# The early flower attracts the bee:

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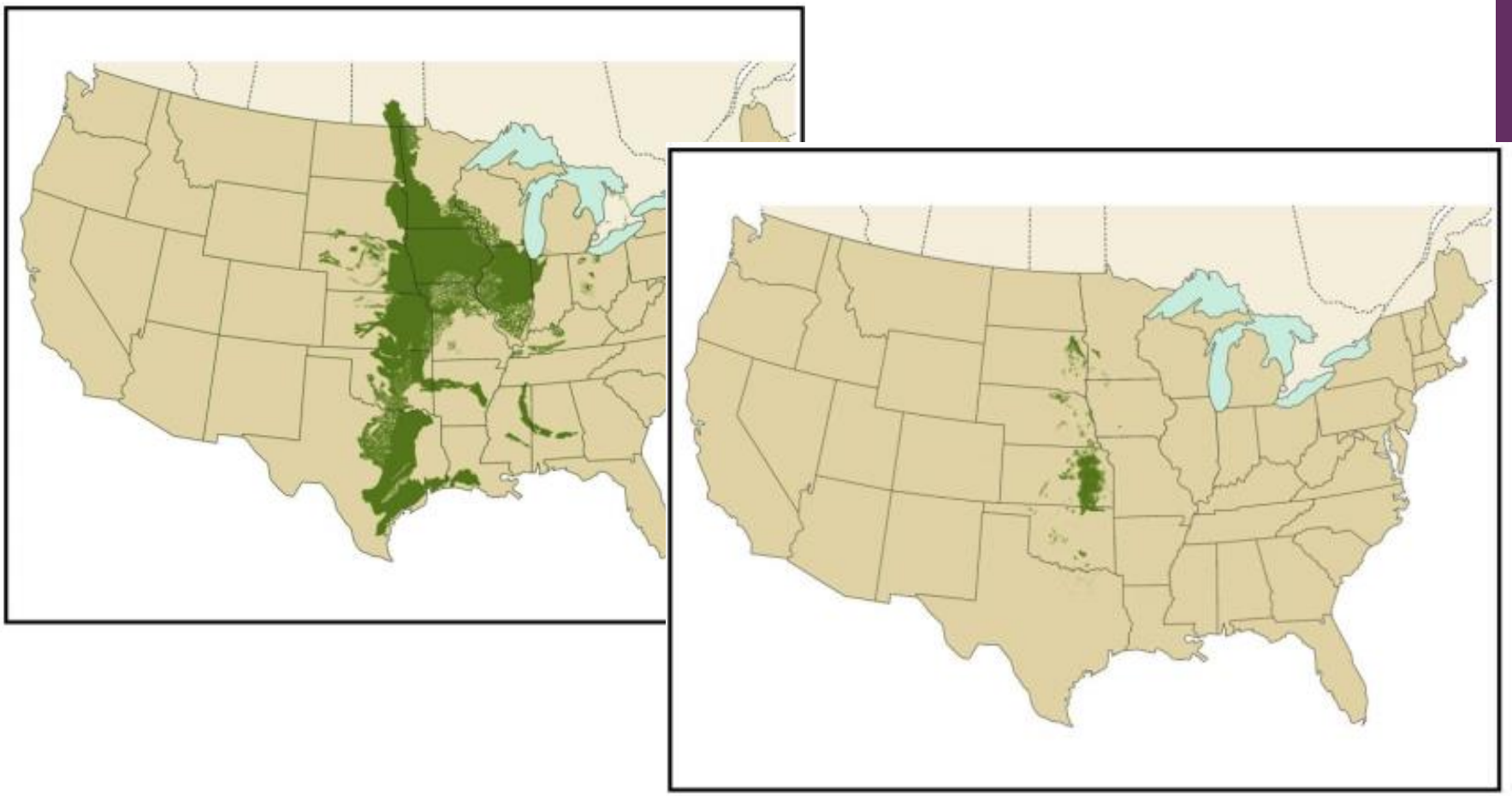
# consequences and mechanisms of phenological isolation in plants

Jennifer L. Ison[1], Leah Prescott[1], Amy Waananen[2], Scott Nordstrom[2], & Stuart Wagenius[2] ([1]The College of Wooster, [2]Chicago Botanic Garden)

# The loss and fragmentation of the tallgrass prairie

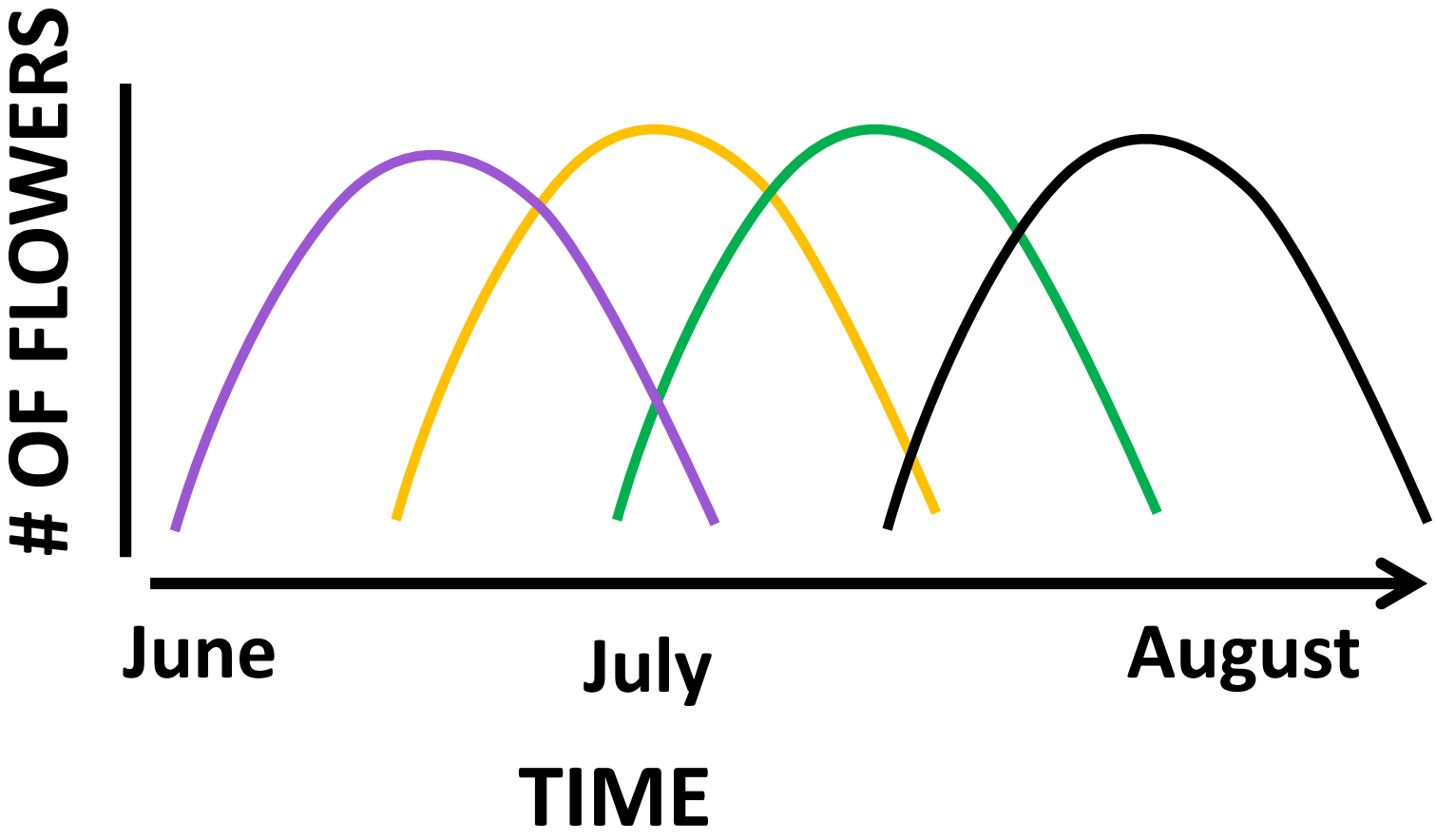


(adapted from Landscape America and the Tallgrass Prairie Center).

# Timing of reproduction can cause temporal isolation

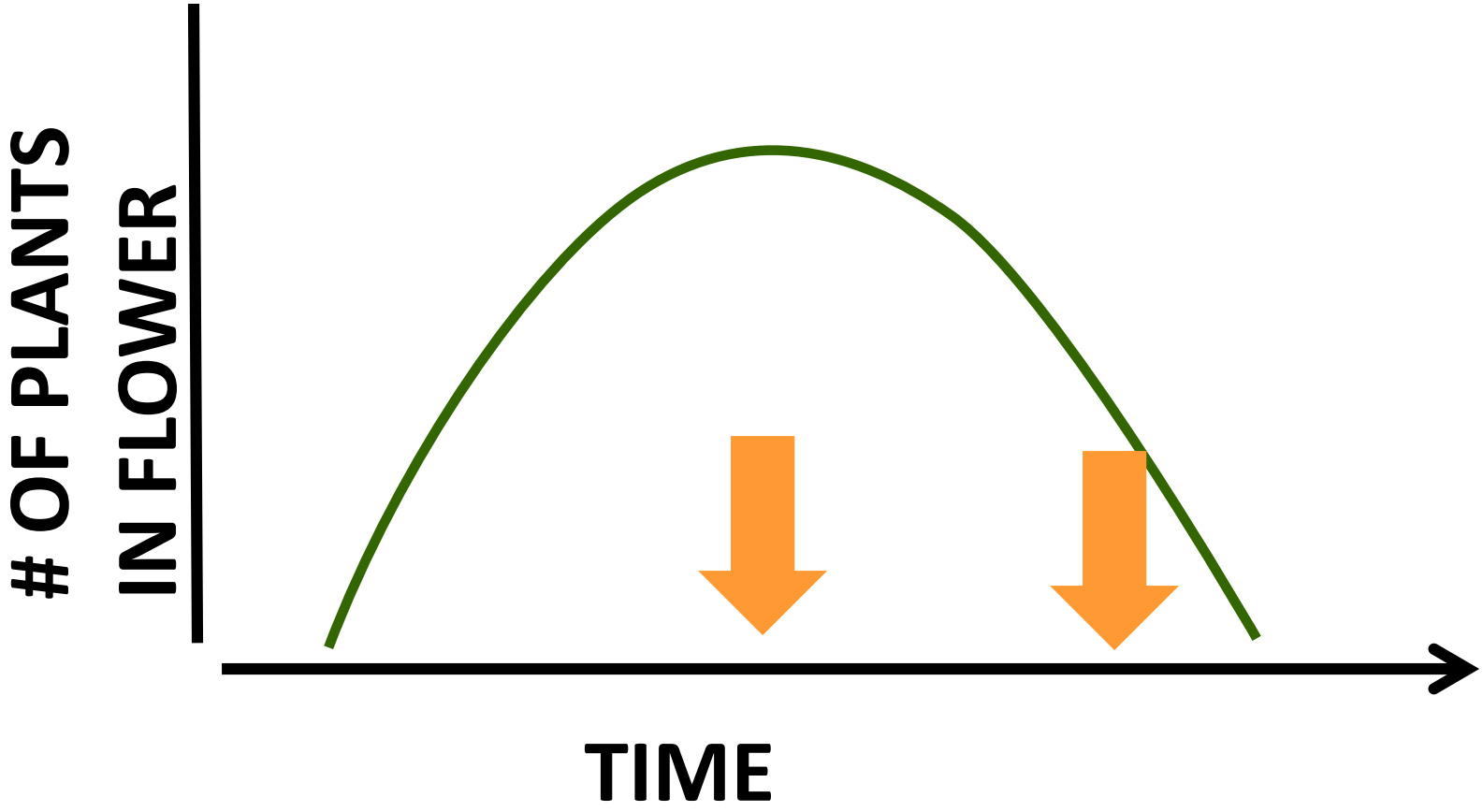
# Flowering synchrony

- Pairs of plants



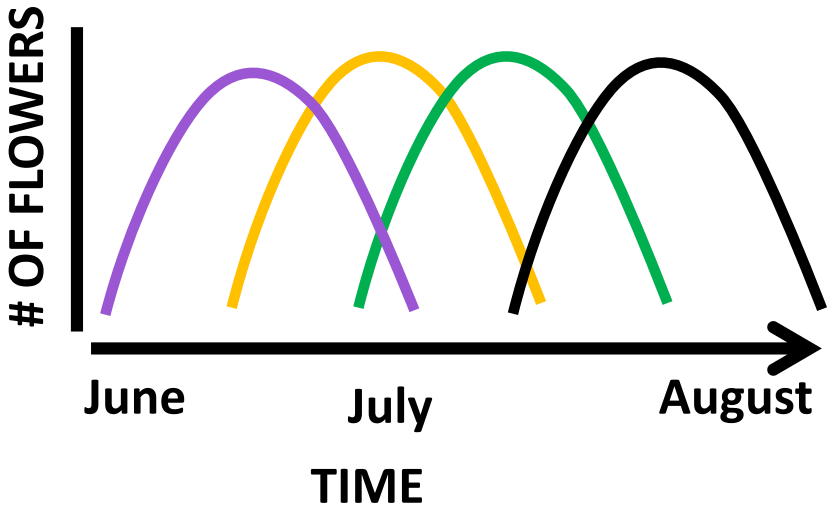
# Flowering synchrony

- Individual to the population

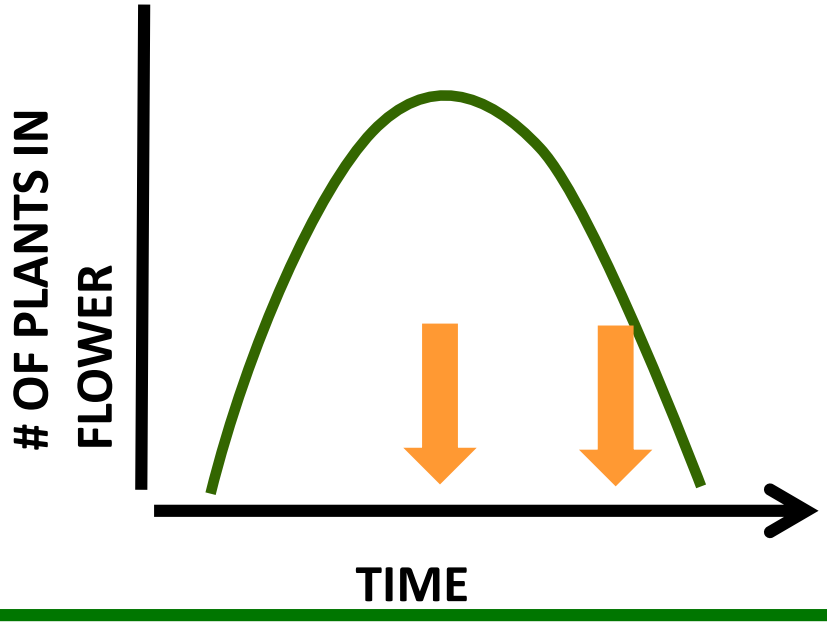


# Potential consequences of phenological isolation

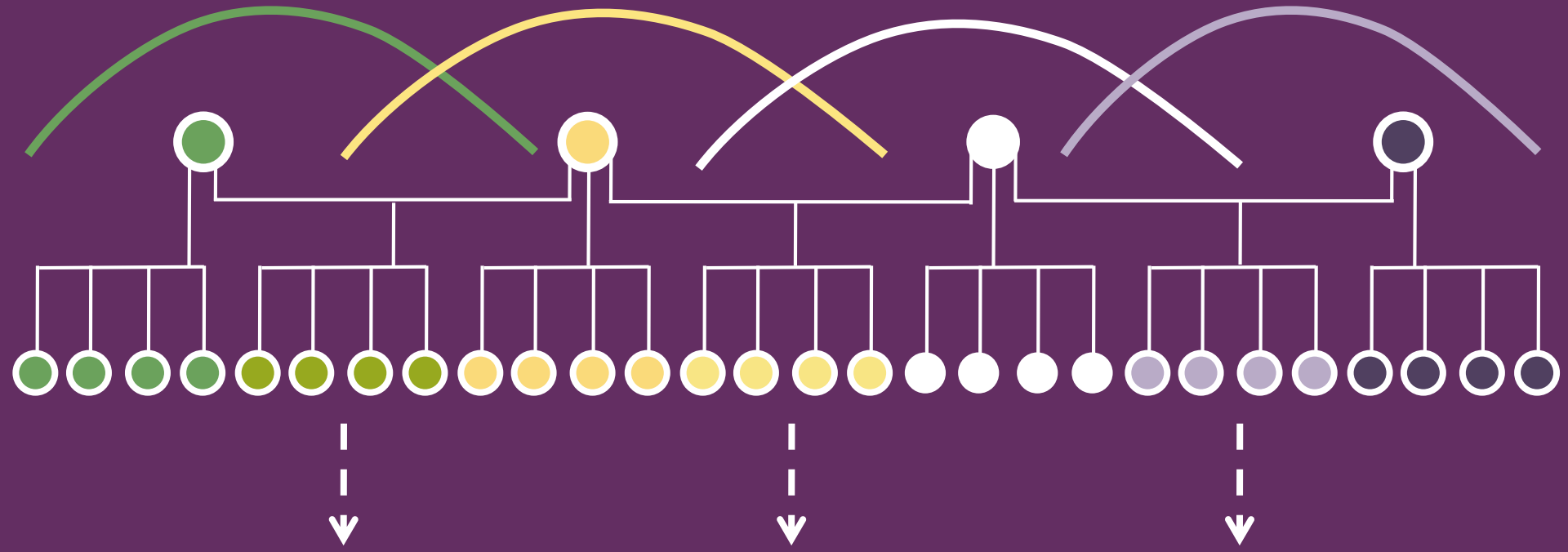
Limits the mating pool
--> temporal genetic structure



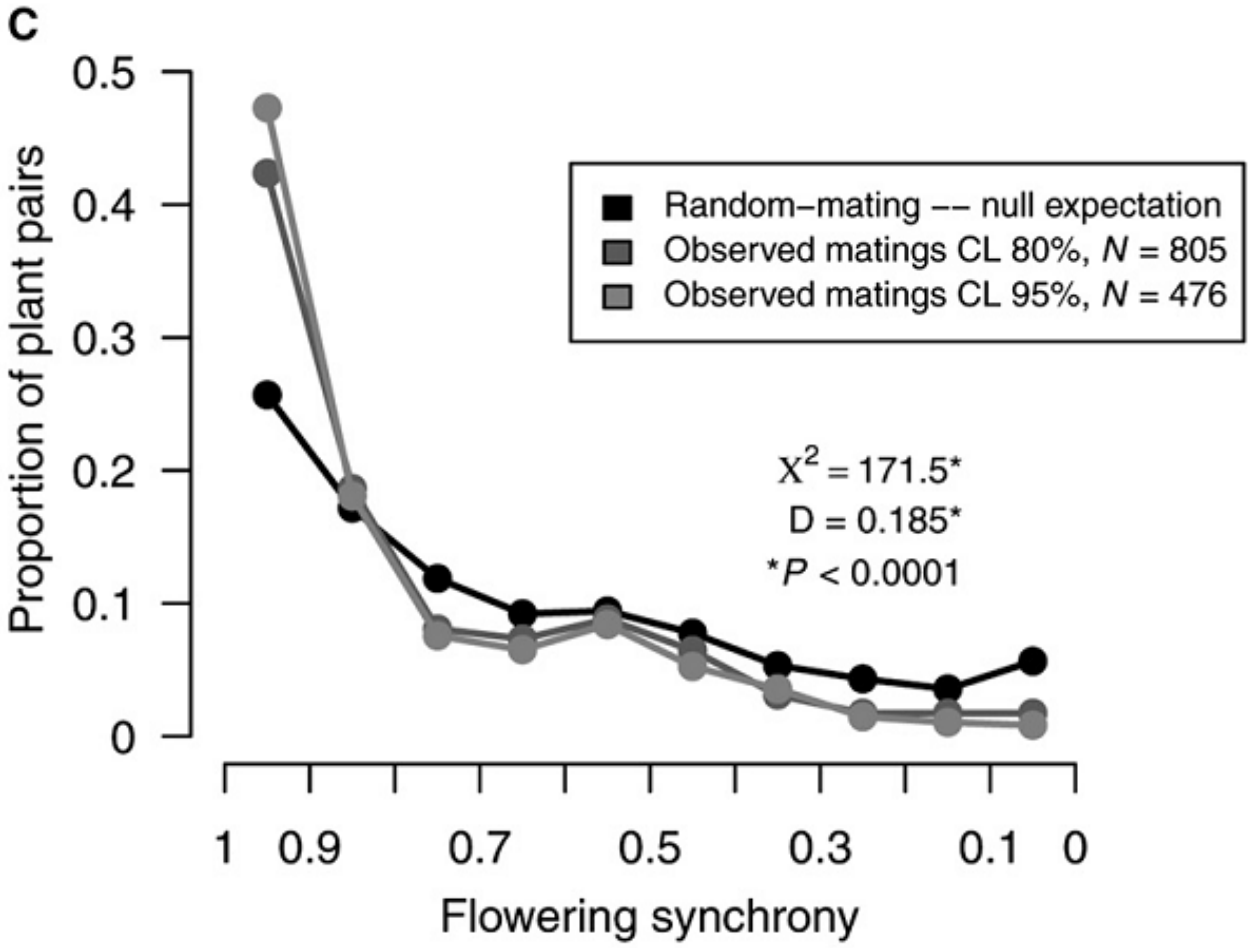

Limits the opportunity for mating
--> reproductive failure



# Can phenological isolation cause temporal genetic structure?



# Paternity analysis revealed that plants assortatively mate by flowering time

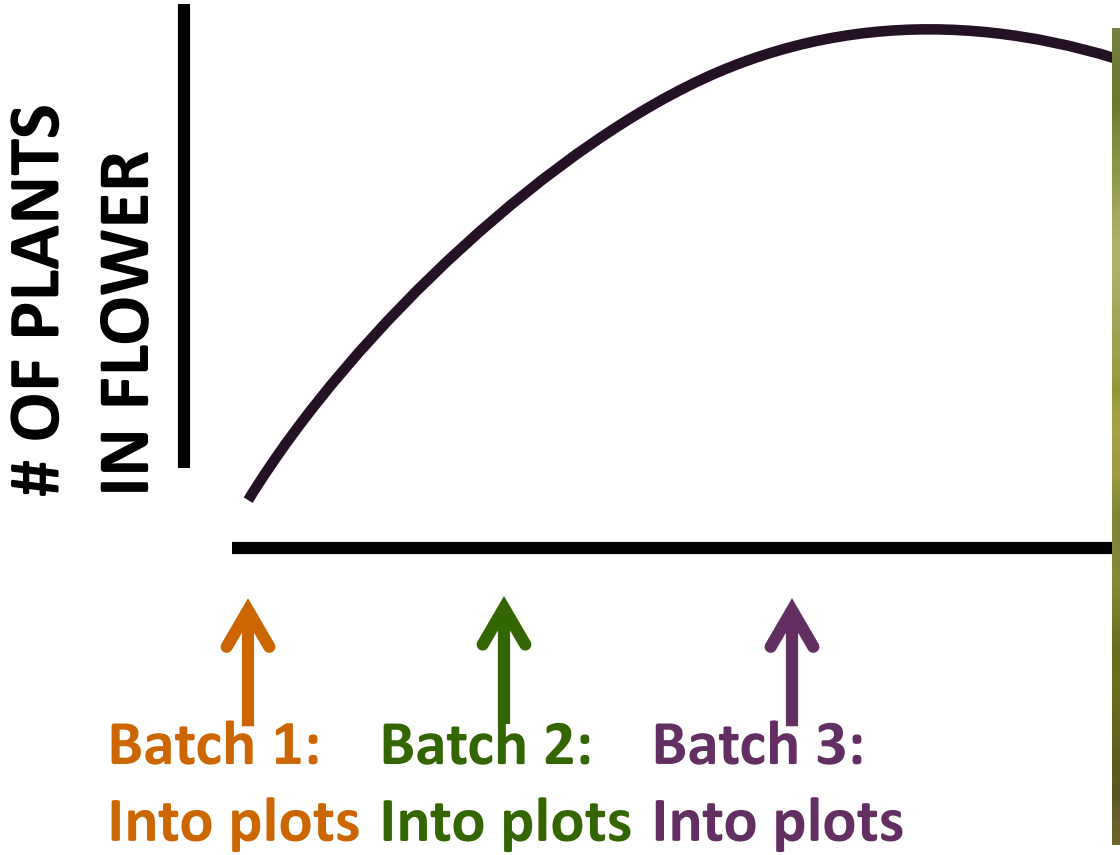



Ison et al. 2014 AJB

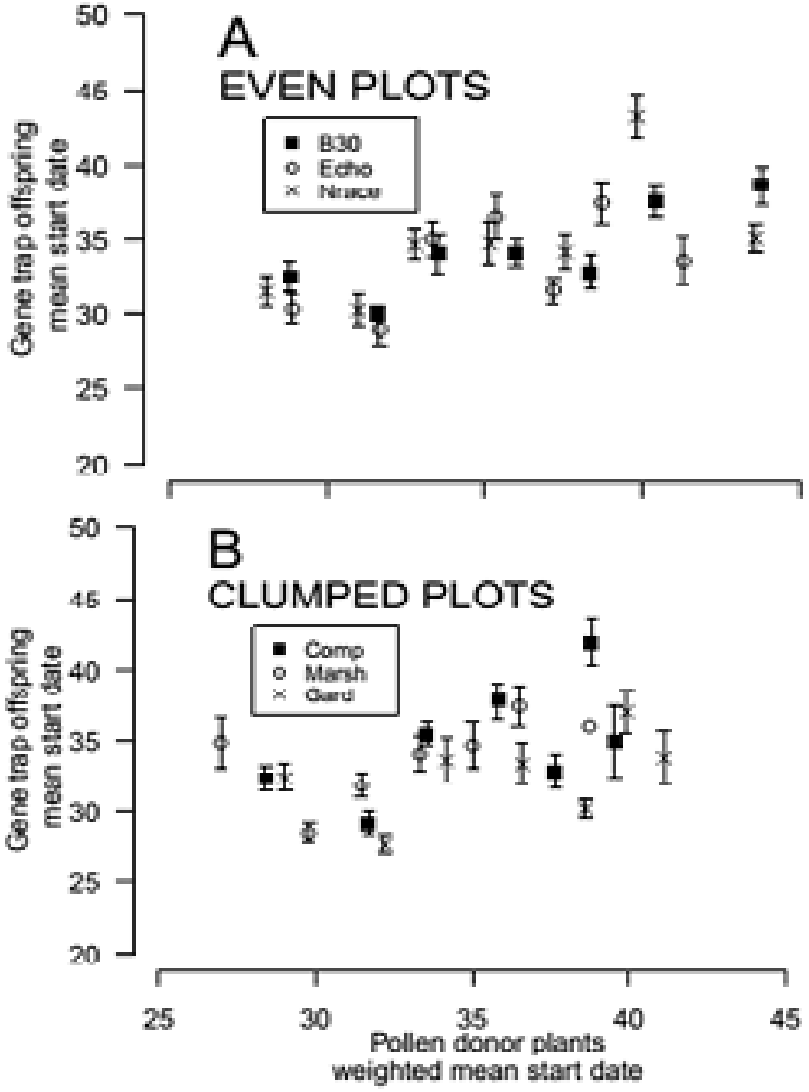
# Evidence of temporal genetic structure in plants

- Examined the temporal change in the pollen pool's breeding value for first flower date.

# Breaking the maternal-paternal phenotypic correlation using ‘gene traps’



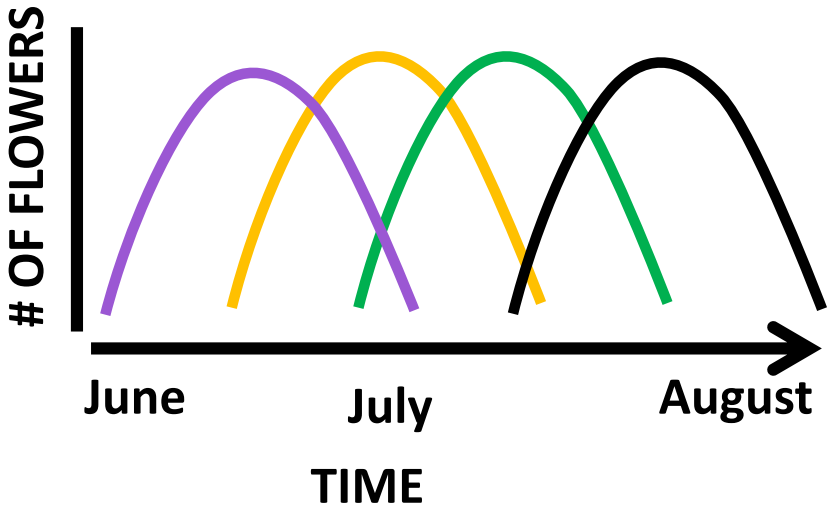

# Found temporal genetic structure for flowering time



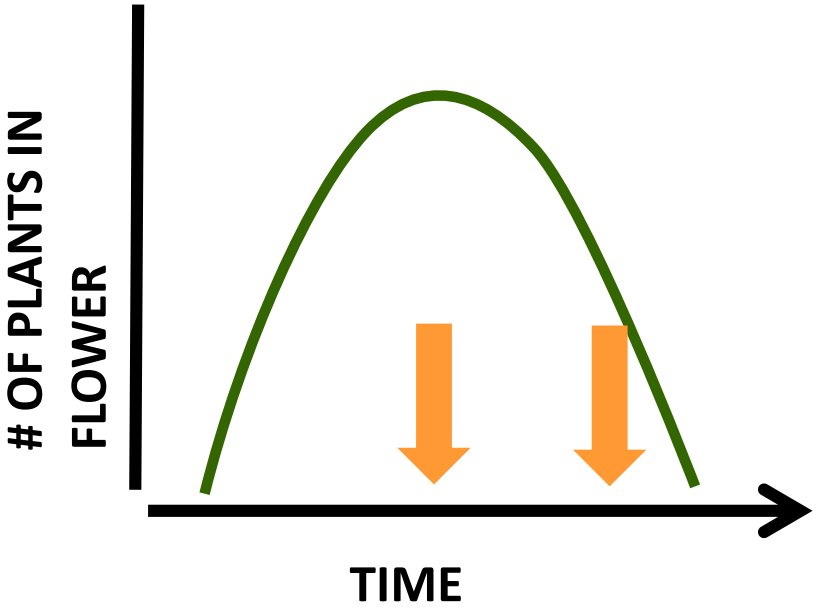

**Ison & Weis Submitted**

# Potential consequences of phenological isolation

**Limits the mating pool**
**--> temporal genetic structure**




**Limits the opportunity for mating**
**--> reproductive failure**



# Female (and male) fitness are consistently higher in earlier flowering plants

ECOLOGY LETTERS

*Ecology Letters*, (2011) doi: 10.1111/j.1461-0248.2011.01601.x

REVIEW AND SYNTHESIS

**Meta-analysis of phenotypic selection on flowering phenology suggests that early flowering plants are favoured**

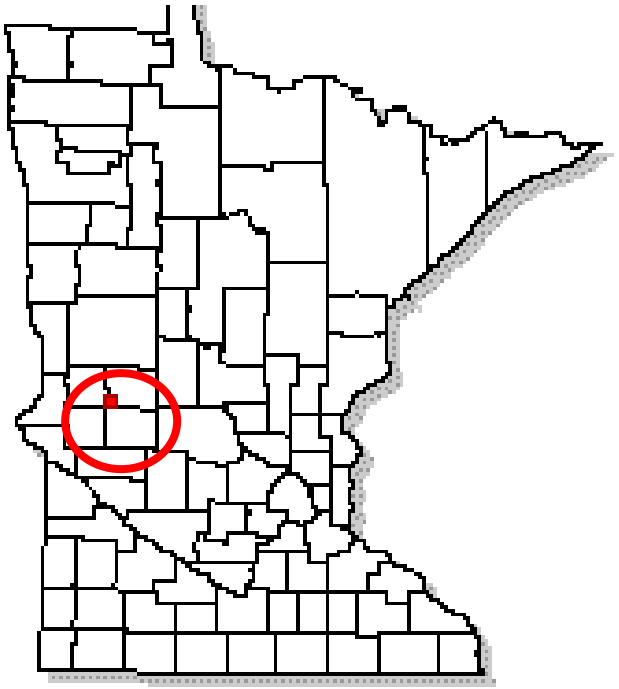
# *Echinacea angustifolia*

## A model prairie plant

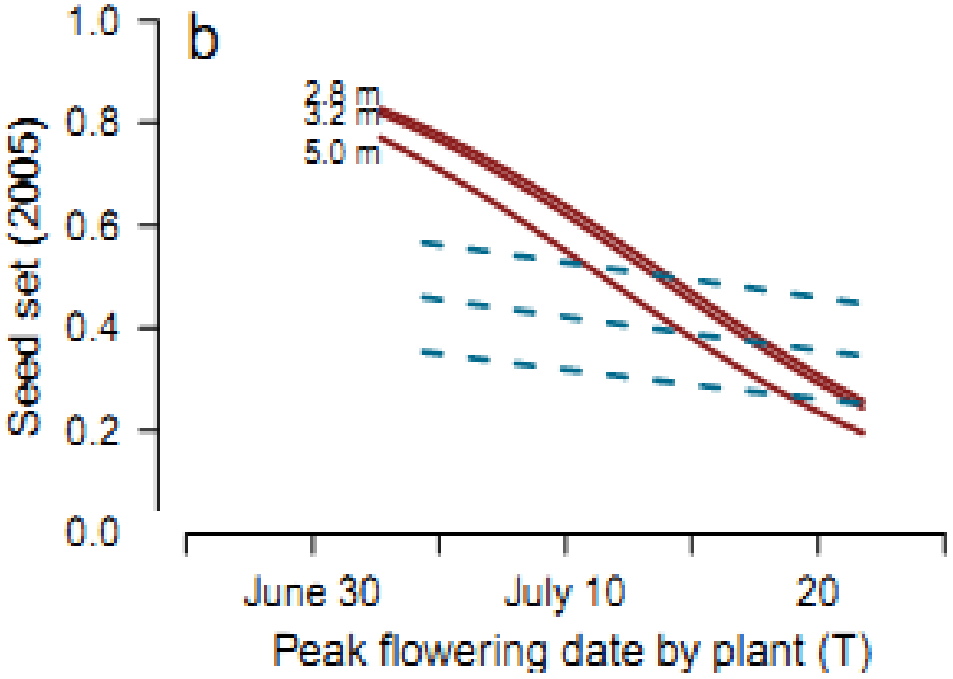
- Native prairie plant
- Long-lived
  - -Generation time: 17 - 44 years
- Generalist insect pollinators
  - -Solitary native bees
- Self-incompatible

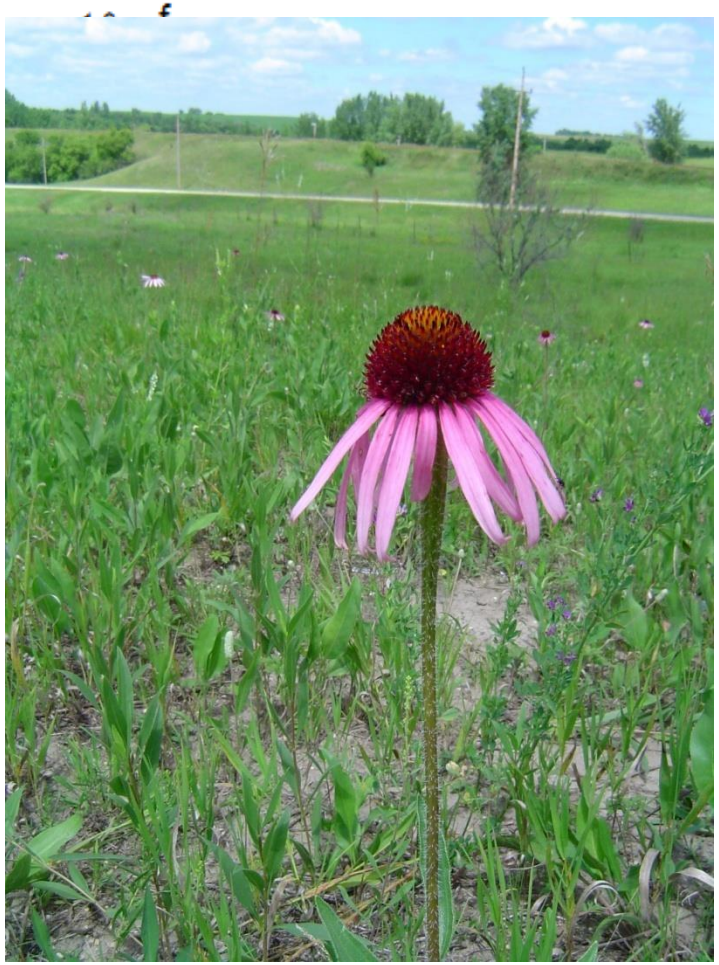
# Study area: western Minnesota

- Pre-settlement: Tallgrass prairie and lakes
- Present day: Farmland, forested areas, and lakes



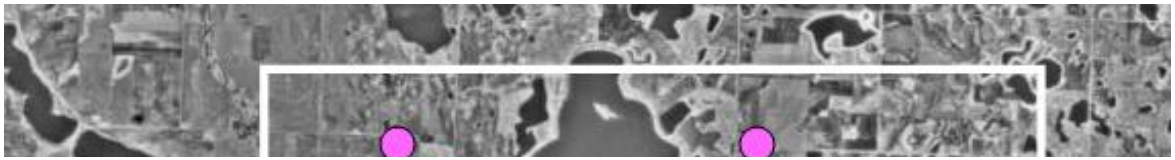
# Early flowering plants have higher seed set than late flowering plants



Ison & Wagenius JoE 2014

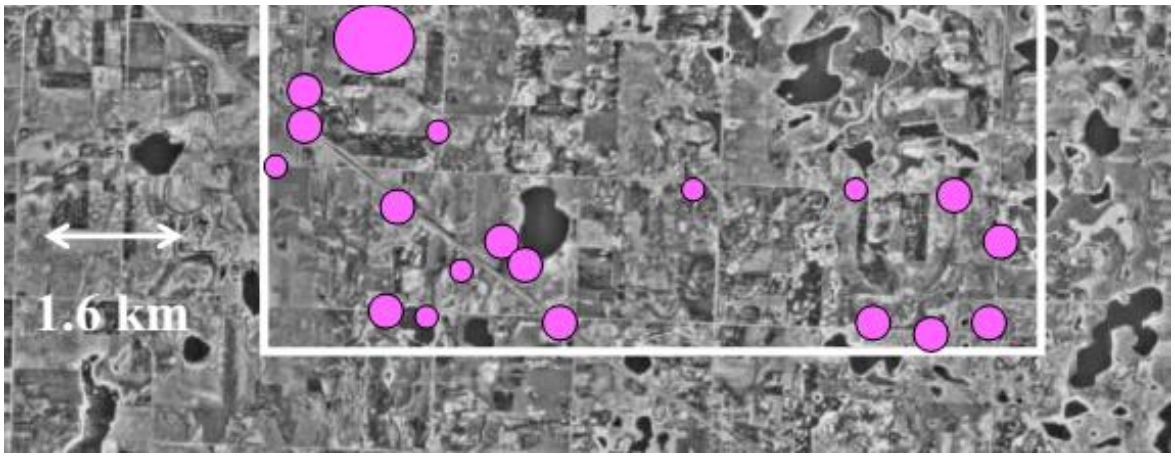
# Previous research: pollinator observations were conducted in 21 remnants over two years



*Ecology*, 91(3), 2010, pp. 733–742

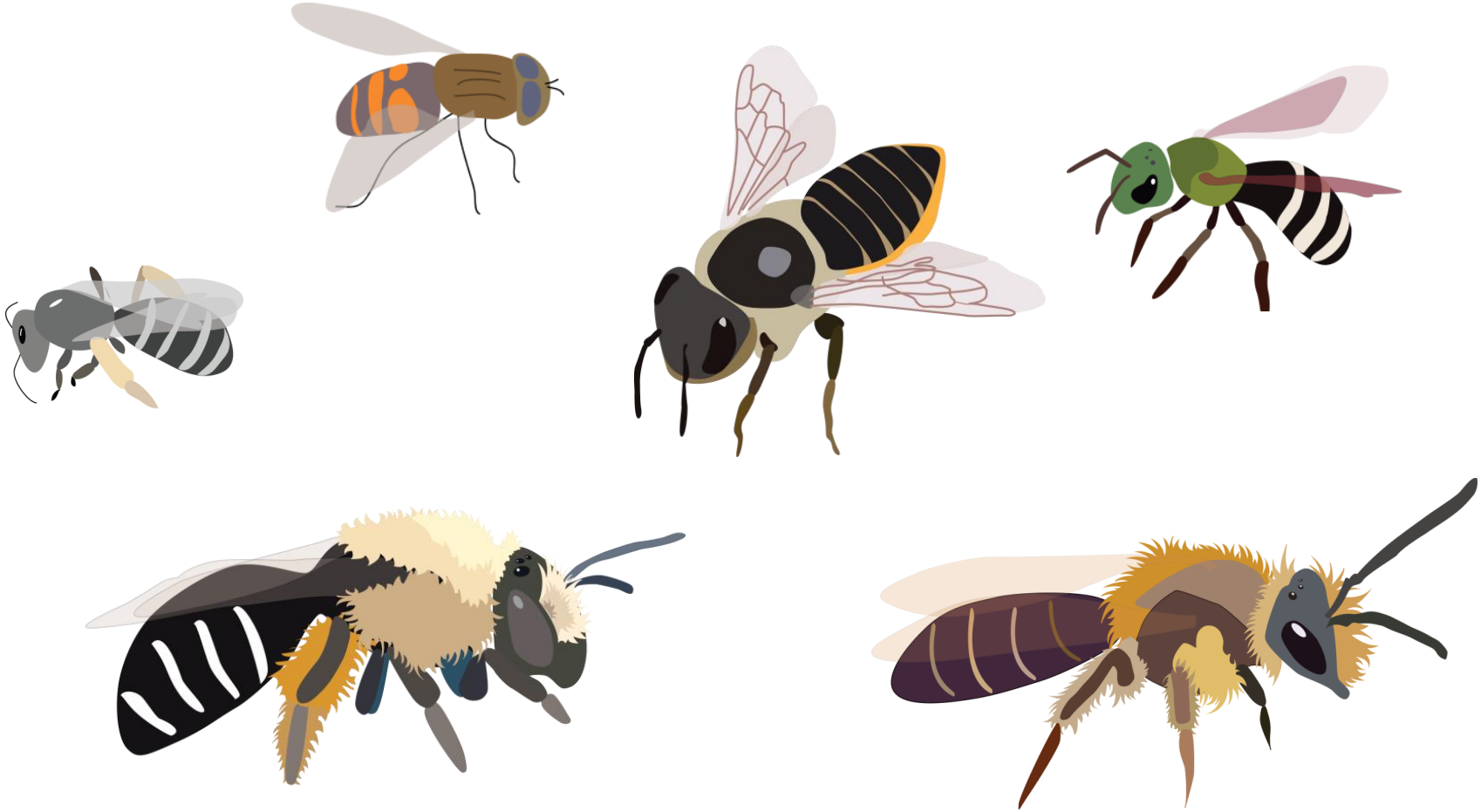

Reproduction of *Echinacea angustifolia* in fragmented prairie is pollen-limited but not pollinator-limited

STUART WAGENIUS[1,3] AND STEPHANIE PIMM LYON[1,2,4]




**Wagenius & Lyon 2010 Ecology**

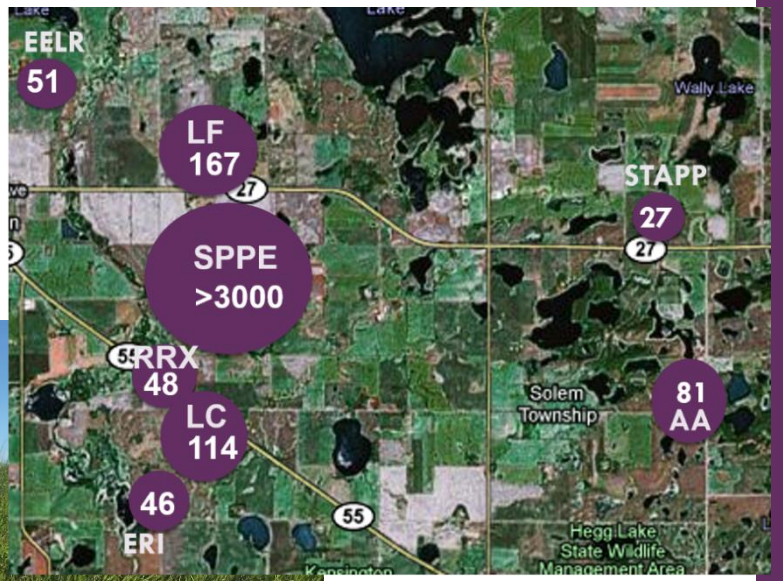
# Study aim: Examine pollinator-mediated mechanisms for the seasonal decrease in seed set



# Over the flowering season we examined:

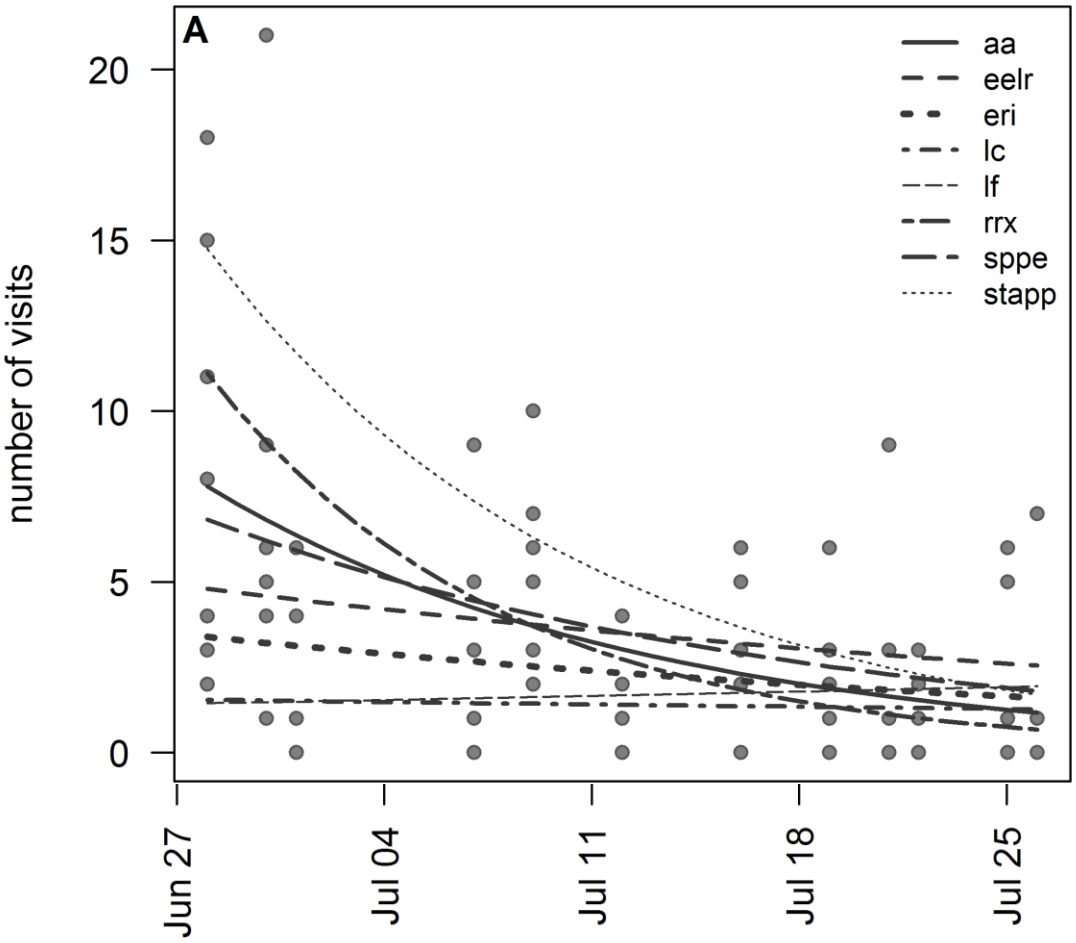
1. Pollinator visitation rates
2. Pollinator community composition
3. Pollen load composition –proxy for pollinator foraging behavior

# Temporal pollinator community methods

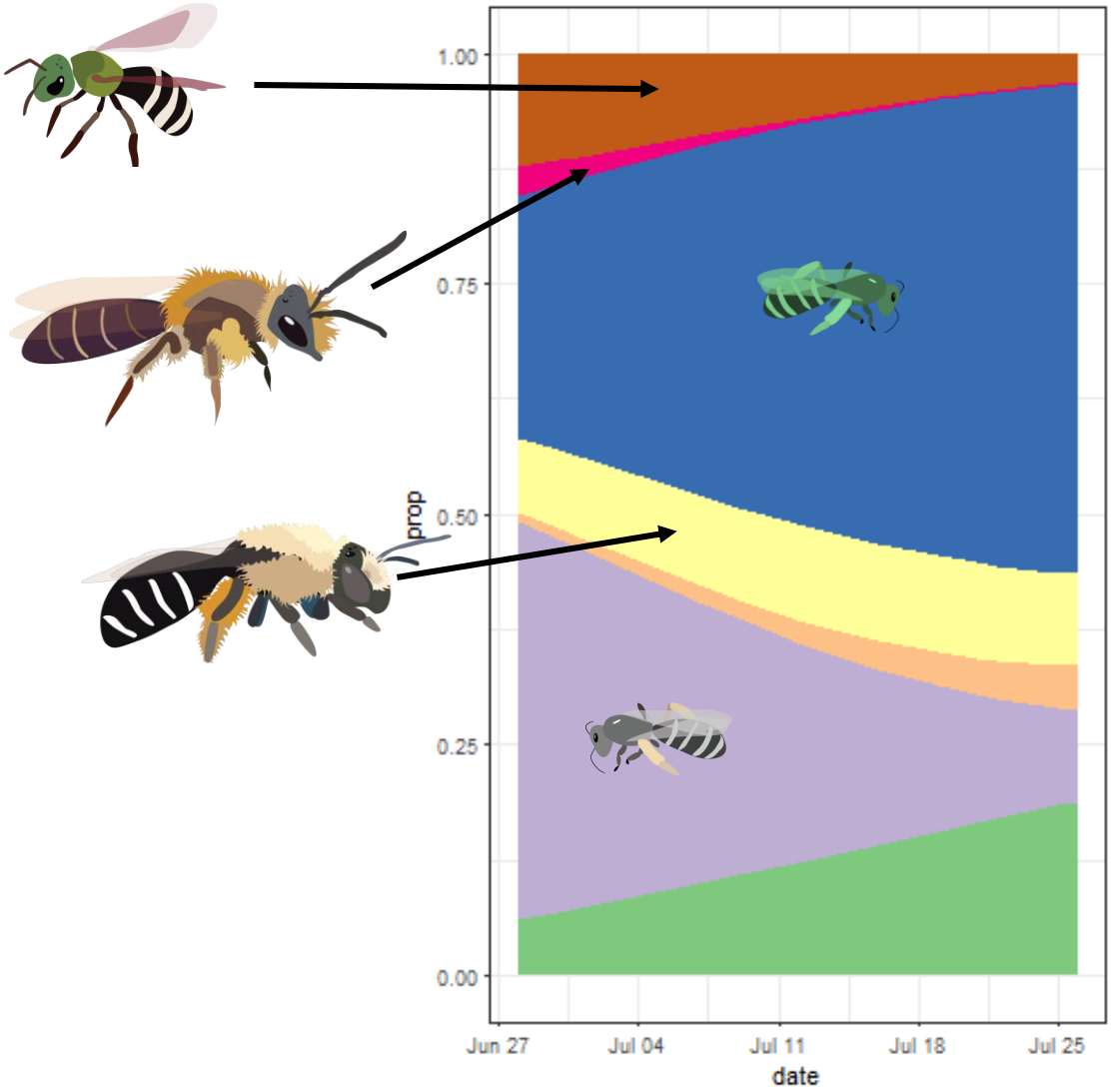



**8 remnant sites**
**12 observation days**
**10 observation periods (each 10 mins) for each day**
**~10,000 mins of observations**
**337 pollinator visits observed/recorded**

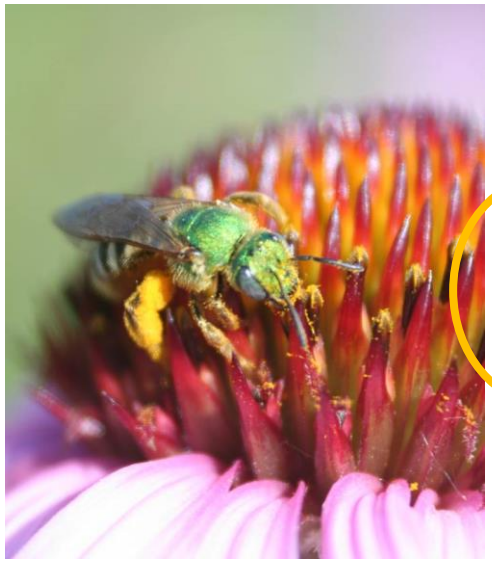
# Pollinator visitation rate is highest earlier in the flowering season

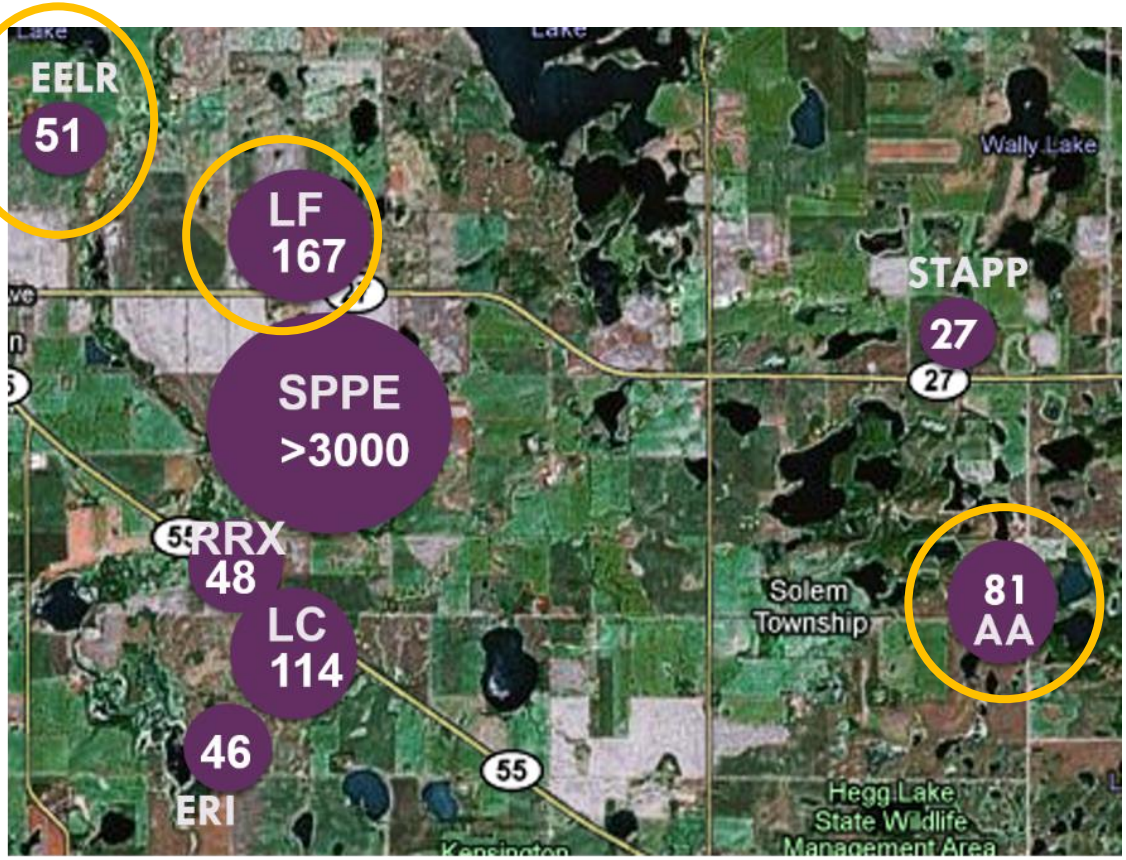



# The pollinator community composition changes over the flowering season




# Pollen load study



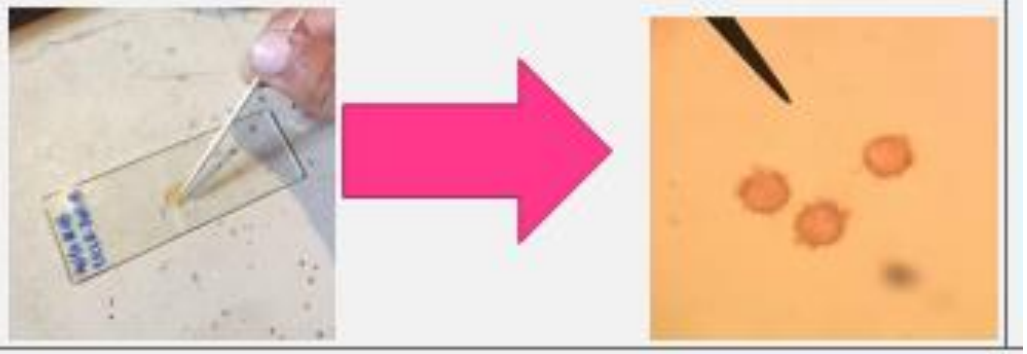


# Pollen load methods

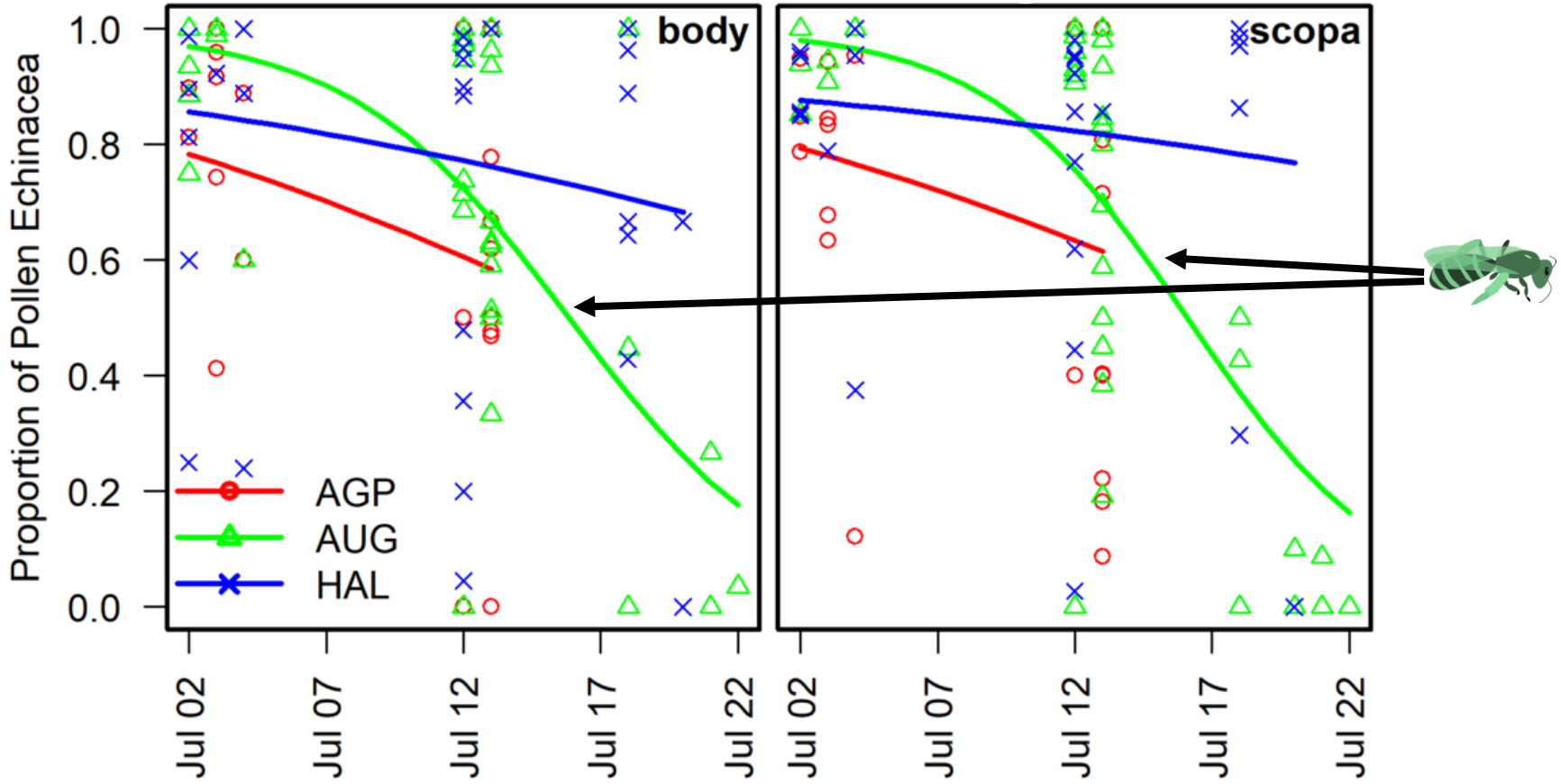
1. Catch pollinators that land on *Echinacea* during early, peak & late flowering at 3 sites, record taxa.

2. Cool and wipe pollen from body and scopa

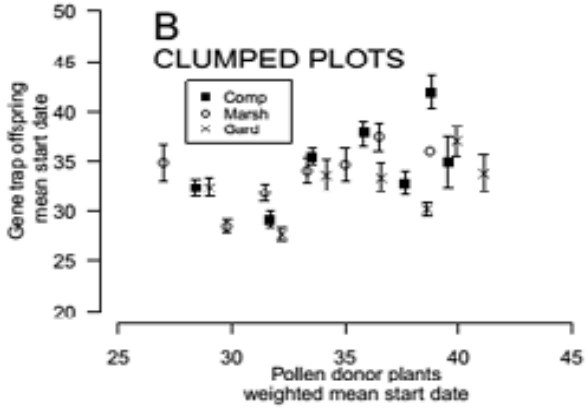
3. Mount pollen on slide and count pollen grains

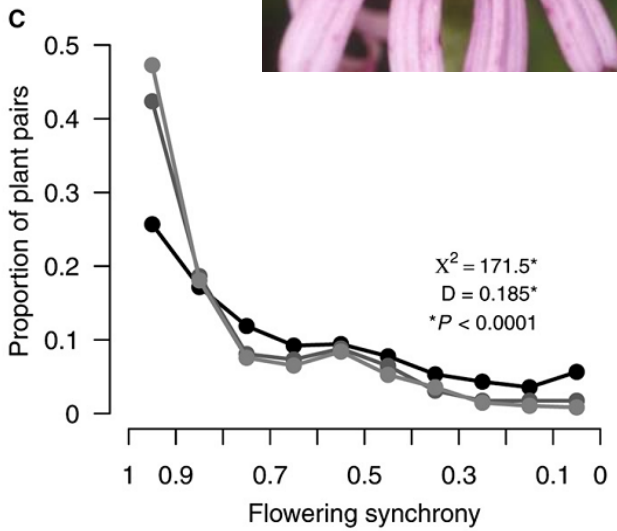


# Bees carried proportionally less *Echinacea* pollen late in the flowering season

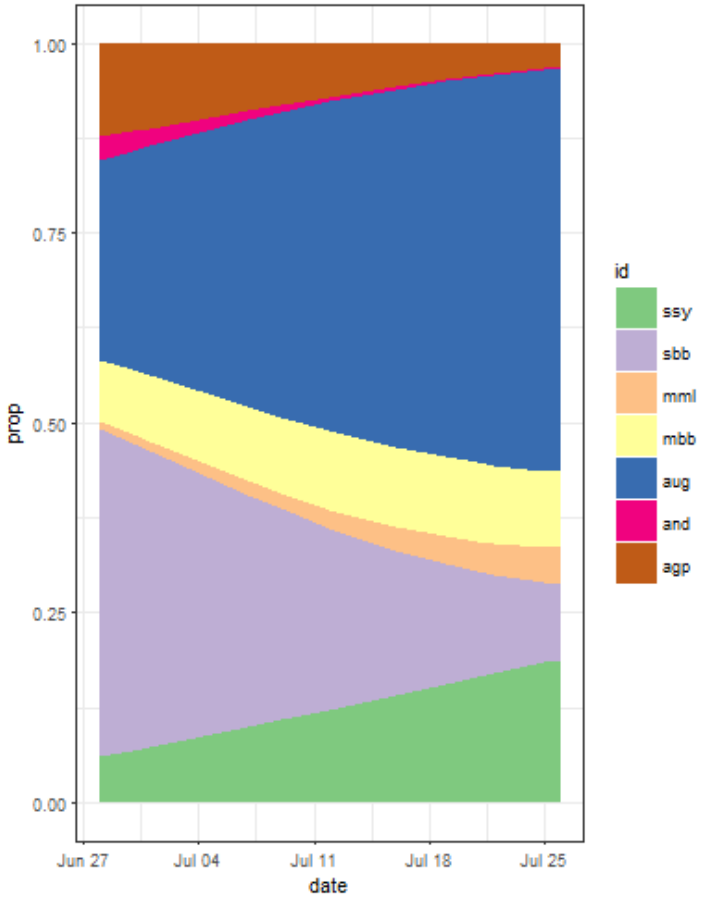


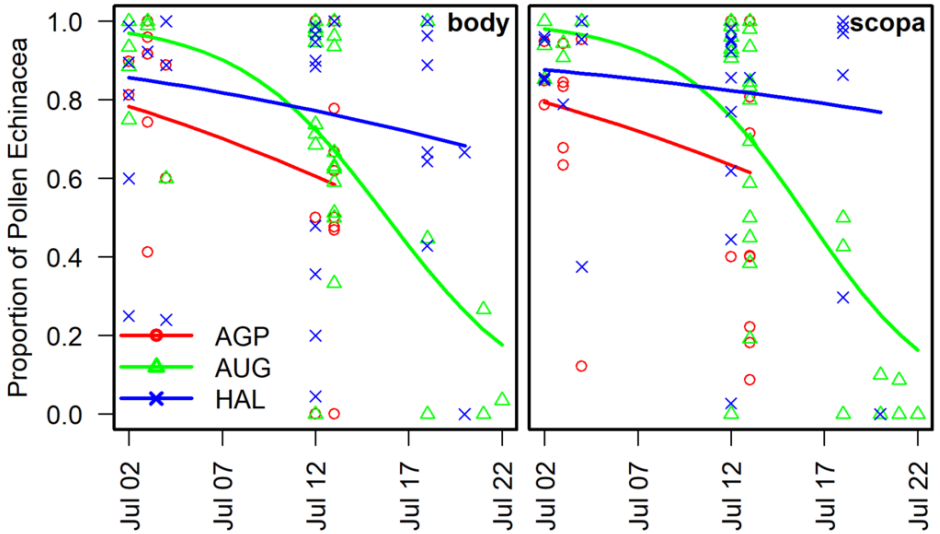
# Conclusions: Temporal genetic structure



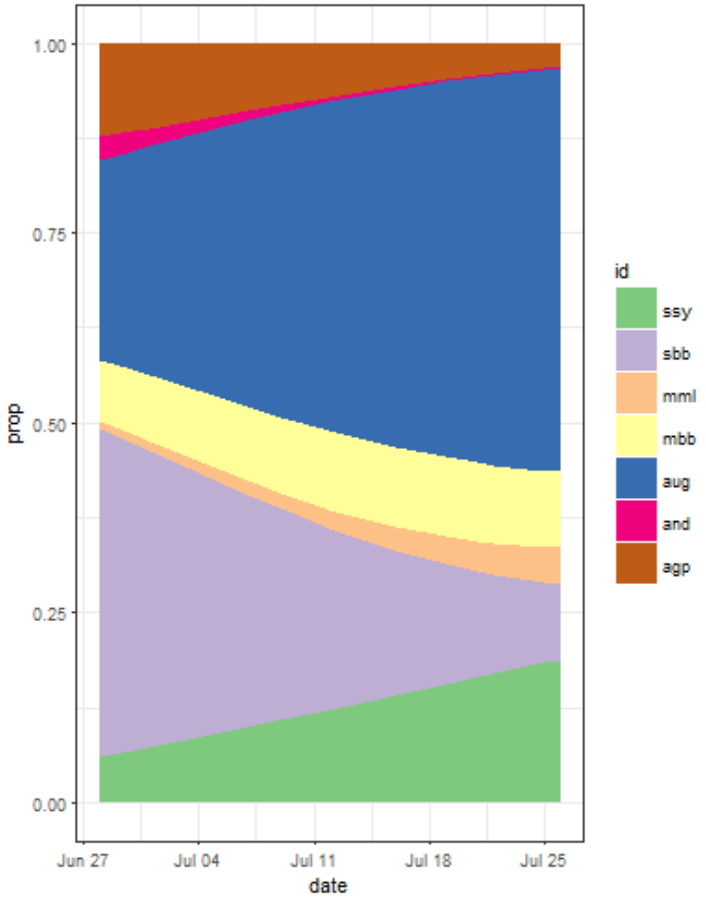



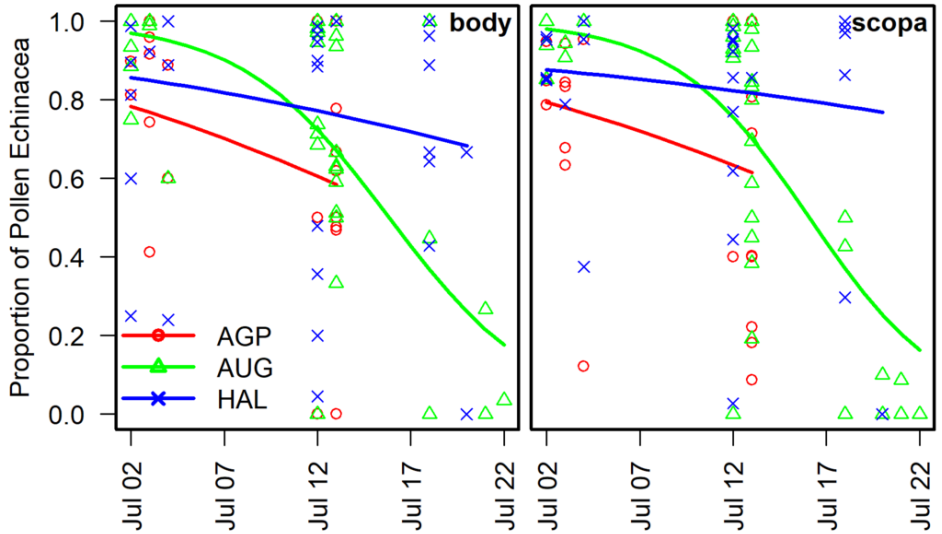

# Conclusions: Pollinator-mediated mechanisms for seasonal decrease in seed set



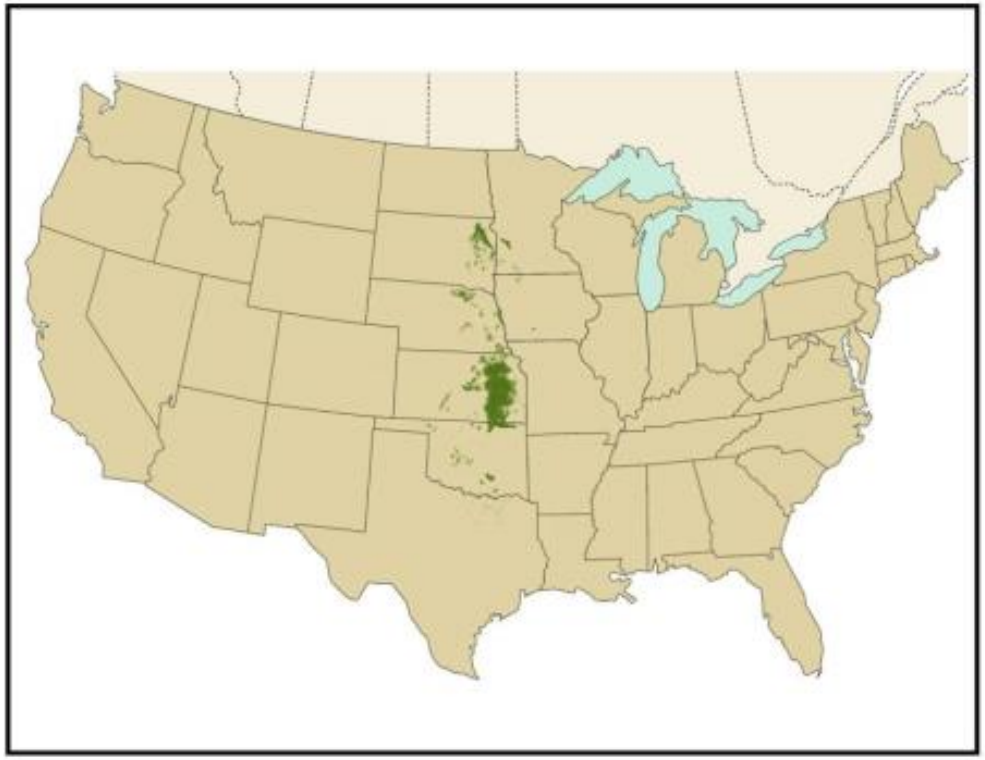



# Take home message: By the end of the flowering season *Echinacea* is both pollen and pollinator limited



# Implications for population persistence: Phenological isolation in fragmented populations



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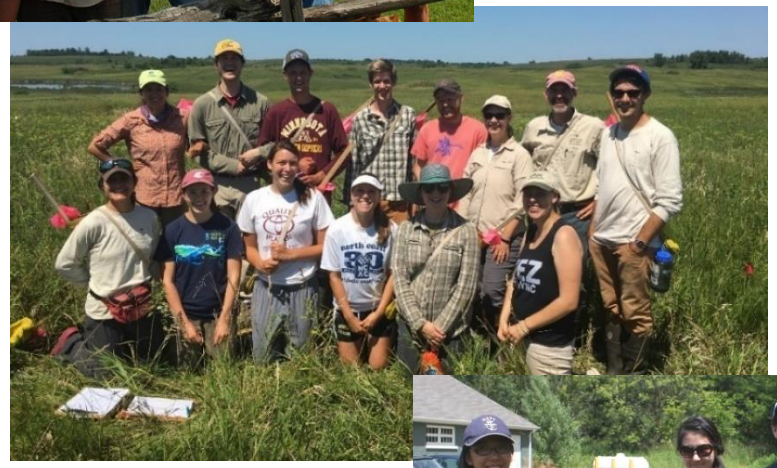

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Plant and pollinator drawings by KJB