

# Conservation genomics of *Amsonia tharpii*: spatial distribution influences gene flow, genetic diversity, and seed viability

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# *Amsonia*

(Apocynaceae)

~18 species  
Western/eastern North  
America, W/E Asia

Long-lived shrubs  
Underground stems  
Pubescence +/-  
Tubular corolla  
Scent  
Follicles

Popular in Horticulture





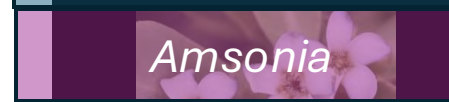
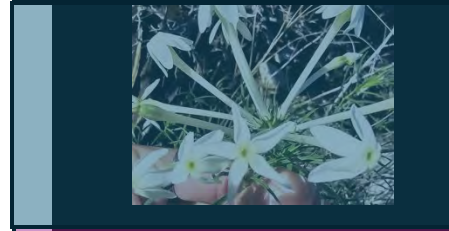
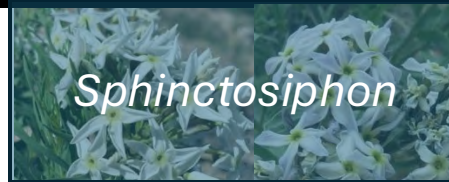
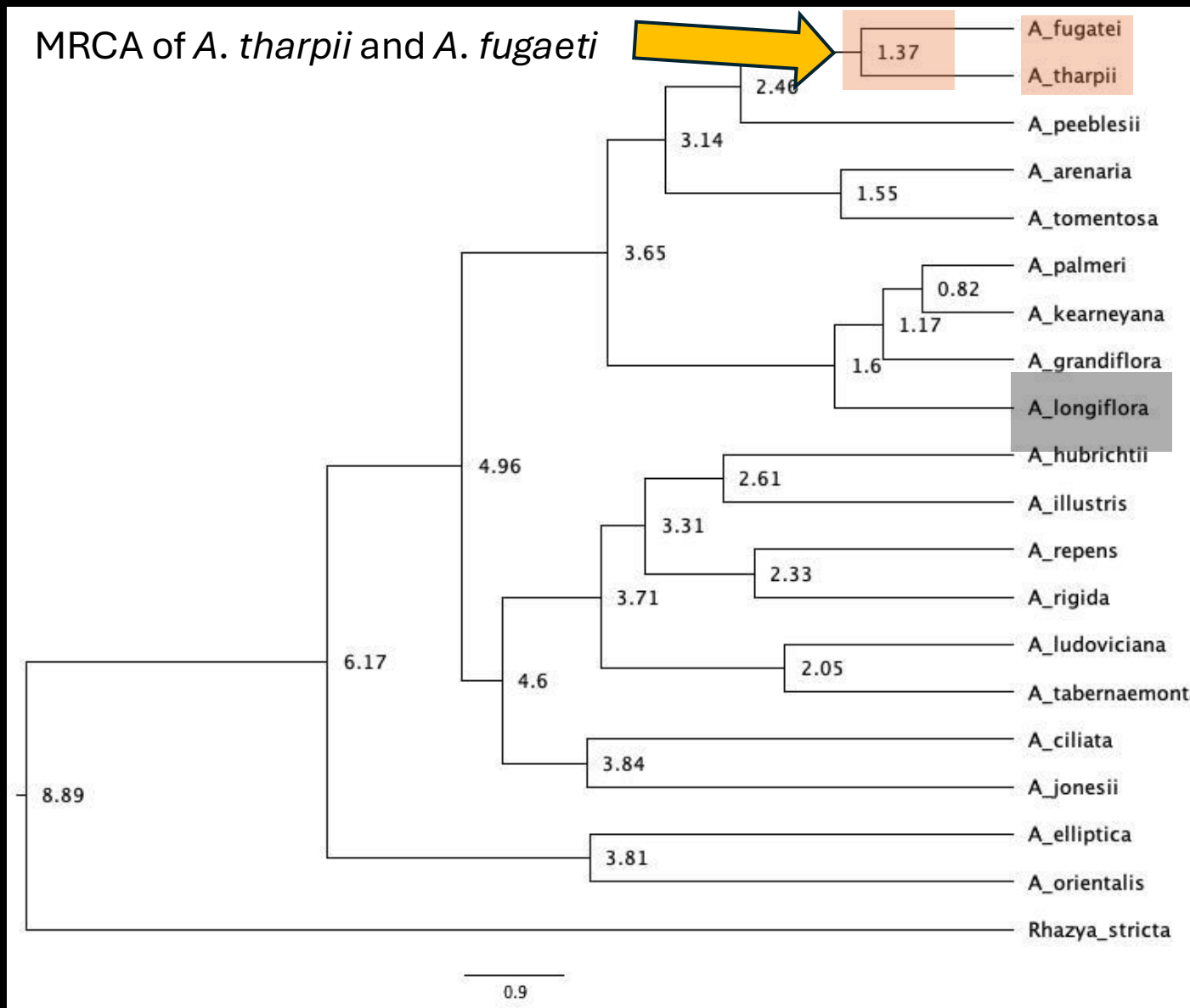


How many genetically distinct individuals?





# Amsonia species tree and divergences dates



# Distribution of Western *Amsonia*

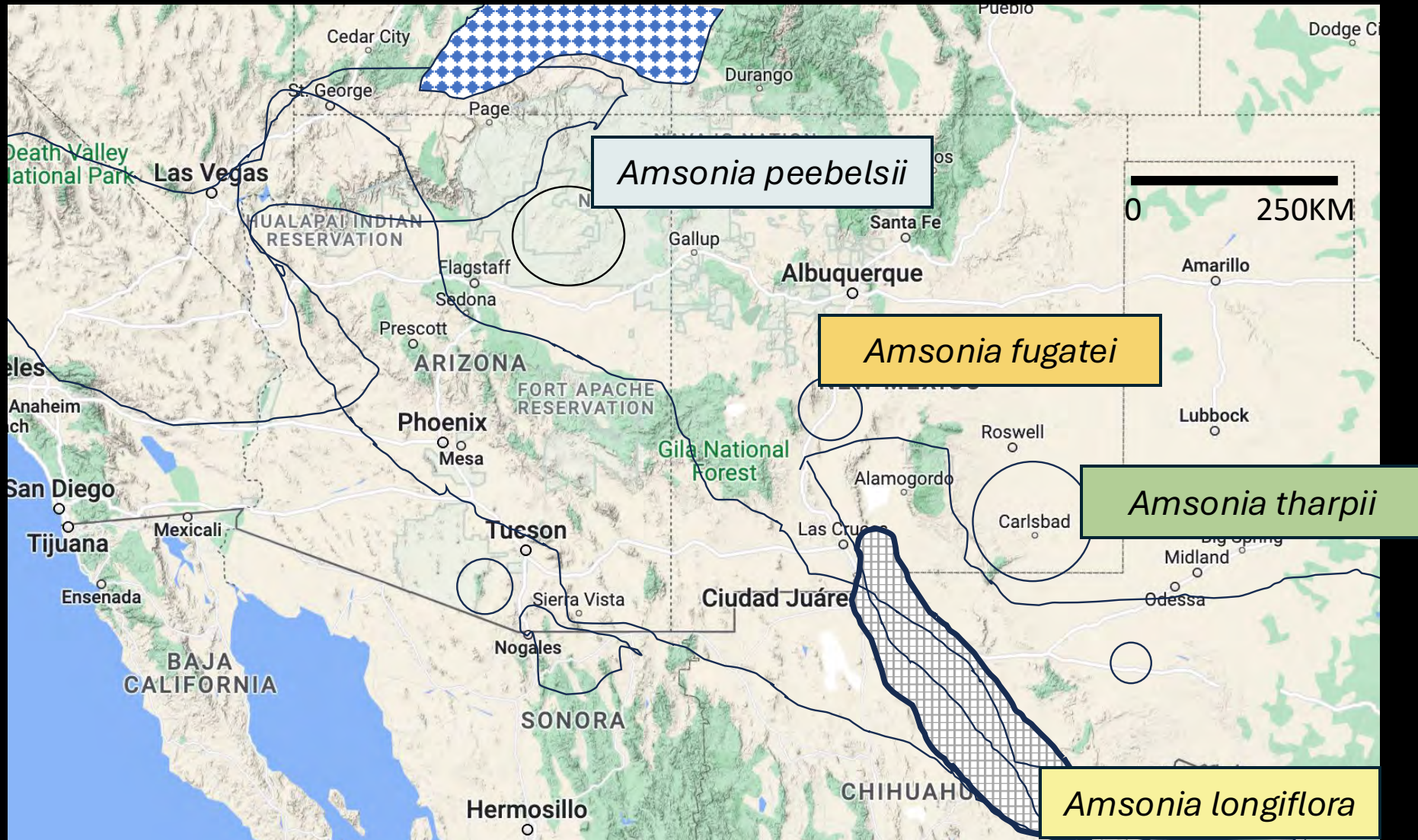


Figure 1. Hypothetical distributions for *Amsonia kearneyana* (red), *A. palmeri* (purple), *A. tomentosa* (blue), *A. fugatei* (orange), *A. tharpai* (green), *A. longiflora* (yellow), *A. grandiflora* (black), *A. peeblesii* (light blue), *A. jonesii* (checkered), and *A. arenaria* (crosshatched).



# *Amsonia* pollinators

- Observations 2022/2023
  - Droughty years : (
- Hawkmoths frequent western *Amsonia*
  - Large pollinators may forage farther



*Amsonia tharpaii* and *A. longiflora*



# Seed movement

- Gravity dispersed
- Water (seeds float)

Follicles

~3-8 seeds/fruit



Seeds



Rio Grande watershed

# Outline

- I. Population genetics
- II. Ben Slaughter Draw
- III. Conservation



*Amsonia tharpia*



# Threats to *Amsonia tharpaii*

Climate change

Habitat fragmentation

Natural resource  
extraction

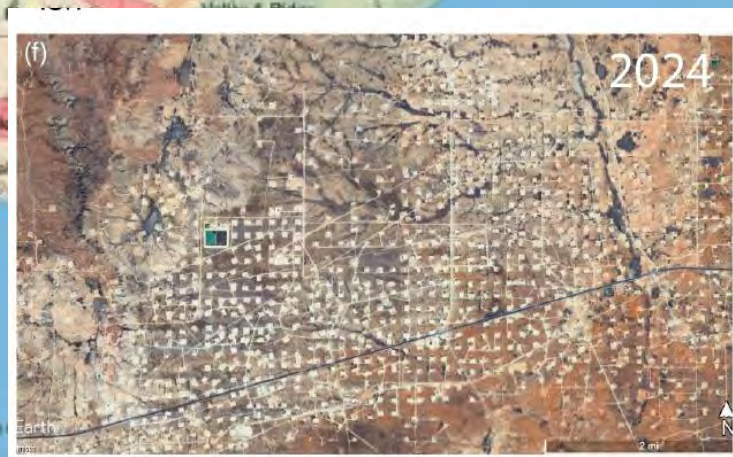




# Permian basin oil fields: A threat to *A. tharpaii*



Red Lake Population Site





# *Amsonia tharpii* concerns

Population Size

Inbreeding

Genetic diversity





# Species comparison

a) *Amsonia tharpaii*

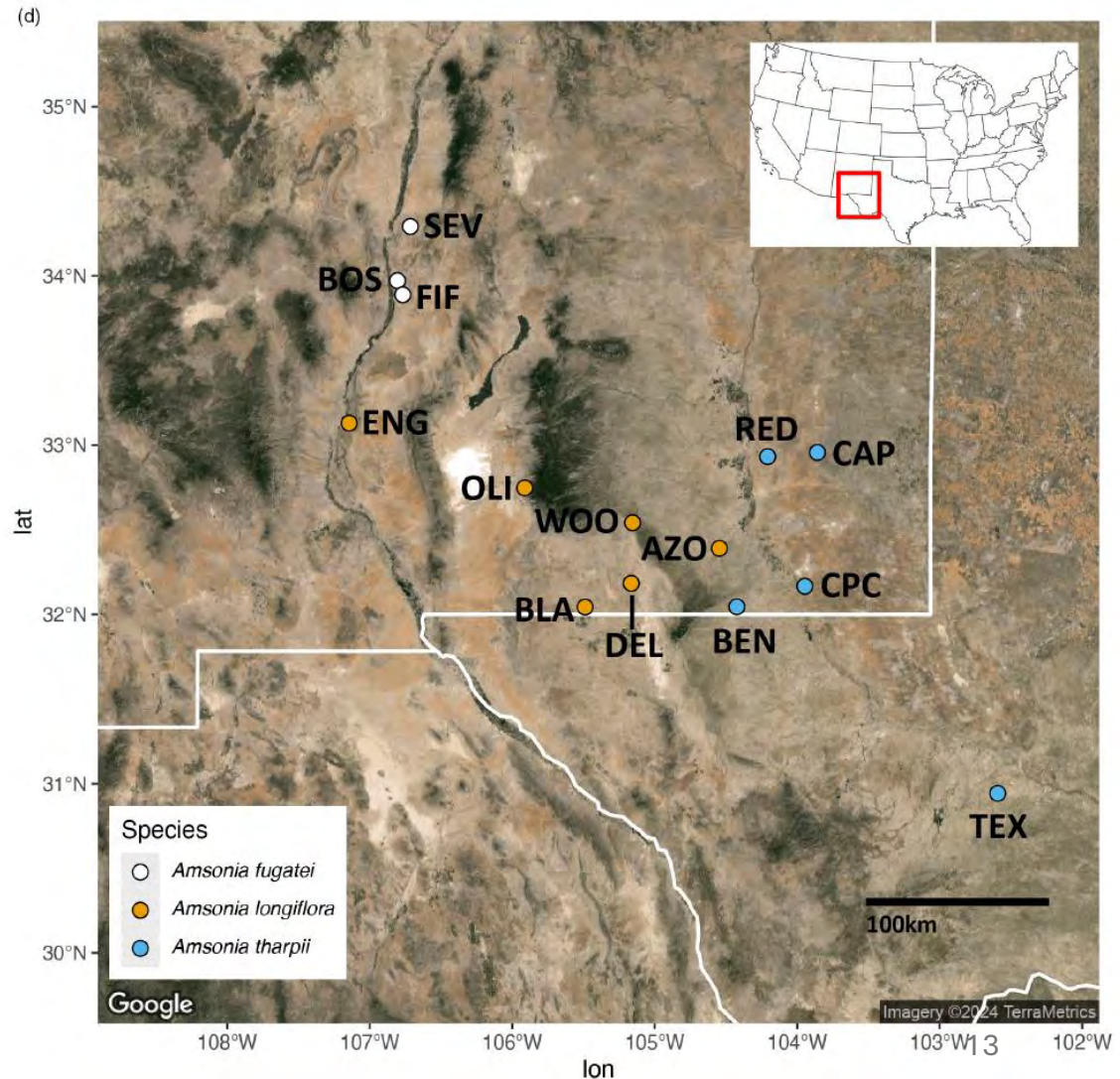
- Threatened

b) *A. fugatei*

- Narrow endemic

c) *A. longiflora*

- Widespread NM-TX





# Buffering against landuse changes

Hawkmoth pollination

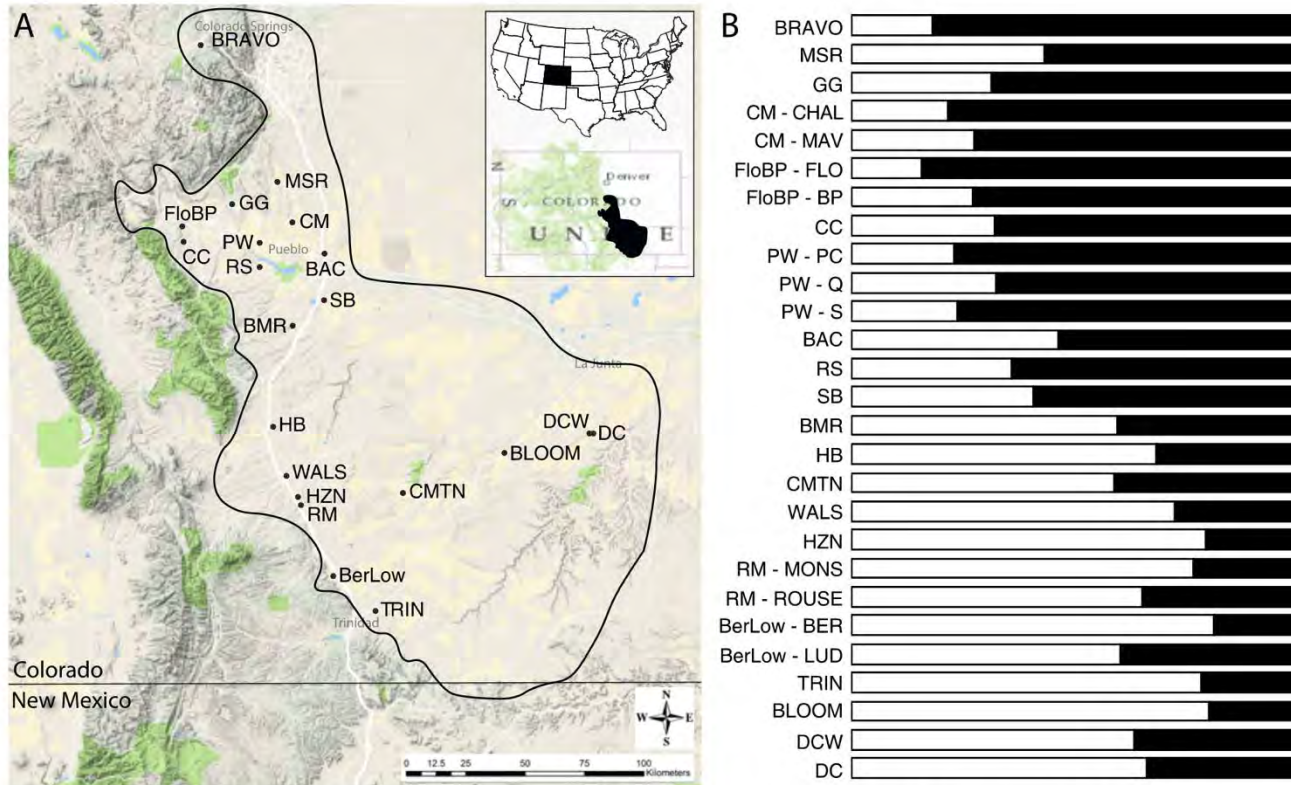


Figure 1. —A. Distribution of *Oenothera harringtonii* W. L. Wagner, Stockh. & W. M. Klein in Colorado and adjacent New Mexico. Insets show the location of Colorado within the United States and the species distribution within Colorado. —B. Negligible population differentiation detected among 21 populations of *O. harringtonii*. Bar graph shows the population summary of  $K = 2$  conceptual populations output from Structure.



*Oenothera harringtonii*



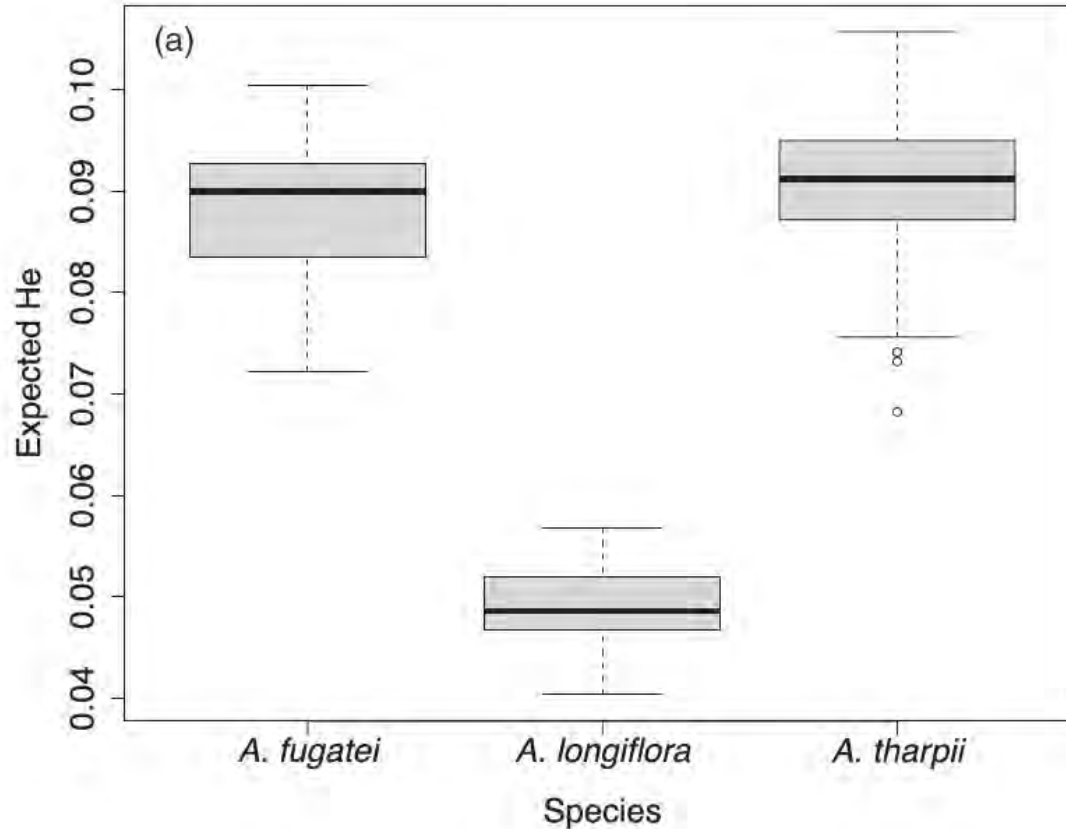
# Hypotheses

1. *Amsonia tharpaii* has lower genetic diversity and higher inbreeding than its sister species due to landuse change and fragmentation
2. *Amsonia* populations are genetically cohesive because of hawkmoth pollination and are structured based on gravity-dispersed seeds





# Is genetic diversity lower in *A. tharpaii*?



Genetic diversity is low across all species  
Measured as expected heterozygosity



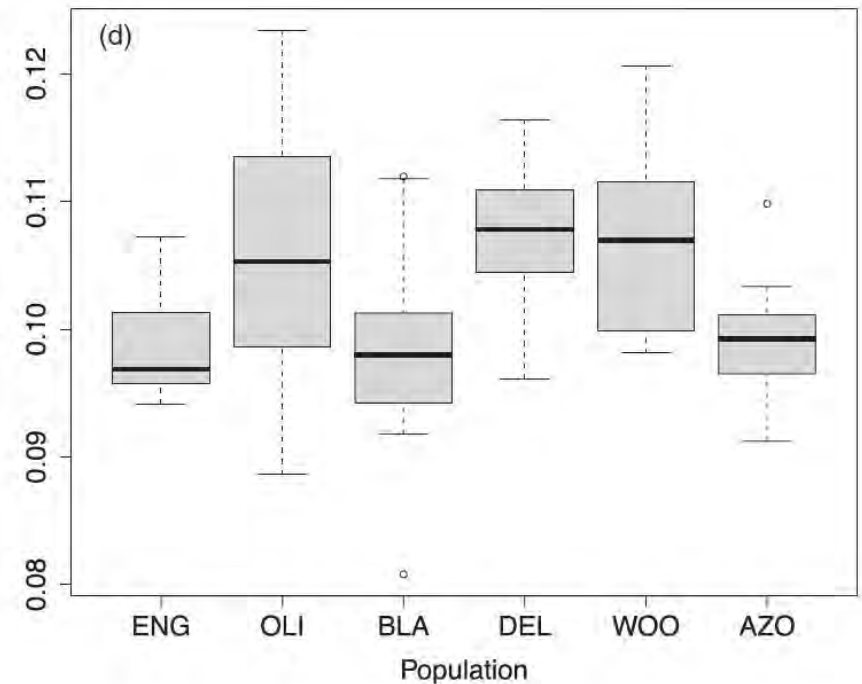
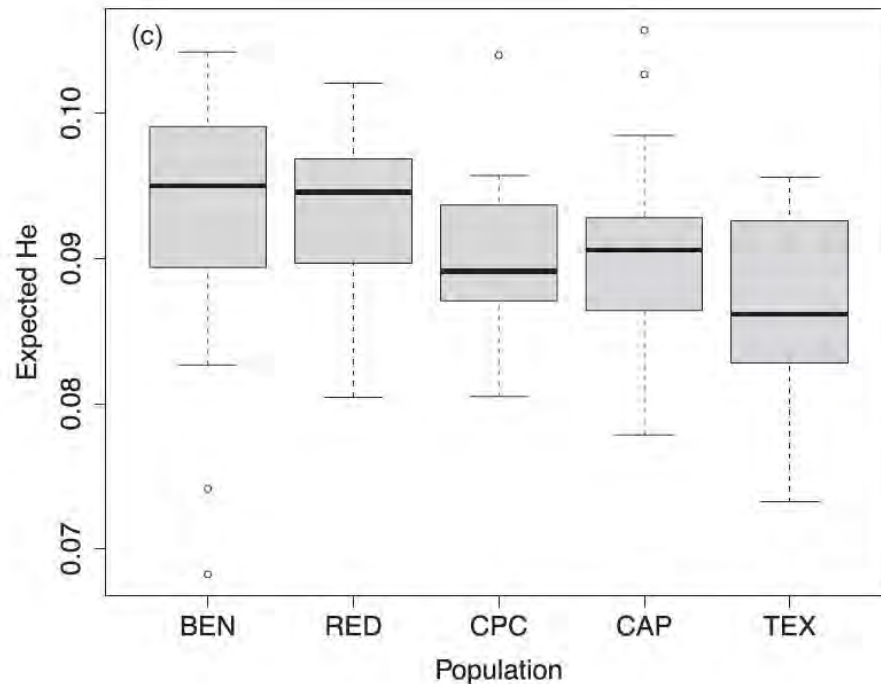
# Do any populations have low genetic diversity?



*Amsonia tharpii*



*Amsonia longiflora*



No difference among populations of each species<sup>19</sup>



# Are there differences in inbreeding between species and populations?

Inbreeding is low across all species and populations

*Amsonia* is most likely self incompatible

Maybe able to reproduce with close relatives/siblings

Species	Locality names	$F_{IS}$
<i>Amsonia tharpia</i>	Ben Slaughter	0.010
	Cap Rock	0.070
	Cedar Pearce	0.060
	Red Lake	0.088
	Texas	0.051
<i>A. fugatei</i>	Bosque	0.070
	Fife	0.096
	Sevilleta	0.060
<i>A. longiflora</i>	Azotea Mesa	0.084
	Black Mountain	0.088
	Dell City	0.043
	Engle	0.064
	Oliver	0.083
	Woods Tank	0.048

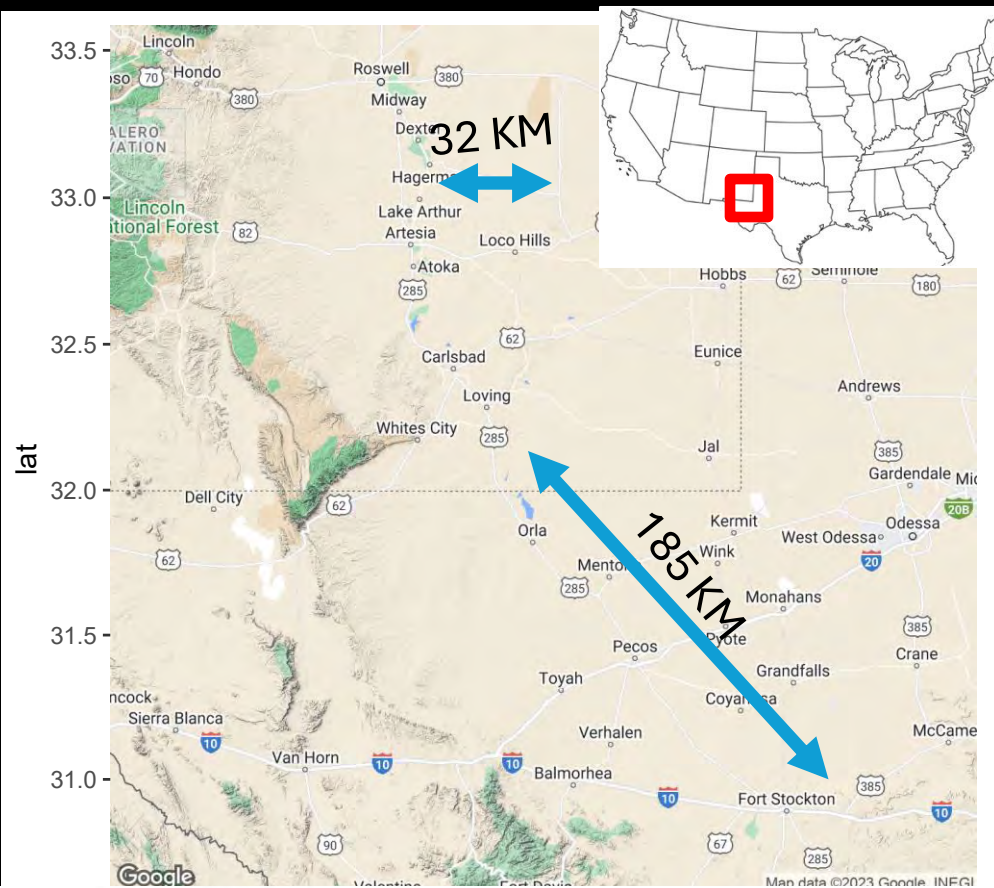


# *Amsonia tharpaii*

## Pollen movement

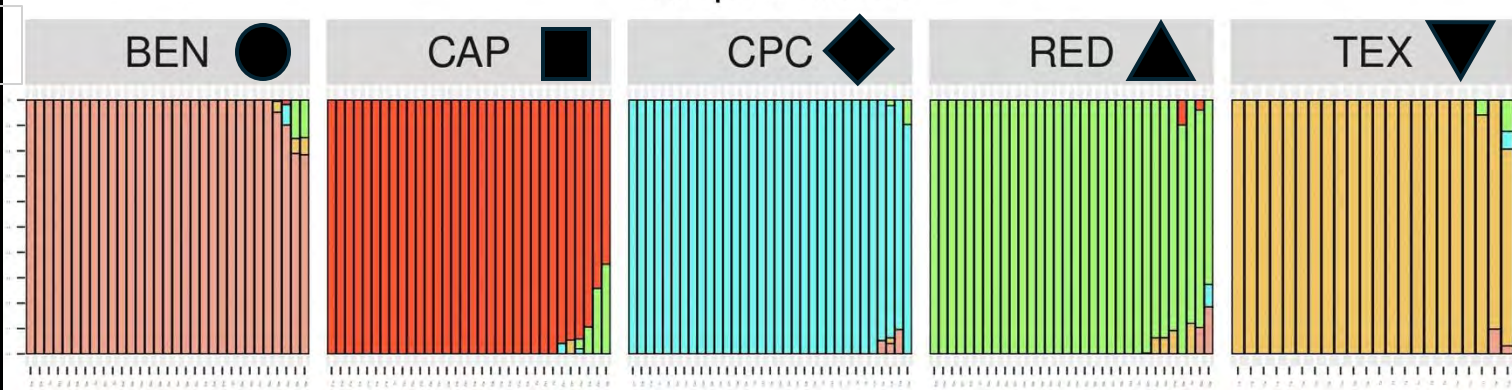


Genetically differentiated



Tharpaii-Nuclear

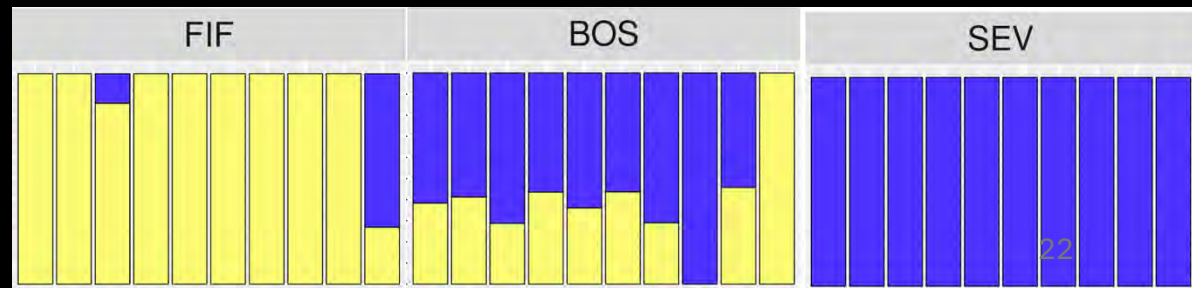
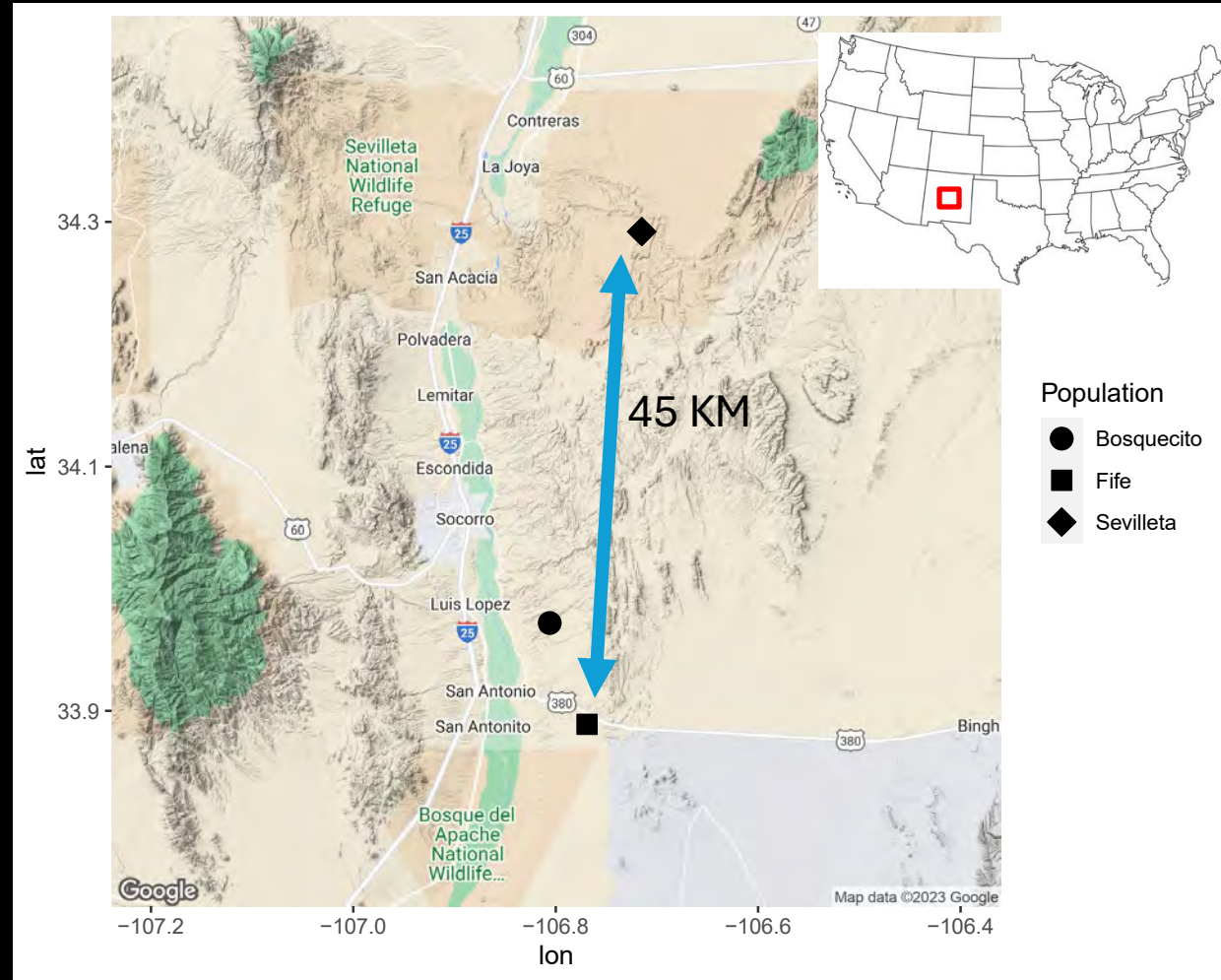
Population names



Each bar represents an individual

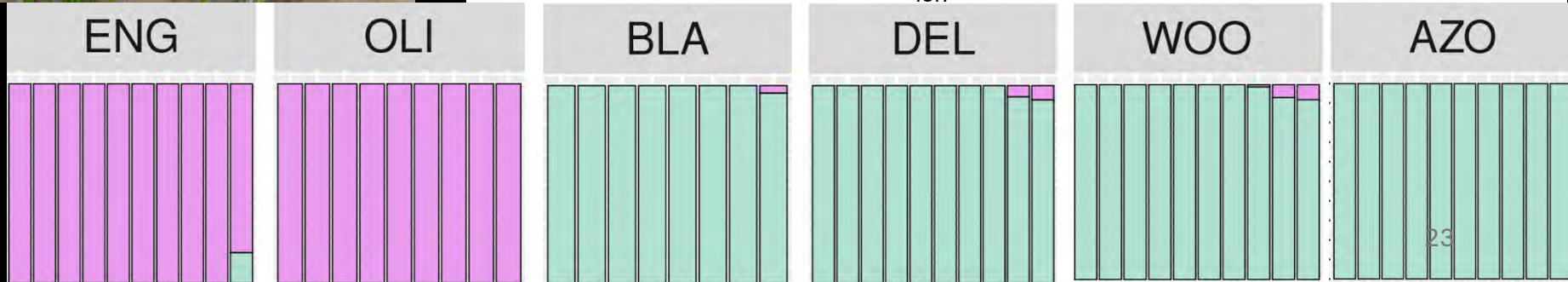
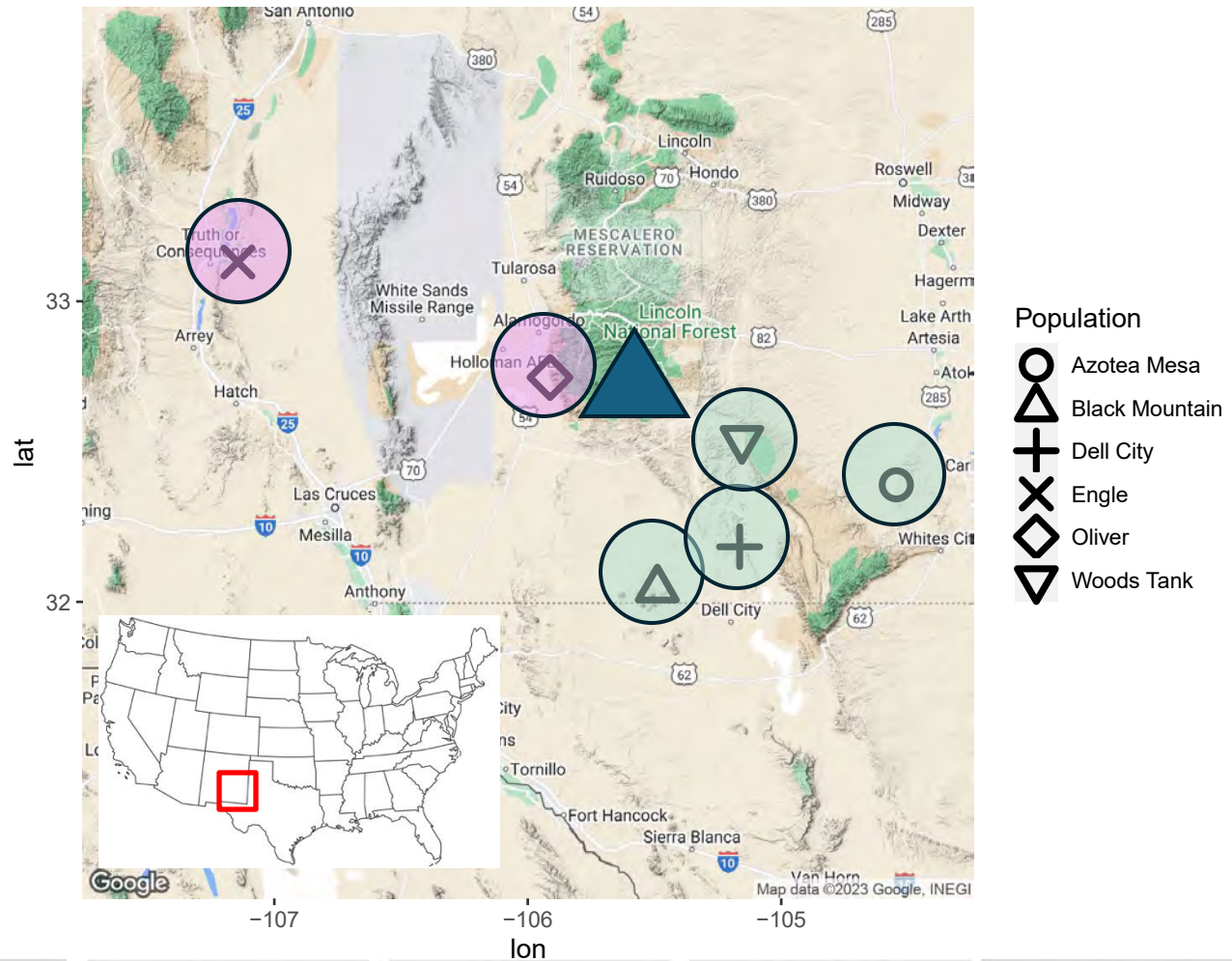


# *Amsonia fugatei* – pollen movement

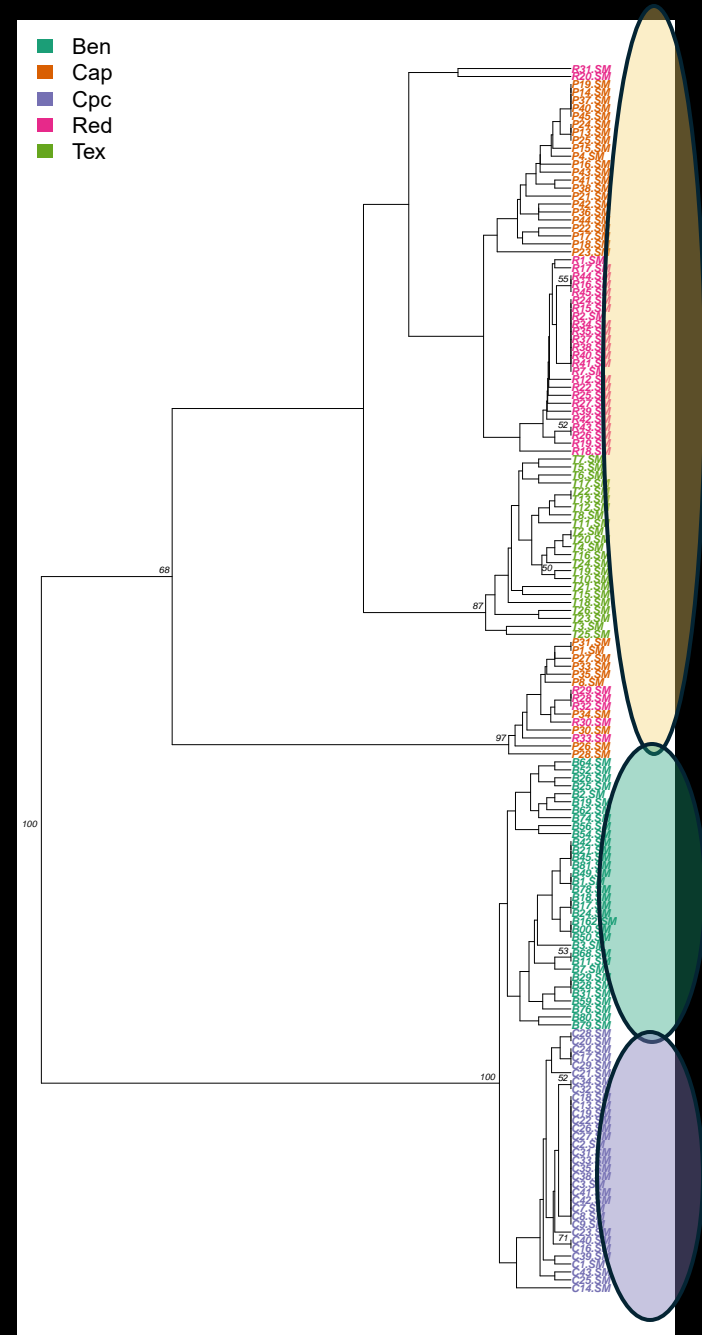
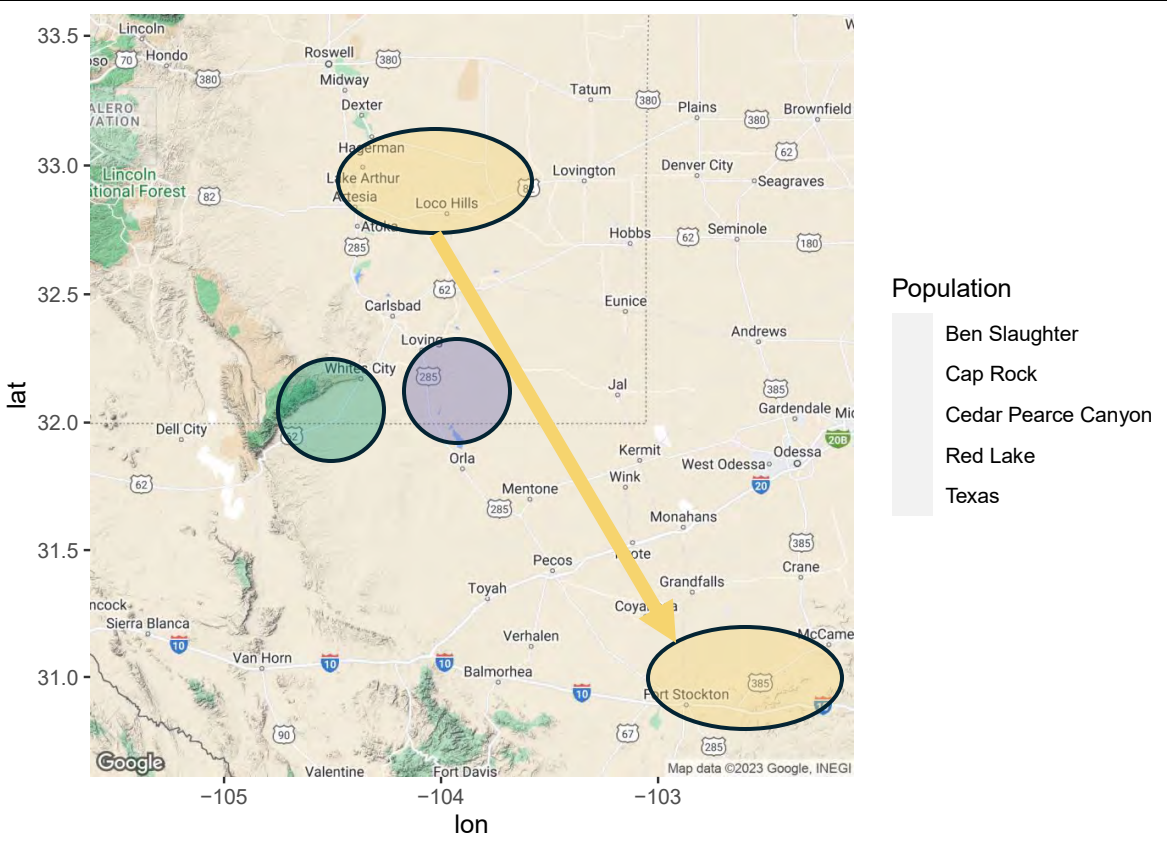




# *Amsonia longiflora* pollen movement



# *Amsonia tharpaii* seed movement



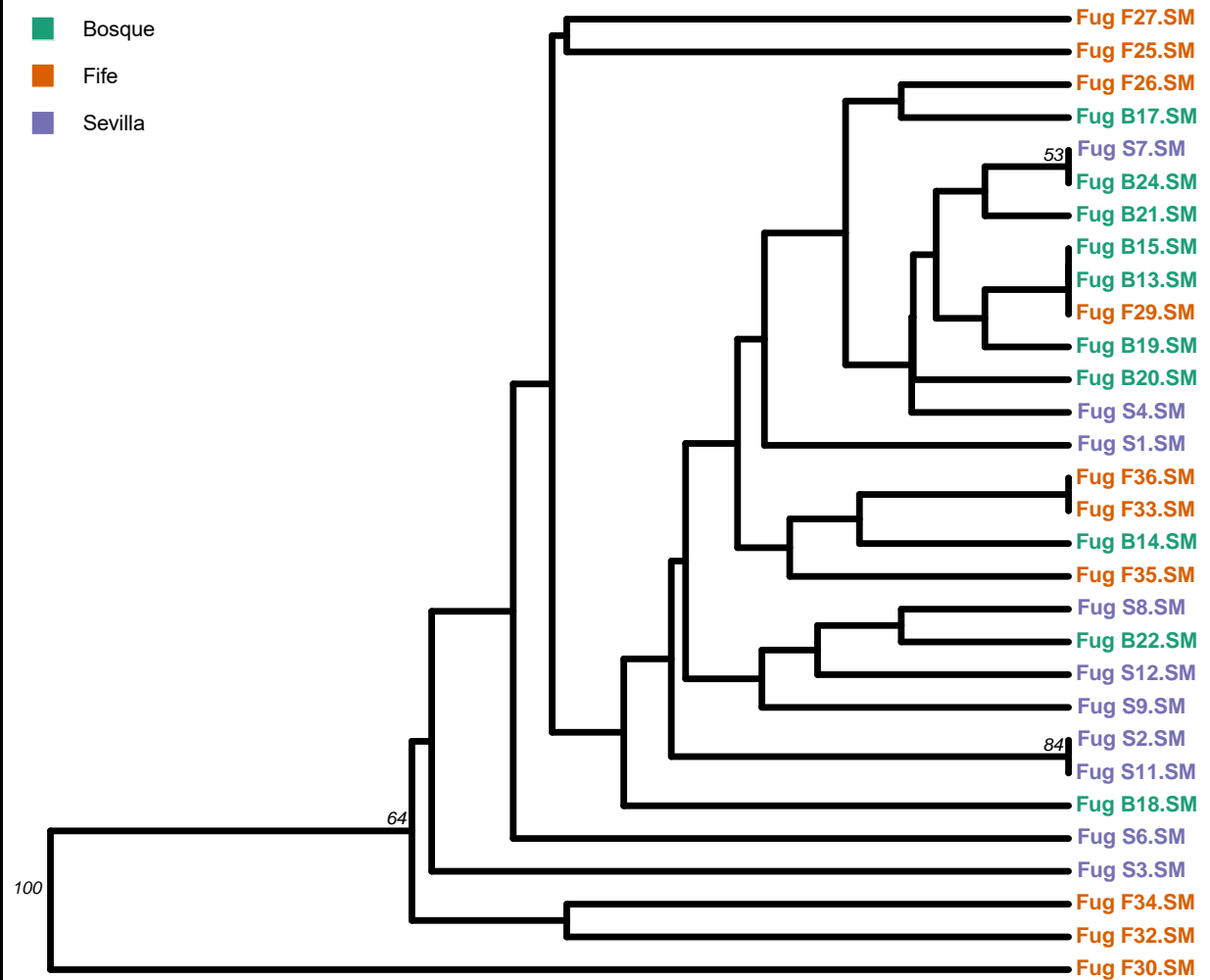
Red Lake and CAP Rock appear to have seed movement



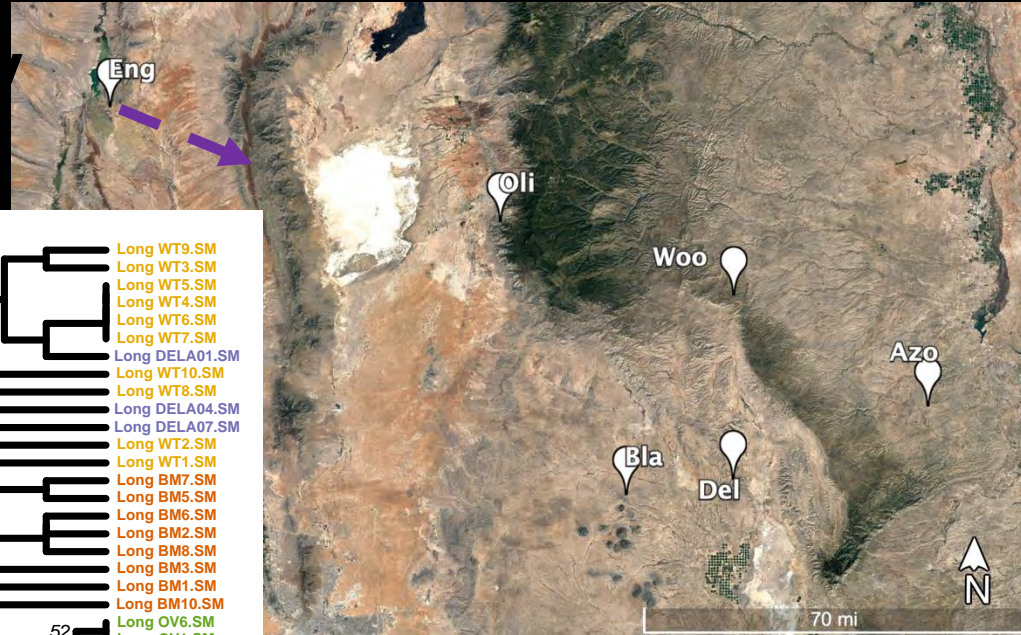
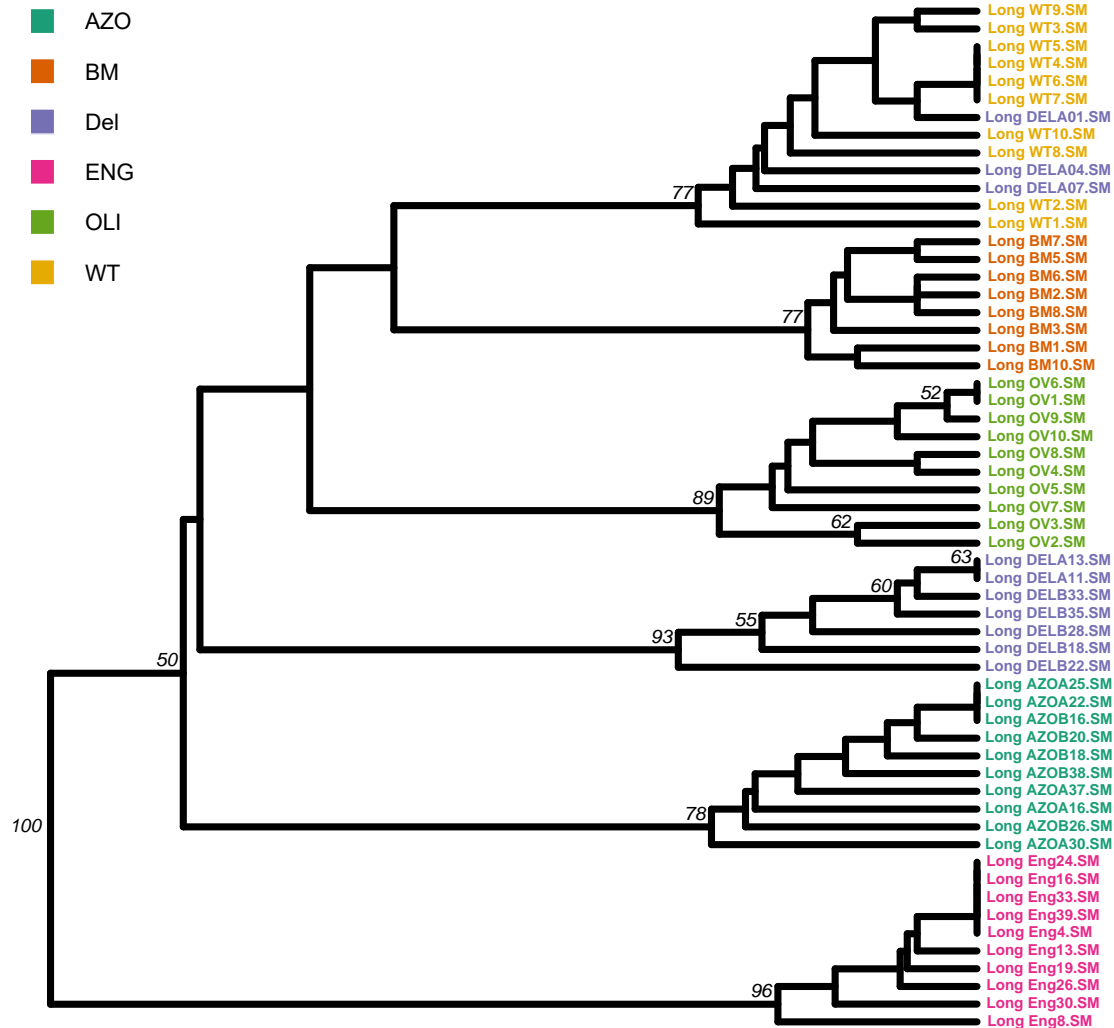
# *Amsonia fugatei* seed movement



Rio Grande River



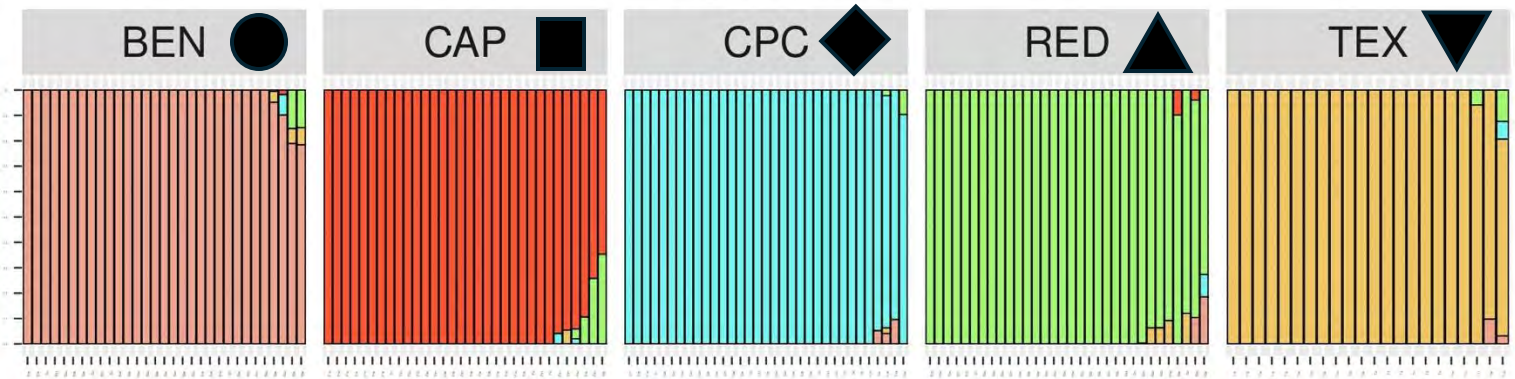
# *Amsonia longiflora* seed movement



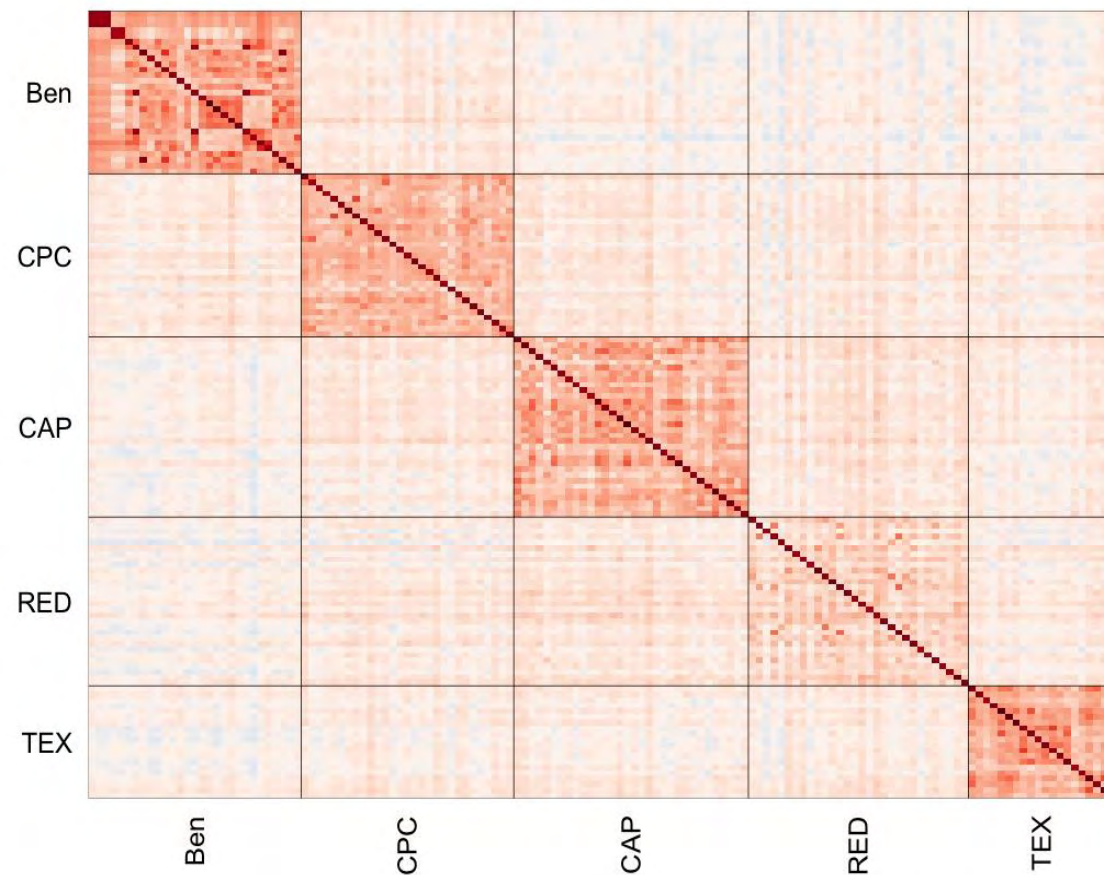
Limited seed movement  
West to east pattern



# Tharpia-Nuclear



Amsonia tharpia Kinship Matrix



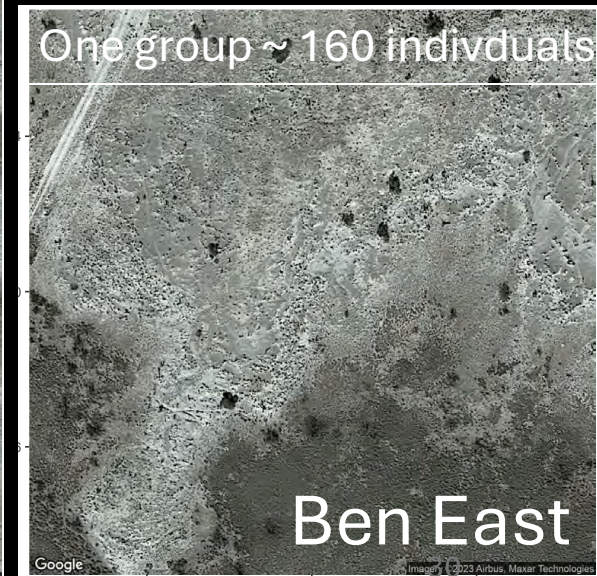
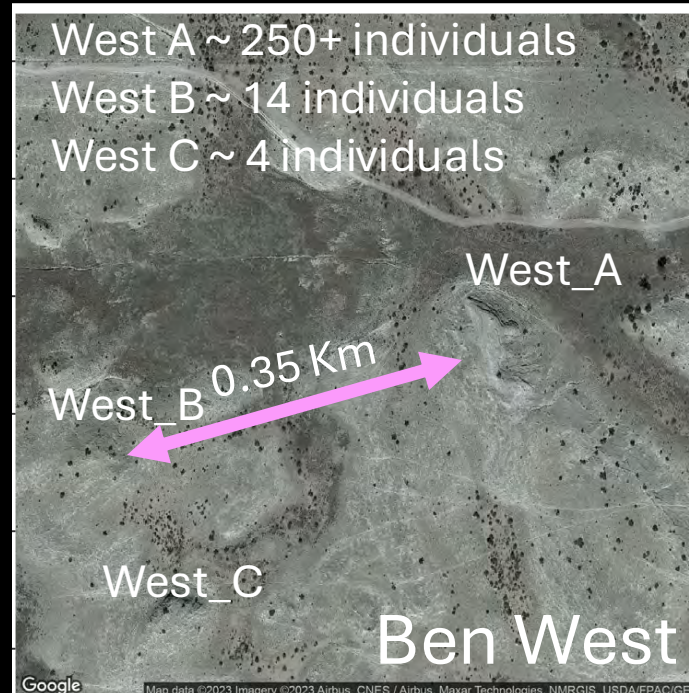
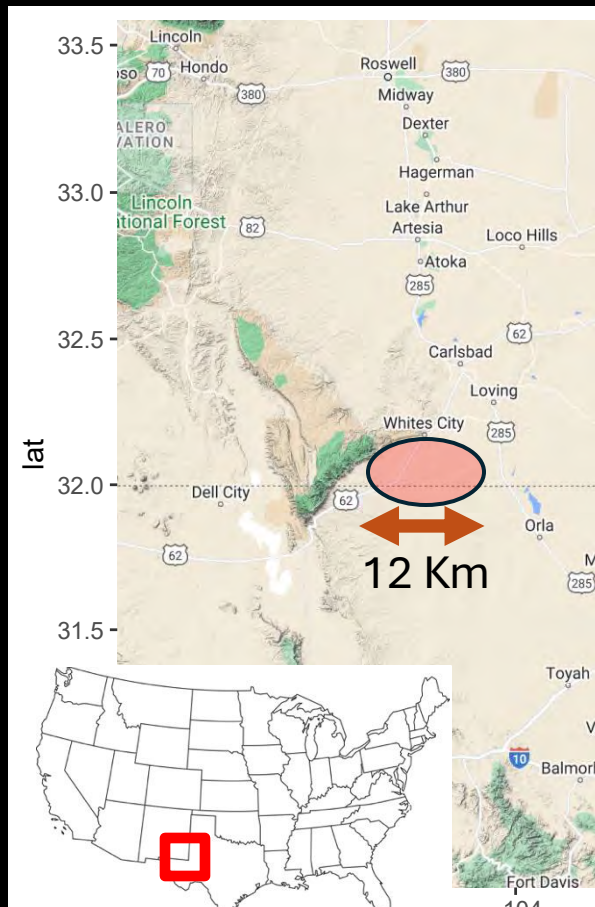
What about pollen transfer between sub populations?



# Ben Slaughter Draw

- Yeso Hills gypsum
  - Sampled all flowering individuals
    - Seeds to assess viability and germination
    - Collected GPS points

Alissa Doucet





# Hypothesis:

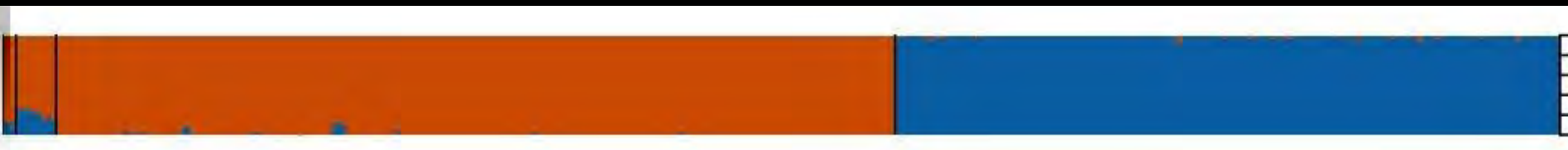
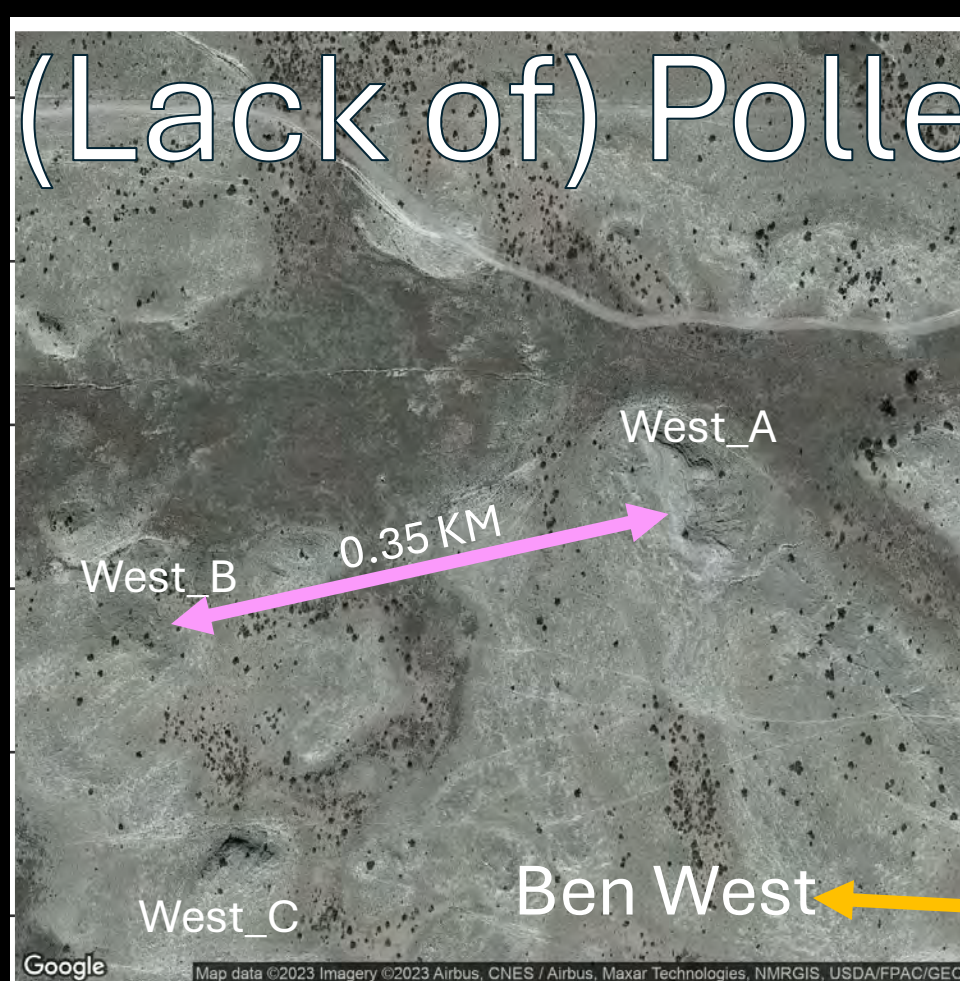
Pollen transfer is occurring between Ben West and with East

Seeds are not dispersing between Ben West and East

There are more clones/siblings within each subpopulation therefore germination and viability will be low



# (Lack of) Pollen movement



West\_B

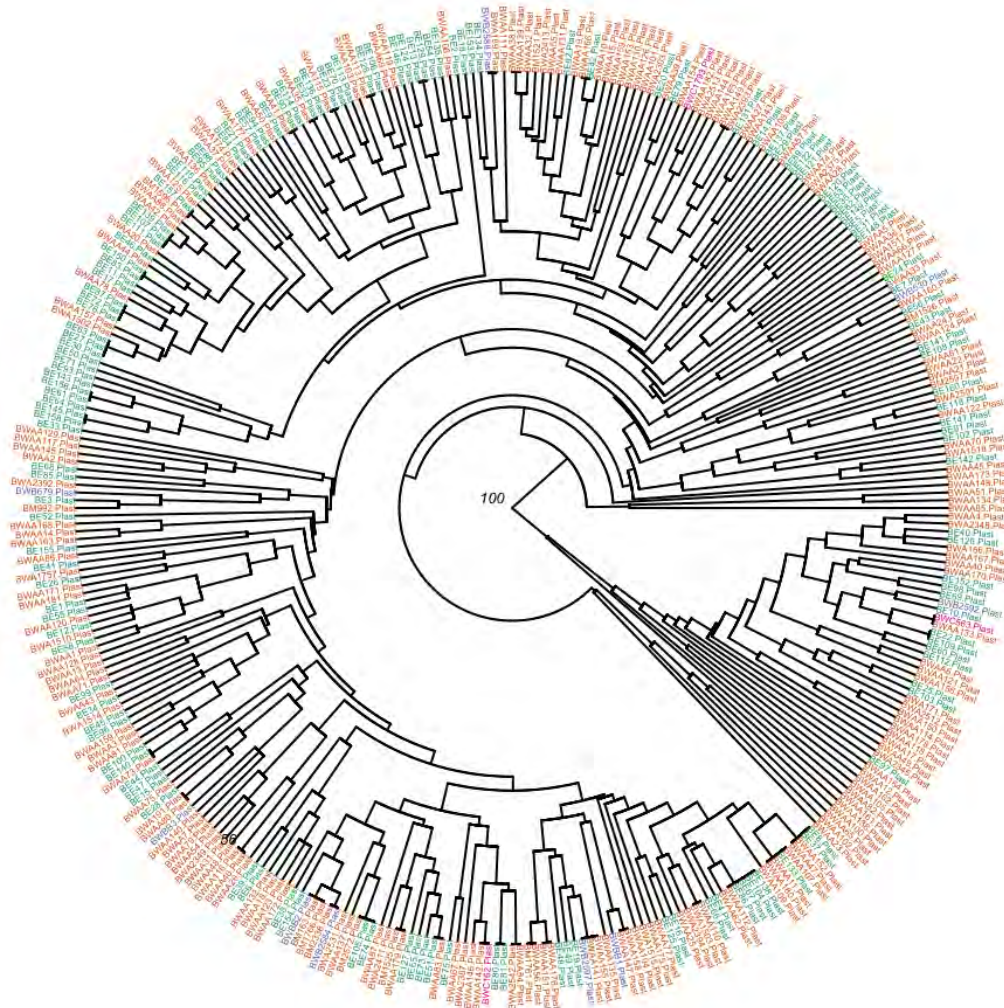
West\_A

Ben East



# Seed movement – Yes!

- East
- West\_A
- West\_B
- West\_C





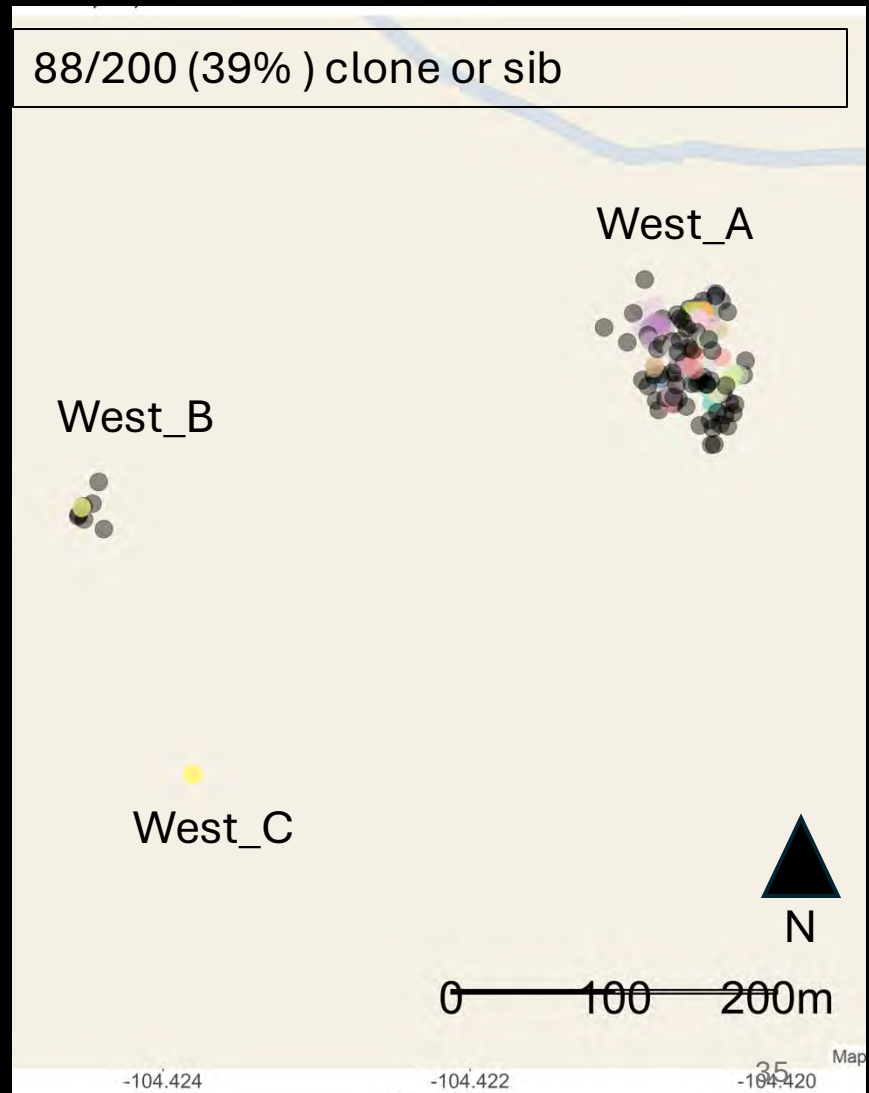
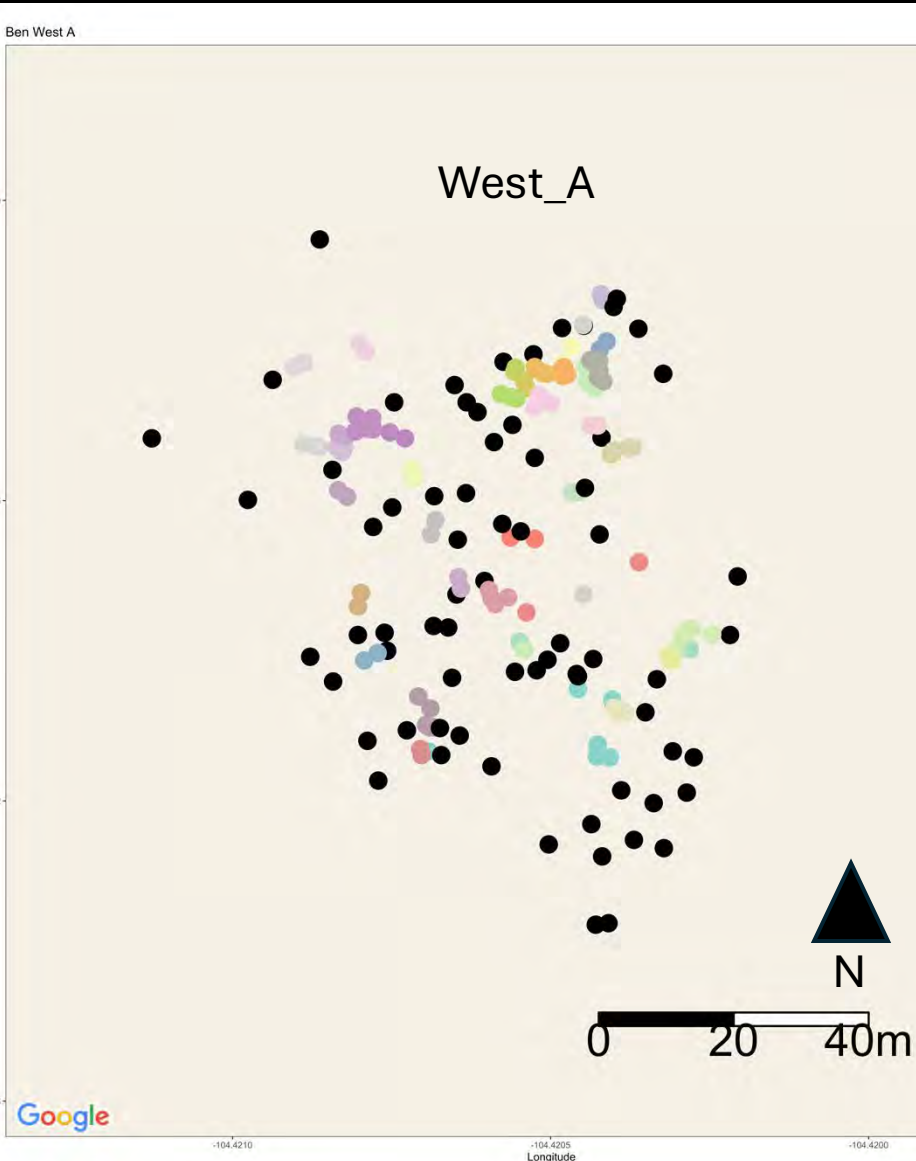
# Ben West Relatedness





# Clones/Sibs – Ben West

Conservative estimates  
 $0.5 > \text{Kinship coefficient}$   
identical/half sibling



# Ben East Relatedness

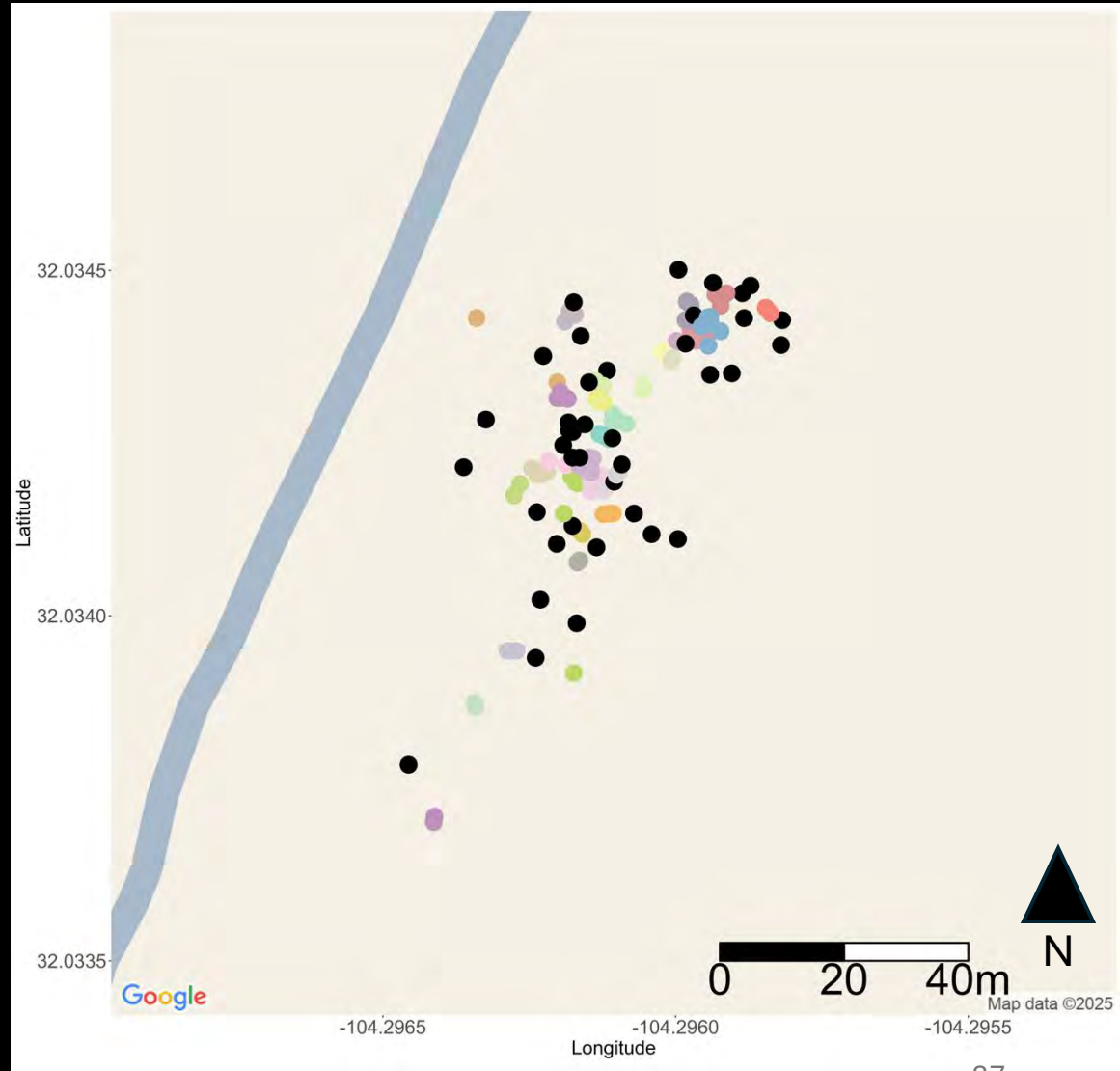




# Clones/Sibs – Ben East

Conservative estimates  
 $0.5 > \text{Kinship coefficient}$   
identical/half sibling

111/149 (75%)  
are clones/sibs



# Census size + Average Relatedness

## Average Relatedness

**0.60:** Clones/extreme inbreeding  
**0.30-0.50:** Full sibs/parent offspring  
 high inbreeding  
**0.15-0.25:** Half siblings  
**0-0.10:** Unrelated

## Ben West/East

Census = Number of flowering plants

All populations Census Estimates  
 2019 Roth and Sivinski\*

Pop (subpops)	Census Size (Sampled)	Average Relatedness
West_A	250	0.274
West_B	14	0.296
West_C	4	0.577
East	160	0.270
Ben (1)*	122 (31)	0.187^
Cap (3)*	1800-2800 (32)	0.152^
Cpc (4)*	5300-8500 (33)	0.150^
Red (5)*	4600-6700 (32)	0.086^
Tex (2)*	565 (22)	0.170^





# Seed viability and Germination Success

Pop (subpops)	Maternal lines	Seed N <sub>v</sub>	% Viable	Seed N <sub>G</sub>	% Germ Success
West A	15	185	88%	113	83%
West B	11	112	17%	57	19%
West C	0				
East	29	320	90%	205	95%
Ben (1)*	20	294	61%		
Cap (3)	20	299	38%		
Cpc (4)	20	301	74%		
Red (5)	20	299	71%		
Tex (2)	5	57	44%		

Smaller population = lower reproductive success

Ben East - high relatedness but viable seeds

Cap Rock – Low Seed Viability despite population size



# Effective population Size ( $N_e$ )

Pop (subpops)	Census Size (Sampled)	Average Relatedness	$N_e$
West_A	250	0.274	11.7
West_B			
West_C			
East	160	0.270	3.2
Ben (1)*	122 (31)	0.187^	6.5
Cap (3)	1800-2800 (32)	0.152^	44.9
Cpc (4)	5300-8500 (33)	0.150^	63.4
Red (5)	4600-6700 (32)	0.086^	72.8
Tex (2)	565 (22)	0.170^	37.3

Effective population size ( $N_e$ ) = the number of individuals contributing to the gene pool

**$N_e \geq 50$  for short-term survival and avoiding inbreeding**

**$N_e \geq 500$  for long-term evolutionary potential**

Ben East: Extreme genetic drift, alleles lost, bottleneck, high extinction risk

Red Lake: Few individuals are contributing to next generation even in large pops



# Final thoughts - Conservation

*Amsonia tharpaii* populations are unique lineages

Consider monitoring in the summer (after monsoons)

Ex-situ conservation

# Final thoughts - Conservation

Support a robust pollinator community

Recommend 1-5 Km buffers

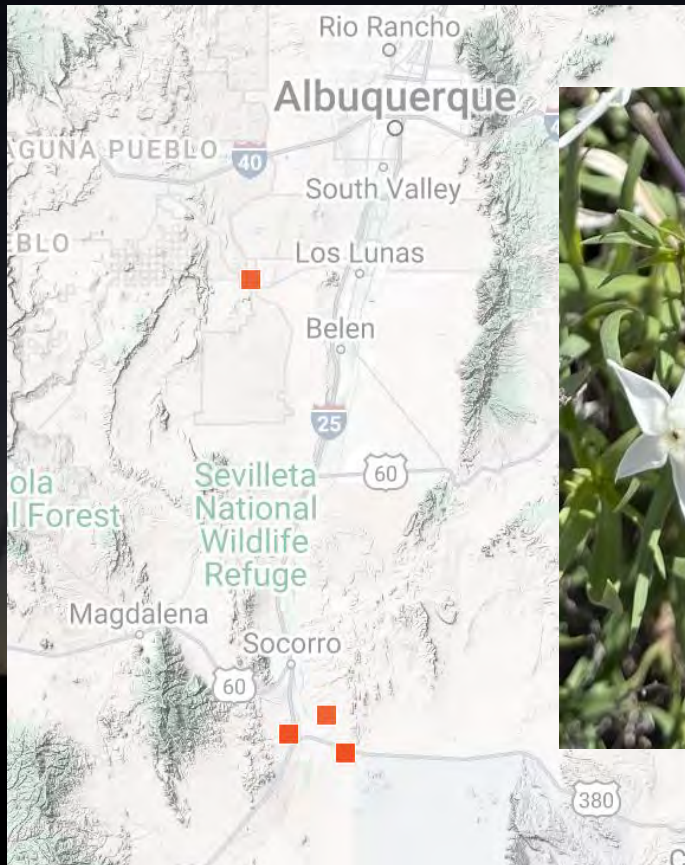




# Final thoughts - Conservation

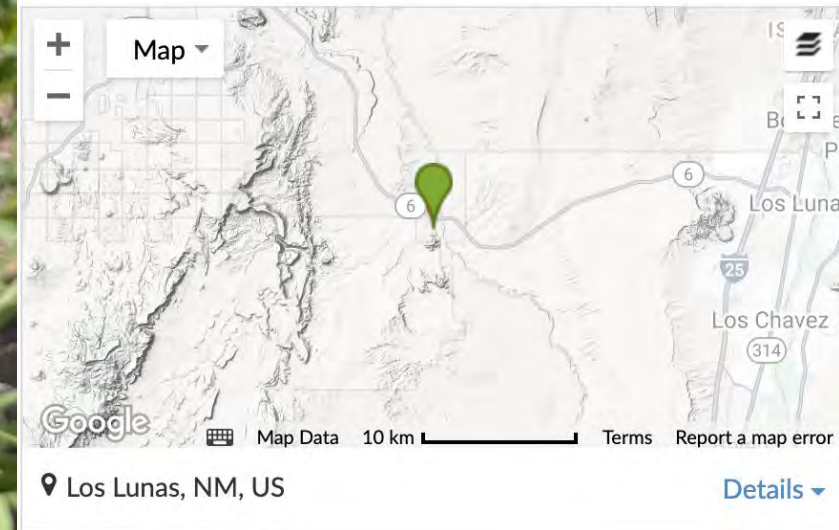
*Amsonia fugatei*

Possible new population



Observed:  
Apr 27, 2024 · 9:55 AM MDT

Submitted:  
Apr 27, 2024 · 9:18 PM CDT



Lat/Lon: 34.79124, -106.99737  
Accuracy: 3m



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