Using plastic tree shelters and mechanical weeding practices to improve post-fire ecological restoration of highly invaded California native plant communities

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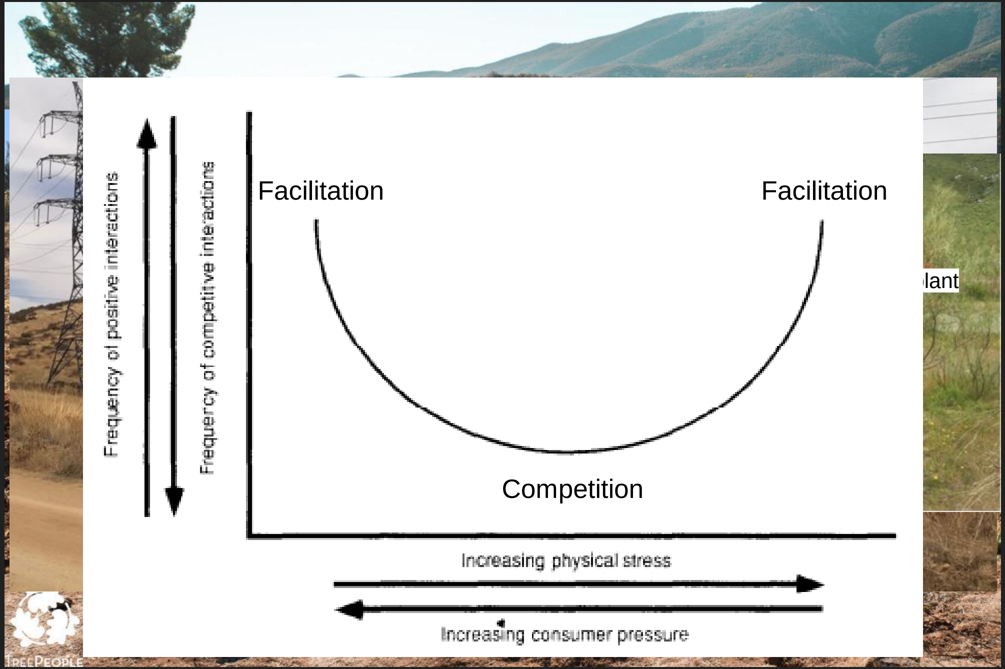
Effects of high fire frequency on shrublands

- Reduced recovery time for shrubs between fires
    - Higher shrub mortality
- Increased annual grass cover
    - Benefited by increased fire frequency and reduced competition from shrubs

Restoration via seeding into tree shelters

- Lowered costs
  - Via local seed collection and seeding on site
- Potential higher establishment
  - Tree shelters protect seedlings from herbivory and facilitate seedling growth by altering microclimate around seedling like a nurse plant
  - Stress gradient hypothesis
    - Positive interactions more common in high stress environments
      - Slopes vs. flat areas
      - South-facing vs. north-facing slopes



Questions and hypotheses

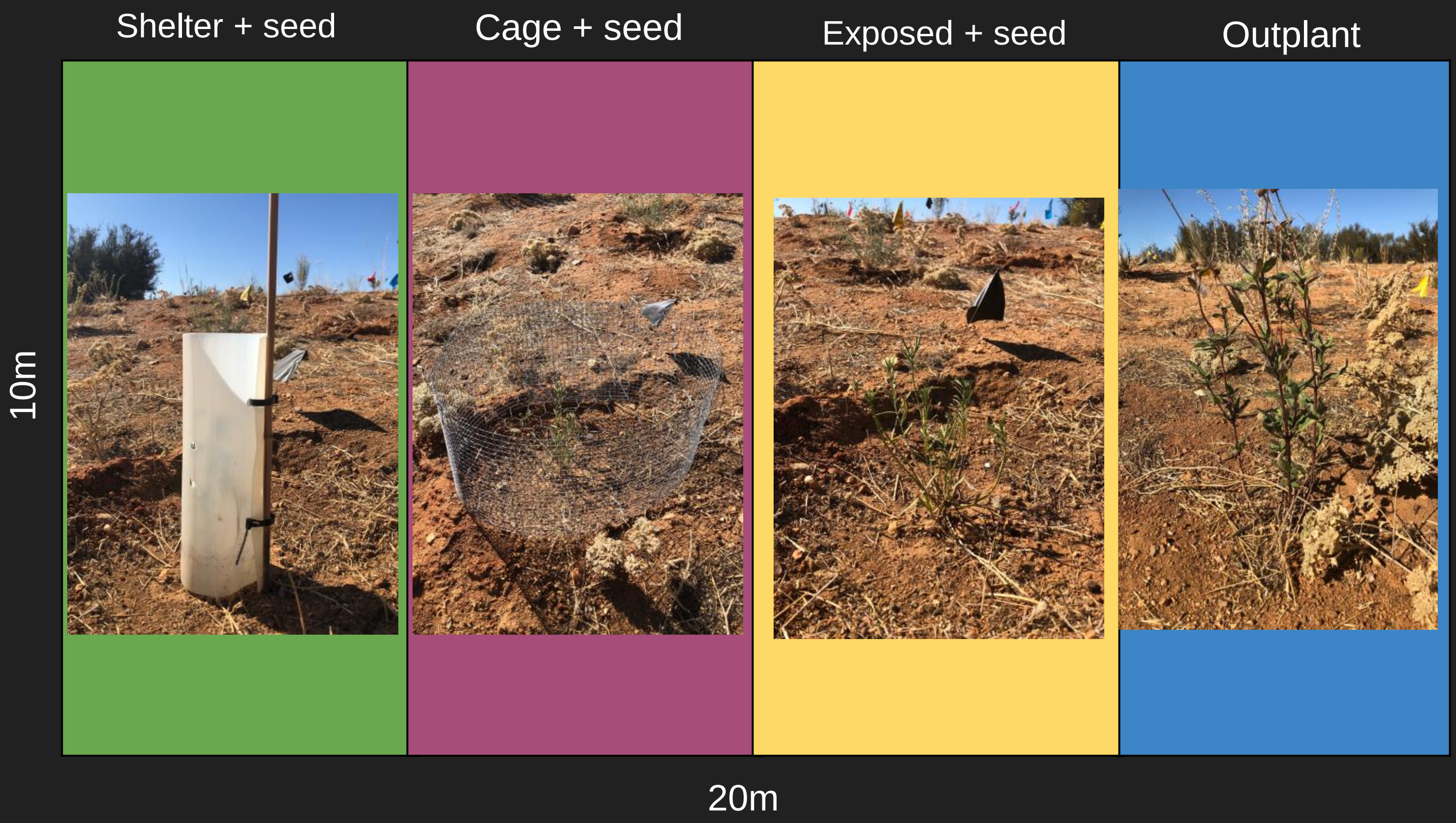
1. How do plastic tree shelters affect seedling germination and establishment, represented by seedling presence and survival?
    a. *Hypothesis*: Sheltered seeds will experience higher germination and survival rates than the exposed seeds due to amelioration of physical stresses by tree shelters.

2. How does the facilitative effect of tree shelters change along an environmental gradient of site slopes and aspects?
    a. *Hypothesis*: The facilitative effect of tree shelters on seed germination and seedling establishment will be most apparent in the harshest environmental conditions (e.g. steep, south-facing slopes).

Site description

- ANF near Santa Clarita, CA
- 2002 Copper Fire (8k hectares)
- Plant communities: coastal sage scrub, chaparral, Douglas fir, riparian
- Highly invaded by non-native grasses and forbs
  - Cattle grazing
  - Frequent fires
- Mediterranean climate
  - Avg. annual precipitation 420 mm
    - Study precipitation
      - 2020: 188.5 mm
      - 2021: 47.6 mm

Treatments



Study species

Salvia leucophylla

Salvia mellifera

Eriogonum fasciculatum

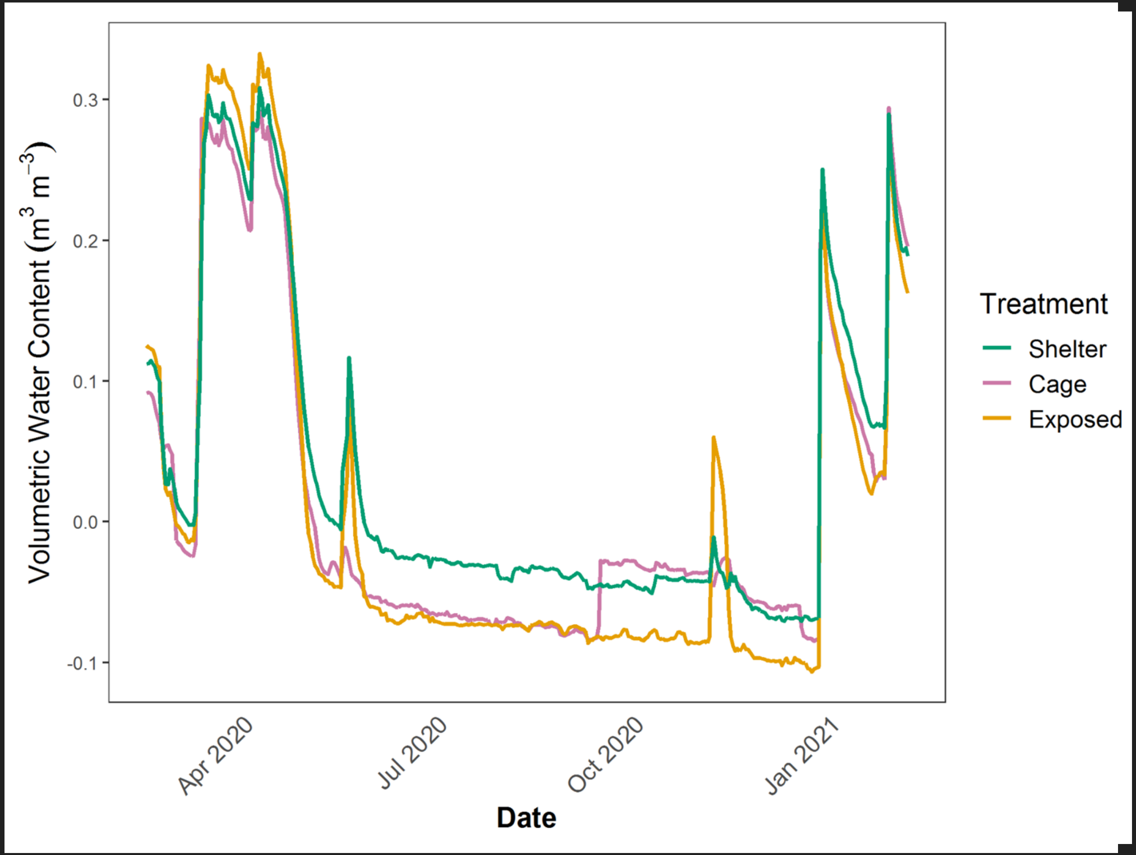
- Seed collected locally and treated prior to seeding to increase germination rate
- 2 replicates per species per treatment at each site
- Seeded in January 2020
- Outplants added in March 2021

Data collected

- P_S - seedling presence (proportion of subplots with any seedlings present)
- P_L - seedling survival (proportion of subplots with surviving live seedlings present)
- Total solar radiation
- Soil moisture

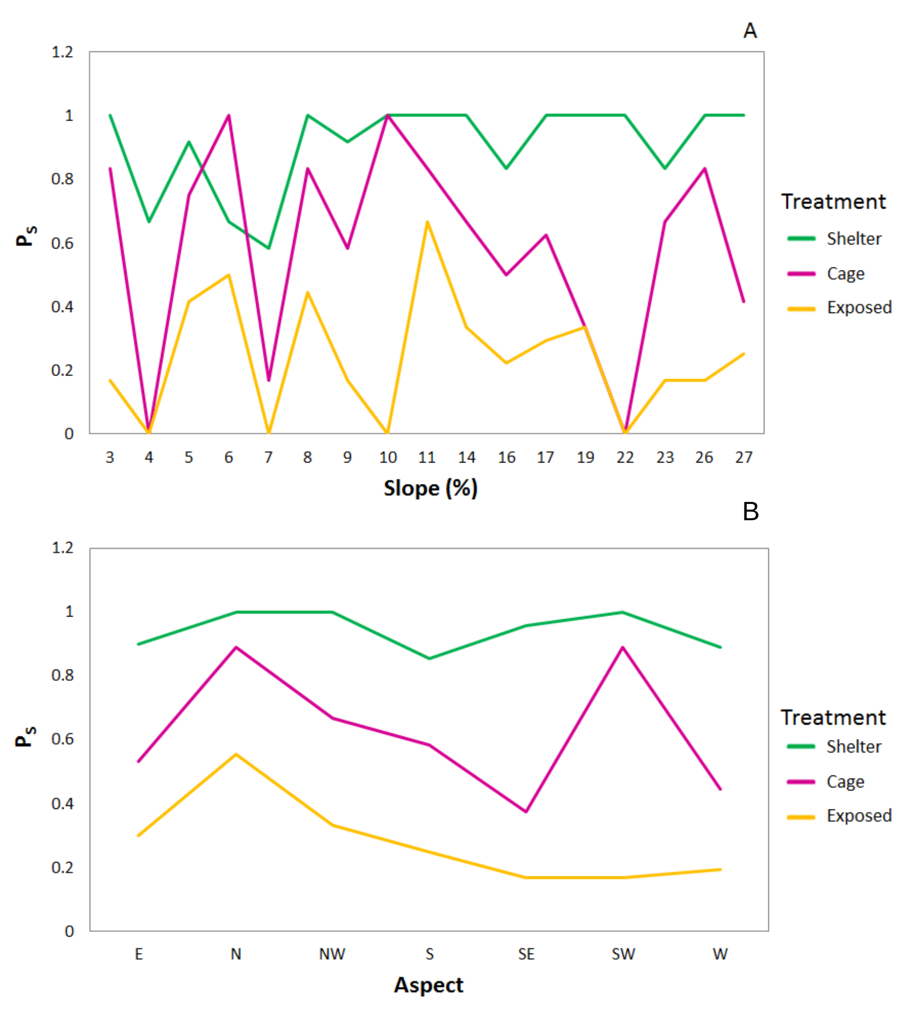
Abiotic effects of shelters

- Shelters reduced total solar radiation by nearly 30%
- Shelters retained about 5% more soil moisture during dry summer, fall, and early winter months than Exposed
    - Soil shading by shelters may lead to higher soil moisture retention



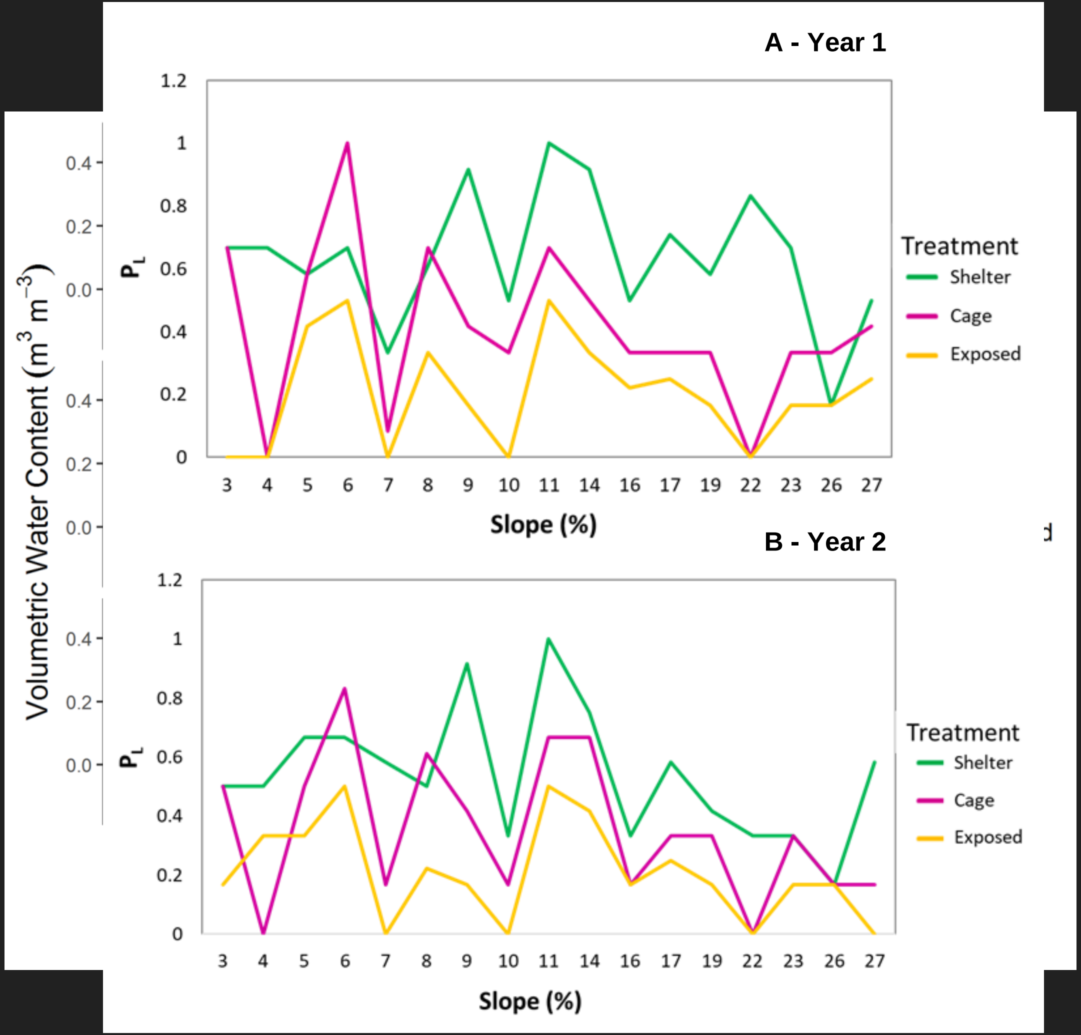
Seedling presence (P_S)

- Slope
  - Seedling presence (P_S) highest in the Shelter treatment on steeper slopes
- Aspect
  - Seedling presence (P_S) highest in Shelter treatment across all aspects



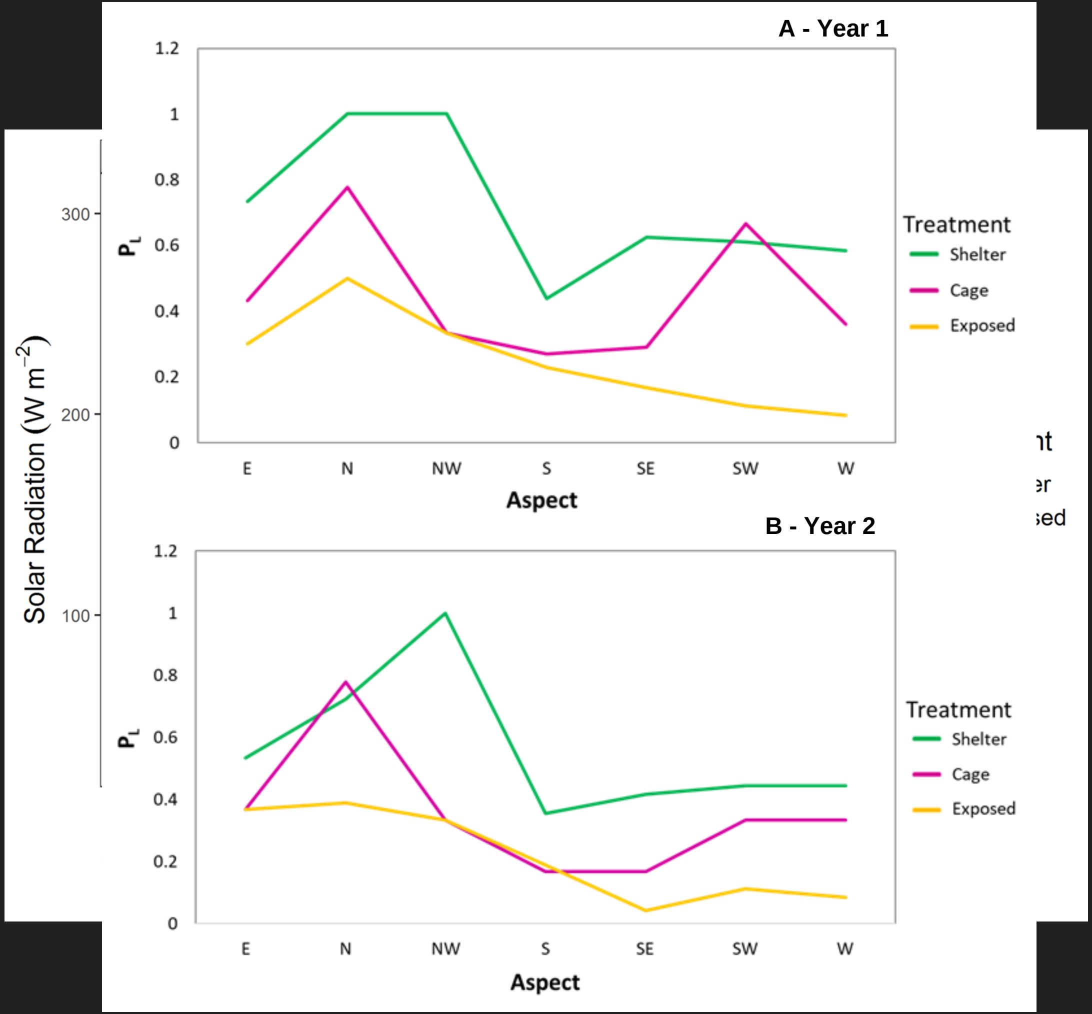
Slope and seedling survival (P_L)

- Seedling survival (P_L) higher in the Shelter treatment on most steep slopes even with decreased overall survival in second year
  - Likely due to higher soil moisture retention in Shelter treatment on steep slopes
  - May also be due to prevention of soil erosion and seedling burial



Aspect and seedling survival (P_L)

- Seedling survival (P_L) higher in Shelter treatment than others on nearly all aspects in both years
    - Low overall P_L on S-facing aspects likely due to higher solar radiation in fall and winter combined with low overall precipitation this season



Cost analysis

- Cost of outplanting nearly 8x higher than cost of seeding into shelters
  - Due to purchasing nursery-raised outplants and watering them during establishment
- Cost of each seeded treatment per surviving seedling was 2.5x higher for Cage and 2x higher for Exposed than Shelter

Costs of seeding and outplanting methods (including shared costs).

Category	Material Expenditures ($)	Travel Expenditures ($)	Labor Hours	Total Cost ($)
Seeding				
Establishment	1538.27	521.34	83.62	3732.01
Monitoring	0.00	208.53	36.67	941.93
Total				**4673.94**
Outplanting				
Establishment	5866.00	9071.20	1010	35137.20
Monitoring	0.00	782.00	45	1682.00
Total				**36819.20**
Shared				
Maintenance	794.54	1798.60	245.53	7503.74

Seeding costs for the Shelter, Cage, and Exposed treatments.

Treatment	Material Expenditures ($)	Travel Expenditures ($)	Labor Hours	Total Cost ($)	Number of Subplots with Live Seedlings	Cost per Surviving Seedling ($)
Shelter	1538.27	729.87	120.29	4673.94	99	47.21
Cage	2141.63	729.87	231.08	7493.10	65	115.28
Exposed	438.57	729.87	120.29	3574.24	37	96.60

Conclusions and Acknowledgments

- Shelters reduced solar radiation, increased soil moisture, and had higher seedling presence and survival than the other treatments on steep slopes and south-facing aspects
- Shelters are recommended for low-cost plant community restoration in arid and semiarid environments

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