

Using Native Shrubs as Nurse Plants for Seedling Establishment in Response to Drought and Herbivory in Degraded California Sage Scrub

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Introduction

- The use of nurse plants is a popularized revegetation approach to improve the growth, fitness, and survival of neighboring plant species by sharing limited resources (1).
- Nurse plants may also provide protection from herbivory, UV radiation, and temperature extremes (2).
- Prolonged drought in water-limited environments has left abundant dead shrubs in the landscape, whose effect on seedling establishment is unknown.
- Herbivory pressures on recruiting seedlings under nurse plants is another factor that warrants further investigation (3, 4).
- Degraded inland California sage scrub is an ideal system for studying the effects of nurse plants due to its need for restoration and its harsh conditions for seedling establishment.

Questions:

- Does native establishment and survival under nurse plants depend on abiotic factors or biotic factors?
- Can dead nurse shrubs provide the same benefits as live nurse shrubs?

Methods

Study Species

Artemisia californica (California sagebrush)
• native, shrub

Salvia mellifera (Black Sage)
• native, shrub

Annual natives

• *Amsinckia intermedia* (Common fiddleneck), *Deinandra fasciculata* (Clustered tarweed), *Phacelia distans* (Common phacelia), and *Pseudognaphalium californica* (California everlasting)



Exposed nurse shrub level, with caged and un-caged levels nested within.

Location: Voorhis Ecological Reserve at Cal Poly Pomona, in Pomona, CA.

Experimental Design

- Five blocks, with a nurse shrub factor that has three levels (exposed, live *Artemisia californica*, and dead *A. californica* nurse shrubs) and an herbivore exclusion factor with two levels (uncaged and caged) nested within each level of the nurse shrub factor.
- In order to measure abiotic conditions, soil moisture, soil temperature, and solar radiation sensor was installed in each nurse level in two blocks.
- Motion sensor cameras were installed in each block to monitor herbivore activity.
- A. californica* and *S. mellifera* seedlings were outplanted in January 2016. Native annuals were sown in February 2016.

Data collection (January 2016- September 2016)

- Biotic data collected: shrub height, chlorophyll fluorescence, leaf water potential, seedling counts, seedling height, and herbivore activity.
- Abiotic data collected: soil moisture, soil temperature, solar radiation, PAR, and humidity.

Results

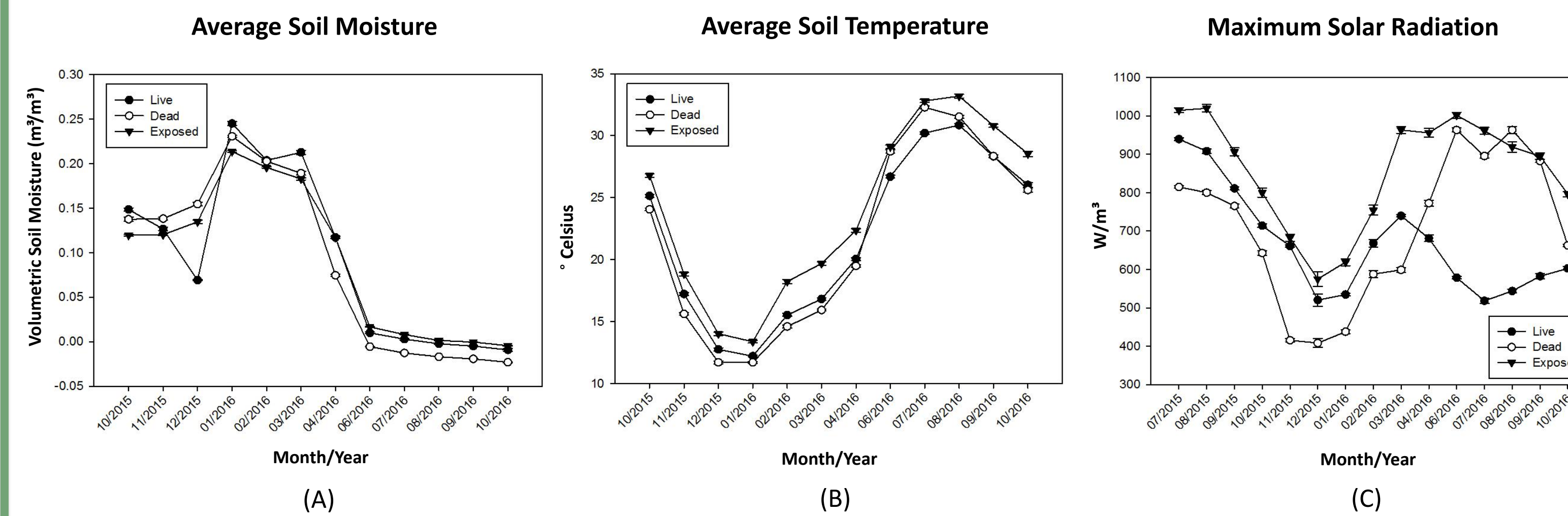


Fig 1. Environmental Sensor Data

Average soil moisture, soil temperature, and maximum solar radiation was measured in each nurse shrub treatment. Average soil moisture in all shrub treatments increased between winter and spring, and decreased during the summer. Maximum solar radiation in all shrub treatments varied seasonally; solar radiation was lowest under live shrubs during summer.

Table 1. Significant effects of each factor on shrub growth and water potential of each shrub species.

Factor	Shrub growth	Water Potential
Shrub Type	-	<i>A. californica</i> **
Cage	<i>A. californica</i> ** , <i>S. mellifera</i> **	-
Date	<i>A. californica</i> ** , <i>S. mellifera</i> **	<i>A. californica</i> ** , <i>S. mellifera</i> **
Shrub Type x Cage	<i>A. californica</i> **	-
Shrub Type x Date	-	<i>A. californica</i> ** , <i>S. mellifera</i> **
Cage x Date	<i>A. californica</i> *	-

** indicates $p < 0.05$, *** indicates $p < 0.001$, and - indicates no significant effect.

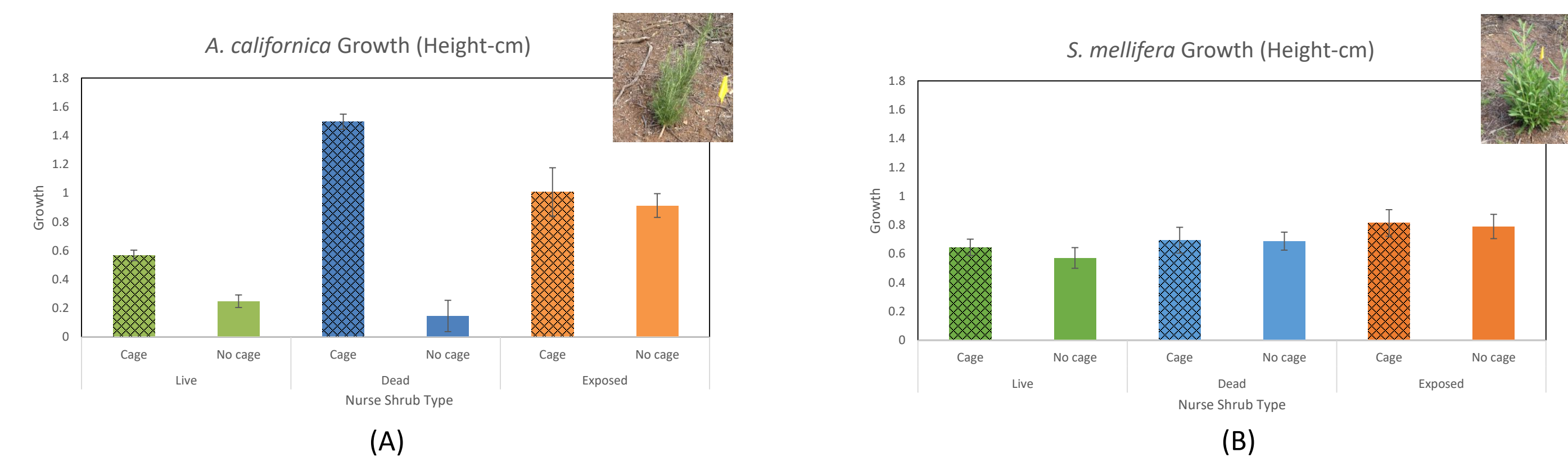


Fig 2. Shrub Growth

Height of each seedling was measured to determine the effect of nurse shrub treatments and exclusion treatments on seedling growth.

- Caged seedlings under dead nurse shrubs grew more than caged seedlings under live shrubs and in exposed areas.
- Uncaged seedlings did not grow as much as caged seedlings across all nurse shrub treatments.

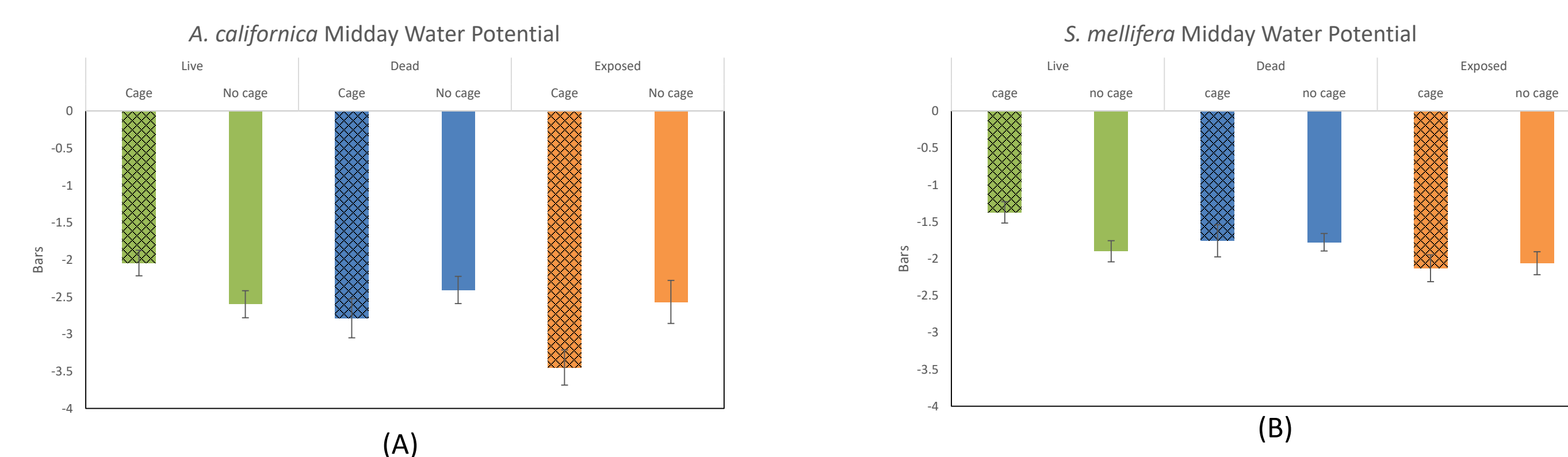


Fig 3. Average Leaf Water Potential

A. californica and *S. mellifera* midday water potential was measured to determine plant water uptake in nurse shrub treatments.

- Seedlings in exposed treatments had low water potentials (were the most water-stressed), compared to other treatments.
- Treatments did not significantly affect water potential.

Discussion

- Nurse shrubs appear to benefit restoration for *A. californica* by favorably affecting abiotic conditions (Question 1). Dead nurse shrubs appear to provide a similar or even greater benefit to seedlings than live nurse shrubs (Question 2).
- Caged *A. californica* seedlings grew more under dead shrubs, being in partially shaded microclimate protected from herbivory. It was observed that herbivores ate some uncaged *A. californica* seedlings under live and dead nurse shrubs. These results suggest that herbivory limits seedling growth more under shrubs than in exposed areas.
- The benefit of nurse shrubs was not as clear for *S. mellifera*. The differences among cage treatments were smaller for *S. mellifera* than for *A. californica*, and strong effects of nurse shrubs were not as apparent. It was observed that some *S. mellifera* seedlings did not grow well under live nurse shrubs. However, overall, caged plants did grow more, reinforcing that herbivory restricts seedling growth.



A. californica seedling eaten by an herbivore.



Rabbits near a live nurse shrub with *A. californica* seedlings underneath.

Future Directions

- Analysis of native annual seedling counts, seedling height, and PAR data may reveal further insight to whether dead nurse shrubs can provide the same benefits as live nurse shrubs as well as additional information about abiotic interactions within treatments.
- Herbivore occupancy and abundance analysis of each block may reveal a stronger relationship between seedling survival and increased herbivore activity.

References

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