Presidio of San Francisco

Diversifying Understory Vegetation of Eucalyptus Forests

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Introduction

Fragmentation of native plant communities in the Presidio of San Francisco

Urban parks face challenges in preserving natural and cultural resources simultaneously. In the Presidio of San Francisco, planted forest stands contribute to the national park's National Historic Landmark status while natural areas continue to support numerous native plant and animal species. Diversifying the forest understory with native plant species could increase wildlife habitat and create corridors between fragmented natural areas, while also preserving the historical significance of planted trees.

We investigated methods for establishing native plant species and increasing vegetation structure in the understory of a blue gum eucalyptus (*Eucalyptus globulus*) forest understory. We selected treatments presumed to remedy harsh conditions characteristic of eucalyptus stands in the Presidio: deep leaf litter and debris (duff), sandy and acidic soils, and Mediterranean seasonal drought.

Management Questions

- Can urban park managers diversify native vegetation structure and composition in a *Eucalyptus globulus* forest?
- What are the effects of treatments (irrigation, duff removal, and/or lime addition) on planted species' survival and cover?
- What is the effect of forest canopy cover on survival and cover?
- What species and treatments may be most successful in future diversification projects?

Methods

- Study site is a 2-acre *Eucalyptus globulus* stand with forest canopy cover ranging from 16% to 99% per plot.
- 3-way full-factorial design resulting in 8 treatment combinations, n=64 (72 m^2) plots.
- 22 species totaling 113 individuals planted in each plot in winter 2000-01.
- Treatments:
  - *Irrigation*: Pressurized drip-ring emitters irrigated plants with 10 gal. every 14 days for deep saturation. Only shrubs and trees were irrigated in treatment plots, during the first drought season after planting (May-Nov 2001).
  - *Duff removal*: Leaf litter and debris (duff) were removed manually and mechanically, to clean sand (approx. 8" depth).
  - *Lime addition*: 50 lbs. per plot of powdered lime (calcium carbonate) in the form of crushed oyster shells was distributed manually and raked into the soil surface.
- Survival and cover of each species were measured in all plots 18 months after planting.
- A 3-way analysis of variance was used to examine treatment effects on survival or cover of each species.

June 2000

Prior to study implementation

April 2004

Three years after planting

Drip-ring irrigation installation, Spring 2001

Heavy equipment removing duff layer, Fall 2000

After duff removal, Fall 2000

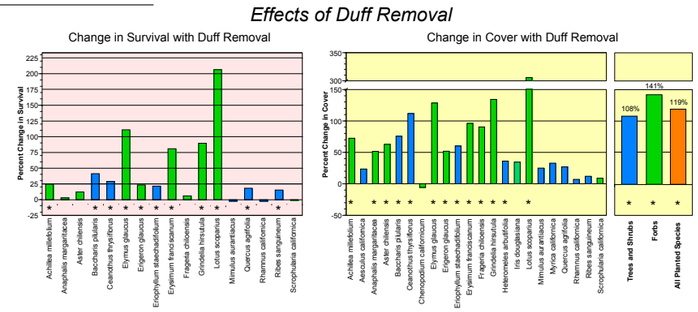
Planting by staff and volunteers, Winter 2000-01

High school interns conducting cover monitoring, Summer 2002

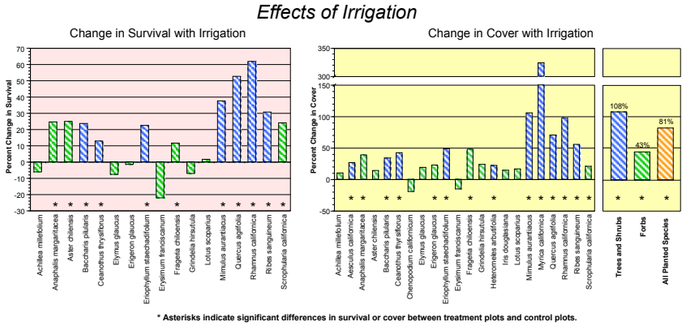
Results

- **Duff Removal.** Duff removal significantly increased survival of 12 species and cover of 13 species. Increases were slightly greater for smaller stature forbs than for woody species.
- **Irrigation.** Irrigation significantly increased survival of 11 species and cover of 13 species.
- **Lime Addition.** Lime addition had no effect on species except for small increases in survival for *Aster chilensis* and *Baccharis pilularis*. (Results are not shown here.)
- **Canopy Cover.** Survival of all planted species increased significantly under greater forest canopy cover. However, cover of all planted species was significantly lower under greater canopy.

Effects of Duff Removal

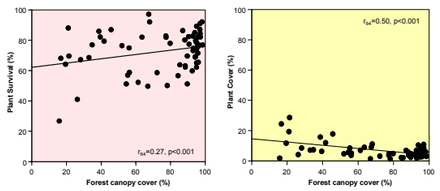


Effects of Irrigation



* Asterisks indicate significant differences in survival or cover between treatment plots and control plots.

Effects of Forest Canopy Cover



Conclusions and Recommendations

- All 22 planted species increased in survival with either duff removal or irrigation. 19 of 22 species increased in cover with duff removal or irrigation.
- **Irrigate woody species.** Woody species had the largest increases in cover due to direct irrigation. Many forbs receiving indirect watering in irrigation plots also had increased in survival or cover.
- **Remove duff and leaf litter when feasible.** Duff and leaf litter shift and smother smaller stature plants. Accordingly, results show greater increases in survival for forbs than shrubs and trees. However, increases in cover were large for both forbs (141%) and shrubs and trees (108%).
- **Select shade-tolerant species.** Six species had high survival and large increases in cover with duff removal or irrigation: *Aster chilensis*, *Heteromeles arbutifolia*, *Quercus agrifolia*, *Rhamnus californica*, *Ribes sanguineum* and *Scrophularia californica*. Five of these six species are shade-tolerant; other shade-tolerant species may respond similarly.
- **Select forest stands of low to moderate canopy cover for diversification.** Moderate forest canopy cover (or tree density) may provide the initial benefits of increases in survival, while also allowing increases in cover.

Pink-flowering currant (*Ribes sanguineum*), a shade-tolerant species, six months after planting

Acknowledgements

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