Remediating the Microbial Legacy Effects of Invasive Grasses for Restoration

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Background

- *Phalaris aquatica* is an invasive perennial bunchgrass in the Santa Monica Mountains
- 8 years of removal over 25 acres, but native species recruitment was minimal
- Does lack of native growth suggest soil legacy effects of Phalaris?
- Legacy effects

Experiment 1: Greenhouse Study

My Research Questions

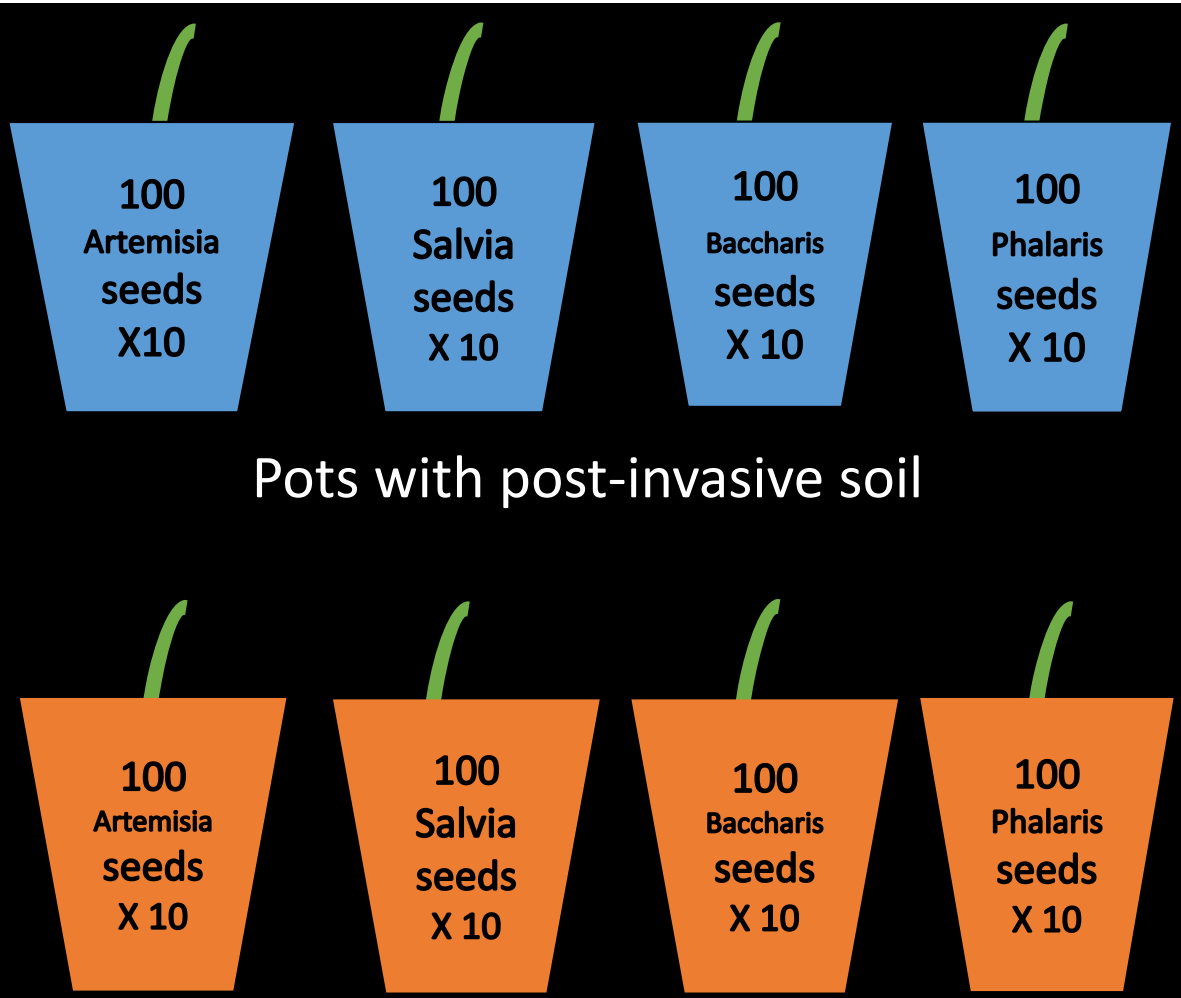
Do native and invasive plants differ in growth rate and size in native vs. post-invasive soil?

Which native species will survive best in the soil after invasive removal?

1 Invasive:
Phalaris aquatica

Species Studied

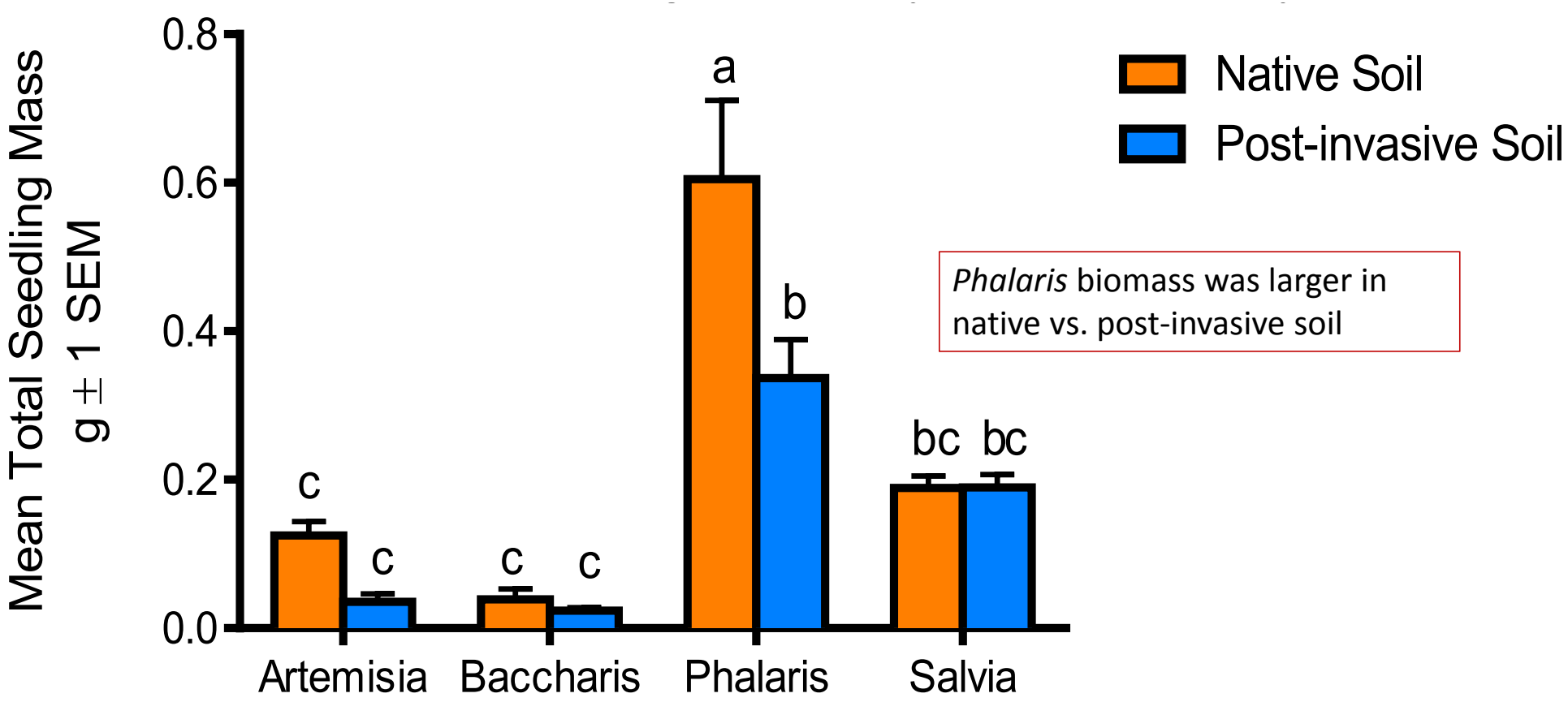
3 CSS Natives:
Artemisia californica
Salvia leucophylla
Baccharis pilularis



Methods

1. Collected post-invasive and native soil
2. Sowed 100 seeds per species into separate pots filled with either native or post-invasive soil (10 reps each)
3. After seven months of growth in the greenhouse, the seedlings were dried and measured

Mean Total Seedling Biomass by Species in Soil Type

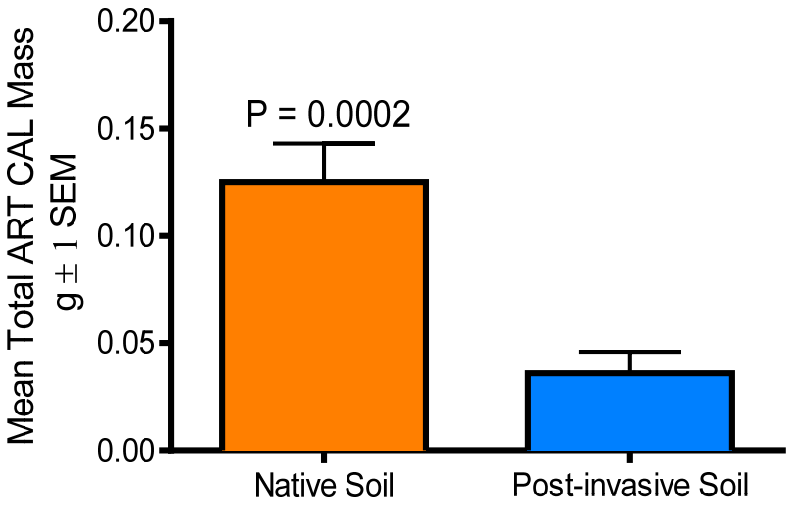


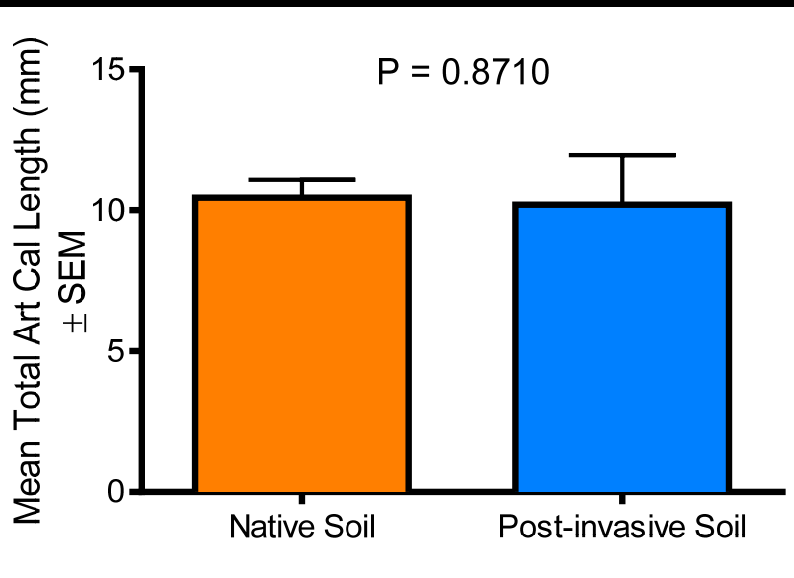
Phalaris biomass was larger in native vs. post-invasive soil

Artemisia Total Biomass and Length in Soil Type

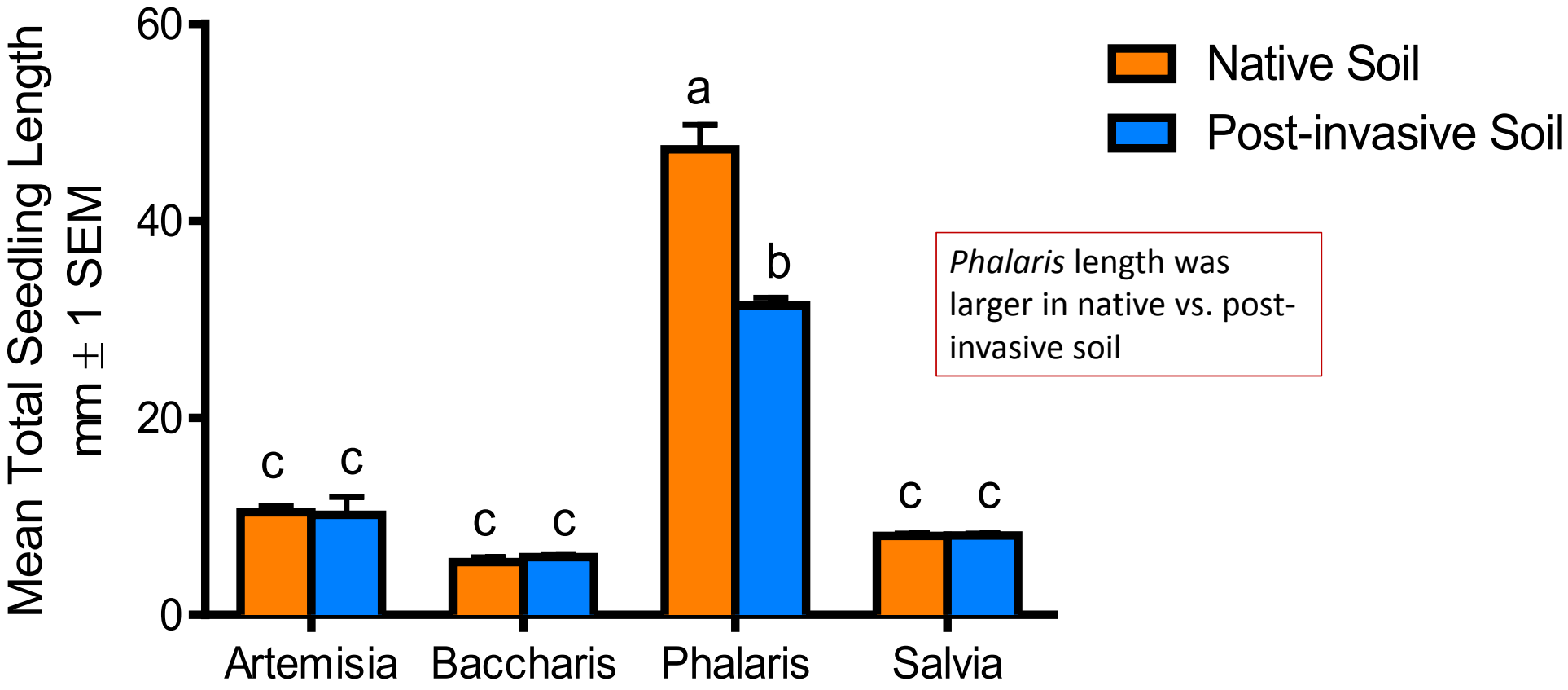
- *Artemisia* biomass was much higher in native soil than post-invasive soil

- The length of *Artemisia* between both soil types was still not significantly different

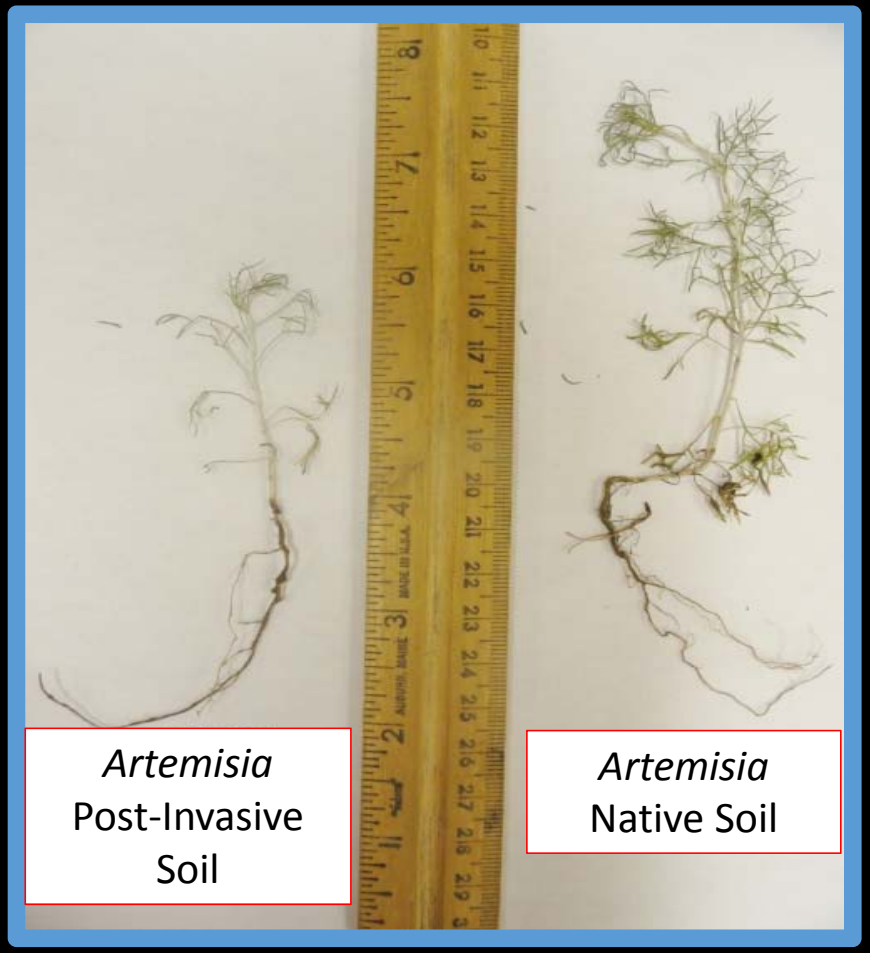


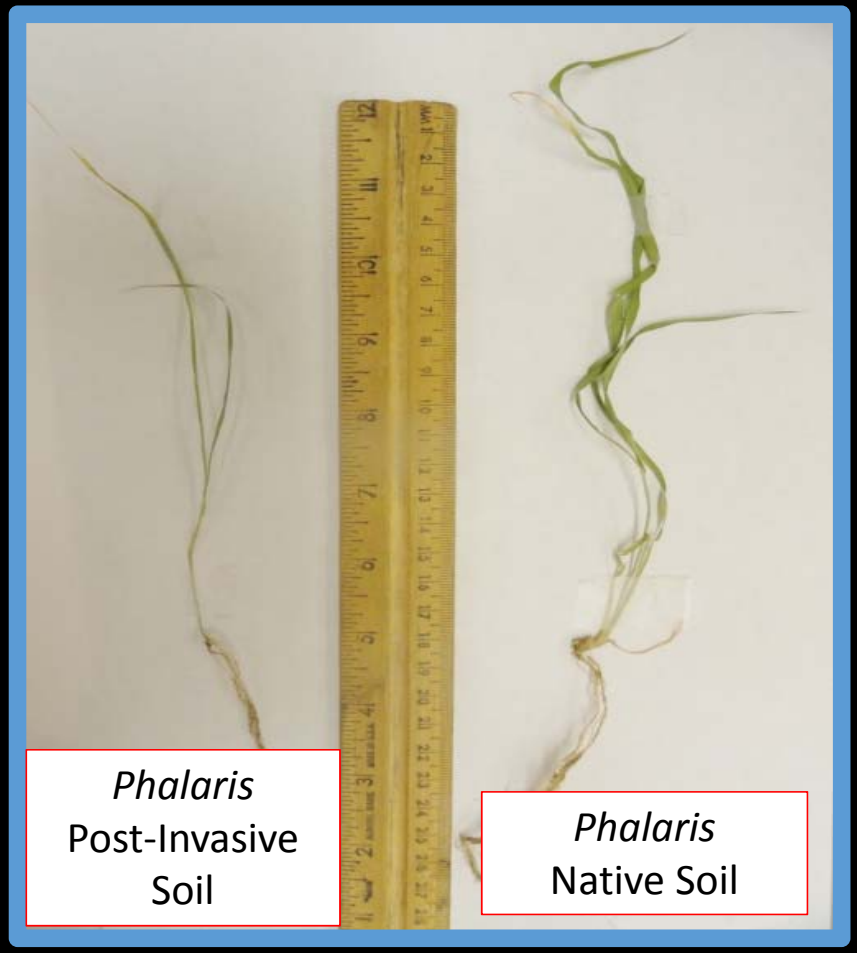


Mean Total Seedling Length by Species in Soil Type



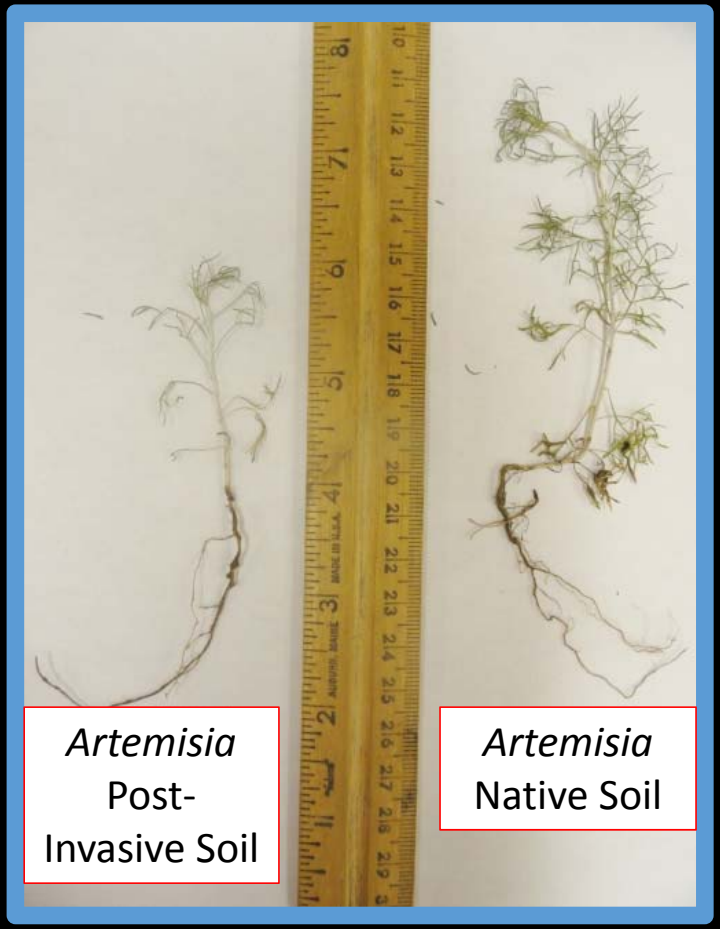
Visual Representation of Graphs: Change in plant growth with soil type





Conclusions

- The soil type did have an effect on plant species growth
- *Salvia* and *Baccharis* were not affected by soil type
- *Phalaris* consistently had the greatest growth in native soil
- *Artemisia* biomass was higher in native soil



Experiment 2: Field Study

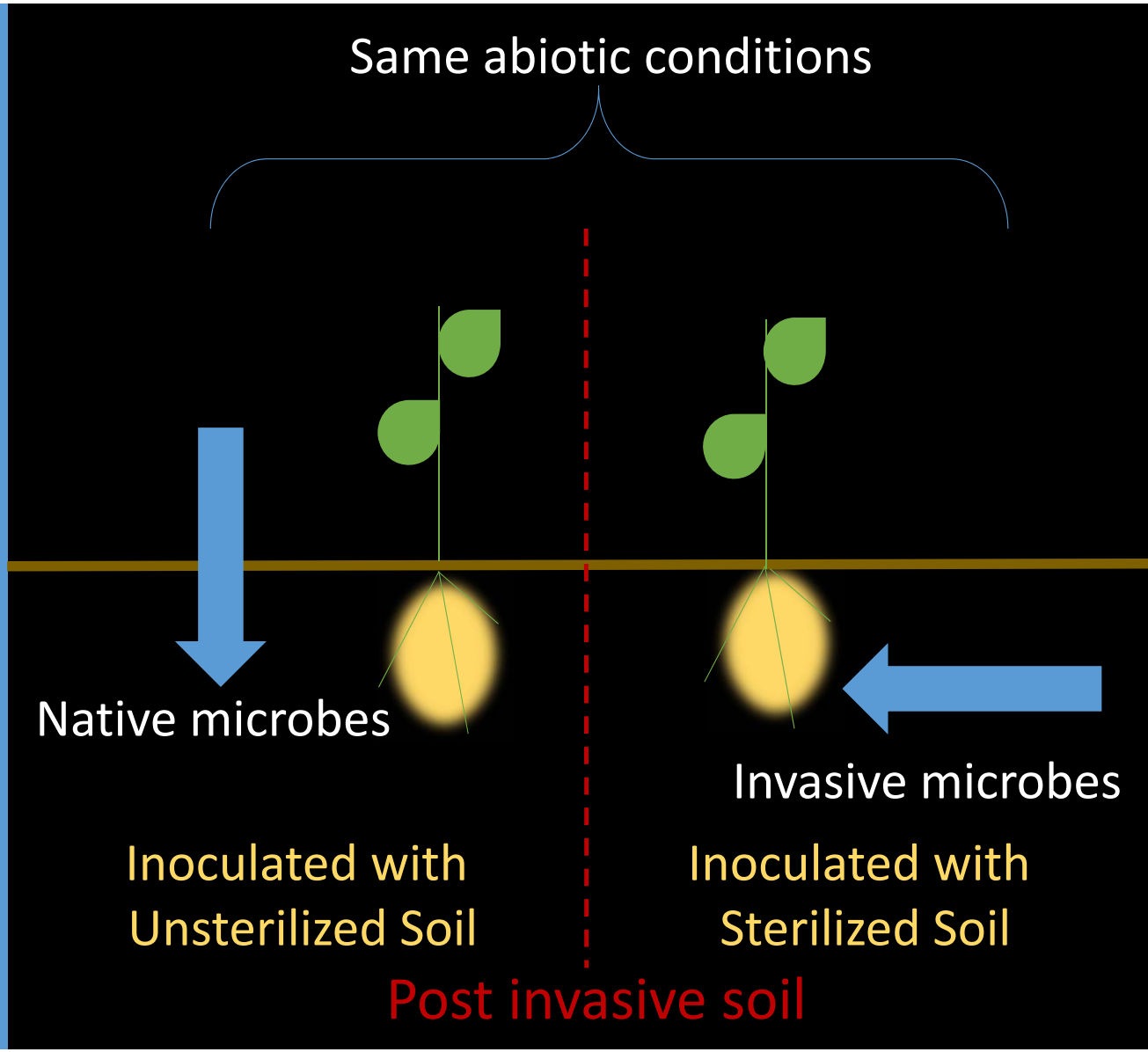
My Research Questions

Are differences in native plant growth explained by host dependent changes in the microbial community?

Does remediation of soil microbial conditions through inoculation improve restoration in post-invasive sites?

Inoculation Experiment

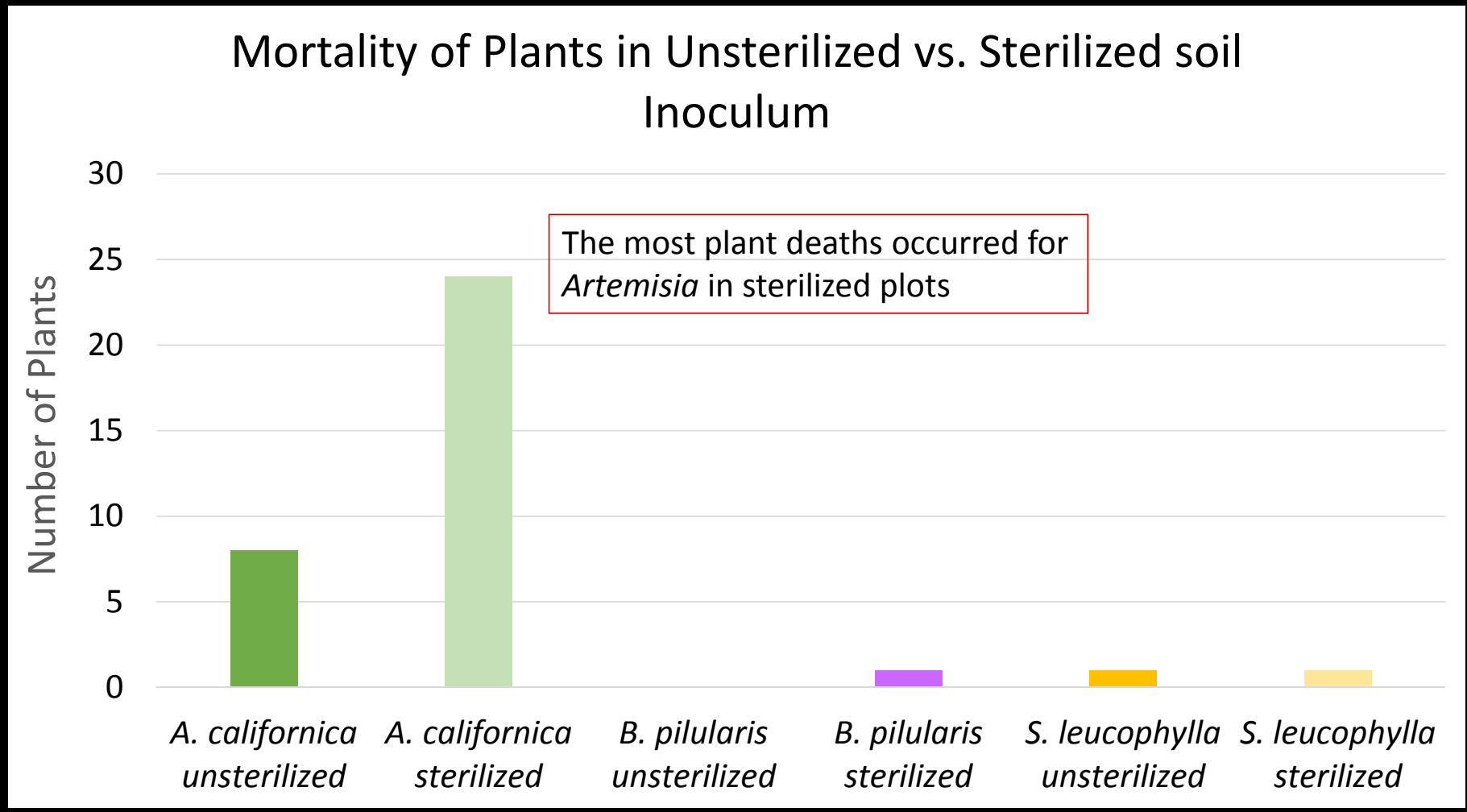
- I grew the same three native species in commercial potting mix inoculated with native soil or sterilized native soil
- Transplanted 180 plants into the 25 acre post-invasive grass site
- Soil cores were taken over 7 months of growth
- We expected that Artemisia would have higher mortality in sterilized plots

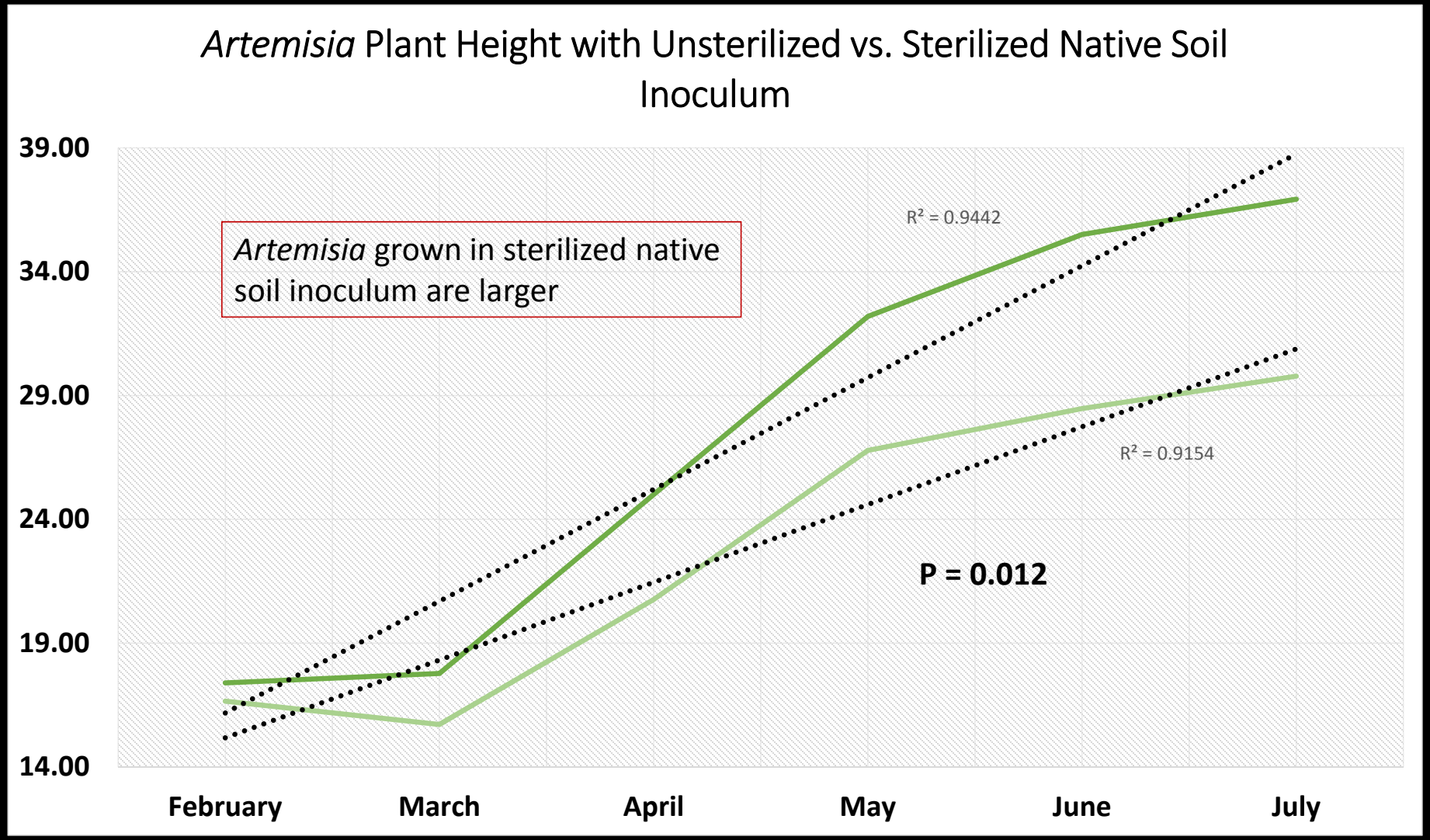


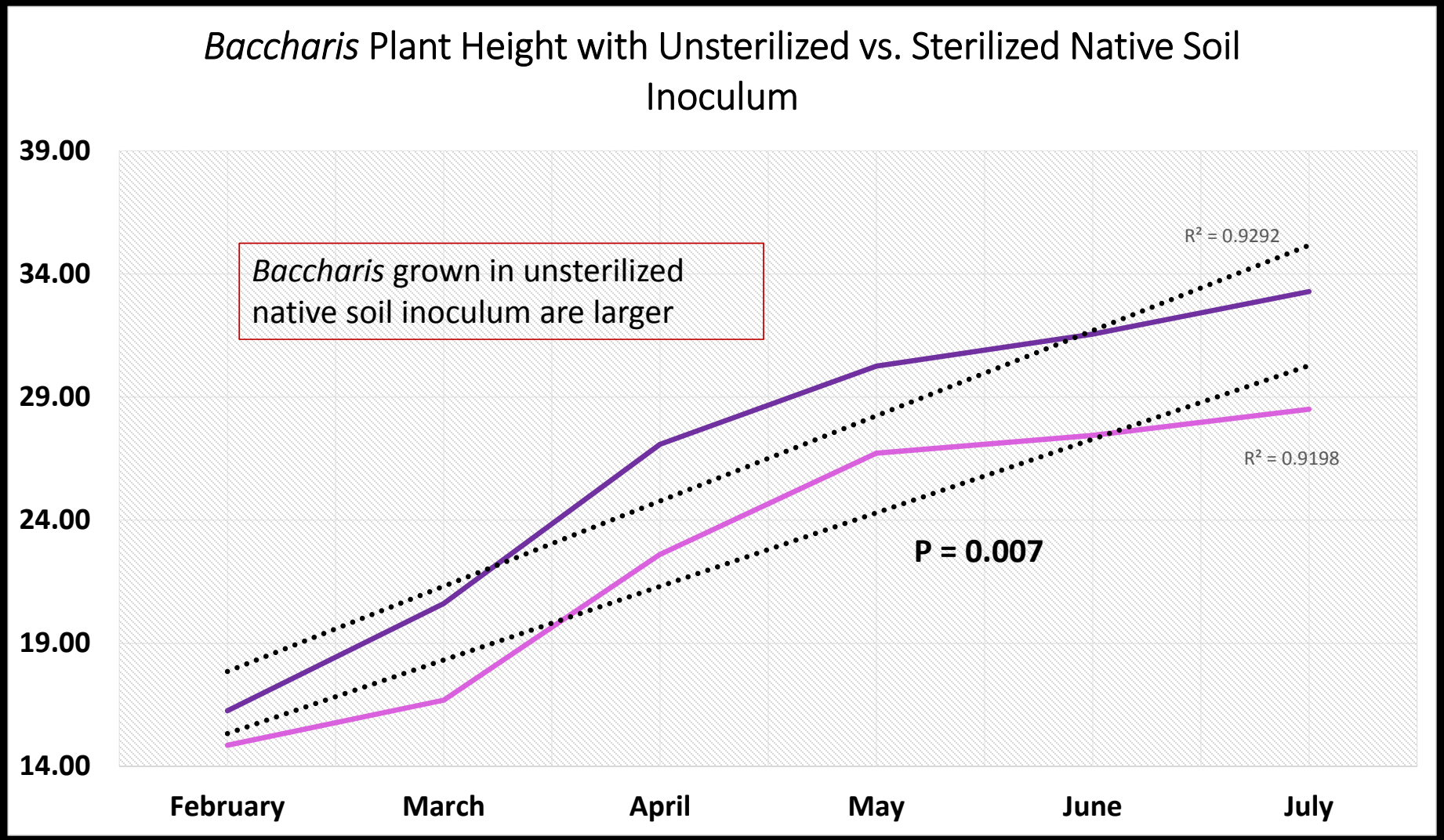
Set-up: 3 Blocks with 10 Plots Each

Each block has:

- 6 plots that are single-species plots with 6 plants each
- 4 plots that are mixed-species plots with 2 of each plant species (6 plants total)
- Plots do not mix plants grown in sterilized native soil vs. unsterilized native soil


Mortality of Plants in Unsterilized vs. Sterilized soil Inoculum
Number of Plants
30
25
20
15
10
5
0
The most plant deaths occurred for *Artemisia* in sterilized plots
A. californica unsterilized
A. californica sterilized
B. pilularis unsterilized
B. pilularis sterilized
S. leucophylla unsterilized
S. leucophylla sterilized

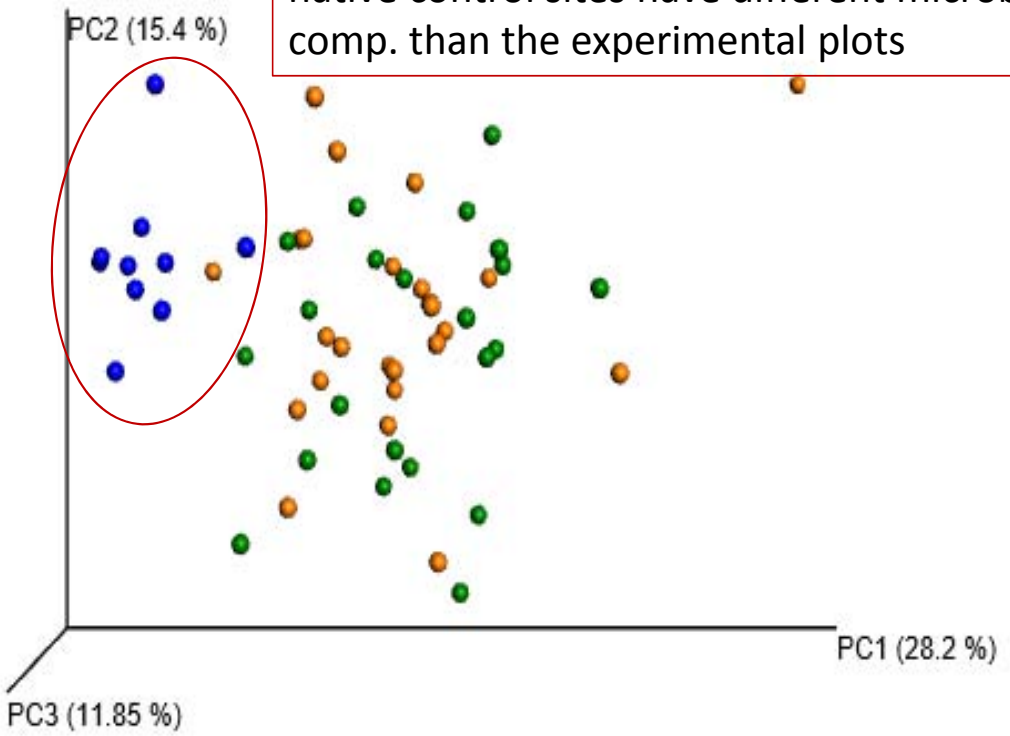

Artemisia Plant Height with Unsterilized vs. Sterilized Native Soil Inoculum
39.00
34.00
29.00
24.00
19.00
14.00
Artemisia grown in sterilized native soil inoculum are larger
R² = 0.9442
R² = 0.9154
P = 0.012
February
March
April
May
June
July

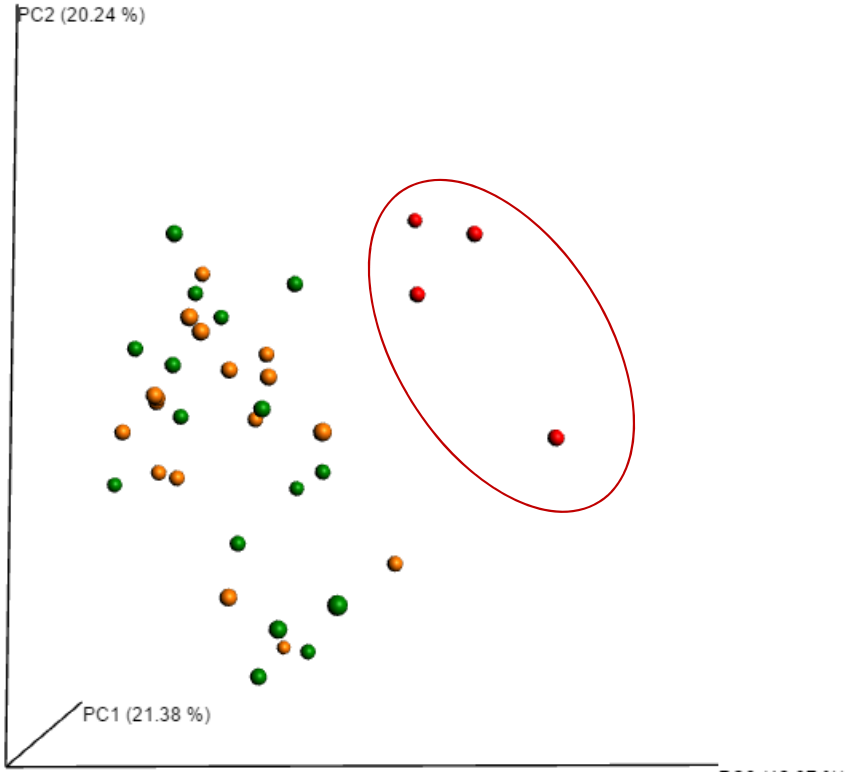

Baccharis Plant Height with Unsterilized vs. Sterilized Native Soil Inoculum
39.00
34.00
29.00
24.00
19.00
14.00
Baccharis grown in unsterilized native soil inoculum are larger
R² = 0.9292
R² = 0.9198
P = 0.007
February
March
April
May
June
July

Microbial Composition (first two months)

Sterilized soil inoculum plot | Intact native soil | Unsterilized soil inoculum plot | Post-invasive soil

Only soil cores from post-invasive and native control sites have different microbial comp. than the experimental plots





Conclusions

- Native plant growth was affected by native soil inoculum (unsterilized or sterilized)
- Artemisia had less mortality and higher growth after inoculation with unsterilized native soil
- Instead of just seeding a plot, we can transplant a native species with its own soil to insure survival
- Continued analysis of the microbial soil composition may shed some light on the difference in plant growth between unsterilized and sterilized native soil

Restoration Importance of Results: Restoration that starts with soil

- Ensure native plant establishment in post-invasive sites
- The Salvia and Baccharis can be used as nurse species
- Perhaps isolate and use certain microbes for inoculations in restorations
- Greater understanding of plant/microbe symbioses in invaded habitats may improve restoration

Future research: Identify microbes that associate with native plant species in a restored system with soil inoculum vs. a native system.

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Future Research

Identify microbes that associate with native plant species in a restored system with soil inoculum vs. a native system

Are restoration strategies using native soil inoculum in post-invasive sites as successful as native plants planted among intact CA sage scrub