Evaluating Return of Ecosystem Services after Shrubland Restoration Post-fire

Emma Underwood[1], Neda Brehm[2], Sarah Cusser[2], Zach Phillips[2], Nicole Molinari[3], Josephine Lesage[2], Denise Knapp[2], and Charlie Schrader-Patton[3]

[1]UC Davis Institute of the Environment; [2]Department of Conservation and Research, Santa Barbara Botanic Garden; [3]USDA Forest Service Pacific Southwest Program

Introduction

Fire in chaparral shrublands impacts native vegetation, ecosystem services, and ecological function. As a consequence, post-fire restoration can be implemented to promote chaparral integrity. However, there are few studies to indicate the value of restoration particularly given the costs involved.

In this study, we undertook a two year restoration experiment on the Piru Fire (2003, Fig. 1) to determine **how have ecosystem services and function recovered following restoration?**

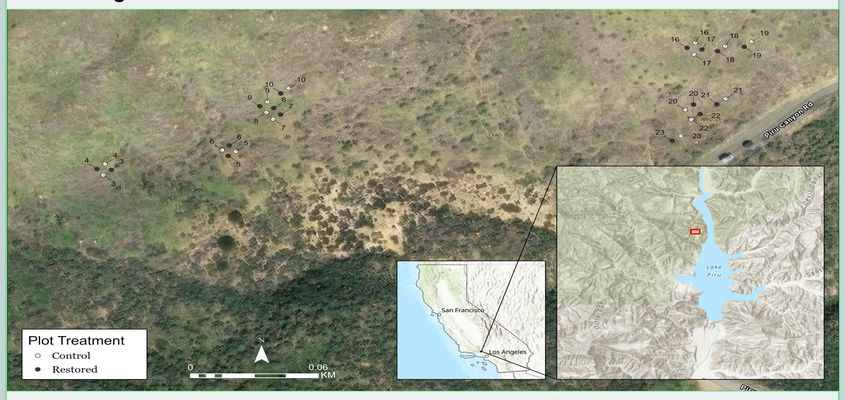

Figure 1. Restoration and control plots in areas with low shrubland regeneration following the Piru Fire on the Los Padres NF

Restoration

Methods

- We established 16 restored plots, 16 paired controls, and 8 reference plots of intact shrubland (all plots 4 m x 4.5 m, Figs. 2,3,4)
- We planted 896 plants in Jan 2022 from a palette of 18 native species: 8 coastal sage scrub, 7 chaparral and 3 grasses/other which we hand-watered from Feb-Oct 2022
- We recorded: monthly data on plant survivorship and annual data (April 2022 and March 2023) on plant height and canopy cover, and presence of non-native species

Figure 2. Intact reference plot

Figure 3. Preparing restoration plot, 56 plants per plot

Figure 4. One year old *M. fasciculatus* shrub

Preliminary Results

Plant Survivorship After 2 Years

- Irrigated individuals had significantly higher survivorship with 58% alive versus 43% of non-irrigated individuals (Fig.5A), except for *Frangula californica*
- Drought tolerant scrub species had significantly higher survivorship at 70% versus 30% in non-drought tolerant chaparral species (Fig. 5B). Chaparral species showed a sharp drop in survivorship in August to November in the first year.

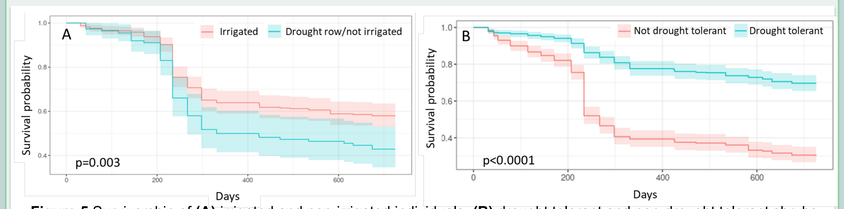

Figure 5 Survivorship of **(A)** irrigated and non-irrigated individuals; **(B)** drought tolerant and non-drought tolerant shrubs

Biomass / Carbon Storage Services Over 2 Years

- We calculated biomass using the shrub general equation (Lutes et al. 2006). There was a significant increase in biomass of restored plots between years 1 and 2 (x 4, (Fig. 6), and a significant difference in restored versus reference plots
- After 1 year, biomass of scrub species increased significantly more than chaparral species (Fig. 7)

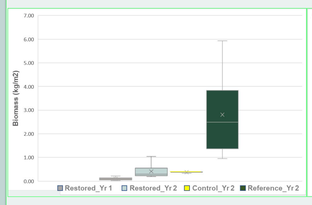

Figure 6. Comparison of plot biomass

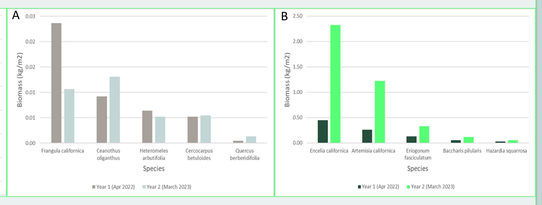

Figure 7. Total biomass in restored plots: (A) chaparral and (B) scrub species

Soil Decomposition Services

- We buried tea bags: 4 rounds for 4 month each over the year and determined decomposition rates using Tea Bag Index (Fig. 8 and 9, Keuskamp et al. 2013)
- We found no significant difference in decomposition rates between treatments, but there was a significant increase in decomposition rate with wetter conditions from summer going into winter

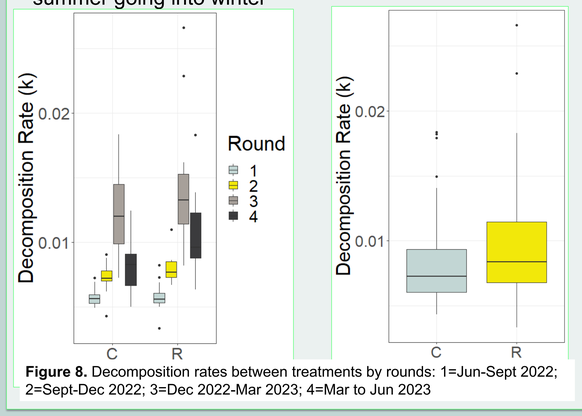

Figure 8. Decomposition rates between treatments by rounds: 1=Jun-Sept 2022; 2=Sept-Dec 2022; 3=Dec 2022-Mar 2023; 4=Mar to Jun 2023

Figure 9. Unearthed tea bags: green tea (left) and rooibos (right)

Results Continued

Invertebrate Biodiversity Services

- We conducted sweepnetting and set pitfall trips in spring 2022 and 2023 in restored, control and reference plots
- Samples were sorted to 39 Coleoptera, 49 Diptera, and 73 Hymenoptera unique morphospecies
- Functional orders were selected based on their biological contributions to ecosystem services: seed dispersal, nutrient cycling, pollination

- In both years 1 and 2 insect richness was significantly higher in restoration plots than controls (Fig. 10A) but we detected no significant difference in insect abundance (Fig. 10B).
- This is due to increased diversity (structure) in restored plots as well as recent planting (disturbance) which would have opened up micro-niches

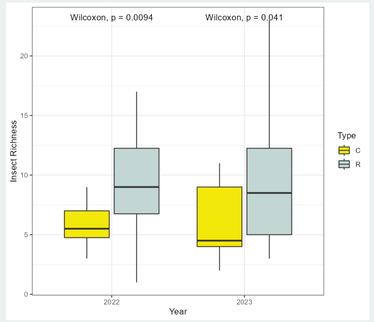

Figure 10 (A) Insect richness and **(B)** insect abundance from control and restored plots

Figure 11. Chimney Bee (*Diadasia, left)* from sweep nets and soft-winged flower beetle (*Microasydates umbratus, right) from* pitfalls

Discussion

- Post-planting irrigation and using drought tolerant species can help achieve restoration goals of reinstating vegetation cover and providing habitat
- *Frangula californica* performed better without irrigation, likely owing to a higher root to shoot ratio
- Drought tolerant scrub species coped better with the first summer drought than chaparral species, e.g., highest survival after 2 years was recorded in *Artemisia californica* (98%) and *Encelia californica* (87%)
- Clear differences were recorded in the biomass of scrub versus chaparral species in both years 1 and 2
- Testing for soil decomposition would be beneficial to repeat with longer time since planting
- Restoration increased species richness of Coleoptera and Hymenoptera, and species abundance of Hymenoptera in sweep net samples
- Our findings are intended to contribute to best management practices for undertaking restoration of shrublands post-fire

References

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