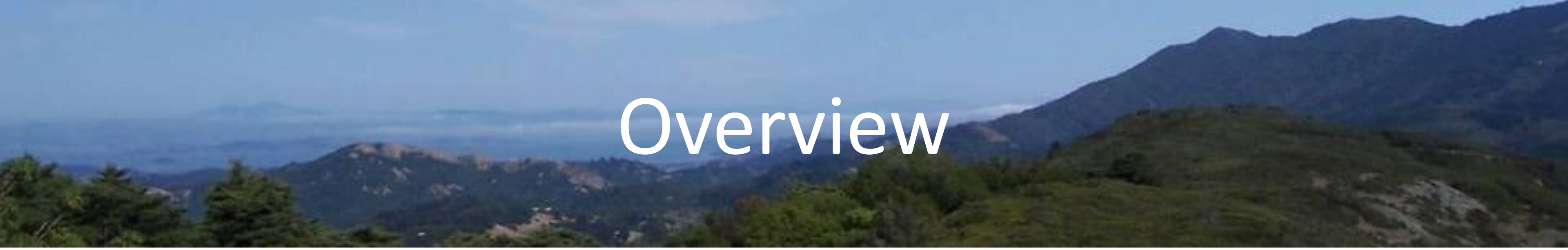
The hoe isn't the only thing scuffling

Testing non-chemical control techniques for *Brachypodium distachyon* in serpentine and non-serpentine grasslands

Cal-IPC Symposium
October 25, 2017
Palm Springs, California

Andrea Williams, Vegetation Ecologist
Marin Municipal Water District



Overview

What we will cover today:

- About the Marin Municipal Water District
- Serpentine, rare plants, weeds
- Questions
- Objectives
- Methods
- Results
- Next steps

MARIN MUNICIPAL WATER DISTRICT

Marin Municipal Water District Mission

To sustainably manage our natural resources, and to provide our customers with **reliable, high-quality water at a reasonable price**.

Marin Municipal Water District

Our watersheds are the primary source of our water.

We get approximately 50% of our water from Mt Tamalpais
And 25% of our water from Nicasio Reservoir

Marin Municipal Water District

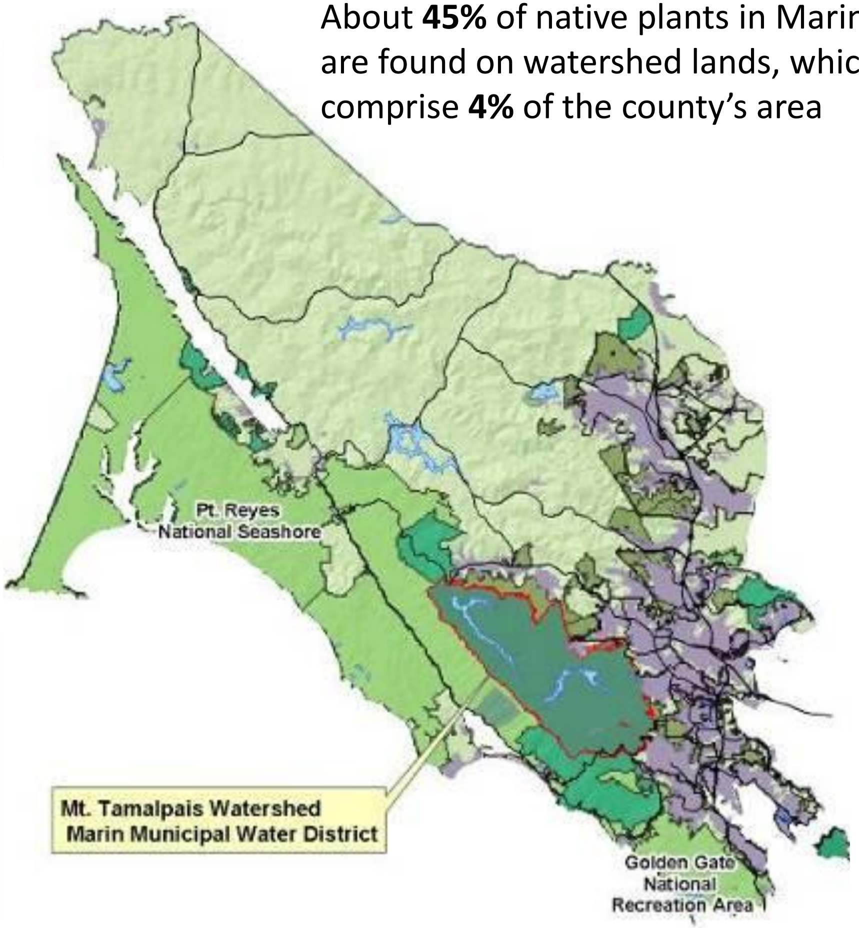
Our watersheds are where we relax, restore, and play.

Estimated 1 to 2 million visitors a year

Marin Municipal Water District

Our watersheds are part of an internationally recognized biodiversity hot spot: the UNESCO Golden Gate Biosphere Reserve

About **45%** of native plants in Marin are found on watershed lands, which comprise **4%** of the county's area



The Mt Tamalpais watershed is part of a 300,000 acre complex of publicly accessible wild lands.

It supports at least 113 distinct vegetation assemblages and at least 1000 plant species.

MARIN MUNICIPAL WATER DISTRICT

Serpentine rare annuals

- Tamalpais lessingia *Lessingia micradenia micradenia* (Tam endemic)
- Tiburon buckwheat *Eriogonum luteolum caninum* (Marin endemic)
- Tamalpais bristly jewelflower *Streptanthus glandulosus pulchellus* (Tam endemic)
- Marin dwarf flax *Hesperolinon congestum* (Endangered)

Tamalpais lessingia and Tiburon buckwheat

(these were the only 2 rare species in our plots)

Marin Municipal Water District

Serpentine weeds

- Barbed goatgrass
  Aegilops triuncialis
- Purple false brome aka silica grass
  Brachypodium distachyon
- Some oats, rye, bromes
- Silica grass appears to be impacting rare plants, particularly Tam lessingia

MARIN MUNICIPAL WATER DISTRICT

Timing is key

- Silica grass emerges Feb-Mar, flowers April
- Tam jewelflower rosettes Feb, bolt May
- Barbed goatgrass visible Apr-May
- Other rare annuals rosettes April, bolt July

Post-treatment frequency cell 4/28

Tiburon buckwheat

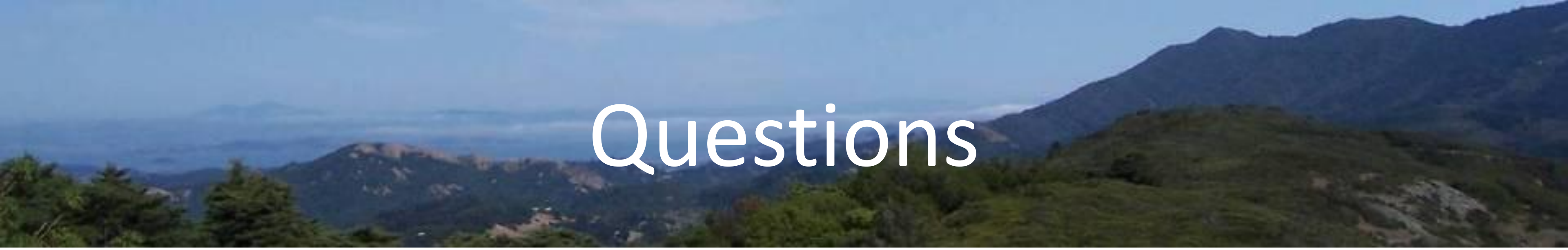
Marin Municipal Water District

Herbicide prohibition 2005 to present

District policy prohibits the use of ***ALL*** herbicides in the Mt Tamalpais Watershed.

The prohibition was established in response to public concern and extended due to regulatory uncertainty.

MARIN MUNICIPAL WATER DISTRICT



Questions

Is there an effective, efficient non-herbicide method to reduce the prevalence of silica grass?

Do treatments vary in success between serpentine and non-serpentine soils?

Do treatments vary in damage to native plants, particularly rare species?

Marin Municipal Water District

Objectives

Reduce frequency of silica grass by >50%, cover by >80% compared with pre-treatment levels

Minimize (<50%) loss of native species cover and frequency, especially rare plants

Rate treatment methods based on target effectiveness, non-target safety, scalability

Marin Municipal Water District

Methods

Survey literature for potential techniques

Select sites with adjacent serpentine and non-serpentine soils and moderate-high invasion

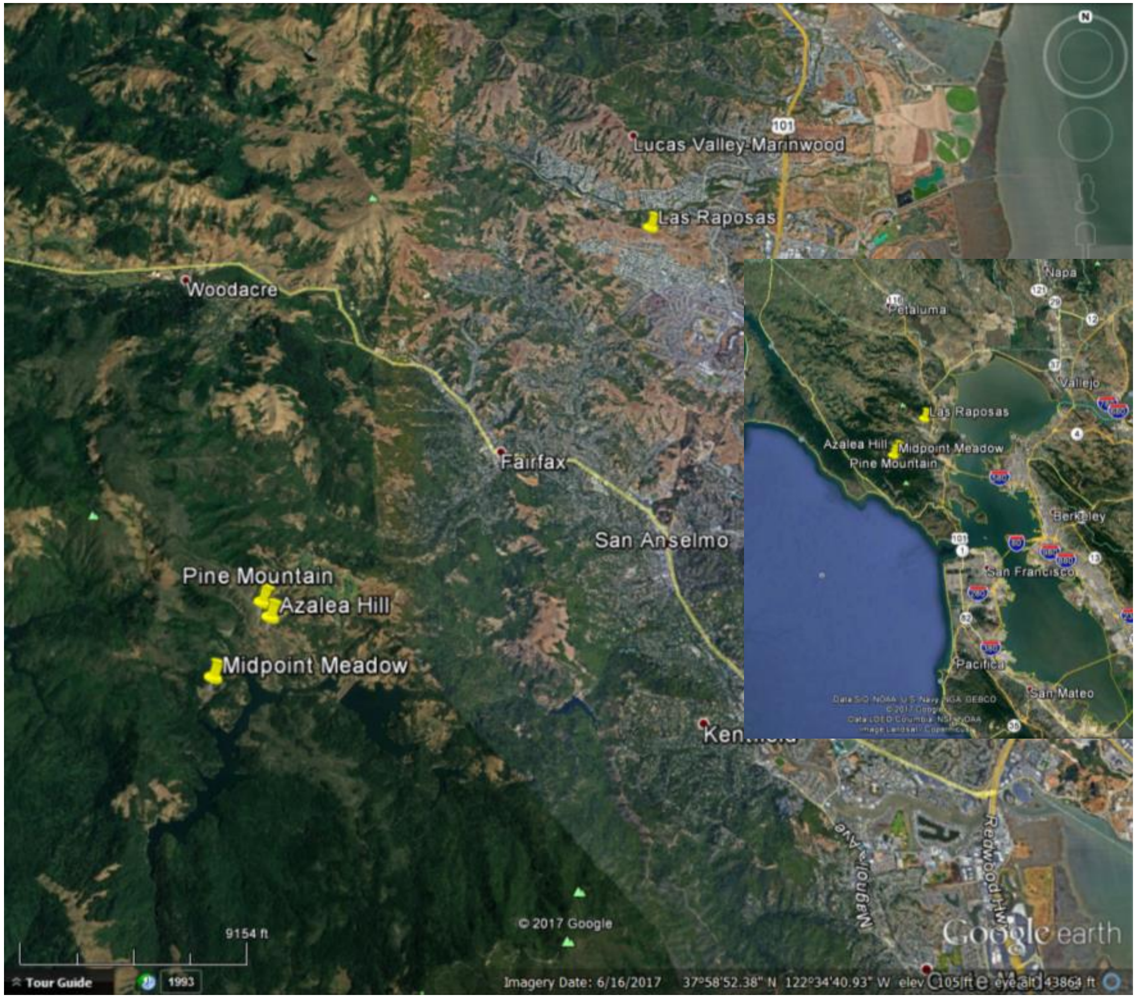
Photograph, measure, treat (March); measure, photograph (April); wait, photograph (June)

Marin Municipal Water District

Sites

3 sites on MMWD land

1 site on Marin County Open Space land (not all treatments performed)



MARIN MUNICIPAL WATER DISTRICT

Measurements

Frequency selected: robust to changes in cover. All plants in 50 5cm x 10cm cell of 0.5m x 0.5m frame recorded.

Cover estimation added to characterize dominants in 3m x 3m plots.

Photographs taken pre-, immediate post, ~1 and ~2 months post-treatment.

Marin Municipal Water District

Treatments

- Cut (string trimmer) – 8 plots
- Cut and pile (string trimmer, rake) – 5 plots
- Flame (propane flamer) – 7 plots
- Hand-pull (many hands) – 6 plots
- Scuffle hoe (oscillating hoe) – 6 plots
- Organic herbicide (d-limonene) – 2 plots

Up to 6 3mx3m plots in 2 blocks (serpentine and non)=up to 12 plots/site

Marin Municipal Water District

Acknowledging issues

I'm a botanist, not a statistician

Small sample sizes—frequency frame/plot counted as unit; frequency cells not independent

Site selection was subjective; plot assignment was not (exception—two control plots were 0.5m x 0.5m to accommodate irregular sites)

Cover estimated for dominants only; dominant species may not match before and after treatment

Not all taxa identifiable to species (*Trifolium, Bromus, Galium* problematic during analysis as they contain both natives and non-natives)

Treatment time scale-up calculations do not account for efficiencies or inefficiencies of scale

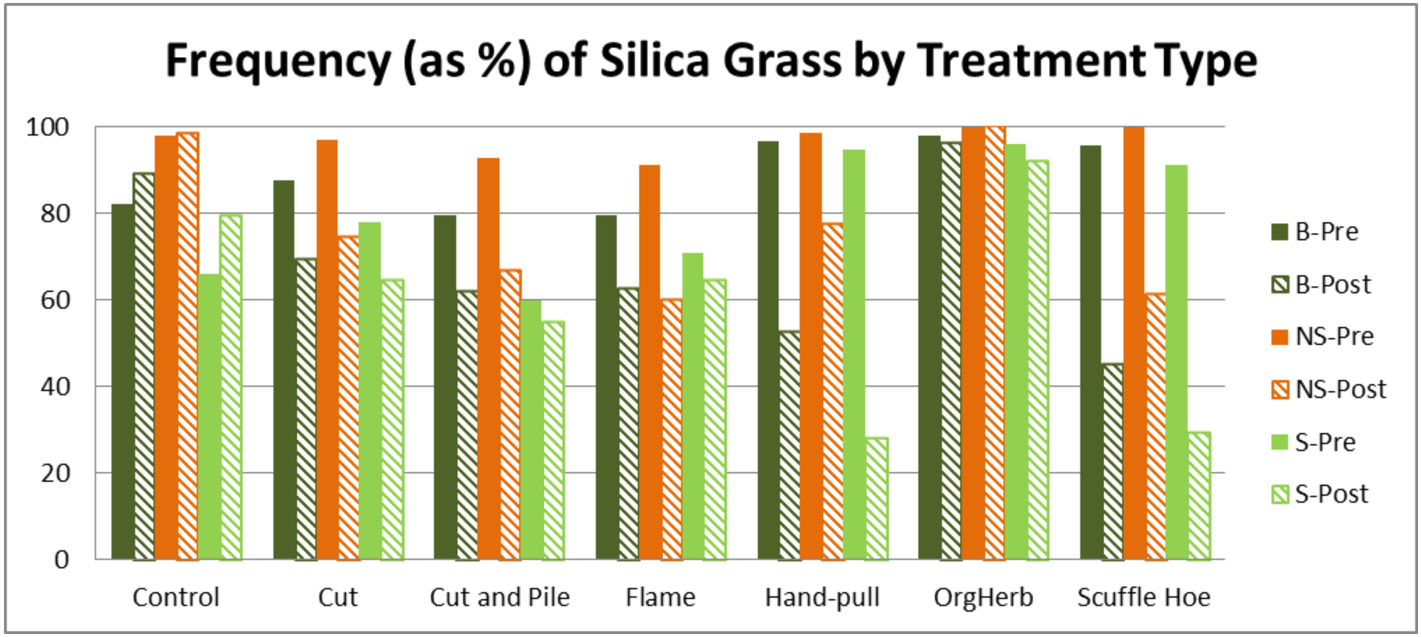
Marin Municipal Water District

Results: Silica grass

Frequency:

Only cutting, scuffle hoe, hand pulling showed significant reduction in silica grass. ($p<0.05$)

Maximum reduction for a treatment type was 70%.

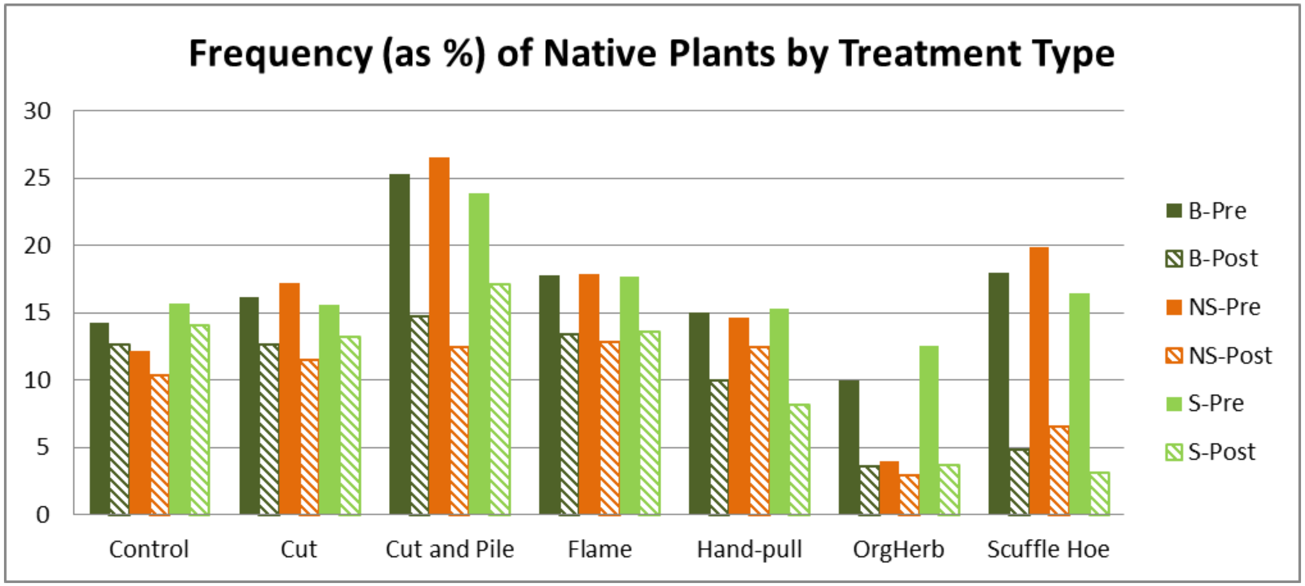


Marin Municipal Water District

Results: Native plants

All treatments except organic herbicide (small sample size) showed **significant reduction in native plants**. ($p<0.05$)

Maximum reduction for a treatment type was 93%.



Only flaming showed an increase in rare plants (small sample size) →

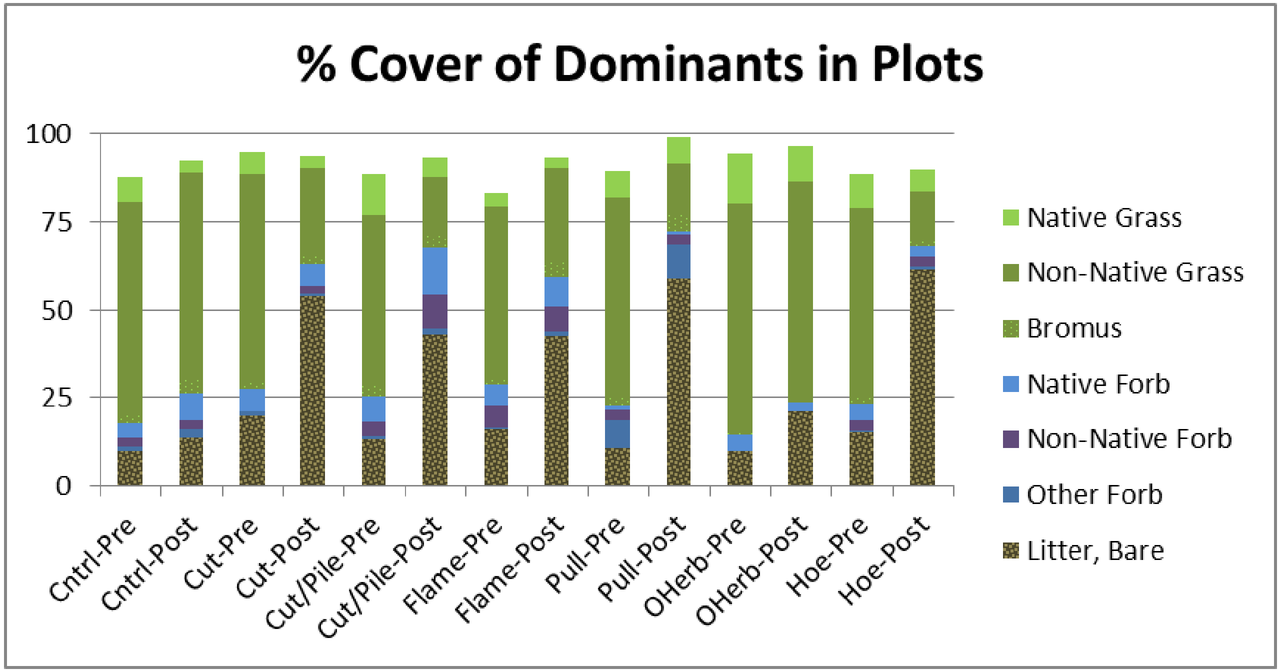
Treatment Type	Average of Freq%	N	Average of Freq%	N	Change in Frequency	% Change
Control	9.0	2	6.0	1	-3.0	-20%
Cut	24.0	1	14.5	4	-9.5	-25%
Cut and Pile	40.0	1	11.0	2	-29.0	-57%
Flame	15.0	2	18.0	2	3.0	9%

Marin Municipal Water District

Results: Cover by guild

Cover:

Only estimated for dominants; summed below by guild.



MARIN MUNICIPAL WATER DISTRICT

Results: Photo sampler

Azalea Hill

Non-serpentine;
Control

PRE →

IMMEDIATE POST→

~3 WEEKS POST→

Marin Municipal Water District

Results: Photo sampler

Azalea Hill

Non-serpentine;
Cut

PRE →

IMMEDIATE POST→

~3 WEEKS POST→

MARIN MUNICIPAL
WATER DISTRICT

Results: Photo sampler

Azalea Hill

Non-serpentine;

Cut and pile

PRE →

IMMEDIATE POST→

~3 WEEKS POST→

Marin Municipal Water District

Results: Photo sampler

Azalea Hill

Non-serpentine;
Flame

PRE →

IMMEDIATE POST→

~3 WEEKS POST→

MARIN MUNICIPAL WATER DISTRICT

Results: Photo sampler

Azalea Hill

Non-serpentine;
Hand pull

PRE →

IMMEDIATE POST→

~3 WEEKS POST→

MARIN MUNICIPAL
WATER DISTRICT

Results: Photo sampler

Azalea Hill

Non-serpentine;
Scuffle hoe

PRE →

IMMEDIATE POST→

~3 WEEKS POST→

MARIN MUNICIPAL WATER DISTRICT

Results: Photo sampler

Azalea Hill

Serpentine; Control

PRE →

IMMEDIATE POST→

~3 WEEKS POST→

MARIN MUNICIPAL WATER DISTRICT

Results: Photo sampler

Azalea Hill

Serpentine;
Cut

PRE →

IMMEDIATE POST →

~3 WEEKS POST →

Marin Municipal Water District

Results: Photo sampler

Azalea Hill

Serpentine;

Cut and pile

PRE →

IMMEDIATE POST→

~3 WEEKS POST→

MARIN MUNICIPAL WATER DISTRICT

Results: Photo sampler

Azalea Hill

Serpentine;
Flame

PRE →

IMMEDIATE POST→

~3 WEEKS POST→

MARIN MUNICIPAL WATER DISTRICT

Results: Photo sampler

Azalea Hill

Serpentine;

Hand pull

PRE →

IMMEDIATE POST→

~3 WEEKS POST→

MARIN MUNICIPAL WATER DISTRICT

Results: Photo sampler

Azalea Hill

Serpentine;

Scuffle hoe

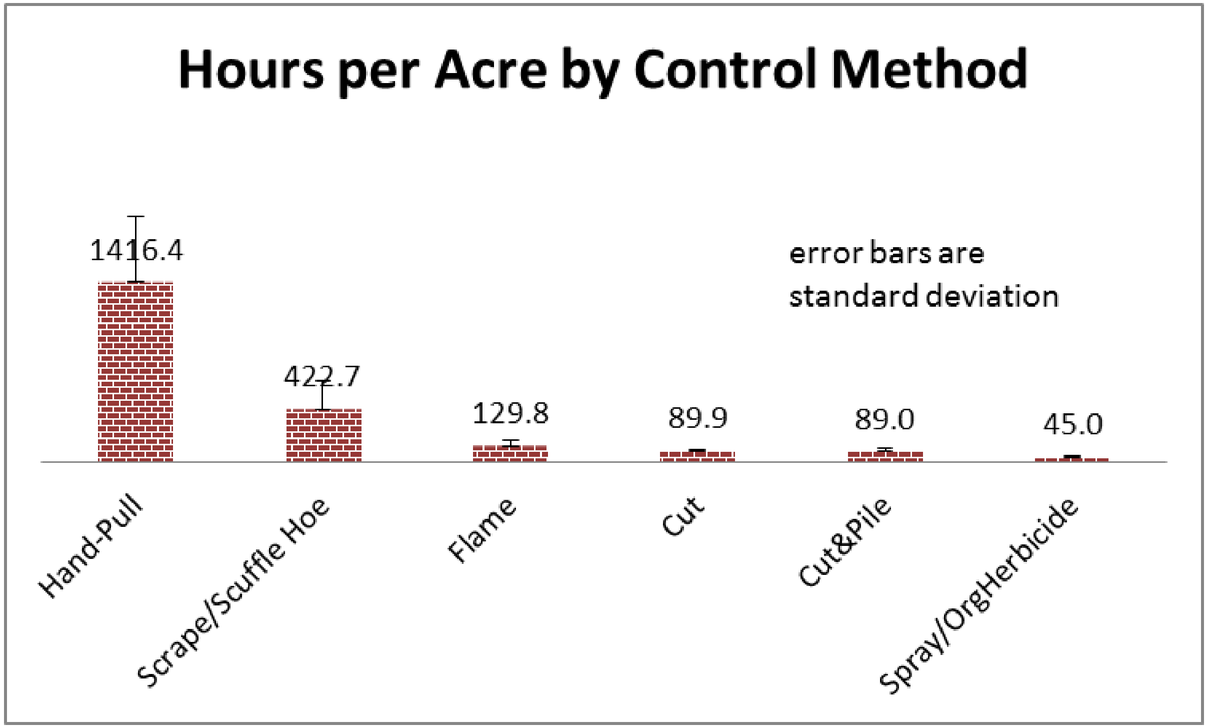
PRE →

IMMEDIATE POST→

~3 WEEKS POST→

MARIN MUNICIPAL WATER DISTRICT

Results: Treatment time



Hours per acre based on multiplying time for treating 3x3m square; does not adjust for efficiencies (2 fire suppressors for flaming) or maintenance (refueling, restringing, mixing/washing).

Hand-pulling and scuffle-hoeing were both the most time-intensive and variable (based on cover of target).

Marin Municipal Water District

Objectives + Results

1. Reduce frequency of silica grass by >50%, cover by >80% compared with pre-treatment levels
2. Minimize loss of native species cover and frequency, especially rare plants
3. Rate treatment methods on target effectiveness, non-target safety, scalability

1. Only hand-pull and scuffle hoe on serpentine met this objective.
2. All plots saw reduction in native frequency, from control (-23%); to flame (-35%); to cut, and pull, (-47%); to scuffle hoe (-89%).
3. Hand-pulling and scuffle hoe rejected based on time and non-target effects. Flaming and cutting will be re-tested at larger scales.

Marin Municipal Water District

Next steps

- Re-test flaming and cutting at larger scales
- Re-survey existing plots for second-year growth

Marin Municipal Water District

Questions?

ACKNOWLEDGEMENTS: Many thanks to Yumi Igarashi, Chris Qian, Raphaela Floreani-Buzbee, Leslie Fisher-Sanders, and David Greenberger!