

Nurse effect of cushion plants: Plant interactions in Arctic tundra ecosystems in the face of climate change

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Plant-plant interactions

- Specific case – facilitation (nurse plants)
- Shrubs in arid zones, cushion plants



Cushion plants

- Known from Alpine ecosystems to:
- Enhance soil resources^(1,2)
- Milder climatic extremes (both high and low temperature)⁽³⁾
- Increase species diversity^(4,5)



- (1) Arroyo et al. 2003, Plant Ecol.
- (2) Schöb et al. 2013, J. Ecol.
- (3) Cavieres et al. 2007, AAAR
- (4) Cavieres et al. 2014, Ecol. Lett.
- (5) Butterfield et al. 2013, Ecol. Lett.

Plant-plant interactions with cushion plants

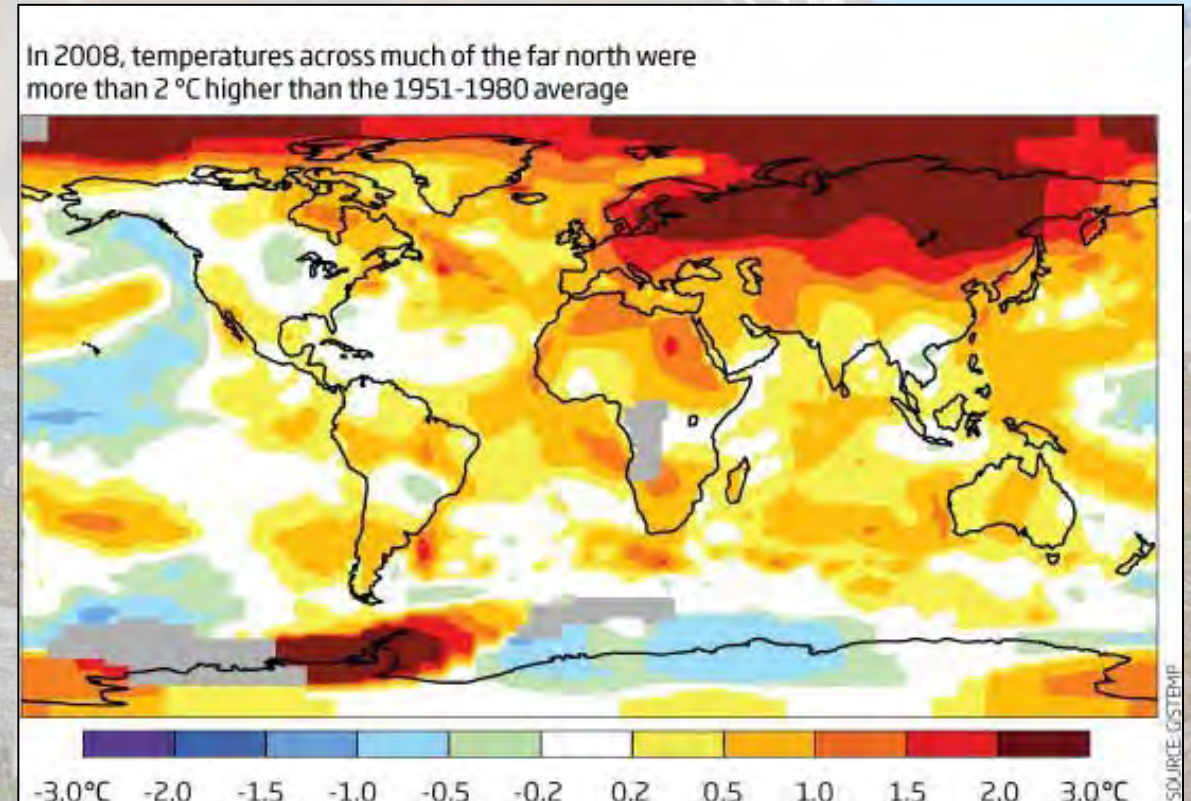
- Positive interactions
- Cost of interaction (COI)
 - one plant's benefit may be another plant's cost ⁽¹⁾



(1) Schöb et al. 2013, Funct. Ecol.

Climate change – ongoing and fast

- Everyone acknowledge it (except Donald ;)
- Fastest in the Arctic and Alpine zone ⁽¹⁾
- Influencing ecosystem functioning ^(1,2)
 - *Most likely also positive plant-plant interactions*

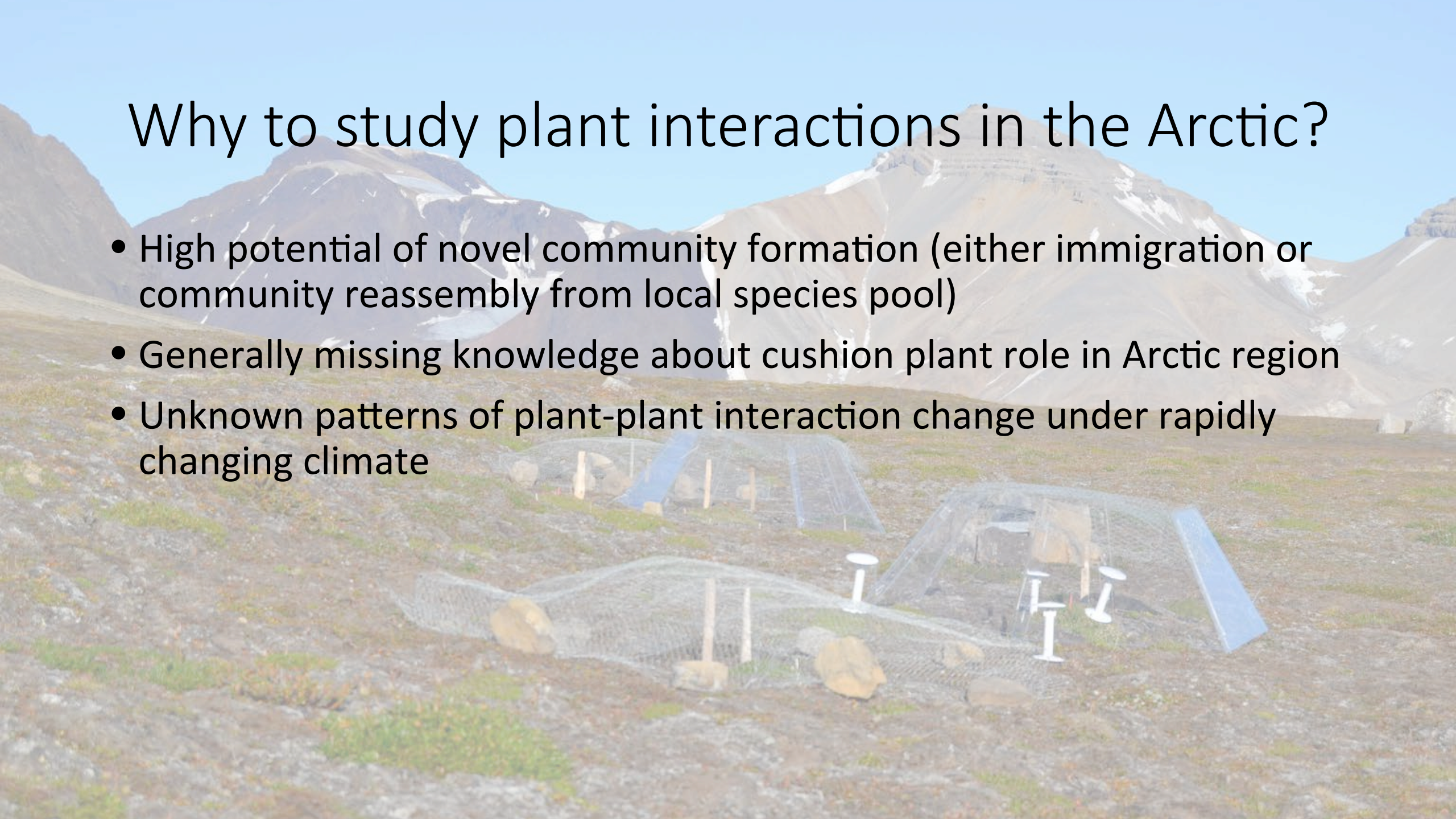


(1) Thuiller *et al.*, 2005, PNAS

(2) Rosenzweig *et al.*, 2007, IPCC

Why to study plant interactions in the Arctic?

- High potential of novel community formation (either immigration or community reassembly from local species pool)
- Generally missing knowledge about cushion plant role in Arctic region
- Unknown patterns of plant-plant interaction change under rapidly changing climate



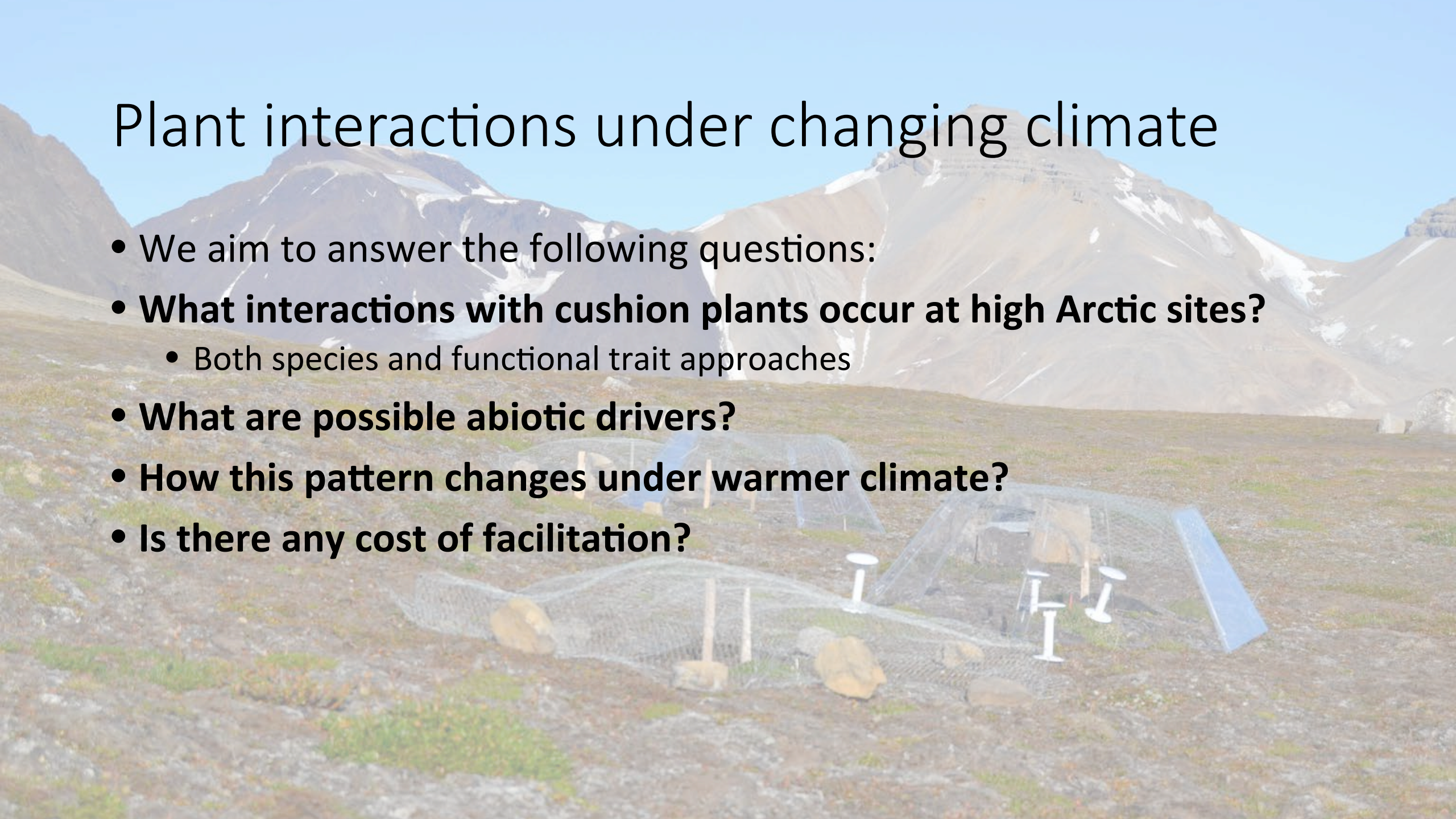
Plant interactions under changing climate

- To gather basic knowledge about plant interactions in the Arctic we follow cushion plant *Silene acaulis* at Svalbard, Spitsbergen



Plant interactions under changing climate

- We aim to answer the following questions:
- **What interactions with cushion plants occur at high Arctic sites?**
 - Both species and functional trait approaches
- **What are possible abiotic drivers?**
- **How this pattern changes under warmer climate?**
- **Is there any cost of facilitation?**



Manipulative experiment - design

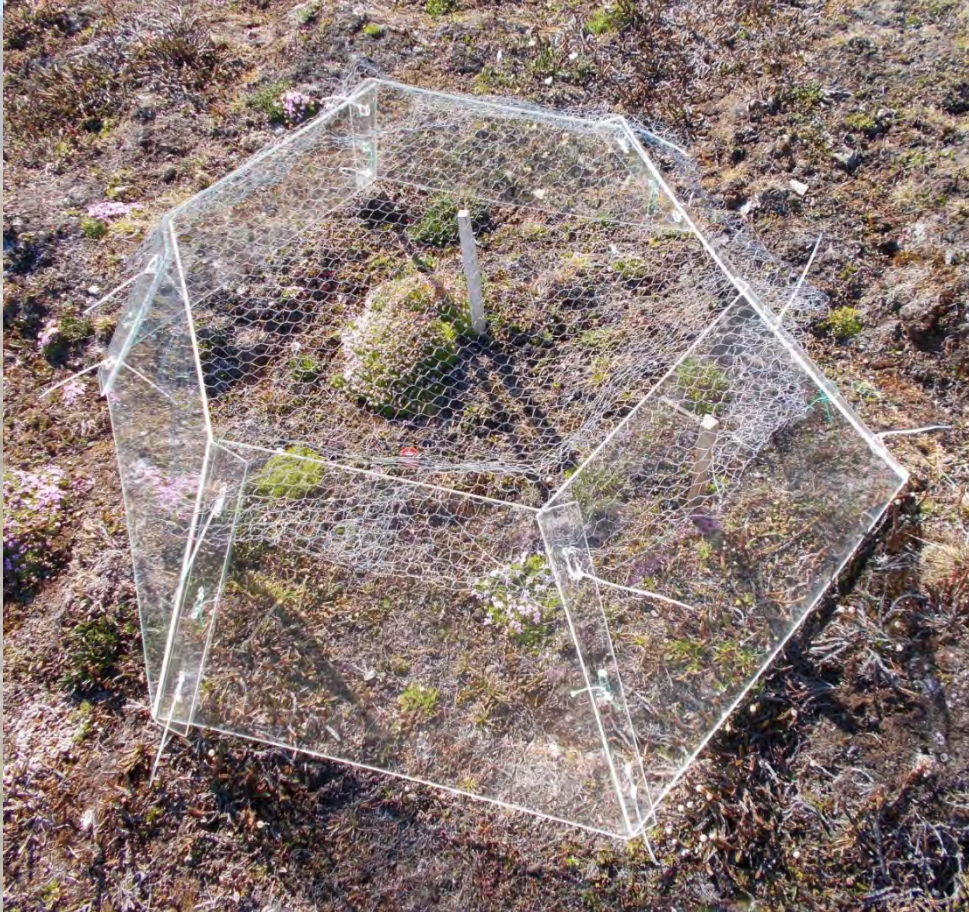
- Two nearby locations
- Three treatments – OTC (with herbivore exclusion); Cage for exclusion of herbivores; Control (CTRL)
 - Herbivores to be excluded: Ptarmigan (*Lagopus muta hyperborea*), Goose (*Anser brachyrhynchus*), Reindeer (*Rangifer tarandus platyrhynchus*)
- 15 replicates



Study area



Treatment effect: OTCs and CAGEs

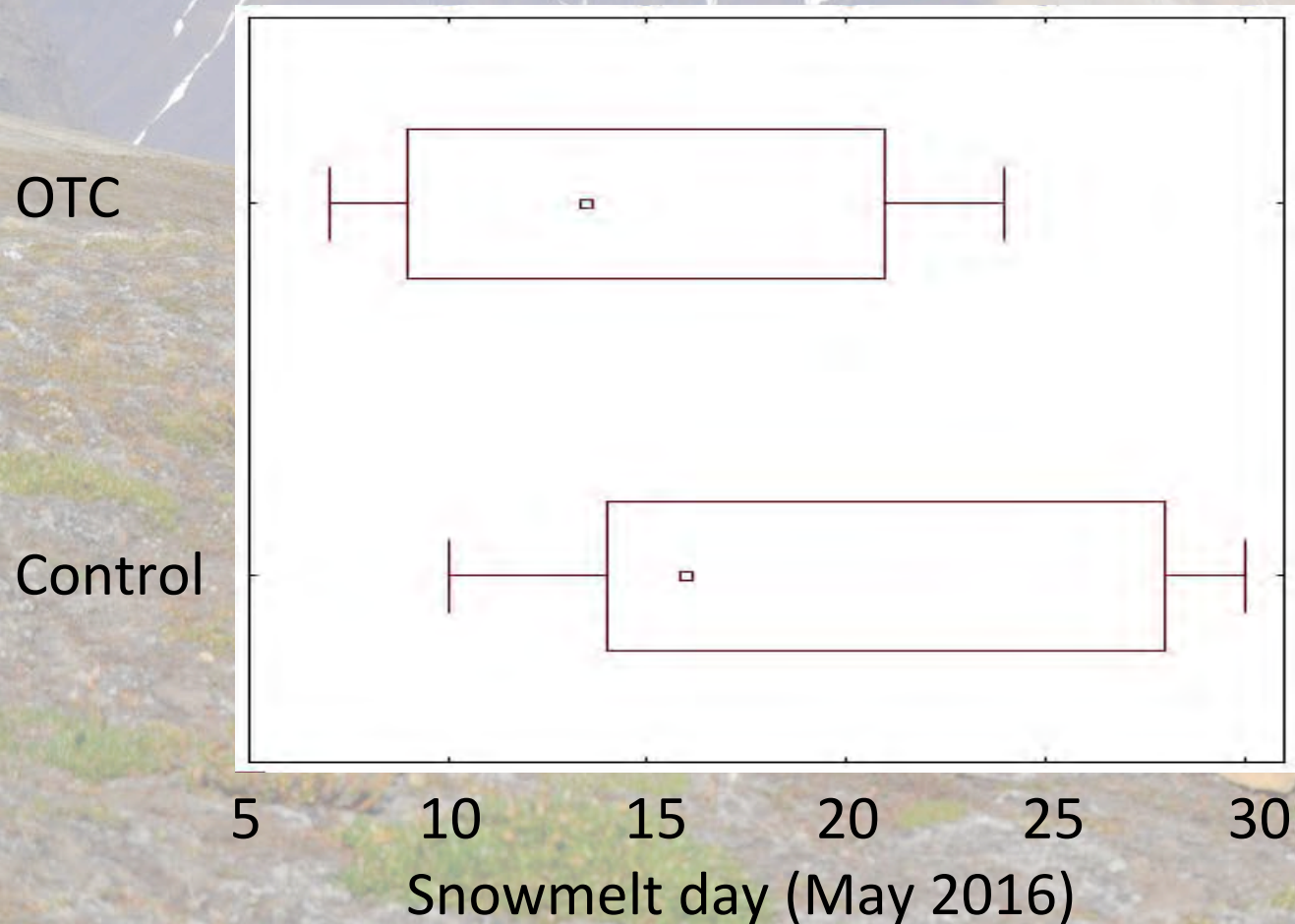


- Installed (July 2015):
- The difference between the OTC and Control

**Temperature increase average
(growing season of 2015): 0,57 °C**

Treatment effect: Snowmelt

- In OTC 2.5 days earlier snowmelt

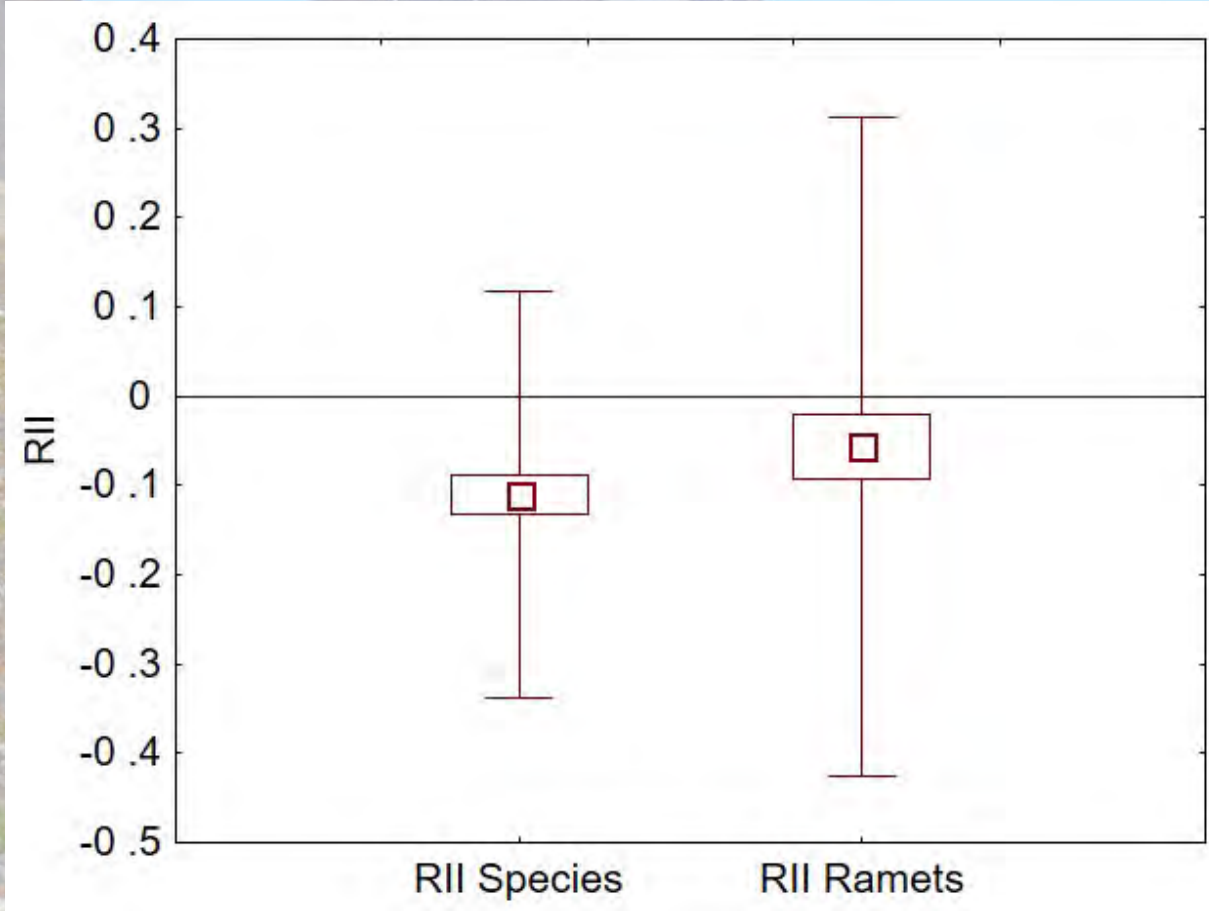


Interaction estimate: Relative interaction index⁽¹⁾



(1) Armas et al. 2004, Ecology

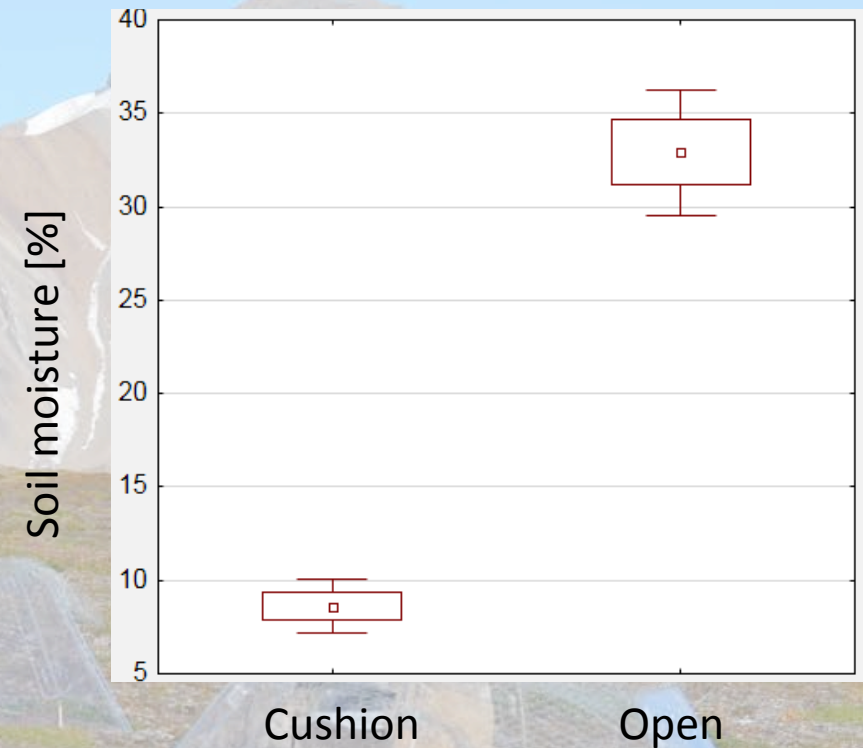
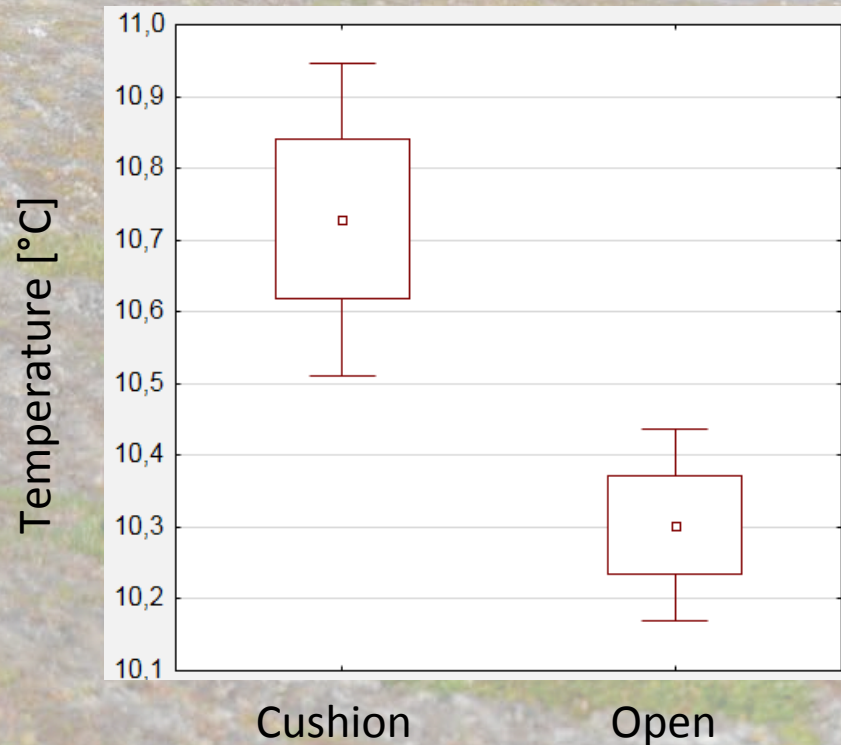
Relative interaction index⁽¹⁾



- No difference between inside **cushion versus open areas** (for both species richness or ramet density)
- Tendency to have more negative RII in cushions, i.e. overall **competitive interactions**

Physical parameters

- Temperature higher (at least in one location) in cushions regardless of treatment



- Moisture lower in cushions regardless of treatment

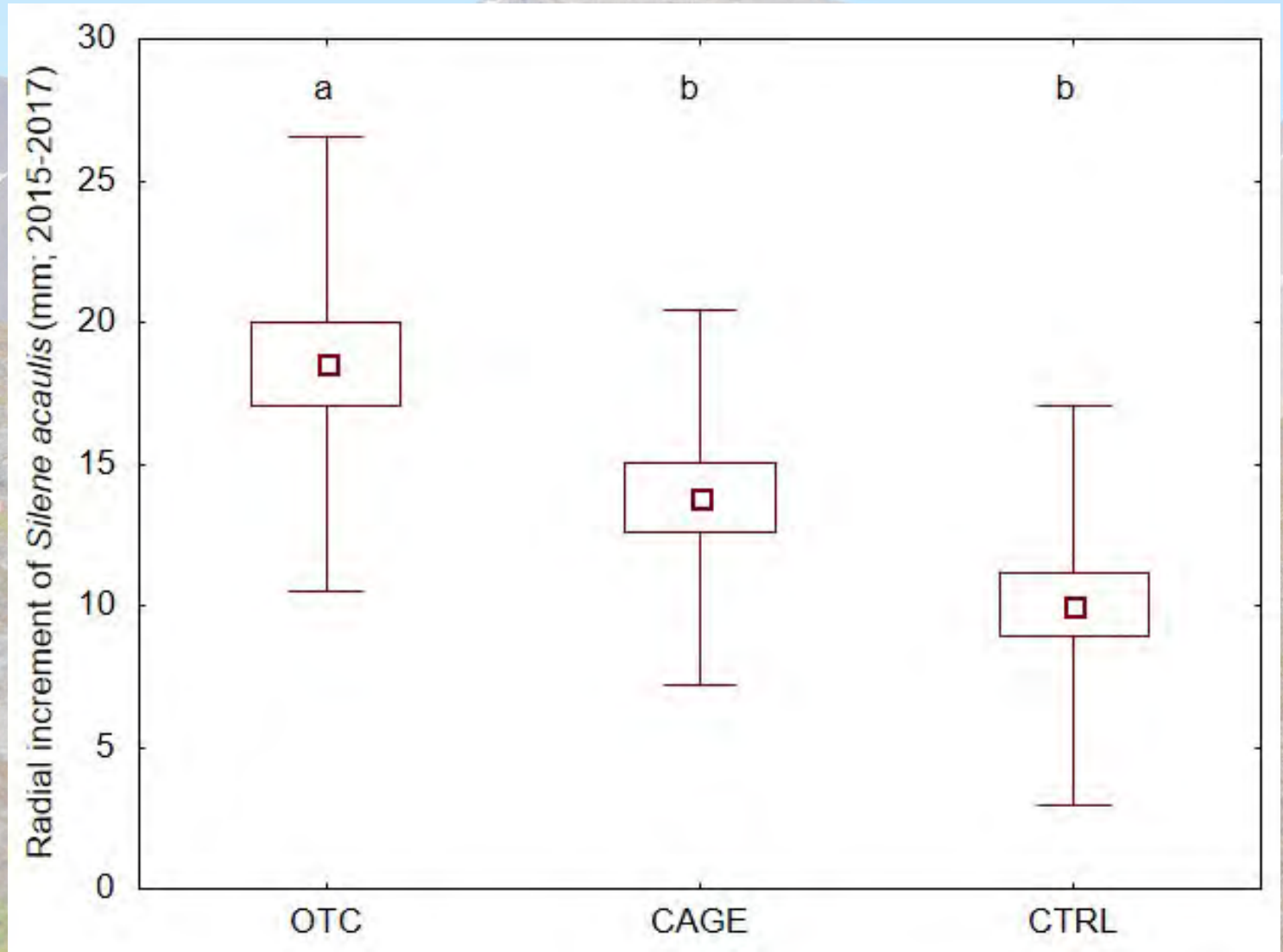
Monitored cushion performances

- Cushion diameter
 - To know how cushions grow inside and outside of OTC



Silene acaulis cushion diameter

- Clear effect of warming
- Close to significant effect of herbivore exclusion



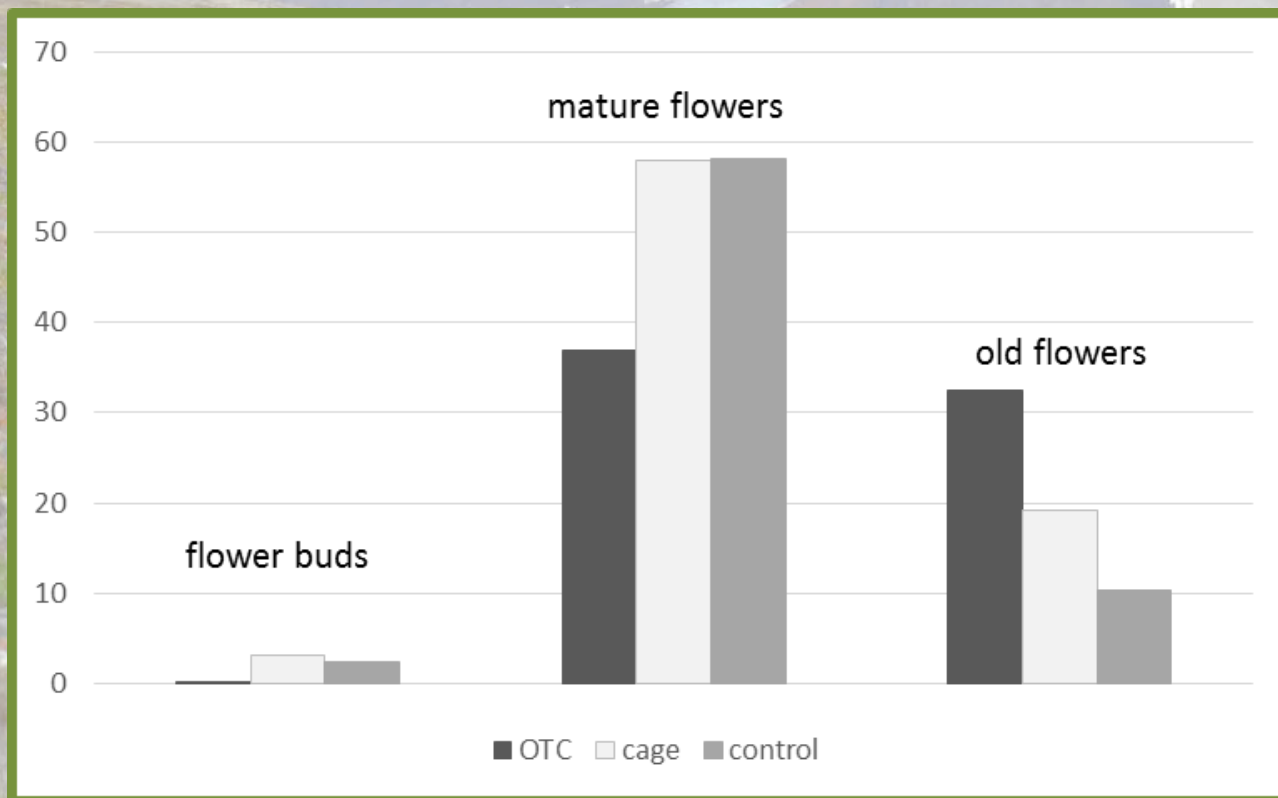
Monitored cushion performances

- Cushion diameter
 - To know how cushions grow inside and outside of OTC
- Reproductive effort
 - To see shifts in flowering pattern (season) inside and outside of OTC
 - Calculate COF



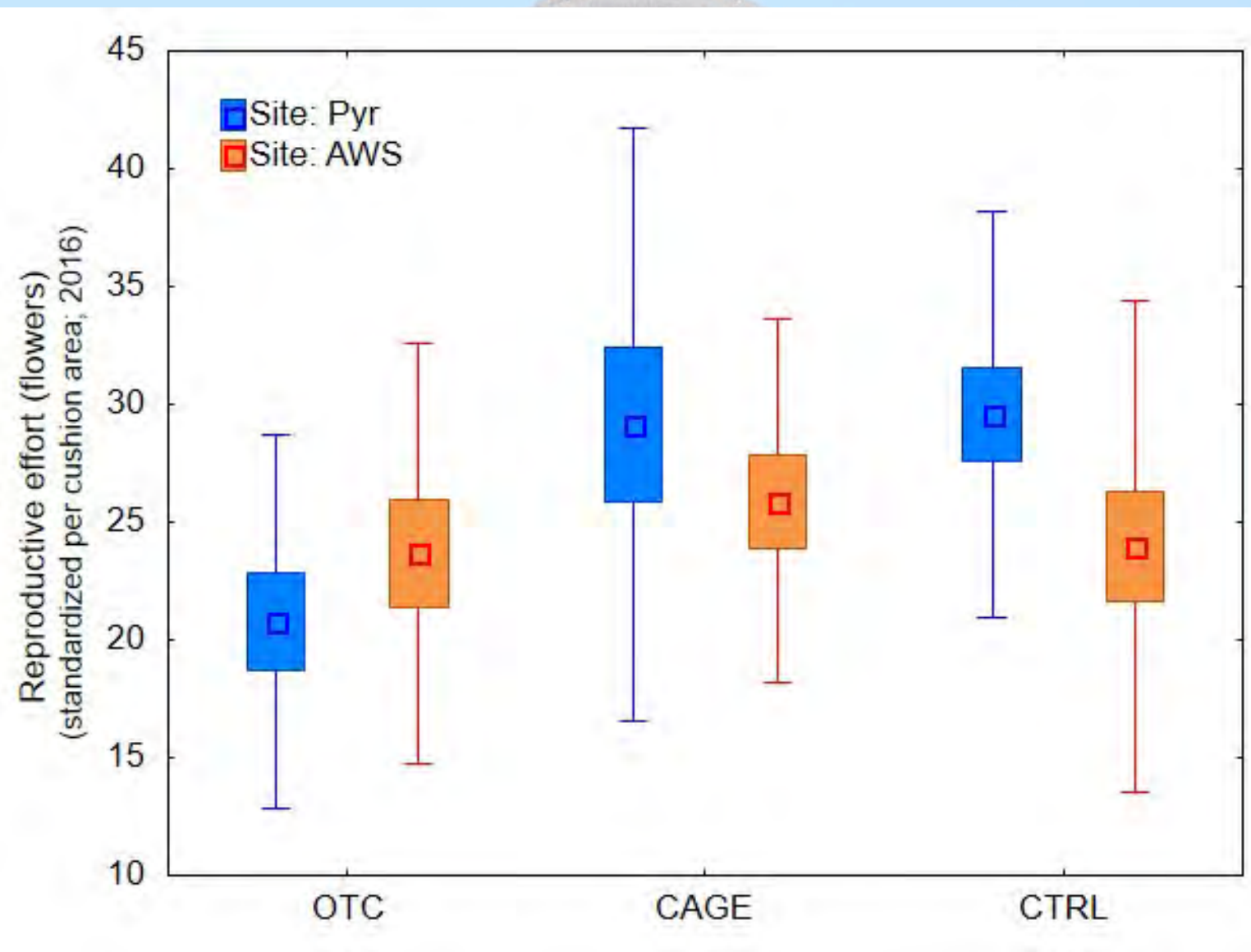
Reproductive effort

- Phenology shift in OTCs



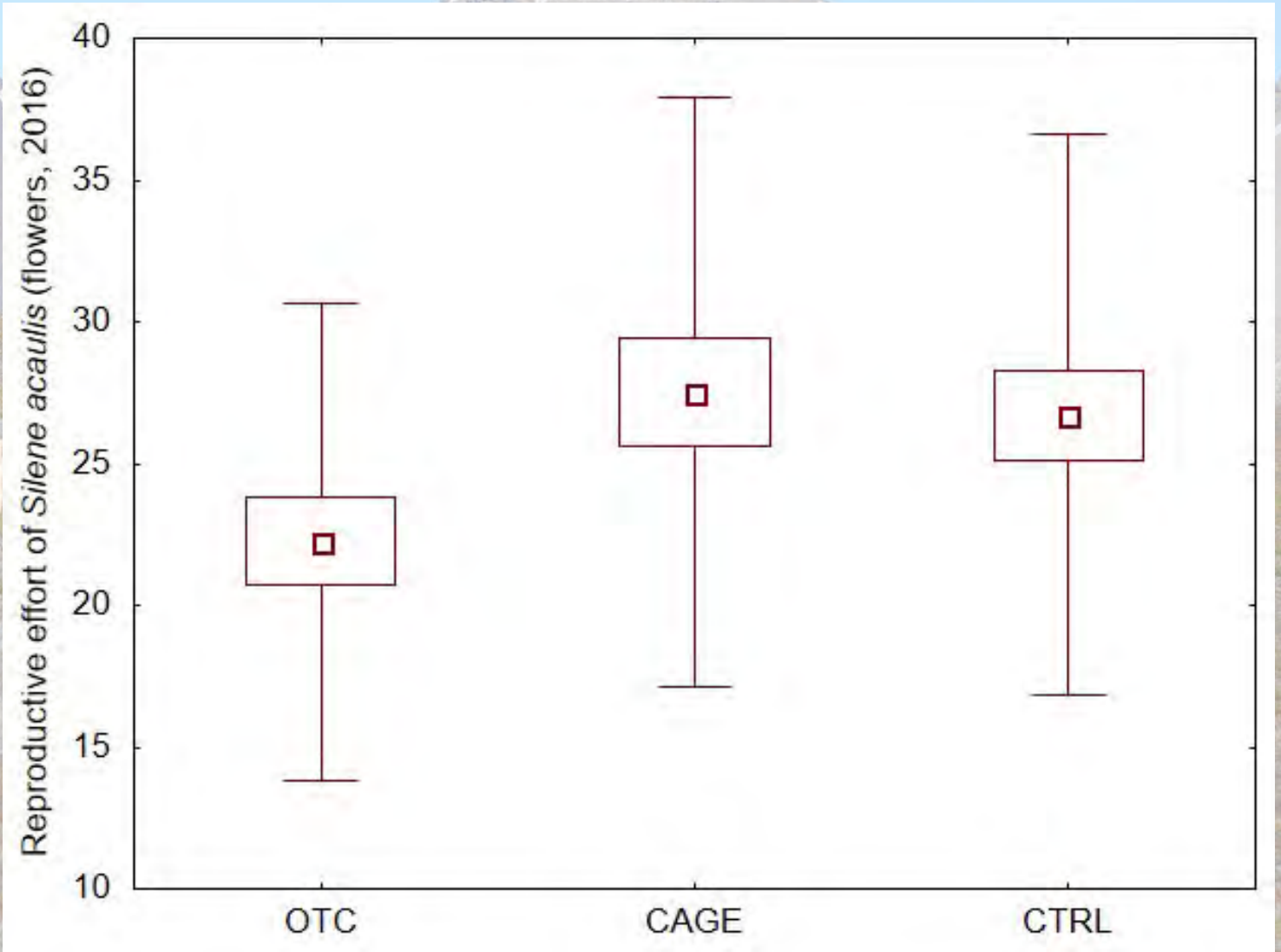
Reproductive effort

- Differences between sites



Reproductive effort

- Differences between sites
- Still tendency of lower reproduction in OTCs
 - = greater COF under warmer climate?

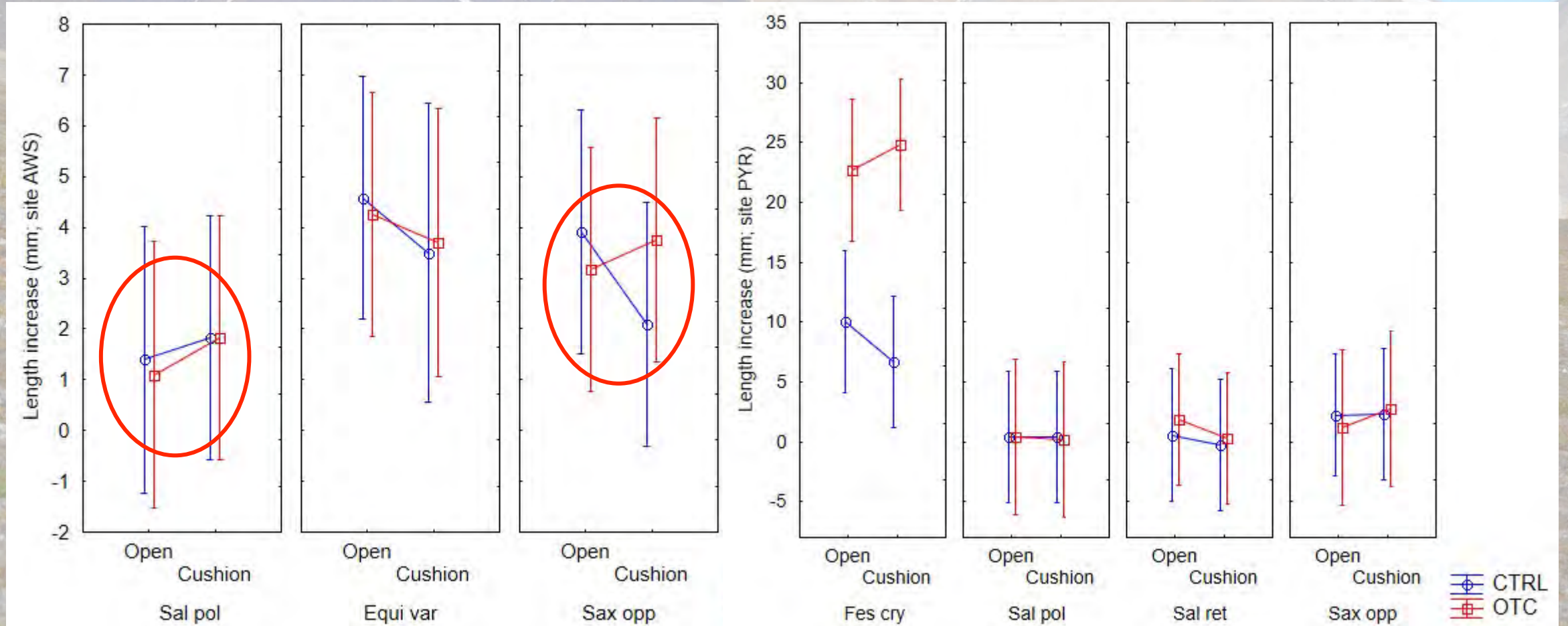


Recorded traits

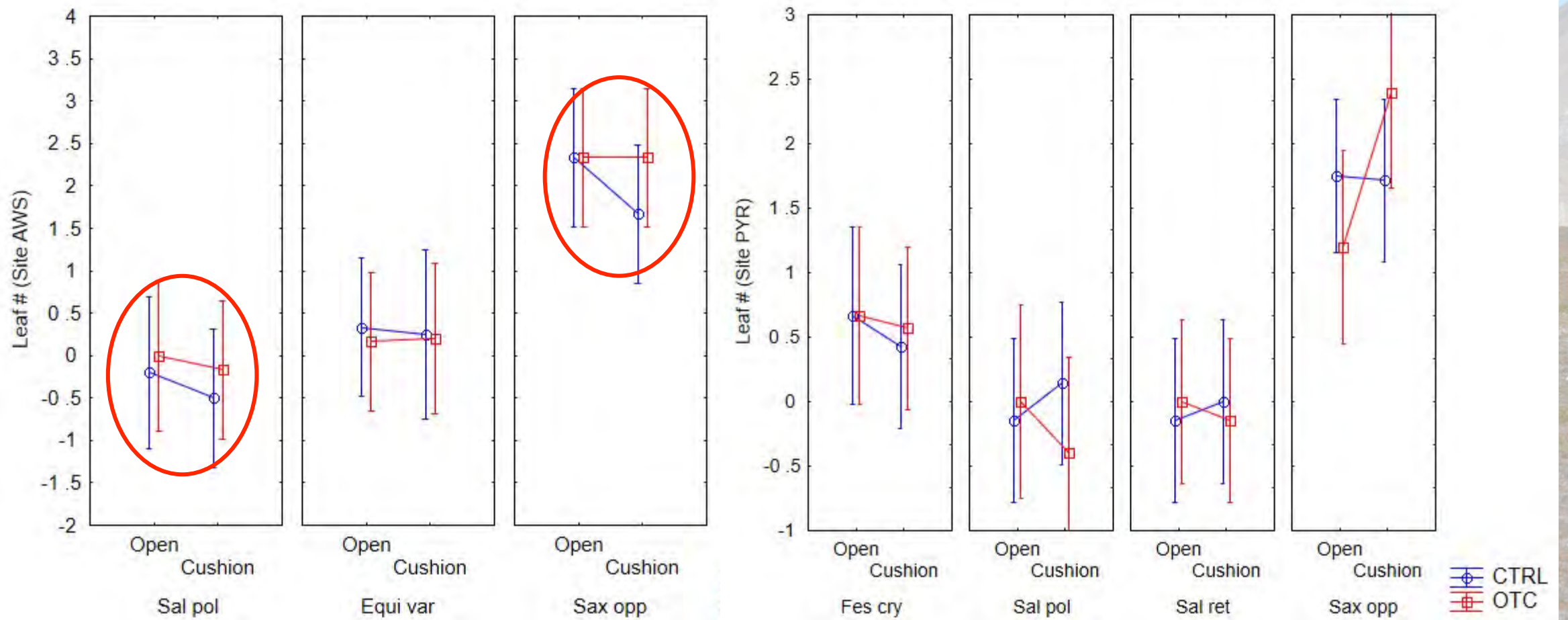
- Growth of other (beneficiary) species (RGR)
 - To know wheather the plants grow faster inside or outside the cushion / inside OTC or in control plots



RGR stem length



RGR leaf number



Other plant traits at OTC versus Cage level

Trait collected during 2017

- Leaf area
- SLA
- LDMC (dry mass/fresh mass)
 - So far no differences for any species between OTC and Cage
- Vegetative and reproductive height
- Species
 - AWS: *Bistorta vivipara* (**Bisviv**), *Salix polaris* (Salpol), *Saxifraga oppositifolia* (Saxopp), *Silene acaulis* (Silaca)
 - PYR: *Bistorta vivipara* (**Bisviv**), *Oxyria digyna* (Oxydig), *Salix reticulata* (Salret), *Trisetum spicatum* (Trispi)

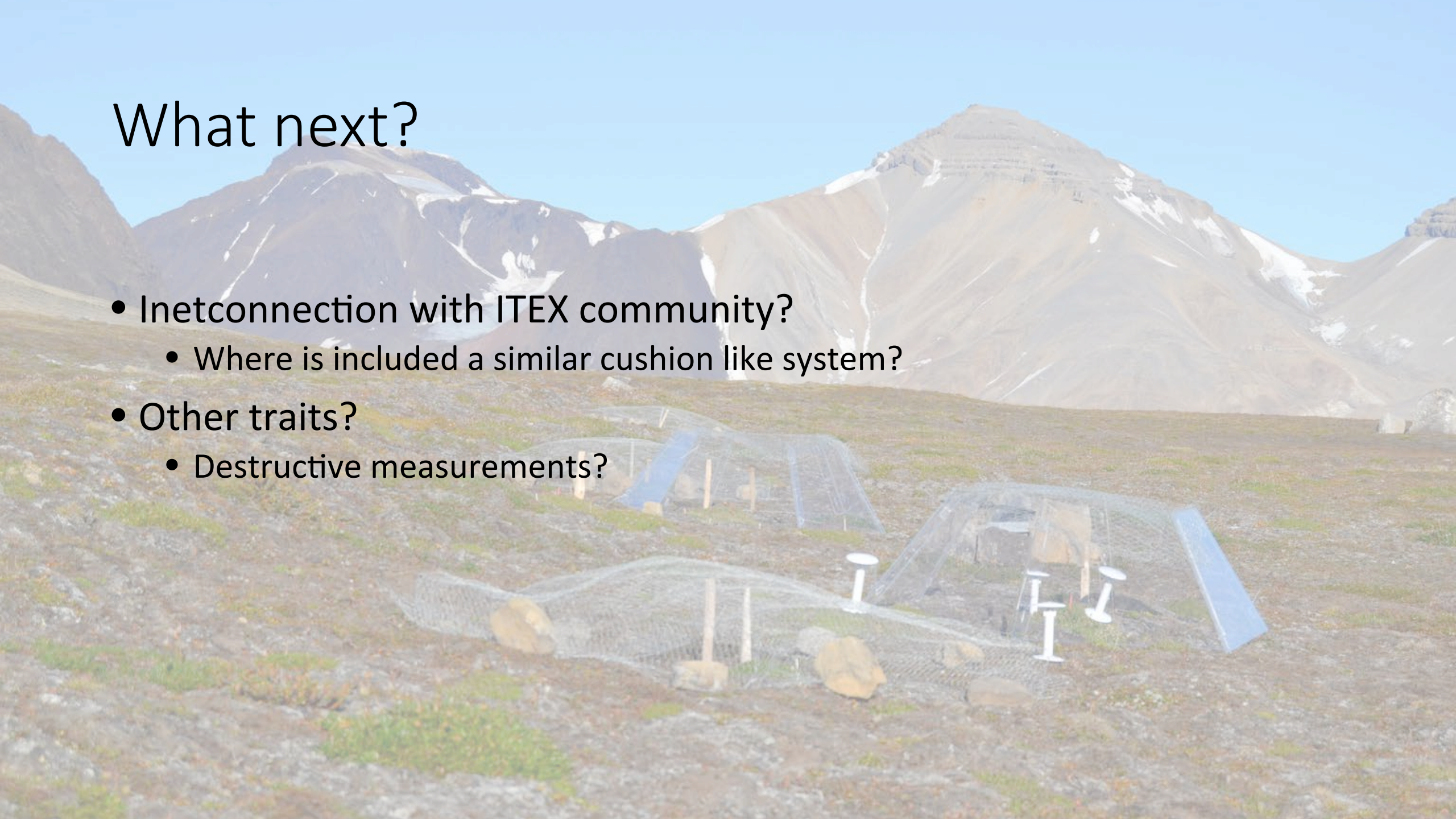
Other characteristics monitored

- Chlorophyll fluorescence (F_v'/F_m')
- Leaf temperatures

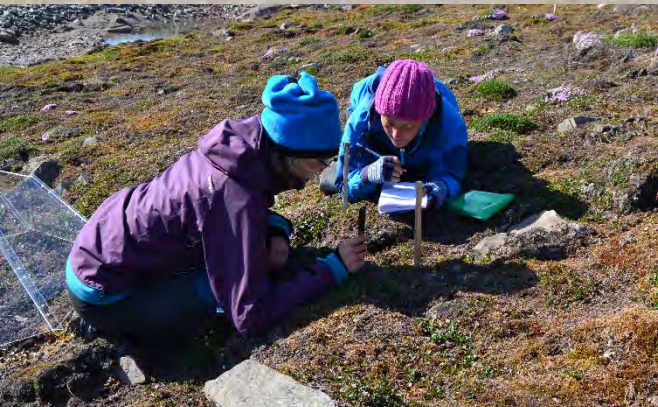
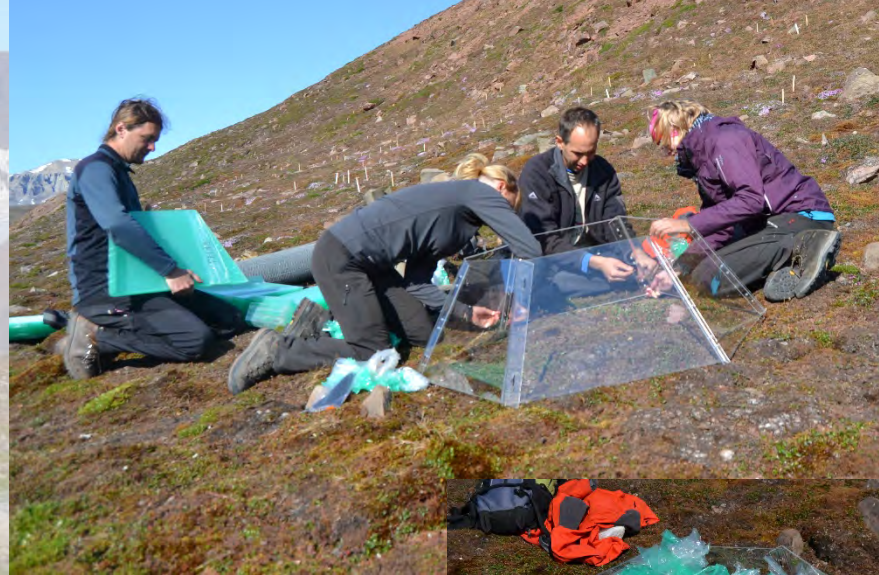


What next?

- Inetconnection with ITEX community?
 - Where is included a similar cushion like system?
- Other traits?
 - Destructive measurements?



Thank you!



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Thanks to all students that participated on establishment of the experiment and field measurements.

