Diverse Habitats Support Resilience in *Rubus idaeus* Pollination and Fruit Production

Sokaris Vanegas-Farrara[1,2] & Katie Spellman[1,3]

1 Climate Scholar Program & International Arctic Research Center, University of Alaska Fairbanks, Fairbanks, Alaska.

2 Department of Biology and Wildlife, 3 Department of Natural Resources and Environment

Author Contact: svanegas@alaska.edu

Introduction

- Berries are a vital part of food systems for humans and other animals in the far north [1,2]
- Alaskans are concerned that berries are changing and that the changes will impact food security [3]
- Heterogeneity in habitats and in cultivars of key berry species, such as raspberries (*Rubus idaeus*), could help provide resilience to food systems in the far north [4]
- This research seeks to determine if heterogeneity in raspberry habitat types and cultivars changes phenology, pollination, and fruit set of raspberry at a household scale, and the potential for this to extend the resource season length or reduce variability

Research Questions

Question 1: Does the timing of flowering and fruiting of raspberries differ between wild and agricultural sites?

Question 2: How do pollinators, pollination, and fruit set differ between forest and agricultural sites?

Methods

Figure 1. Raspberry patch types compared at Ice Wedge Farm near Fairbanks, Alaska included a wild raspberry patch in the forest (photo A, "Wild Forest"), a wild raspberry patch on the edge of the garden (B, "Wild Garden"), and a domesticated variety of raspberry in the garden (C, "Domesticated Garden").

- We established transects in a wild raspberry patch in the forest (A), wild raspberry patch on the edge of the garden, and a domesticated raspberry patch in the garden at a local farm.
- The twelve raspberry individuals tagged at every meter along the transects to track phenology, number of flowers, number of fruit, % flowers turning into fruit (fruit set), fruit and seed (drupelet) production.
- On each stem, one small branch was bagged with fine mesh to exclude pollinators, and a paired control branch, to determine baseline pollinator dependence.
- Pollinators were observed for twenty minutes in 1m x 1m sub-plots in three locations on the transects. We counted the number of pollinators that made contact with the flowers.
- Pollinator observations were done for two consecutive days at early and peak flowering periods.
- To observe phenological differences between patches, we recorded bud, flowering, unripe and ripe fruit, when more than 50% of the plants were at that phenopahse.
- At peak fruiting, fruits from individuals were collected, counted and weighed. We collected all reproductive units from the plant, including remaining buds, flowers and failed flowers, and used these to calculate a second measure of phenology, creating a phenophase index, and more accurately calculating fruit set.

Results

Phenology

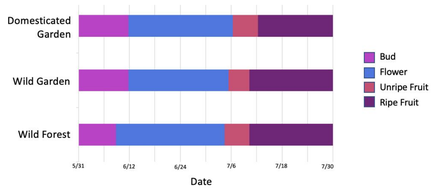

Figure 2. Dates in 2024 when the raspberries in each patch type at Ice Wedge Farm near Fairbanks, AK. Date for each phase indicates when at least 50% of the plants in the patch had flower buds, open flowers, unripe fruit, and ripe fruit.

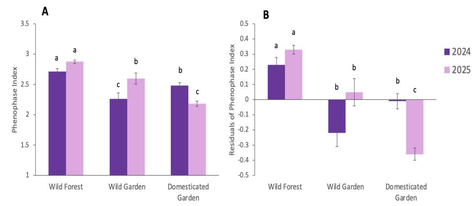

Figure 3. Phenophase index of raspberry branches in different patch types at the time of harvest in 2024 and 2025 (A), and residuals of the phenophase index for each patch type in each year to account for the 11 day difference in harvest date between years (B).

Pollination

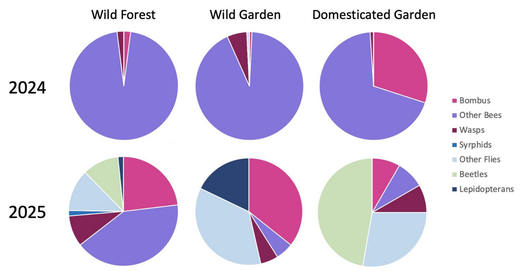

Figure 4. Mean percentage of insect pollinators from different guilds observed pollinating flowers in the three raspberry patch types in 2024 and 2025 during peak flowering.

Figure 5. *Bombus spp.* lands on bagged raspberry plant in the Wild Garden Patch. Though plants could produce fruit with pollinators excluded, the percentage of flowers turning into fruit, total number of fruits, fruit mass, and drupelets per fruit doubled in almost every instance when pollinators had access to the flowers.

Fruit

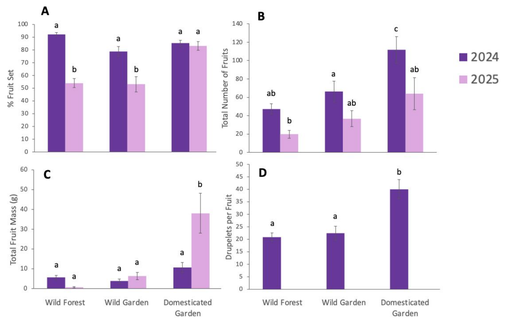

Figure 6. Mean (+ S.E.) % fruit set (A), total number of fruits (B), total fruit mass (C) in 2024 and 2025 and druplets per fruit in 2024 (D). Different letters above the bars indicate significant differences in Tukey post-hoc tests ($P < 0.05$).

Figure 7. Raspberries during peak fruiting in the Domesticated Garden Patch.

Discussion

Phenology - Our data suggests that having a diversity of raspberry patches did lengthen the full time for flowering across the whole Ice Wedge Farm food system by a few days. In both wild garden and wild forest plots, fruiting occurred earlier than in the domesticated plot where fruiting occurred later and sustained further throughout the growing season.

Pollination- We found that both domesticated and wild raspberries had higher fruit and seed set when they were open to pollinators. The types of pollinators varied significantly between years, with other bees dominating pollination in year one, and higher diversity and richness in year two across all patches.

Fruit- We found that domesticated berries have higher fruit set, fruit and seed production, and total fruit mass per stem than wild berries. These fruit and seed variables varied significantly between the two years, possibly driven by higher abundances of bees in 2024.

Takeaways- Finally, the data supports the potential of increasing the berry resource season length by promoting diverse habitats and cultivars on a household property. Further research should replicate this study at other farms or households to see if berry resilience strategy could scale up to a community level.

Citations

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[3]Hupp, J., Brubaker, M., Wilkinson, K., & Williamson, J. (2015). How are your berries? Perspectives of Alaska's environmental managers on trends in wild berry abundance. *International journal of circumpolar health*, *74*(1), 28704.

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