The effects of fire frequency on the reproductive success of buzz-pollinated blueberry (*Vaccinium pallidum*) and huckleberry (*Gaylussacia baccata*)

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Abstract

Fire suppression has dramatically modified wildlands in the United States. Following forest fires, the release of nutrients triggers flowering, seed germination, and the creation of bee nesting habitats. Since fire suppression prevents this regeneration from occurring, pollination services may be diminished as well. The focus of our project is to determine the effects of fire on the reproductive success of two buzz-pollinated plant species, blueberry (*Vaccinium pallidum*) and huckleberry (*Gaylussacia baccata*). Our prediction is that fire will increase the reproductive success of these plant species through enhanced bee abundance and diversity. To test this, we quantified flower production bee activity along a fire gradient at Brookhaven National Lab. We examined pollination success (the number and diversity of pollen grains on stigmas) and fruiting success. Our results indicate that flower production, bee activity, and plant reproductive success were influenced by fire frequency. However, our results did not support our hypothesis, and instead showed that fire has a significantly negative effect on huckleberry and blueberry reproductive success.

Introduction

- Fire suppression turns pine habitats into closed-canopy forests dominated by oaks and other hardwoods, and hinders the growth of many understory flowering plants [1].
- Prescribed fires help to maintain natural processes in pine barren habitats. Fires release nutrients and reset ecological succession, increasing plant and wildlife diversity.
- Pollinator populations are impacted by the habitat and landscape distributions of floral resources [2], so they may influence pollinator abundance and plant reproductive success.
- Here, we determine the effects of fire on the reproductive success of buzz-pollinated blueberry (*Vaccinium pallidum*) and huckleberry (*Gaylussacia baccata*).
- We inferred that fire will increase flower production due to nutrient release, and fruit through enhanced bee abundance and diversity.

Methods and Materials

- Four 15-acre sites were set up along a fire gradient at Brookhaven National Laboratory (Fig. 1A).
- We quantified flower density of *Gaylussacia baccata* (Fig. 1B and C) and *Vaccinium pallidum* (Fig. 1D and E) in 12 plots per site throughout the flowering season.
- To determine bumblebee density, we collected bees from each site via netting surveys.
- We quantified pollination services by surveying pollination (stigma pollen loads) and fruiting success (Fig. 2A and B) for .
- Mixed-effect general linear model, with fire as a fixed effect and plant species as a random effect

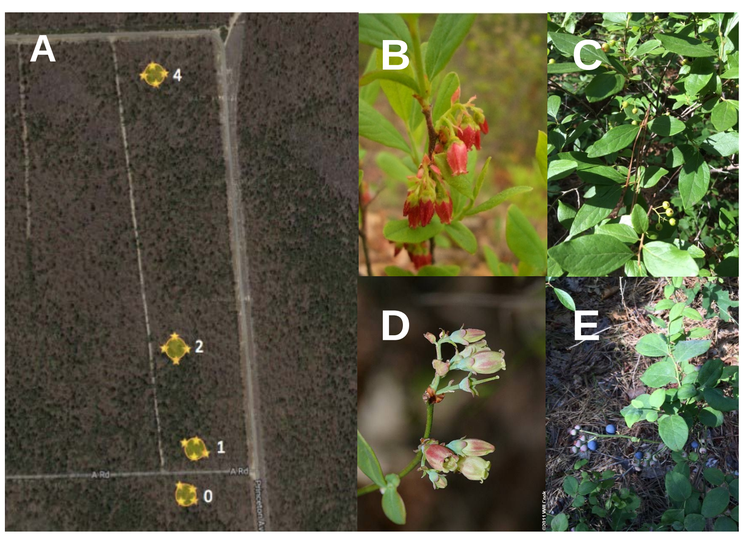

Figure 1. Map (A) showing the four study populations of *Gaylussacia baccata* (B: flowers, C: fruits) and *Vaccinium pallidum* (D: flowers, E: fruits) in the Pine Barrens at Brookhaven National Lab (Photo credits: http://plants.usda.gov and http://www.carolinanature.com).

Results

- Bee density was directly correlated with flower abundance ($F_{1,1}$ = 161.28, P = 0.050; Fig. 2A) and indirectly correlated with fire frequency ($F_{1,1}$ = 18.59, P = 0.15; Fig. 2B).
- Fire has a marginally significant negative effect on pollination success (number of conspecific pollen grains on the stigmas) ($F_{1,18}$ = 2.70, P = 0.12; Fig. 3A).
- However, there was no effect on the amount of foreign pollen found on the stigmas ($F_{1,18}$ = 0.047, P = 0.83; Fig. 3B).
- No relationship was found between the amount of conspecific and foreign pollen present on the stigmas (t_{19} = -0.051, P = 0.96; data not shown).
- Contrary to our predictions, fire had a negative effect on fruiting success ($F_{1,69}$ = 61.53, P< 0.0001; Fig. 4A)
- As expected, fruit set was positively correlated with bee density ($F_{1,5}$ = 75.25, P = 0.0003; Fig. 4B), indicating that they estimate pollination services.

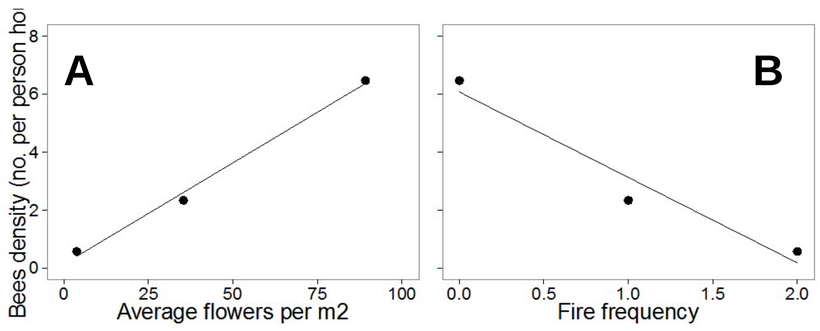

Figure 2. Flower density (A) and fire frequency (B) influence bee density (number of bees collected per person hour).

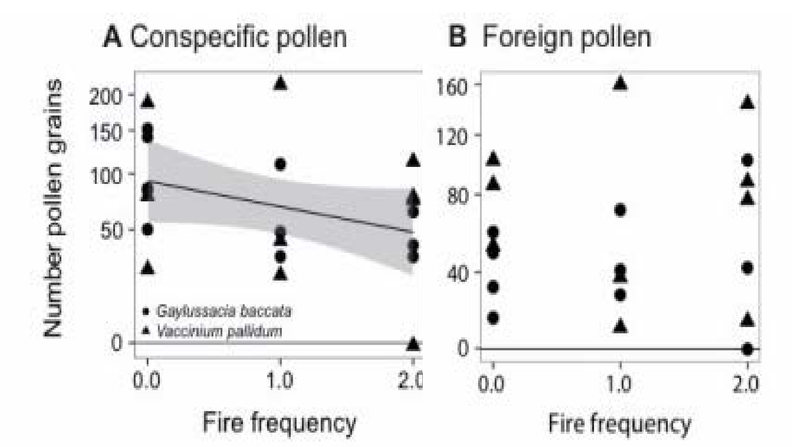

Figure 3. Pollination success in two plant species, *G. baccata* and *V. pallidum*, along a fire gradient. Conspecific pollen deposition was negatively correlated with fire frequency (A), but heterospecific (foreign) pollen deposition was independent of fire frequency (B).

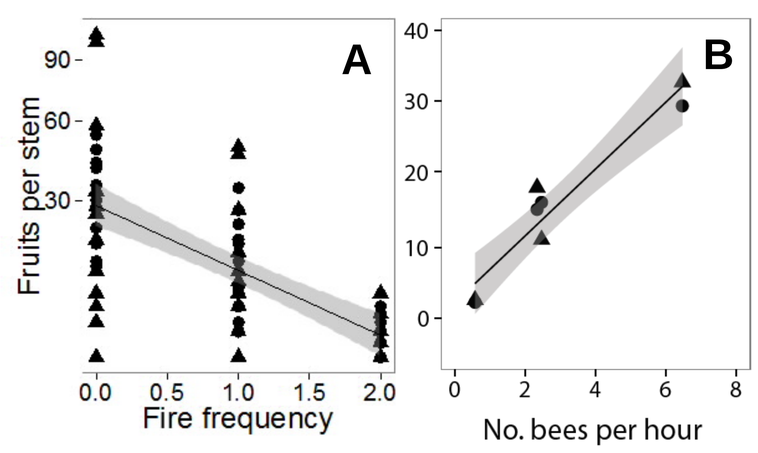

Figure 4. Fruit production (number of fruits per stem) of *G. baccata and V. pallidum* was correlated with fire frequency (A) and the number of bees per hour (B).

Discussion

- Our hypothesis that fire would increase flower production and fruiting success was not supported.
- Conspecific stigma loads were greater when fire was less frequent (Fig. 3A).
- Lower bee density in frequently burned sites (Fig. 2B) likely lead to lower fruit production (Fig. 4).
- The lack of a relationship between foreign pollen deposition (Fig. 3B) suggests wind-pollinated plants may be less affected by fire than insect-pollinated plants.
- Understanding the effects of fire on pollinator populations is important given recent insect declines and the prevalence of fire suppression [1].
- While fire seems to inversely relate to fruit set, inter-annual variation in precipitation may confound this relationship.

References

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[2] Geib, JC., Strange, JP., Galenj, C. "Bumble bee nest abundance, foraging distance, and host-plant reproduction: implications for management and conservation." *Ecological Applications* 25. 3 (2015): 768-778. PubMed. Web. 5 Aug. 2016.

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