A close-up photograph of a bumblebee on a pink flower. The bee is positioned on the lower part of the flower, facing left. The flower has five petals, with the lower ones being a vibrant pink and the upper ones a lighter, almost white color. The background is a soft, out-of-focus green, suggesting a natural outdoor setting. The overall composition is a vertical shot, with the flower and bee occupying the left half of the frame.

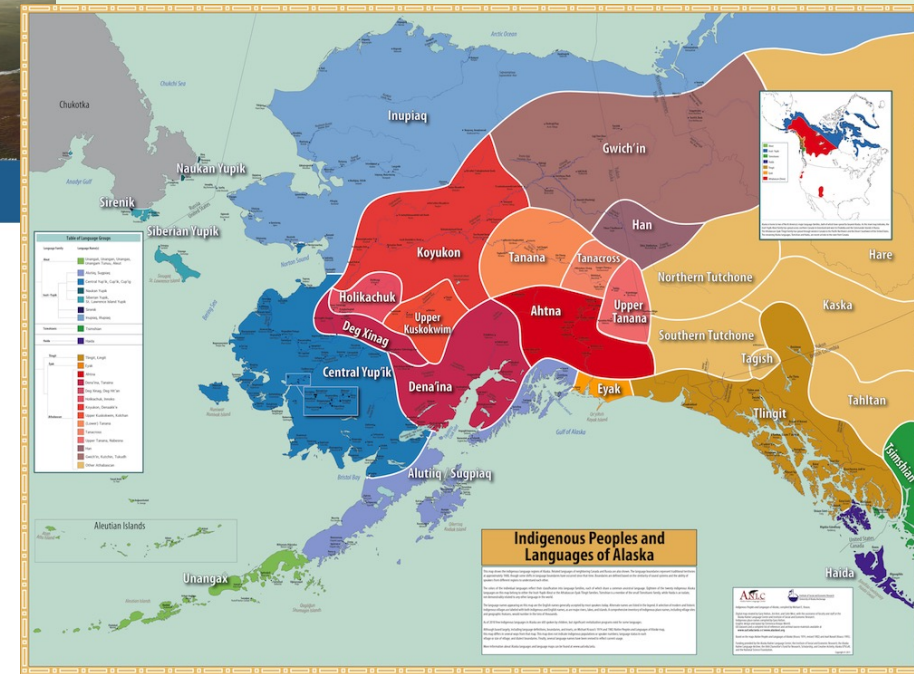
Spatio-temporal patterns in floral resource availability and plant-pollinator interactions on the North Slope of Alaska

Roxaneh Khorsand
Department of Organismal Biology and Ecology
Colorado College

Land Acknowledgement Statement

We acknowledge the Alaska Native nations upon whose traditional lands our field station operates. In Fairbanks, our Logistic Offices are located on the traditional lands of the Troth Yeddha' Dena people of the Lower Tanana River. We acknowledge that Toolik Field Station and the surrounding areas are located on the ancestral hunting grounds of the Nunamiut, and occasional hunting grounds and routes of the Gwich'in, Koyukuk, and Iñupiaq peoples. Toolik Field Station recognizes, and is grateful for, the Indigenous people who inhabit and steward this land.

We are endeavoring to become better stewards of the land that we research. When you visit Toolik Field Station, we invite you to join us in offering respect and gratitude to the Nunamiut and their ancestors that have resided and hunted in this area. Please take a moment to consider the impact of colonialism to the Nunamiut through the legacies of displacement, migration, and settlement over the past century. The Nunamiut primarily live in Anaktuvuk Pass, a community about 65 miles (103 km) to the southwest of Toolik Field Station.



“At this moment in time we can’t talk about **Land Back** without talking about **Palestine.**”

Luna Reyna, In *Land Back from Turtle Island to Palestine*. Nov. 20, 2023

Colorado College recognizes and honors the original inhabitants who first settled in the area and who called the nearby highest mountain “Tava,” the original name given by the Ute people to what is now known as Pikes Peak. At CC, we respect all peoples and strive to grow as a unique and welcoming community.



It is a future where Black reparations and Indigenous LANDBACK co-exist. Where BIPOC collective liberation is at the core.

It is acknowledging that only when Mother Earth is well, can we, her children, be well. It is our belonging to the land – because – we are the land.

We are LANDBACK!

View more LANDBACK resources on the LANDBACK website.

LANDBACK.ORG

“I have many reasons to stand with Palestine, some are deeply personal but it is also an ethical, political, and intellectual position. I was taught through Native Studies that we cannot separate these commitments so neatly, as our university would like us to do, pushing us to *professionalize* rather than develop our analyses more fully to **understand and intervene in the present we recognize so well from that past.**”

Lou Cornum, enrolled member of the Navajo Nation and Assistant Professor of Native American studies, NYU. Dec. 7, 2023



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Oct 12 - Written By Aisha Mansour

The Right of Return is Land Back: A Statement of Solidarity with Palestine

Today, we mourn the lives tragically lost in Palestine and the broader Arab region. We remain steadfast in our collective hope for a future where every life is valued, and all individuals can relish freedom and security. **As Indigenous people, we understand that true security and freedom can only be achieved through decolonization.**

Who I work with...



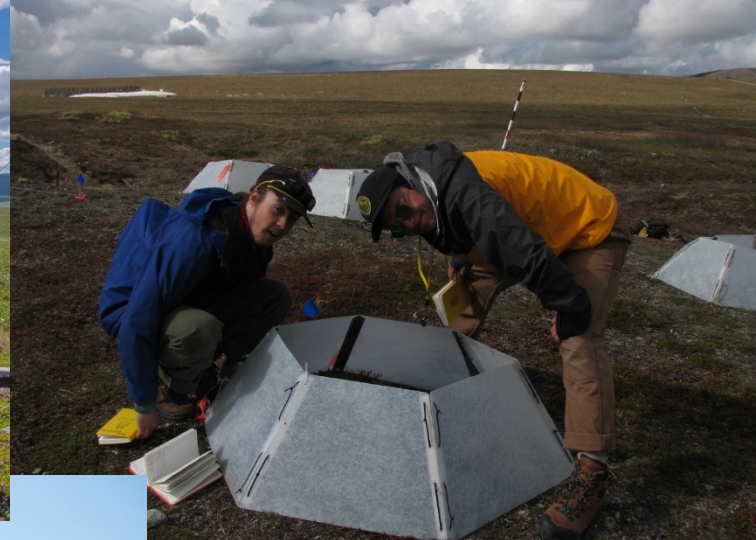
Dr. Steve Oberbauer
(Florida International University)



Dr. Jeremy May
(Marietta College)



Dr. Flavia Sancier-Barbosa
(Colorado College)



What we know...

1.



2. “While the global mean surface temperature has increased by 0.4°C over the past 150 years, Arctic warming has been two to three times that amount (IPCC 2007)...”

communications earth & environment

ARTICLE

<https://doi.org/10.1038/s43247-022-00498-3>

OPEN

 Check for updates

The Arctic has warmed nearly four times faster than the globe since 1979

Mika Rantanen¹✉, Alexey Yu. Karpechko¹, Antti Lipponen², Kalle Nordling^{1,3}, Otto Hyvärinen¹, Kimmo Ruosteenoja¹, Timo Vihma¹ & Ari Laaksonen^{1,4}

What we know...

3. Tundra plant communities are composed of 4 broad functional types (Molau, 1997):

- Deciduous shrubs
- Evergreen shrubs
- Forbs
- Graminoids



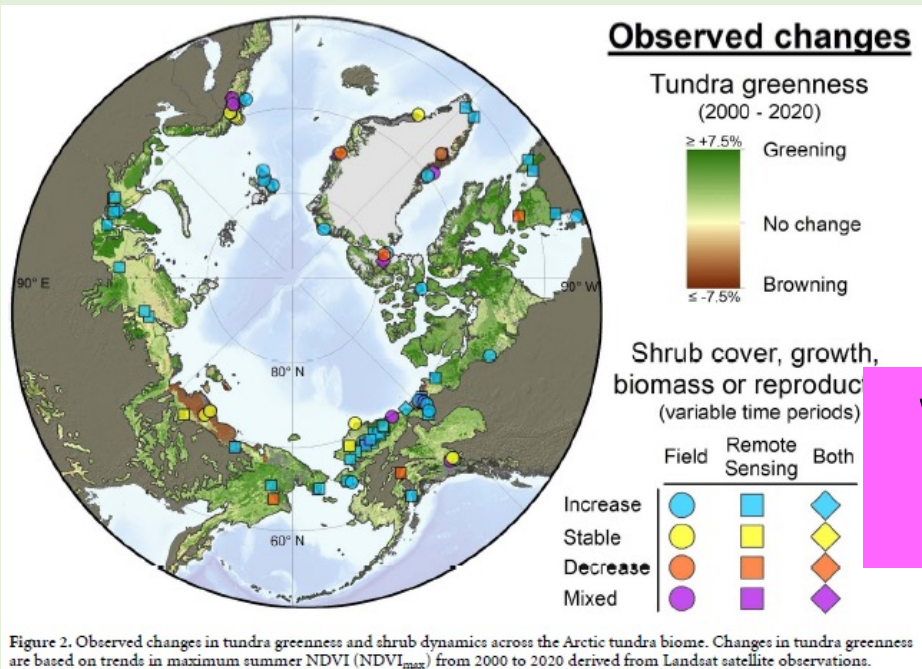
What we know...

4. Responses to warming are heterogeneous and non-linear

- **Species-specific responses and growth form-specific responses**
- “Winners vs. losers”
- Range expansion
- Shrubification, “Greening of the Arctic”



Betula spp.
Salix spp.
Alnus spp.



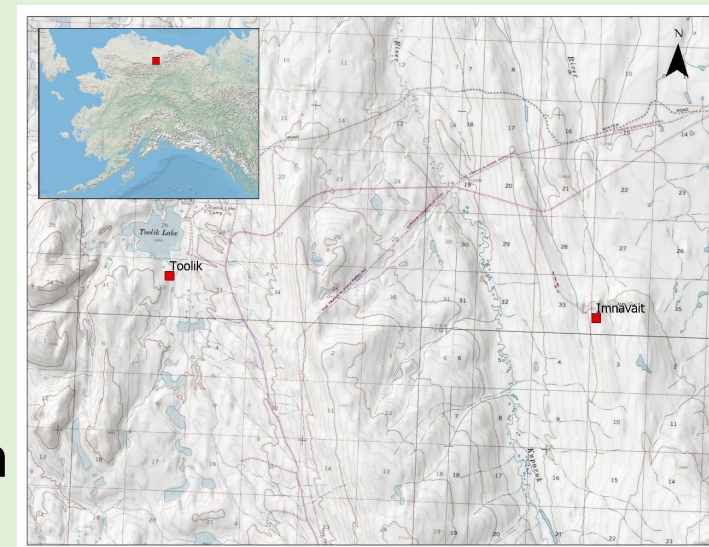
What does shrubification mean for floral rewards?



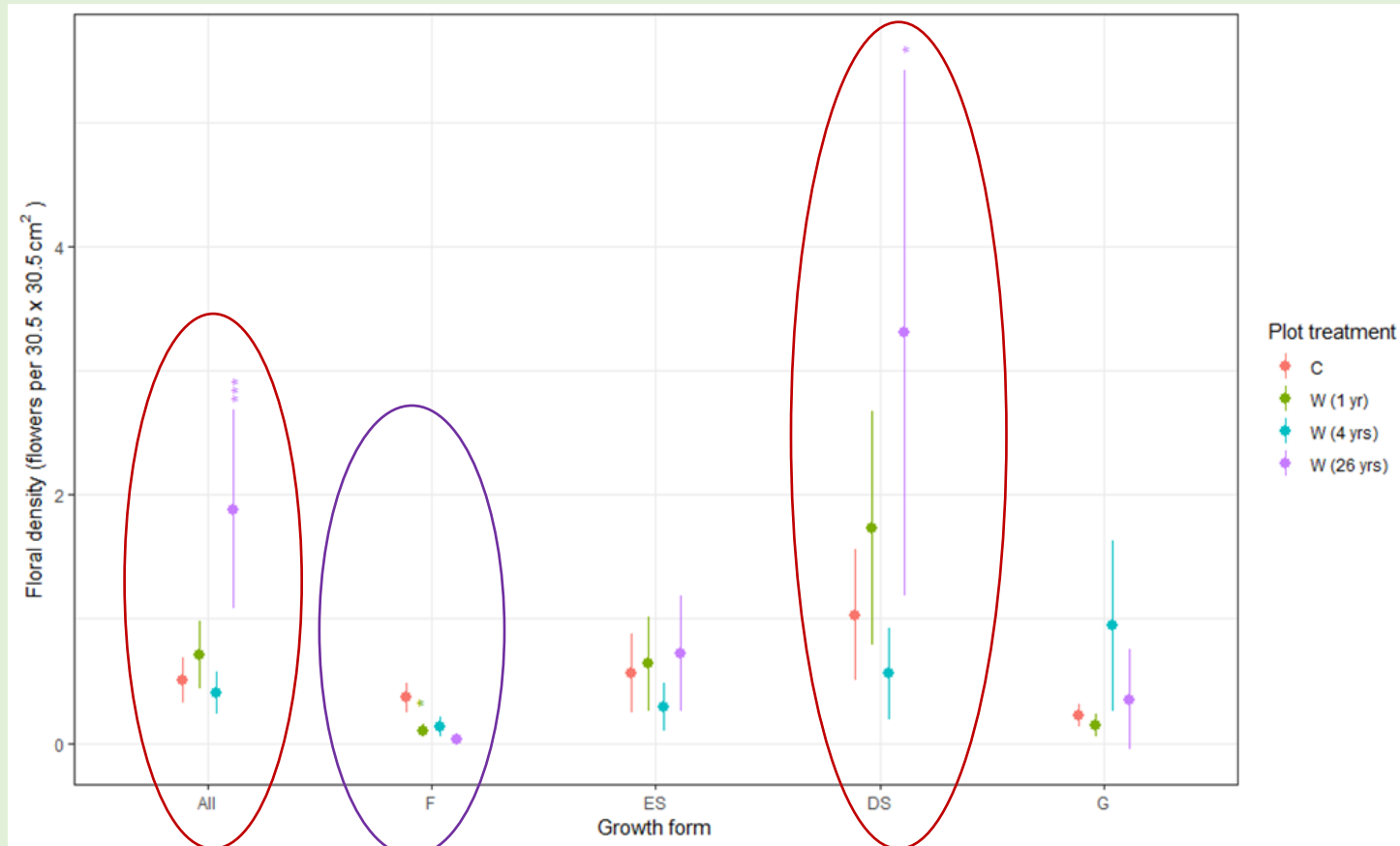
What we *don't* know...

How does warming affect plant-pollinator interactions and plant reproductive success in the Alaskan Arctic?

- International Tundra Experiment (ITEX)
- ITEX since 1994, our plots since 2016 and 2019
- Passive warming by Open Top Chambers (OTCs)
- Flowering phenology, floral visitation, nectar, pollen limitation



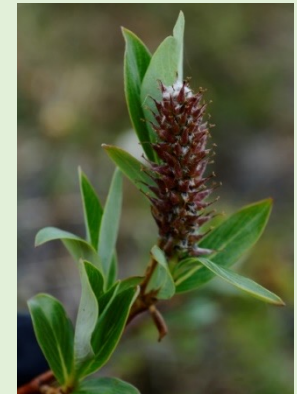
Floral density by growth form



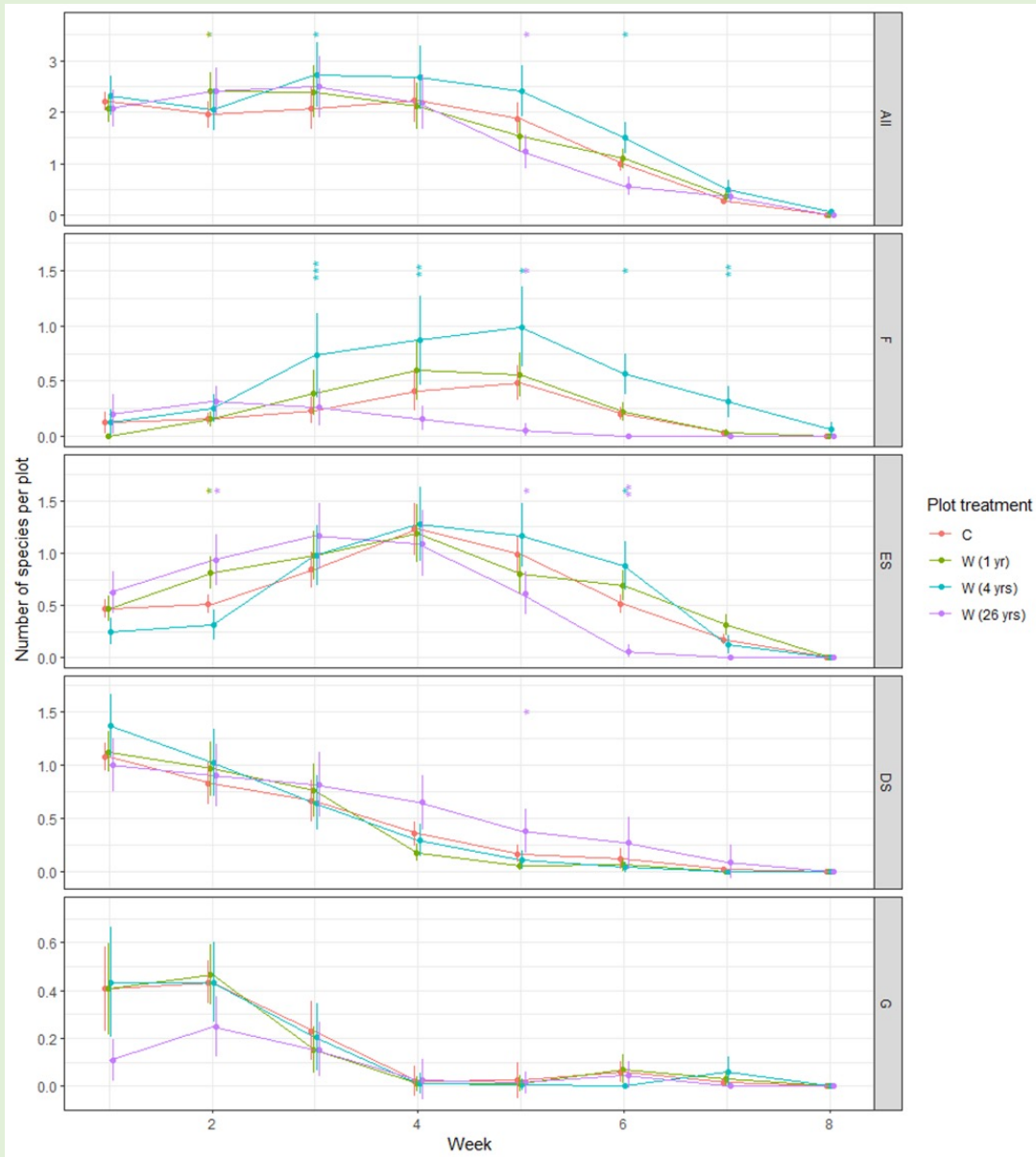
Khorsand et al. (2024). *Arctic Science*.

How does warming affect *quantity* of flowering?

1. Long-term warming increased floral density
2. This increase was driven primarily by deciduous shrubs

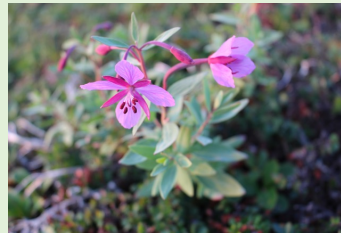


Number of species in bloom over the growing season



How does warming affect *quality* of flowering? (diversity of floral rewards)

- On a week-by-week basis, long-term warming reduced the number of species that bloomed
- The number of deciduous shrub species in bloom was consistently higher in long-term warmed plots

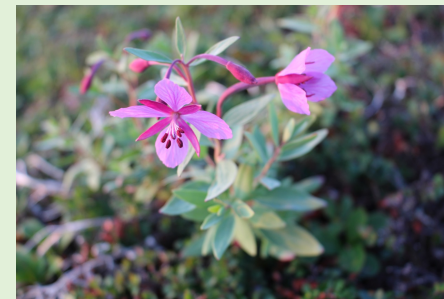
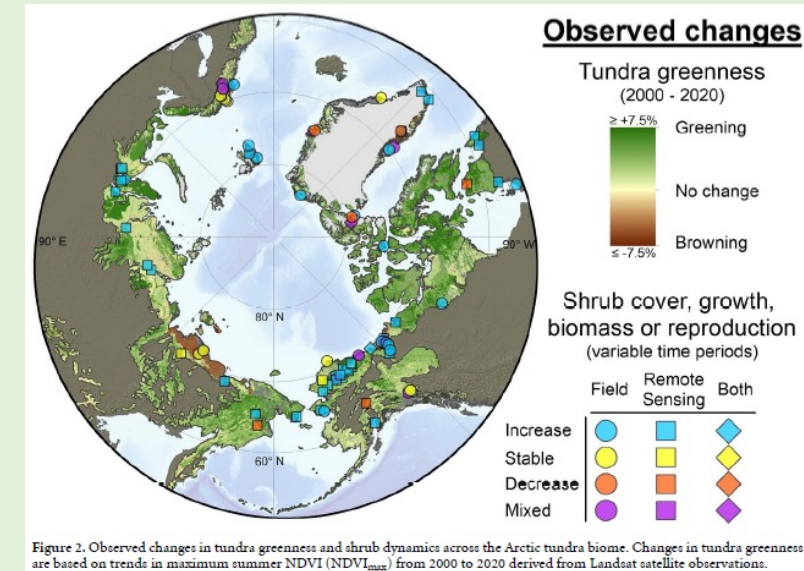


How does warming affect flowering phenology?

Conclusions:

- LTW increased floral density
 - * driven by deciduous shrubs
- LTW reduced number of species in bloom
 - * opposite trend for deciduous shrubs

Floral resources for the pollinator community?

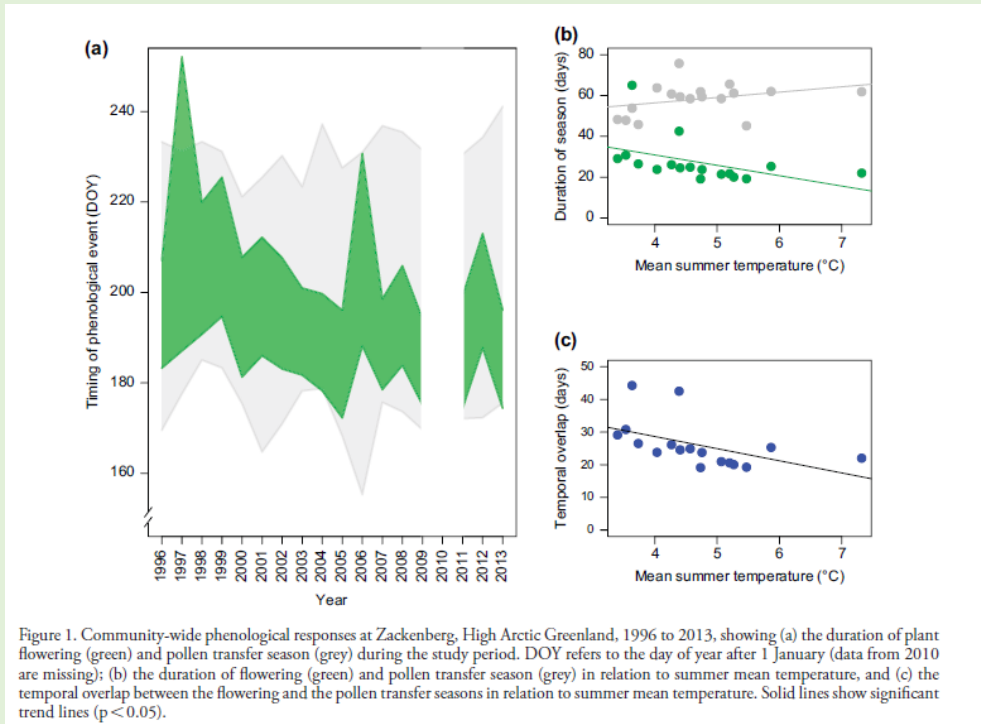


What we *really* don't know...

Do we find evidence for plant-pollinator trophic mismatch (asynchrony)?

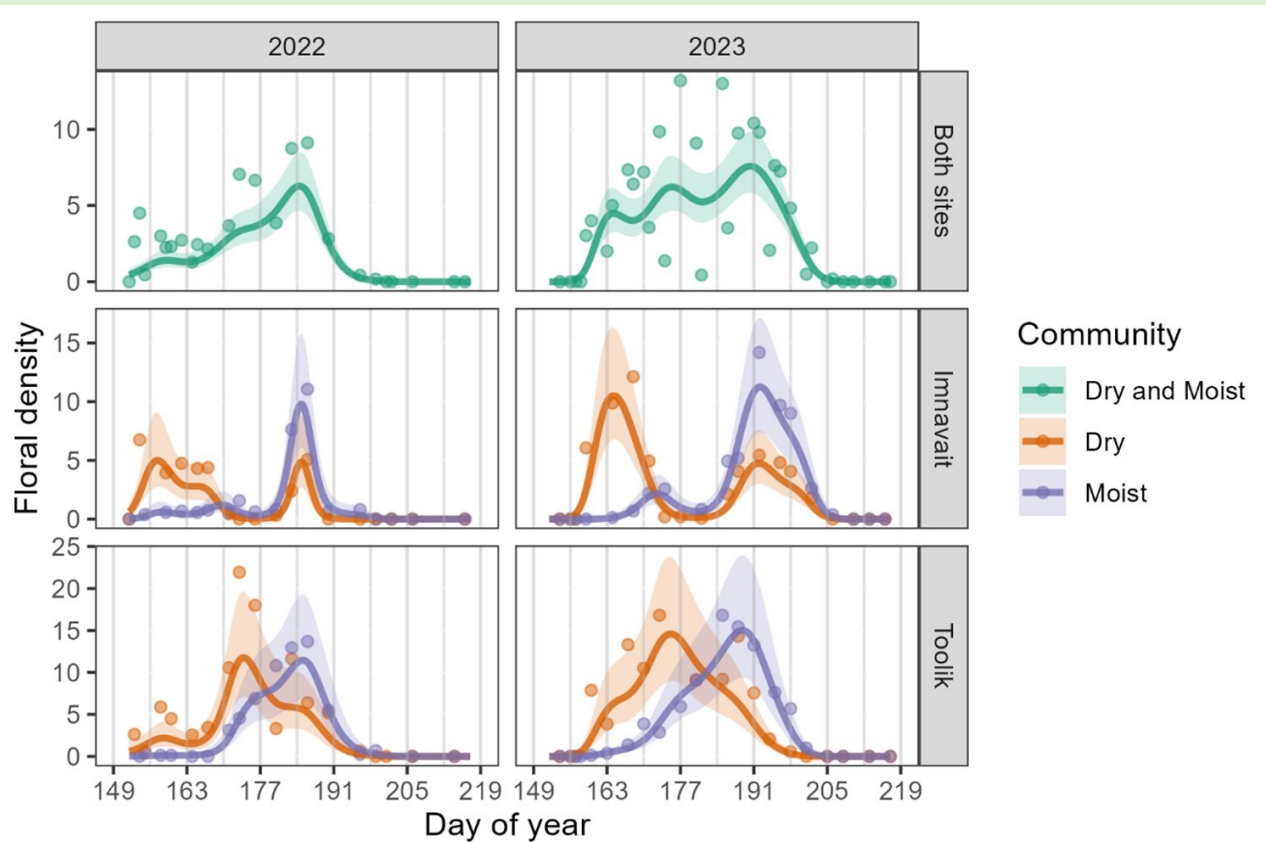
- We need baseline data on flowering and floral visitation to determine if asynchrony is developing

Diff. response rates to warming? (green = plants, grey = insects)



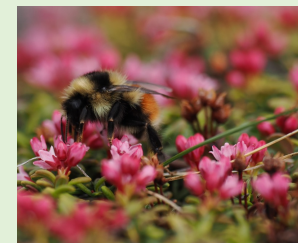
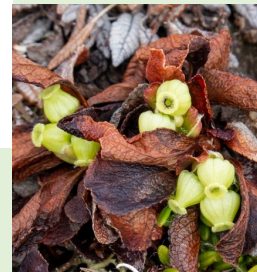
Implications for plant reproductive success,
plant diversity, food web

How do floral resources (floral density) vary spatially and temporally throughout the growing season?



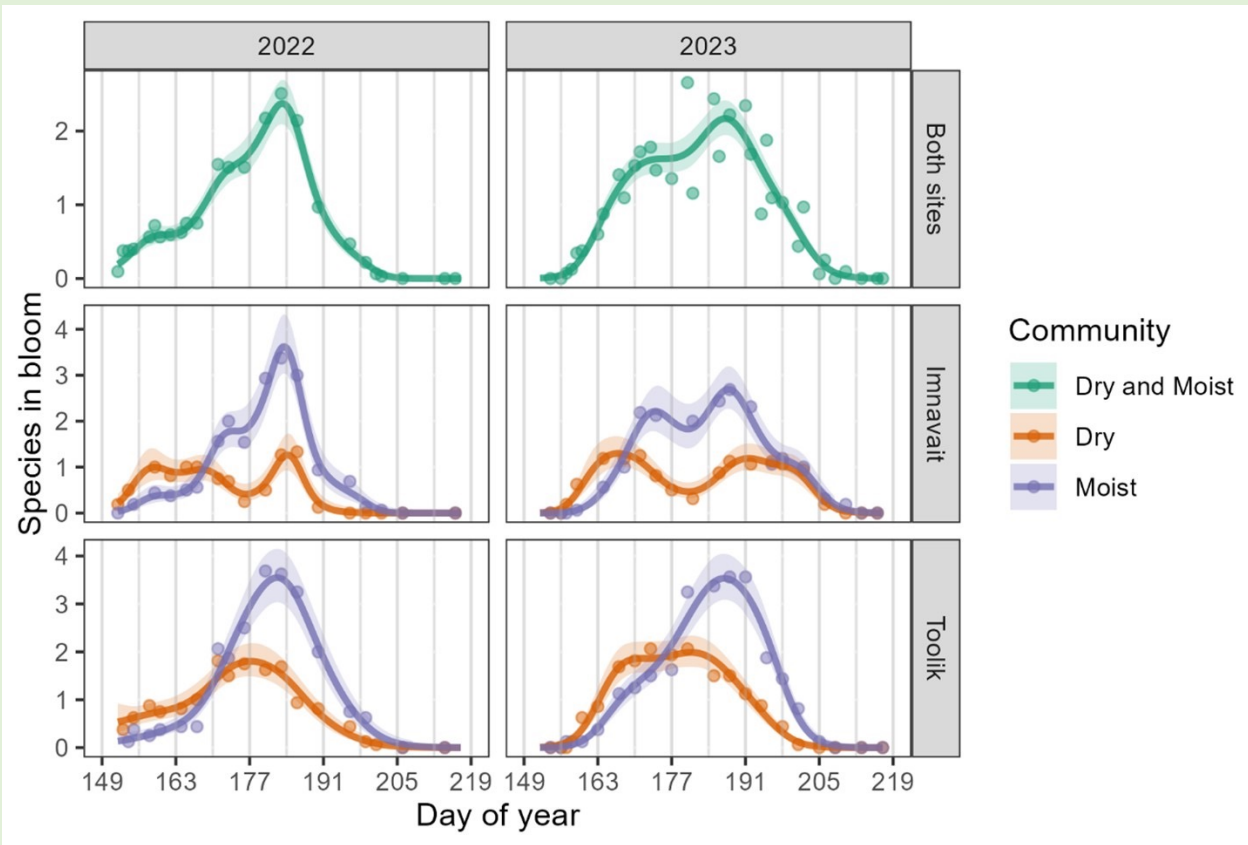
Khorsand et al. (In Review). *Frontiers in Plant Science*.

1. Floral density peaked earlier in **DHT** than in **MAT**
2. Species-specific responses
 - *Arctous alpina*, *Dryas octopetala*, *Kalmia procumbens* = 1st peak in **DHT**
 - *Rhodendron tomentosum*, *Vaccinium vitis-idaea* = 2nd peak in **DHT**
 - *R. tomentosum*, *V. vitis-idaea*, *Bistorta officinalis* = peak in **MAT**

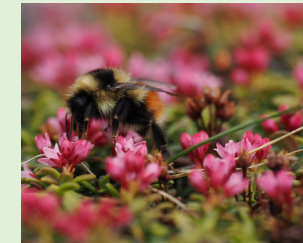
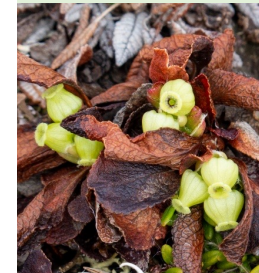


Spatio-temporal heterogeneity
in floral resources

How do floral resources (species in bloom) vary spatially and temporally throughout the growing season?



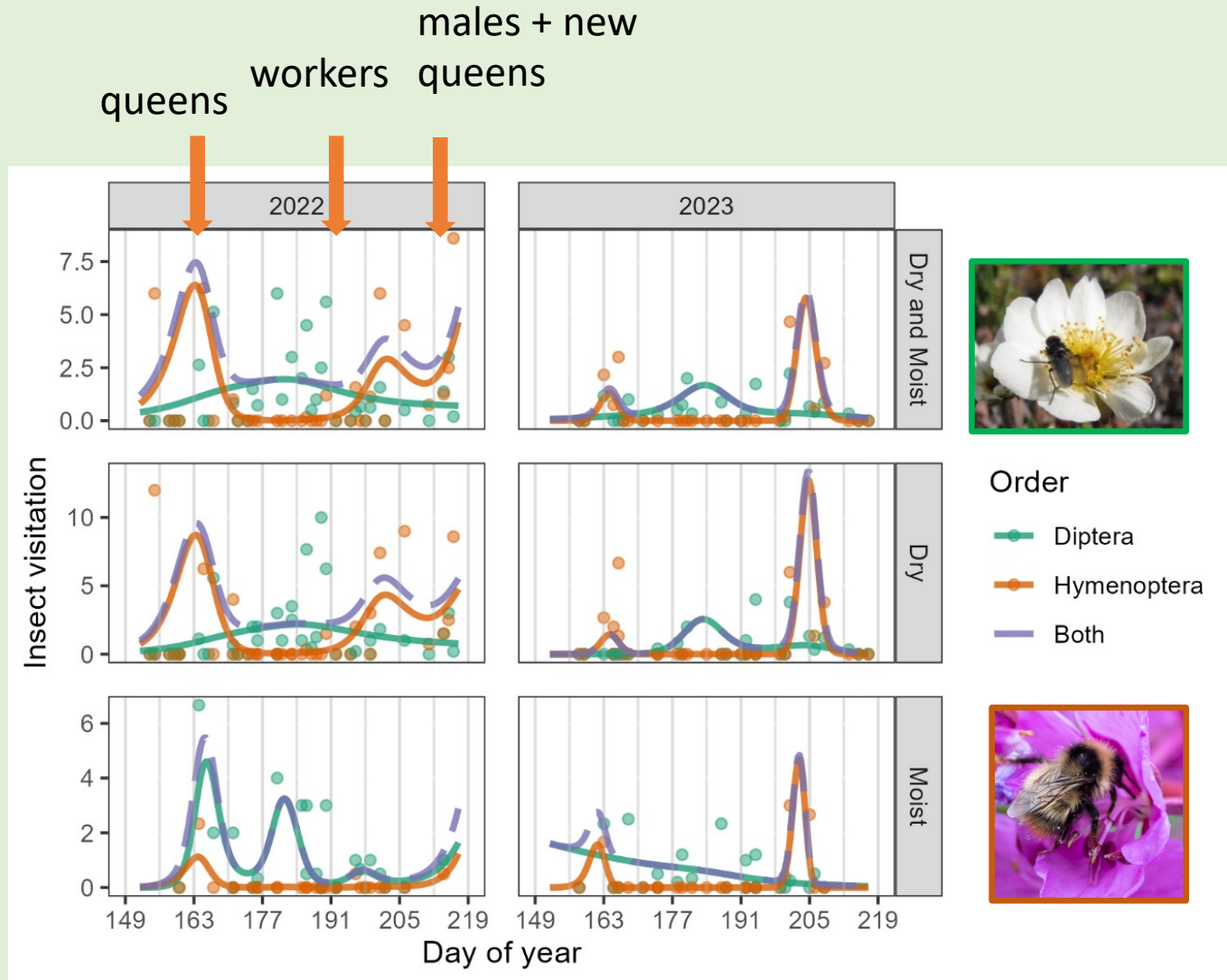
1. # of spp. in bloom peaked earlier in **DHT** than **MAT**
2. # of spp. in bloom was higher in **MAT** than **DHT**



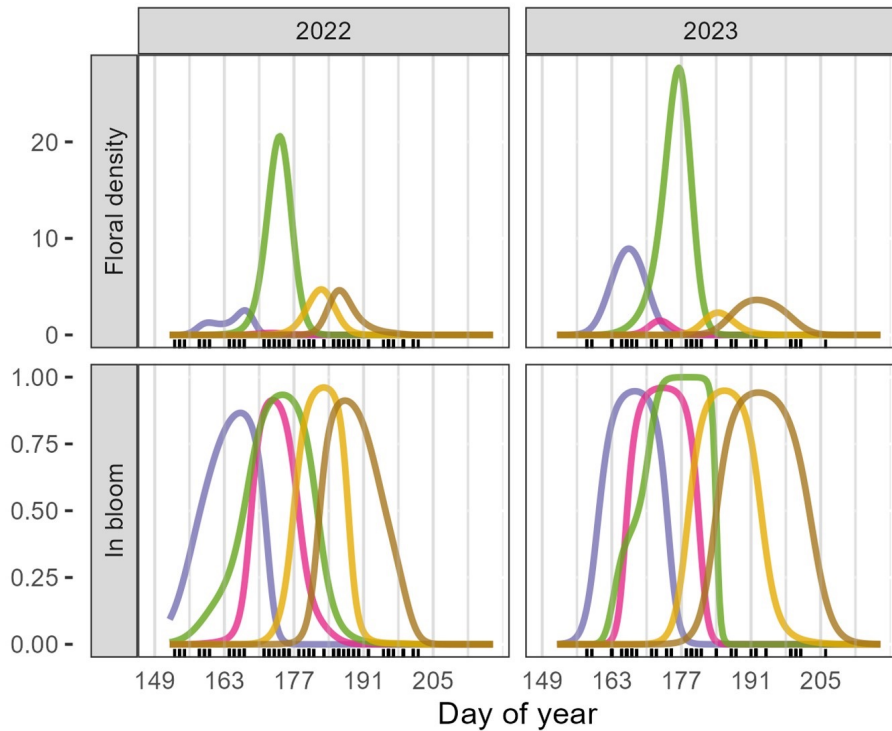
Khorsand et al. (In Review). *Frontiers in Plant Science*.

Spatio-temporal heterogeneity
in floral resources

How does insect visitation vary spatially and temporally throughout the growing season?



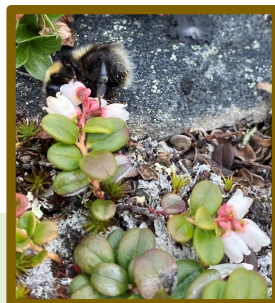
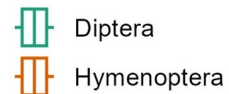
- Bumblebees: bimodal peaks
- Flies: less defined, unimodal peak
- Life history: bees depend on floral resources for their entire life cycle in contrast to flies
- Bees may have higher visitation rates during distinct points in the growing season, but flies are more abundant and account for more *total* visits
- BOTH bees and flies important Arctic pollinators!



Species



Order

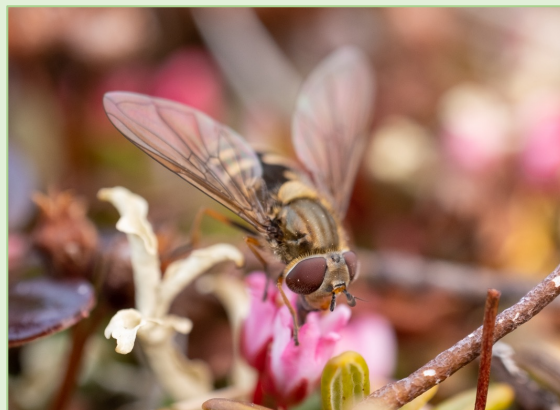


- Trajectory of the flowering season
- 5 species
- Clear sequential pattern in flowering phenology and corresponding visitation
- Specific examples of specialization within the network
- Heterogeneity in the timing and taxa of floral resources lengthens the overall duration of resources available to potential pollinators
- Spatio-temporal **variation in floral resources could potentially buffer the plant-pollinator network** from disturbance



Conclusions:

- Spatio-temporal heterogeneity in floral resources is important for the pollinator community
- Habitat variation is critical to the integrity of the plant-pollinator network and can potentially buffer from phenological mismatch





"If grief can be a doorway to love, then let us all weep
for the world we are breaking apart
so we can love it back to wholeness again."

Robin Wall Kimmerer

