

## Introduction

*E. angustifolia* is a model system for habitat fragmentation

- Disc florets emerge in a concentric ring that moves each day from the outer edge towards the center.
- Pollen availability, not pollinator visitation, limits reproduction, yet pollinators may visit Echinacea heads erratically.
- Styles, the plant's pollen receptor, shrivel upon pollination and persist in absence of pollen (Figures 2 & 3).
- Florets use a self-incompatible pollination system.
- The impacts of style age, floret position, and sporadic pollen are not yet well understood.



Figure 1. *E. angustifolia* head.



Figure 2. *E. angustifolia* before receiving pulse pollination treatment (A) and after receiving pollen (B). The shriveling of styles is noticeable between the pre-pollination and post-pollination photos.

Figure 3. *E. angustifolia* disc florets on its third day flowering. Within the disc florets, there are persisting styles in Row 1 (A), fresh styles in Row 2 (B), and new anthers in Row 3 (C).

## Methods

- I selected 21 flowering heads on 20 plants
- I randomly assigned a pollination treatment: Pulse or steady
  - Pulse: Styles in Rows 1-7 received pollen on flowering day 8, so there was an array of style ages.
  - Steady: Each row received pollen on its first flowering day, so all styles were fresh.
- I applied pollinator exclusion bags to remove confounding pollinator services (Figure 4).
- To ease pollen application, I painted bracts of rows 1, 3, 5, and 7 pink, white, aqua, and green, respectively (Figure 5).
- I pollinated 1980 styles over 19 days in July 2017.
- 2 days after pollination, I counted styles shriveled to assess shriveling and pollination rate.



Figure 4. Pollinator exclusion bag twist-tied over an *E. angustifolia* head on its first day flowering. Only the outermost anthers are present.



Figure 5. Bracts painted within an *E. angustifolia* head

## Results

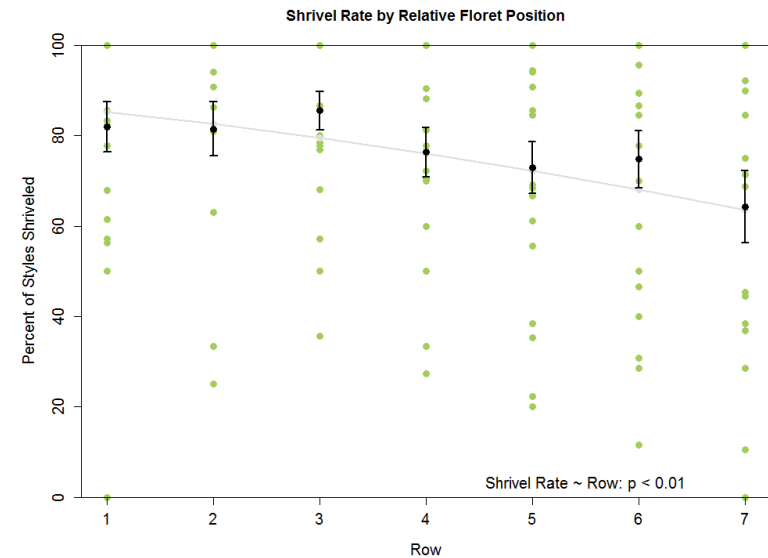


Figure 7. Style shriveling differs among rows ( $n=21$ , mean $\pm$ SE). A generalized linear model analysis found that row number ( $p < 0.01$ ), not style age ( $p > 0.05$ ) or pollination treatment ( $p > 0.05$ ) influenced pollination rates ( $p < 0.01$ ). All shriveling rates by row are shown in green, GLM continuous model is shown by a gray line, and averages and their standard errors are shown in black.

- Relative floret position within a flowering head best indicates pollination rate as indicated by style shriveling (Figure 7, GLM,  $p < 0.01$ ).
- There is no evidence that style age or pollination treatment influence style shriveling ( $p > 0.05$ ).

## Discussion, Conclusions, & Implications

- Surprisingly, the only factor influencing style shriveling rate or pollination was relative floret position within a flowering head (Figure 7).
- These results indicate resource allocation may play a large role in reproduction.
- Experimental design limited examination of age and treatment, as pulse treatment styles were all fresh.
- Some styles in row one of the pulse treatment lacked the turgidity of those in the upper rows.
- Seed set information will be collected in January of 2018.
  - This information will further elucidate the role of relative floret position, pollination treatment, and style age on reproduction.

## References

- Wagenius, S. & Lyon, S. P. (2010). Reproduction of *Echinacea angustifolia* in fragmented prairie is pollen-limited but not pollinator-limited. *Ecology*, 91(3): 733-742.
- Wagenius, S. (2004). Style persistence, pollen limitation, and seed set in the common prairie plant *Echinacea angustifolia* (Asteraceae). *International Journal of Plant Science*, 165(4): 595-603.

## Acknowledgments

The National Science Foundation (awards 1557075 & 1555997) funded this Research Experience for Undergraduates program of the Echinacea Project. <http://echinaceaproject.org/>