Measuring pollinator effectiveness in composites: A case study with *Echinacea angustifolia* and native bees

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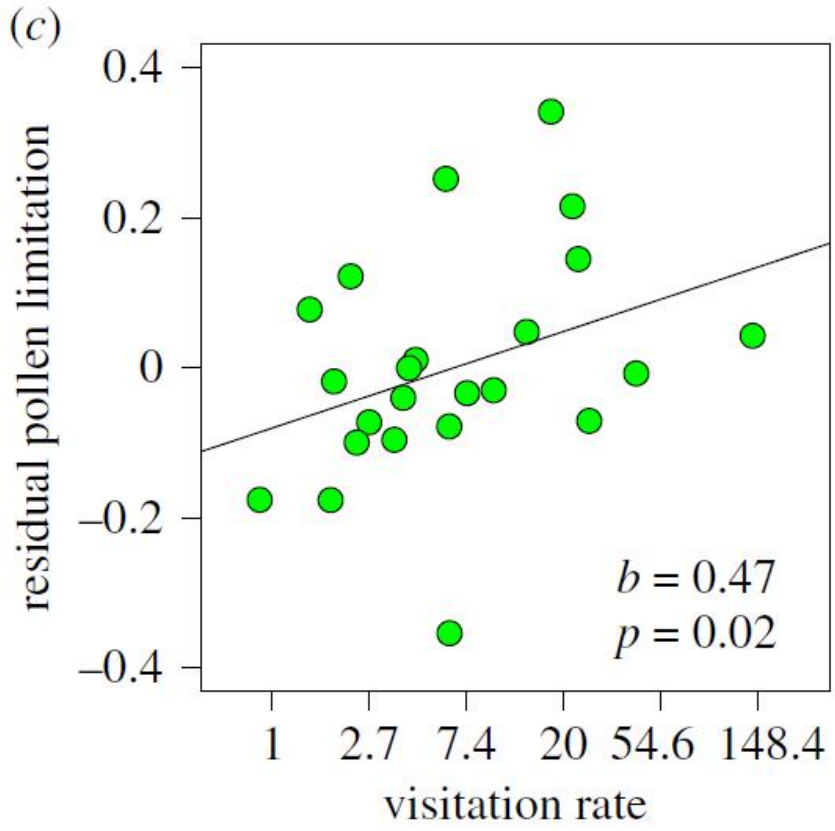
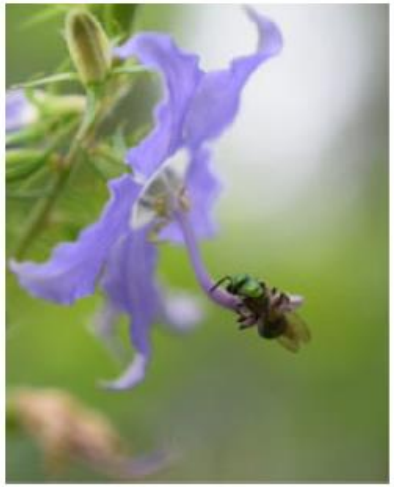
Flower visitors often vary in their pollinator effectiveness — per-visit contribution to a plant's reproductive fitness

https://www.fs.fed.us/wildflowers/features/posters/pollinators.pdf

Consequences of visits by ineffective pollinators



small bees



Linking pollinator efficiency to patterns of pollen limitation: small bees exploit the plant–pollinator mutualism

Matthew H. Koski[1], Jennifer L. Ison[2], Ashley Padilla[2], Angela Q. Pham[1] and Laura F. Galloway[1]

More visits = higher pollen limitation

An ineffective pollinator –a functional parasite

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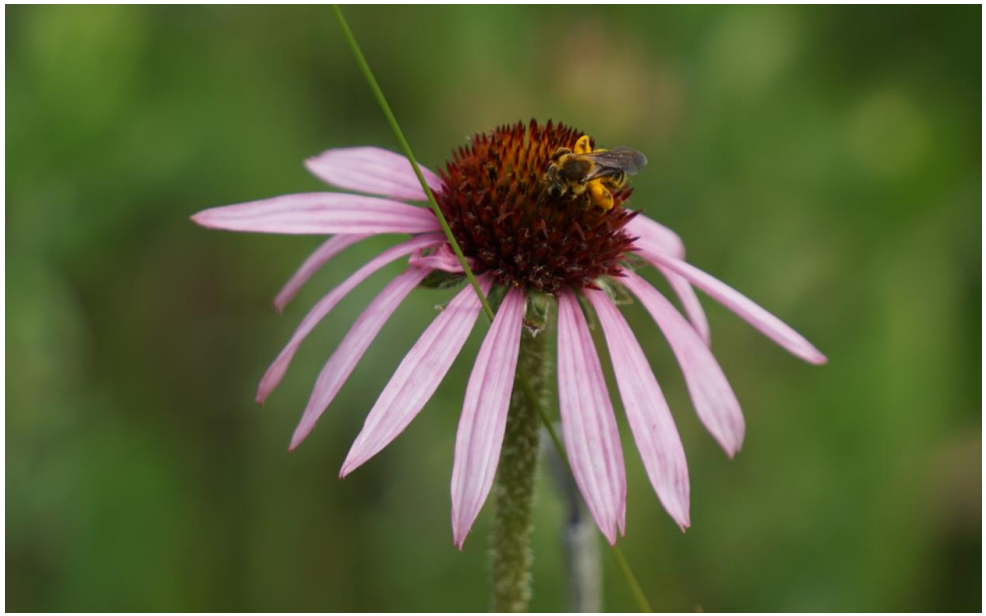
the echinacea project

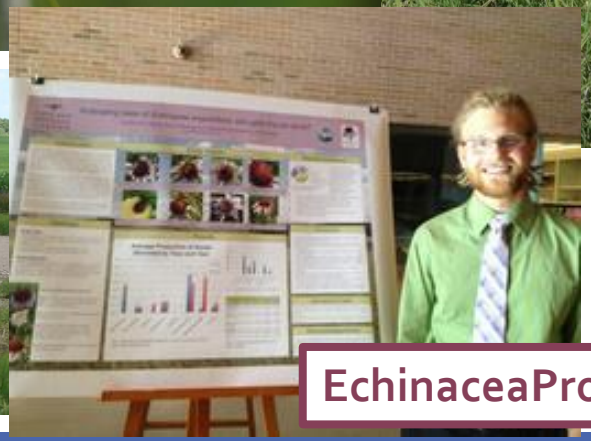
investigating ecology and evolution in fragmented prairie habitat since 1995



Echinacea angustifolia:

- Long-lived perennial
- Self incompatible
- Insect pollinated

EchinaceaProject.org

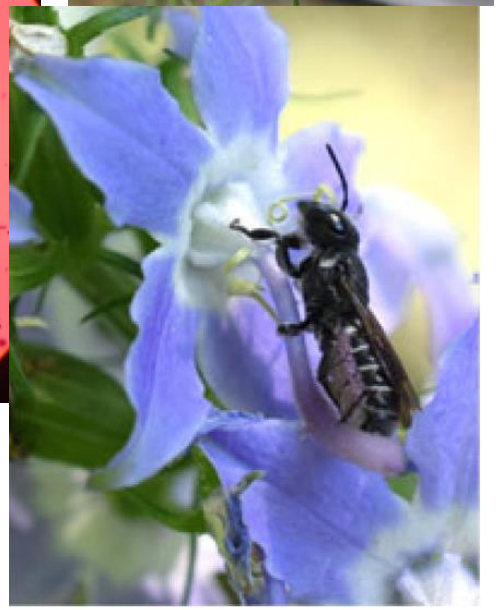


EchinaceaProject.org

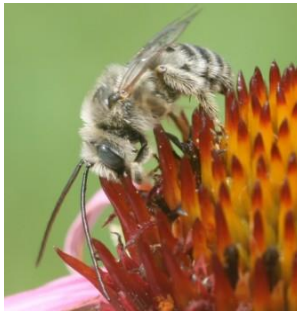
Do *Echinacea*'s pollinators vary in their pollinator effectiveness?

Common measures of per-visit pollinator effectiveness

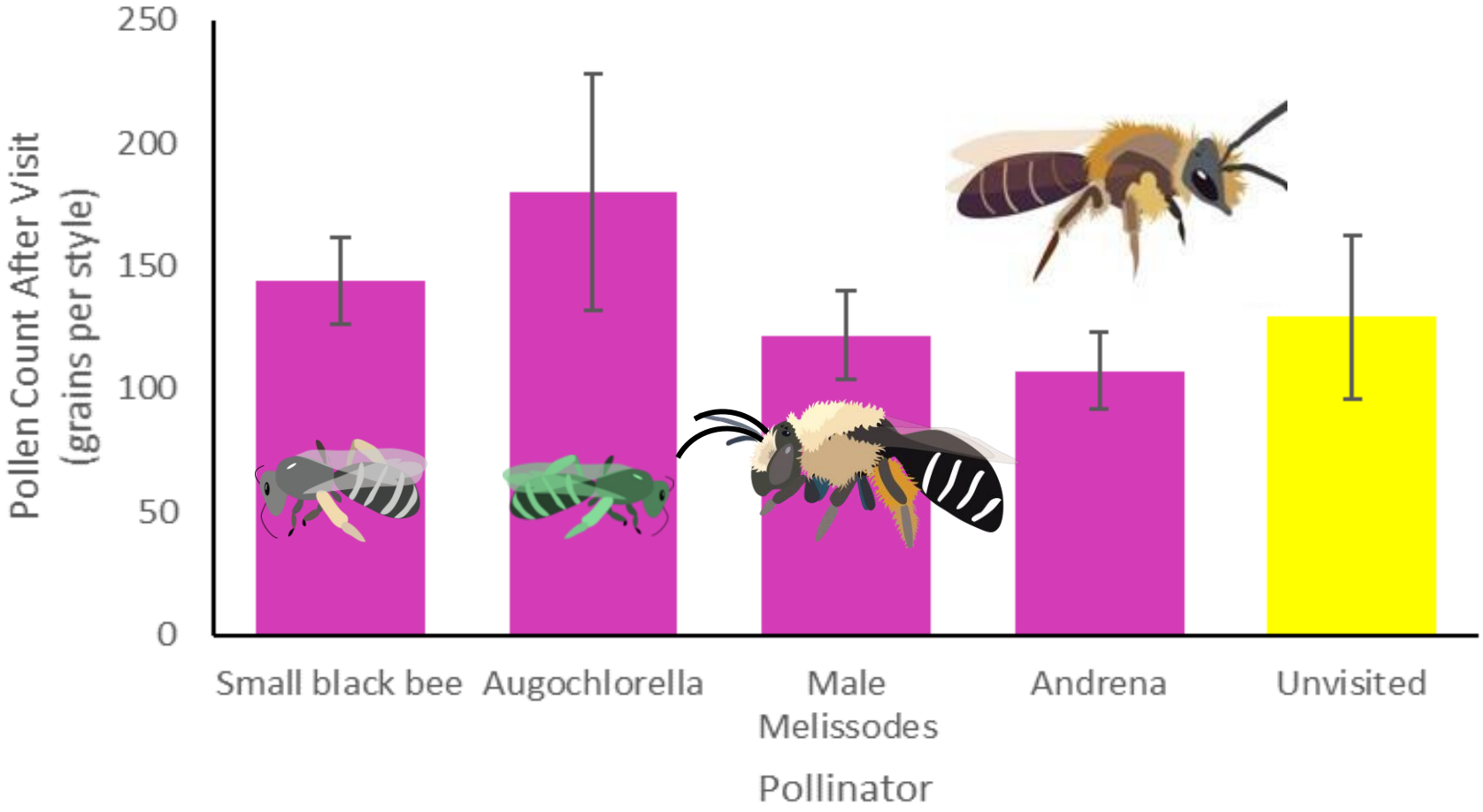
- Number of pollen grains deposited on stigma
- Probability of producing a fruit
- Number of seeds produced
- Seed to ovule ratio
- Pollen removal



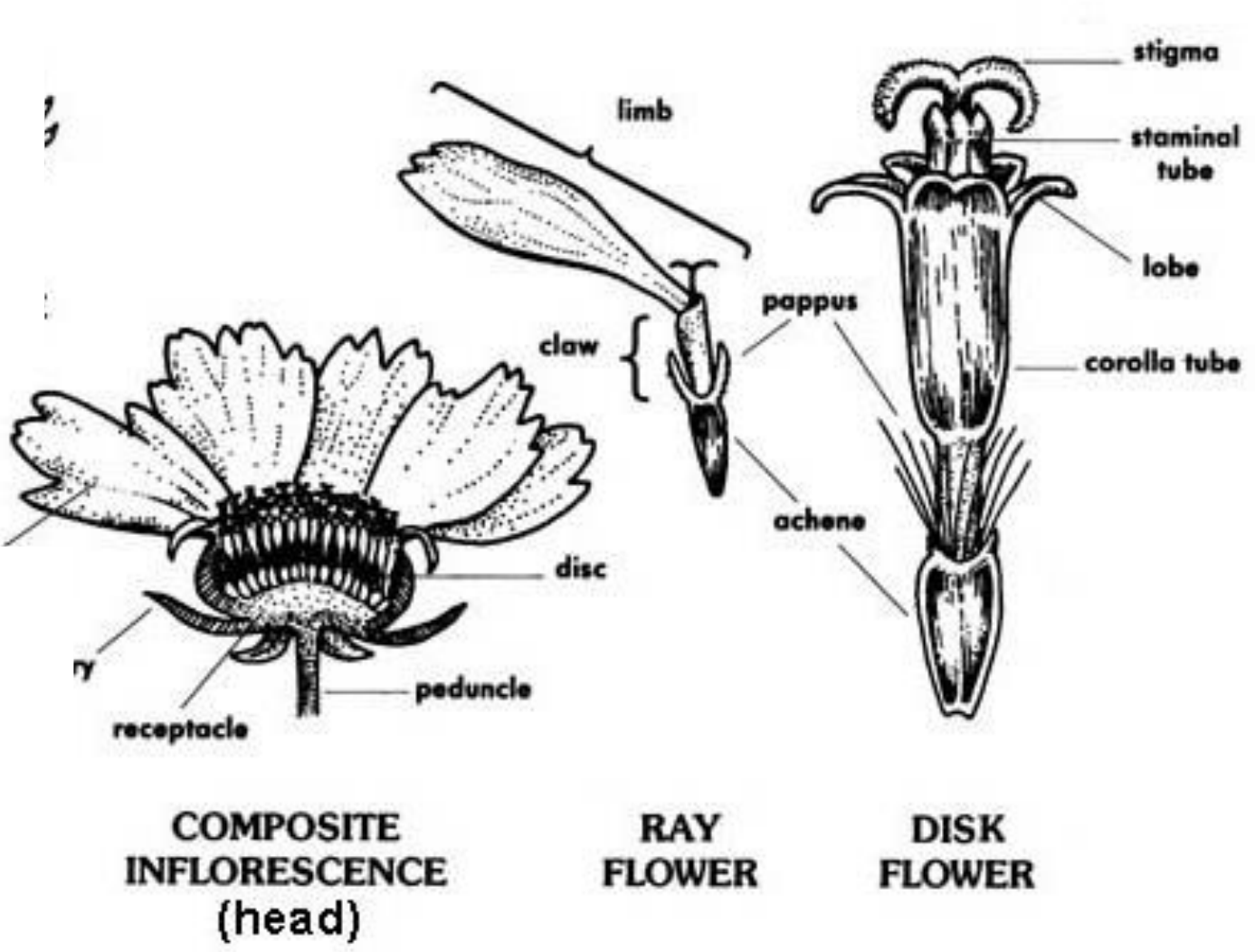
Pollen deposition by different pollinator taxa



There is no difference in the number of pollen grains deposited on a stigma after a single bee visit



Composite florets are uniovulate



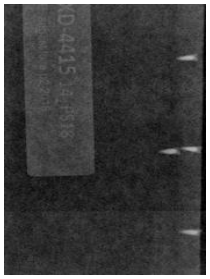
Does the number of pollen grains deposited on a stigma predict seed set?

60 hand crosses (6 florets per cross)

3 styles removed

3 styles left

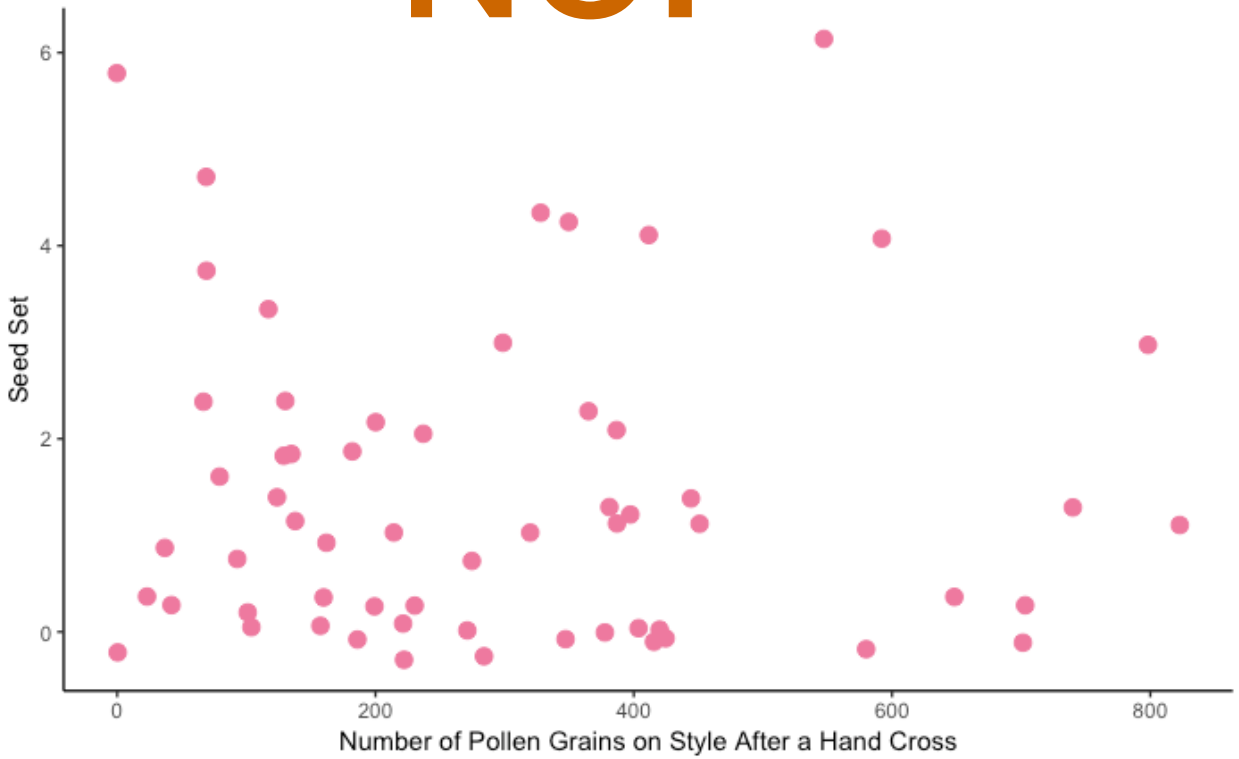
Pollen counted on stigma using microscope



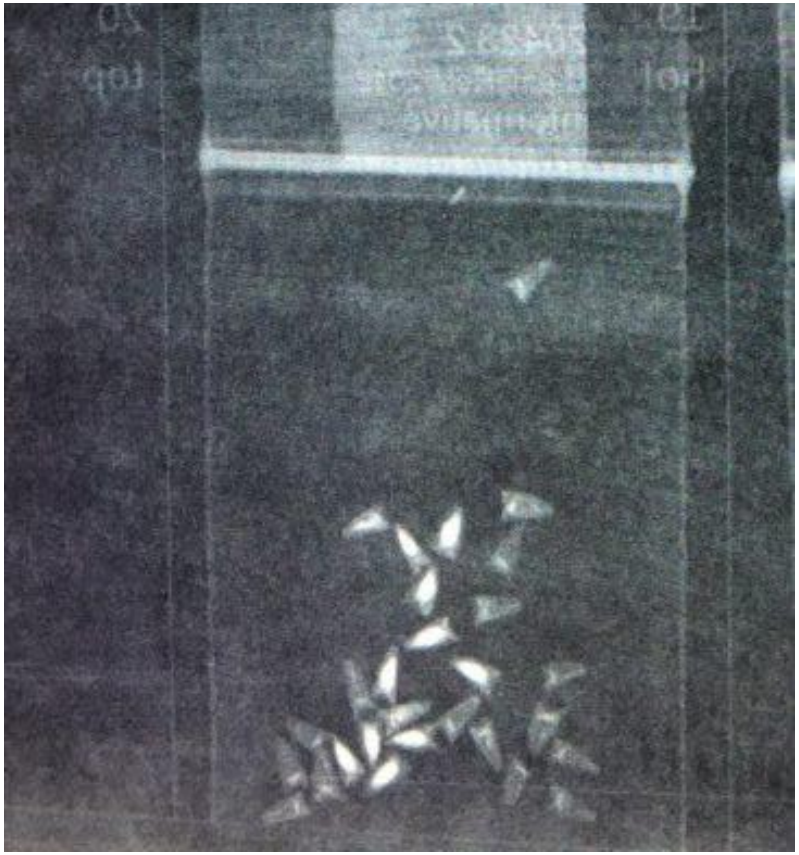
Corresponding fruits x-rayed to determine if seed present

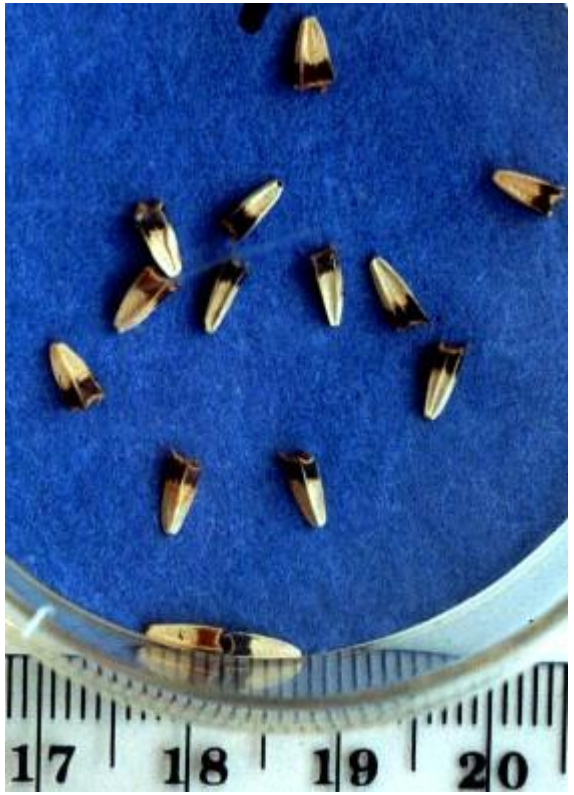
Does the number of pollen grains deposited on a stigma predict seed set?

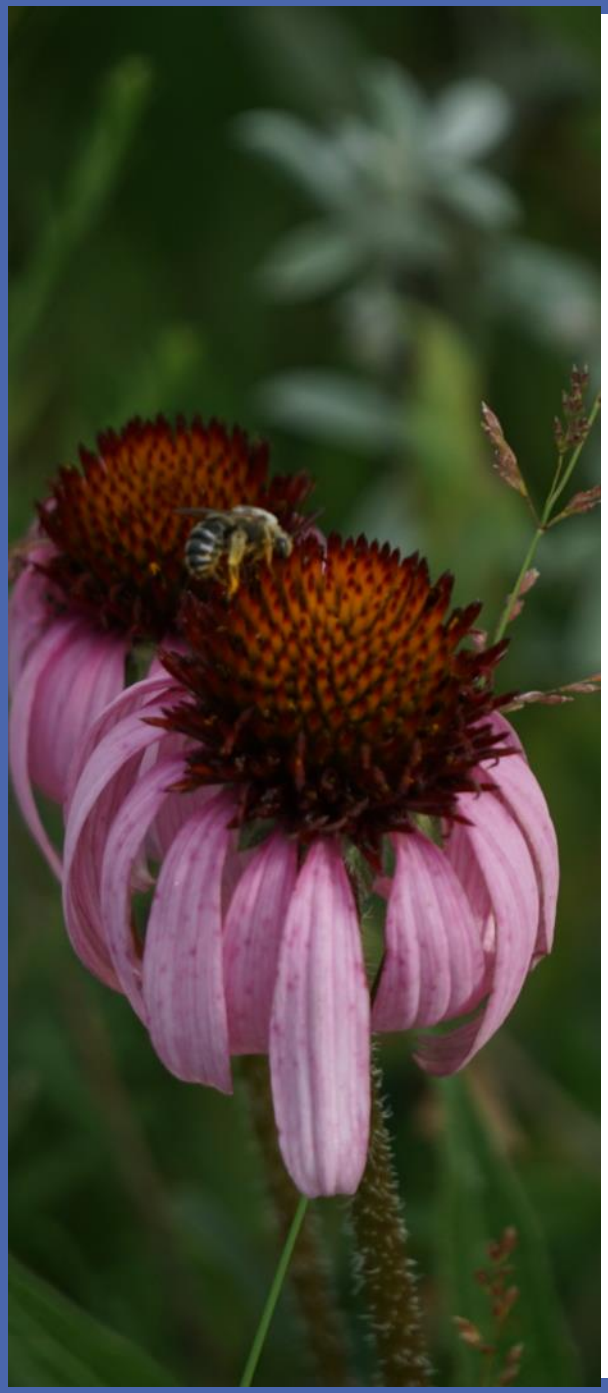
NO!



Achenes (fruits) expand regardless of pollination status





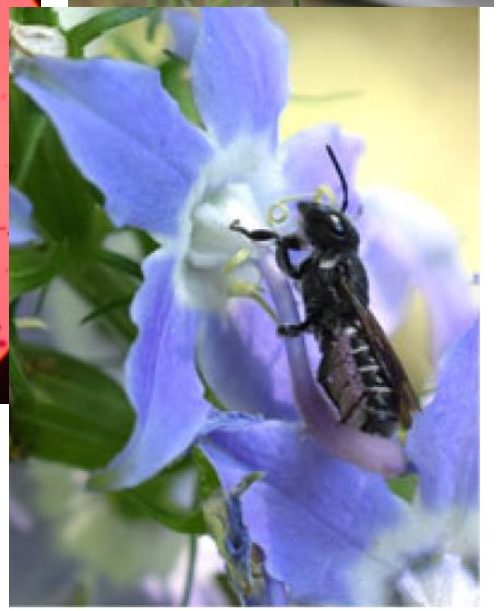


Take-home messages

- **Common pollinator effectiveness measures may not be appropriate in uniovulate systems.**
  - Number of pollen grains deposited on stigma
  - Probability of producing a fruit

Common measures of per-visit pollinator effectiveness

- ~~Number of pollen grains deposited on stigma~~
- ~~Probability of producing a fruit~~
- Style shriveling
- Number of seeds produced
- Seed to ovule ratio
- Pollen removal



Styles that receive compatible pollen shrivel within 24hrs

Well-pollinated

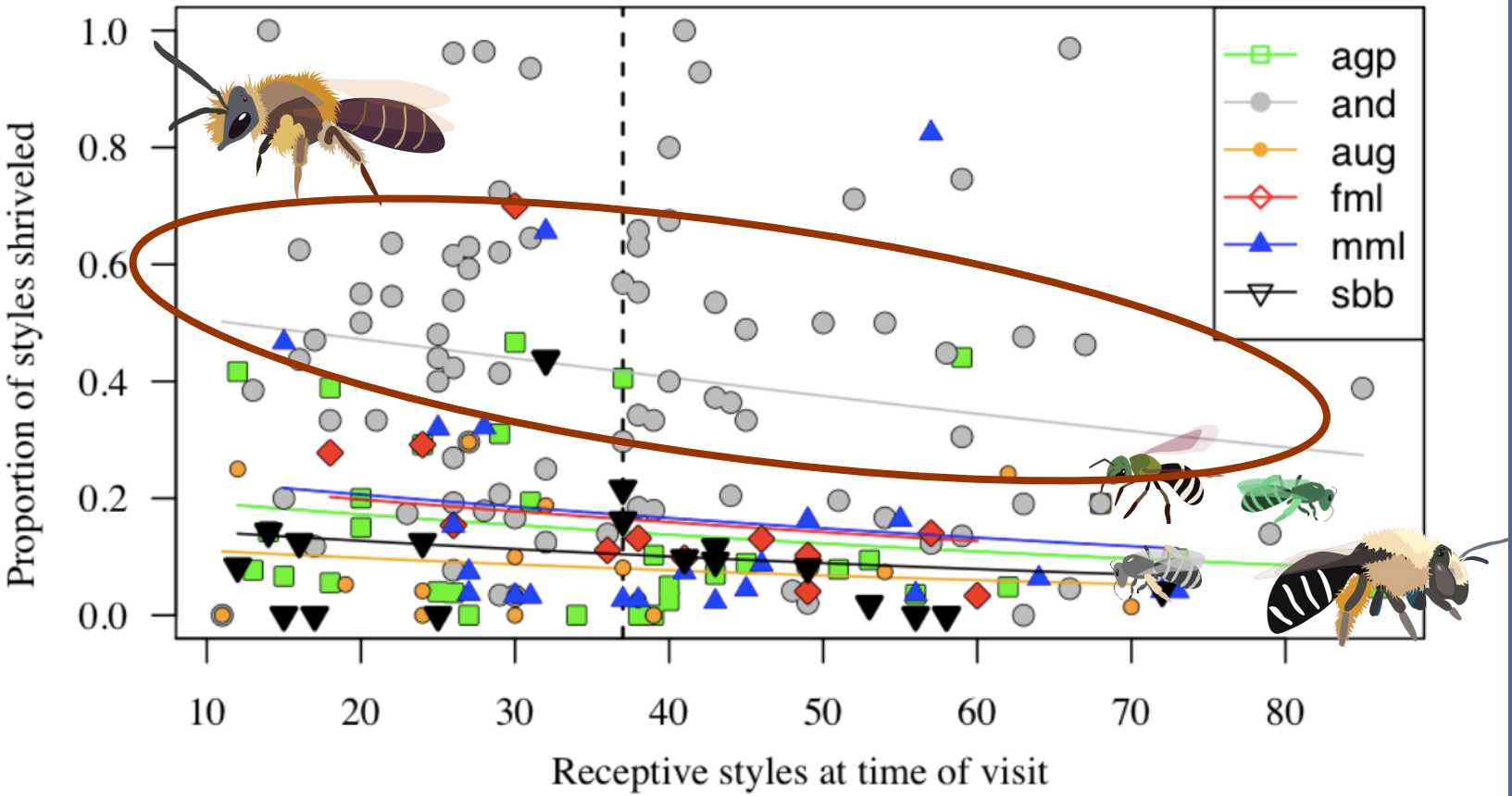
Needs some

Per-visit pollinator efficiency methods

Summers 2010, 2012-2014
229 observations

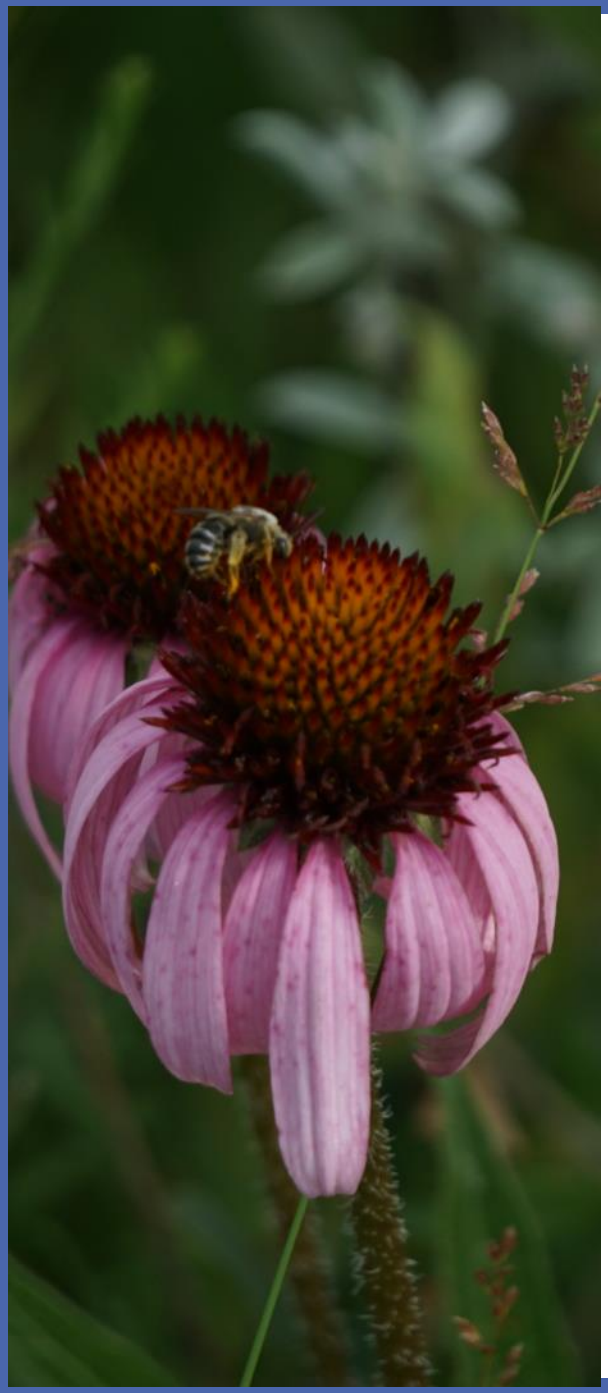
All videos available on Echinacea Project's YouTube channel.
Check them out!!

Per-visit *Andrena* is a significantly more effective pollinator than other bees



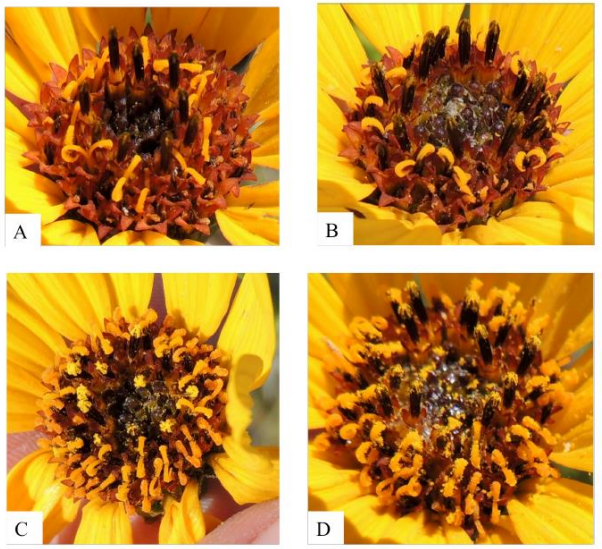
generalized linear model; taxon- $p < 0.001$;
receptive styles available $p = 0.011$; N = 189 visits.

Page et al In Review



Take-home messages

- **Common pollinator effectiveness measures may not be appropriate in uniovulate systems (e.g. composites)**
- **Style shriveling is an straightforward metric of determining compatible pollen receipt in some composites**

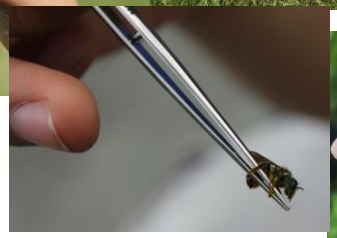


Karen Taira's MS thesis (2013) on 8 *Helianthus* species

Do *Echinacea*'s pollinators vary in their pollinator effectiveness?

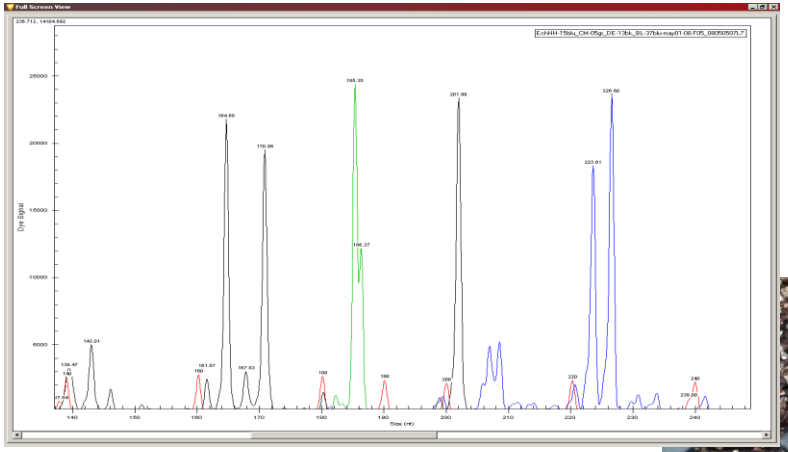
- Quality of the per-visit pollen transferred:
  - Distance pollen is moved
    - Increases likelihood of compatible pollen transfer
  - Number of pollen donors
    - Increases genetic diversity in offspring

Do pollinators differ in the conspecific diversity of pollen they carry?



Sire diversity study (2016):

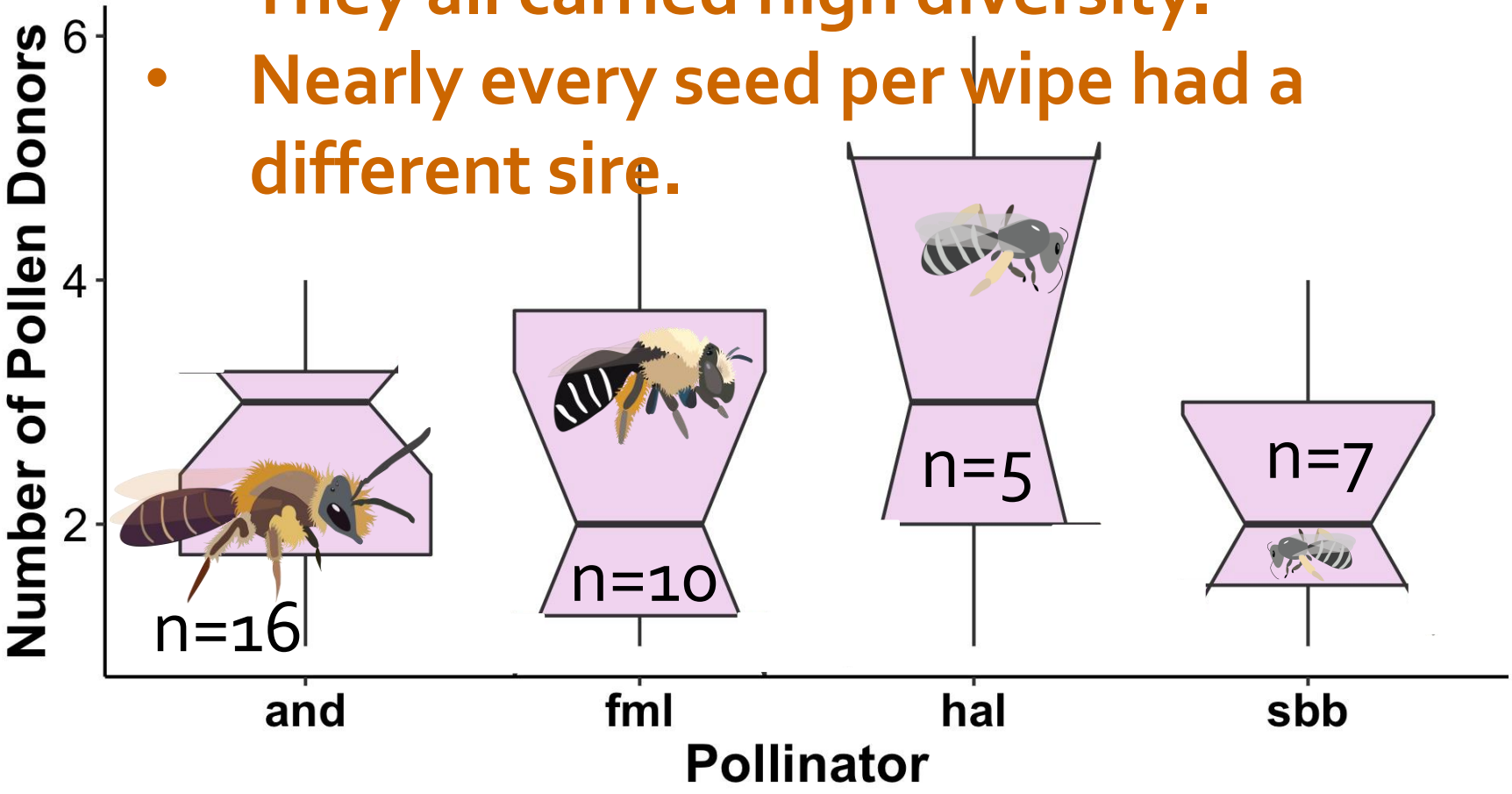
- Conducted 105 ‘wipes’
- Genotyped 122 offspring from 38 ‘wipes’ (had at least 3 offspring)

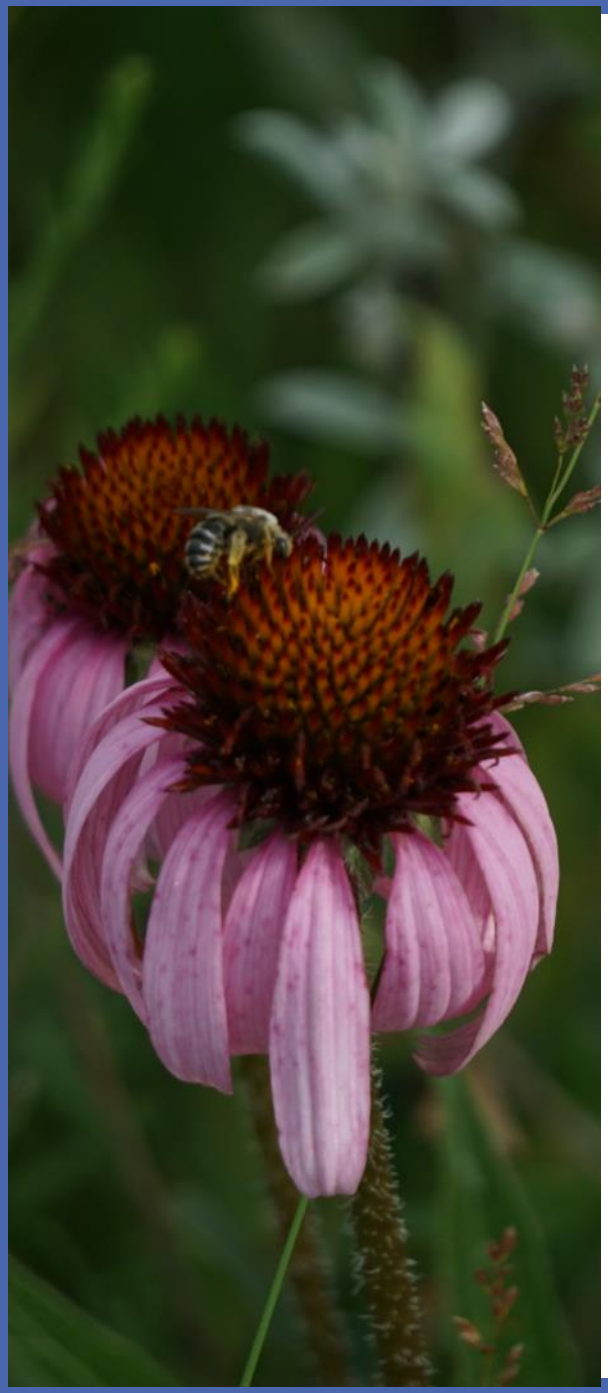


Do pollinators vary in the diversity of conspecific pollen they carry?

NO!

- They all carried high diversity.
- Nearly every seed per wipe had a different sire.



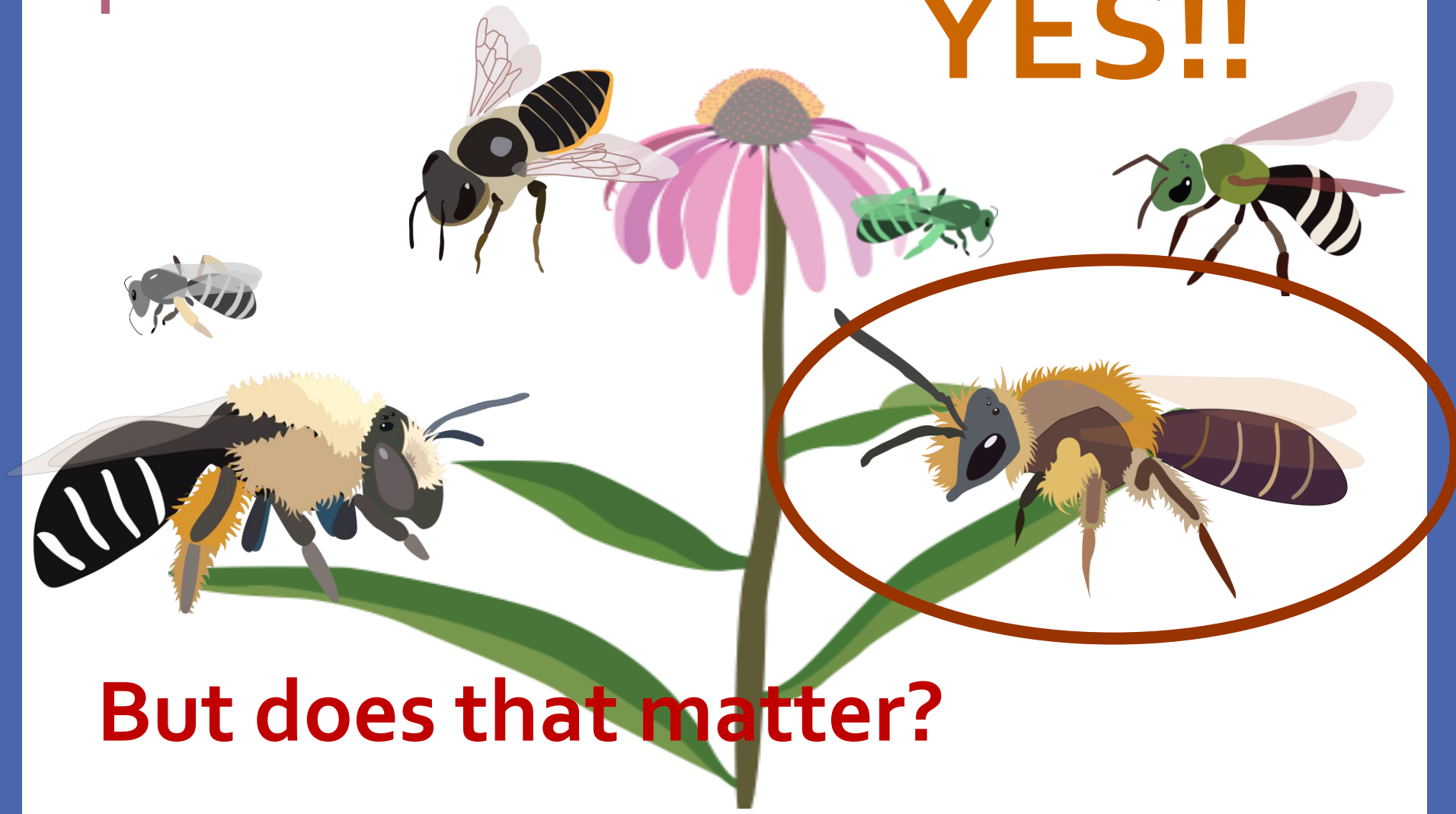


Take-home messages

- Common pollinator effectiveness measures may not be appropriate in uniovulate systems (e.g. composites)
- Style shriveling is an straightforward metric of determining compatible pollen receipt in some composites
- The genetic component should be added to pollinator effectiveness measures

Do *Echinacea*'s pollinators vary in their pollinator effectiveness?

YES!!



But does that matter?

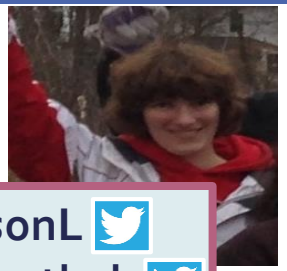
Andrena is only found in larger remnant populations

Pollinator-mediated mechanisms for increased reproductive success in early flowering plants

Jennifer L. Ison, Leah J. Prescott, Scott W. Nordstrom, Amy Waananen and Stuart Wagenius

Oikos
127: 1657–1669, 2018
doi: 10.1111/oik.04882



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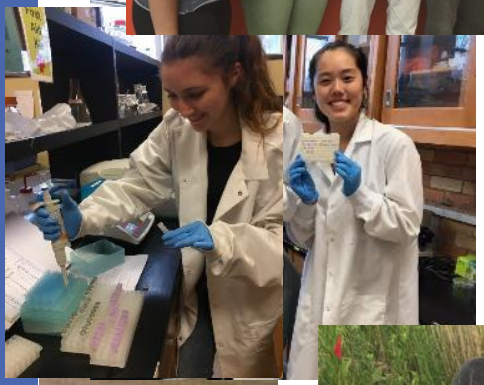
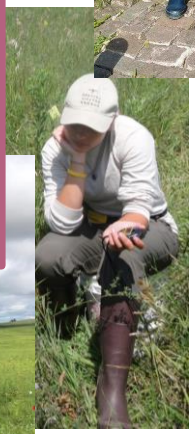




the echinacea project
investigating ecology and evolution in fragmented prairie habitat since 1995

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Pollinator drawings by KJB

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