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

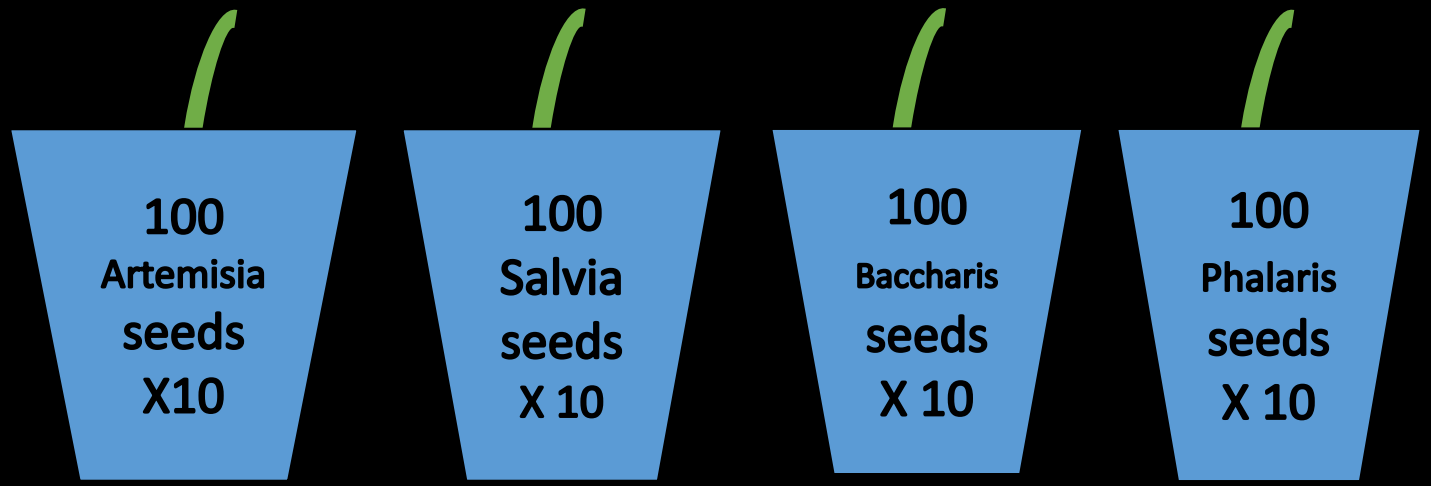
Do native and invasive plants differ in growth rate and size in native vs. post-invasive soil?

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

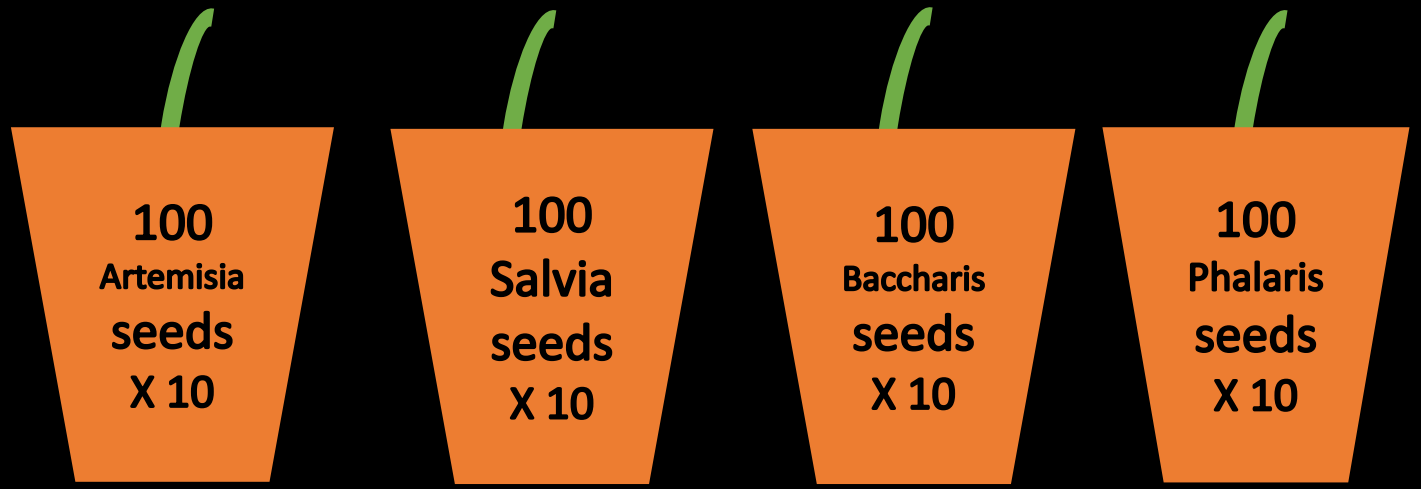
Species Studied

1 Invasive:
Phalaris aquatica

3 CSS Natives:
Artemisia californica
Salvia leucophylla
Baccharis pilularis



Pots with post-invasive soil

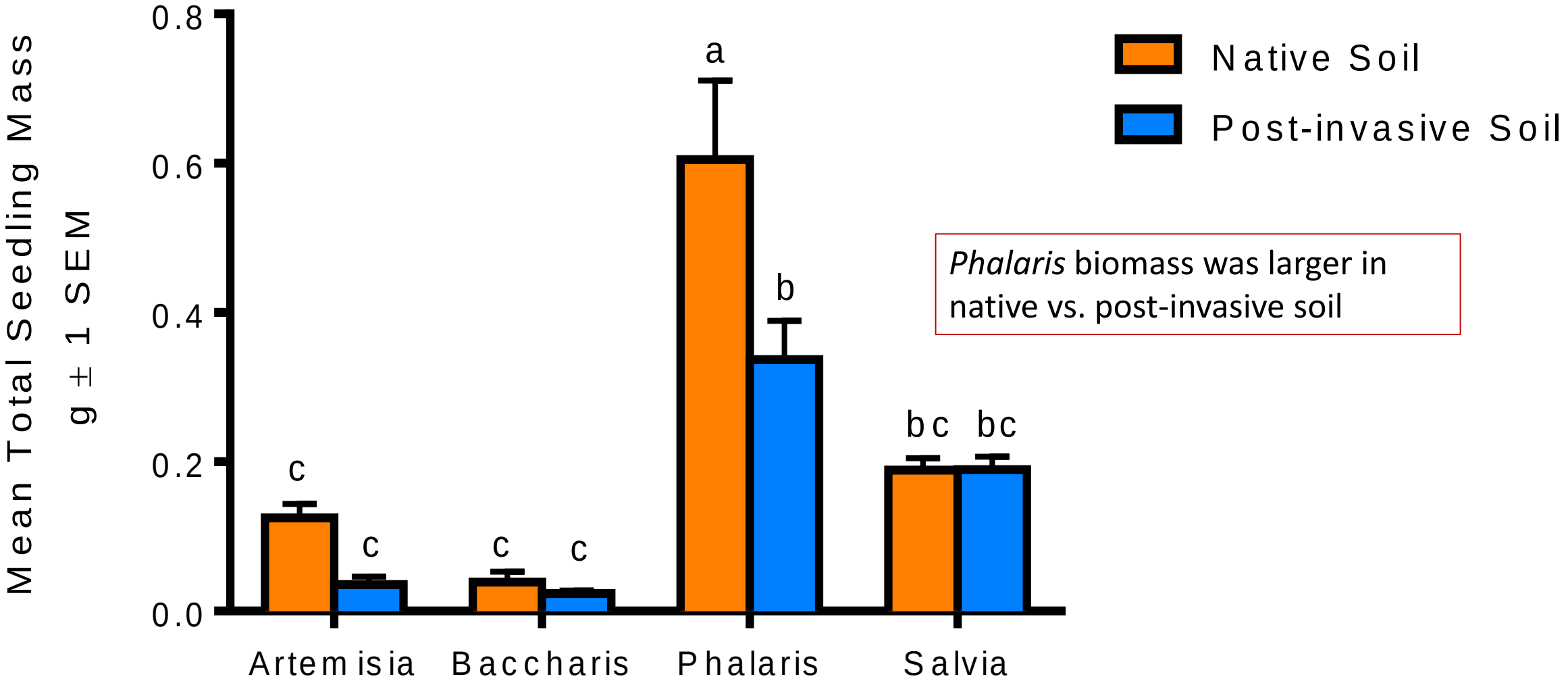


Pots with native soil

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

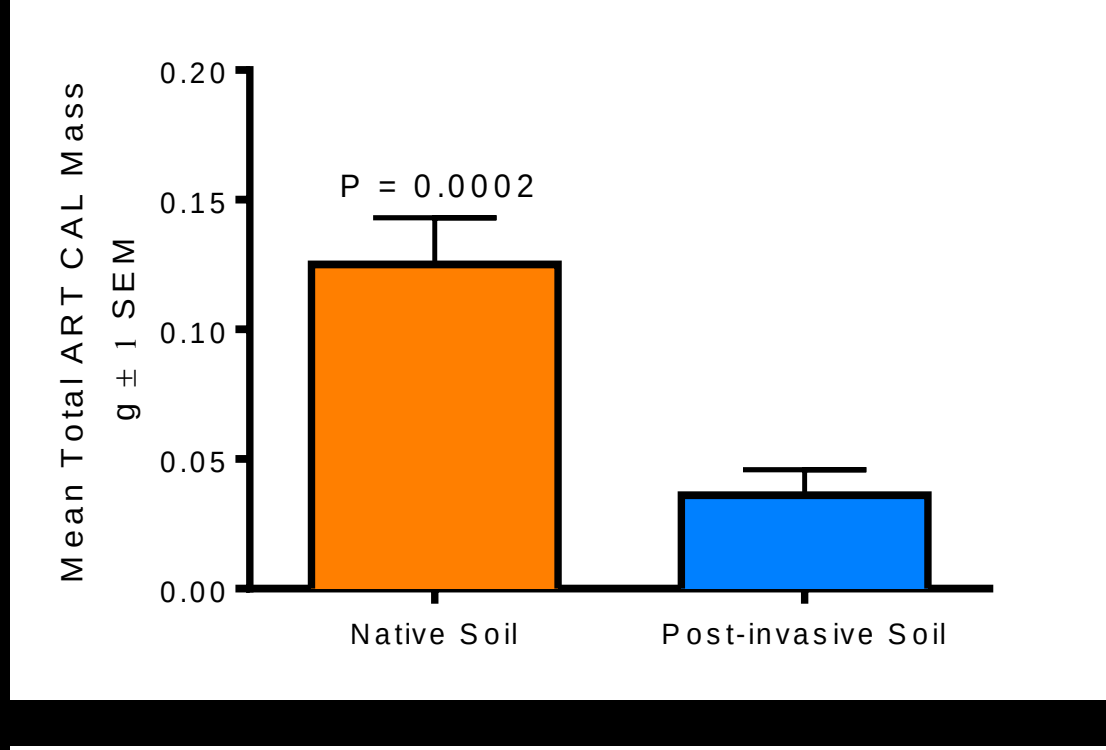


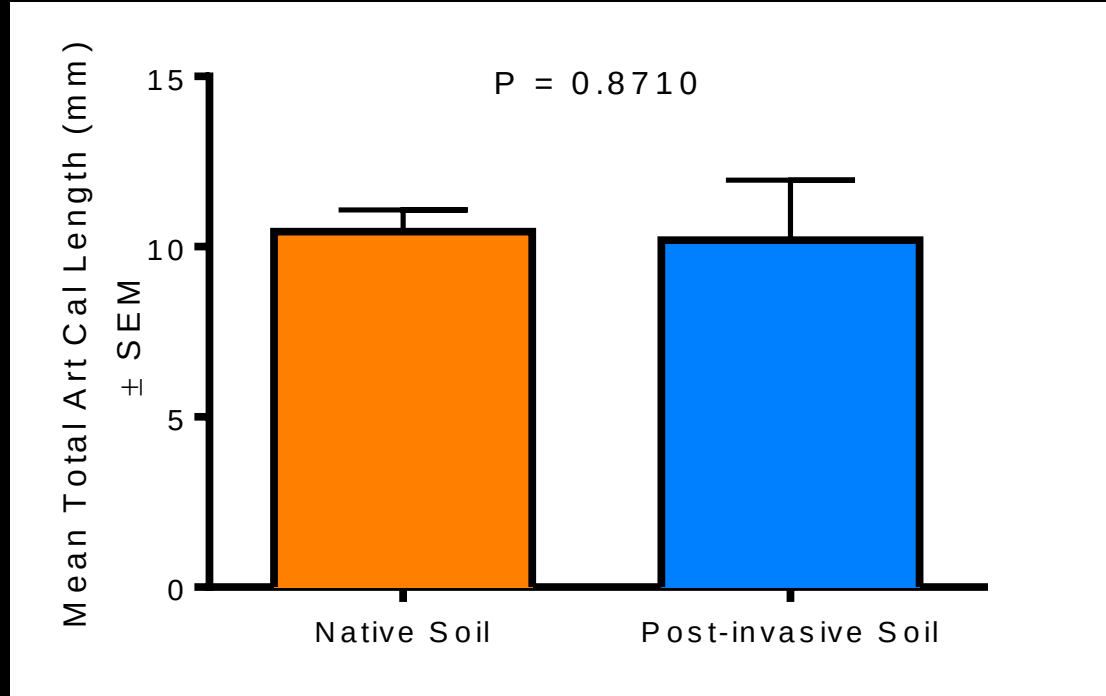
Phalaris biomass was larger in native vs. post-invasive soil

Artemisia Total Biomass and Length in Soil Type

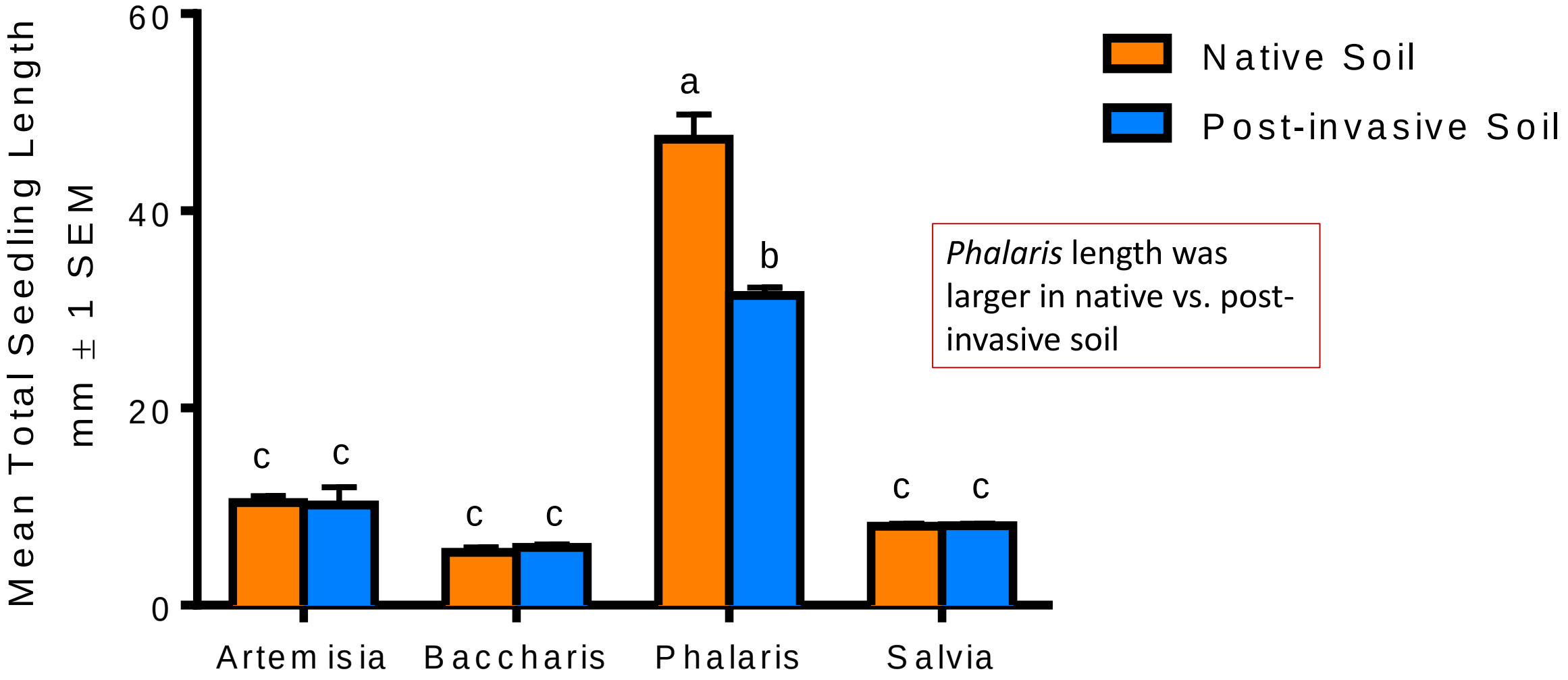
- *Artemisia* biomass was much higher in native soil than post-invasive soil

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



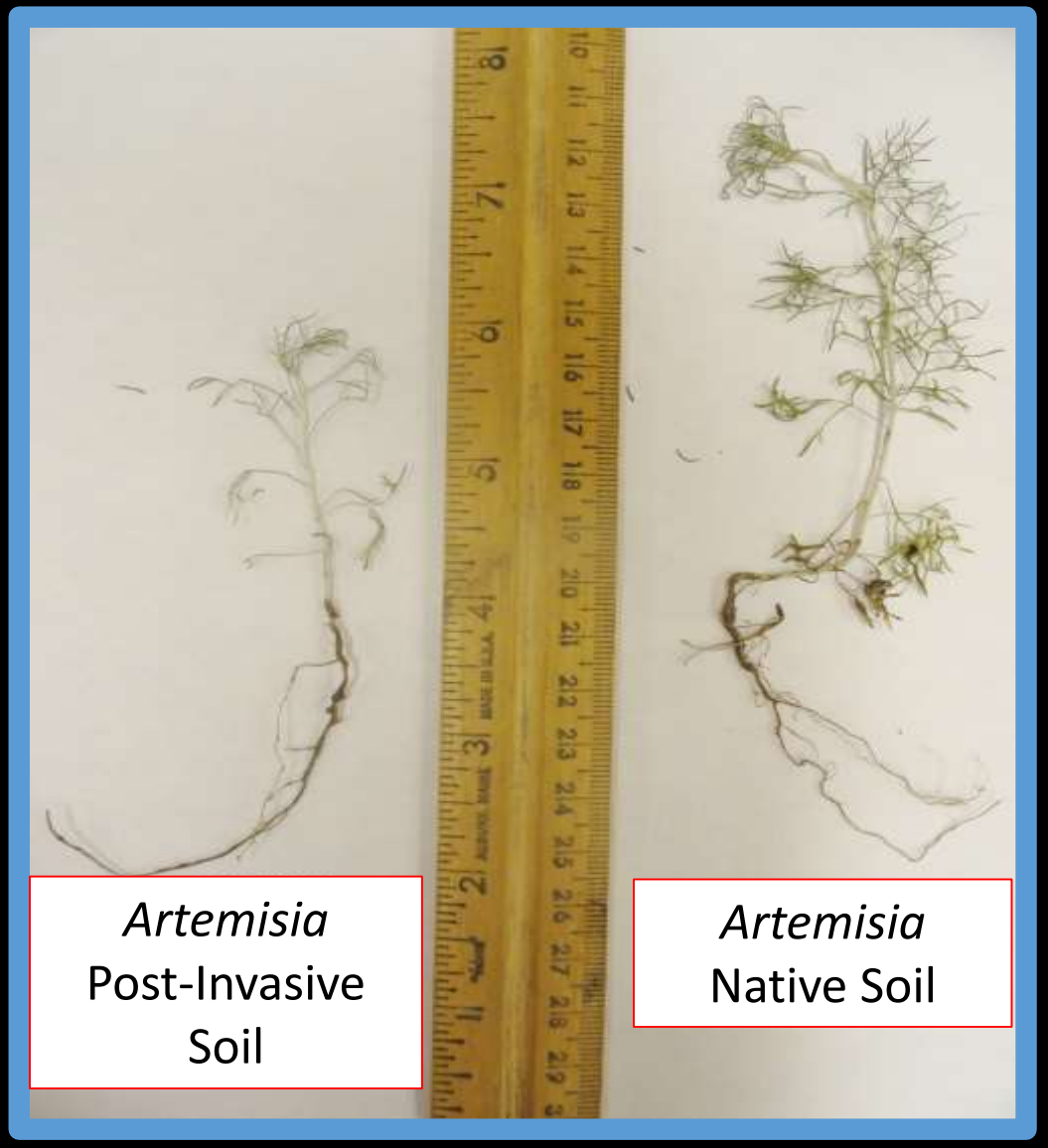


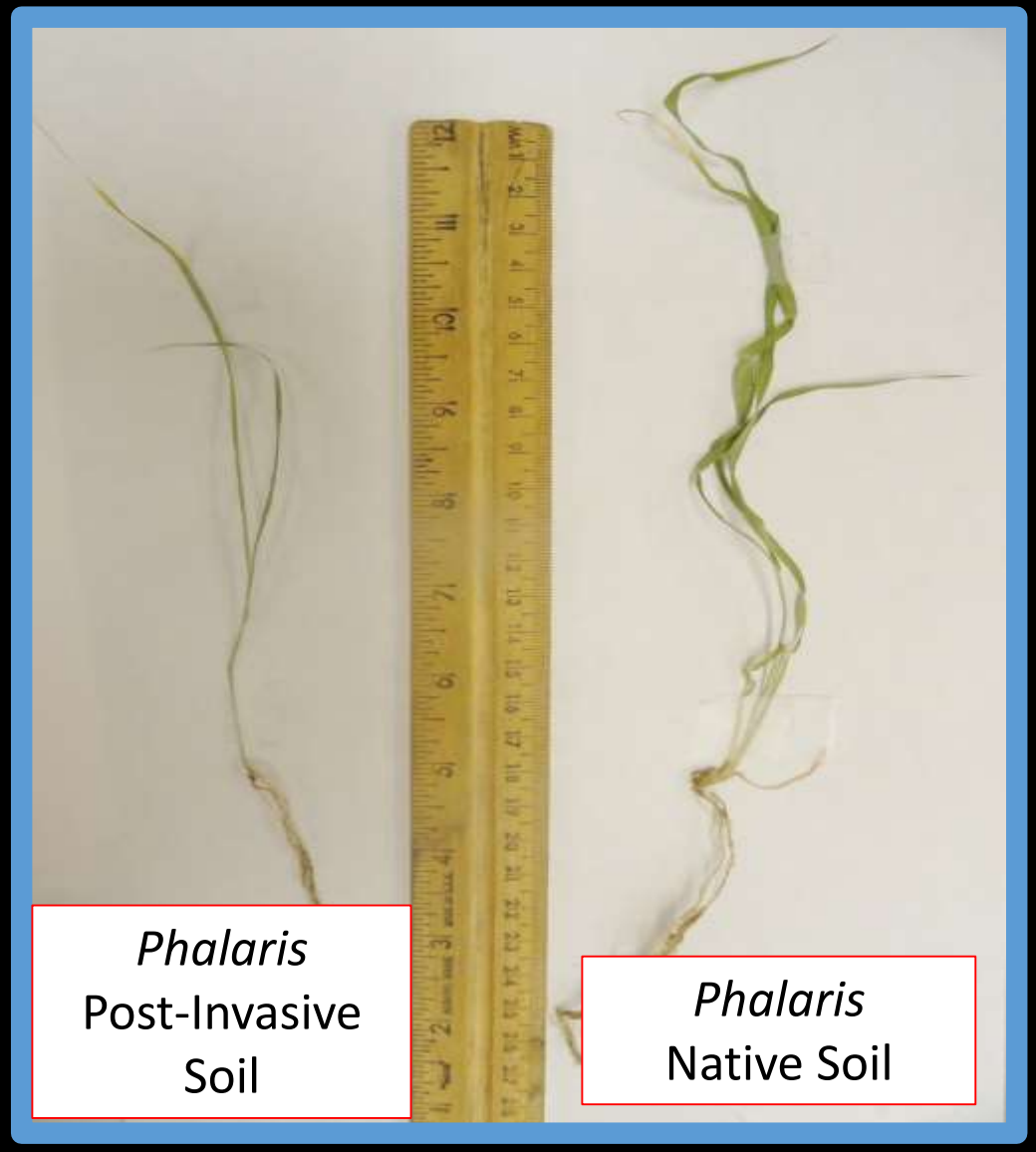
Mean Total Seedling Length by Species in Soil Type



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

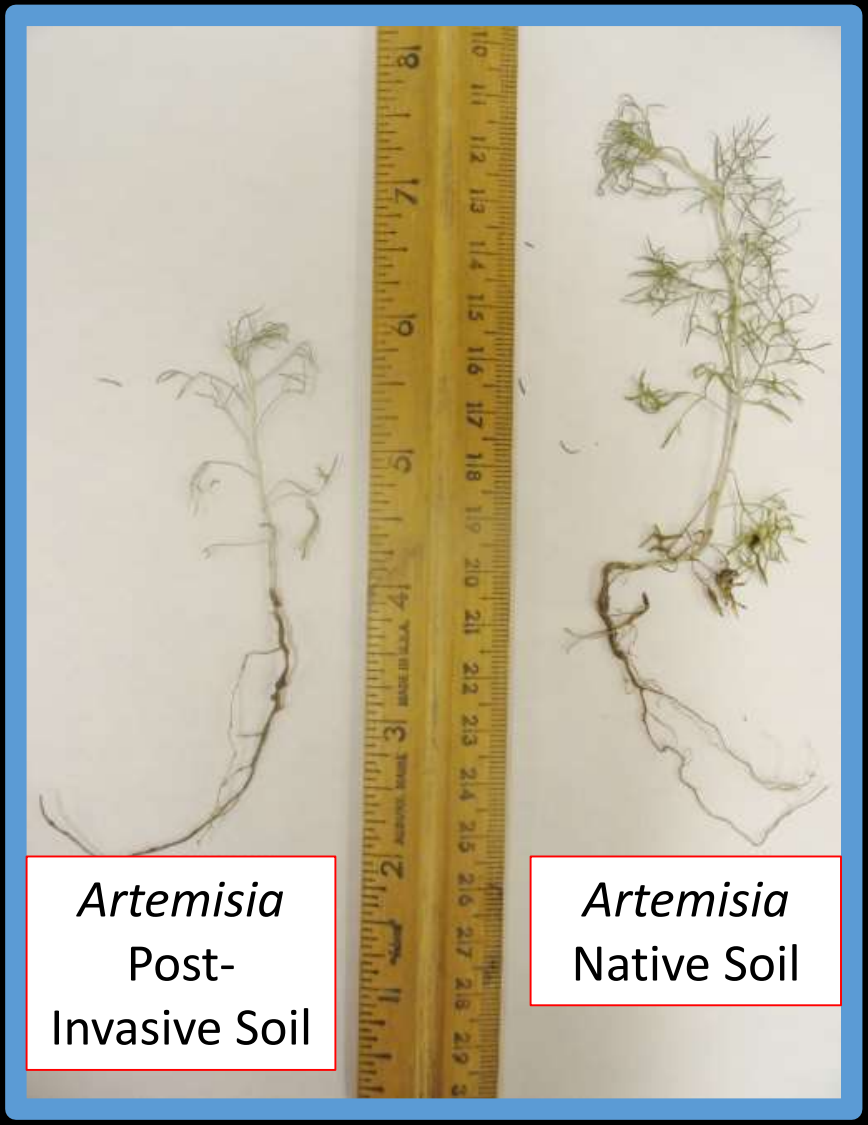
Visual Representation of Graphs: Change in plant growth with soil type





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

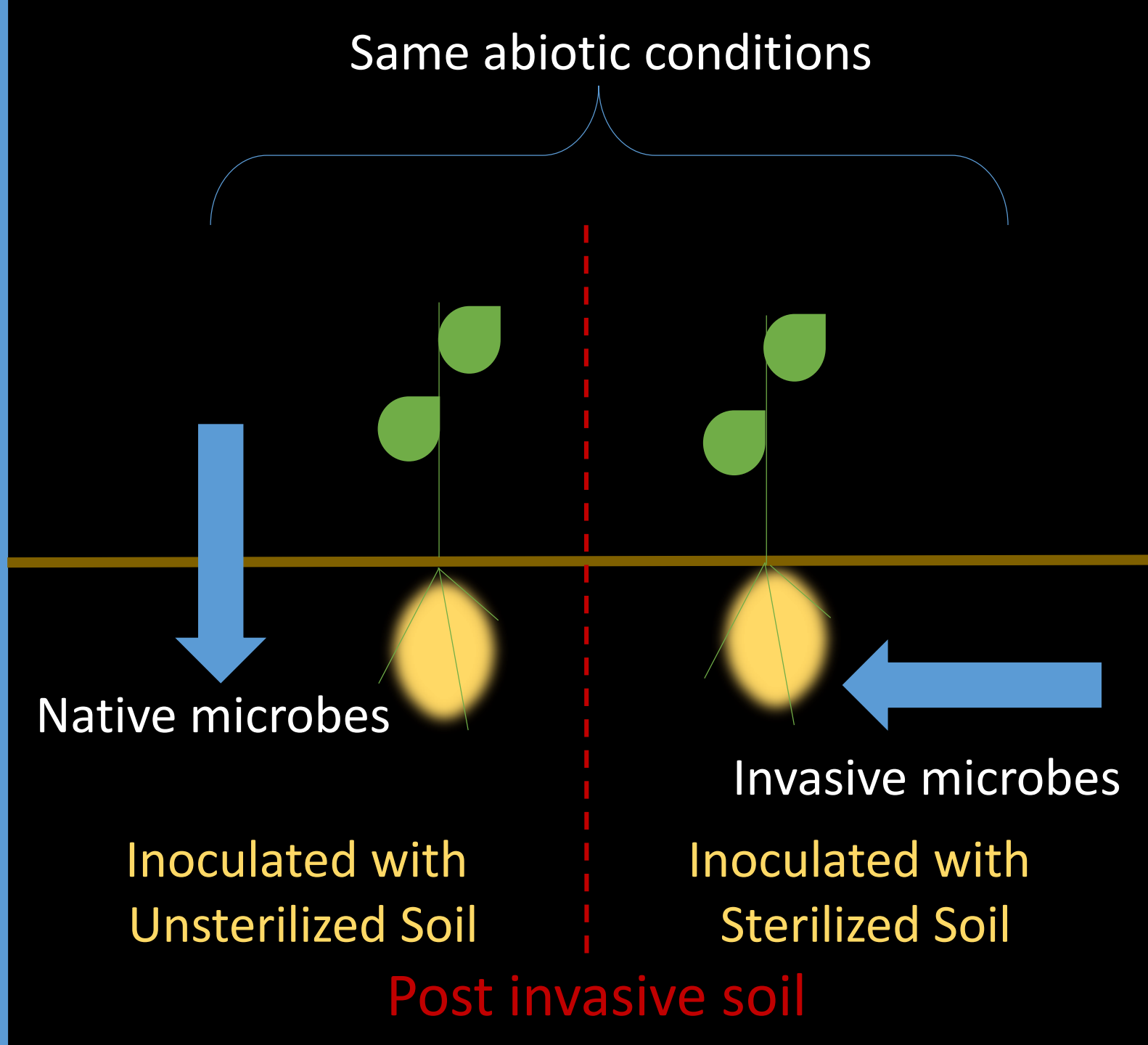
My Research Questions

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

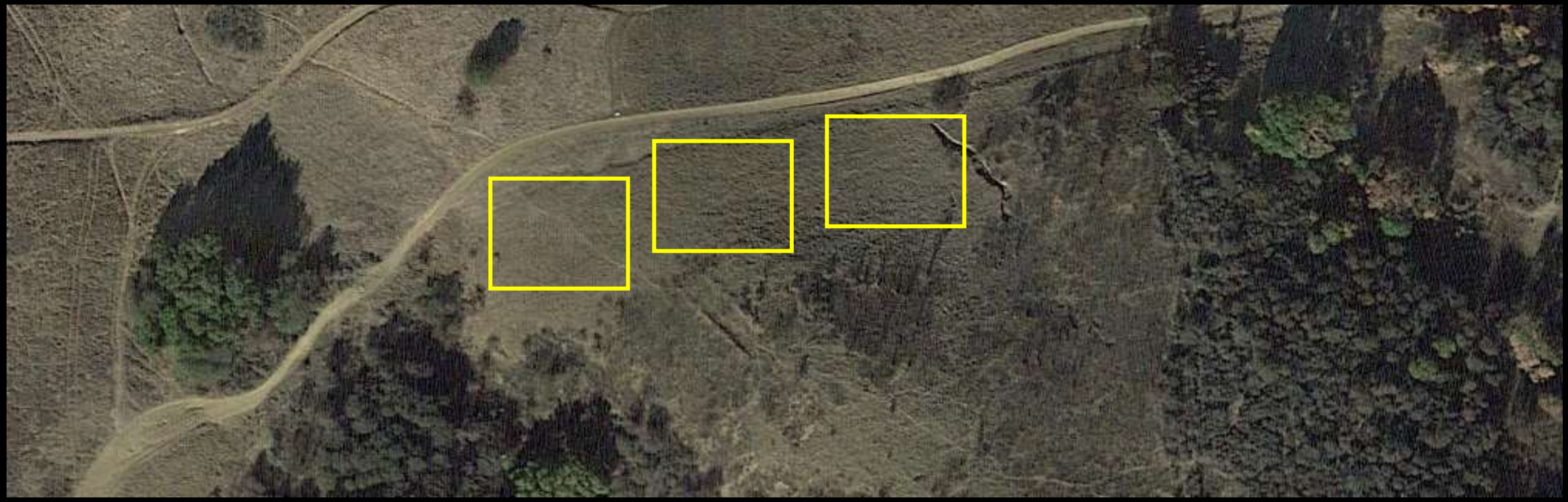
Does remediation of soil microbial conditions through inoculation improve restoration in post-invasive sites?

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
- Plant height measurements were taken over 7 months of growth
- Soil cores for 16S sequencing were taken every other month
- 30 plants destructively sampled in August



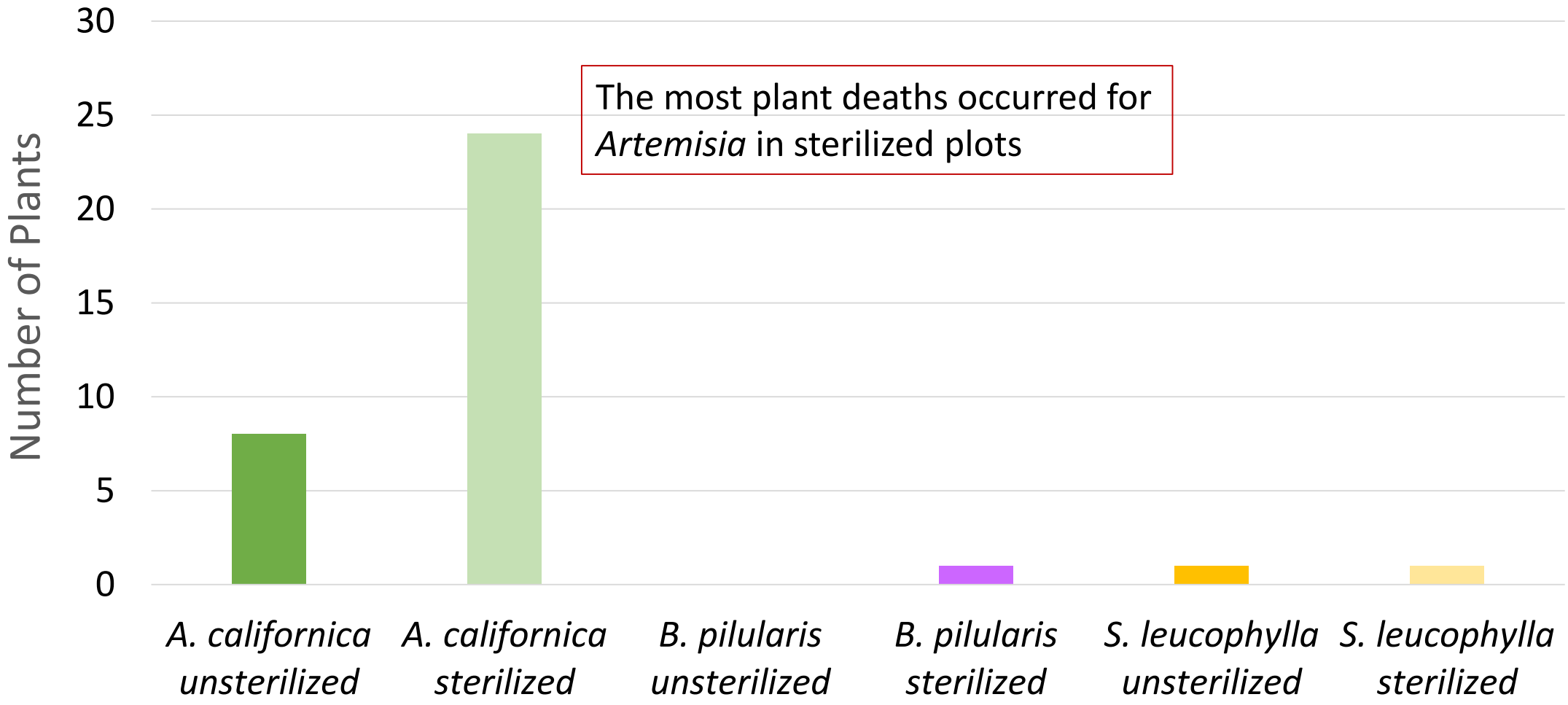
Set-up: 3 Blocks with 10 Plots Each

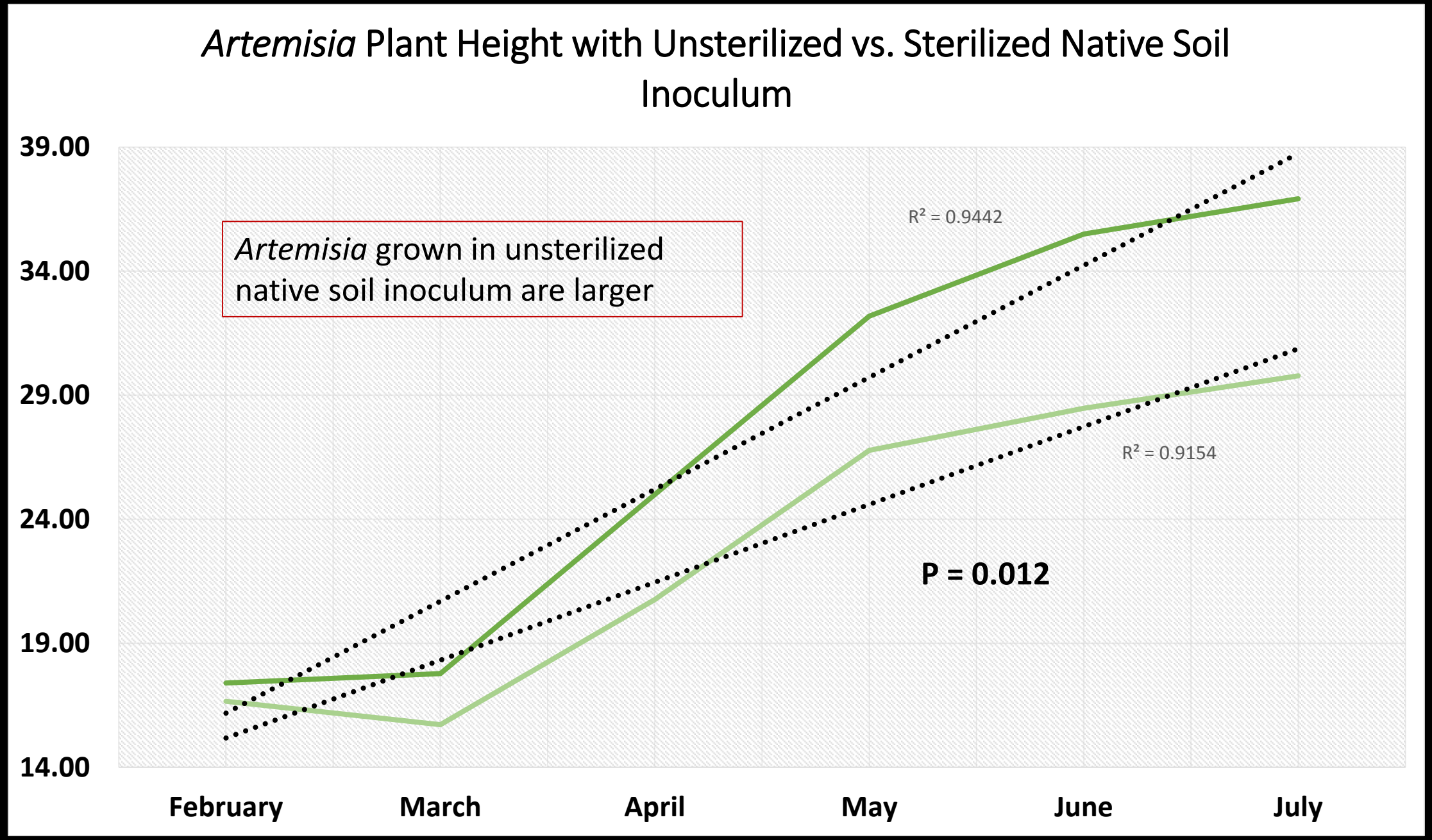


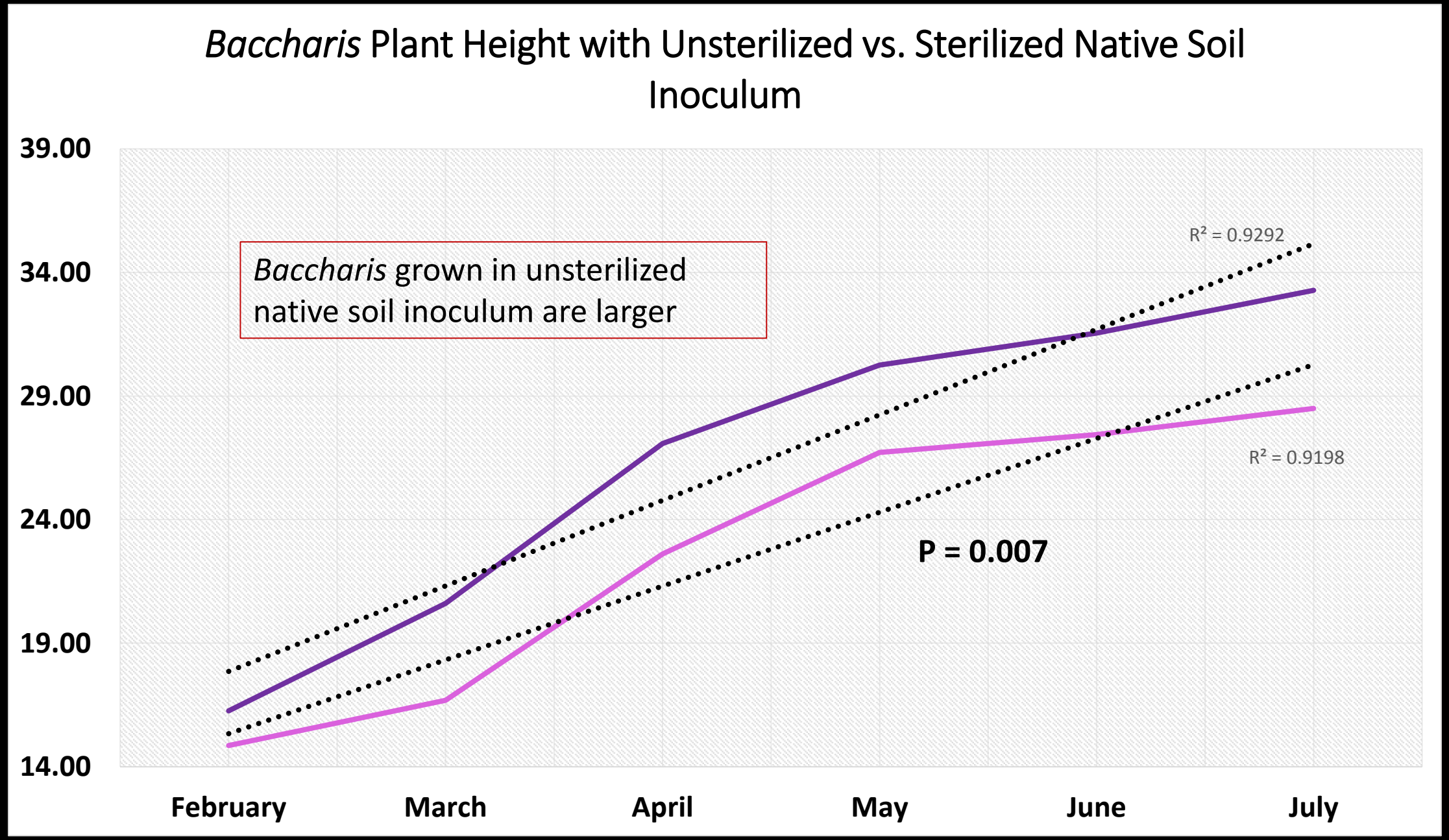
Each block has:

- 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

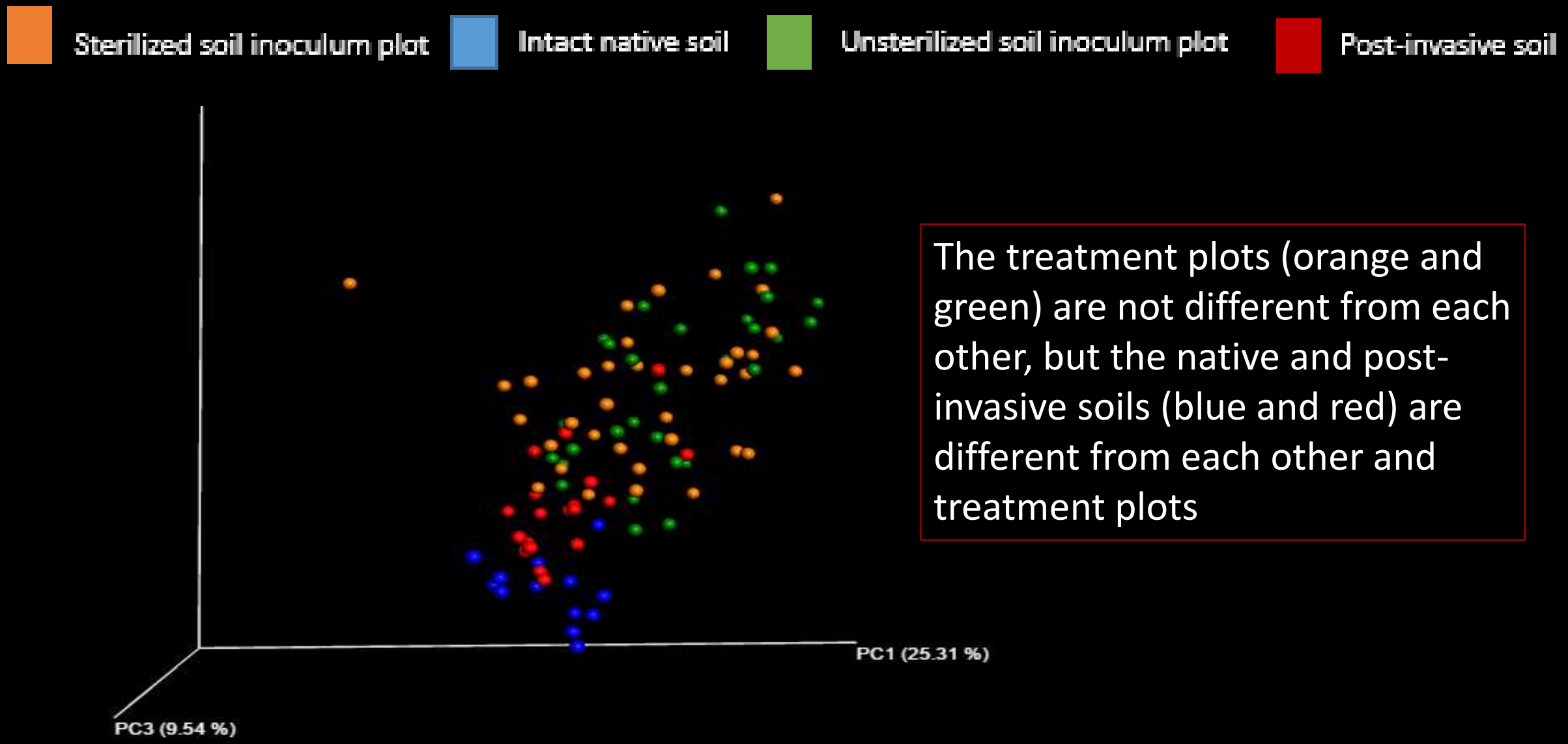
Mortality of Plants in Unsterilized vs. Sterilized soil Inoculum




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

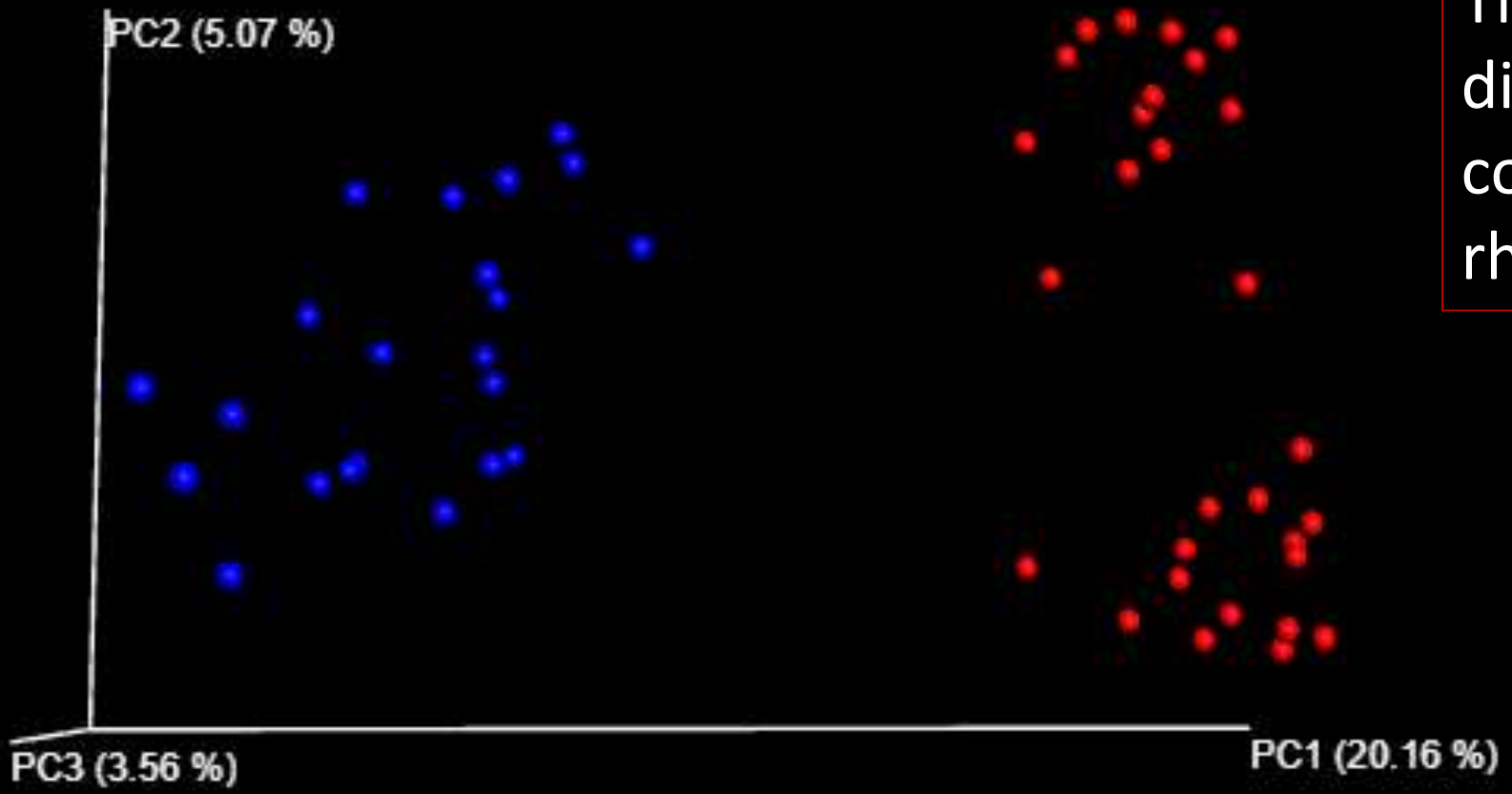

Baccharis Plant Height with Unsterilized vs. Sterilized Native Soil Inoculum
39.00
34.00
29.00
24.00
19.00
14.00
Baccharis grown in unsterilized native soil inoculum are larger
R² = 0.9292
R² = 0.9198
P = 0.007
February
March
April
May
June
July

PCoA of February and April Soil Cores



The treatment plots (orange and green) are not different from each other, but the native and post-invasive soils (blue and red) are different from each other and treatment plots

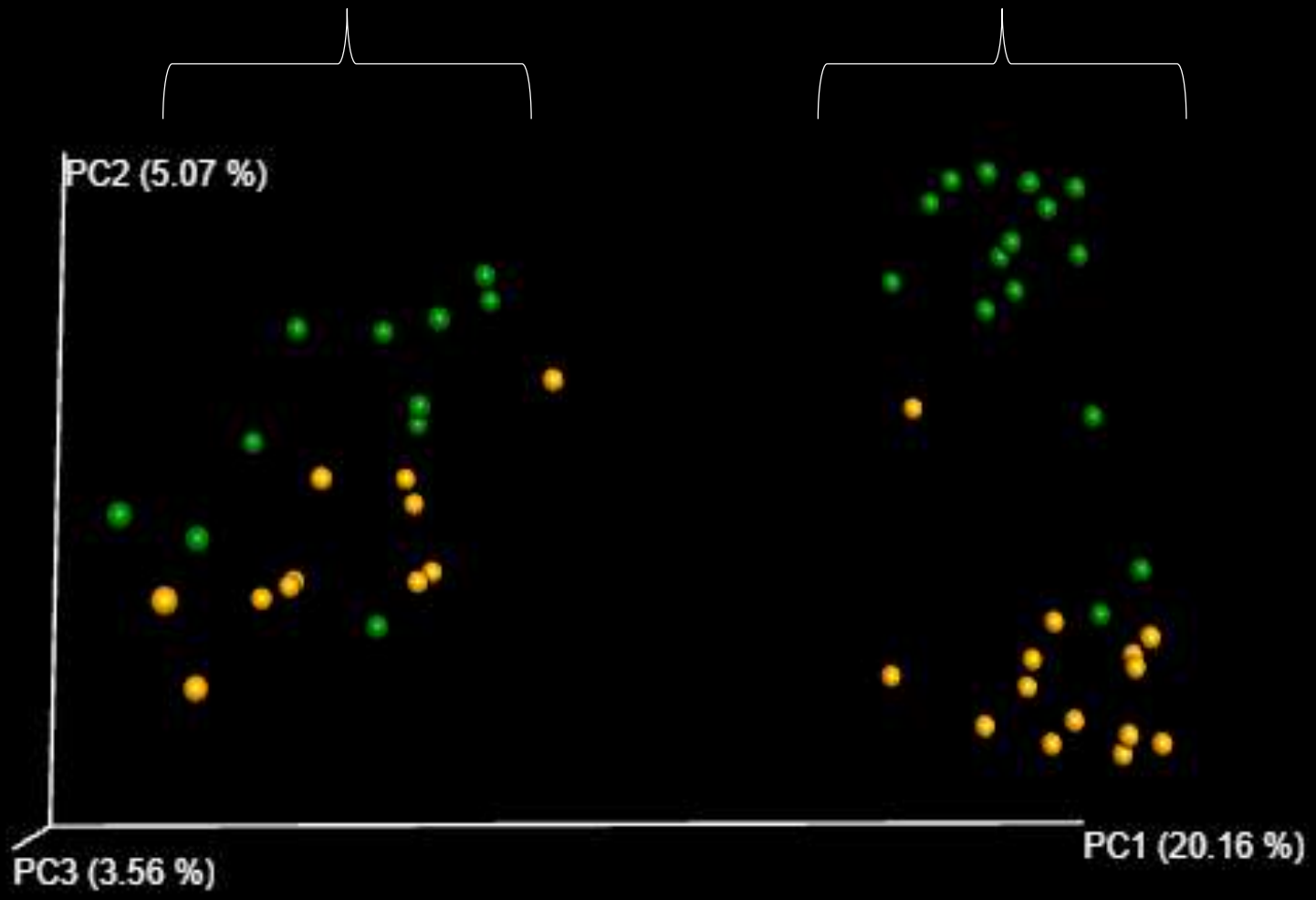
PCoA of Destructively Sampled Plants



The roots (blue) have a different microbial composition than the rhizosphere soil (red)

Roots

Rhizosphere

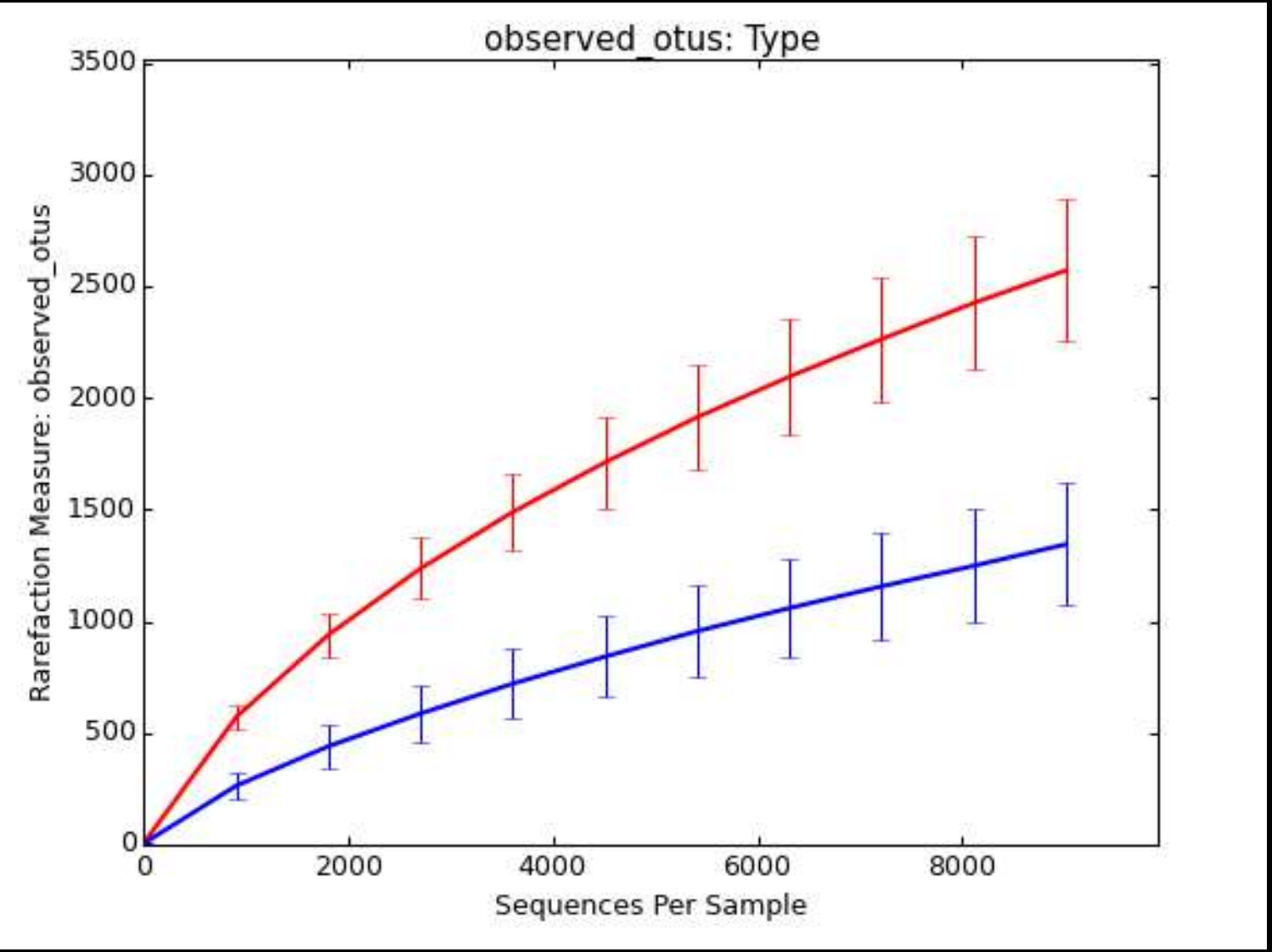


The sterilized treatment plots (green) are distinct from the unsterilized treatment plots (orange) especially for rhizosphere soil

Sterilized treatment

Unsterilized treatment

Rhizosphere Soil is more OTU rich



Taxa plots are being generated to help explain differences in microbial composition

Rhizosphere
Root

Conclusions

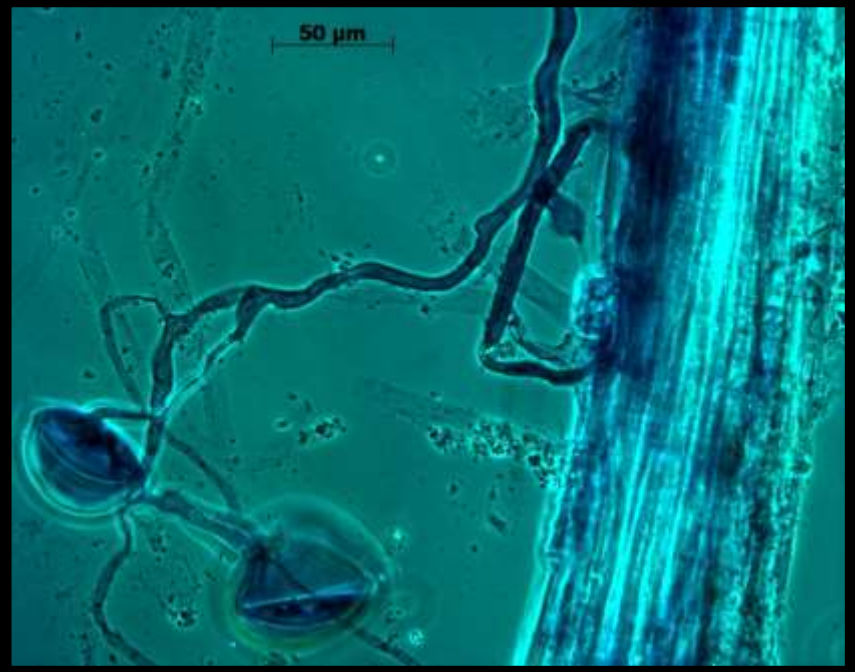
- Native plant growth was affected by native soil inoculum (unsterilized or sterilized)
- Artemisia had less mortality and higher growth after inoculation with unsterilized native soil
- Instead of just seeding a plot, we can transplant a native species with its own soil to insure survival
- The microbial composition of the roots and rhizosphere are different
- The microbial composition of plants grown in the unsterilized vs. sterilized soil treatment are different, esp. in rhizosphere soil
- Taxa plots of the rhizosphere soil and the native soil may shed some light on the difference in plant growth between unsterilized and sterilized treatment plots

Restoration starts with the 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

Next Steps

Using primers for arbuscular mycorrhizal fungi (AMF) and fungal pathogens to taxonomically identifying soil fungi (just finished troubleshooting this)



P. aquatica root with mycorrhizal and fungal pathogen infections

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