Warming up the Arctic

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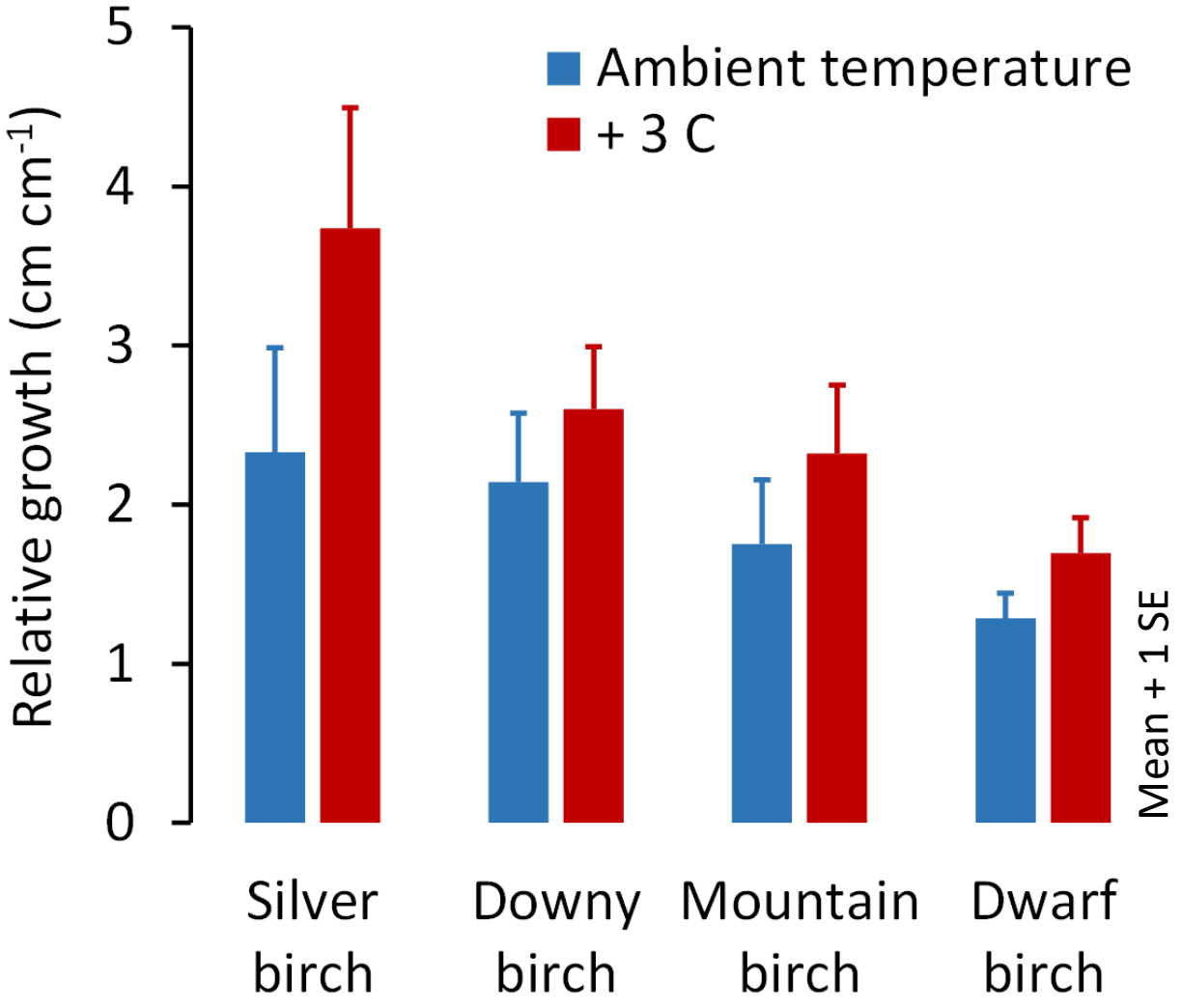
BETUMICS – what was it all about?

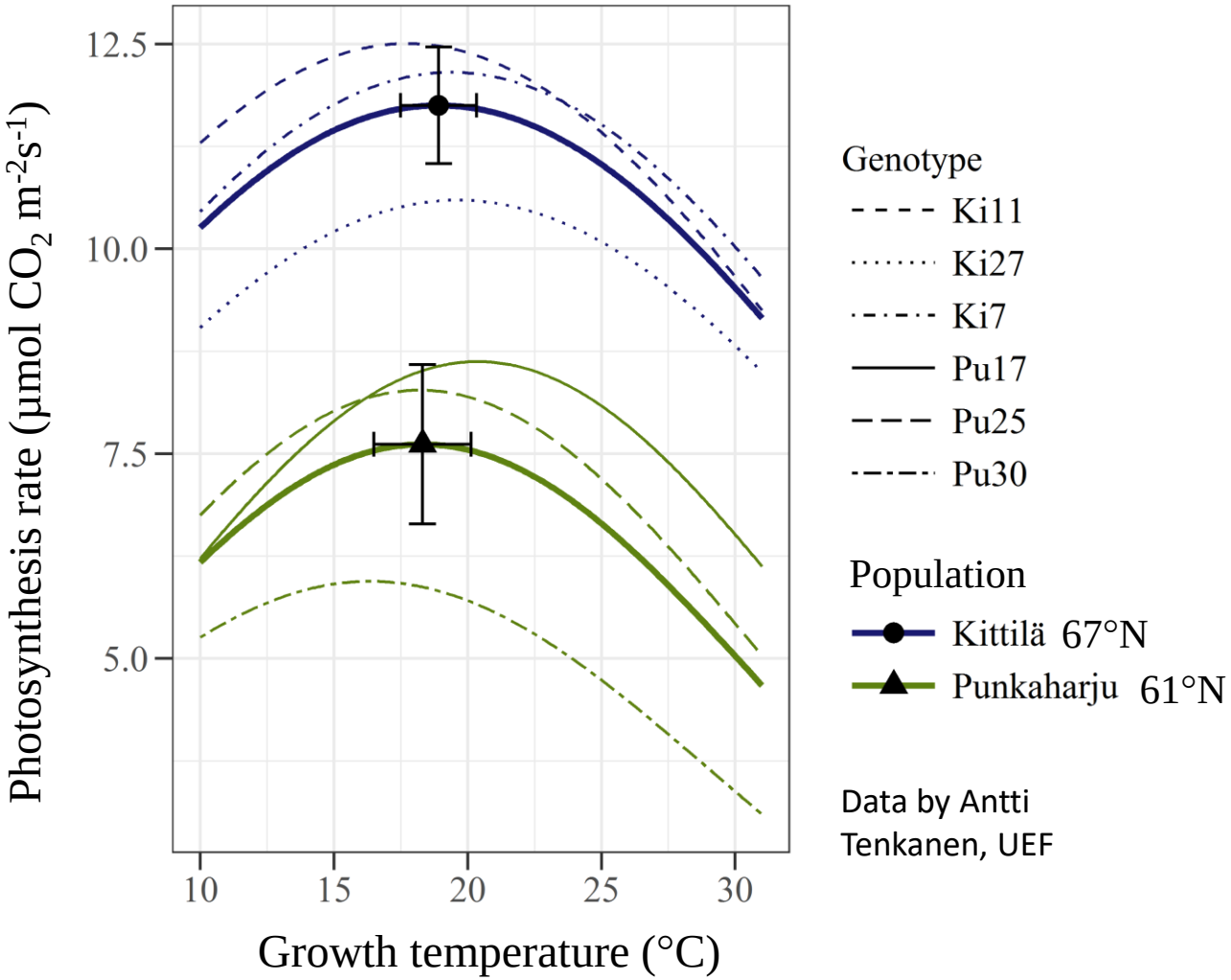
- **Birches** (*Betula*) are abundant in many ecosystems in boreal and Subarctic climate zones > let's focus on their responses to climate warming!
- **Growth chamber experiments** to reveal "northern *Betula* traits" (e.g. Punkaharju 61°N vs. Kittilä 67°N)
- **Reciprocal transfer of populations** (among Florence 43°N, Punkaharju 61°N and Kolari 67°N) to estimate the ultimate boundaries of *Betula* acclimation capacity
- **A field experiment** at the Kevo Subarctic Research Station (Utsjoki 69°N) to study responses of northern *Betula* populations and Subarctic mountain birch forest ecosystem to climate warming

Kevo warming experiment

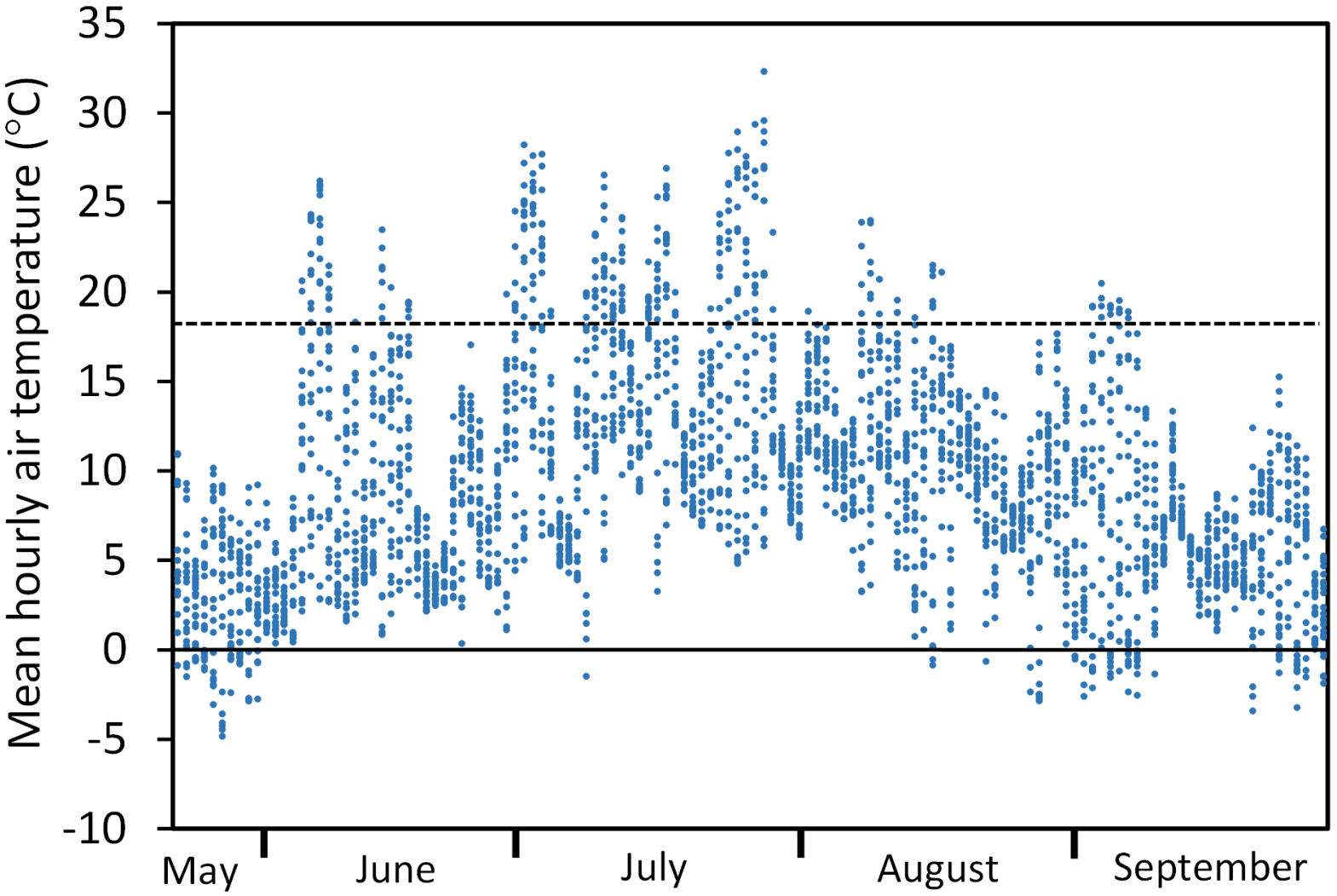
- twenty field plots, with a **2×2 factorial set-up** consisting of warming and herbivory treatments (n = 5)
  - plots with **ambient vs. + 3 °C "leaf" temperature** (infrared heaters)
  - plots with **normal vs. reduced insect herbivory** (weekly insecticide sprayings)
- **cloned offspring of northern *Betula* populations** planted on each plot

In field plots, all *Betula* species had positive responses to warming, with **growth rates increasing by 20–60%.**



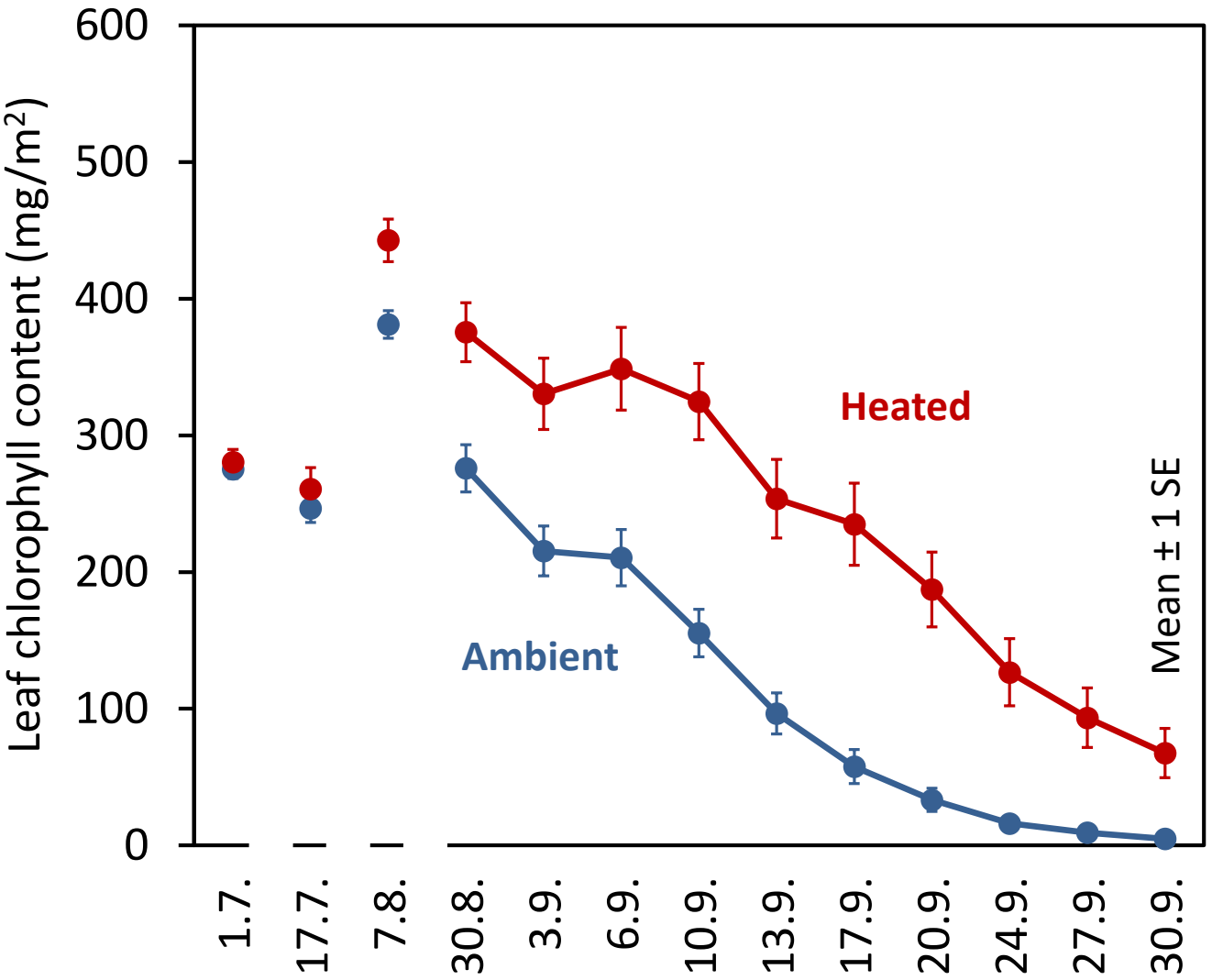


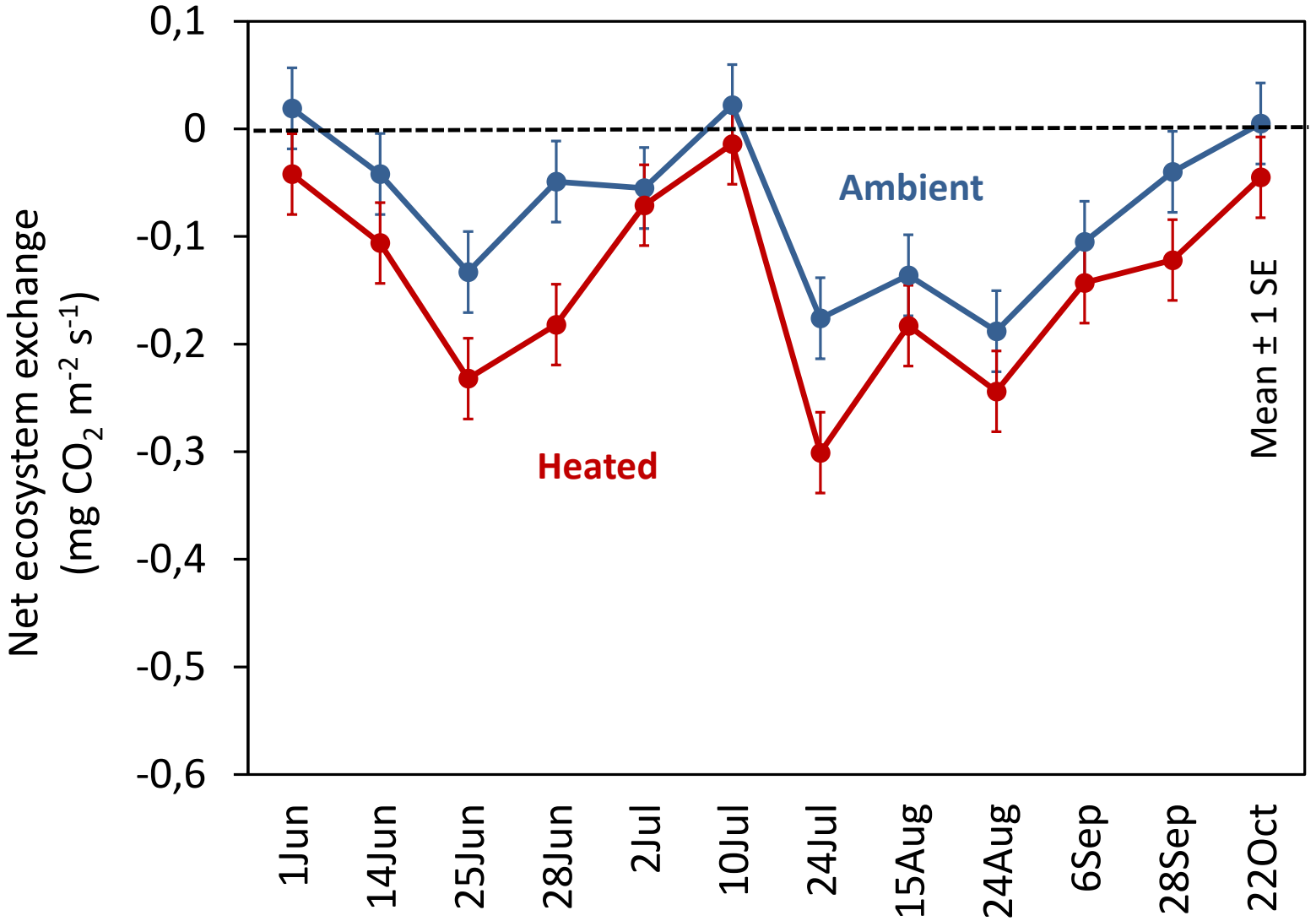
In a growth chamber test, **a northern silver birch population had 50% higher photosynthesis rate than a southern population** (adaptation to cold climate), **but the same optimum temperature of 18 °C**



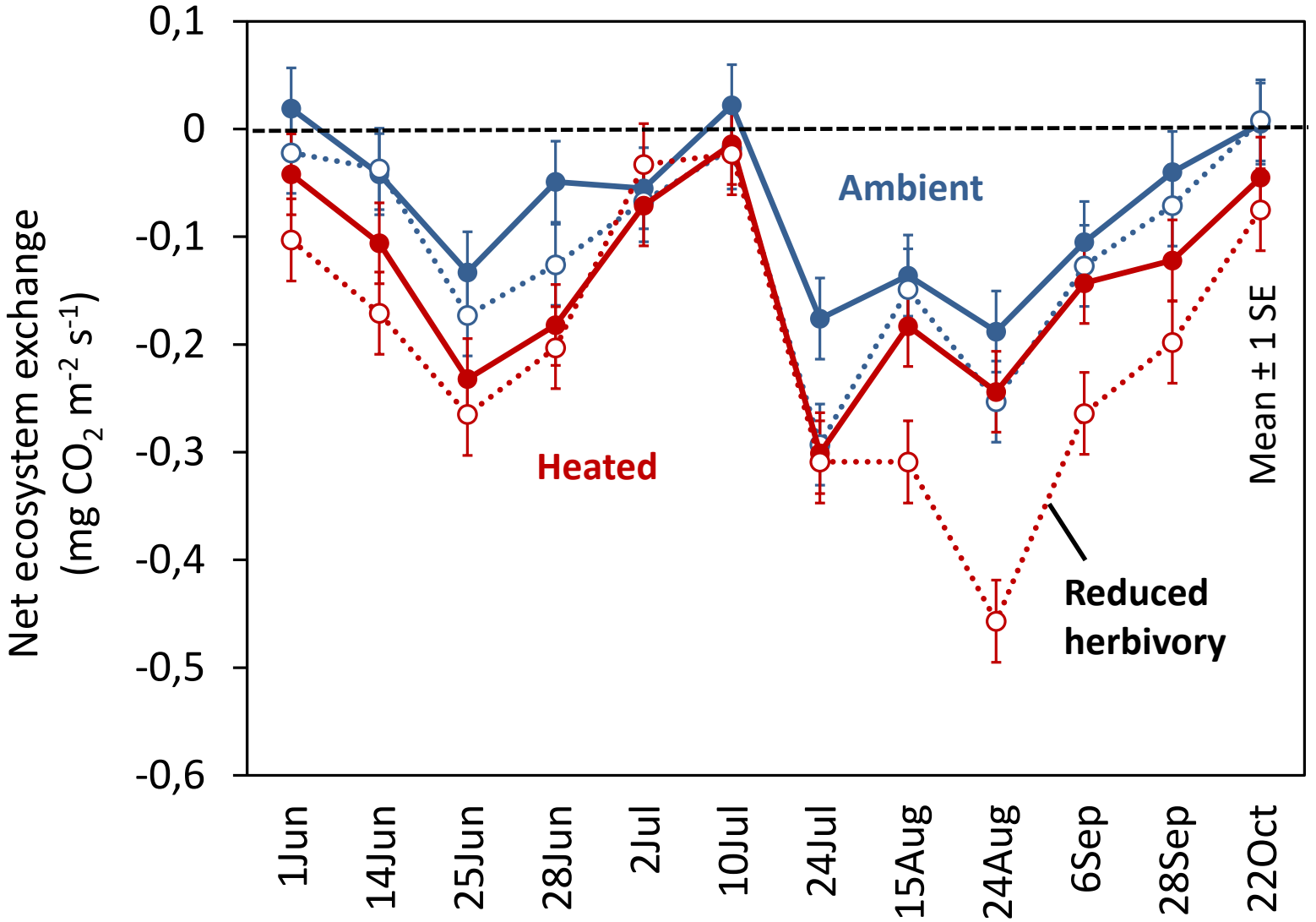
For most part of the growing season 2017, **air temperatures in Kevo were below 18 °C** > plant photosynthesis rates were likely raised by warming

In field plots, **warming raised late season leaf chlorophyll concentrations** (all *Betula* species included)





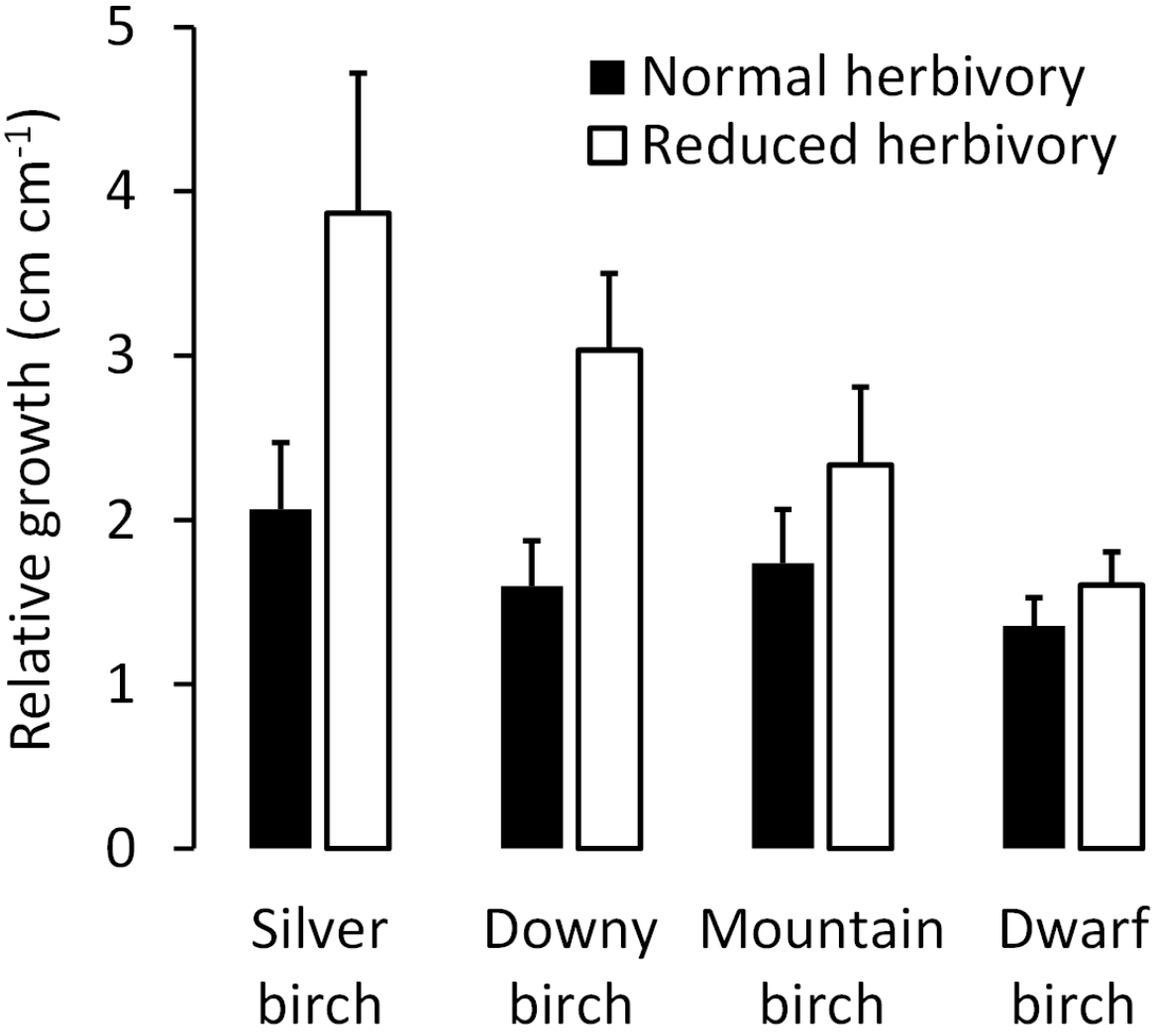
In field plots, **warming increased ecosystem CO_2 uptake** through the growing season > mitigation for climate change



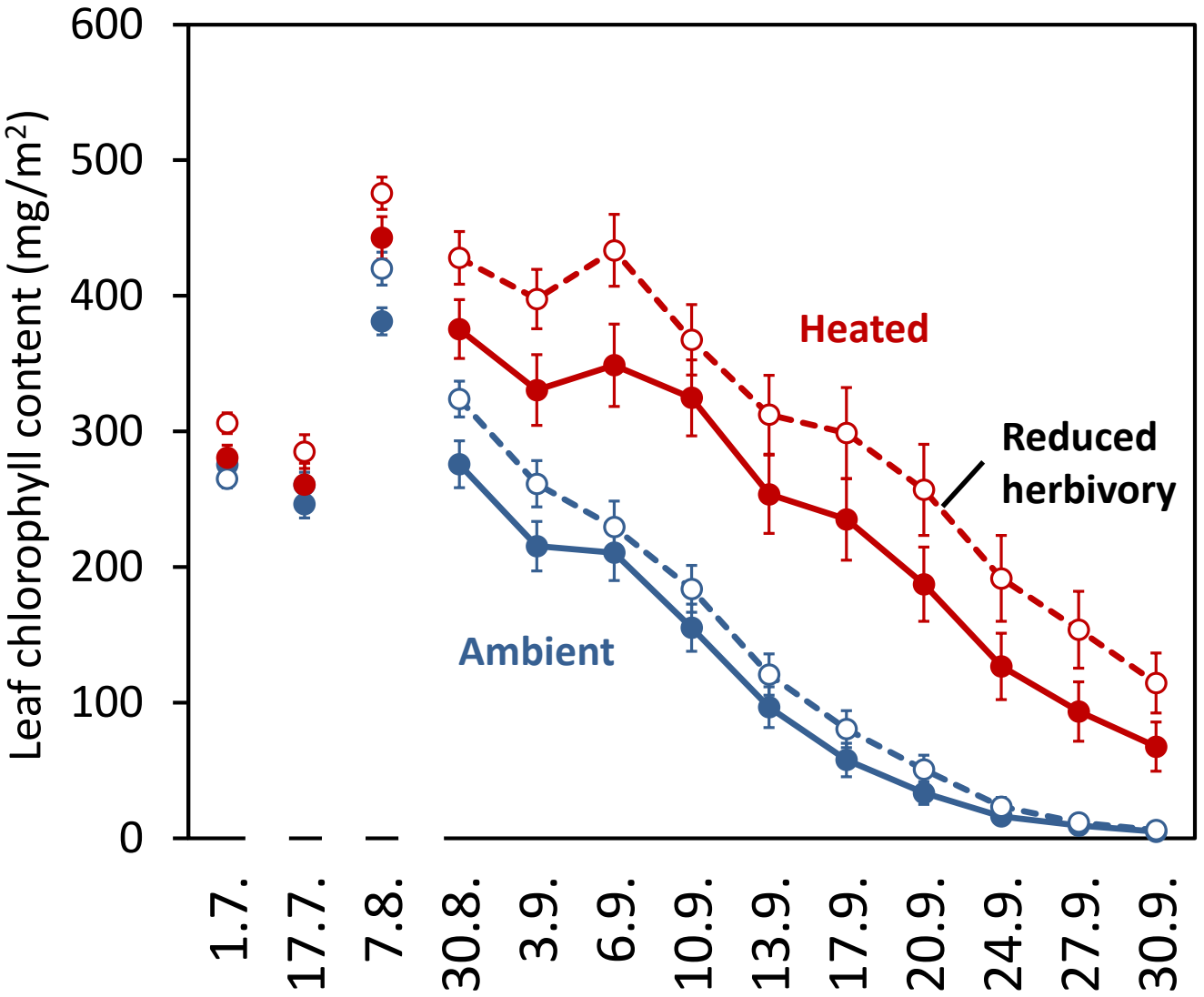
Insect herbivory decreased ecosystem CO_2 uptake

Herbivores reduced *Betula* growth by 15–50%

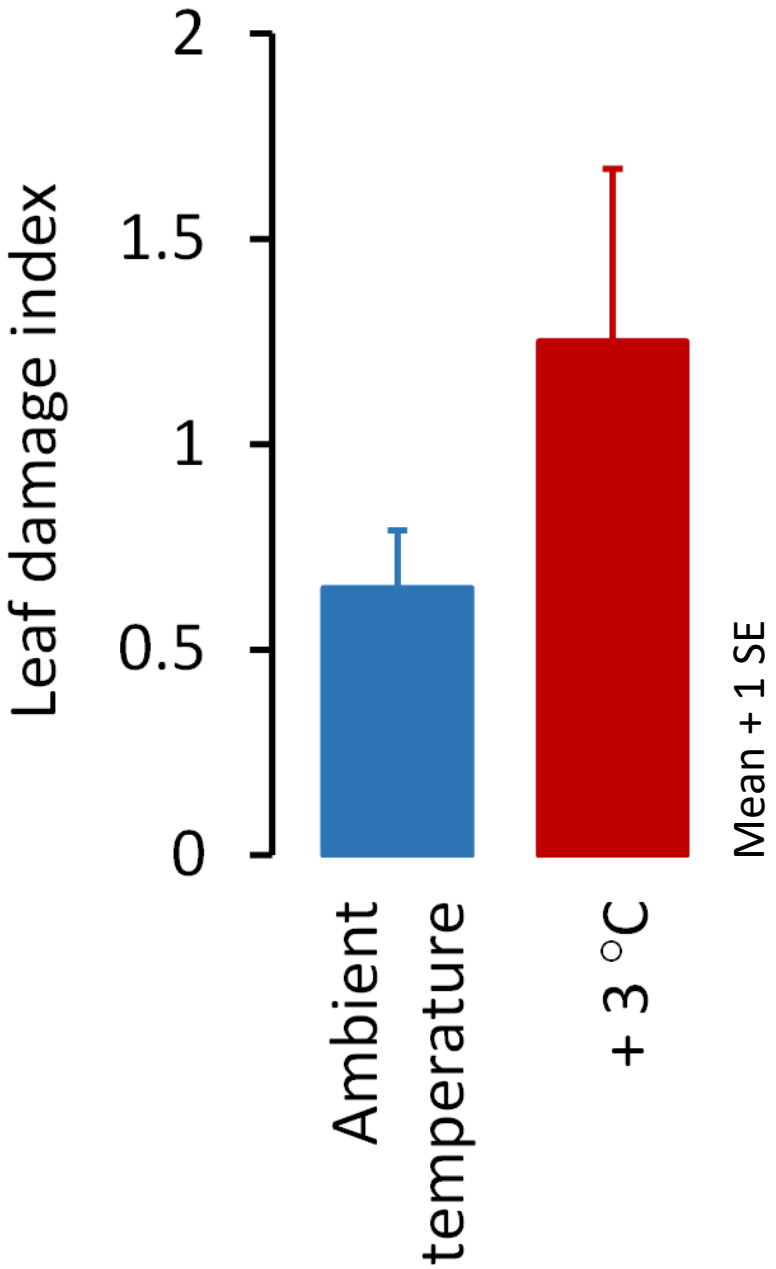
- local mountain and dwarf birch were more resistant than more southern silver and downy birch

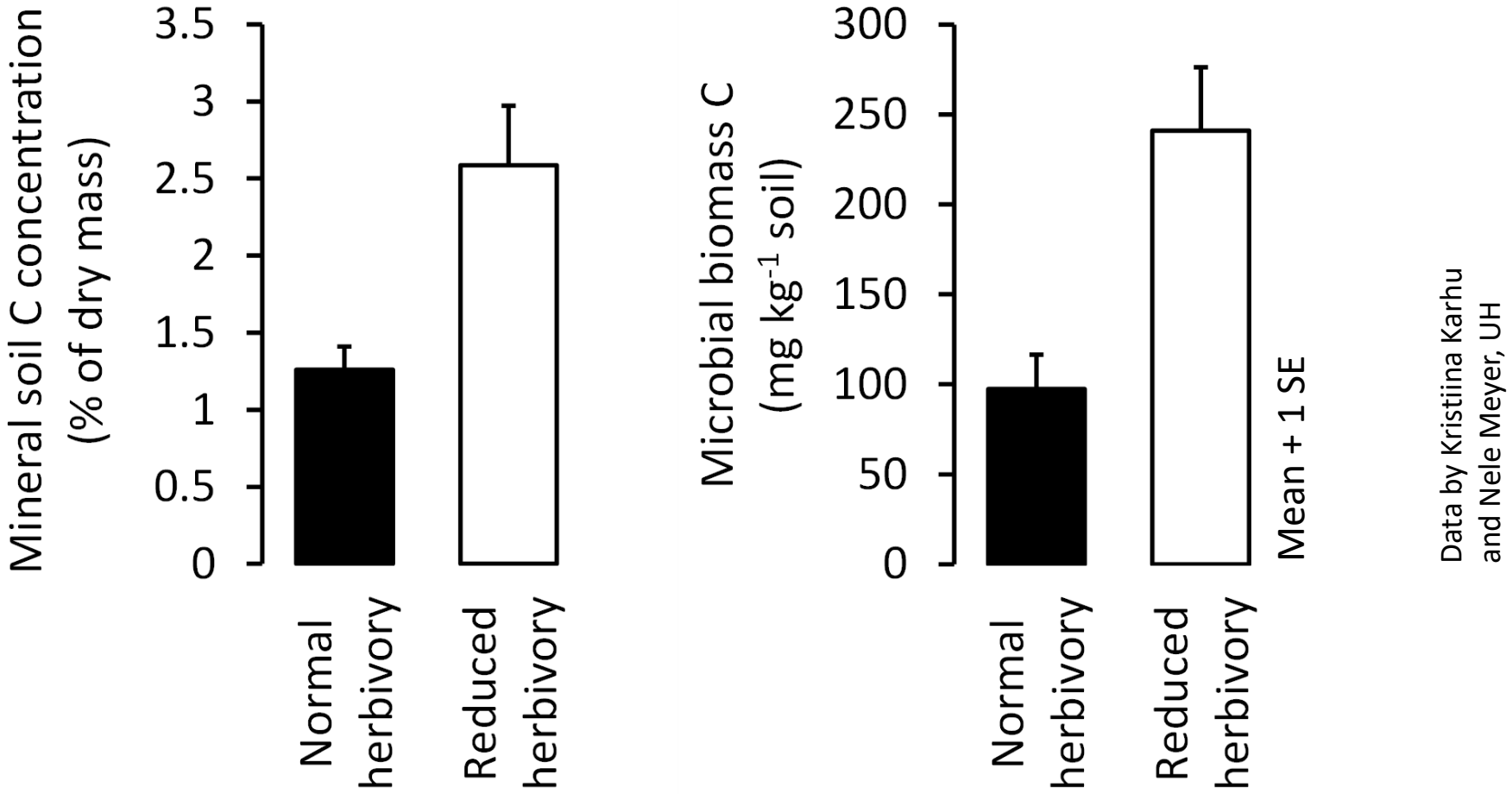


Herbivores decreased leaf chlorophyll concentrations (all *Betula* species included)



Leaf damages by herbivores doubled with 3 °C warming (all *Betula* species included)





Aboveground growth reduction had belowground consequences: herbivores reduced mineral soil C stocks and microbial biomass by 50–60%

When warming up the Arctic:

- **Plants are ready for action**
  - high photosynthesis rates in northern populations
  - high optimum temperature for photosynthesis
  - warming increases leaf chlorophyll concentrations
  >> plant growth and CO_2 uptake will increase
- **…but watch out for the herbivores**
  - insect herbivores decrease plant growth and belowground C allocation
  - warming increases herbivore damages
  >> increasing plant growth, CO_2 uptake and soil C storages can be significantly curtailed by increasing herbivory
- **Herbivory and trophic interactions need to be involved in climate change models and predictions**

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