CAN WE SUCCESSFULLY MANAGE WEEDS ON A LANDSCAPE SCALE WITHOUT HERBICIDES?

Lessons Learned 10 Years into Zero-Use

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Marin Municipal Water District
A little background

- MMWD provides drinking water to 180,000 people in southern Marin.
- Water comes from the Mt Tamalpais Watershed, an 18,000 acre biodiversity hotspot.
- We have approximately 1,400 acres of broom.

**Mission Statement:** To manage our natural resources in a sustainable manner, and to provide our customers with reliable, high-quality water at a reasonable price.
Weed control is central to our fuelbreak maintenance work
Weed control is central to our biodiversity protection work
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.
Primary tools now in the toolbox

Mowing

Manual weeding
Secondary tools

- Conventional mulch
- Sheet mulch
- Solarization
- Prescribed burning
- Volunteer work parties
Systematic review of alternatives: 2003 to present

**Organic Herbicides**
- Citric Acid
- Vinegar
- Clove oil extract
- D-limonene
- Pelargonic acid

**Mechanical Alternatives**
- Pressurized water (HMO)
- Other mower heads
- Sub-soil brushing
- Girdling
- Bark peel
- Weed Wrench alternatives

**Biological Control Agents**
- Rusts
- Smuts
- Psyllids
- Weevils
- Beetles
- Nematodes
- Genista moths
- Scotch broom gall mites

**Terra Torch**

**Grazing**

**Hot foam**

**Propane flaming**
Spending is increasing, but broom has a head start

- One time reallocation of internal crews for Carbon / Water Yield Study plot installation
Upshot: We need better tools and we need to take a landscape-scale approach to the work

**Terra Torch:** fun but dangerous

**Organic Herbicides**
- Citric Acid
- Vinegar
- Clove oil extract:
  - D-limonene
  - Pelargonic acid

**Mechanical Alternatives**
- Pressurized water (HMO)
- Other mower heads: YES!
- Sub-soil brushing
- Girdling: occasionally
- Bark peel
- Weed Wrench alternatives: Still looking

**Biological Control Agents**
- Rusts: present but ineffective
- Smuts: present but ineffective
- Psyllids
- Weevils
- Beetles
- Nematodes
- Mites / Caterpillars: present / but ineffective

**Grazing:** suitable sites limited, trials in 2003, 2014 and 2015 not encouraging

**Hot foam:** Company failed, toxicity concerns with foaming agent

**Propane flaming:** suitable sites limited
- Not as efficient as alternatives
Stepping back to re-assess

• Understanding the full situation
• Good goals
• Meaningful metrics
• Realistic expectations
• Raised resources
Good maps

MMWD invests $20-50,000 every 3 years to update weed and other vegetation maps
There’s more to weeds than broom

Stepped-up early detection surveys and botanical blitzes added 102 plants to the 900+ on our list.

59 of those were not native, including

- **THOROUGHWORT, AGERATINA ADENOPHORA**
- African asparagus fern, *Asparagus asparagoides*
- **HANGING SEDGE, CAREX PENDULA**
- New Zealand cabbage tree, *Cordyline australis*
- **MILKFLOWER COTONEASTER, COTONEASTER LACTEUS**
- **PORTUGUESE BROOM, CYTISUS STRIATUS**
- **OBLONG SPURGE, EUPHORBIA OBLONGATA**
- Herb Robert, *Geranium purpureum*
- Yellow flag iris, *Iris pseudacorus*
- Peavines, *Lathyrus sphaericus* and *tingitanus*
- Glossy privet, *Ligustrum lucidum*
- Mini-marguerite, *Mauranthemum paludosum*
- White sweetclover, *Melilotus albus*
- Woodsorrels, *Oxalis latifolia* and *rubra*
- Dyer’s mignonette, *Reseda luteola*
There’s more to weeds than broom

New weeds, continued

- **ROSY SAND CROCUS, ROMULEA ROSEA VAR. AUSTRALIS**
- Purple awned wallaby grass, *Rytidosperma penicillatum*
- **INDIAN HEDGE MUSTARD, SISYMBRIUM ORIENTALE**
- **HARLEQUIN FLOWER, SPARAXIS TRICOLOR**
- **SMILO GRASS, STIPA MILIACEA VAR. MILIACEA**
- Narrow leaved clover, *Trifolium angustifolium*
- Hop clover, *Trifolium campestre*
- White clover, *Trifolium repens*
- Woolly clover, *Trifolium tomentosum*

Plus new populations of EDRR targets

- Barbed goatgrass, *Aegilops triuncialis*
- Stinkwort, *Dittrichia graveolens*
- Panic veldtgrass, *Ehrharta erecta*
- Medusahead, *Elymus caput-medusae*

Only **NINE** of the new weeds are currently in a control program. Six more are being considered for control.
There’s more to the mountain than weeds

Bolinas Ridge 2006
SOD impacts are also expanding

Over 10,000 acres impacted to date
...Which means the work plan has to factor in tasks and projects other than weeds.
Compounding stressors

SOD isn’t just the loss of tanoak

Oak woodlands—mostly coast live oak—are being impacted by SOD, broom, and conifer encroachment.
There’s more to monitor than weeds

Mt Tamalpais has lost 5-10% of its native plants in the last 50 years—and no one noticed.
## Formal metrics: Annual Work Plan/Performance Criteria

<table>
<thead>
<tr>
<th>Action</th>
<th>Performance Criteria</th>
<th>Unit</th>
<th>2016</th>
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<tbody>
<tr>
<td>Cyclical Fuelbreak Maintenance</td>
<td>Retreat fuels in existing fuelbreaks</td>
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<td>Cyclical mowing of fine fuels</td>
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<td>Cyclical removal of broom in Optimized and Transitional Zones</td>
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<td>Fuelbreak Construction</td>
<td>New fuelbreak construction</td>
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<td>Early Detection Rapid Response</td>
<td>Annual surveys</td>
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<td>Weed control treatments</td>
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<td>Forest Stand Structure improvement</td>
<td>Reduce accumulated fuels and brush</td>
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<td>Prescribed burning</td>
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<td>Grassland and Oakwoodland improvement</td>
<td>Douglas Fir thinning</td>
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<td>Prescribed burning</td>
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<td>Broom: Initial removal</td>
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<td></td>
<td>Broom: Long term maintenance</td>
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<td>Yellow Star thistle</td>
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<td>Goat grass</td>
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<td></td>
<td>Other weeds</td>
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<td>Reintroduce species</td>
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<td>habitat modification</td>
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<td>Meadow Restoration</td>
<td>Implementation</td>
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<td>Weed Control trials</td>
<td>Implementation</td>
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Maps as metrics

Time series maps are essential for measuring effectiveness

While we may contain 20 acres in one area, another 60 pop up elsewhere
Where have we failed to contain weeds and where should we go next?
Formalizing our expectations

Coming Soon:

Official adoption of the “Deferred Action Zone”

740 acres of broom not managed over the first five years
The Deferred Action Zone: Not just for weeds

Areas with weeds or forest disease so severe or so remote that we will not get to it in the foreseeable future.
• Bald Hill Broom Bust was one of the largest and most productive broom event this year
• Productivity rate = 400 person-hours an acre
• Completed 0.05% of the 550 acres of broom management on Mt Tamalpais this fiscal year

The greatest benefits from volunteer events come from community engagement, education, and good will.
BFFIP calls for annual increases of $400,000 for the next 5 years, until we reach an operating budget of $3,000,000 per year.
All of which is to say:

To successfully manage 1,400 acres of broom, and over 100 acres of other target weeds, on Mt Tamalpais with ZERO herbicides, we are asking for an additional $400,000 a year for the next 5 years until our operational budget reaches $3 million annually.

Which translates into:

- 73,500 hours of field work per year
- 4,500 hours of supervision time per year
- 5,000 hours of ecosystem monitoring
- 28 Equivalent full time positions

Also needed:

- $1,000,000 in capital equipment (vehicles, computers, tools)
- Office space for at least 2 supervisors

District leadership has committed to scaling up to this level over a 5-year period.