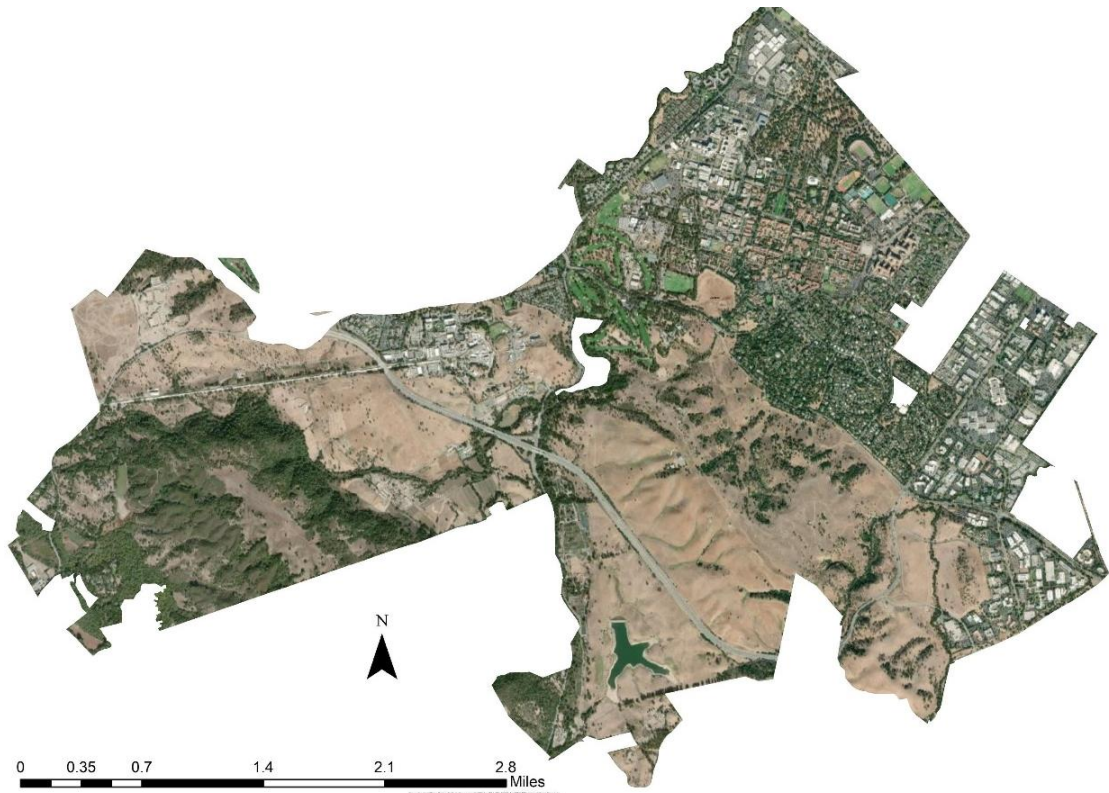




Timed Mowing in Combination with Broadcast Seeding Increases Native Plant Coverage in a California Grassland

Esther Cole Adelsheim¹, Katie Preston¹, Julian Tattoni²
Stanford Conservation Program¹; University of California, Davis²

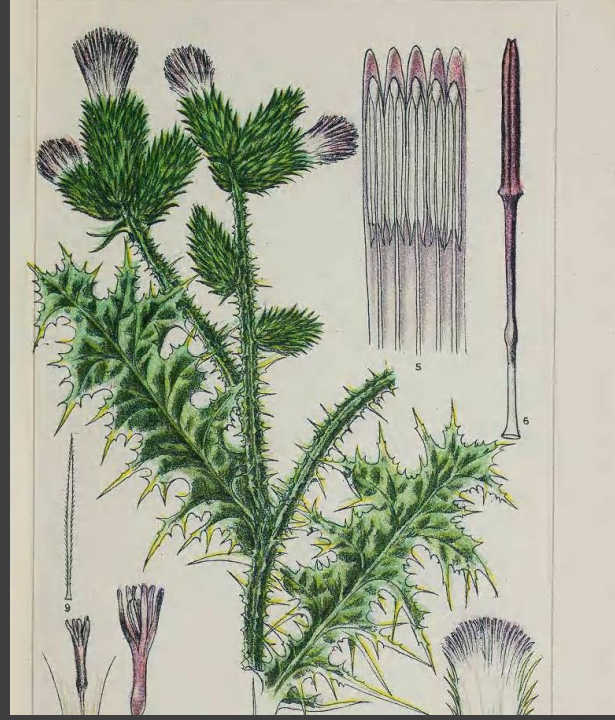


Common Grassland Restoration Projects at Stanford

- Restoration of construction sites
- Post-maintenance restoration (underground pipe maintenance, road maintenance, etc)
- Restoration of agricultural sites
- Habitat enhancement on undeveloped lands

Factors Contributing to Success of Non-natives and Displacement of Native Plants in California Grasslands

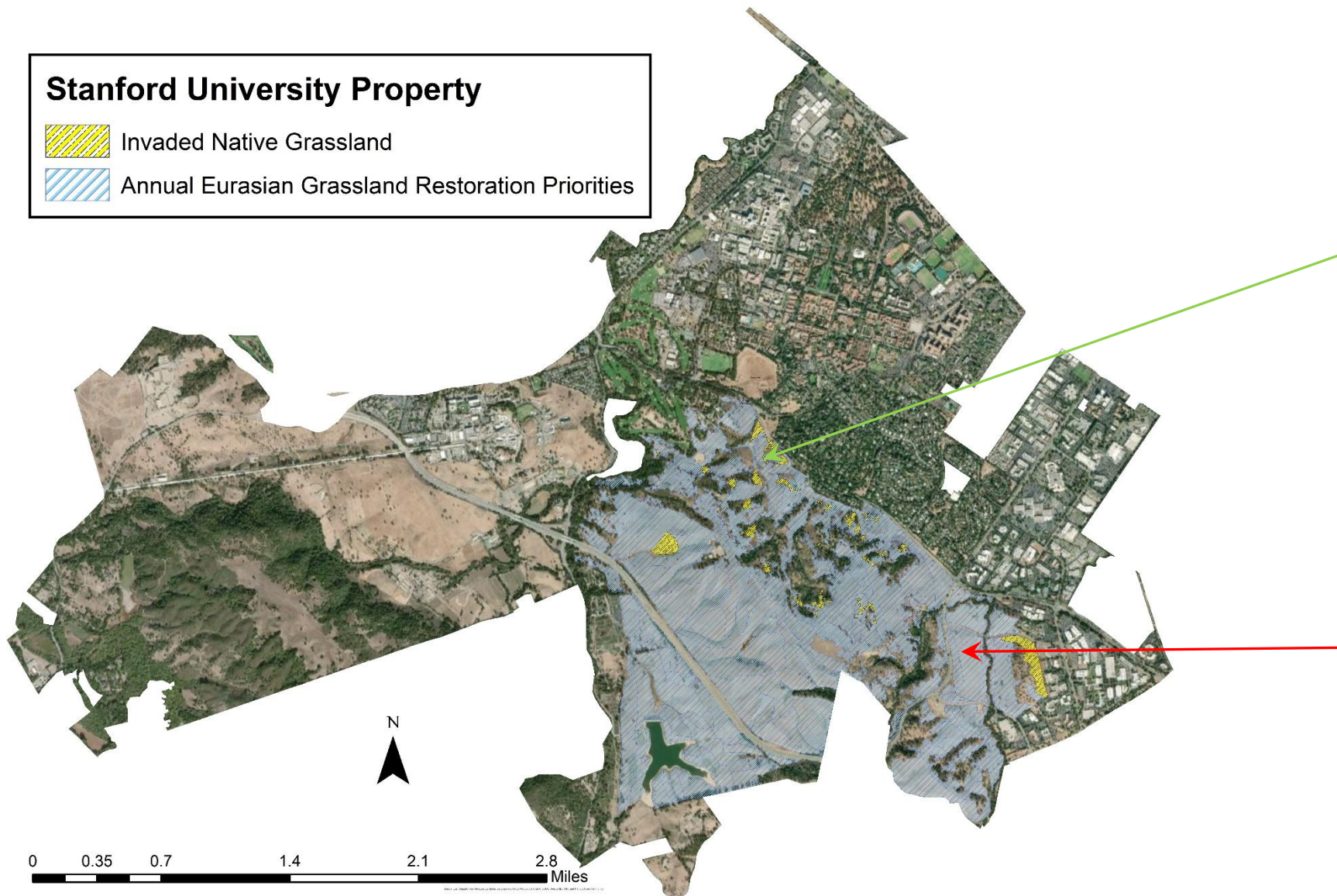
- **Altered Disturbance Regimes**
 - Fire suppression (Greenlee and Langenheim 1990)
- **Nitrogen Deposition**
 - Atmospheric (Weiss 2001)
 - Agricultural (Vitousek et al 1997)
- **Plant Traits**
 - Propagule abundance and establishment success (Seabloom 2011)
 - Plant productivity (Corbin & D'Antonio 2010)
 - Ability to fix nitrogen (e.g., Vitousek et al. 1987; Stock et al. 1995)
 - Ability to alter fire severity or frequency (D'Antonio and Vitousek 1992; Knapp 1996)
- **Site Conditions**
 - Soil chemistry (Zefferman et al 2015)

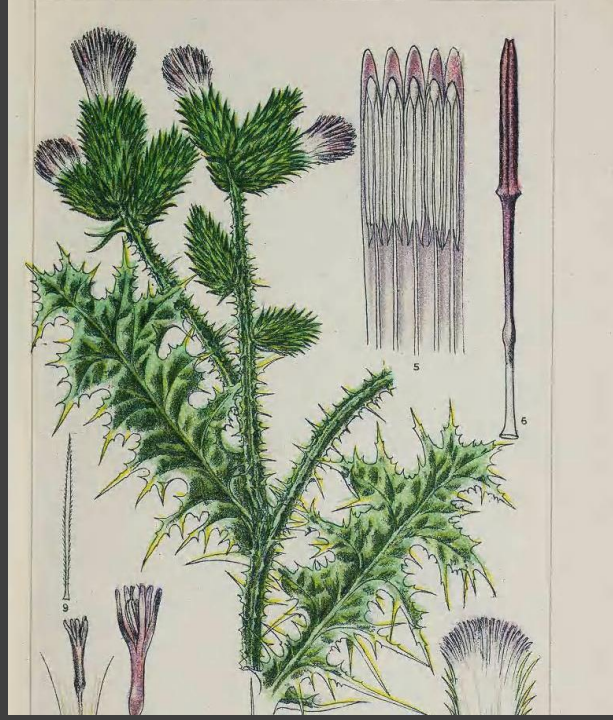


Common Tools for Grassland Restoration

- Fire
- Grazing
- Herbicides
- Scraping off top layer of soil
- Solarization
- Timed Mowing
- Seeding

Highest Priority Grassland Restoration Sites





Common Tools for Grassland Restoration

- Fire
- Grazing
- Herbicides
- Scraping off top layer of soil
- Solarization
- Timed Mowing
- Seeding

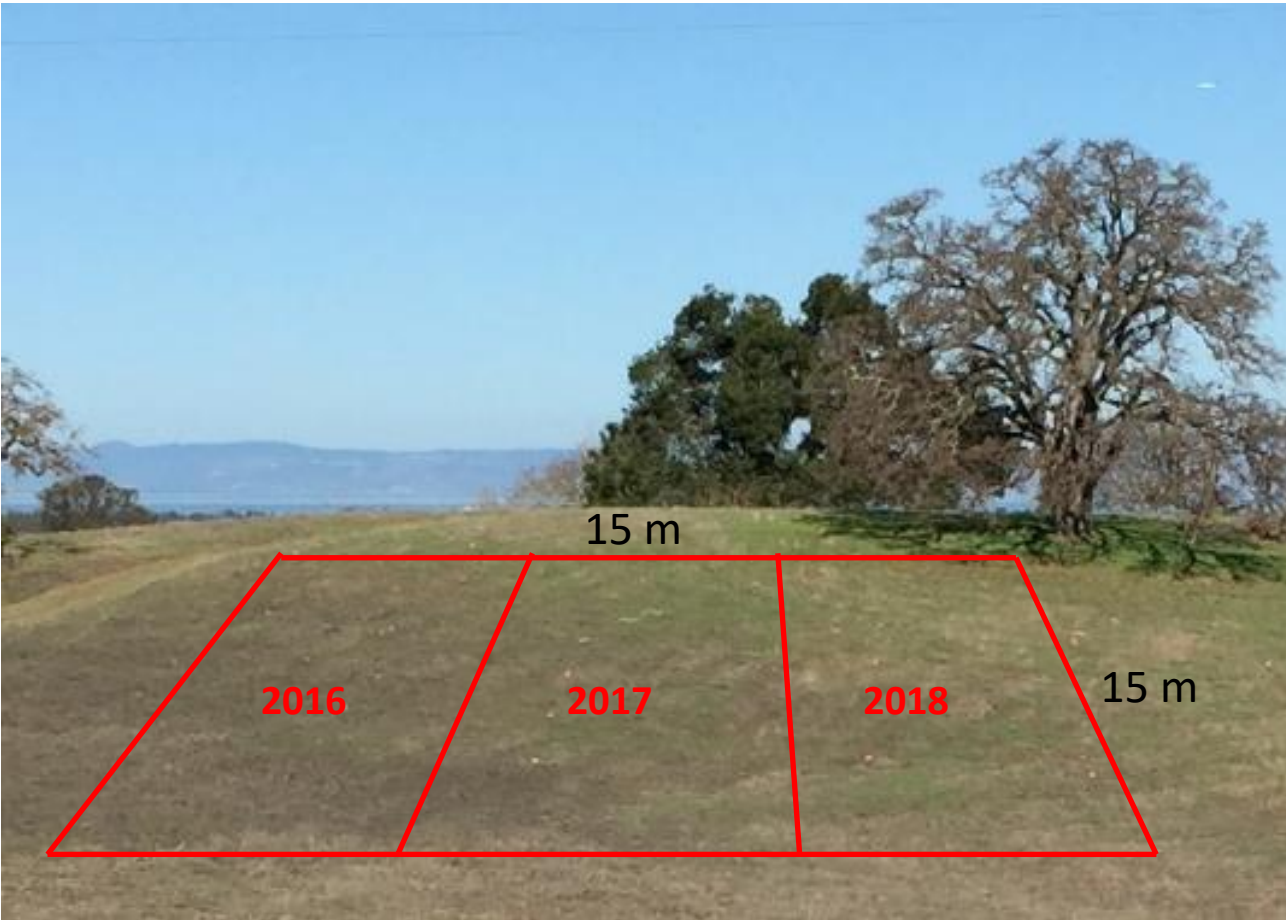


Timed Mowing and Broadcast Seeding Experiment

Research Questions:

- Does mowing or timed mowing combined with native seeding increase coverage or species richness of native plants?
- Does aspect influence the outcome of restoration treatments?
- To what degree do year effects persist with repeated application of restoration treatments over 5 years?
- What native plant species successfully increase in coverage through seeding?

Block Design: Treatment, Aspect, 1st Year of Treatment Application



Species Seeded:

- Grasses:
 - *Elymus glaucus*
 - *Elymus triticoides*
 - *Stipa pulchra*
 - *Stipa lepida*
 - *Bromus carinatus*
 - *Hordeum brachyantherum*
 - *Melica californica*
- Forbs:
 - *Achillea millefolium*
 - *Eschscholzia californica*
 - *Lasthenia glabrata*
 - *Phacelia californica*
 - *Sisyrinchium bellum*
 - *Lupinus bicolor*

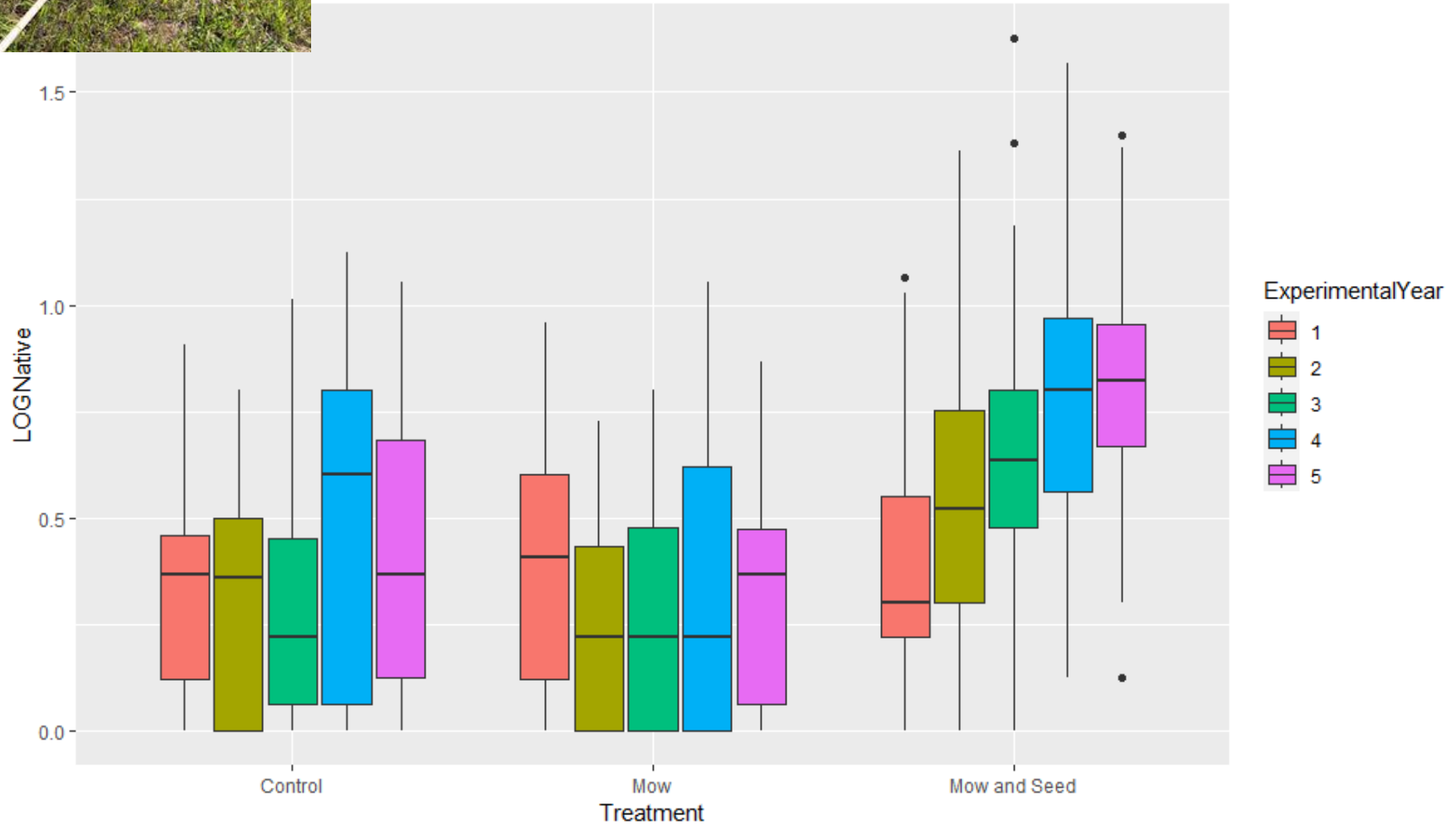
Does mowing
or mowing
combined
with native
seeding
increase
coverage of
native
plants?

Mowing –
No!

Mowing and
Seeding –
Yes!



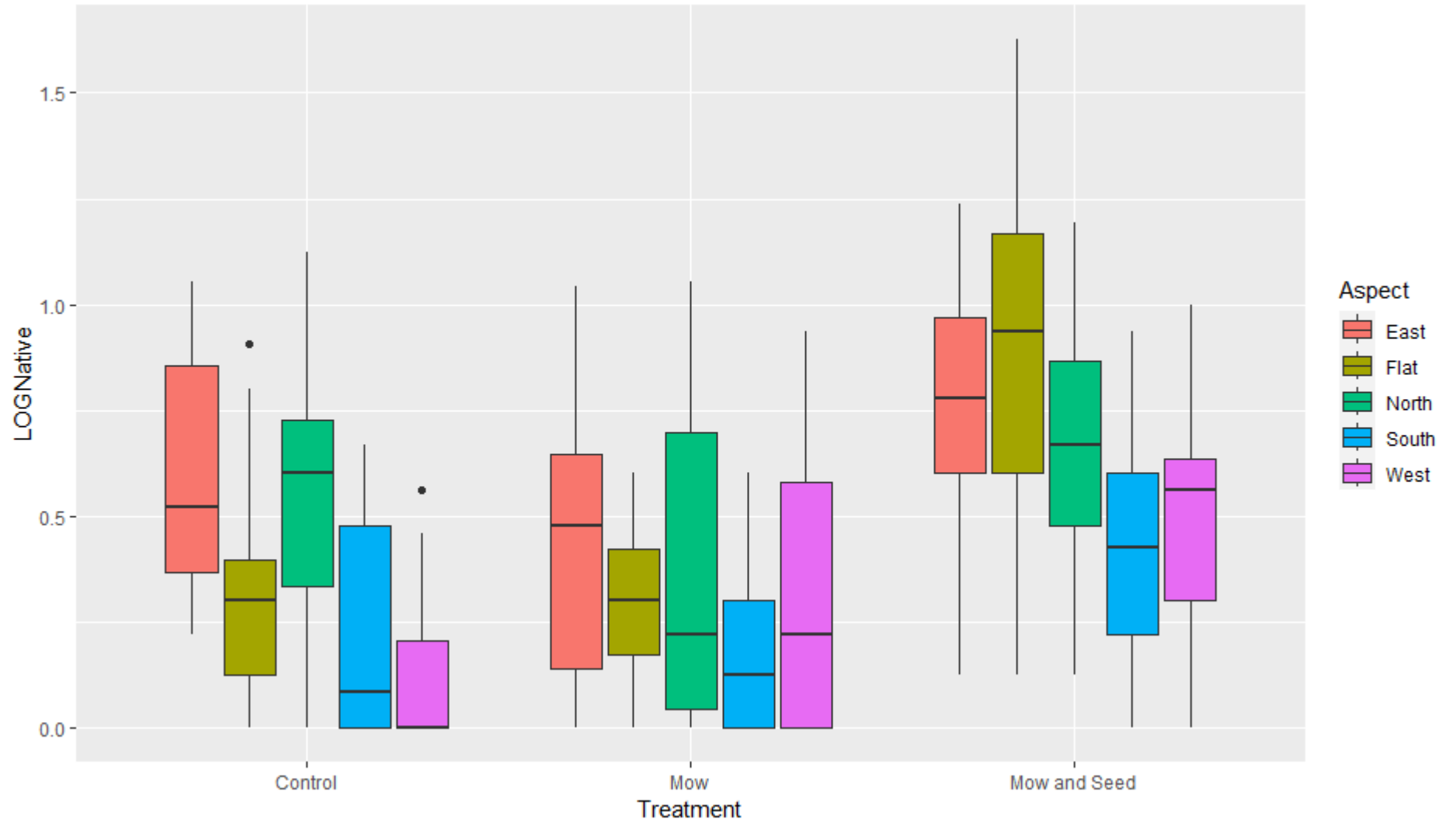
Mowing and Seeding Increased Native Coverage After 3 Years



Does aspect influence the outcome of restoration treatments?

Yes!

Mowing and Seeding in Flat and West-facing Slopes Increased Native Coverage

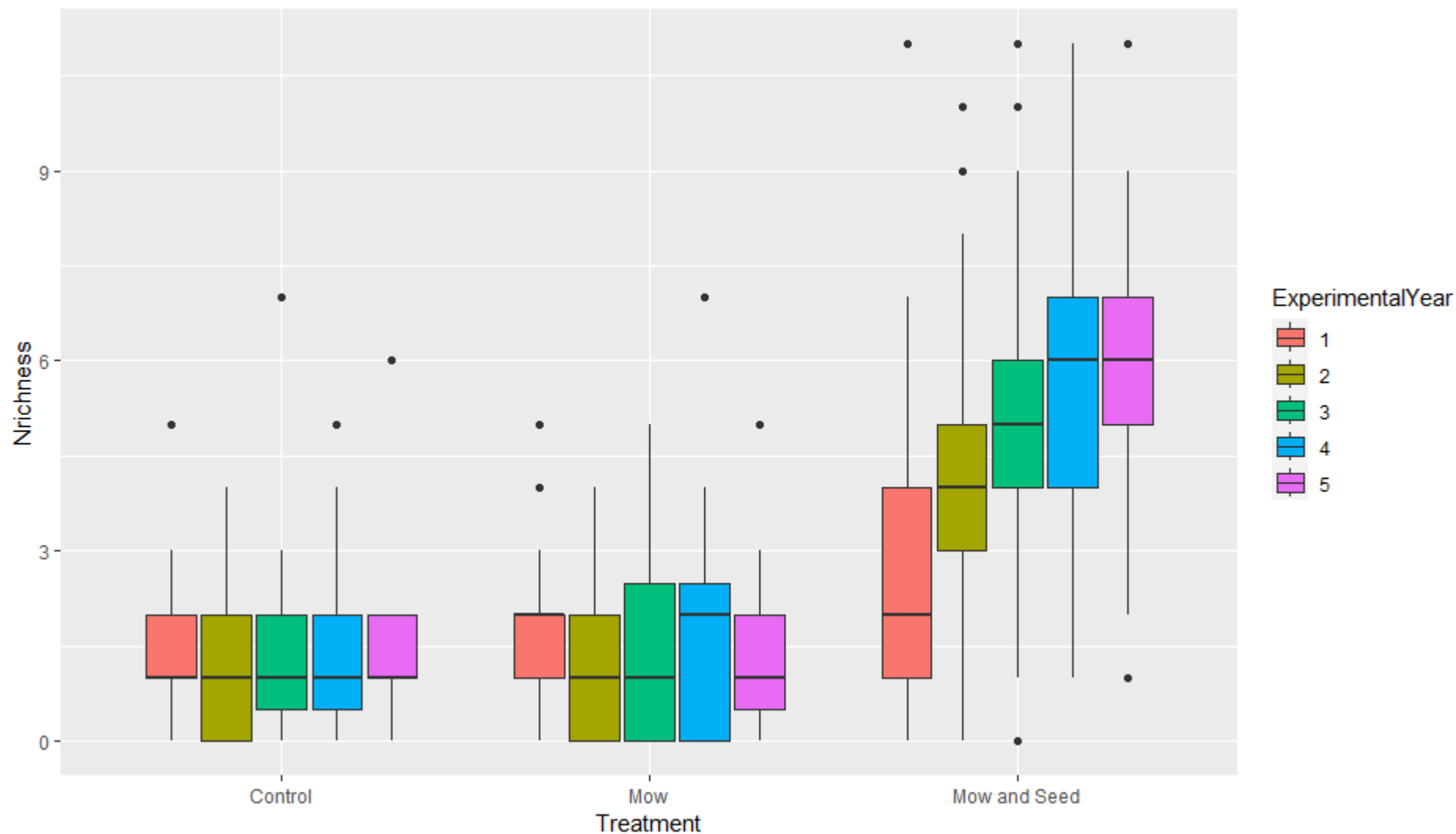


Mowing and Seeding Increased Native Species Richness After 2 Years

Does mowing or mowing combined with native seeding increase native plant richness?

Mowing – No!

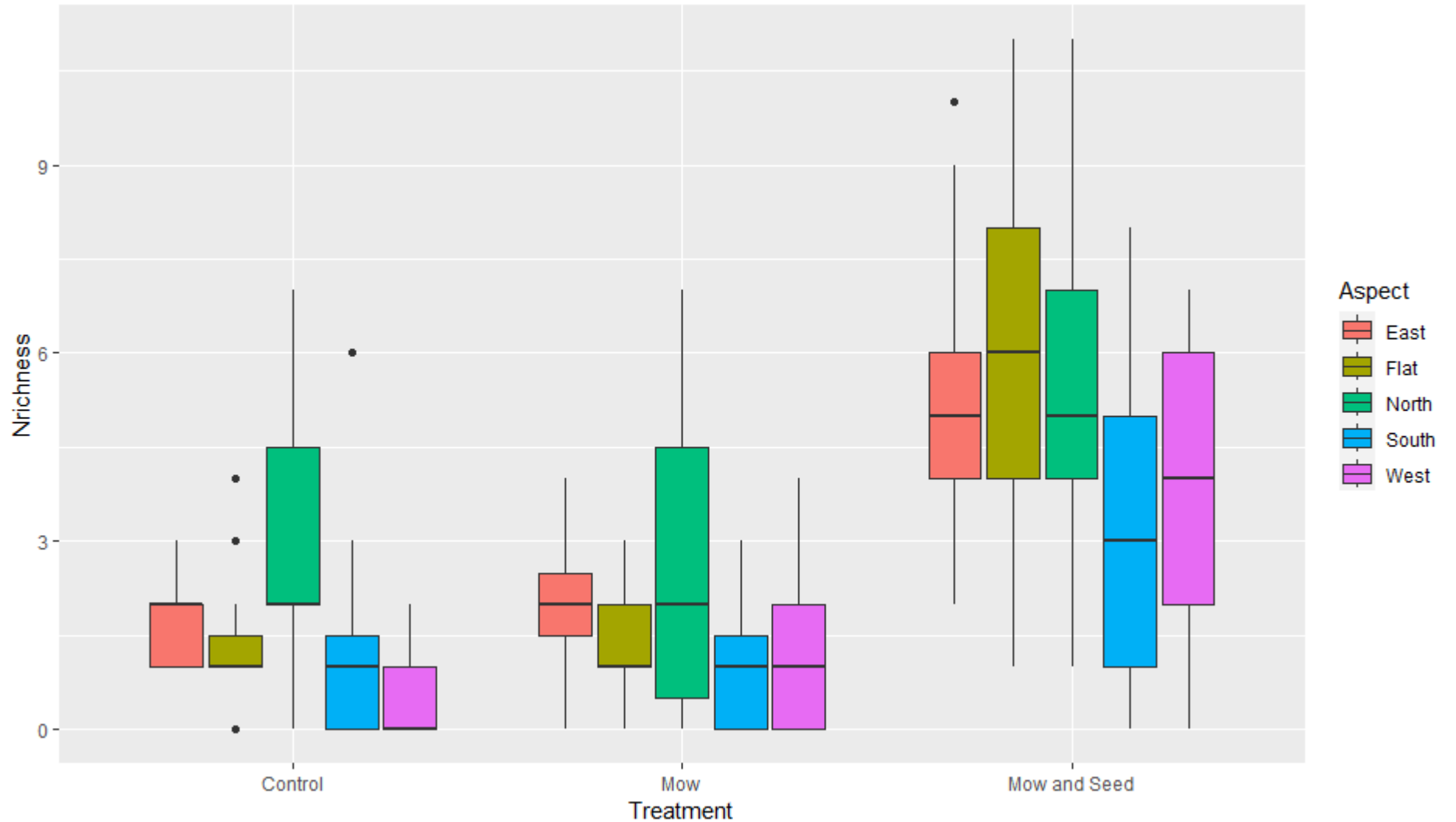
Mowing and Seeding – Yes!



Does aspect influence the outcome of restoration treatments?

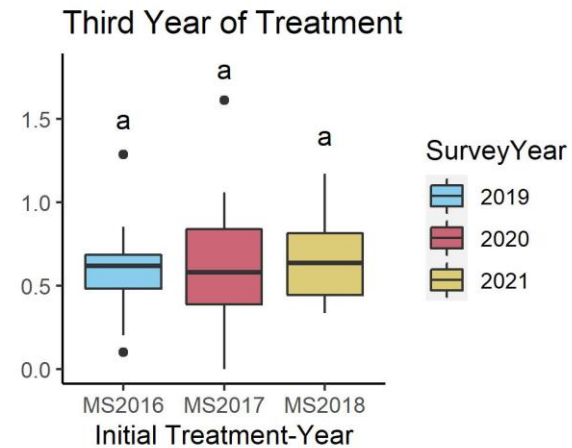
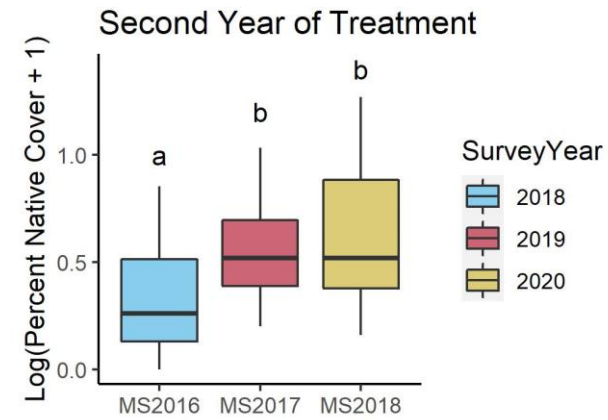
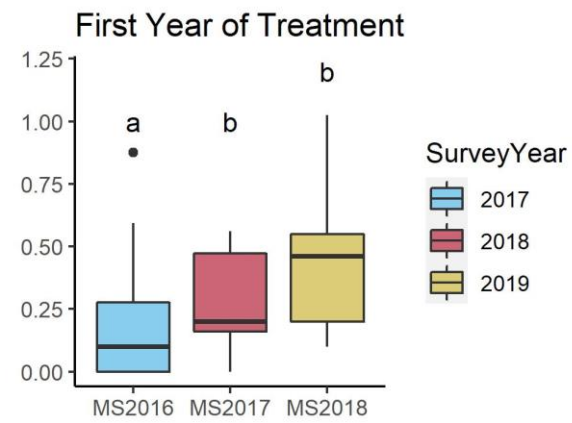
Yes!

Mowing and Seeding Increased Native Species Richness Across All Aspects



To what degree do year effects persist with repeated application of restoration treatments over 5 years?

After 3 years of restoration treatment, no differences in native coverage based upon initial seeding year



What gains might we expect?



ASPECT	EXPERIMENTAL YEAR	AVERAGE NATIVE COVERAGE	NATIVE RICHNESS
Flat	3	12.15 \pm 12.78	7.00 \pm 1.66
Flat	5	12.89 \pm 6.51	8.00 \pm 2.06
West	3	2.56 \pm 1.04	4.67 \pm 1.66
West	5	4.59 \pm 1.88	5.89 \pm 1.05

ASPECT	EXPERIMENTAL YEAR	<i>Stipa pulchra</i>	<i>Bromus carinatus</i>	<i>Eschscholzia californica</i>	<i>Elymus glaucus</i>	<i>Elymus triticoides</i>	<i>Lasthenia glabrata</i>	<i>Sisyrinchium bellum</i>	<i>Phacelia californica</i>	<i>Achillea millefolium</i>	<i>Hordeum brachyantherum</i>	<i>Melica californica</i>	<i>Lupinus bicolor</i>	<i>Stipa lepida</i>
Flat	3	0.81 \pm 1.41	2.63 \pm 4.89	3.85 \pm 6.93	1.07 \pm 1.61	0.89 \pm 1.09	0.59 \pm 0.40	0.22 \pm 0.55	0.70 \pm 0.81	0.19 \pm 0.18	0.63 \pm 1.34	0	0.04 \pm 0.11	0
Flat	5	3.07 \pm 3.54	2.04 \pm 3.87	1.56 \pm 1.37	1.48 \pm 1.39	1.04 \pm 0.86	0.81 \pm 0.29	0.70 \pm 1.55	0.48 \pm 0.38	0.30 \pm 0.39	0.15 \pm 0.44	0.15 \pm 0.24	0.04 \pm 0.11	0
West	3	0.52 \pm 0.56	0.15 \pm 0.24	0.26 \pm 0.32	0	0.07 \pm 0.22	0.63 \pm 0.31	0.11 \pm 0.17	0.11 \pm 0.24	0.30 \pm 0.26	0	0	0	0
West	5	1.93 \pm 1.58	0.11 \pm 0.24	0.33 \pm 0.33	0.07 \pm 0.22	0.11 \pm 0.24	0.70 \pm 0.35	0.19 \pm 0.24	0.26 \pm 0.32	0.19 \pm 0.34	0	0	0	0

Implications for Restoration

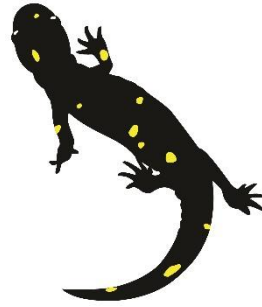
- Timed mowing in combination with broadcast seeding increases native plant coverage and richness in a California grassland with repeated applications
- Pilot studies can help fine tune management interventions to increase effectiveness and reduce the costs associated with large scale restoration projects by:
 - Refining species pallets for native seed mixes so that only those species that will successfully establish are used.
 - Selecting restoration sites that will achieve the greatest increases in native plant species richness and coverage.

Next Steps

- What (if any) period of re-application of restoration interventions is needed to maintain or increase gains in native plant coverage?
- Can non-local ecotypes more successfully establish in aspects where we saw little change in native plant coverage?



Thank You!



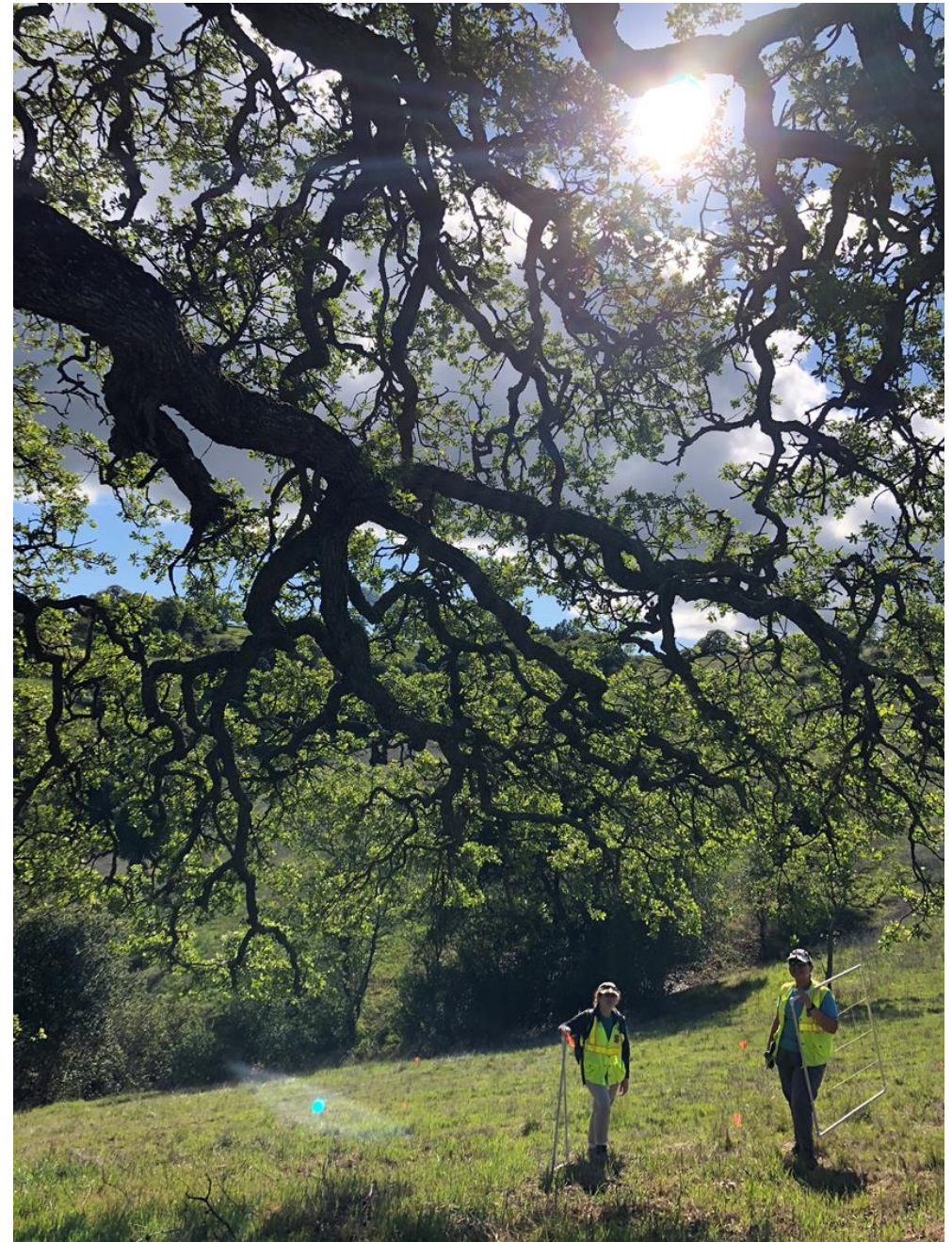
To contact me: ecolea@stanford.edu

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California
grasslands
are dynamic!

