

NON-HERBICIDAL WEED CONTROL STRATEGIES IMPLEMENTED BY CITY PARKS STAFF IN THE NORTHWEST: **Maintaining Shrub Beds & Landscaped Areas**

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ALKI PARK, SEATTLE

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Cover Photo:

A landscaped area in Alki Park, a pesticide-free park in Seattle

MAINTAINING SHRUB BEDS AND LANDSCAPED AREAS

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INTRODUCTION

Purpose

Parks maintenance employees look to their peers for strategies that have worked well to control weeds. This report is one in a series that offers effective, non-herbicidal strategies used by city parks maintenance staff in the Northwest, in both wet and dry climates, to control weeds in and around the following park areas:

- shrub beds and landscaped areas
- hardscapes and fence lines
- tree wells
- turf (excluding golf courses and high profile athletic fields)

This report covers effective, non-herbicidal weed control strategies specifically for maintaining shrub beds and landscaped areas. All reports are posted on the NCAP website: www.pesticide.org. The material in these reports is also being presented in training sessions for pesticide applicators, featuring parks maintenance staff whose practices are described in the reports.

Definitions of “effective” weed control is subjective, varying not only among cities but also among employees within a single parks department. A particular strategy was deemed effective if the maintenance employee using it and his or her supervisor felt satisfied with the degree of weed control, safety, resources, and environmental impact involved. This research study was not exhaustive, meaning that other effective strategies may be used currently in the Northwest. Also, what works in one location may not work in another location because of differences in climate, soil type, budget, planning processes, public opinion, or level of volunteerism. Nevertheless, a strategy that works in one city may be adapted without too much effort elsewhere. The intent of this report is to share with you the expertise, innovations, and

inspiration of other parks staff. We encourage you to experiment on your own as resources allow.

Methods

Cities from northern California, Oregon, Washington, Idaho, and Montana were selected to achieve variety in climate, geography, and size. Parks maintenance employees and their supervisors, who manage either developed parks or natural areas in the selected cities, were surveyed. Parks maintenance employees responded to an initial survey that asked which park areas they manage using herbicides and how often herbicides were applied in these areas. They were also asked for which areas in parks they are most interested in learning about effective, non-herbicidal weed control strategies. Upon receiving these responses, the five most problematic areas for weed control were identified: landscaped areas, fencelines, hardscapes, tree wells, and turf.

In a second survey, parks maintenance employees were asked to provide the names of weeds that are most problematic in these areas and to describe any effective, non-herbicidal strategies for these areas or to target a specific weed. Strategies that could be implemented by other parks staff with limited resources were selected from among these, with preference given to strategies that had been used over long periods of time or tested in an experimental setting. Also, strategies from both wet and dry climates were selected so that parks staff from both climates would benefit.

To witness the effectiveness of the strategies and document them firsthand, site visits were conducted during August and September of 2007 in the following cities: Eugene, Portland, and Bend, Oregon; Seattle, Washington; San Francisco, California; and Boise, Idaho. The results from the surveys and site visits are compiled in this and the other reports in this series.

PROPER PLANNING

In many cases, when planning input from parks maintenance employees and their supervisors is limited, excluded or undervalued, the result is more weeds and insufficient resources to control them. Of the city parks departments visited, only Boise Parks and Recreation Department has a planning process that requires written input from parks maintenance staff in every step of parks project design.¹ This more inclusive process is critically important in reducing maintenance costs and headaches in the long-term. Used now for 10 years and also involving urban foresters and infrastructure staff, Eden Belanger, Horticulture Manager of Boise Parks and Recreation, remarked that changing this planning process is “the biggest gap we’ve closed.”

Seattle Parks and Recreation Department built its maintenance capacity, leading to better long-term weed control outcomes.² The program conducts long-term maintenance cost analysis, and formal maintenance funding requests are made in a budgetary process. The department periodically and formally assesses the needs of its landscapes and plans needed maintenance accordingly. Barb DeCaro, Resource Conservation Coordinator of Seattle Parks and Recreation, pointed out the Pro-Parks Levy passed eight years ago added maintenance crews from March to October to provide help where needed. With the levy funds, Seattle Parks and Recreation is able to “keep up” with weeds, she said.

Although slated to end in 2008, the mayor has added \$7 million to a continuation budget proposal, brightening the prospect of sustaining effective weed control. One of DeCaro’s future plans is to acquire funds for a full-time community outreach staff person. Already, many of the city’s 14 pesticide-free parks have their own neighborhood volunteer crew that helps significantly with weed control.

The lesson from these two cities is that proper planning is essential. Inclusive planning is critical when deciding where to put landscaped areas and shrub beds, selecting the most sensible plants, including hardscape shrub bed borders and budgeting labor resources to control weeds in adjacent areas whenever feasible. Proper planning is essential for not only preventing weeds, but also saving parks departments money in the long-term by enabling them to invest more time in growing beautiful and healthy parks and open spaces. Changing the planning process is challenging but possible.

SOIL PREPARATION AND MANAGEMENT

Weed control starts with soil. Good soil management can optimize the health of landscape plants and reduce weeds. Important components of soil are the materials that determine texture (clay, sand and silt), microbes, and carbon and nitrogen levels. Phil Rossi, IPM Coordinator with San Francisco Recreation and Park Department, noted that good soil mixes on the market cost \$50 per cubic yard.³

Instead of purchasing soil, the San Francisco Parks Department produces its own: a sandy loam made of root balls and recycled plant material (carbon) at the city’s greenwaste



Machine at San Francisco’s greenwaste and composting facility used for recycling greenwaste to use as soil (at right) and wood chips in parks.

and composting facility. In fact, this facility contains all of the necessary machinery to load, grind, and size-separate the output material into a variety of mulches and wood chips used in the city's parks and larger wood used in San Francisco's cogeneration power plant.

To make soil mixes, the output material is put back through the system and then partially composted, with well-rotted manure that contains nitrogen and microbes. However, with 4,000-5,000 cubic yards of greenwaste generated by San Francisco's parklands annually and limited staff time to operate the machines, turn the piles and transport material, composting occurs only partially and is not all aerobic (with oxygen).³

Compost

Compost improves soil structure, texture, and aeration and increases the soil's water-holding capacity. It improves soil fertility, stimulates healthy root development in plants, and provides food for microorganisms.⁶

Aerobic composting also does not produce methane, a potent greenhouse gas, like anaerobic composting does. Some cities have the resources to make their own compost. Bend Parks and Recreation District received funding for a \$65,440 mixer machine from the Oregon Department of Environmental Quality.^{4,5}

According to Paul Stell, Natural Resource Manager of the Bend Parks and Recreation District, aerobic composting using proper technique is very important to prevent weed seed contamination and provide plants and the microbes that support them with as many immediate nutrients as possible.⁴ Several factors ensure maximum aeration and temperature required for the most efficient and complete decomposition.

The procedure that Bend uses takes up to six months.⁵ According to Stell (Bend), first, the size of the particulate matter in the compost bin or pile must be large enough. About one-third of the volume should be material that is 1½ inches in diameter. Soil should not be

added to the compost. Second, the pile must be turned, or mixed, to aerate the material and get the temperature hot enough to kill pathogens and inactivate weed seeds (137° F in the center of the pile for at least five days). Bend turns its piles using a three-yard front loader every seven to 10 days. The temperature sometimes exceeds 180° F and is above 120° F for most of the process, tapering off at the end. Adequate decomposition, a process that involves microbes breaking down the material to the extent that it becomes the easiest form of nitrogen for plants to use, occurs most efficiently when the temperature inside the pile is 104-131° F.⁶ Third, the material is sprayed with water and kept about as wet as a wrung sponge, but not soaked.⁵ Decomposed manure or another nitrogen source can be added to help increase the temperature, notes Rossi (San Francisco).³ Beneficial microbes, which have been removed with heat treatment, will return after composting with exposure to air and adjacent soil.

The staff time and other costs associated with the mixing operation are as follows: Landscape debris is ground into chips in a tub grinder by a contractor at a cost of \$3,900. Chips are mixed with manure in a large mixing machine and put into windrows. That process requires two people working eight days (about 128 hours) with one three yard loader and one smaller front end loader. The windrows are turned every 10 days until the compost is done "cooking" about 12 times. That process takes two to three days each time for a total of about 240 hours. Stell (Bend) comments that the cost of making compost is probably close to \$20,000 per batch. The department used to spend \$13,000 to dump the waste material at the landfill in addition to purchasing compost as needed.

Stell concludes, "So we use more compost than we used to and spend about the same. Of course the benefit is that we now are using better cultural methods and

using less herbicide because the plant communities are healthier and more resistant.”⁵

According to DeCaro (Seattle), a wood waste committee, using information from a commissioned study, decided that operating a facility like this is not economically feasible.² Instead, Seattle contracts with a “clean green” service and other recyclers of wood and greenwaste and buys fully aerobically composted material to use as a soil amendment.

In summary, hot, aerobic composting is ideal for weed control and plant health. However, aerobic composting involves labor in watering and turning compost piles, so many city parks departments do not practice proper aerobic composting.

Soil Mixes

Other amendments to the soil, which add essential minerals and nutrients that plants and their microbial companions need, are important to add before potting or planting in beds.

Because Golden Gate Park and other San Francisco parks were built on giant sand dunes, San Francisco Parks Department staff work to boost the carbon content of the soil.³ Rossi’s organic matter of choice is aged redwood, which he says conditions the soil and allows better drainage. However, the price has been increasing and is now at \$32 per cubic yard. Other amendments that Rossi adds to his soil mix are asbes-



Potted plants at San Francisco’s nursery get a head start with heat-treated and amended soil.

tos-free vermiculite, perlite, and a starter 2-4-2 N,P,K fertilizer “to kick start microbe growth.”

Adding amendments that include microbes, or nutrients for the microbes, is especially important when the soil is used for potting or planting. According to Rossi (San Francisco), all soil used by Department staff for potting in the park nursery and for top dressing before adding new plants to beds has been heat-treated under high pressure to kill microbes and weed seeds.³

To “start with a clean slate,” he recommends that the boiler temperature reach 180-212°F for one hour, with 20-30 lb./in. of wet air pressure. The pressure is necessary to achieve such a high temperature, and the moisture helps to establish a uniform temperature throughout the soil. Even so, with a large volume, perhaps not all of the soil reaches the temperature needed to kill weed seeds (150° F).⁶ This technique is feasible for San Francisco Parks staff because they have a large enough boiler, and they have the resources to store and transport the soil. Ideally heat-treated soil should be covered during transport to prevent exposure to new weed seeds.³



Sitting in a windy valley, the Atlantic City Nursery in Seattle is prone to weed seed and fungal spore contamination.

Seattle Parks and Recreation Department’s Jefferson Greenhouse and Atlantic City Nursery facilities use a purchased pre-mixed growing medium of peat, pumice and aged fine bark with added nutrients for growing greenhouse and nursery stock.^{7,8} When first arriving

in 2001, at her current position as senior gardener of the Seattle Parks Atlantic City Nursery, Jeanne Schollmeyer was challenged with potted plants full of weeds. The previous Senior Gardener had purchased a potting mix that was contaminated with weed seeds. The nursery is also in a windy valley, allowing weed seeds to blow in. With Lake Washington nearby, the nursery is committed to combating weeds with the least amount of herbicide possible.

Corn Gluten Meal

Schollmeyer (Seattle) was interested in experimenting with corn gluten meal (CGM), as a natural pre-emergent herbicide on seeds.⁷ She conducted a controlled experiment with 1,500 newly potted, bare root Oregon Ash in groups of 500 each: one group as a negative control with no treatment, one group with corn gluten meal (CGM), and one group with CGM and bark covering the soil.

The groups with CGM, which prevents weed seed germination, showed very little weed growth, as compared to the control group. In addition, the plants with CGM grew faster and were obviously healthier, as CGM also acts as a supplemental nitrogen source, 10-0-0.^{7, 8}

Schollmeyer first added CGM to the soil and then potted plants in this mix. Next, she top-dressed the potted plants with CGM and mixed it into the top 1" of soil. She discovered that the weed suppression was equally good, but incorporating CGM into the soil used more product than top dressing. Because of its low cost and efficiency, the top dressing method became the preferred strategy.

In addition, an organic fertilizer with native beneficial mycorrhizae is mixed into the growing medium when potting up the native plants. It appears that this helps with plant establishment and improves water and nutrient absorption.

Covering the soil with bark mulch gave added suppression and prevented weed seeds from establishing in the pots.⁷ Schollmeyer

(Seattle) noted that the bark cover depletes the soil of nitrogen as it breaks down, so she is now considering alternative mulches, such as gravel, a longer lasting material. CGM's preemergent abilities last approximately six weeks in the soil depending on the weather conditions.⁸ Plants growing in the older, weed seed-contaminated soil needed several more CGM applications over time than those plants growing in less contaminated soil. So the nursery is now covering large loads of soil with a tarp upon delivery.^{7, 8} Covering the soil keeps weed seeds from being blown onto the surface.

Preventing Fungi and Pathogens

Routine sanitation procedures are practiced at Seattle's Atlantic City Nursery to suppress pathogens and pests.⁷ Pathways and plant holding areas are graveled, to improve drainage and eliminate standing water. These areas are then covered with ground cloth, allowing water to drain through while completely suppressing weed growth and enabling the surface to be easily brushed or washed off.⁸ Turf areas around the nursery holding areas are frequently mowed to prevent seed dispersal and keep rodent habitat in check.⁷

The most difficult challenge for the nursery is keeping the growth of fungi, mold and bacteria at bay, especially in poly houses.^{7, 8} One particular problem is that CGM, when applied to plants in poly houses during winter months, decomposes and becomes moldy.⁸ While not appearing to damage the plants, mold spores can be unhealthy to humans and attract rats and mice, so this product is not used inside poly houses during the winter months. Several ceiling fans inside the nursery help to prevent mold problems.

In outdoor spaces, spacing of plants, grooming and cleaning, as well as gravel and ground cloth, keep pathogens down. Parks staff in drier climates may not need to take as much care to avoid problems with fungal and bacterial pathogens. To combat insect pests, the

nursery purchases and releases beneficial insects and plants hedgerows to help establish their population.⁷

BED CONSTRUCTION AND PREPARATION

The slope of a shrub bed or landscaped area is important, especially for areas with drainage and/or fungal problems. According to Bob Fiorello, a San Francisco Recreation and Park Department Gardener and Pest Control Advisor at the San Francisco Botanical Garden, planting areas often need to be built up and sloped to allow for good drainage.⁹



A sloped, newly constructed shrub bed in the San Francisco Botanical Garden.

Bed construction techniques and timing depend on several factors, including the current condition of the soil and the amount of time that the site will be bare.

To achieve good soil and minimal weed pressure, wood chips, leaf mulch, or compost are generally good choices for mulching when planting a bed or portion of a bed.⁹

If the soil is poor and/or weed pressure is high, then more intensive mulching might be needed. Intensive mulching allows for en-

hanced weed control initially and builds better soil over time as it decomposes. To prepare the bed, a layer of fibrous plant material (e.g., bamboo, palm fronds, or other materials that do not decompose easily and may otherwise be sent to the landfill) can be laid first, followed by a layer of cardboard or newspaper, followed by wood chip mulch, with leaf mulch on top if available.⁹

This process is often referred to as “lasagna” mulching. Mary Preus, Senior Gardener of Seattle Parks and Recreation, also uses this layering technique for bed preparation.¹⁰ With this decomposing lasagna mulch, the site will undergo some radical changes and should be undisturbed for several months before being planted.⁹

A similar technique can be used for a site where weeds have gotten out of control. Simply laying the lasagna overtop the weedy surface of the bed will smother and kill the weeds, allowing a fresh start after several months. The cardboard or newspaper, after decomposing, may even leave a thin residual film that acts as a chemical barrier to weeds below. Some parks employees prefer polypropylene cloth to cardboard or newspaper. The cloth is more durable as a barrier but, as Fiorello (San Francisco) notes, it prevents beneficial nutrients, organic material, and organisms from traveling easily between soil layers. Weed barriers can impede the free flow of air and water, leading to disease and other problems. Polypropylene cloth can be accidentally damaged or moved, can become visible, and is difficult to readjust without disturbing the bed. Moreover, the cloth provides a safe cover for gophers, rats, and moles, making management of these animals difficult. Moles in particular, when left unchecked beneath weed fabrics, can create huge air pockets that disturb root systems and make irrigation challenging.⁹



“Soil building” and weed suppression underway with wood chip mulch in the San Francisco Botanical Garden.

After bed construction in an area with a high level of weed contamination, Eugene Parks and Open Space Landscape Crew Lead Worker Josiah Sheehan recommends a three-step process.¹¹ First, hand pull or similarly disturb the soil to promote weed germination, especially if the top dressing has not been sterilized. Next flame the weeds that grow up, and finally repeat the disturbing and flaming until the bed is fully purged of its weed seed bank. Sheehan follows up with a dense planting of hardy plants and a thick layer of certified, composted mulch, obtained from a local supplier.

“The best way to control weeds is to not give them bare ground to germinate from in the first place,” says Sheehan.

Although Fiorello (San Francisco) sometimes uses flaming when renovating a bed, he does not repeat the disturbance and flaming. Instead, he tries to mulch thickly as soon as possible after disturbing the soil in bed construction or when adding a new plant.⁹

Both the repeated disturb-and-flame and the single disturbance and flaming-followed-by-mulching approaches are very effective at suppressing weeds that spread by seed, but not those that spread via rhizomes. Both Fiorello and Sheehan caution against using the disturb and flame approach as a default practice or permanent maintenance regime.^{9,11}

While disturbance can help aerate the

soil and reduce the weed seed bank at the site, invasive weeds can emerge.⁹ Also, soil disturbance can result in the release of carbon dioxide, into the atmosphere, cause drying, and can interfere with important soil ecosystems.

MULCHING

Wood Chips

Although many parks maintenance employees still use bark mulch, those who have compared it experimentally to wood chips all greatly prefer wood chips. As explained by Belanger (Boise) bark mulch becomes a barrier to water intended for plants roots. Because it has finer particles that break down more rapidly, bark mulch supports a mat of mycorrhizae (a symbiotic association of the mycelium of fungus with plant roots).¹ As a result, the desirable plant roots grow shallowly in the mulch rather than deeply, below the mulch. The layer also retains nutrients and water above for the benefit of weeds.



Wood chip mulch suppresses weeds and retains moisture for desirable plants in San Francisco's Botanical Garden.

In contrast, wood chips can provide 6-10 years of excellent weed suppression, given the right conditions and management of the area, without harming desirable plants as bark mulch can do, according to Steve Maki, Horticulturist for Portland Parks and Recreation Department.¹²

Having conducted experiments using different mixes of mulching materials, Maki notes that wood chips are larger in particle size and break down slower. Weed seeds that germinate on woodchips are less likely to take root than on bark or other mulches with finer particles. Maki produces wood chips from hardwood or conifer sources, using the City's own equipment. He composts the wood chips before using them to kill weed seeds, making a mixture of about 80% wood chips and about 20% softer organic matter that will break down faster than wood alone, helping to raise the temperature of the compost pile. He uses "beast grindings," recycled weed and other non-tree plant material that have been chewed up by a "Beast Grinder" machine, and that have already gone through a composting process once. He wets the chips with a sprinkler as needed and turns the whole pile about once per week over at least a three-week period to ensure that the temperature rises to at least 140° F.

Maki states that the literature he has read gives 140° F as an adequate temperature to kill most weed seeds. Even so, "beast grindings," which are full of weed seeds, need to go through the composting process twice, to kill the seeds. Ideally, a bed mulched with wood chips would be monitored once per year and more material would be added as needed without raising the mulch layer above the crowns of the plants.



Keeping bare areas near the Children's Garden, at Yesler Community Center in Seattle, mulched with wood chips helps reduce weed pressure in the garden.

Parks departments used to spend thousands of dollars per year to purchase bark

mulch, but now most cities have the chipping equipment to make wood chips from trees removed from parks and other areas of the city. This supply often runs out though, and most parks departments supplement with free wood chip donations from private businesses.^{2, 13}

DeCaro (Seattle) warns the quality of wood chip mulch can be variable and sizes inconsistent; therefore, quality control is very important when working with arborists and tree companies. She recommends using companies that routinely sharpen chipper blades and maintain their equipment for better product consistency.² Tai Trang, Gardener for the Port of San Francisco, noted that maintaining mulch in landscaped areas is one way to keep park areas treated with more respect by parks patrons as it looks more respectable.¹³



Agrifolia Tree Care, a private company, donates wood chips at Islais Park, managed by the Port of San Francisco.

Leaf Mulch

In the autumn, when they are abundant, leaves can serve as an excellent barrier to weeds, and they make mineral-rich compost^{9,11,14} Sheehan (Eugene) blows leaves into shrub beds in the same park where they fall, making a thick layer that keeps weed seeds out and prevents sunlight from reaching weed seeds already present. Parks staff in Boise, Davis and the San Francisco Botanical Garden use leaf mulch when available, as well.^{1,14,9} The colored leaves can be a nice visual substitute for wood chips. Leaves decompose

much more quickly than wood chips and will become compost on their own when warmer weather returns. Although most leaves will work, leathery ones, such as those from holly bushes, are not suitable.⁶ Trees that produce toxins, like black walnut, eucalyptus, poison ivy, poison oak, or sumac, are also undesirable.⁵

Mulch Layer Thickness

Fiorello (San Francisco) notes that using wood chips or other mulch not aged or fully composted to kill fungi can lead to noticeable fungal growth, especially if it is too thick.⁷ Excessive mulch, which provides an ideal moist environment, also attracts harmful fungi, such as *Phytophthora* (root rot fungus).

Portland Parks and Recreation Pesticide-free Parks Program Coordinator Martin Nicholson notes that rodents will also be more likely to chew on the plant if the mulch is above the plant's crown, providing habitat near the base of the plant.¹⁵ Ensuring that the mulch is not too deep will encourage plant roots to grow deeper, below the mulch layer.

According to John Reed, Pest Management Program Coordinator and Botanical Specialist with Portland Parks and Recreation, mulch should not be reapplied too frequently, or some of the old mulch should be removed first, in order to prevent the mulch layer from thickening over time.¹⁶ The standard mulch depth for the City of Seattle is two to four inches.⁸

PLANT SELECTION AND ARRANGEMENT

Sheehan (Eugene) says, "Appropriate selection of landscape plants will eventually out-compete the weeds."¹¹ More specifically, Reed (Portland) advises selecting plants of a variety of sizes, filling in spaces around large plants with smaller plants. Not only is it a good idea aesthetically, but it also helps to shade out

weeds.¹⁶ If ground covers are not thick enough, weeds will crop up among the groundcover plants. According to Reed, the best weed suppressing groundcover shrubs are in the three to four foot range and provide complete coverage and shade. Reed recommends using plants that have dense foliage, are quick to fill in, are stable, cold hardy and require little irrigation.¹⁶ However, taller groundcovers may not meet the approval of law enforcement personnel, who like open beds with visibility for safety.^{11,13,16}

Phil Renfro, Senior Gardener at Seattle Parks and Recreation, points out that overcrowding does not produce healthy plants and planting too ambitiously can be wasteful.¹⁷



Bend Parks and Recreation District is reducing the turf area in its new parks and expanding landscaped area planted with drought-tolerant plants.

Native plants

The goal of many parks staff, especially those managing natural areas, is to provide better habitat for animals, raise healthy plants with minimal inputs, and minimize the risk of invasive plants. Some parks departments make an effort to use native plants that are well adapted to the local climate. In fact, parks departments in dryer areas, like Boise and Bend, are actually replacing turf and other plants that require a lot of water with drought-tolerant plants.^{1,4}

Even when choosing among natives, some plants are better choices than others.

For example, according to Sheehan (Eugene), choosing a tree that will provide shade for more years, like the native white oak, is better than one with a shorter lifespan, like an apple tree.¹¹ Stell (Bend) also recommends using native plants that are resistant to fungal or insect pests.⁴ Replacing larger-canopy trees that die with other large canopy new trees allows less sunlight to reach the ground, giving weeds less of an opportunity to take hold.

Non-native plants

For aesthetic reasons, parks personnel sometimes choose non-native plants that work well with the design of a park and that parks patrons enjoy. Without careful plant selection, though, some of these can prove invasive. For example, Alki Park, a pesticide-free park in Seattle, contains many ornamental grasses, one of which is the invasive pampas grass.¹⁷ Parks employees had reviewed and approved planting plans and later a decision was made without their input to feature pampas grass.⁸ As a result, the grasses have been spreading throughout this landscape. Parks employees have been removing the pampas grass plantings and also spending extra time monitoring for and removing seedlings.¹⁷

Similarly, the landscaped area surrounding the bow and arrow sculpture in Rincon Park, along the Embarcadero in San Francisco, contains *Stipa tenuisima* (Mexican feather grass).



The invasive but beautiful *Stipa tenuisima* (Mexican feather grass) undulates in the breeze in Rincon Park, managed by the Port of San Francisco, along the Embarcadero with the Bay Bridge towering in the background and characteristic bow and arrow sculpture in the foreground.

The public loves this plant because it waves in the breeze like ocean waves.¹³ Non-native species must be regarded with care, however. The Mexican feather grass has cost Trang (Port of San Francisco), countless hours of hand-pulling labor. The grass became invasive on Port of San Francisco property, spreading by roots and seeds into surrounding beds in the park.

Although Trang had the port's permission to use herbicide on the invasive grass, he has opted not to use these chemicals in this area that is frequented by children and is only several feet from the bay. This port is also important to the local fishing industry and is habitat for sea lions.¹³ Controlling the widespread grass with a pre-emergent herbicide would require treatment of the entire park to be effective, which would expose a large area of the park to chemicals and potential runoff into the bay. The Port of San Francisco has not applied herbicides at all in the past three years. Instead, the department has hired a temporary employee to help Trang with the hand-pulling. The department plans to keep the Mexican feather grass around the sculpture, but it will not be planted elsewhere on Port of San Francisco property.



Curtis Burns, General Laborer of the Port of San Francisco, diligently pulls the invasive *Stipa tenuisima* (Mexican feather grass) in Rincon Park along the Embarcadero.

Bioretention Systems

Plant selection is also an important consideration as some landscaped areas are sited and designed to serve additional purposes. In response to city sustainability mandates, some cities, particularly those of Bend, Boise, Portland, and Seattle, are installing planted swales that are bioretention systems.



A bioswale (rocky area), installed in the newly constructed Quail Park in Bend.

Bioswales are included in new parks or added adjacent to existing parks.^{4, 1, 16, 12} These bioretention systems slow surface runoff and/or pond water briefly so that particulates (contaminants and nutrients) settle out. Plants can also take up some of these particulates and sequester them. As Belanger (Boise) pointed out, some bioretention systems are indistinguishable from landscaping projects, although they may contain more plant diversity than some shrub beds.¹ This greater diversity helps to make weeds less conspicuous. One bioretention system contains the following plants: river birch, red osier dogwood, woods roses, golden currants, drummond willows, and shrubby cinquefoil.

While public works personnel are often in charge of bioretention projects, they usually lack the horticultural and weed control experience of parks maintenance staff.^{1, 16} Closer partnership between parks and those who design, construct, and maintain bioretention systems will lead to effective systems that do not add weed pressure to parks.



An attractive bioretention system in Boise. The system (shown from two perspectives, above and below) contains river birch, red osier dogwood, woods roses, golden currants, drummond willows, and shrubby cinquefoil.



SHRUB BED BORDER STRIPS

A common frustration is successfully maintaining a weed-free shrub bed and then having weeds grow up along the edges. This is especially irksome for the area between a bed and a path that is used frequently by parks visitors. One solution is to install a border around the bed. Border strips or headers are narrow strips of steel, concrete or other material that create a physical barrier and transition zone between a turf area or path and a shrub bed.

The purpose of this strip is to block turf or weeds from growing into the bed. According to Phil Renfrow, Senior Gardener, Seattle Parks and Recreation, border strips are ideally four to five inches wide, level with the turf, and four to six inches deep, curved to snugly fit the perimeter of the bed.¹⁷



This interface between shrub beds and paths in the San Francisco Botanical Garden becomes weedy in spring and early summer.



Alki Park, a pesticide-free park in West Seattle, has concrete border strips at the interface between shrub bed and turf, adding aesthetic, as well as weed control, value.

The edges may be rounded for aesthetic reasons and to minimize cracking and other wear and tear. Besides reducing the need for weed control, a border strip can sharpen-up

the appearance of the shrub bed. Intended to be permanent, border strips can be used more flexibly if they are installed in sections. Installation of border strips typically occurs only in the construction of new parks or redesign of an older park, but the features are not yet a common design standard in Seattle parks. Renfrow remarks that, even when the consensus in the department is to install border strips, these weed control structures are cut from budgets, saving money in the short-term but resulting in a constant weed problem in the long-term. Revising the parks planning process to incorporate input from parks maintenance staff at each stage would help ensure the use of border strips, a great investment in long-term weed prevention.



A border strip in Alki Park in West Seattle is elevated above the bed to block weeds from entering.

HEAT TREATMENT OF WEEDS

Heat treatment with a propane-powered weeder is an immediately effective method for knocking back broadleaf weeds. Martin Guerena, Integrated Pest Management Specialist for the City of Davis, recommends flaming for weed control in shrub beds during the wet season.¹⁴ These weeders raise cell temperatures,

boiling the plant material and bursting cell walls.¹¹



Steam rises from weeds seared by the Eco-Weeder (Puzzy Boy) in Scobert Gardens, a pesticide-free park in Eugene.

As Sheehan of Eugene Parks and Open Space, explains, from the perspective of a weed, being seared by a heat treatment is a slower assault relative to being cut by a line trimmer, for example. The slower assault by searing is less likely to send a signal to the roots to re-grow. Hence, treatments may not need to be repeated as many times to permanently remove a particular weed. The heated weeds will turn brown within one day during hot weather, two to three days during cooler weather, in contrast to herbicides, which can take a few weeks to show results.¹¹ A patch that has been heat-treated will probably stay weed-free for a few weeks. Sheehan notes that heat treatment is a great alternative in parks where contaminated hypodermic needles are often discarded, posing a danger to staff and volunteers who might otherwise hand pull weeds.

The Eco-Weeder (Puzzy Boy) model (\$1,200) is the most appropriate for shrub beds. This model has a rectangular grill with internal ceramic plates, and a tank filled with propane (20 pounds, five gallons and lasts four to six hours) that sits on a dolly.^{11,9}

It is used in shrub beds where the tool is targeted low to the ground to avoid burning desirable nearby plants.¹¹ Patches of low-growing broad-leaf weeds and weed seeds on the sur-

face are effectively killed with just 1-2 seconds of contact at 1,500° C. Also, the Eco-Weeder leaves a grill pattern and shiny appearance on the burned weed leaves, making it easy to see which areas have already been heat-treated.



The Eco-Weeder (Puzzy Boy) model has a rectangular grill, with internal ceramic plates and is connected to a 20 pound propane tank sitting on a dolly.

Some parks staff think flaming is not very effective for removing most grasses, which are evolutionarily adapted to regrow after fire disturbance in nature.⁸ Although effective for broad-leaf plants, heat treatment can actually stimulate grasses to grow, note both DeCaro (Seattle) and Sheehan (Eugene).^{8, 11} Even so, Trang (Port of San Francisco) does use a flame weeder successfully to control invasive Mexican Feather grass seedlings.¹³



The Eco-Weeder leaves a grill pattern and shiny appearance on the burned weed leaves, making it easy to see which areas have already been heat-treated.

HAND REMOVAL OF WEEDS

Some parks employees do not recommend removing weeds by hand in an established bed, as soil disturbance can cause weeds to germinate.¹¹ However there are tools that minimize soil disturbance, while aiding in removal of non-rhizomous and non-taproot weeds. During the dry season or in dry climates, these tools are also important substitutes for flaming. The stirrup hoe, also known as the hoola hoe, for example, allows easy removal even from the inner part of shrub beds.¹⁵ Taproot weeds can be simply cut back frequently.



A stirrup hoe, also known as a hoola hoe

For removing grasses, the hori hori, a Japanese tool that looks like a knife, is more appropriate.¹³ As Trang (Port of San Francisco) demonstrated, the hori hori is placed under the roots of a grass clump, held against one's foot, and moved as a lever, reducing arm stress and severing grass roots.



The hori hori weeding knife viewed from either side. One side is convex and tapered (above), the other concave and graduated (below).



Repetitive motion injury prevention is an important consideration.^{2,3,13} For parks personnel, such injuries can be devastating to those who enjoy the work and who depend on their physical health. Furthermore, workers compensation insurance costs may be higher for the city if documented injury occurs, in addition to the cost of training a replacement employee. The Seattle Parks Safety Office provides injury prevention education, according to DeCaro (Seattle), and this preventative wisdom also is passed down informally to new staff. DeCaro recommends the use of arm braces or special gloves that hold the wrists stable.² Trang (Port of San Francisco) recommends spending no more than two hours at a time engaged in the same repetitive motion and stretching afterward.¹³ If not

Tai Trang, Gardener for the Port of San Francisco, holds the grass in one hand and the convex part of the hori hori against his foot with the other hand, moving the knife into the soil under the grass and using the knife as a lever, severing the grass roots (left).

neglected, a particular park site should not require more than two hours of hand removal. Scheduling hand removal regularly at each site, varying the tools used, and interspersing hand removal with other kinds of work can achieve effective weed control and minimize injury.^{4,9,13}

TECHNIQUES THAT WERE NOT EFFECTIVE

Corn Gluten Meal Applied to Beds

Although corn gluten meal (CGM) effectively suppresses weeds in nursery plant pots, it does not do so in shrub beds, according to Nicholson (Portland).¹⁵ He experimented with CGM applying it to beds four times a year at the rate specified on the label (at the highest rate and also at ½ rate), compared them to sites with no treatment at all, and found that CGM vastly increased weed growth. As mentioned above, CGM can control weeds by preventing germination; but it also acts as a fertilizer.⁷

Similar trials were conducted by San Francisco city departments over a number of years. They concluded that CGM was useful in some situations, where high rates were economically feasible and the material could be covered by mulch. On bare ground and turf, however, the pelletized CGM, commonly sold in the trade, is often consumed by birds, rats and other wildlife. Bob Fiorello notes that CGM, when handled correctly, remains a solid choice for a non-manure, balanced, organic fertilizer regardless of the benefit of weed control.

Clove Oil or Vinegar-Based Products

As an alternative to conventional petroleum-based herbicides, companies have developed herbicides that contain the natural ingredients clove oil and vinegar. However, these ingredients can pose hazards. For example, Nicholson (Portland) noted that his staff felt very nauseated by the strong smell of the Eco-Exempt Herbicide Concentrate (21% clove oil) product after working with it for a few hours.¹⁵ Moreover, citizens who smelled it became very

concerned, as the smell indicated to them that something potentially hazardous had been used.

Vinegar-based products are even more of a safety concern for staff, as vinegar is composed of acetic acid. A vinegar-based product, Nature's Glory (25% acetic acid prior to mixing), which Nicholson used, corroded the bottom seal on his backpack sprayer, spilling acid onto his pants. In the concentrated form, before it is mixed, the acetic acid in Nature's Glory can also cause permanent eye injury if unprotected eyes make contact with the product, warns DeCaro (Seattle).⁸ Nicholson stresses the importance of thoroughly cleaning out spray equipment following any application using vinegar-based products.¹⁵ This wastewater from rinsing should be applied to landscaped area allowed on the label, he states. Sheehan (Eugene) shares these concerns.

In Nicholson's experiments, neither clove oil nor vinegar-based products were as effective in controlling weeds as wood chip mulching and/or hoeing. Although the viability of the surfactant in these trials may have been a complicating factor in the effectiveness of the clove oil-based products tested. Air temperature is known to be an important factor in determining the degree of weed control. Clove oil works best above 65° F.¹¹

Also, Nicholson needed to frequently reapply both the clove-oil and vinegar-based products to achieve the same level of control as with Roundup + Surflan.¹⁵ He achieved better control with thorough hand removal with a hoola hoe every three to four weeks than with any chemical product. Considering the time spent applying a product versus hand-weeding, and travel cost to and from a site for re-application, Nicholson thinks the use of clove oil and vinegar-based products is not cost-effective.

A report covering the results of these Pesticide Enhancement Trials as well as a cost analysis of the treatments used will be available after June 2008 by contacting Portland Parks and Recreation, City Nature Services.¹⁵

CONTACT INFORMATION

The following parks departments were referenced in this report:

Eugene Parks and Open Space	541-682-4800
Portland Parks and Recreation	503-823-1636
Seattle Parks and Recreation	206-684-7250
Bend Parks and Recreation	541-388-5435
Boise Parks and Recreation	208-384-4190
San Francisco Recreation and Parks Department	415-831-6306
Port of San Francisco	415-597-7990
City of Davis	530-757-5656

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