The Feasibility of Chaparral Restoration on Type-converted Slopes

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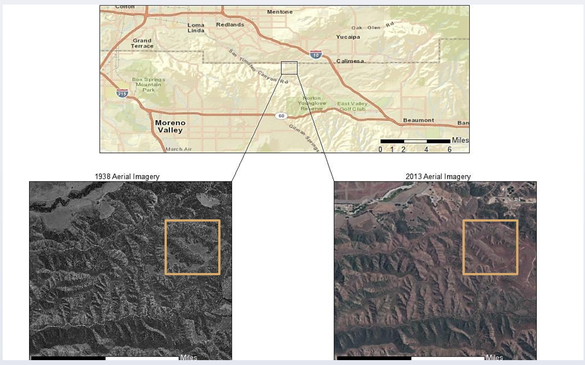
Introduction

Non-native annual grass competition is an obstacle to restoration and reestablishment of chaparral on type-converted slopes. This study compared several methods of restoration on type-converted slopes in San Timoteo Canyon on an ecological preserve owned by the Riverside Land Conservancy. The map below shows a comparison of 1938 aerial imagery to 2013 aerial imagery in San Timoteo Canyon, west of our study site. The 1938 aerial imagery indicates there was chaparral present on the slopes of the canyon. By 2013 these slopes were covered by annual grasslands.

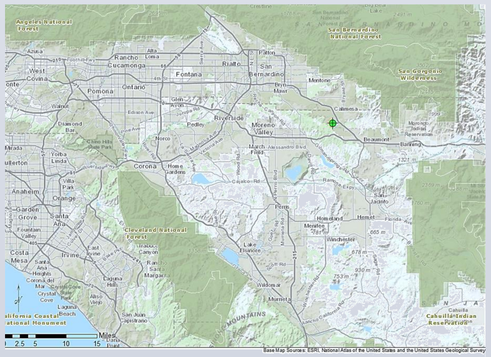


Objectives

- Assess the effectiveness of a broad-spectrum herbicide and a grass-specific herbicide in reducing competition and fostering establishment of chaparral shrubs
- Compare seeding and planting seedlings of chaparral shrubs as a mode of restoration
- Analyze the seed bank to see if there was a relict seed bank that can be manipulated (e.g. through smoke water application) to promote restoration

Project Area

This study was conducted on steep, grass-covered slopes in San Timoteo Canyon in Riverside County. Patches of degraded chaparral adjacent to the study plots were typically dominated by *Adenostoma fasciculatum* and had a dense understory of non-native annual grasses. The plots were set up in October 2012.



Methods

Experimental Design

Treatment	No treatment	Smoke Water Application	Seeding	Planting
No Herbicide	Control Control	Control SW	Control Seeding	Control Planting
Fusilade	Fusilade Control	Fusilade SW	Fusilade Seeding	Fusilade Planting
Glyphosate + Fusilade follow up	Gly + Fus Control	Gly + Fus SW	Gly + Fus Seeding	Gly + Fus Planting

***Treatments were replicated three times

Seedlings of four chaparral species were planted:

- *Adenostoma fasciculatum*
- *Eriogonum fasciculatum*
- *Quercus berberidifolia*
- *Rhus ovata*

Control and Fusilade plots were planted 20 Dec 2012, and Glyphosate + Fusilade follow-up plots were planted on 30 Jan 2013. Subsequent irrigation occurred throughout the season on the planted plots.

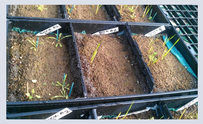
Seven different chaparral species were used for seeding:

- *Adenostoma fasciculatum*
- *Artemisia californica*
- *Eriogonum fasciculatum*
- *Gutierrezia sarothrae*
- *Quercus berberidifolia*
- *Rhus trilobata*
- *Rhus ovata*

Seed Bank Assay

Soil was collected from the San Timeoto Canyon research site in October 2012. The soil was then spread into flats, and 4 different treatments were applied:

- No treatment
- Smoke water
- Smoke water + heat
- Gibberellic acid



The four different treatments were used to manipulate the seed bank to see if any chaparral species were left in the seed bank. Germinants were counted, and representatives of each species were transplanted and grown for identification.

Soil Moisture

The effect of herbicide treatments on competition for soil water was assessed by measuring soil water content in late spring (April 2013). Soil was sampled in unplanted plots that had been subjected to different herbicide treatments (the first column of the treatment matrix above). Soil was also sampled in plots planted with seedlings, where seedlings had been periodically watered (the last column in the treatment matrix above).

Soil was sampled in three depth increments:

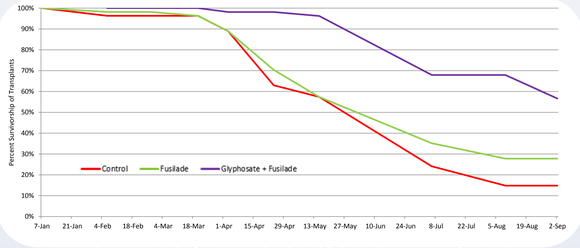
- 0-5 cm
- 5-15 cm
- 15-35 cm

Gravimetric soil water content was determined by weighing soil before and after drying at 105 C

Results

Survivorship

The total number of seedlings surviving through the summer was higher in the glyphosate-treated plots than any other treatment. (All four species are combined in this graph.)

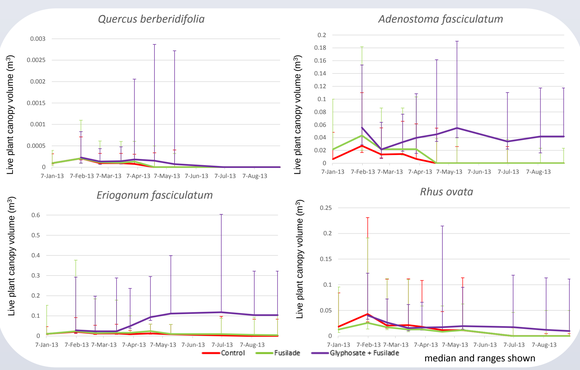


By September, survival of *Quercus berberidifolia*, *Adenostoma fasciculatum*, *Eriogonum fasciculatum*, and *Rhus ovata* in glyphosate-treated plots was 0.0%, 87.5 %, 80.0%, and 73.3%, respectively. For each species, except the *Q. berberidifolia*, survival was lower in all other treatments.

Live Plant Canopy Volume

All individuals are accounted for in the graphs below, including those with 0m^3 of live plant canopy volume. The glyphosate-treated plots through summer have higher live plant canopy volume over any other treatment.

Live plant canopy volume m^3= 4/3 π(height X width 1 X width 2)

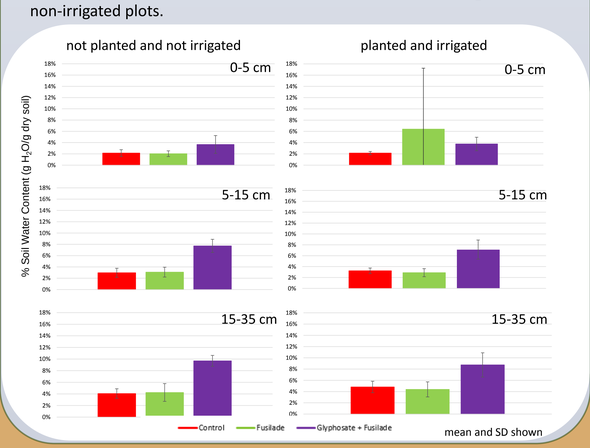


Seedling success:

- Seeding was unsuccessful at the site, presumably due to the lack of precipitation.

Soil Moisture

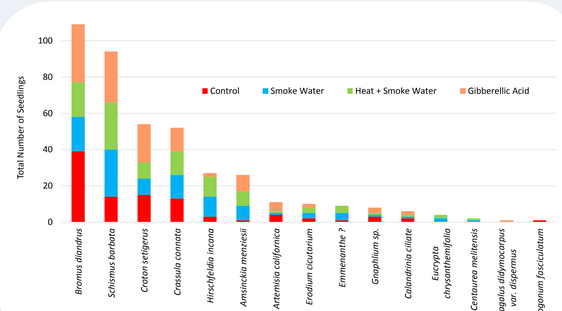
With one exception, spring soil moisture was higher in glyphosate-treated plots than in either Fusilade-treated plots or control plots at all depths that were sampled. There was little to no difference between the irrigated versus non-irrigated plots.



Results

Seed Bank Assay

As expected, most of the seedlings that emerged were non-native annual grasses. There were some weedy natives, some native herbs, and some native shrubs. Very few native shrubs emerged from the seed bank, however, and there was no evidence that heat or smoke water preferentially stimulated the germination of native shrubs.



Consistent with these findings, smoke-water application in the field produced no marked changes in species composition (data not shown).

Conclusions

- Glyphosate with a Fusilade follow-up treatment was much more successful in both reducing soil water depletion and promoting shrub transplant survival than either Fusilade alone or no herbicide treatment.
- The Fusilade-only plots were not as successful as expected. This was possibly due to the early maturation of the non-native annual grasses. This early maturation is likely due to the lack of rain and early season warm temperatures this year.
- Springtime soil moisture content was strongly influenced by glyphosate application, but not by the irrigation of transplanted seedlings. This pattern supports the contention that modest irrigation without weed removal in restoring annual grassland to other vegetation types is futile.
- So far, transplanting shrub seedlings has been more successful than applying chaparral shrub seeds to the site, and
- At this site the relict native shrub seed bank appears minor, and would not be effective to manipulate as a means of restoration.

Acknowledgments

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