

# Rapid evolution of native and invasive California grassland species to altered water availability



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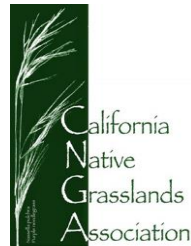
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- GGE Stats Support Group

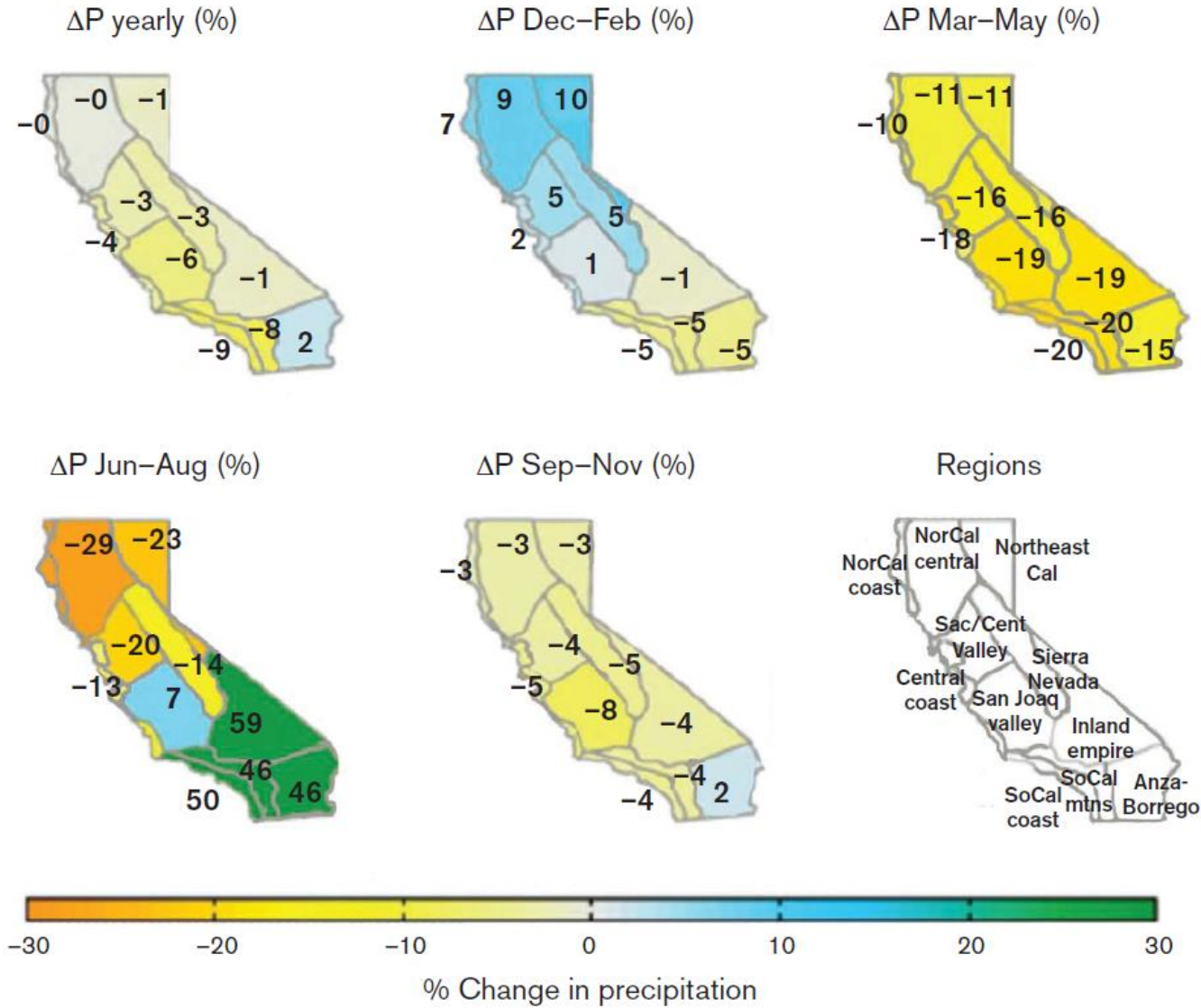


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# Western USA: Climate Forecast

- Much of CA drier
- Drier dry periods even in areas where annual rainfall remains the same



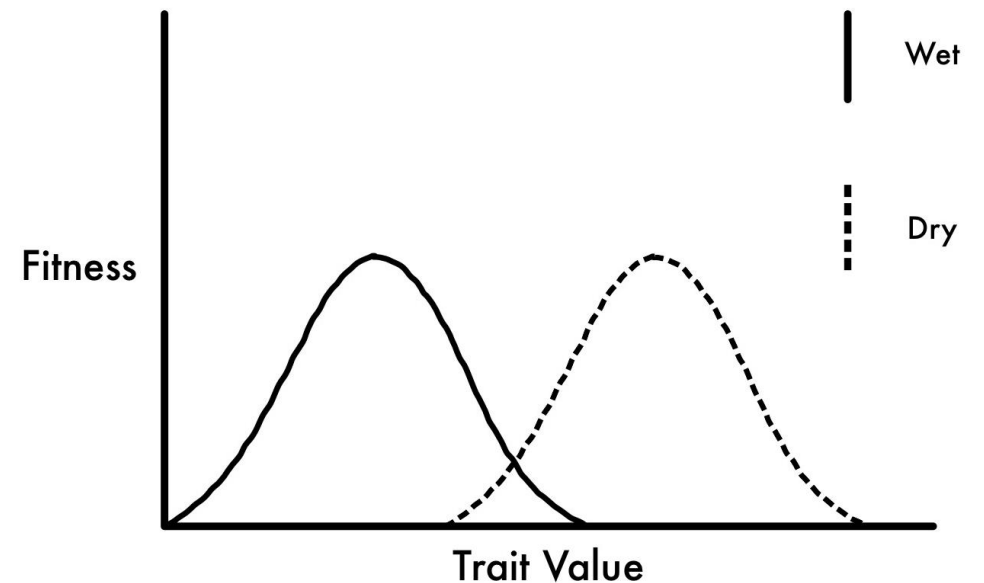
# How plants deal with water limited environments

**Functional trait:** Any measurable characteristic which impacts fitness<sub>1</sub>. (i.e. height, seed weight, flowering time)

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Traits that may lead to higher fitness in drought conditions:

- **Early flowering** = complete lifecycle before drought
- **Larger seeds** = provides resources for young seedlings to grow even when conditions are hard
- **More smaller seeds** = higher chance some offspring will germinate at the right time and in the right place



## Rapid evolution/inherited traits

- Sometimes, traits in populations of short-lived plants can quickly change in response to new environmental conditions
  - Rapid evolution
  - Maternal effects
- This includes in response to changes in water availability
  - Such as: Nguyen, 2016; Franks et al., 2014; Metz et al., 2020; Kooyers et al., 2021; Franks et al., 2007
- Most often see changes in phenology (i.e. flowering time)
- Many speculate that invasive plant populations might be able to adapt more quickly than natives

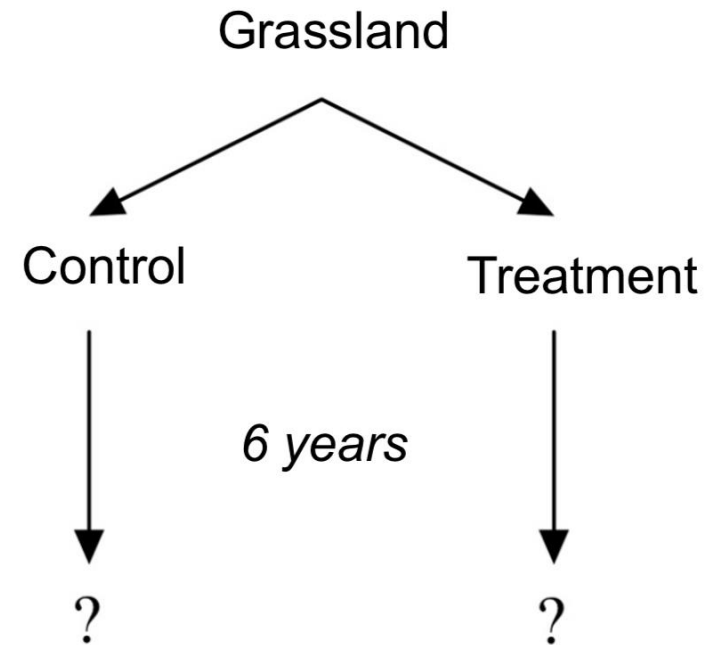
# Aims



# Background

Test 13 short-lived species for adaptive changes after six years of exposure to altered water conditions

- Natives and invasives
- Early, mid, and late season bloomers
- Growth form (grasses and forbs)
- Mating system
- Lifespan (annuals and short-lived perennials)



## Relevance

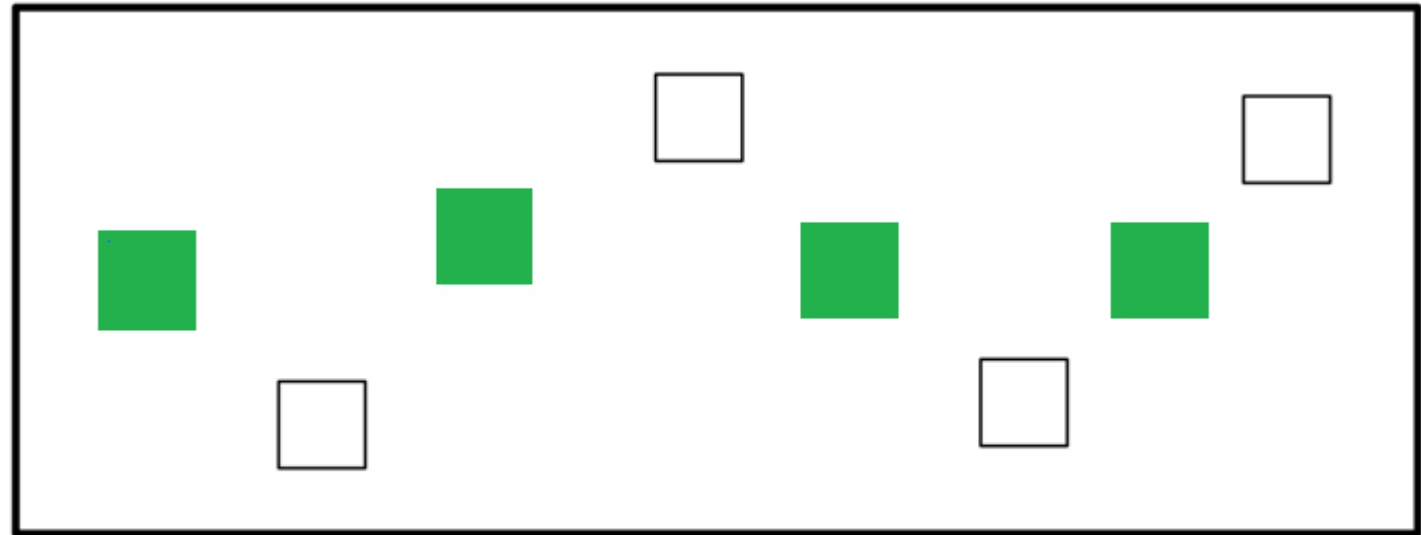
- Inform on when to plant local seed vs. seed adapted to the future climate
- Inform on when to plant non-local seed (lower cost/higher availability) vs. local seed (higher cost/lower availability)
- Identify non-natives to prioritize for control

# Field Site



Methods

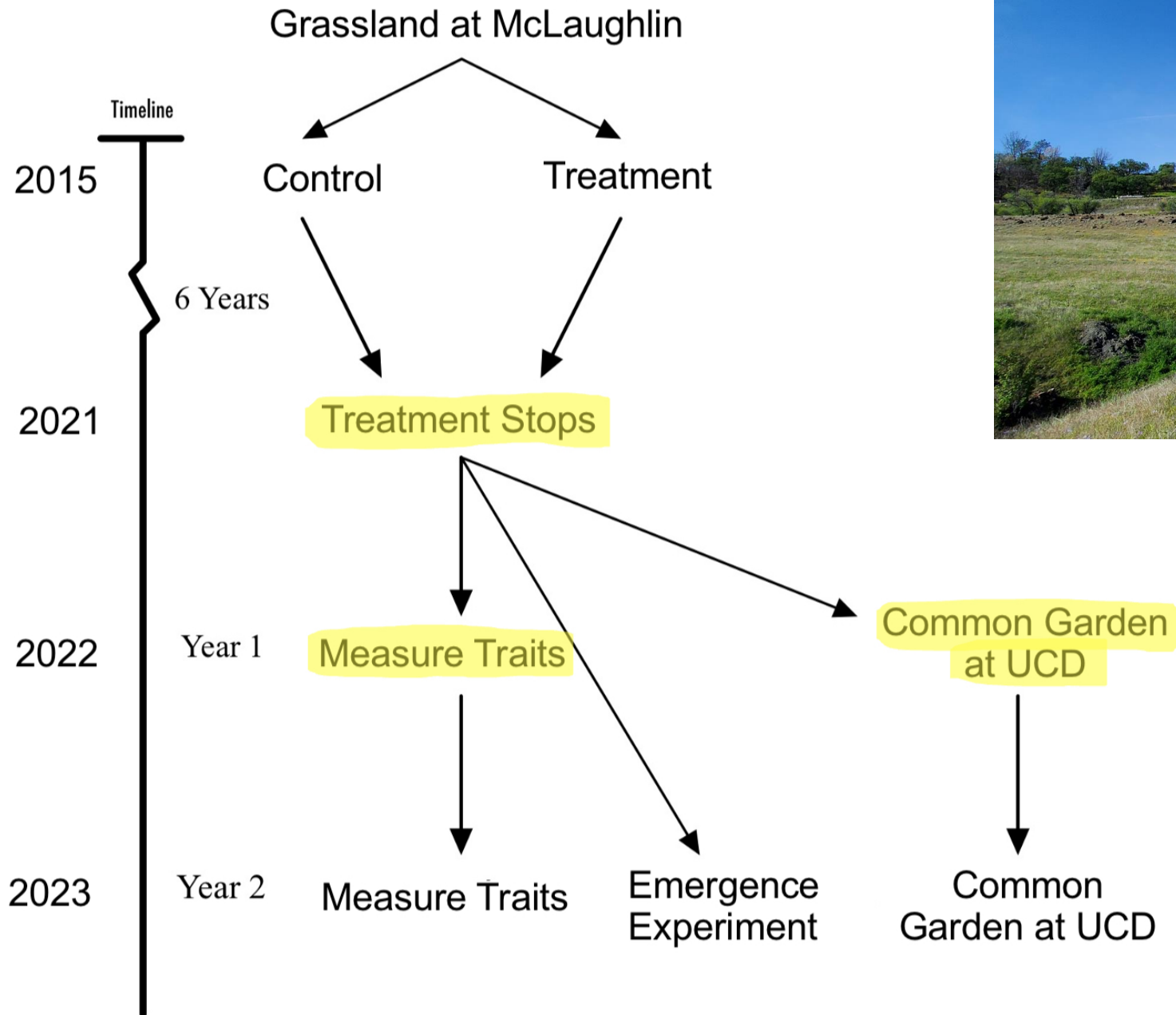
# General Plot Layout



□ Control    ■ Treatment



# Methods






# Seed mass McLaughlin 2021

**Serpentine shelter/control** (treatment  $p < 0.001^{***}$ ; species\*treatment  $p = 0.036^*$ )

brho	elel	fepe	heco	mh	trla
1.01	1.22	<b>*1.17</b>	<b>*1.21</b>	1.06	1.02

Key:

-  Drier = heavier
-  Wetter = heavier
-  Same weight

**Non-serpentine watered/control** (no significant differences between treatments)

avfa	brho	mh	vivi
0.97	0.97	0.98	0.94

**Serpentine watered/control** (near-significant species\*treatment interaction  $p = 0.058$ )

avfa	brho	capa	clgr	elel	femi	fepe	heco	mh	pler	trfu	trla
0.94	1.03	0.89	<b>*1.21</b>	0.92	1.00	<b>*0.86</b>	0.99	0.98	0.91	0.99	0.92

# Seed mass McLaughlin 2022

**Serpentine shelter/control** (no significant differences between treatments)

brho	clgr	elel	femi	fepe	heco	mh	pler
1.10	0.71	1.07	0.97	0.9	1.11	1.03	1.19

**Non-serpentine watered/control** (no significant differences between treatments)

avfa	brho	mh
0.90	0.87	1.01

Key:

- Drier = heavier
- Wetter = heavier
- Same weight

**Serpentine watered/control** (no significant differences between treatments)




avfa	brho	capa	clgr	elel	femi	fepe	heco	mh	pler	trla
1.06	1.01	0.75	1.18	0.91	1.09	0.87	1.13	1.00	1.01	1.09

# Seed mass greenhouse 2022

Results

**Non-serpentine watered/control** (treatment  $p=0.008^{**}$ ;  
treatment\*species  $p=0.022^*$ )

avfa	brho	mh	vivi
*1.11	0.87	1.00	0.98

Key:  
 Drier = heavier  
 Wetter = heavier  
 Same weight

**Serpentine watered/control** (treatment  $p=0.053$ ; treatment\*species  $p=0.005^{**}$ )




avfa	brho	capa	clgr	elel	femi	fepe	heco	mh	pler	trfu
1.04	0.96	*1.34	1.28	1.03	0.97	1.04	0.95	1.07	0.98	0.98

# Date of first flower 2022

**Non-serpentine watered/control** (no significant differences between treatments)

avfa	brho	mh	vivi
0.99	1.01	0.96	1.03

Key:

-  Drier = earlier
-  Wetter = earlier
-  Same time

**Serpentine watered/control** (no significant differences between treatments)

avfa	brho	capa	clgr	elel	femi	fepe	heco	mh	pler	trfu
1.05	0.97	1.00	1.00	1.02	1.05	0.99	1.00	0.99	1.02	1.05

Still need to analyze more traits from F1 and F2 generations

## **Tentative conclusions**

- Plants that received less water have the same seed mass or have heavier seeds
- Historic water conditions had either no effect or an unclear effect on seed mass
- Historic water conditions had no effect on first flowering date

# What does this mean?

At this point, no obvious signs of adaptation

If this is true, then:

- Population success will be highest if best-adapted species is planted
- Facilitate the movement of ecotypes of desirable plants rather than counting on them to adapt
- Stop the movement of invasive weed seeds, especially from regions that might have ecotypes that are a good fit for your site

# Thank you for listening!

Questions?

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