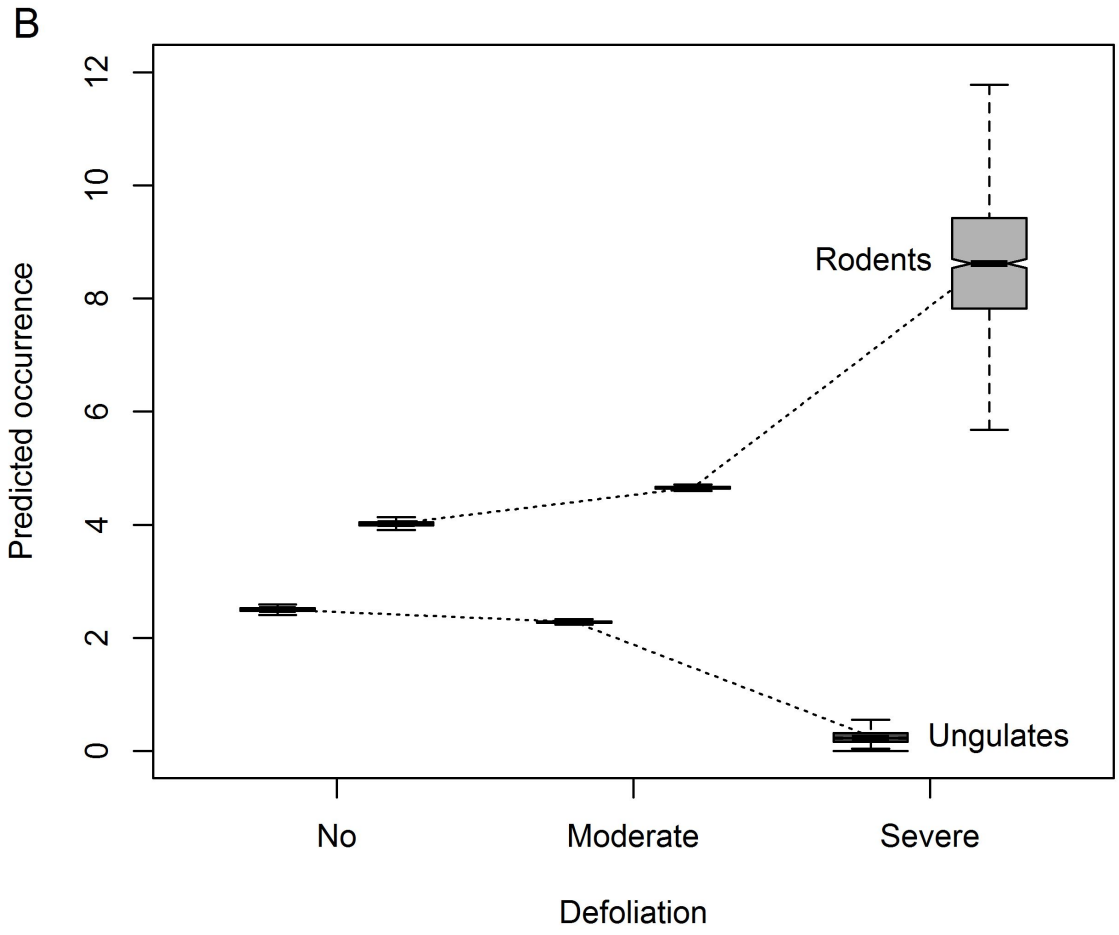


Jepsen et al. 2013 *Ecosystems*

..and abrupt state changes to the understorey vegetation

Karlsen et al. 2013 *Oecologia*

..which cascade to other herbivores in the ecosystem



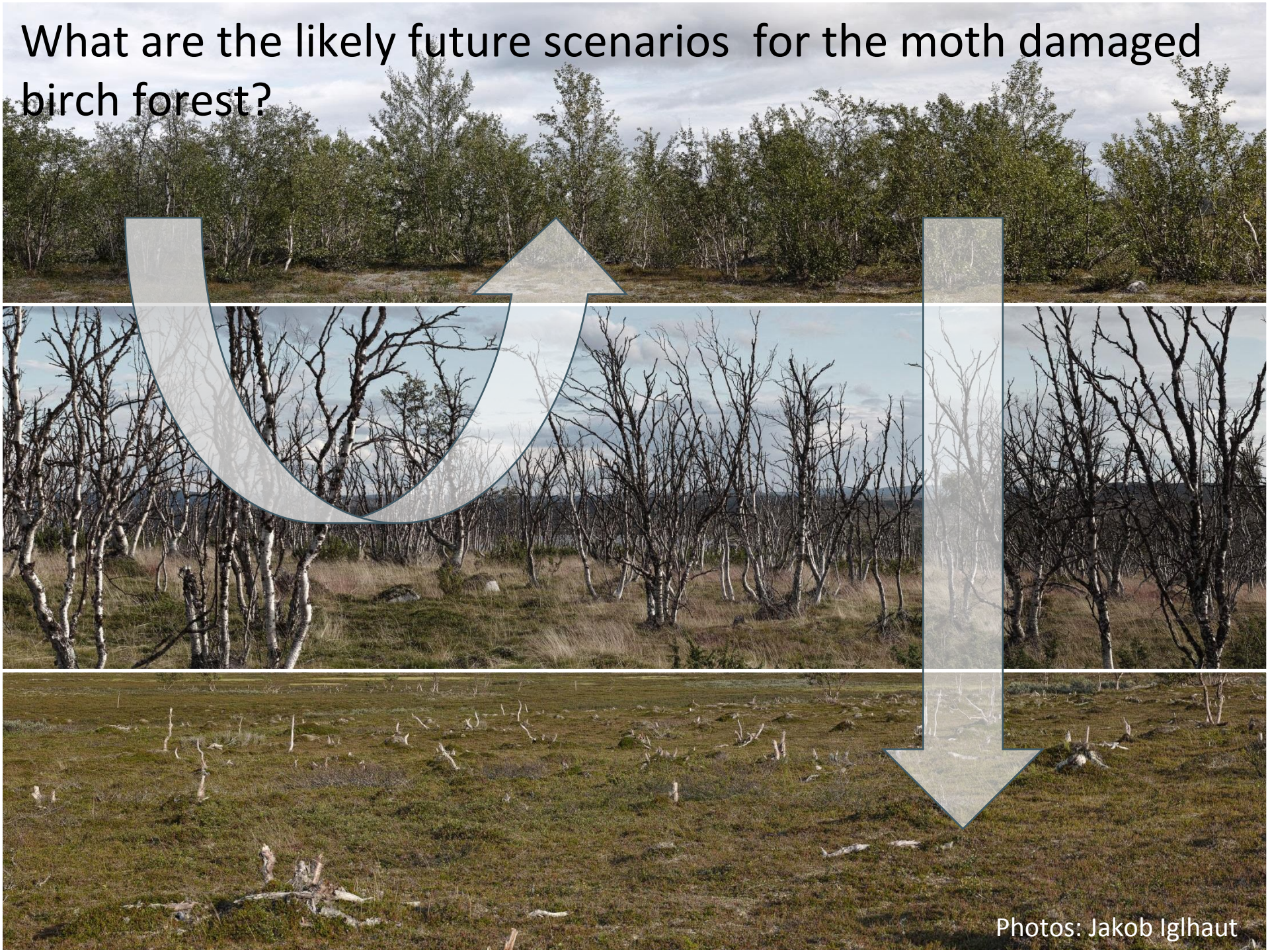
Jepsen et al. 2013 *Ecosystems*

The successional trajectories for the birch forest following moth outbreaks will in turn depend on the presence of these other herbivores


Photo: Rolf A. Ims


Photo: Geir Vie

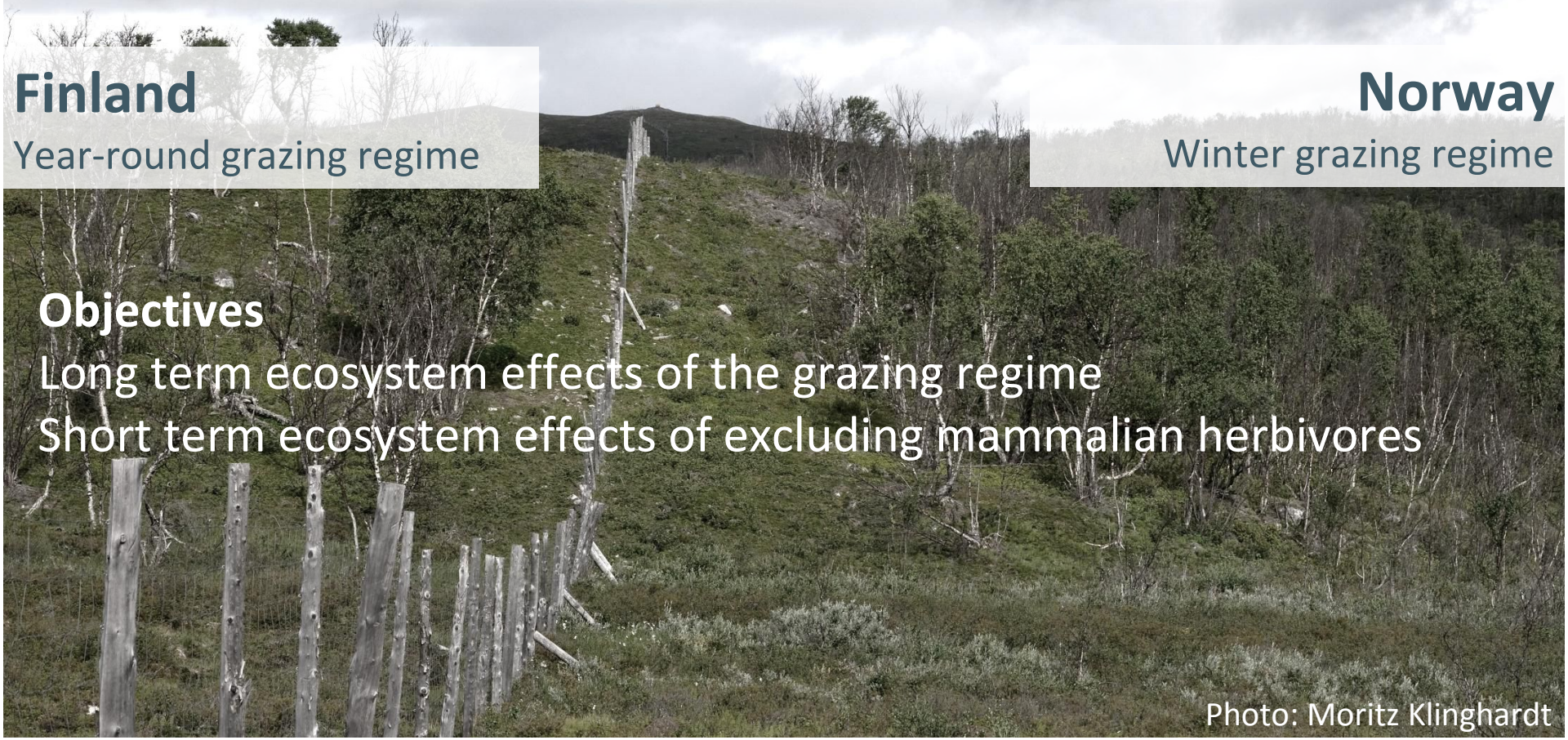
What are the likely future scenarios for the moth damaged birch forest?



Photos: Jakob Iglhaut

Polmak

- Oligotrophic birch forest most affected by outbreaks
- Contrasting herding regimes in Finland and Norway
- Experimental exclusion of small and large herbivores



Finland

Year-round grazing regime

Norway

Winter grazing regime

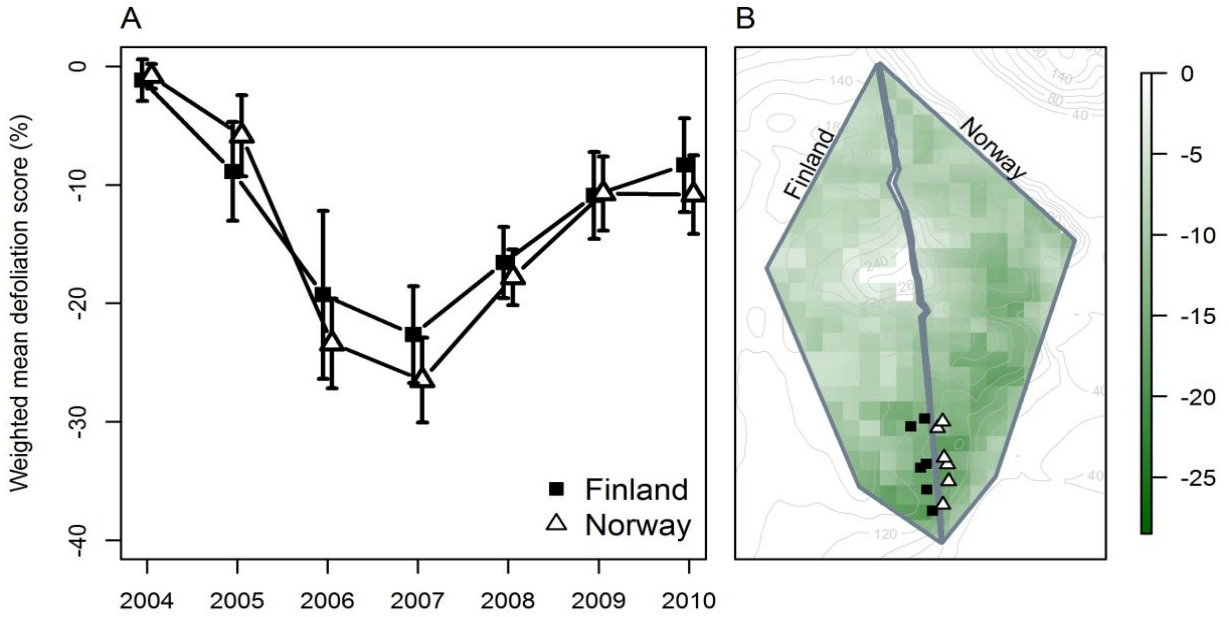
Objectives

Long term ecosystem effects of the grazing regime

Short term ecosystem effects of excluding mammalian herbivores

Photo: Moritz Klinghardt

Similar defoliation history and stem damage across the border



	No crown loss	< 50% crown loss	> 50% crown loss	Dead
Finland (YRG)	1 (0.16)	1 (0.16)	15 (2.35)	620 (97.33)
Norway (WG)	0 (0)	2 (0.29)	67 (9.84)	612 (89.87)
p_{Boot}	n.s.	n.s.	<0.001	<0.001

The year-round grazing regime drives changes towards a more open forest structure with less long-term recruitment

	Finland Year-round grazing	Norway Winter grazing
Stems per tre	6.7 stems	9.3 stems
% trees with basal shoots	3.4 %	64 %
Density of saplings (0-20 cm)	0.022 /m²	0.082 /m²
Distance between trees	4.9 m	4.3 m
Snow depth	61.6 cm	72 cm

Biuw et al. 2014 *Ecosystems*

Photo: Moritz Klinghardt

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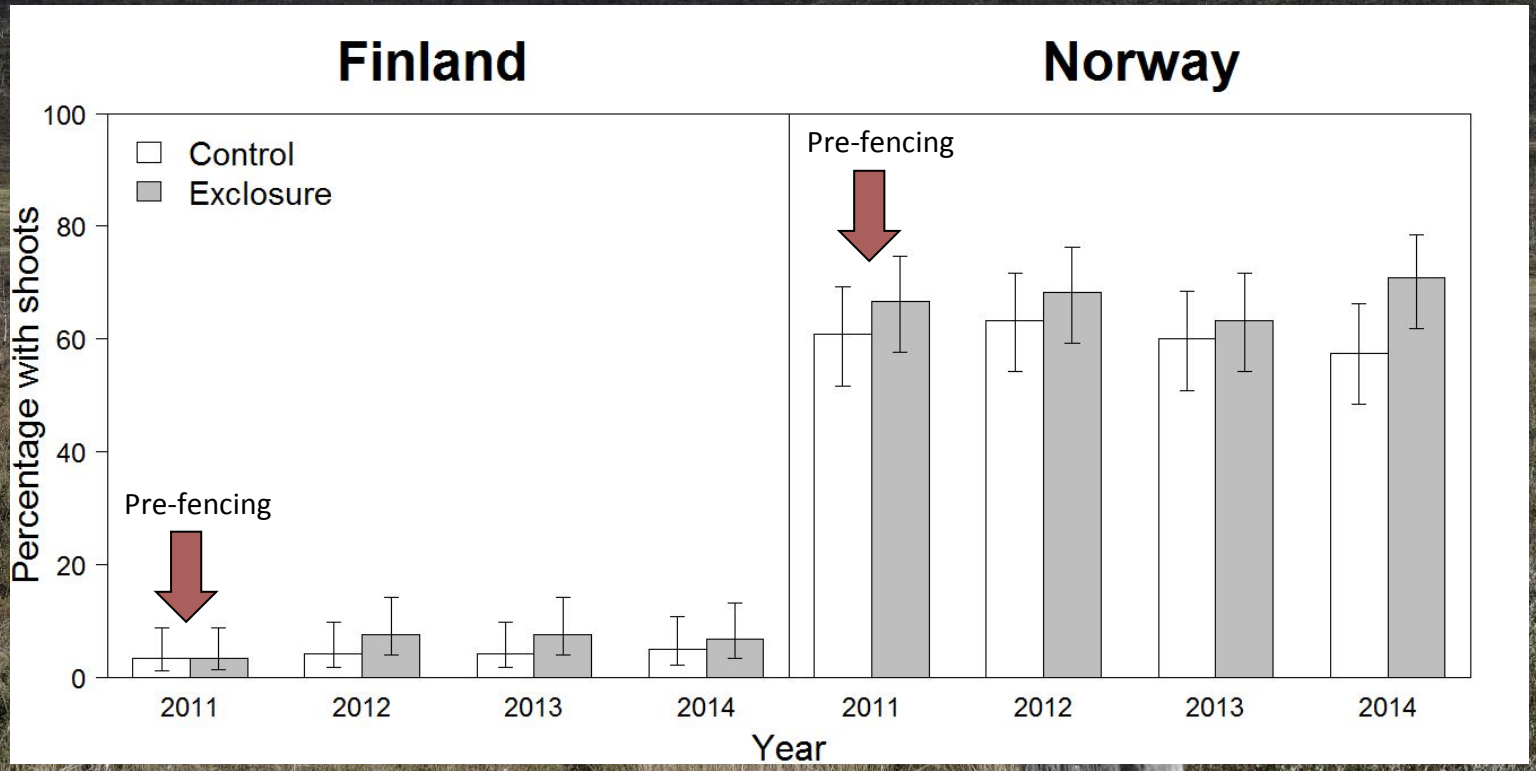
Biuw et al. 2014 *Ecosystems*

Photo: Moritz Klinghardt

Fencing has so far not increased the % trees with basal shoots



Jepsen et al. unpublished

Photo: Moritz Klinghardt

These structural changes translate into a significantly elevated spring albedo in Finnish plots

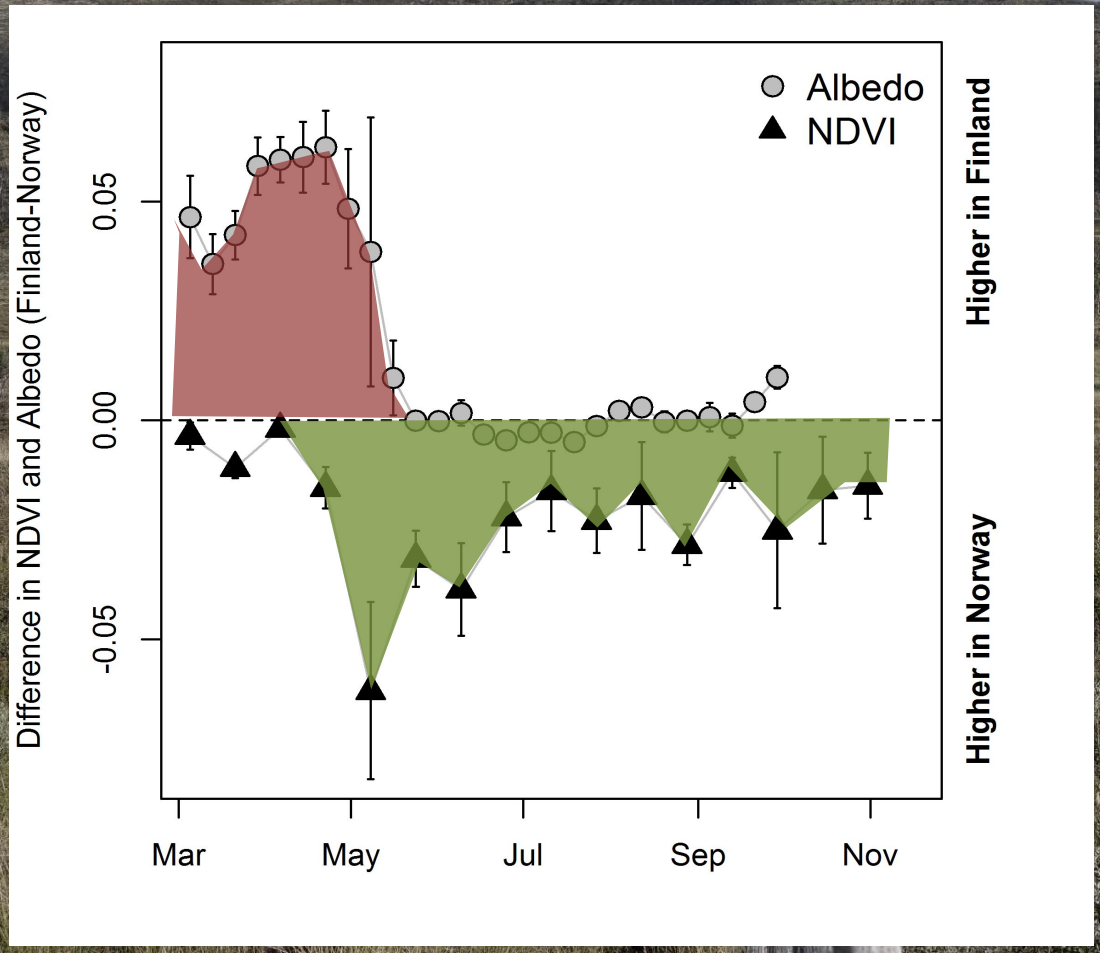


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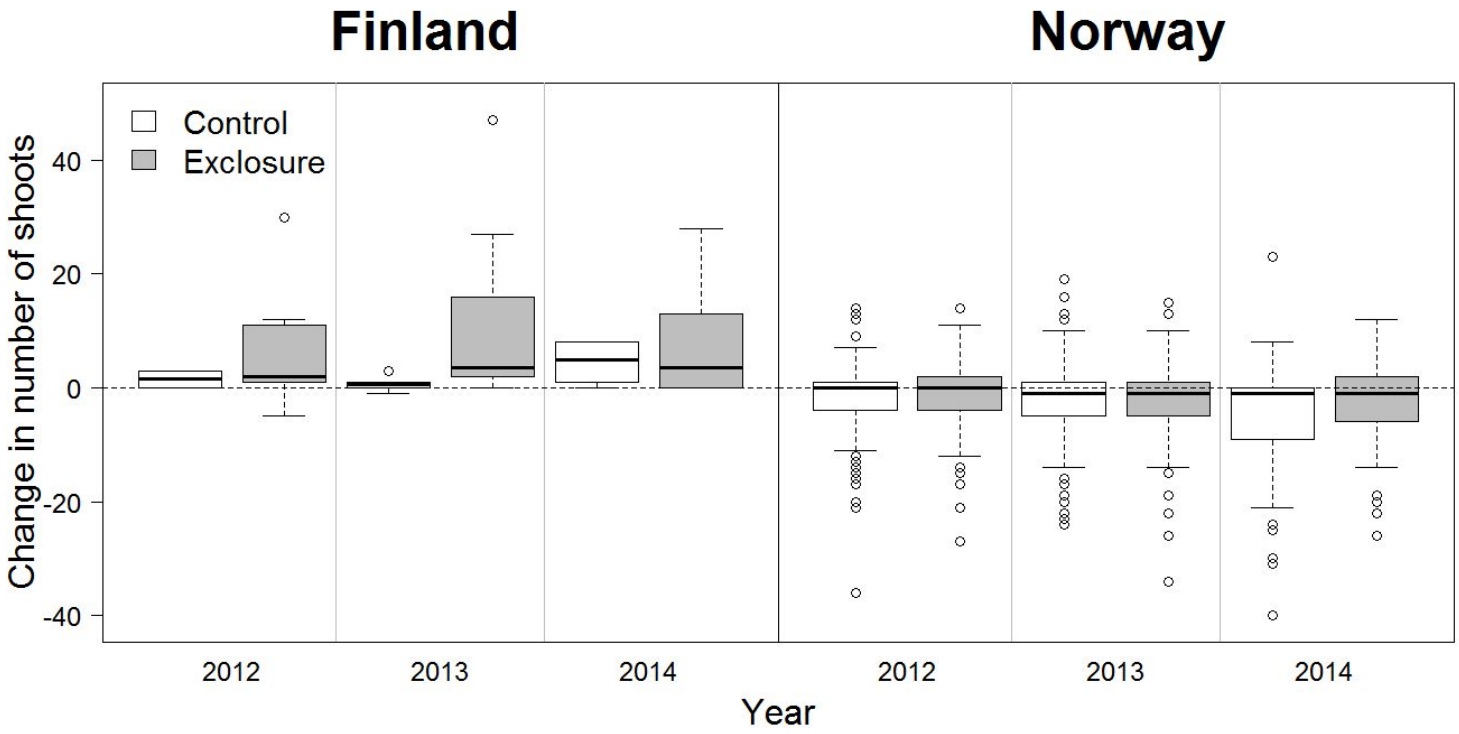
Photo: Moritz Klinghardt

Short term effects of excluding ungulates on forest regeneration differ between grazing regimes:

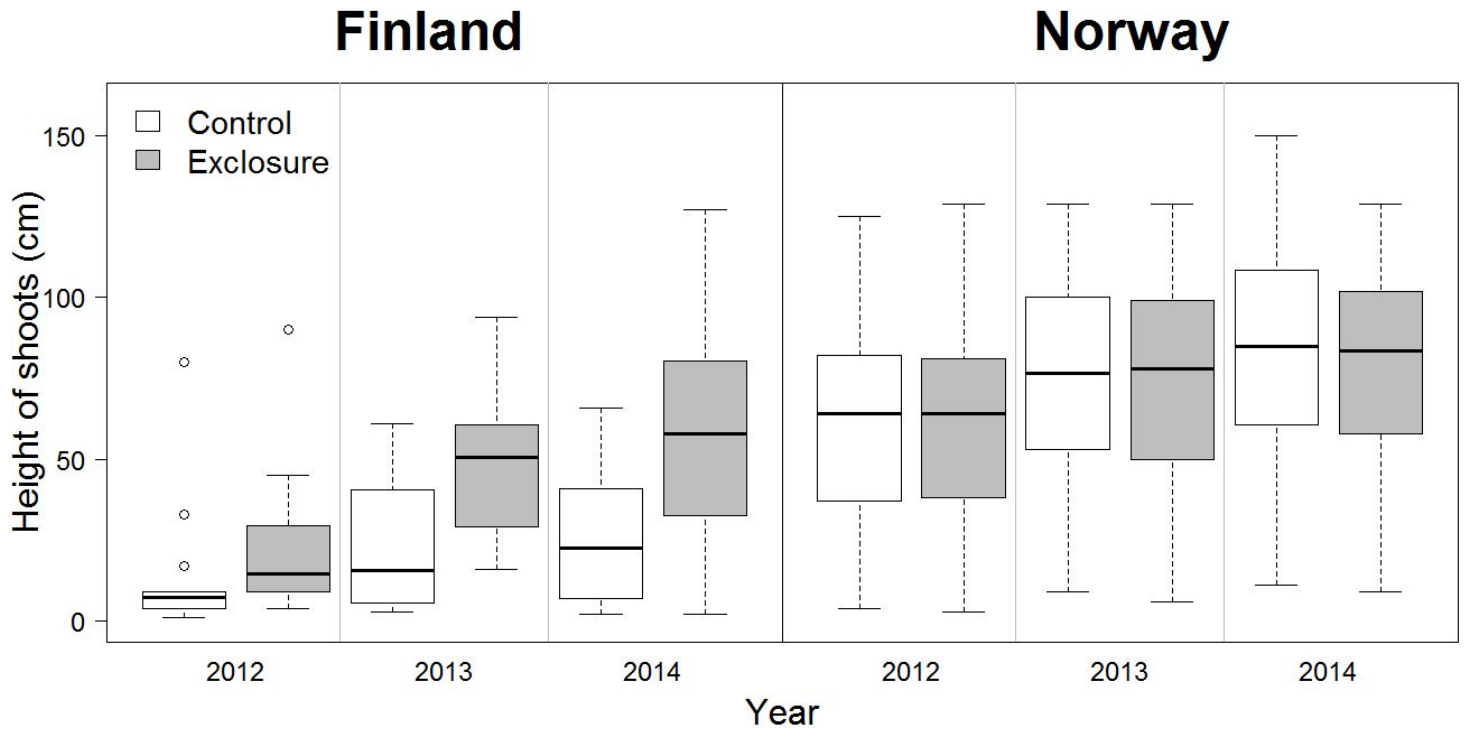
The number of shoots per tree



Jepsen et al. unpublished

Short term effects of excluding ungulates on forest regeneration differ between grazing regimes:

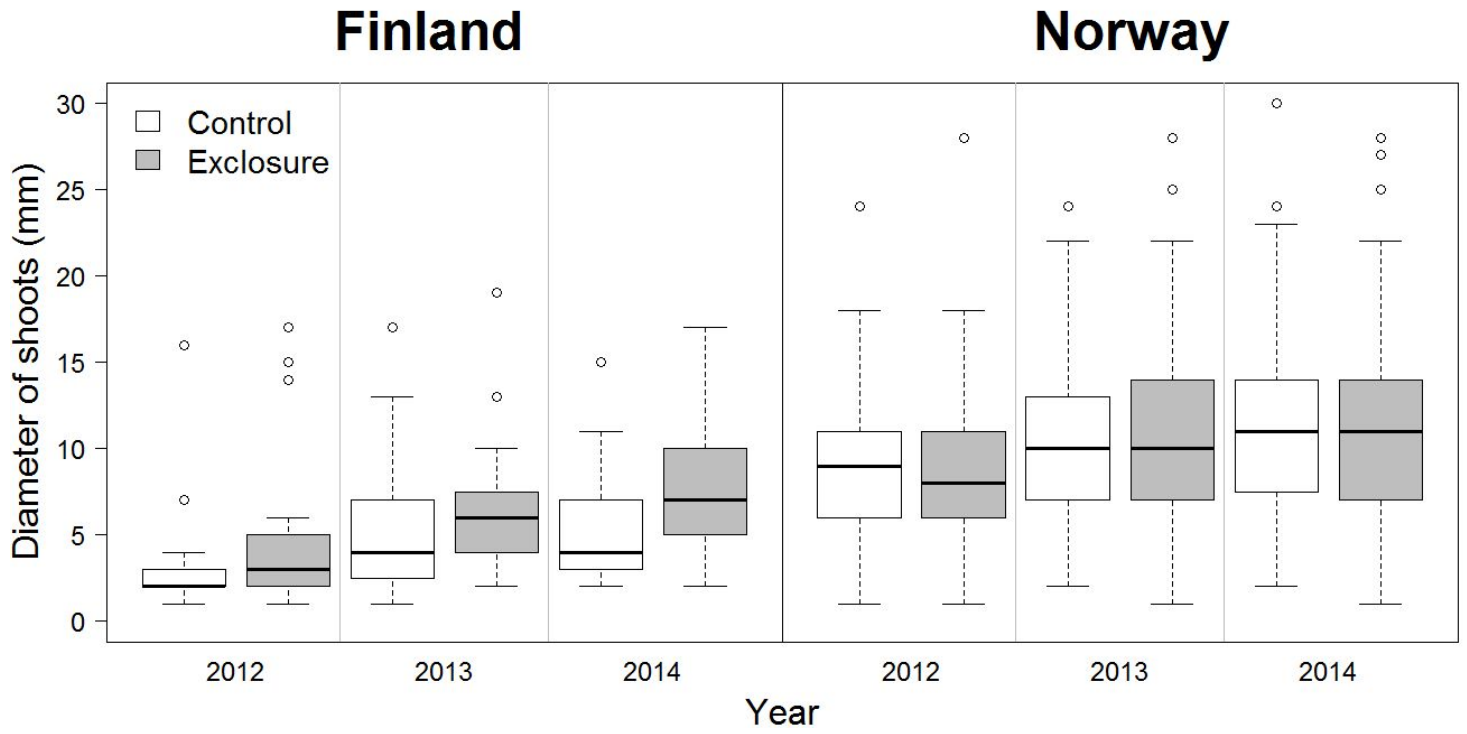
Shoot height



Jepsen et al. unpublished

Short term effects of excluding ungulates on forest regeneration differ between grazing regimes:

Shoot diameter



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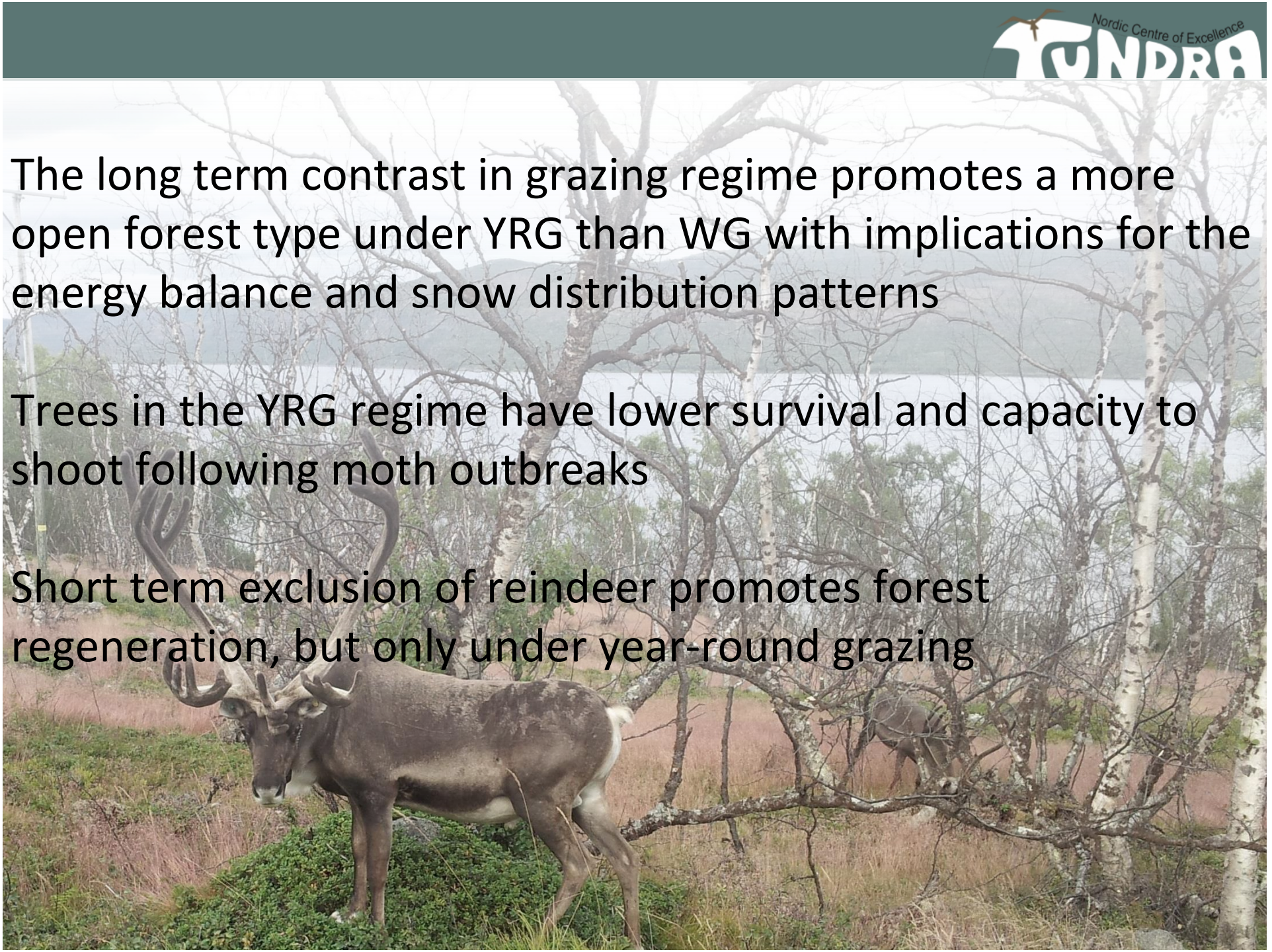

The long term contrast in grazing regime promotes a more open forest type under YRG than WG with implications for the energy balance and snow distribution patterns

Trees in the YRG regime have lower survival and capacity to shoot following moth outbreaks

Short term exclusion of reindeer promotes forest regeneration, but only under year-round grazing