Little cost of reproduction in the long-lived perennial, *Echinacea angustifolia*

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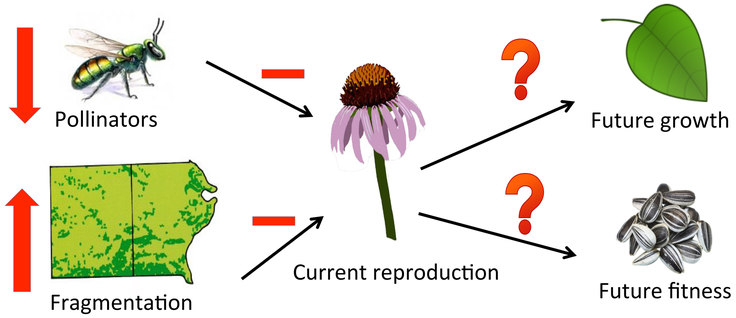
Background

- Landscape fragmentation, changing fire frequency, and decreased pollinator abundance are exacerbating pollen limitation in tallgrass prairies.
- However, according to the Cost of Reproduction Hypothesis, present pollen limitation might lead to increased growth or fitness of perennial plants in years following pollen limitation.



- To address how present pollen availability affects tallgrass prairie plants' future outlook, we compared important growth and fitness traits of *Echinacea angustifolia* (family: Asteraceae), a long-lived, self-incompatible, iteroparous, forb in western Minnesota.

Question

How do pollen exclusion and pollen addition affect future growth and fitness in *Echinacea angustifolia*?

Methods

- **Treatments:** Beginning in 2012 and 2013, three treatments were randomly applied to *Echinacea*:
  1) Pollen addition: hand pollinated and bagged
  2) Pollen exclusion: bagged
  3) Open pollination: untouched
- **Measurements:** Leaf length, leaf count, and rosette count were used to approximate growth. Achene (fruit) count, flowering frequency, and survival were used to approximate fitness.


Pollen excluded from *Echinacea*

Results

1. Pollination treatment largely does not affect *Echinacea* growth.

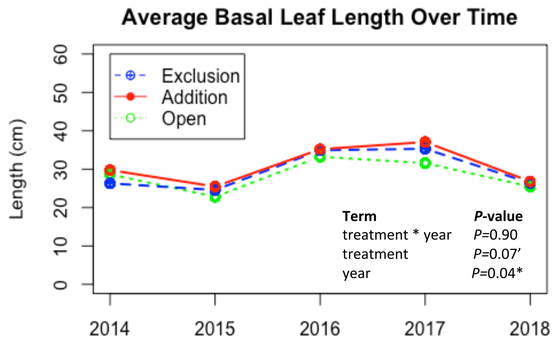


Figure 1. Evidence for an effect of year and marginal evidence for an effect of treatment on basal leaf length. We used backwards elimination to select the best linear model.

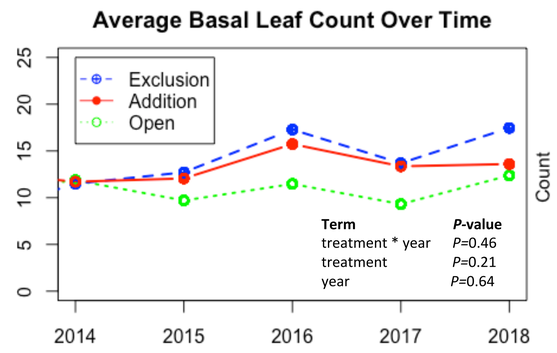


Figure 2. No evidence for effect of treatment or year on basal leaf count. We used backwards elimination to select the best generalized linear model (quasipoisson family).

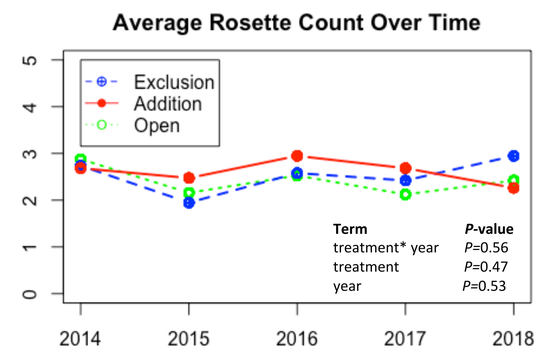


Figure 3. No evidence of effect of treatment or year on basal rosette count. We used backwards elimination to select the best generalized linear model (quasipoisson family).

2. Pollination treatment has mixed effects on *Echinacea* fitness.

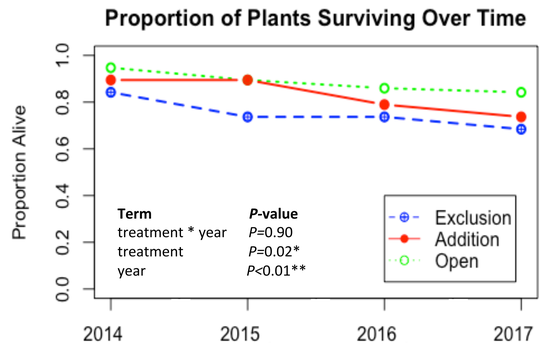


Figure 4. Evidence for effects of treatment and year on survival. We used backwards elimination to select the best generalized linear model (binomial family).

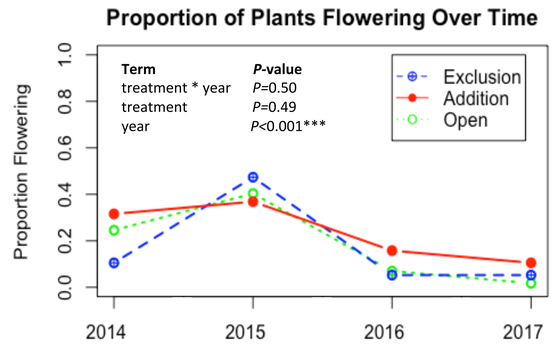


Figure 5. Evidence for effect of year, but not of treatment, on flowering. We used backwards elimination to select the best generalized linear model (binomial family).

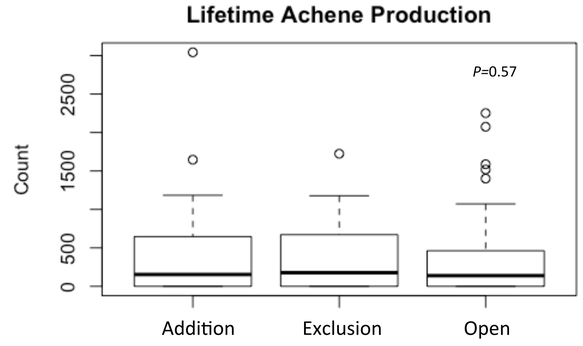


Figure 6. No evidence for effect of treatment on lifetime achene production. Data were non-normal. A Kruskal-Wallis test revealed no difference between treatments (P=0.57)

Discussion

- Pollen exclusion and addition had mixed effects on future growth and fitness in *Echinacea*, compared to the open control.
- Pollen exclusion did not affect *Echinacea* in consistent, or predictable ways, suggesting that current pollen limitation will not enhance *Echinacea* growth or fitness in future years.
- Lack of pollination treatment effects could be because *Echinacea* is not resource limited or because seed production is inexpensive compared to generation of the large floral reproductive structure and achenes, which are produced regardless of if pollination occurs.

Conclusions/Future Directions

- *Echinacea* displays little evidence of costs to reproduction, and therefore will likely not experience future benefits of present pollen limitation.
- Future studies should quantify the extent of pollen limitation in *Echinacea*.

Acknowledgments

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