High-Arctic phenology shifts: climate change consequences for reproductive success and plant community composition

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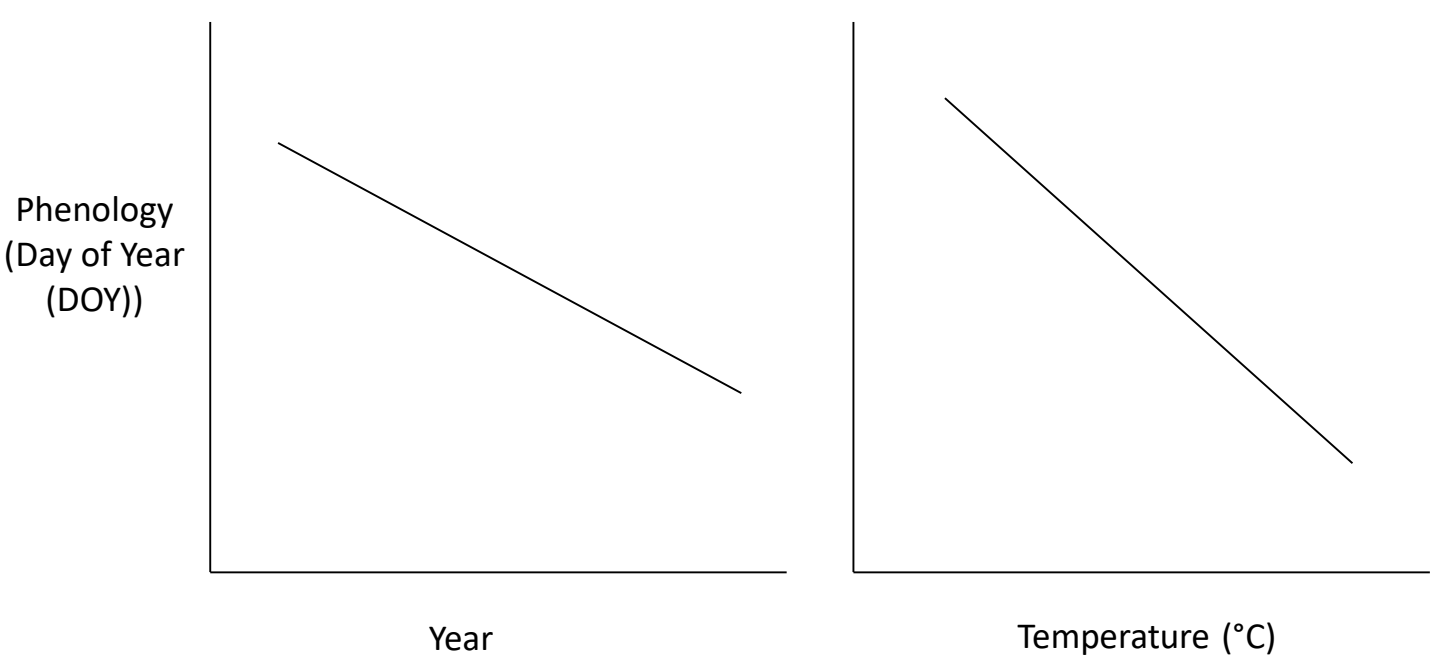
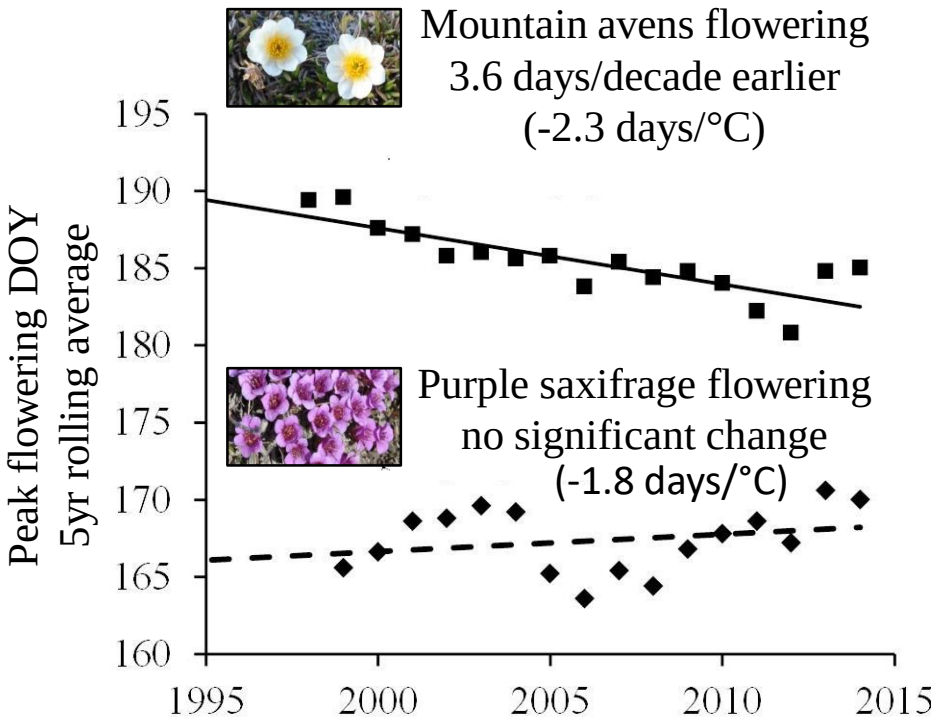
Phenology shifts due to climate change



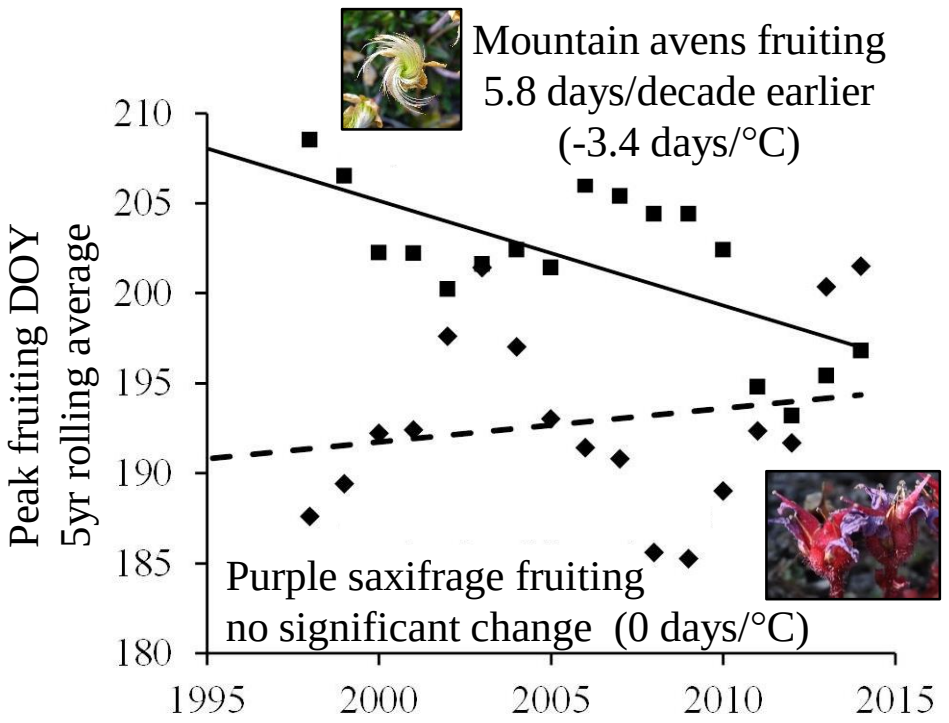
Tundra green-up, flowering and fruiting generally getting earlier as climate warms

Phenology responses differ

Flowering Time



Fruiting Time



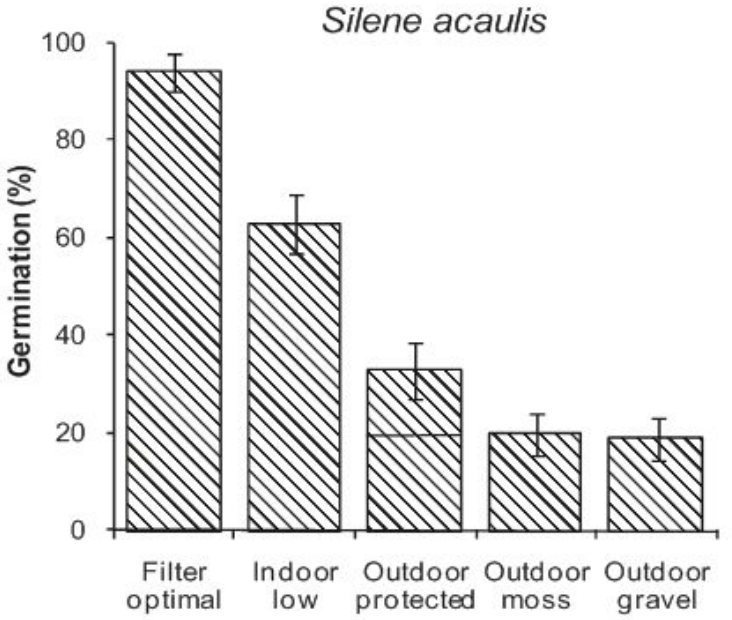
- Differences among species
- Differences among phenological events of same species

Panchen & Gorelick (2015)

Arctic plant reproductive success

With warmer Arctic temperatures …

- greater germination
- more viable seed

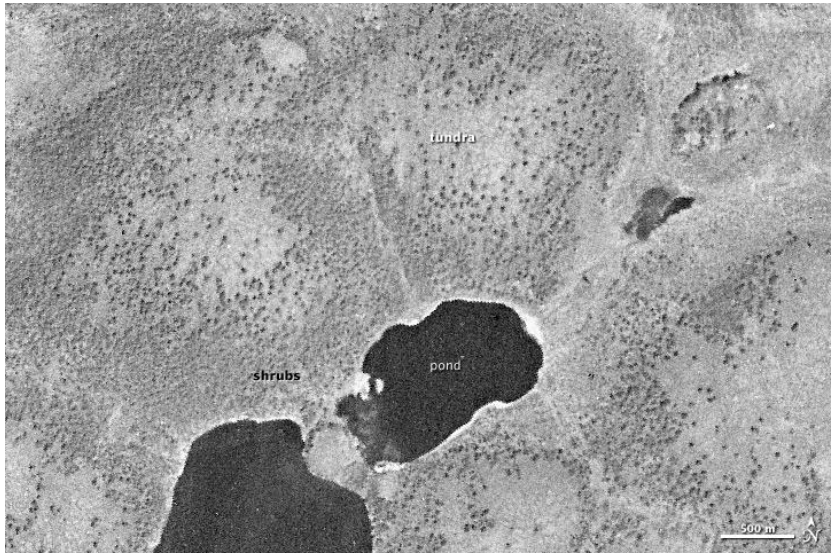


Müller et al. (2011)

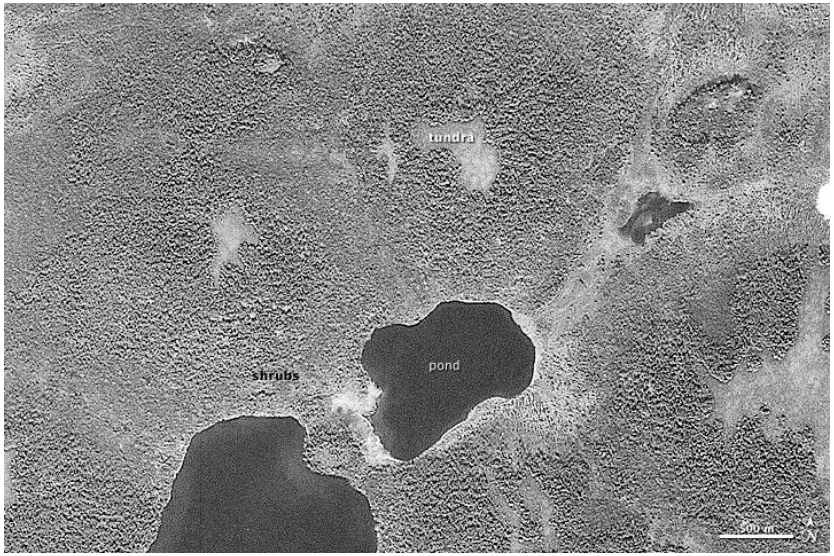
Plant community composition changes

With warmer Arctic temperatures …

- change in Arctic plant community composition
- Arctic shrub-ification



1966: Siberian tundra



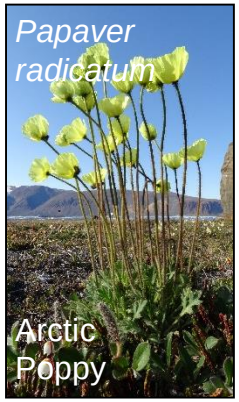
2009: Siberian tundra

Phenology – reproductive success - plant community structure

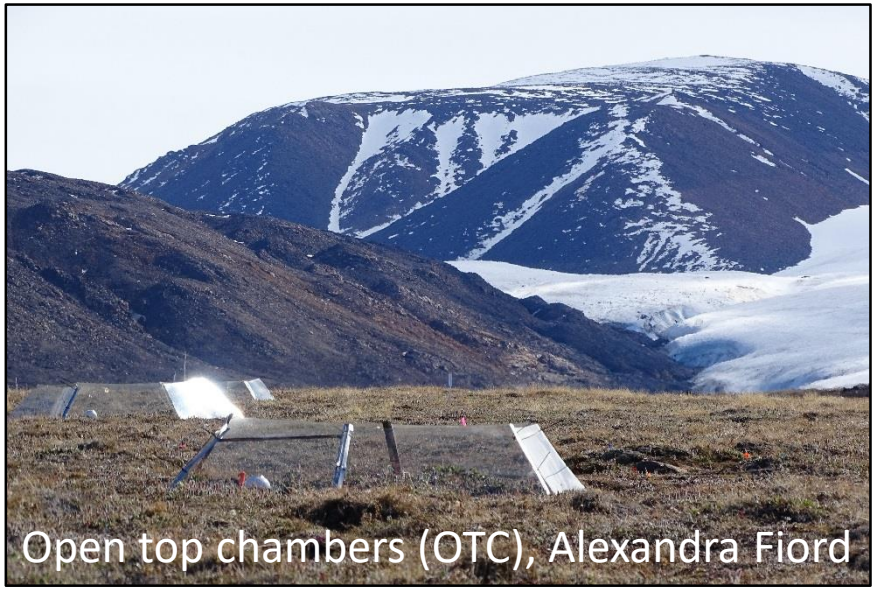
What is the relationship between

- Flowering times and reproductive success?
- Phenology-reproductive success and species composition and abundance changes?

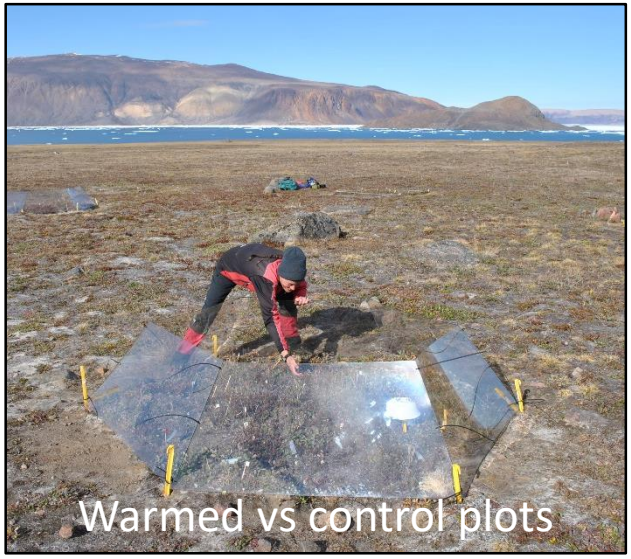
Expect shift towards greater proportion of species that benefit most from climate change.



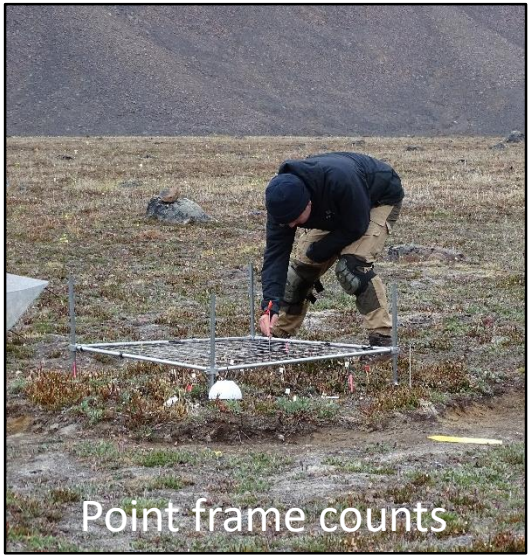

Alexandra Fiord, Ellesmere Island (79°N)


Open top chambers (OTC), Alexandra Fiord

Phenology, reproductive success & plant community composition

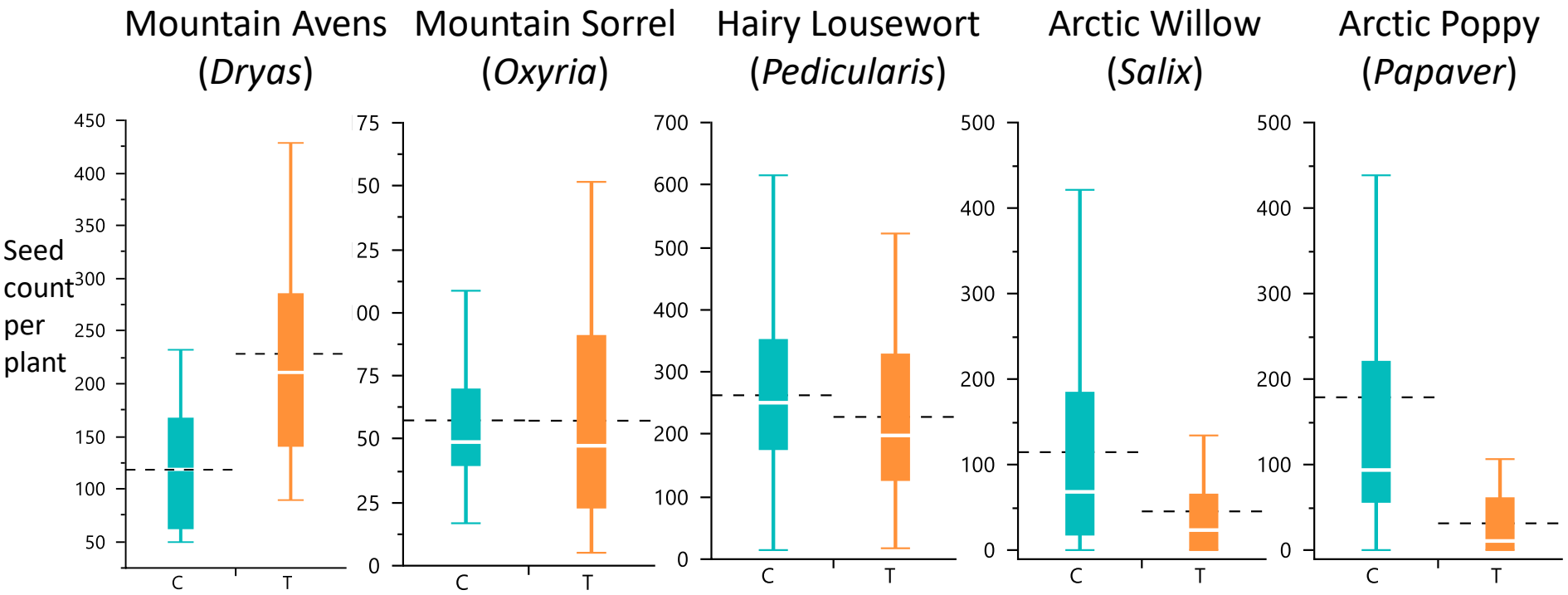

Warmed vs control plots


Seed germination


Point frame counts

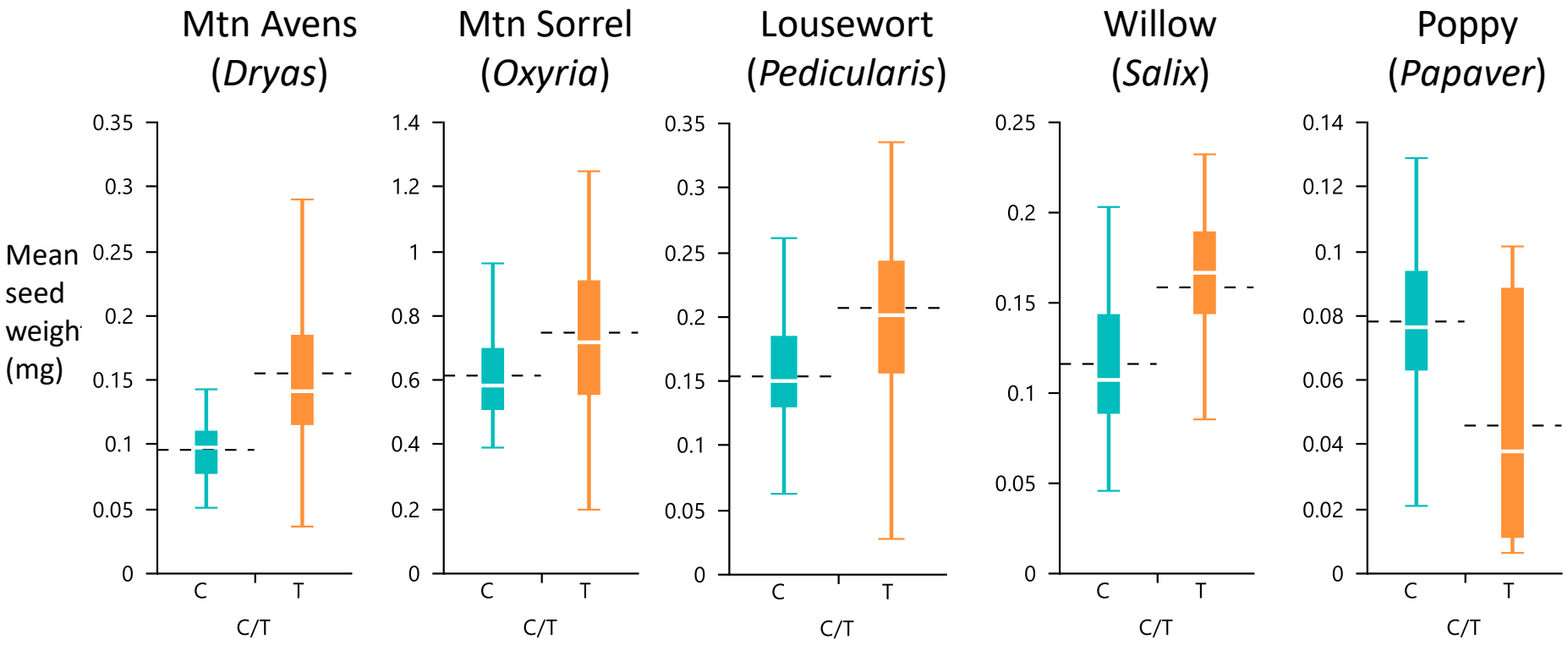
Phenology	⟷	Reproductive success	⟷	Community structure
• flowering times • green-up times • fruiting times		• seed quantity • seed weight • seed viability		• composition • abundance

Seed quantity



- *Dryas*: More seeds in warmed versus control plots
- *Oxyria* and *Pedicularis*:
  No difference in warmed versus control plots
- *Salix* and *Papaver*:
  Fewer seeds in warmed versus control plots

Seed weight



Plants in warmed plots produce heavier seeds

Except Poppy

Seed viability

Arctic Willow (*Salix*)

Mountain Avens (*Dryas*)

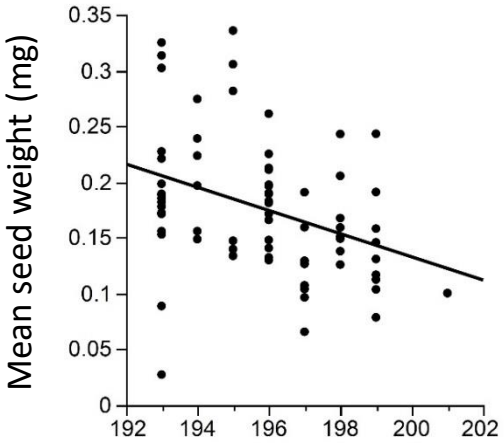
Mountain Sorrel (*Oxyria*)

Arctic Poppy (*Papaver*)

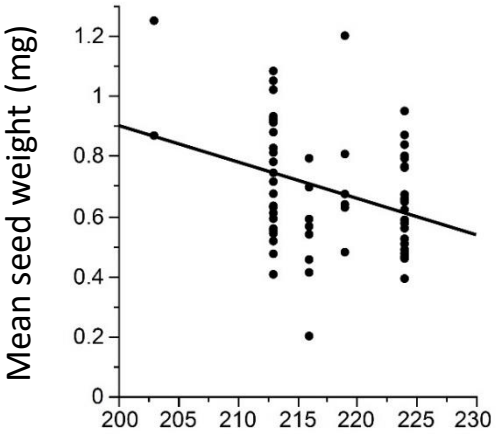
Heavier seeds = greater germination

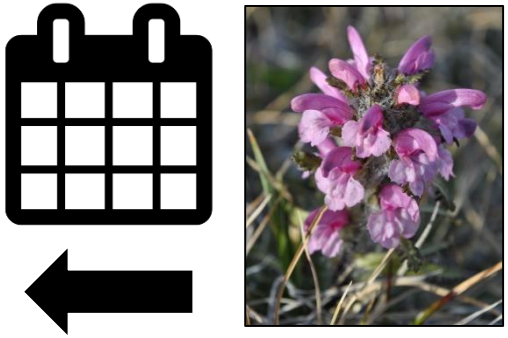
Phenology - reproductive success

Hairy lousewort
(*Pedicularis hirsuta*)

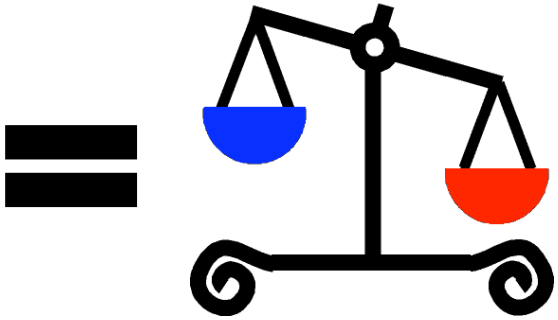


Mountain sorrel
(*Oxyria digyna*)



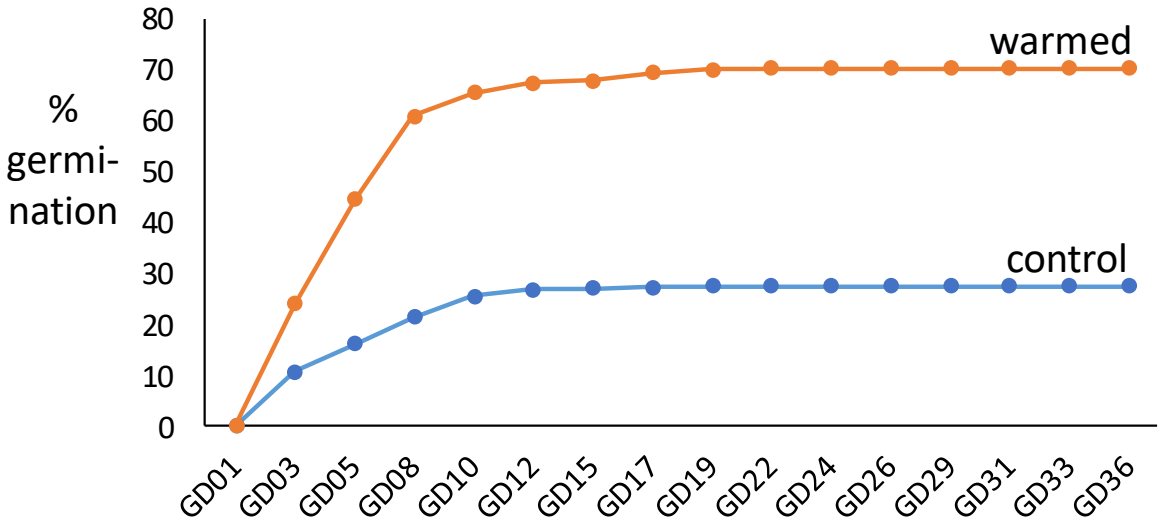


Earlier flowering/fruiting

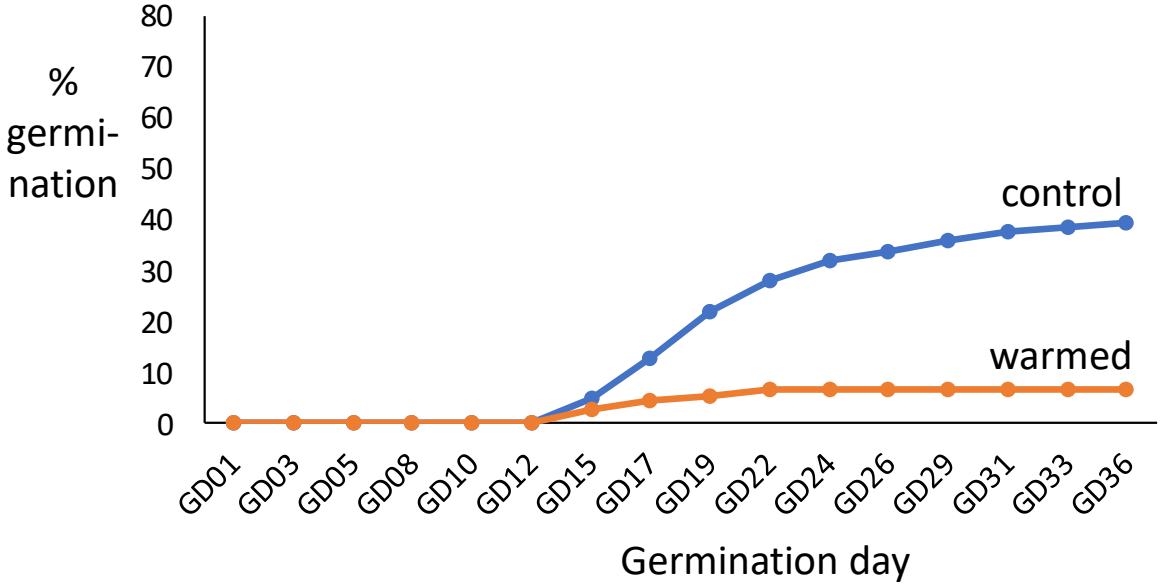


Heavier seeds

Reproductive success – species composition

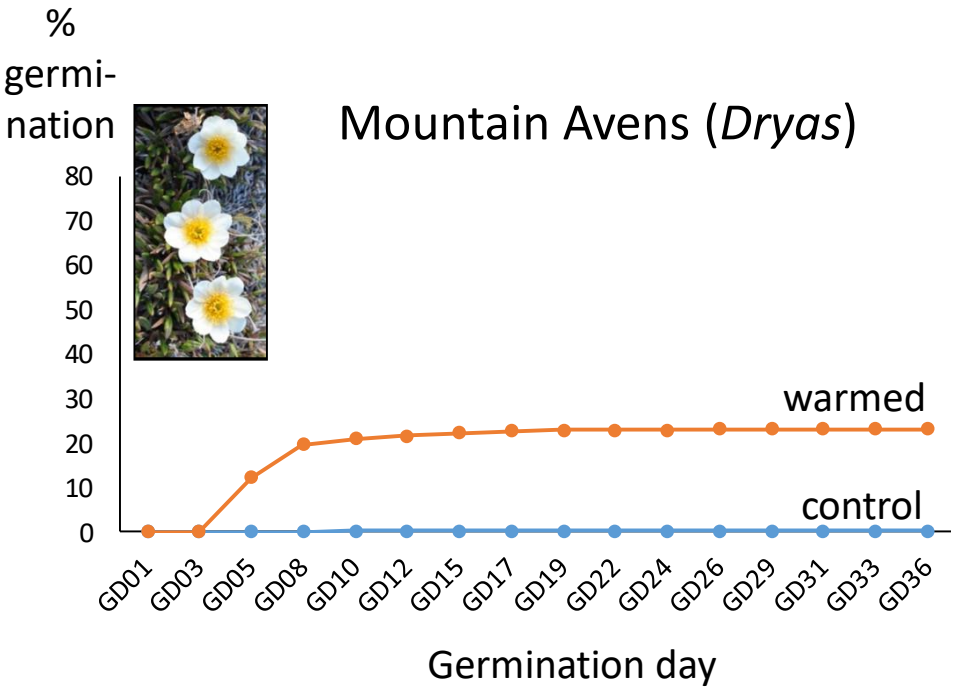


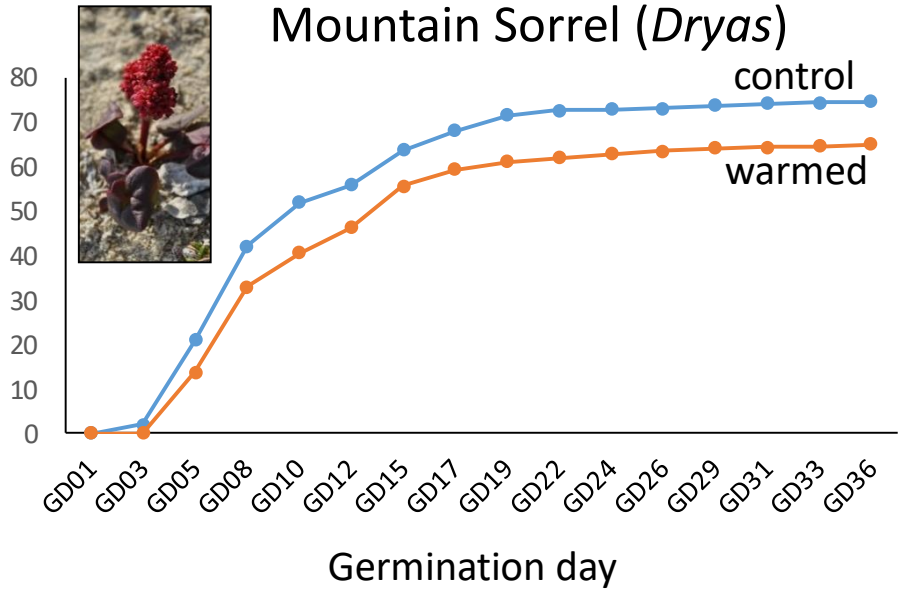
Arctic willow is "taking over"



Arctic poppy is "now seen less often in warmed plots"

Reproductive success – species composition





Only seeds from warmed plots germinated

Only 1/3650 seeds germinated!

- tetrazolium test +ve
- germination conditions not met

Seedling vigor

Seedling weight (mg)

Willow (*Salix*)

Poppy (*Papaver*)

Mountain Sorrel (*Oxyria*)

Mountain Avens (*Dryas*)

Salix warmed plots seedlings more vigorous

Earlier germinating Salix seeds are more vigorous

In warmed plots…

↓ # seeds
↑ seed weight
↑ germination
↑ seedling vigor

↓ # seeds
↓ seed weight
↓ germination
↓ seedling vigor

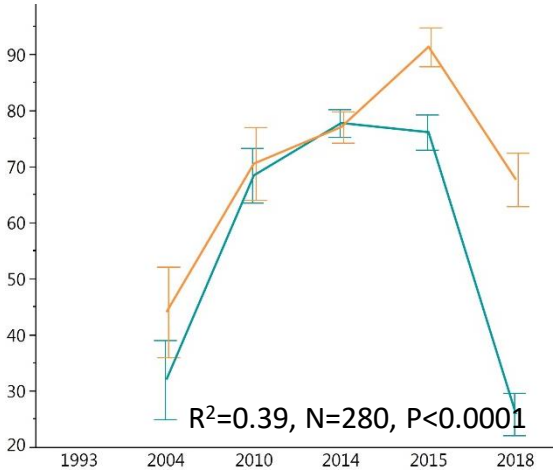
~= # seeds
↑ seed weight
↓ germination
↑ seedling vigor

↑ # seeds
↑ seed weight
↑ germination
?↑seedling vigor

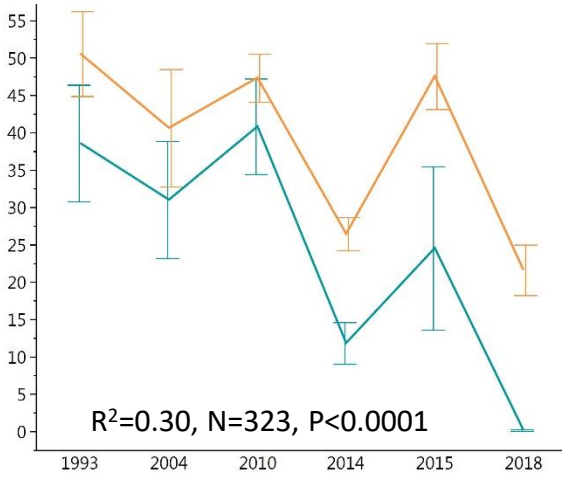
% germination over the years

Mean % germination

Arctic Willow (*Salix*)

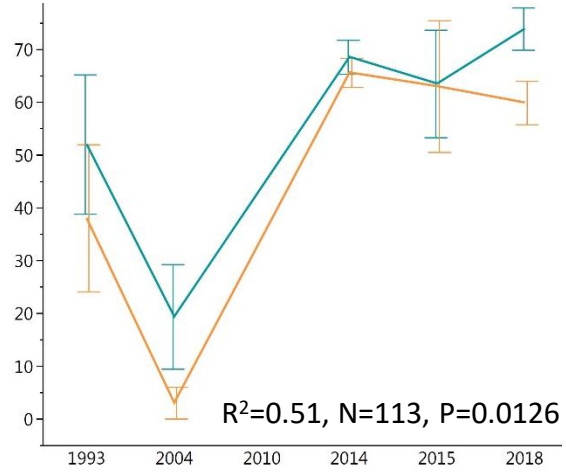


Mountain Avens (*Dryas*)

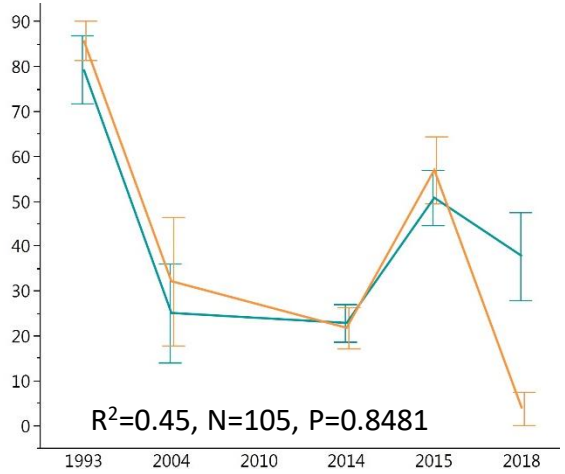


Mean % germination

Mountain Sorrel (*Oxyria*)

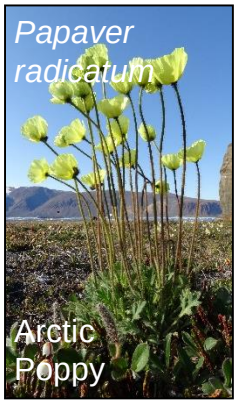


Arctic Poppy (*Papaver*)



Preliminary analysis suggests …

- Warmer temperatures appear to increase some reproductive success measures
- Link between phenology, reproductive success and plant community composition/species abundance but … further analysis required



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