

**APPENDIX H**

**MARIN MUNICIPAL WATER DISTRICT  
HERBICIDE STUDY INFORMATION**



## FACT SHEET: **Vegetation Management & Herbicides** *Protecting the Mt. Tamalpais Watershed & the Public Health*

The Marin Municipal Water District is committed to reducing the threat of wildland fire and preserving the ecology of Mt. Tamalpais. The Mt. Tamalpais Area Vegetation Plan, which represents the most comprehensive natural resources management plan in MMWD's history, has served as the district's guidelines for protecting the watershed and the public health since 1995 when the plan was adopted. The plan's goals are to:

- Proactively reduce the hazard of uncontrolled wildfires and prevent the death and destruction that has happened in the past in Marin County and most recently in the 1991 Oakland Hills fire;
- Preserve the watershed's major ecological systems, encourage biodiversity by restoring fragile meadow and oak woodlands, and protect sensitive and rare plant species, many endemic to Mt. Tamalpais;
- Control the spread of invasive non-native plant species, which displace native plants and eliminate habitat for native animals.

Invasive, non-native plants represent one of the major challenges facing MMWD. Problem species include: French, Scotch and Spanish broom, yellow starthistle and pampas grass. The problems posed by French broom are just an example:

- High densities: i.e. 120,000 stems per acre for broom, thousands of seeds per square meter;
- Resilience: the ability to re-sprout from stumps and fragments;
- Hardiness: the ability to thrive in droughty, compacted, poor nutrient soils;
- Ecosystem alterations: changes to soil, available light and moisture, fire regime.

### **Current Plans**

MMWD staff will be conducting the following activities in 2007:

*Risk Assessment* – MMWD staff and independent experts will evaluate the latest information on herbicide toxicology, potential exposures to humans and other organisms under normal usage patterns.

*Update of MMWD's Integrated Pest Management (IPM) Policy* – MMWD staff will update the policy with the results of MMWD's research and experience with various weed control alternatives, and will use the risk assessment to define restrictions under which herbicides can be used safely. **MMWD's policy has been to use only the least-toxic herbicides available, and never to use carcinogens, mutagens or herbicides that could migrate into the water supply.**

*Addendum to the Vegetation Management Plan EIR* – MMWD staff and consultants will prepare an addendum to the 1994 environmental impact report, to cover new weed control options.

*Public Involvement* – MMWD will convene a public advisory panel to review the risk assessment and IPM policy as they are developed, and will convene a series of public workshops on these documents.

*MMWD Board Action* – the MMWD Board will review and act on the proposed update of the IPM policy and the EIR.

## Background

MMWD has relied on multiple means to keep non-native plant species in check. Before selecting a treatment option, MMWD assesses how well it meets these parameters;

- Cost per acre: initial treatment and 10-year projection;
- Re-treatment interval needed to achieve management objectives;
- Time to restoration;
- Logistical limitations;
- Wildfire risk reduction;
- Ecological protection;
- Invasive species spread control;
- Environmental impacts.

The approaches MMWD has used to manage non-native vegetation control in the past include:

- Mechanical removal
- Hand removal
- Controlled burning
- Herbicides

Over the years, MMWD has tested other means of plant control, including goat grazing and new technologies that have relied on high-intensity heat/flame, water or foam (soap-based). None of these alternatives has proven effective.

MMWD continues to use manual and hand removal of non-natives as well as limited controlled burning, but it suspended herbicide use in August 2005 pending a review of this practice. Herbicides had been in use in accordance with MMWD's Integrated Pest Management (IPM) policy, which was adopted in 2003, and were extremely effective in killing invasive weeds.

The 2003 IPM policy was developed with extensive input from the public, including Marin Breast Cancer Watch, Marin Beyond Pesticides Coalition and the Pesticide Education Group. Oversight of the policy has been provided by the MMWD IPM committee, composed of senior management, licensed herbicide applicators, fisheries biologists and water quality experts.

IPM guidelines for herbicide use are as follows:

- Herbicides are used only as a last resort and in combination with mowing, burning, and hand removal;
- Inter-agency cooperation and public education critical;
- Approved herbicides restricted to a subset of San Francisco's "Reduced Risk" Pesticide List:
  - Glyphosate (Roundup, Aquamaster)
  - Triclopyr (Garlon 4, Pathfinder)
  - Clopyrild (Transline)
- Five-year herbicide reduction plan and monitoring program in place for all treatment sites;
- Application methods restricted to spot treatment of resprouting stumps and cut-stump painting;
- Applications restricted to dry season and low-wind conditions;
- Trail heads posted during and at least 12 hours after applications;
- All applications conducted in compliance with environmental and worker safety regulations;
- Quarter mile use-restriction zone around reservoirs and 100 foot buffers around water-bearing drainages.

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MARIN MUNICIPAL  
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## Frequently Asked Questions: Vegetation Management & Herbicides *Protecting the Mt. Tamalpais Watershed & the Public Health*

March 7, 2007

### 1. ISN'T IT TRUE THAT MMWD HAS BANNED THE USE OF HERBICIDES TO CONTROL INVASIVE PLANTS ON MT. TAMALPAIS?

**Yes, we currently are not using any herbicides on MMWD's watersheds.** In fact, MMWD is one of the few public land management agencies in California that has totally suspended herbicide use. This suspension has been in effect since August 2005 when the MMWD Board of Directors voted to not use herbicides on any of the 22,000 acres that MMWD manages.

### 2. IF MMWD IS NOT USING HERBICIDES, WHY RE-EVALUATE THEIR USE NOW?

MMWD has been actively pursuing other methods to control invasive plants. **However, since the herbicide suspension went into effect, we have been losing the battle against these non-native plants that exacerbate wildfire risk.** MMWD staff has asked the Board to re-evaluate the use of herbicides as a means of controlling this critical fire threat.

### 3. WHY IS CONTROLLING INVASIVE PLANTS ON MT. TAMALPAIS SO IMPORTANT?

**The fire danger on Mt. Tam increases with heavy infestation of invasive non-native plants, or "weeds."** Many of Marin's developed areas share a border with the Mt. Tamalpais Watershed, including Mill Valley to the south and Corte Madera, Larkspur, Kentfield, Ross, San Anselmo, Fairfax and the San Geronimo Valley to the northwest. Devastating fires in Marin and other parts of California, such as the 1991 Oakland Hills fire, the 1995 Vision fire and even the notorious 1929 Mt. Tamalpais fire (in which a large part of Mill Valley was destroyed), have taught us that the risk of fire in this "urban-wildland interface," is extremely high. The more MMWD can do to reduce invasive plants here, the safer those communities will be from fire.

MMWD has spent the last 12 years strategically locating fuel breaks between the developed communities and the undeveloped, natural watershed lands. These fuel breaks are critical to neighborhoods at risk of fire, and to firefighter safety, should a fire occur. The non-native plants that are taking hold within these fuel break areas can be highly flammable and are spreading faster than we can stop them. In fact, the spread of invasive, non-native plants is a major contributing factor to the growing fire danger.

### 4. WHAT ARE THE OTHER RISKS ASSOCIATED WITH FIRE?

**A catastrophic fire carries its own risks.** In the event of a fire, fire retardant chemicals could be broadcast over a wide area. Beyond the dangers to human life, homes, and property, the risks to the environment are severe, and include soil erosion, air pollution, a permanent loss of mature trees, wildlife fatalities, and long-term visual impacts.

## **5. WHAT ARE THE OTHER RISKS OF INVASIVE PLANTS BESIDES PROVIDING FUEL FOR FIRES?**

### ***Invasive plants are threatening the unique biodiversity of the local ecosystem.***

The Mt. Tamalpais Watershed is home to many rare and endangered plant species, many of which are found only on Mt. Tamalpais. If native plant species are pushed out by weeds, some of them will be lost forever. A variety of non-native, invasive plants, notably French broom, yellow starthistle, and pampas grass, are overtaking the native plants, altering the ecosystem permanently and eliminating habitat that provides food and shelter for birds and animals. MMWD's mission includes responsible stewardship of Mt. Tamalpais to preserve its diversity for future generations.

## **6. IF YOU AREN'T USING HERBICIDES NOW TO CONTROL WEEDS, WHAT ARE YOU DOING?**

Currently we are using these approaches to control weeds:

- Mechanical mowing
- Hand removal (including volunteer labor)
- Controlled burning
- High-intensity heat/ propane flame

We have also evaluated these other means to control weeds:

- Goat grazing
- Heat foam (soap-based)
- Flame throwing
- Biological control
- "Alternative" or non-toxic herbicides

## **7. HOW EFFECTIVE ARE THE CURRENT WEED CONTROL EFFORTS?**

### ***All of the methods listed above have proven to be limited in their effectiveness.***

Taken together, these techniques have not solved the problem of invasive plants, nor can they be used in all locations where weeds have spread.

- Mechanical mowing reduces the fuel load temporarily, but allows the weeds to spread even further
- Hand pulling is effective in certain locations when weed patches are small and soil conditions are wet.
- Propane flaming is effective when plants are small and soil conditions are wet.
- Controlled burns are effective, but limited to certain types of weather. They cannot be used repeatedly without damaging native plants

We estimate that 1,000 acres, representing five percent of our watershed, are now seriously infested. This infestation is spreading quickly—at a rate of up to 60 acres every year.

## **8. WHAT ELSE CAN BE DONE TO ADDRESS THE WEED PROBLEM?**

That is what we are trying to find out. ***The Board's current position is that the use of any herbicide is the least preferred alternative.*** MMWD's staff has asked the Board for direction in conducting a new analysis of weed management options, including the possible use of herbicides that are proven safe and effective in combating weeds when used in combination with other methods. The analysis will include all available methods for addressing the threats of non-native vegetation to the public and environment, along with the feasibility, costs, safety, and benefits of a number of methods, including limited application of the least toxic substances for weed control. The current suspension on herbicide use will continue while the analysis is conducted.



MARIN MUNICIPAL  
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**List of Study Chemicals  
Mt. Tamalpais Watershed  
Vegetation Management Plan Update  
March 13, 2008**

The update of the MMWD Watershed Vegetation Management Plan includes a thorough review of all available weed control tools, including both conventional and “alternative” herbicides. The District is committed to ensuring all weed control tools used on watershed lands do not compromise water quality or public safety; as such, a risk assessment of considered herbicides has been included as part of the planning process.

Lead consultant Leonard Charles and Associates has finalized the list of chemical weed control products that will be considered for use and undergo the risk assessment (see **Table 1** below). The list includes three conventional herbicides, three additives used to improve performance, and three organic products. The list was developed by Pest Control Advisor Robert Brenton in consultation with toxicologist Dr. Susan Kegley. Most of these products are commonly used in combination with mowing and prescribed burning for wildland weed control. These products are considered to be at the less toxic end of the chemical spectrum. Each product is designed to be effective for a different suite of plants.

In the coming months, Mr. Brenton will develop species-specific and site-specific weed control recommendations that employ these nine products to varying degrees. Dr. Kegley and her associates will complete a thorough analysis of the likely risks associated with these recommendations. The risk assessment will consider the following:

- Effectiveness;
- Air pollution potential;
- Water pollution potential (including aquatic half-life);
- Toxicity (including whether the products have known links to cancer, acute toxicity, endocrine disruption, reproductive or developmental problems, or neurotoxicity); and
- Ecotoxicity with regard to birds, fish, aquatic invertebrates, and insects.

The assessment will look at both likely use and worst-case scenarios. It will also address inert ingredients, researcher biases and conflicts of interest, and data gaps.

The use recommendations and the results of Dr. Kegley's assessment will be released in a report due out the first week of June and discussed at a public meeting to be held on June 11, 2008.

**Table 1: Weed Control Products to be Reviewed in the  
MMWD Watershed Vegetation Management Plan**

<b>Formulated Product</b>	<b>Active Ingredients</b>	<b>Class</b>
<b>Transline</b>	40.9% Clopyralid, monoethanolamine salt	Conventional Herbicide
<b>Aquamaster</b>	53.8% Glyphosate, isopropylamine salt	Conventional Herbicide
<b>Garlon 4 Ultra</b>	60.5% Triclopyr, butoxy ethyl ester	Conventional Herbicide
<b>Matran</b>	50% clove oil, 50% emulsifiers	Organic Herbicide
<b>Scythe</b>	57% pelargonic acid	Organic Herbicide
<b>N/A</b>	15 % vinegar	Organic Herbicide
<b>Competitor</b>	ethyl oleate, sorbitan alkylpolyethoxlate ester, dialkyl polyoxyethylene glycol	Surfactant
<b>Sylgard</b>	polysiloxane	Surfactant
<b>Blazon</b>	proprietary information	Dye

Non-Herbicide Technique Feasibility for Target Weeds\*

Method	Target Weed	Objective	Lethal	Efficiency	Cost	Efficacy	Non-target Impacts	Worker Health/Public Safety
Prescribed Burning	Annual thistles (yellow star thistle, distaff thistle) <sup>1</sup>	Lethal control	Adults - Yes Seedlings-Yes	High efficiency for large scale (>5 acres) removal	High initial cost, dropping as area increases	Extreme variability in effects, impacts and likelihood for implementation	Can benefit certain species/vegetation; increases invasion potential for other exotics; converts habitats to grassland	Smoke inhalation/air quality hazards; fire, equipment and operation hazards to fire crews; escaped wildfire potential
	Annual grasses (Medusahead, barbed goat grass)	Lethal control	Adults - Yes	High efficiency for large scale (>5 acres) removal	High initial cost, dropping as area increases	Extreme variability as species tend to occur in rocky areas resulting in uneven burn. Can leave large unburned areas full of weeds	Can benefit certain species/vegetation; increases invasion potential for other exotics; converts habitats to grassland	Smoke inhalation/air quality hazards; fire, equipment and operation hazards to fire crews; escaped wildfire potential
	Biennials (purple starthistle, tease)	Biomass removal - Pretreatment	No	High efficiency for large scale (>5 acres) biomass removal	High initial cost, dropping as area increases	Likely will not kill adult plants	Can benefit certain species/vegetation; increases invasion potential for other exotics; converts habitats to grassland	Smoke inhalation/air quality hazards; fire, equipment and operation hazards to fire crews; escaped wildfire potential
	Perennial grasses - grasslands (Harding grass, velvet grass)	Biomass removal - Pretreatment	Adults - No	High efficiency for large scale (>5 acres) biomass removal	High initial cost, dropping as area increases	Variable. Burns can either stimulate shoots or damage depending on seasonality. Will not kill adult plants, may stimulate regrowth.	Can benefit certain species/vegetation; increases invasion potential for other exotics; converts habitats to grassland	Smoke inhalation/air quality hazards; fire, equipment and operation hazards to fire crews; escaped wildfire potential
	Perennial grasses - woodland - ( <i>Ehrharta</i> grass)	Not recommended	- fire stimulates additional growth					
Torch Flaming	Annual thistles (yellow star thistle, distaff thistle)	Not recommended - high fire hazard if timed to achieve high kill		Annual thistles (yellow star thistle, distaff thistle)	Possible initial removal of small patches (YST only), but not recommended	Adults- No Seedlings-Yes	Efficient on small patches (<1 acre)	Cost effective on small scale (<1 acre)
	Annual grasses (Medusahead, barbed goat grass)	Not recommended - high fire hazard if timed to achieve high kill		Not recommended - high fire hazard if timed to achieve high kill				
	Biennials (purple starthistle, tease)	Unknown, but possible	Adults- No	Unknown	Unknown	Unknown	Negligible	Smoke inhalation/air quality hazards; fire, equipment and operation hazards to fire crews; escaped wildfire potential
	Perennial grasses - grasslands (Harding grass, velvet grass)	Not recommended - does not kill roots, which resprout		Not recommended - does not kill roots, which resprout				
	Perennial grasses - woodland - ( <i>Ehrharta</i> grass)	Not recommended - fire stimulates additional growth		Not recommended - fire stimulates additional growth				

<sup>1</sup> Yellow star thistle can at times act as a short-lived perennial.



Non-Herbicide Technique Feasibility for Target Weeds\*

Method	Target Weed	Objective	Lethal	Efficiency	Cost	Predictability of Results	Non-target Impacts	Worker Health/Public Safety
Pulling/Digging	Annual thistles (yellow star thistle, distaff thistle)	Initial removal of small patches	Adults - Yes Seedlings - Yes	Efficient on very small patches (<1 acre)	Cost effective on small scale <1 acre	Effective as plants susceptible during long spring/summer growing period	Negligible	Ergonomic impacts to workers at larger scale
	Annual grasses (Medusahead, barbed goat grass)	Initial removal of small patches	Adults - Yes	Efficient on very small patches (<1 acre)	Cost effective on small scale <1 acre	Effective as plants susceptible during long spring/summer growing period	Negligible	Ergonomic impacts to workers at larger scale
	Biennials (purple starthistle, teasel)	Initial removal of small patches	Adults - Yes Seedlings - Yes	Efficient on very small patches (<1 acre)	Cost effective on small scale <1 acre	Effective as plants susceptible after plants bolt but before seedheads are produced	Negligible	Ergonomic impacts to workers at larger scale
	Perennial grasses - grasslands (Harding grass, velvet grass)	Initial removal of small patches	Adults - Yes Seedlings - Yes	Efficient on small patches (<1 acre), larger areas with excavator	Cost effective on small scale <1 acre	Effective as plants susceptible during long winter/spring growing period	Negligible unless heavy equipment used	Ergonomic impacts to workers at larger scale
	Perennial grasses - woodland - ( <i>Ehrharta</i> grass)	Not recommended - hand pulling or digging is reported as a successful short-term strategy, although these methods are extremely time-consuming. Soil disturbance associated with pulling and digging may result in a flush soon after initial plant removal.						
Mowing	Annual thistles (yellow star thistle, distaff thistle)	Initial removal and follow-up control	Adults - Yes Seedlings - No	Efficient at small to medium scale (1-5 acres)	Cost effective on small - medium scale	Not effective as plants only susceptible 1 week a year	Negligible	Wildfire ignition risk in summer
	Annual grasses (Medusahead, barbed goat grass)	Initial removal and follow-up control	Adults - Yes Seedlings - No	Efficient at small to medium scale (1-5 acres)	Cost effective on small - medium scale	Not effective as plant susceptible only a short period during year	Negligible	Negligible
	Biennials (purple starthistle, teasel)	Biomass removal/Pretreatment	No	Efficient at small to medium scale (1-5 acres)	Cost effective on small - medium scale	Effective for biomass removal	Negligible	Negligible
	Perennial grasses - grasslands (Harding grass, velvet grass)	Biomass removal/Pretreatment only	Adults - No Seedlings - No	Efficient at small to medium scale (1-5 acres)	Cost effective on small - medium scale	Effective - can occur anytime spring, summer fall	Negligible	Negligible
	Perennial grasses - woodland - ( <i>Ehrharta</i> grass)	Not recommended - excessive soil disturbance facilitates the germination of seeds in the seed bank						

Non-Herbicide Technique Feasibility for Target Weeds\*

Method	Target Weed	Objective	Lethal	Efficiency	Cost	Predictability of Results	Non-target Impacts	Worker Health/Public Safety
Tapping/Mulch	Annual thistles (yellow star thistle, distaff thistle)	Not recommended - would also kill native species as unable to cover selectively due to intermixing with grasses						
	Annual grasses (Medusahead, barbed goat grass)	Not recommended - would also kill native species as unable to cover selectively due to intermixing with grasses						
	Biennials (purple starthistle, teasel)	May be effective control for teasel	Potentially	Unknown	Unknown	Unknown	Non-selective impacts to most native annual and perennial seedlings	
	Perennial grasses - grasslands (Harding grass, velvet grass)	Seedling/Resprout control in small areas as follow-up to hand removal	Adults - No Seedlings - <50%	Efficient at small scale (<1 acre) near roads	High cost for labor and synthetic/natural materials and delivery	Effective - can be implemented most of the year	Non-selective impacts to most native annual and perennial seedlings	Negligible
	Perennial grasses - woodland - ( <i>Ehrharta</i> grass)	Seedling/Resprout control in small areas as follow-up to hand removal	Adults - <50% Seedlings - <50%	Efficient at small scale (<1 acre) near roads	High cost for labor and synthetic/natural materials and delivery	Effective - can be implemented most of the year	Non-selective impacts to most native annual and perennial seedlings	Negligible
	Annual thistles (yellow star thistle, distaff thistle)	Suppression, initial treatment for reducing populations	Adults - 50-80% Seedlings - No present	Efficient in ag. areas where infrastructure present	Low costs in ag. areas where infrastructure present	Not effective - timing key for any control, poor timing results in population enhancement/ expansion	Non-selective, natives can be severely impacted	Negligible
	Annual grasses (Medusahead, barbed goat grass)	Suppression, initial treatment for reducing populations	Adults - 50-80% Seedlings - No present	Efficient in ag. areas where infrastructure present	Low costs in ag. areas where infrastructure present	Not effective - timing key for any control, poor timing results in population enhancement/ expansion	Non-selective, natives can be severely impacted	Negligible
	Biennials (purple starthistle, teasel)	Not recommended for purple starthistle. Recommended for teasel at Nicasio	Unknown	Efficient in ag areas where infrastructure present	Low costs in ag areas where infrastructure present	Unknown	Non-selective, natives can be severely impacted	Negligible
	Perennial grasses - grasslands (Harding grass, velvet grass)	Not recommended for Harding grass; unknown impact on velvet grass	Adults - No	Efficient in ag. areas where infrastructure present	Low costs in ag. areas where infrastructure present	Unknown	Non-selective, natives can be severely impacted	Negligible
	Perennial grasses - woodland - ( <i>Ehrharta</i> grass)	Not recommended - unknown effectiveness						

Note: Biological controls are not included in this table and will be discussed in more detail in the weed report. While these are certain insects that affect thistles and other target weeds, none are lethal at a large scale.

\*This table focuses on the high priority weeds of concern on the watersheds. Additional weed species of concern will be addressed at a later date. Broom is addressed separately.

Summary of Non-Chemical Broom Control Techniques

Treatment	Mortality Rate		Seed Bank	Constraints	Scale	Possible Health Impacts	Possible Environmental Effects
	Adult	Seedling					
PRESCRIBED FIRE	Broadcast Burning uncut plants (grasslands)	>80%	10-50%	timing - fuel load/moisture - permitting - multiagency coordination	5 acre+	smoke in urban environments	secondary invasions, wildfire, destruction of native plant species and seeds, aesthetics, impacts to nests and small wildlife
	Broadcast Burning cut material (grasslands and woodlands)	>80%	>50%	timing - permitting - multiagency coordination, fuel load	5 acre+	smoke in urban environments	secondary invasions, wildfire, damage to desirable canopy, destruction of native plant species and seeds, aesthetics, impacts to nests and small wildlife
	Propane Torch Flaming	<10%	<10%	timing, terrain, adult stands need to be removed first	<2 acre	minor burns to workers	wildfire ignition if vegetation is too dry
MECHANICAL	Cutting/Mowing - brushcutter (powered)	50-80%	<10%	broom stems <2" dia., single stemmed	1/2 acre +	ergonomic strains, cuts, petroleum product spills	petroleum product spills, noise, seasonal nesting bird disturbance, small wildlife mortality, seasonal fire risk
	Cutting/Mowing - Heavy Equipment	50-80%	<10%	flat, open, accessible terrain only	1/2 acre +	petroleum product spills	non-target vegetation cutting, petroleum product spills, seasonal fire risk, seasonal nesting bird disturbance, loss of wildlife habitat, direct killing of wildlife, aesthetics
	Hot Foam (Waipuna)	10-50%	<10%	road access, large volumes of water required	<1 acre	unknown	non-target vegetation impacts
	HydroMechanical Obliteration	unknown	unknown	road access, large volumes of water required	<5 acre	cuts/bruises	soil disturbance
HAND (NON-POWER)	Scraping/Pulling - Heavy Equipment	>50%	>50%	flat, open, accessible terrain only	1/2 acre +	petroleum product spills	non-target vegetation cutting, petroleum product spills, seasonal fire risk, seasonal nesting bird disturbance, loss of wildlife habitat, direct killing of wildlife, aesthetics
	Cutting - Saw (non-powered)	10-50%	<10%	timing	<1 acre	cuts	negligible
	Mowing - Scythe (non-powered)	<10%	<10%	highly trained/fit operator; not suitable for mature adult plants	<1 acre	ergonomic strains	non-target vegetation
	Cutting Roots below Grade	>50%	10-50%	wet season only, non-rocky sites	<1 acre	cuts	soil disturbance - erosion and prepare seedbed for weeds
	Cut/Peel Bark	50-80%	<10%	plants can not have damaged stems, multistemmed trunks	<1 acre	cuts	negligible
	Hand Pulling (no tools)	<10%	<10%	wet season only, not suitable for large adult plants	<1 acre	ergonomic strains	soil disturbance - erosion and prepare seedbed for weeds
	Weed Wrench	>80%	Not applicable	winter only	<1 acre	ergonomic strains	soil disturbance - erosion and prepare seedbed for weeds
	Scraping (hand tools)	<10%	<10%	winter/spring optimum	<1 acre	ergonomic strains	soil disturbance - erosion and prepare seedbed for weeds
	Competitive Planting	<10%	10-50%	timing, species selection, adult stands need to be removed first	<1 acre	none	negligible
	Grazing	10-50%	<10%	timing, requires infrastructure	<1 acre	potential fecal contamination	soil disturbance, non-target vegetation damage
CULTURAL	Mulching - Organics	10-50%	>50%	road access required, requires relatively flat site, adult stands need to be removed first	<1 acre	none	negligible
	Mulching - Synthetics (solarization)	10-50%	>50%	road access required, requires relatively flat site, adult stands need to be removed first	<1 acre	none	negligible

## Non-Chemical Broom Control Techniques Efficacy for Various Plant Life Stages

Optimal Control Strategies by Lifestage			
Life Stage	Method	Scale	Notes
Adult Control - Biomass Removal	Broadcast Burning (grasslands)	5 acre+	
	Broadcast Burning cut material (grass;lands and woodlands)	5 acre+	
	Cutting/Mowing - brushcutter (powered)	1/2 acre +	chainsaws used for steep terrain
	Cutting/Mowing - Heavy Equipment	1/2 acre +	
	Cutting - Saw (non-powered)	<1 acre	
	Cutting Roots below Grade	<1 acre	variable effectiveness, requires disposable tools
	Cut/Peel Bark	<1 acre	very slow
	Hand Pulling (no tools)	<1 acre	large plants require tools for removal
	Weed Wrench	<1 acre	pre-cutting large stands improves efficiency
Juvenile Plants	Broadcast Burning (grasslands)	5 acre+	
	Cutting/Mowing - brushcutter (powered)	1/2 acre +	chainsaws used for steep terrain
	Cutting/Mowing - Heavy Equipment	1/2 acre +	
	Hand Pulling (no tools)	<1 acre	large plants require tools for removal
	Weed Wrench	<1 acre	pre-cutting large stands improves efficiency
	Mowing - Scythe (non-powered)	<1 acre	requires specialty training, uncommon tool
	Scraping (hand tools)	<1 acre	Pulaski axe, McCleod/Rogue hoes, good for Scotch broom
Seedlings/Seed Bank	Broadcast Burning (grasslands)	5 acre+	
	Propane Torch Flaming	<2 acre	
	Hot Foam	<1 acre	uncommon, expensive tool, road access needed
	HydroMechanical Obliteration	<1 acre	uncommon, expensive tool, road access needed
	Scraping/Pulling - Heavy Equipment	1/2 acre +	
	Competitive Planting	<1 acre	optimum with mulch
	Mulching - Organics	<1 acre	requires adult plant removal
Mulching - Synthetics (solarization)	<1 acre	requires adult plant removal	
Flower Suppression	Cutting/Mowing - brushcutter (powered)	1/2 acre +	repeated, consistent cutting can reduce flowering
	Cutting/Mowing - Heavy Equipment	1/2 acre +	repeated, consistent cutting can reduce flowering
	Cutting - Saw (non-powered)	<1 acre	
	Grazing	<1 acre	requires temporary/permanent infrastructure

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Integrated Non-Herbicide Methods for Landscape Level Broom Control

Method	Initial Removal/Biomass Reduction	Resprout Treatment	Seedling Treatment	Scale	Area Treated	Comments
Prescribed Fire	<p>YR1: Hand/Weed Wrench™ pull broom, leave adult biomass on ground, follow-up several months later with cool spring burn when broom debris has dried.</p> <p>YR2: Repeat burn in grasslands. In woodlands, YR2 rate may be enough fuel for a follow up burn. YR3 to be repeated in woodlands unless repeat mowing occurs. Mowing may be required in YR3 to prevent seed set.</p>	<p>YR2: Repeat burn in grasslands. In woodlands, YR2 rate may be enough fuel for a follow up burn. YR3 to be repeated in woodlands unless repeat mowing occurs. Mowing may be required in YR3 to prevent seed set.</p>	<p>YR3+: Alternate season burns; hand pulling in later phases of treatment.</p>	Large	5 acre +	<p>Ideal for grassland/coastal prairie where frequent burns can be carried by grass fuel loads. Any burn requires significant overhead preparation. Not recommended for areas with poor soil health/safety. Potential to increase broom density. Secondary weed invasions likely follow burn disturbance.</p>
Broadcast Burn (grassland-woodland)	<p>YR1: Cut broom with brushcutters (small stands)/heavy equipment, leave adult biomass on ground, follow-up with broadcast burn when broom debris has dried.</p>	<p>YR2: Repeat burn in grasslands. In woodlands, YR2 rate may be enough fuel for a follow up burn. YR3 to be repeated in woodlands unless repeat mowing occurs. Mowing may be required in YR3 to prevent seed set.</p>	<p>YR3+: Alternate season burns; hand pulling in later phases of treatment.</p>	Large	5 acre +	<p>High frequency burning in woodlands will cause high mortality to woody trees and tend to open woodland canopy. Potential to increase broom density. Secondary weed invasions likely follow burn disturbance.</p>
Out - Winter Pile Burn or Wind Row Burn - Flame	<p>YR1: Cut broom with brushcutters (small stands)/heavy equipment. Pile or stack in wind rows and tarp. Follow-up with winter burning.</p>	<p>YR2 or shortly after Winter Burn: propane flame seedlings.</p>	<p>YR3+: Alternate flaming, pulling then convert to pulling in later phases.</p>	Medium	1-5 acres	<p>Expensive Winter burns get around permit and crew issues. Often followed by seedling flush which can be removed same season.</p>
Out - Winter Pile Burn or Wind Row Burn - Mow	<p>YR1: Cut broom to less than 3 inches in height with brushcutters (small stands)/heavy equipment. Pile or stack in wind rows and tarp. Follow-up with winter burning.</p>	<p>Mow annually</p>	<p>Mow annually</p>	Large	5 acre +	<p>Cost effective method of suppressing seed set. More cost efficient than propane flaming and pulling</p>
Out - Pile - Pull - Propane Flame	<p>YR1: Cut broom to 2 ft in height with brushcutters/chainsaws (small stands)/heavy equipment; pile adult biomass to facilitate follow-up treatments. Broom is pulled by Hand/Weed Wrench™.</p>	<p>YR2: Flaming with propane torch - hand pulling.</p>	<p>YR3+: Flaming with propane torch - hand pulling.</p>	Small/Medium	1-5 acre	<p>Cutting is only used to improve efficiency of pulling broom. Propane flaming is optimum for precision removal of small - medium stands of broom.</p>
Pull - Pile - Propane Flame	<p>YR1: Hand/Weed Wrench™ pull broom, pile adult biomass to facilitate follow-up treatments.</p>	<p>YR2: Flaming with propane torch - hand pulling.</p>	<p>YR3+: Flaming with propane torch - hand pulling.</p>	Small/Medium	1-5 acre	<p>Expensive. Technique on larger scales may produce potential for erosion but erosion control impedes flaming follow-up - optimum for smaller, flat areas. Flaming tools for large production uncommon and still need development.</p>
Pull - Pile - Mow	<p>YR1: Hand/Weed Wrench™ pull broom, pile adult biomass to facilitate follow-up treatments.</p>	<p>YR2: Mow 2X-4X during growing season.</p>	<p>YR3+: Mow 2X-4X during growing season.</p>	Small/Medium	1-5 acre	<p>Technique appropriate when volunteer labor is available to pull initial stands but agency staff is required for follow-up mowing for suppression only. Only results in long term suppression.</p>
Pull - Pile - Pull	<p>YR1: Hand/Weed Wrench™ pull broom, pile adult biomass to facilitate follow-up treatments.</p>	<p>YR2: Pull broom.</p>	<p>YR3+: Pull broom about every other year, after the first 3 years -no seeding aged plants to deal with.</p>	Small	<1 acre	<p>Ideal for small patches with easy access. Typical method for small restoration projects implemented by volunteers.</p>
Pull - Pile - Mulch - Pull	<p>YR1: Hand/Weed Wrench™ pull broom, pile adult biomass to facilitate follow-up treatments. Immediately after pulling apply thick mulch (&gt;12" with rice straw, wood chips or other natural material).</p>	<p>YR2: Pull broom.</p>	<p>YR3+: Pull broom.</p>	Small/Medium	1-5 acre	<p>Untested. Rice straw mulch may or may not significantly reduce resprouts. Excessive mulch can prevent native establishment.</p>

NOTES ON BURNING TREATMENTS: All burning works well for single species management when repeat burning frequency can be guaranteed until project completion. If burn treatment frequency is ever interrupted or delayed, broom populations will rapidly recolonize and double in density, reversing all previous control attempts. All burning creates disturbance which is often exploited by other opportunistic invasive weeds thus requiring a further series of restoration treatments. Most agencies report burning is a wildcard in urban environments and often becomes politically or administratively infeasible for 2nd year and other repeat control attempts.

NOTES ON CUT/PULL TREATMENTS: Piling and processing outpiled vegetation is critical for initial stages. On-site piling/processing is almost always the preferred option. Piles are stacked neatly and buck mulched chipped, or burned in place to reduce biomass. In general, methods reliant on pulling large stands of broom for multiple years require use of abundant, inexpensive labor (volunteer or temporary paid). Flaming is a relatively new method with few commercially available tools for large scale implementation. Custom fabrication and product development would be necessary for large scale use of this tool.

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## Watershed

### WATERSHED OUTREACH

### RESOURCE MANAGEMENT

Lagunitas Creek Fisheries Program  
 2008 and 2009 Vegetation Management Plan Update  
 1994 Vegetation Management Plan  
 Vegetation Management & Herbicides  
 Mt. Tamalpais Watershed Road & Trail Management Plan

Project Restore  
 Reports and Related Resources

### RECREATION

DIRECTIONS TO SKY OAKS, BON TEMPE AND LAKE LAGUNITAS

### CONTACT

## Vegetation Management & Herbicides

### *Protecting the Mt. Tamalpais Watershed & the Public Health*

See below for a printable version of this page.

[Frequently Asked Questions](#) (PDF)

### PROBLEM

Invasive weeds, such as French and Scotch broom, yellow starthistle and others threaten Marin County on two fronts - by eliminating habitat for native plants and animals and by creating large amounts of fuel for uncontrolled fire. Wildfires have wrought death and destruction in Marin County and in other communities in California, and MMWD is taking steps to establish fire breaks and eliminate invasive weeds, to reduce the threat of future fires.

The Marin Municipal Water District is committed to reducing the threat of wildland fire and preserving the ecology of Mt. Tamalpais. At the same time, MMWD's mission is to protect the water quality of its reservoirs and provide clean and safe drinking water to its customers.

### CURRENT STATUS

MMWD adopted an integrated pest management policy in 2003. MMWD's goal is to control invasive weeds in the most environmentally friendly and cost-effective manner possible. The policy specified a number of options for controlling weeds, and limited the use of herbicides to areas away from reservoirs and stream courses and areas in which other alternatives were not feasible.

In 2005, MMWD suspended the use of herbicides on the watershed pending the development of an updated vegetation management plan. The process includes the following:

1. A study of the alternative weed control options. These options include both non-chemical and chemical weed control tools.
2. An addendum to the environmental impact report (EIR) on the vegetation management plan or other appropriate environmental review process. This environmental review will assess and document the whole range of weed control alternatives that MMWD has employed and any new techniques that can be effective. Among the alternatives that will be documented include mowing, hand pulling, controlled burning, propane flaming, animal grazing, vinegar and other chemical mixtures, and herbicides.
3. A risk assessment of herbicides on the least-toxic chemical list from the integrated pest management policy. This risk assessment will review all of the peer-reviewed literature on the toxicology and environmental fate of these chemicals, and will evaluate the potential use scenarios for these chemicals on the MMWD watershed, to identify any potential exposures to humans, animals or non-target plants. The assessment will then identify the resulting risks of health or environmental effects, and restrictions on the use of herbicides to eliminate unsafe exposures.
4. A review of the integrated pest management policy to incorporate any changes to weed control techniques that are identified in the environmental review process or risk assessment that would be necessary to prevent health or environmental impacts.
5. A series of public workshops on the risk assessment and environmental review process that would provide full opportunity for MMWD customers to get their questions answered about different weed control techniques, and to provide information to the MMWD team about these techniques.

*At the March 7, 2007 meeting th MMWD Board will **not** make any decision on whether or not to allow the use of herbicides on the MMWD watershed. Any such decision will not be made until these tasks are completed.*

MMWD staff will be assisted in the environmental review process and risk assessment by independent experts who are knowledgeable about non-herbicidal weed control and about herbicides. MMWD will also rely on a review panel of experts in a broad range of disciplines as it carries out these tasks. The environmental review document and any proposed modifications to the integrated pest management policy will be considered by the MMWD for approval at a public meeting, which will most likely take place in the fall or winter of 2007.

### BACKGROUND

The Mt. Tamalpais Area Vegetation Plan, which represents the most comprehensive natural resources management plan in MMWD's history, has served as the district's guidelines for protecting the watershed and the public health since 1995 when the plan was adopted. The plan's goals are to:

- Proactively reduce the hazard of uncontrolled wildfires and prevent the death and destruction that has happened in the past in Marin County and most recently in the 1991 Oakland Hills fire;
- Preserve the watershed's major ecological systems, encourage biodiversity by restoring fragile meadow and oak woodlands, and protect sensitive and rare plant species, many endemic to Mt. Tamalpais;
- Control the spread of invasive non-native plant species, which displace native plants and eliminate habitat for native animals.

Invasive, non-native plants represent one of the major challenges facing MMWD. Problem species include: French, Scotch and Spanish broom, yellow starthistle and pampas grass. The problems posed by French broom are just an example:



- High densities: i.e. 120,000 stems per acre for broom, thousands of seeds per square meter;
- Resilience: the ability to re-sprout from stumps and fragments;
- Hardiness: the ability to thrive in droughty, compacted, poor nutrient soils;
- Ecosystem alterations: changes to soil, available light and moisture, fire regime.

MMWD has relied on multiple means to keep non-native plant species in check. Before selecting a treatment option, MMWD assesses how well it meets these parameters;

- Cost per acre: initial treatment and 10-year projection;
- Re-treatment interval needed to achieve management objectives;
- Time to restoration;
- Logistical limitations;
- Wildfire risk reduction;
- Ecological protection;
- Invasive species spread control;
- Environmental impacts.

The approaches MMWD has used to manage non-native vegetation control in the past include:

- Mechanical removal
- Hand removal
- Controlled burning
- Herbicides

Over the years, MMWD has tested other means of plant control, including goat grazing and new technologies that have relied on high-intensity heat/flame, water or foam (soap-based). All of these alternatives have had limited effectiveness.

MMWD continues to use manual and hand removal of non-natives as well as limited controlled burning, but it suspended herbicide use in August 2005 pending a review of this practice. Herbicides had been in use in accordance with MMWD's Integrated Pest Management (IPM) policy, which was adopted in 2003, and were extremely effective in killing invasive weeds.

The 2003 IPM policy was developed with extensive input from the public, including Marin Breast Cancer Watch, Marin Beyond Pesticides Coalition and the Pesticide Education Group. Oversight of the policy has been provided by the MMWD IPM committee, composed of senior management, licensed herbicide applicators, fisheries biologists and water quality experts.

Prior to the suspension of herbicide use in August 2005, MMWD followed these IPM guidelines for herbicide use:

- Herbicides used only as a last resort and in combination with mowing, burning, and hand removal;
- Inter-agency cooperation and public education critical;
- Approved herbicides restricted to a subset of San Francisco's "Reduced Risk" Pesticide List:
  - Glyphosate (Roundup, Aquamaster)
  - Triclopyr (Garlon 4, Pathfinder)
  - Clopyrild (Transline)
- Five-year herbicide reduction plan and monitoring program in place for all treatment sites;
- Application methods restricted to spot treatment of resprouting stumps and cut-stump painting;
- Applications restricted to dry season and low-wind conditions;
- Trail heads posted during and at least 12 hours after applications;
- All applications conducted in compliance with environmental and worker safety regulations;
- Quarter mile use-restriction zone around reservoirs and 100 foot buffers around water-bearing drainages.

#### Documents

[Vegetation Management & Herbicides \(PDF\)](#)