Using plastic tree shelters to facilitate seedling establishment for ecological restoration of California native plant communities

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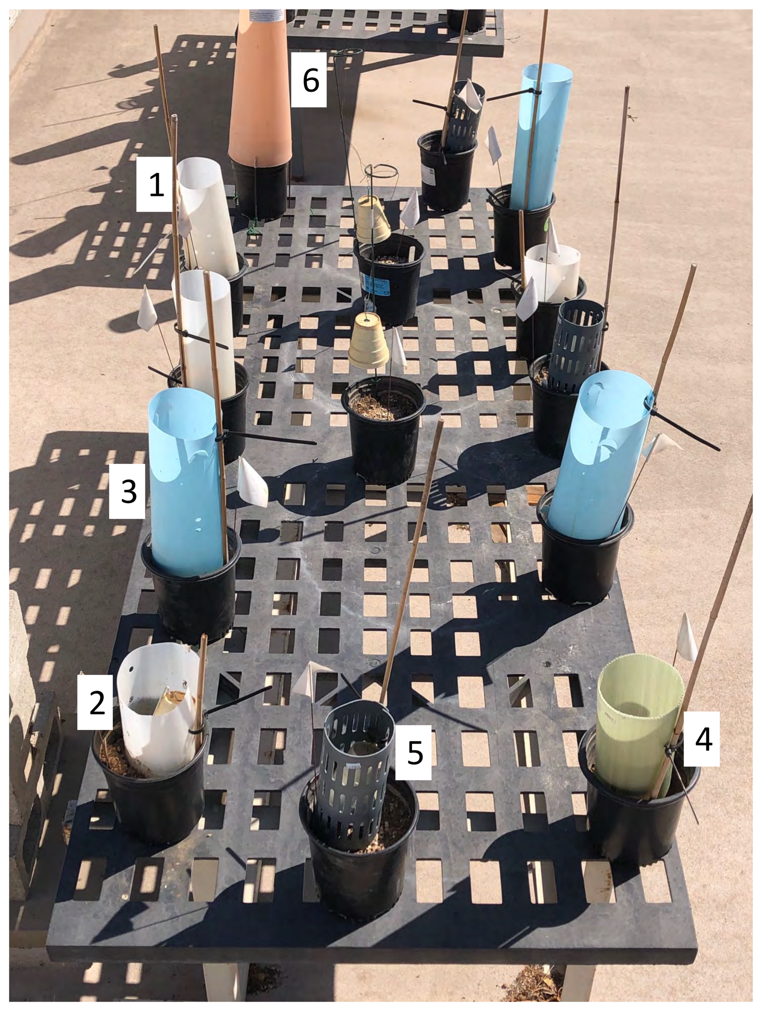
Introduction

- As wildfire frequency in California is increasing, native plant communities are experiencing increased invasion by non-native grasses (7). Southern California shrubland communities, such as chaparral and coastal sage scrub, are particularly at risk due to the aridity of their environments (4, 5). Therefore, restoration methods that are rapid, relatively low-cost, and that can improve native plant recruitment are needed to improve restoration outcomes.
- Plastic tree shelters are typically used to protect seedlings from herbivory, but they have also been shown to improve plant growth by limiting direct sunlight and wind exposure and increasing soil moisture availability (1, 2, 3, 6, 8).
- **Objective:** The goal of this study is to test the effects of six different commercially-available tree shelters on various abiotic and biotic factors affecting plant growth. The highest-performing shelter will be used in a restoration of a native chaparral community in the Angeles National Forest, where locally-collected native seeds will be sown directly into the shelters.

Experimental Design

Materials

1. Tree Pro single-walled, white, translucent, vented, 30cm tall
2. Tree Pro single-walled, white, translucent, vented, 15cm tall
3. Protex Pro/Gro single-walled, blue, vented, 38cm tall
4. Tubex twin-walled, green, translucent, solid, 30cm tall
5. Arbor Guard single-walled, dark grey, vented, 23cm tall
6. Tree Sentry single-walled, tan, solid, conical, 45cm tall



Methods

- The following abiotic measurements were taken on 4 replicates of each shelter and 4 controls (no shelter) arranged on 2 nursery benches in full sun on the roof of Building 8, Cal Poly Pomona:
  - Total solar radiation at soil surface
  - Photosynthetically active radiation (PAR) at soil surface and 20cm above surface; static (mid-day measurements at least once every two weeks) and diurnal measurements (hourly measurements over one day) were taken
  - Soil moisture (measured as volumetric water content)
  - Air temperature
- A mixture of seeds of locally-collected *Eriogonum fasciculatum*, *Amsinckia intermedia*, and *Stipa pulchra* (20 seeds/species) were added to 4 more replicates of each shelter and 4 more controls (no shelter) in an identical setup. Germination rate and plant height were measured.

Results

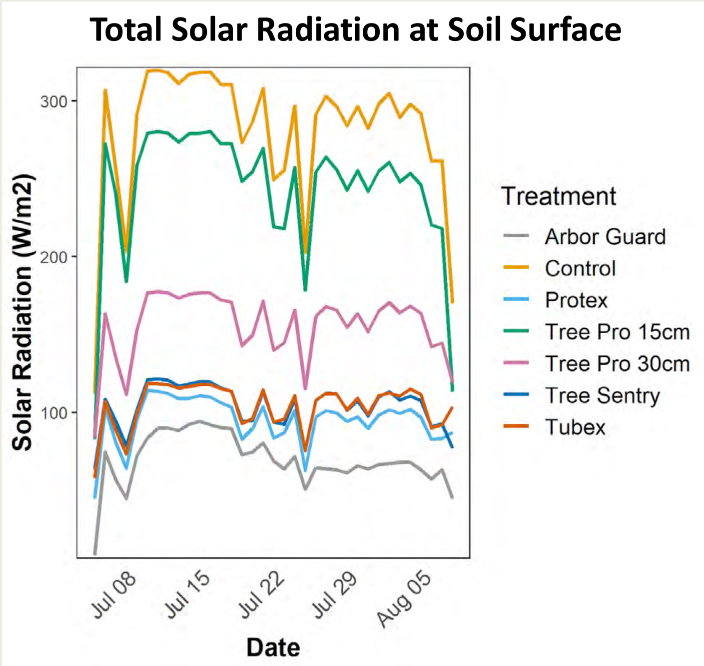


Figure 1. Average total solar radiation at soil surface per treatment. Differences between treatments were significant (ANOVA, P < 0.001). Tree Pro 30cm let in significantly more radiation than the dark shelters (i.e. Tubex, Tree Sentry, Protex, and Arbor Guard; Tukey, p < 0.001) and significantly less than Tree Pro 15cm and the control (Tukey, P < 0.001).

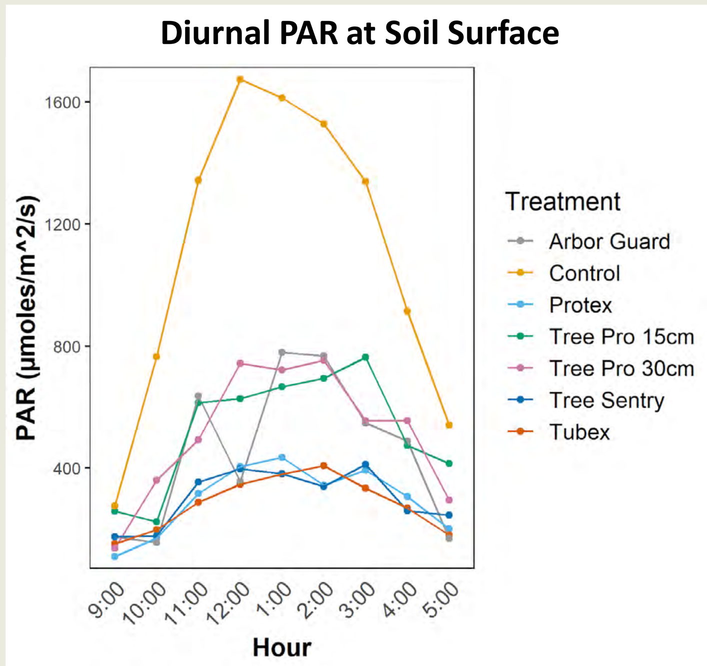


Figure 2. Average diurnal PAR at soil surface per treatment. Differences between treatments were significant (ANOVA, P < 0.001). Both Tree Pros let in significantly more PAR than the dark shelters (i.e. Tubex, Tree Sentry, Protex; Tukey, P < 0.001) and significantly less PAR than the control (Tukey, P < 0.001); they were not significantly different from each other or Arbor Guard.

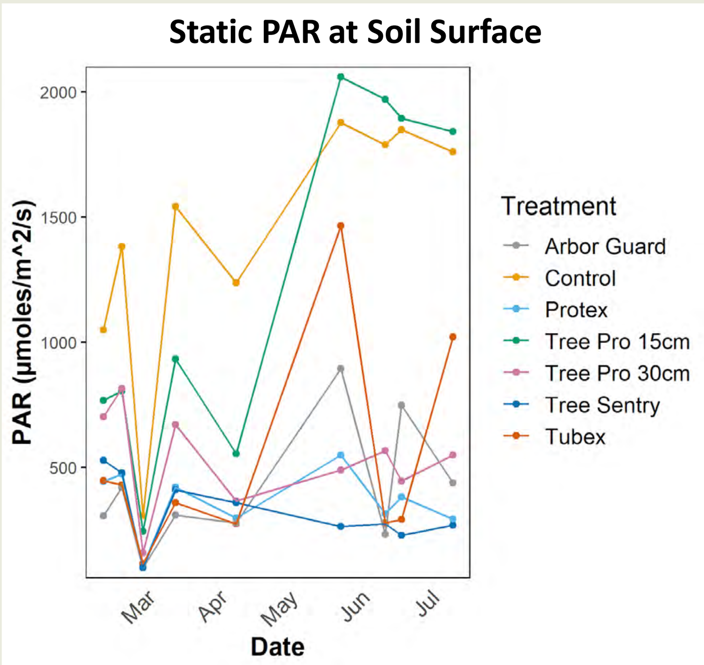


Figure 3. Average static PAR measurements at soil surface per treatment. Differences between treatments were significant (ANOVA, P < 0.001). Tree Pro 30cm let in significantly more PAR than Tree Sentry (Tukey, P < 0.001) and significantly less PAR than Tree Pro 15cm and the control (Tukey, P < 0.001).

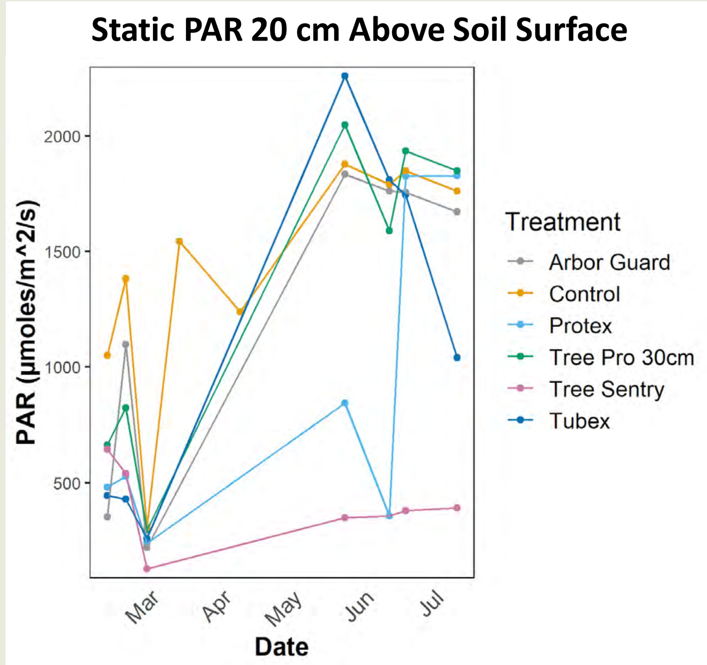


Figure 4. Average static PAR measurements 20cm above soil surface. Differences between treatments were significant (ANOVA, P < 0.001). Tree Sentry let in significantly less PAR than all other shelters and the control (Tukey, P < 0.01).

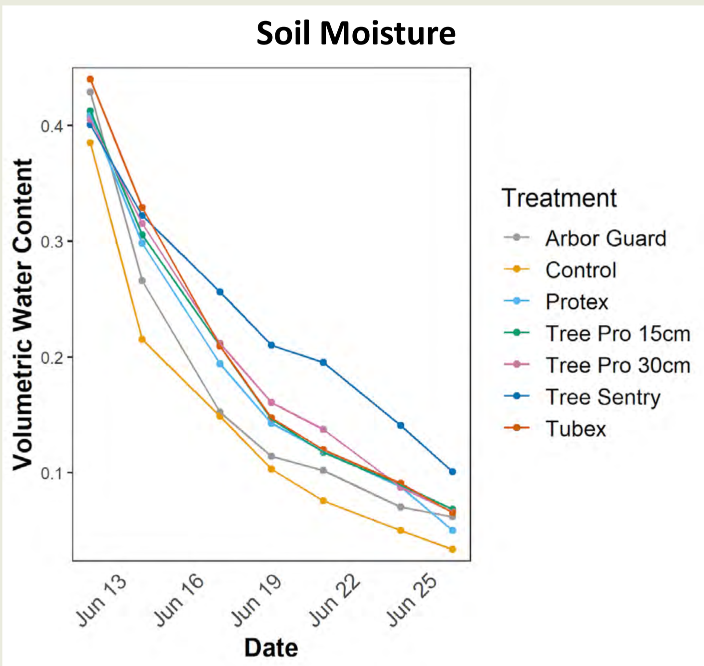


Figure 5. Average soil moisture per treatment measured over two weeks after initial saturation. All shelters had significantly higher soil moisture than the control (ANOVA, P < 0.001). Tree Sentry had significantly higher soil moisture than the next best shelter, Tree Pro 30cm (Tukey, P < 0.001).

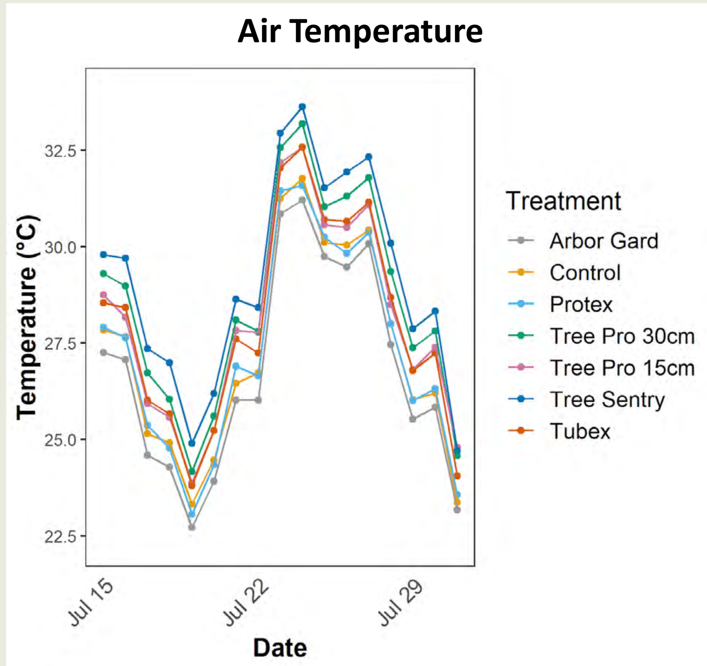


Figure 6. Average daily air temperature. Only a subset of the full February to August data set is shown because differences were difficult to discern at the scale of the full data set. Differences between treatments were significant (ANOVA, P < 0.001). Tree Sentry had the highest average temperatures inside the shelter, followed by Tree Pro 30cm.

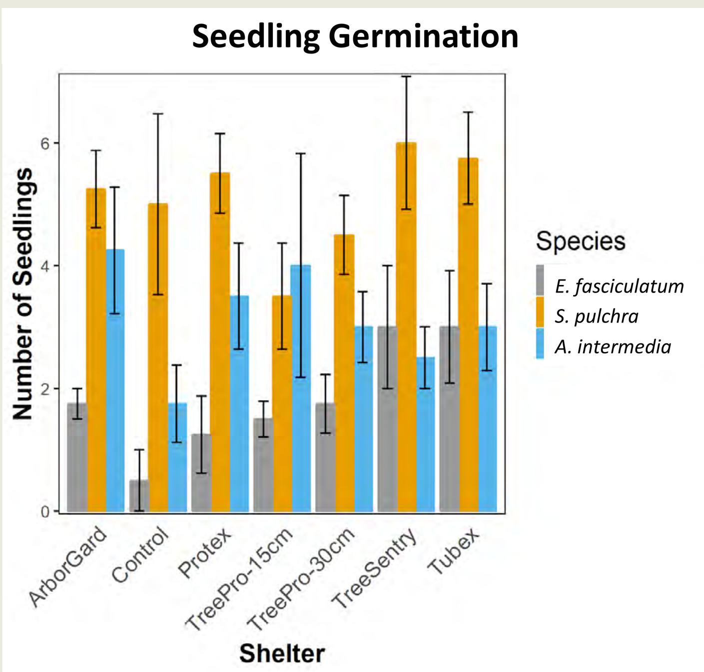


Figure 7. Average number of seeds germinated (out of 20) per species per treatment. Overall germination was low. Differences among shelters were not statistically significant, but differences among species were (ANOVA, P < 0.001). *S. pulchra* had higher germination than *A. intermedia* and *E. fasciculatum* (P < 0.001). *A. intermedia* also had higher germination than *E. fasciculatum* (Tukey, P < 0.001)

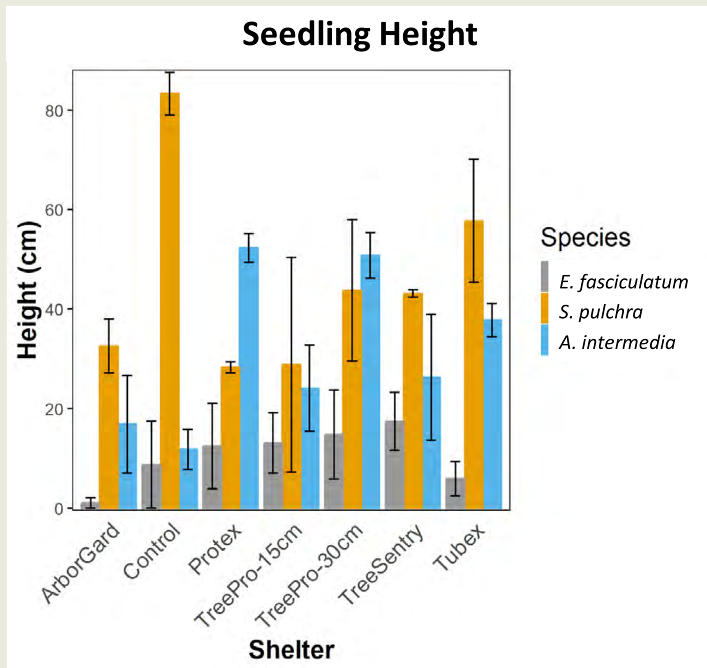


Figure 8. Average seedling height per species per treatment. Differences among shelters were not statistically significant, but differences among species were (ANOVA, P < 0.001). *S. pulchra* was significantly taller than *A. intermedia* (Tukey, P < 0.05) and *E. fasciculatum* (P < 0.001). *A. intermedia* was also significantly taller than *E. fasciculatum* (Tukey, P < 0.001)

Discussion

- **At the soil surface**, Tree Pro 30cm fell in the middle range of solar radiation, allowing in more than the darker shelters (i.e. Tree Sentry, Tubex, Protex, and Arbor Guard) while blocking more than the shorter Tree Pro and the control. Tree Pro 30cm also let in more PAR than the darker shelters.
- **At 20cm above the soil surface**, Tree Pro 30cm was no different from the control in PAR, making it a useful shelter for plants that can handle full sun exposure after establishment. Tree Sentry was consistently the most light-limiting, making it more useful for shade-tolerant plants or taller seedlings.
- **Soil moisture:** All shelters increased soil moisture compared to the control. Tree Sentry consistently had the highest soil moisture retention, likely due to its shading properties. Tree Pro 30cm retained the second highest soil moisture, making both of these shelters useful in arid conditions.
- **Air temperature:** Both Tree Sentry and Tree Pro 30cm retained the highest average daily temperatures, but Tree Sentry showed consistently higher temperatures, likely because it is unventilated.
- **Seedling germination and height:** There were no statistically significant differences in germination and seedling height between treatments.

Restoration Implications

- The Tree Sentry (right) may be better suited for growing large, shade-tolerant species. The Tree Pro 30cm (left) may be better suited for seeding and for species adapted to high light.

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Acknowledgements

We thank Jennifer Alexander for assistance with setting up our study at Cal Poly Pomona. Thanks to Tree Sentry for providing us with several sample shelters. We would also like to recognize the MENTORES Program at Cal Poly Pomona and the CSU Agricultural Research Institute (Grant 19-04-108) for funding this study.