Evaluating Local Adaptation to Drought in *Erythranthe guttata* across Temporal and Spatial Scales

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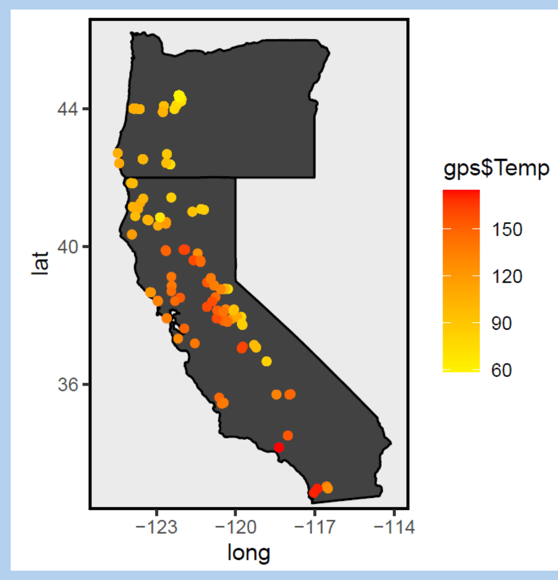
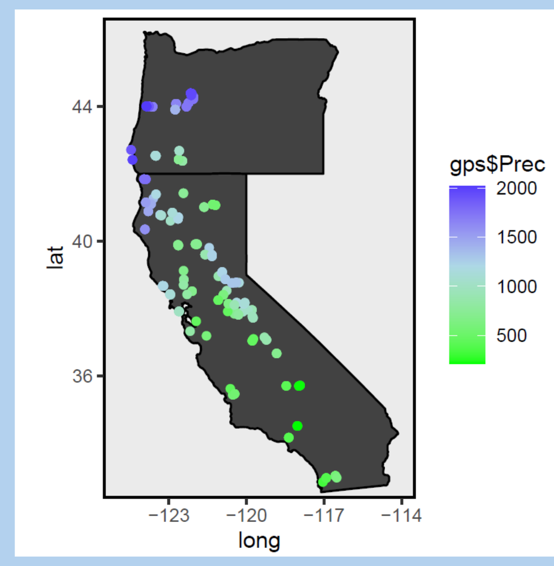
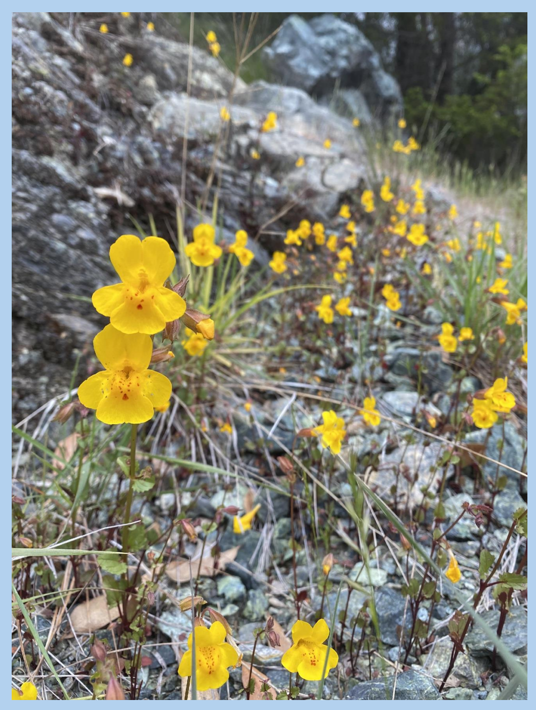
Introduction

- Drought is a critical selective force influencing plant growth, fecundity, and phenology. As climate change is expected to increase aridity globally, understanding plant responses to water stress is crucial for assessing population-level fitness and informing conservation efforts.
- This study investigates local adaptation to drought in 18 populations of *Erythranthe guttata* (formerly *Mimulus guttatus*), a species with a patchy distribution across seasonal wetland landscapes subjected to varying drought intensities.
- Using seeds collected during the historic 2010s drought, I examined phenotypic differences in a resurrection garden, comparing responses to two water treatments (drought and prolonged) across populations and years.
- Fitness-related traits (phenotypes) measured included days to first flower, plant height, fruit number, and leaf production at first flowering.







Top rows : Maps showing locations where *Erythranthe guttata* seeds were collected across California and Southern Oregon, with their corresponding local precipitation and temperature averages. Bottom rows: Wild *Erythranthe guttata* plants in full bloom.

Research Questions

1. How does exposure to drought water conditions influence plant phenotypes?
2. Does generation (pre drought or post drought) of the seed collected influence the phenotypes of the individuals?
3. Do individuals grown from post drought seeds, or individuals coming from drier populations exhibit stronger fitness under drought conditions?

- **I hypothesize** that drought responses will differ significantly among populations and years, with population fitness diverging between pre drought and post drought . Additionally, I expect individuals grown from drier years and populations seed sources to exhibit stronger fitness under the drought water treatment.

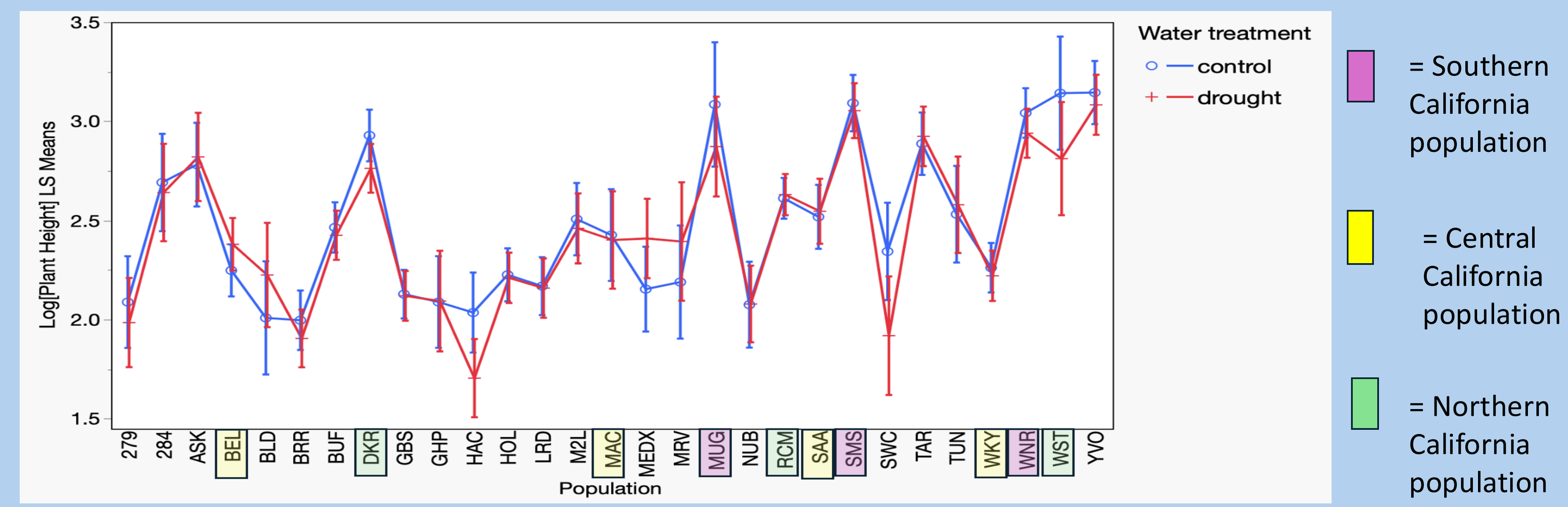
Methods

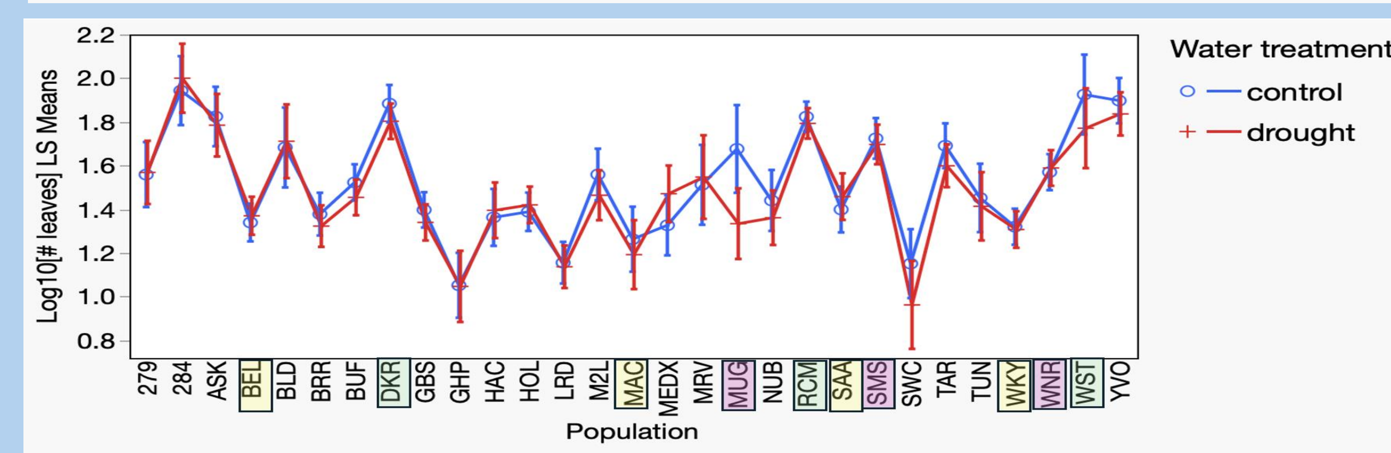
- A resurrection garden was grown with seeds collected from before and after the drought from 18 populations, n= 2112
- 12 blocks were created: 6 having drought water treatment, and 6 having control (prolonged) water treatment
- Drought water conditions were created by mimicking natural conditions of a wild population at the Merced Vernal Pool and Grassland Reserve after weekly soil moisture measurements were done using a TDR probe.
- Each of the 12 blocks held 176 family lines representing the 18 populations and 2 generations
- predrought & post drought). The seed lines were bred in within family crosses to maintain genotypic continuity and to minimize maternal effects.

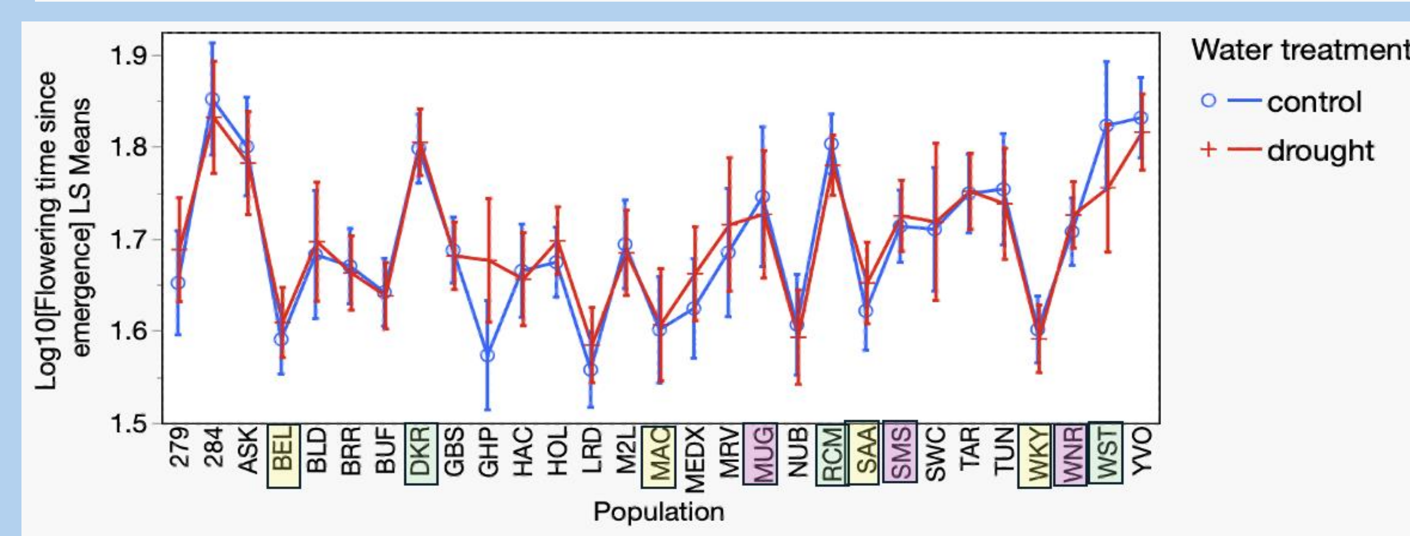
The resurrection garden design of 12 blocks, 6 on a drought water cycle, 6 on a prolonged water cycle. On the top left one drought water treatment block is shown. On the top right the entire garden is shown on May 21st, 2024. Bottom left Lynn Breithaupt is shown planting germinated plants. Bottom right students Emily Solorio, Melissa Hernandez and Lynn Breithaupt are shown with the plants growing in the greenhouse before being transplanted to the garden. April 2024.

Results

- **Populations differed significantly (P = <0.001) in their phenotypic measurements, but water treatments did not have a significant effect on plant height, flowering time since emergence, and the number of leaves produced.**

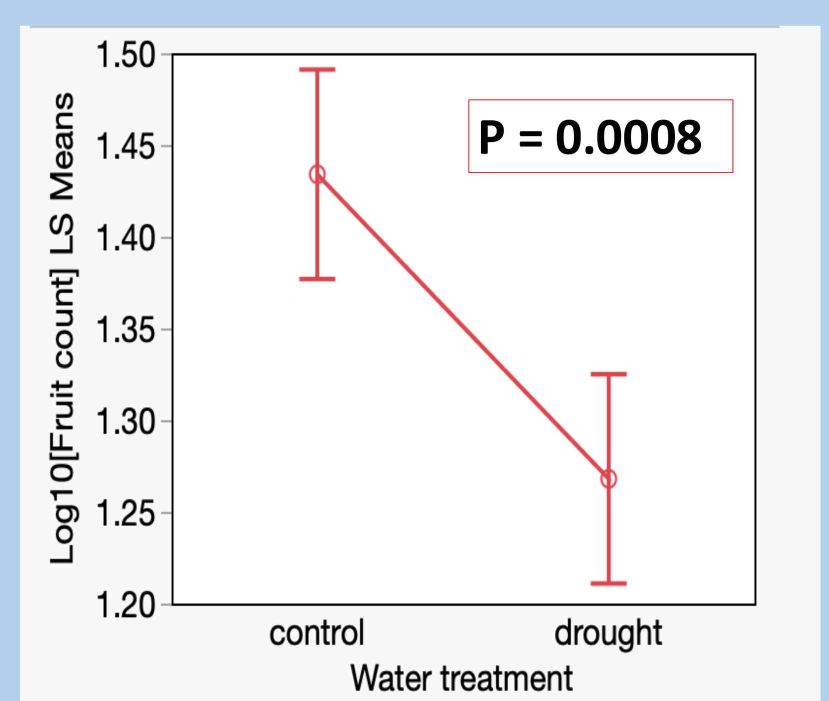


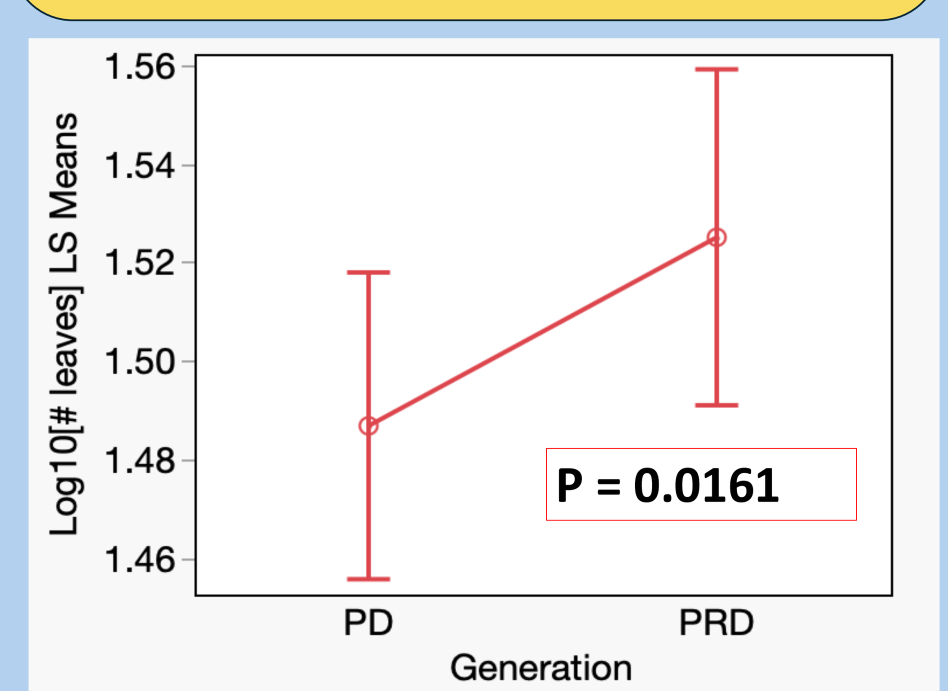




- **However, water treatment had a significant effect on number of fruits produced over all populations.**

- Generation did not significantly impact flowering time since emergence, plant height, or fruit counts, **but it did significantly affect the number of leaves produced.**





Discussion

- Populations differ significantly in their phenotypes regardless of the year seed was collected or water allotments during growth
  - This highlights how local adaptations and genotypes play a key role in survival
- Ranking fitness results between Southern, Central and Northern CA:
  1. Northern showed highest plant height, leaves produced, and # of days to flower
  2. Southern CA was an intermediate response
  3. Central CA showed lowest plant height, leaves produced, and quickest flower time
- **Next steps:** Conduct a second resurrection garden experiment in 2025, and analyze additional traits measured in both years grow out
  - Compare results of our Central California garden with an identical garden grown in Southern Oregon
  - Investigate genomic basis of drought responses between populations and generations

Acknowledgements

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