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.

### 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.

### 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.](image1)

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

![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).](image2)

![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).](image3)

### 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*.

### References

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