Plant diversity dynamics over space and time in a warming Arctic

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@nanitundra

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What do we picture when we think of the Arctic?

900 bryophyte species

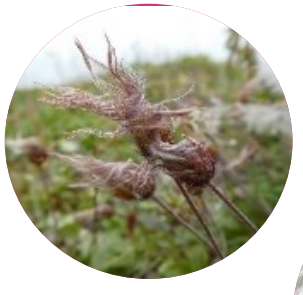
1,750 lichen species

2,200 vascular plant species





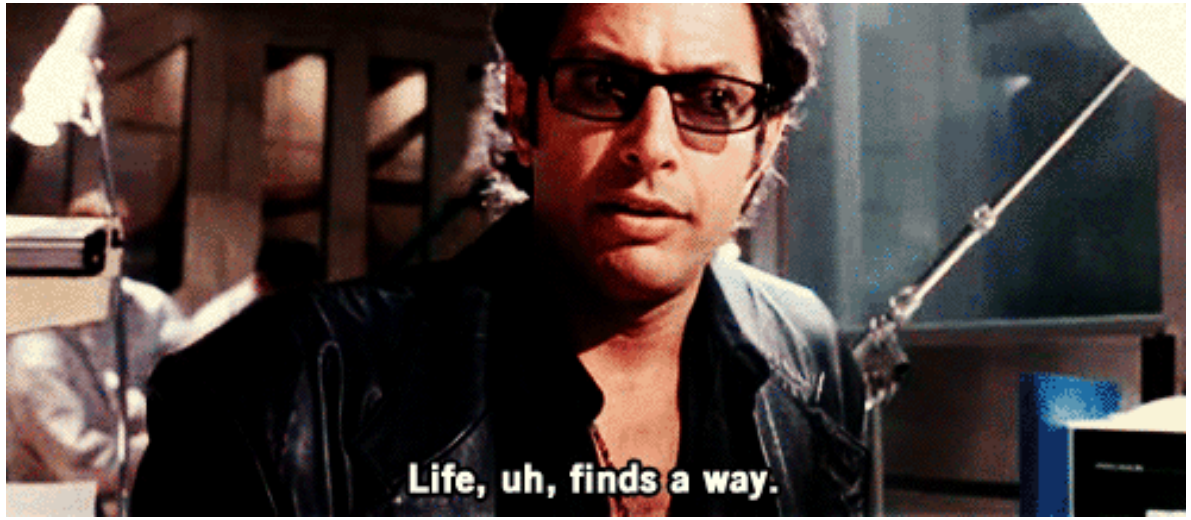




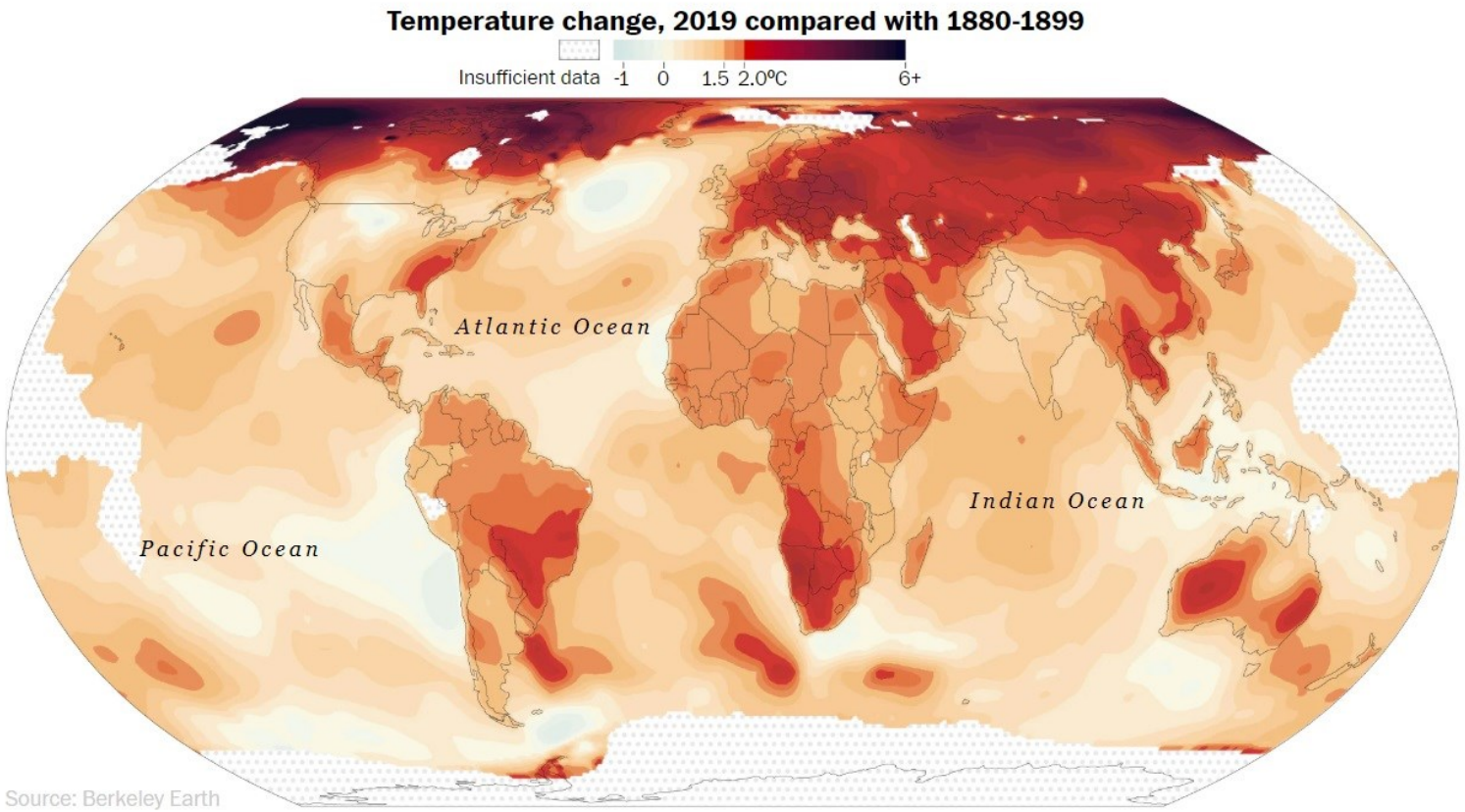


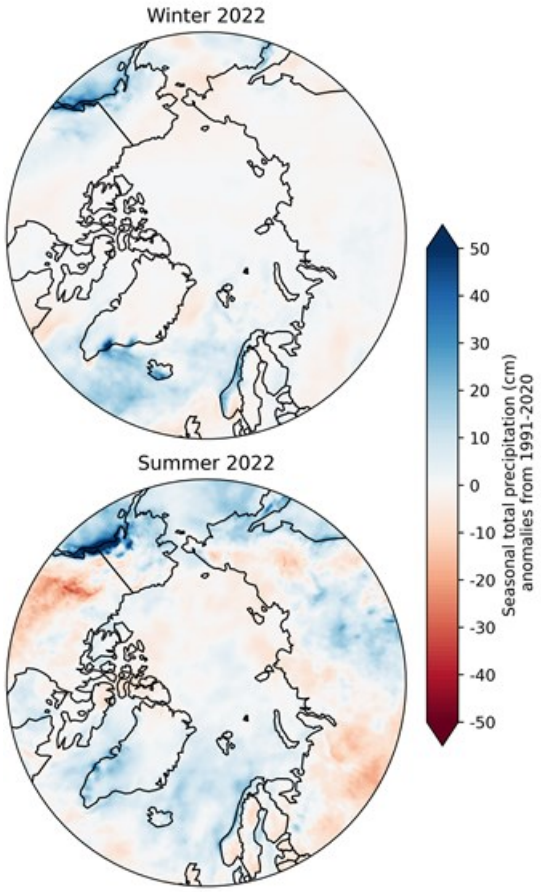


Jeff Goldblum in Jurassic Park (1993)

The Arctic is becoming warmer and wetter





Berkeley Earth, NOAA Arctic Card 2022

Climate impacts on Arctic plants

PLANT COVER

SPECIES RANGES

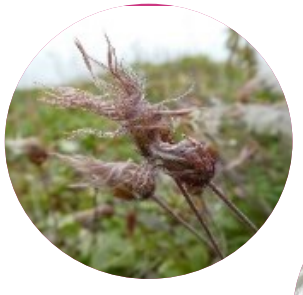
PHENOLOGY

PLANT TRAITS

Plant species are responding differently, which can impact animals and food security

















Research questions

1. How has Arctic vascular plant diversity changed over the past four decades of rapid Arctic warming?

2. Which are the main geographical, climatic and biotic drivers of diversity change?

3. Are Arctic plant communities becoming more homogeneous over time with changes in plant composition?

Methods

INTERNATIONAL TUNDRA EXPERIMENT (ITEX+)

- 42,234 records
- 2,174 plots
- 45 study areas
- 490 species
- 1981-2022

BIODIVERSITY METRICS

Richness	Species gains
Evenness	Persisting species
Turnover	Species losses

CHELSA CLIMATE DATA

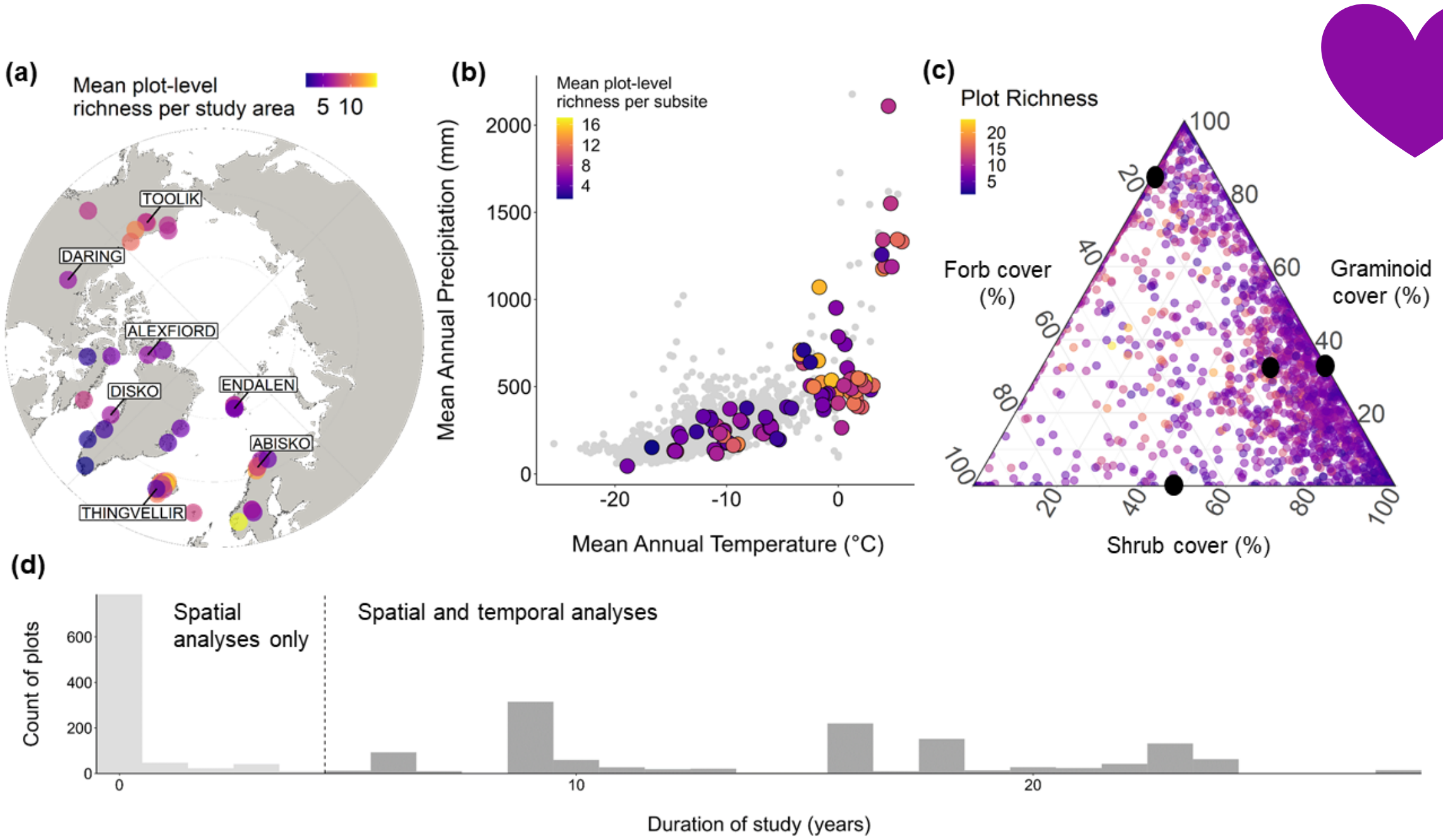
- Mean Summer Temperature
- Mean Annual Precipitation

ANALYSES

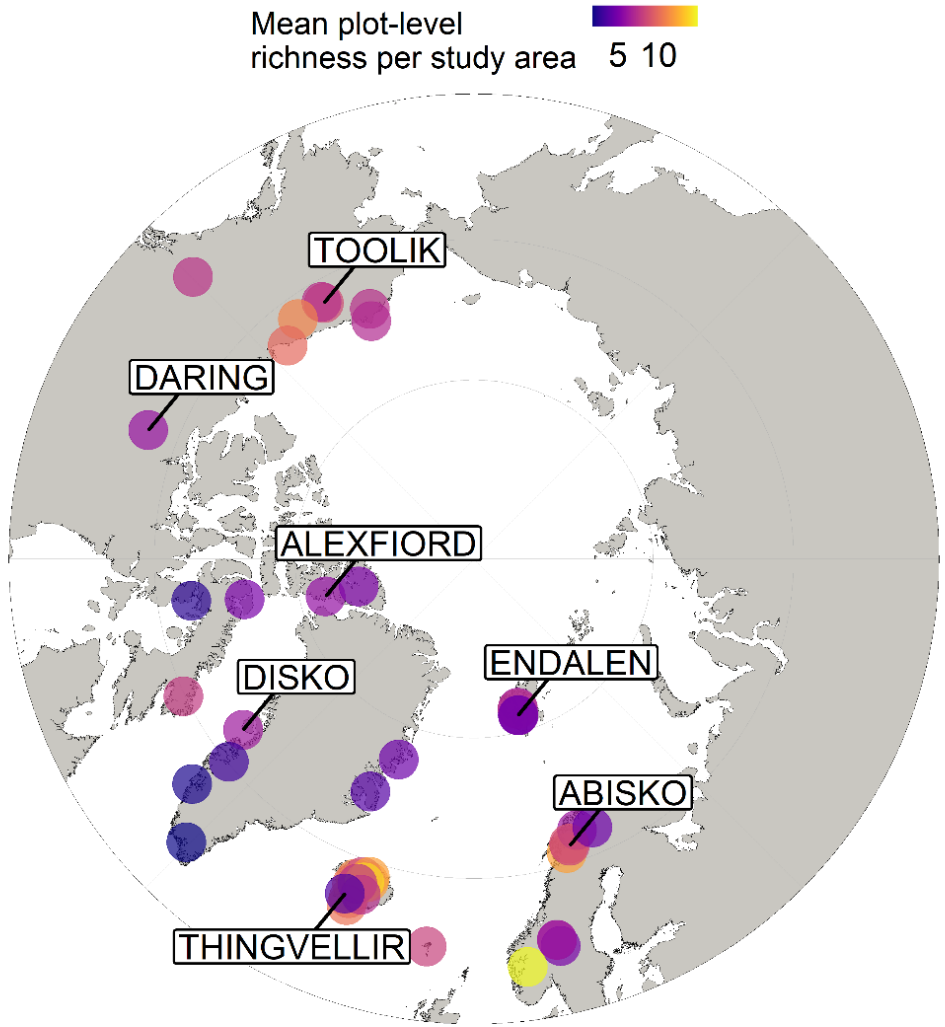
Bayesian hierarchical models

Principal Coordinate Analyses (PCoA)

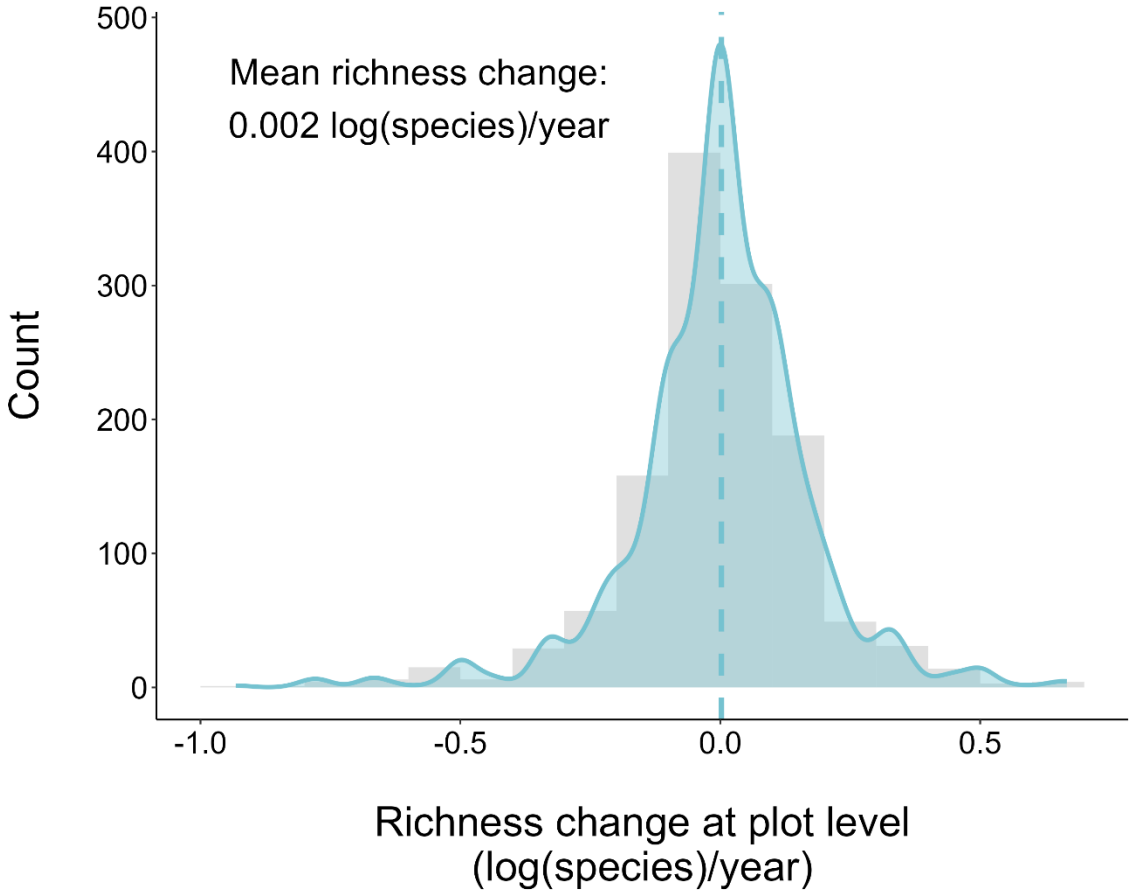
Bjorkman et al. in prep.


(a)
Mean plot-level
richness per study area
5 10
TOOLIK
DARING
ALEXFIORD
DISKO
ENDALEN
ABISKO
THINGVELLIR
(b)
Mean plot-level
richness per subsite
16
12
8
4
Mean Annual Precipitation (mm)
2000
1500
1000
500
0
-20
-10
0
Mean Annual Temperature (°C)
(c)
Plot Richness
20
15
10
5
Forb cover
(%)
Graminoid
cover (%)
Shrub cover (%)
100
80
60
40
20
(d)
Spatial
analyses only
Spatial and temporal analyses
Count of plots
600
400
200
0
0
10
20
Duration of study (years)

Richness across space

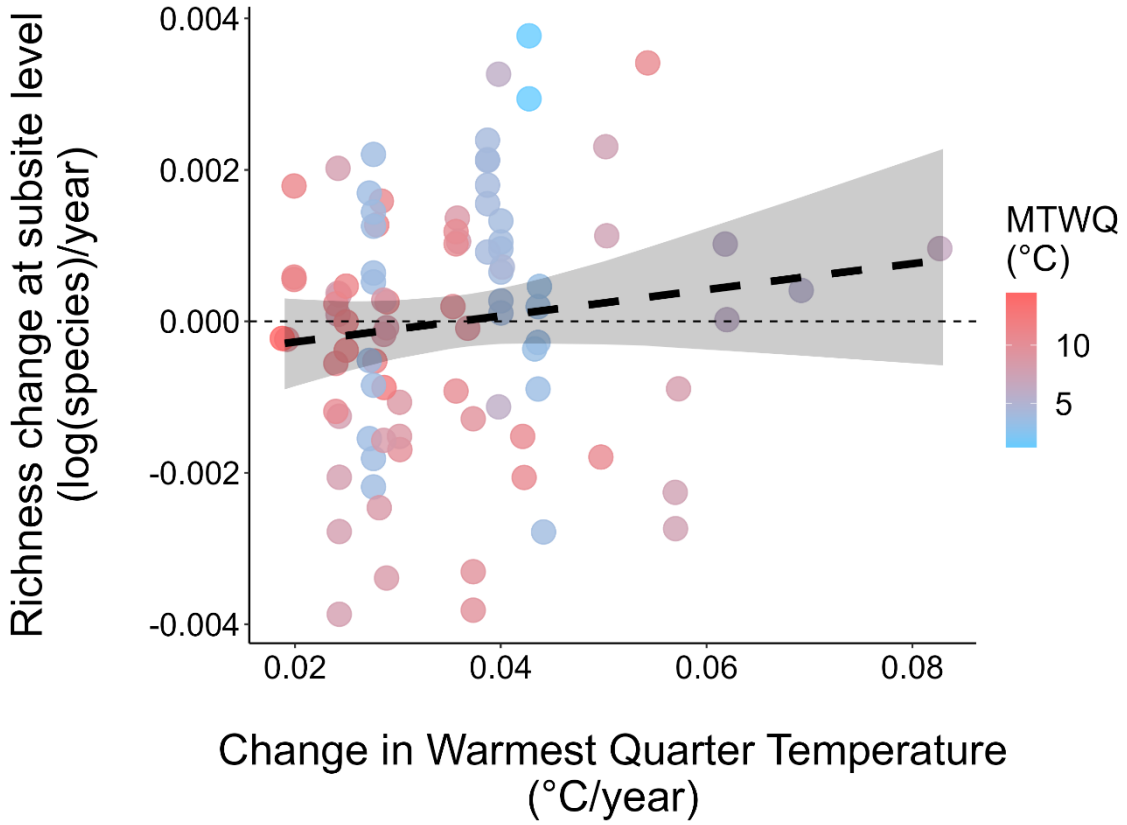


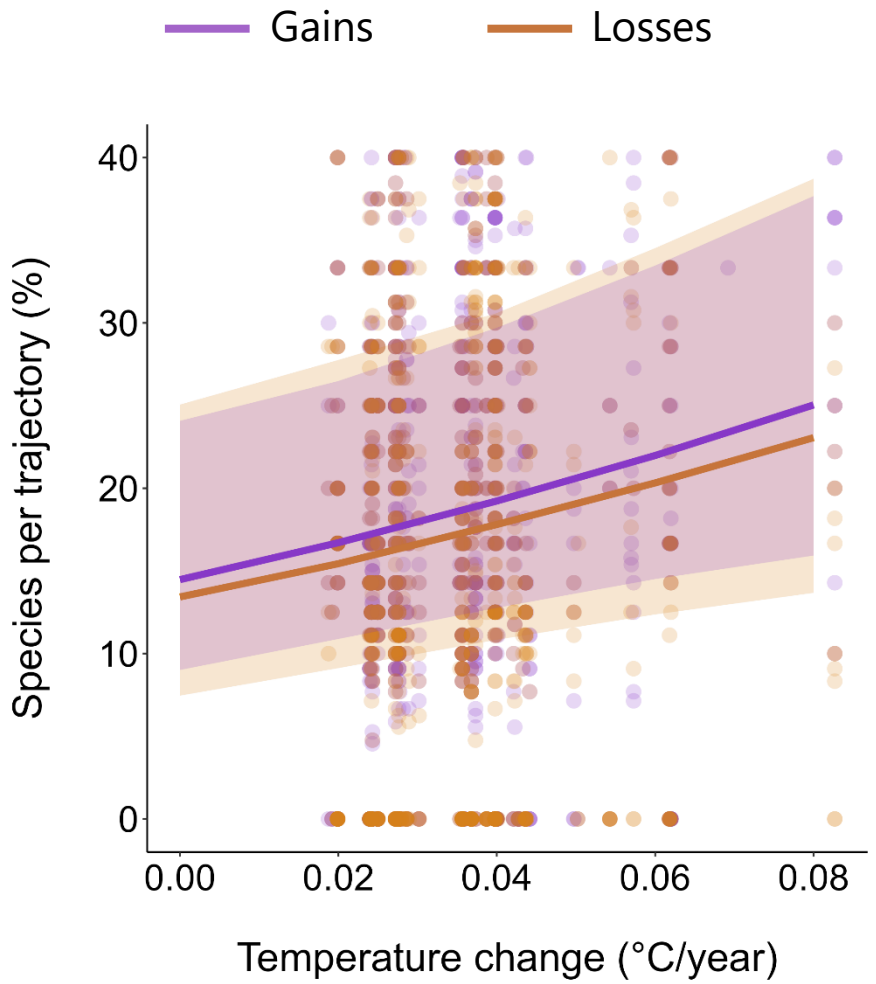
Richness over time



García Criado et al. 2023 *EcoEvoRxiv*, in review at *Nature*

Warming was related to compositional change





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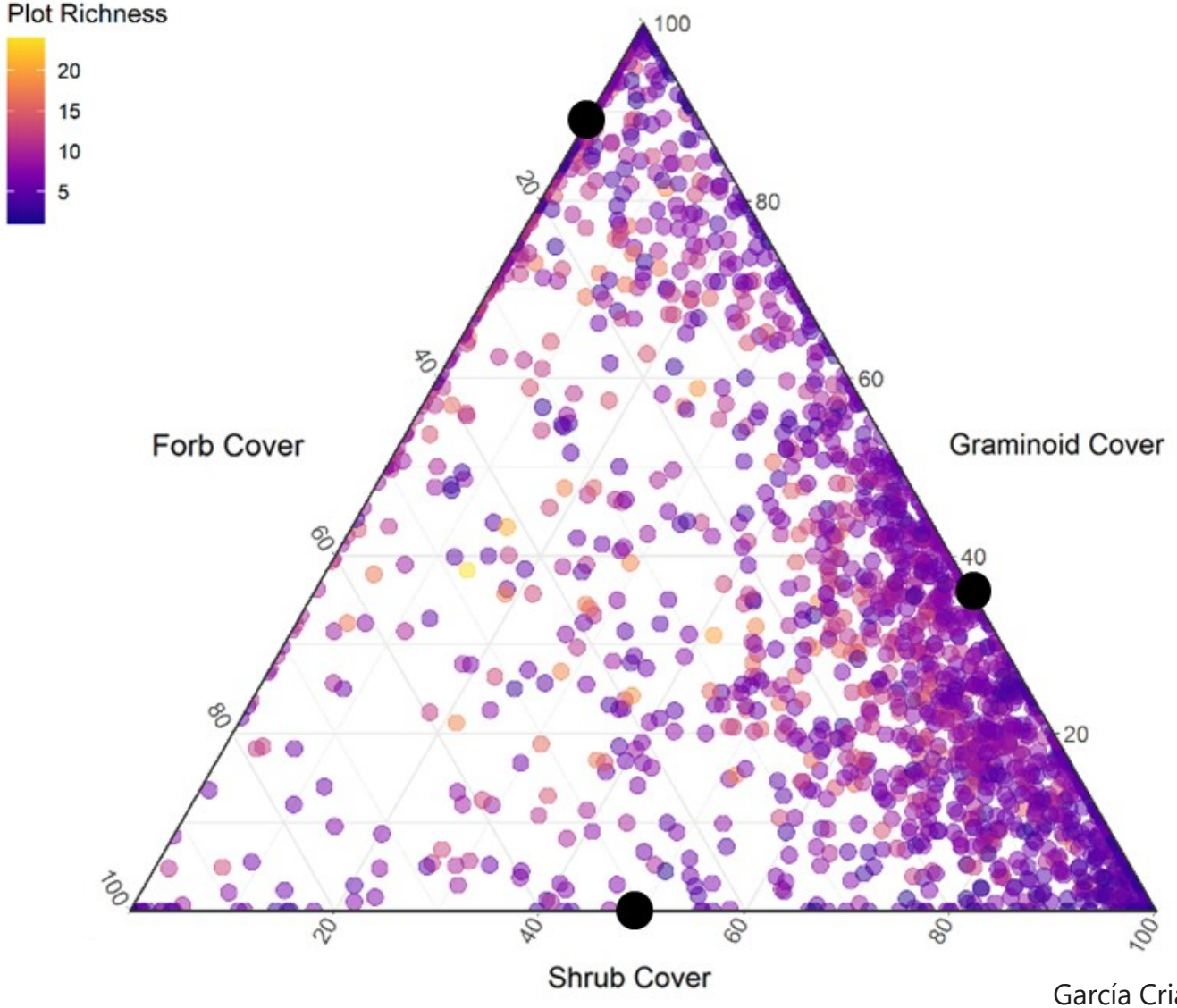
Shrubification



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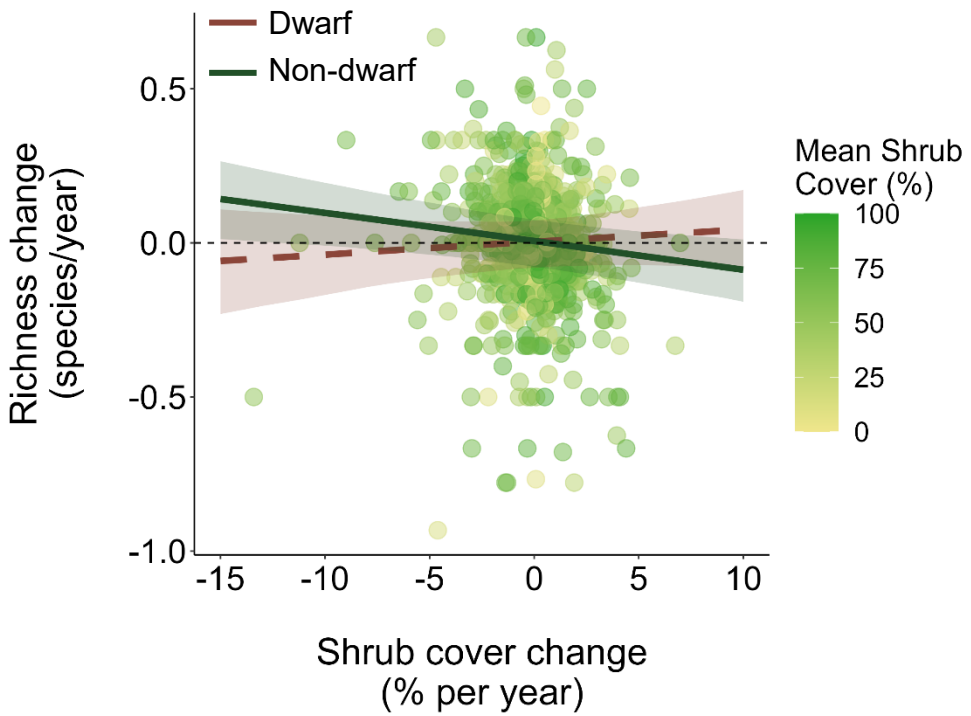
Shrubification



GREATER SHRUB COVER

↓ Evenness

INCREASED SHRUB COVER

↑ Species losses

↓ Richness over time

↓ Evenness over time

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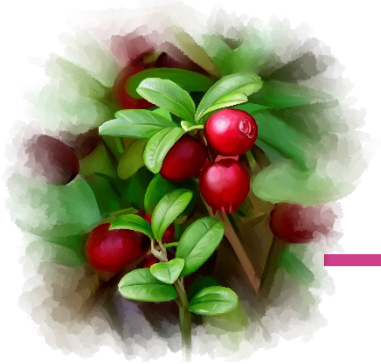
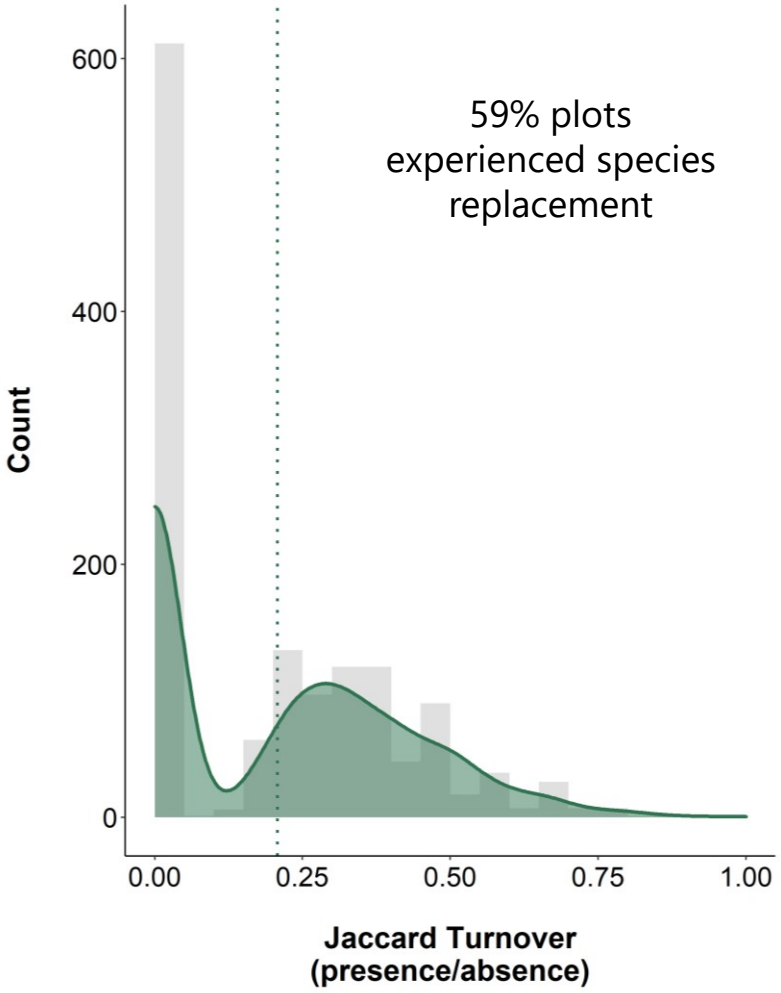
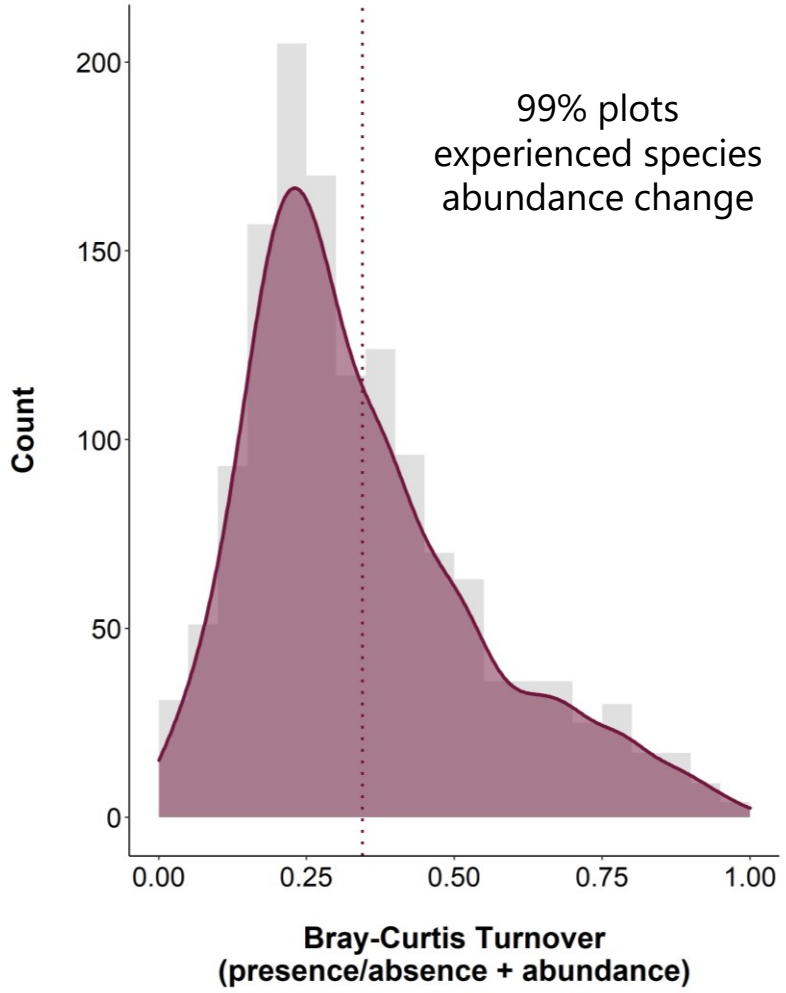


Temporal turnover

0.22





0.36

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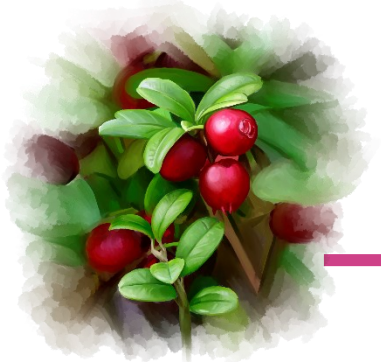
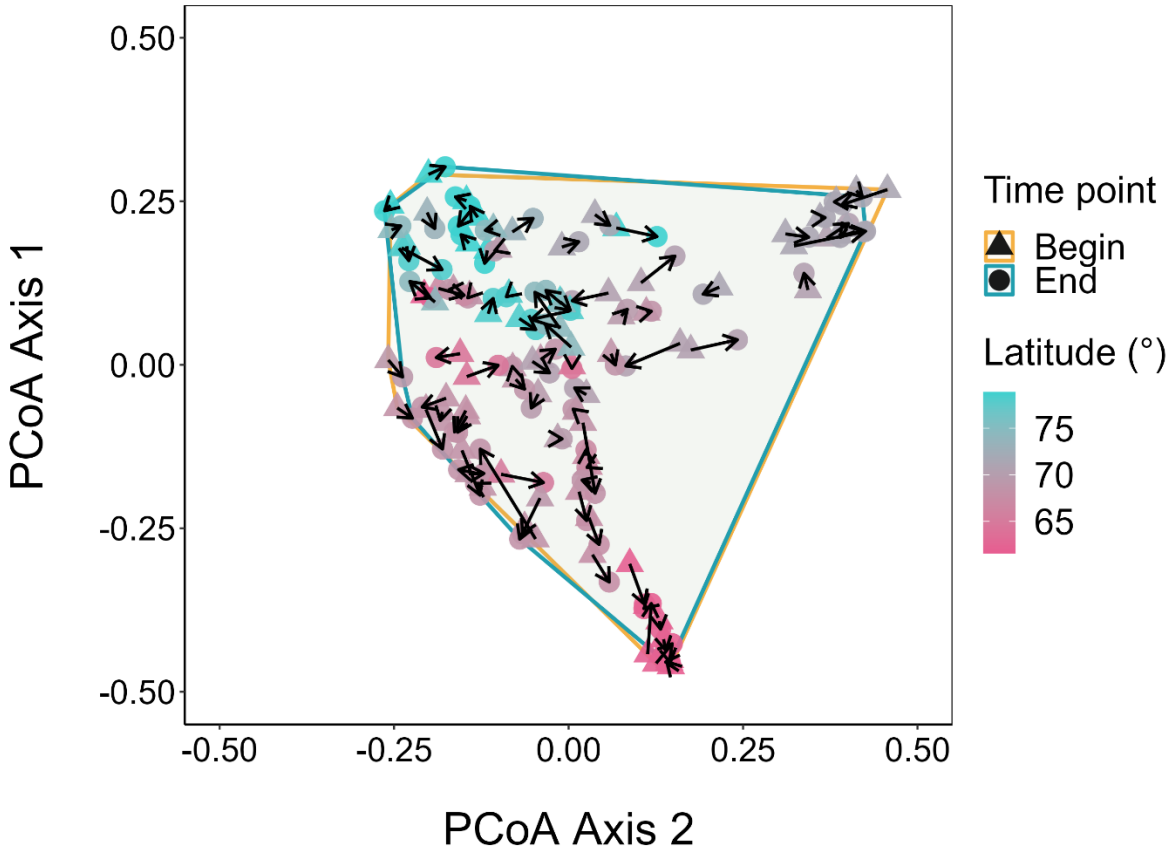


No homogenization

Jaccard
(presence/absence turnover)



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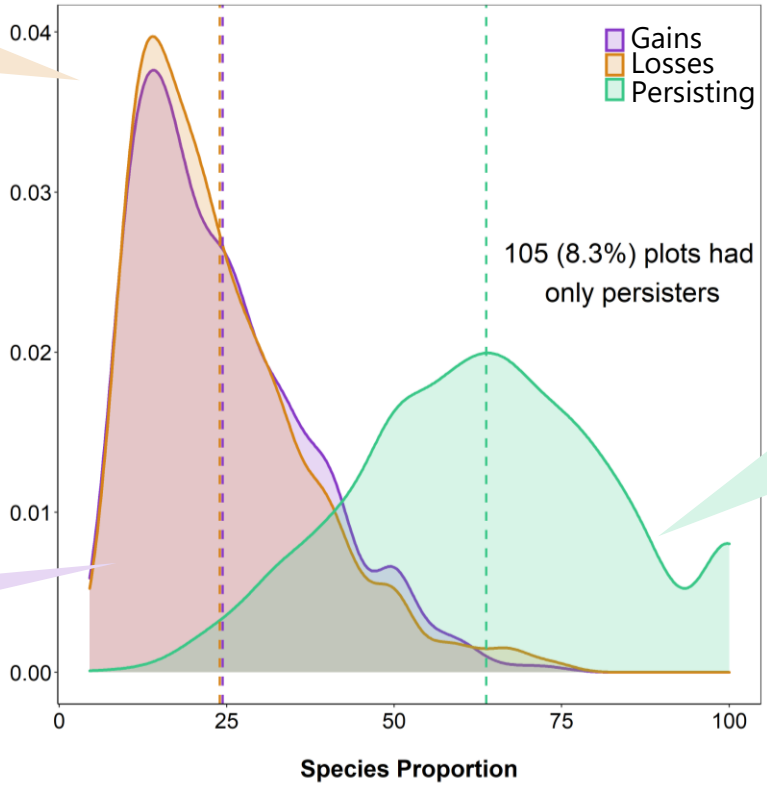
Resistance to change

LOSSES

Saxifraga cernua

GAINS

Carex bigelowii



PERSISTING

Betula nana

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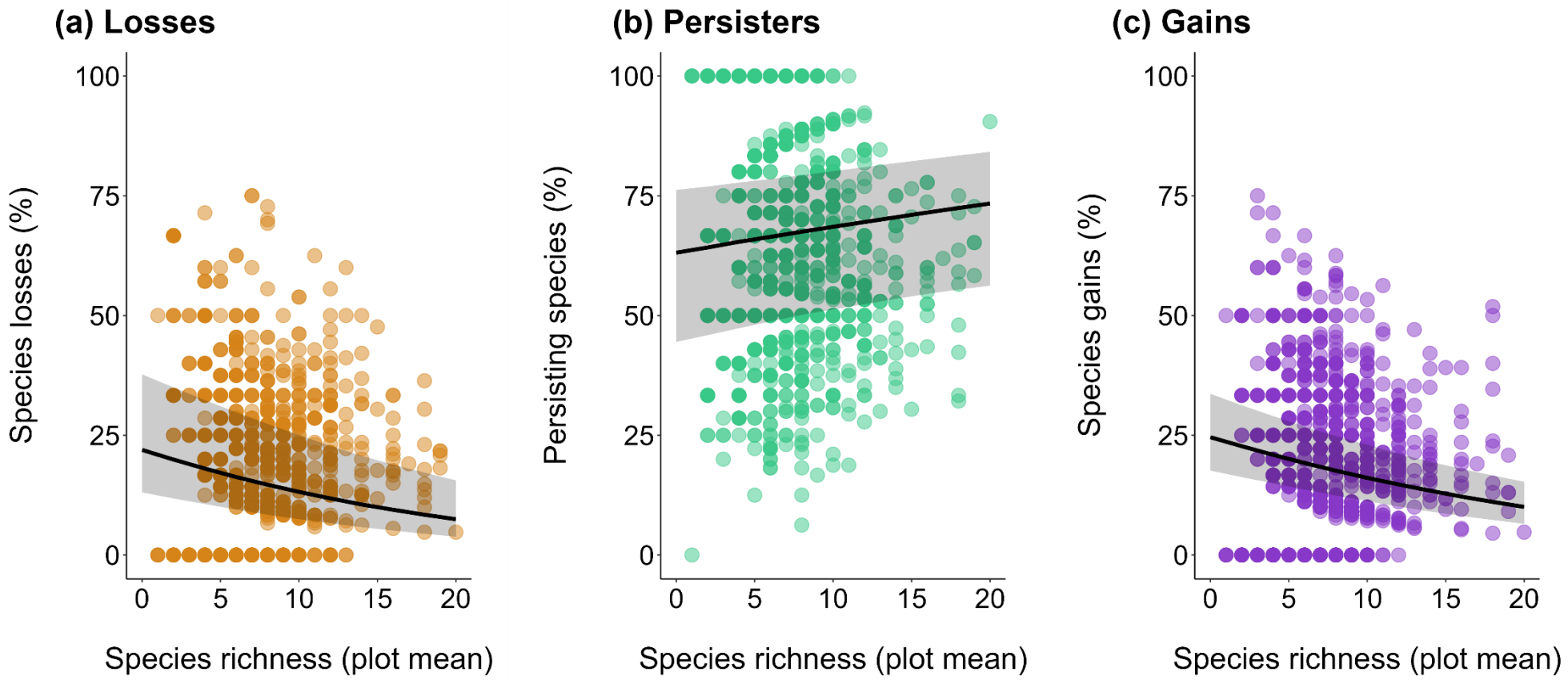
Resistance to change

Plant communities that are more species-rich and more even are more resistant to change



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No consistent trend of richness change over time, reflecting a strong influence of site idiosyncrasy and a variety of processes.

Both warming and shrubification are driving community richness and species trajectories.

Take-away message:

Contrasting richness trends but widespread compositional change in Arctic vascular plants.

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