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TOOLS AND TECHNIQUES: MANUALLY CONTROLLING WILDLAND WEEDS



There is no single right way to control weeds. Although there are many things to think about when deciding which method to choose, three factors are especially important: the nature of the infestation, the tools and techniques available to you, and the biology of the target. The first two issues are discussed in this chapter, while the third is covered in detail in the next chapter.

For various reasons, including liability and union issues, volunteer weed workers in the Bay Area tend to rely on manual techniques using hand tools. Even if you rely exclusively on such techniques in your own work, it's still quite useful to know about the wide range of other techniques that are employed. This chapter provides a broad overview of many control techniques followed by more specific details about manual techniques.

NATURE OF THE INFESTATION

Not all invasive plant infestations are the same. Some contain only a few plants, while others cover acres. Pulling the weeds out by hand might make sense in the former situation, but if the population is large, other techniques, like mowing, might be more appropriate. Terrain is another factor. Mowing works fine on level ground, but it isn't an option on steep or uneven terrain. Proximity to trails and buildings is yet another important thing to think about. Girdling a small invasive tree may make sense if you are working in a wilderness area far from trails or buildings, but it's not the best technique to use in less remote situations

where the invasive tree might present a potential hazard to people or structures or where a dead tree might trigger adverse publicity.

In general, removing large trees is a job that should be left to expert arborists and foresters. When removal isn't an option, populations of invasive trees like blue gum eucalyptus can be contained using hand labor. Removing seedlings and saplings on the edges of the infestation will prevent it from spreading into adjacent native plant communities while you marshal support for the eventual removal of the larger trees.

It's important to keep these considerations in mind when choosing which tool to use. There are no hard and fast rules, so use your common sense, rely on your own experience with the land, and talk with seasoned weed workers if you're feeling particularly uncertain.

TOOLS OF THE TRADE

Relying on a single tool can get you in trouble. It's okay to develop a favorite tool, of course. The Bay Area weed workers who were consulted in writing this handbook each had their own favorite. Some singled out large tools like the Pulaski, with an ax and a hoe on the business end, while others picked much smaller tools such as the soil knife as their favorite. Between these two extremes there were many other preferences, which suggests that there is no single most useful tool for Bay Area weed workers.

They may have made different choices about their favorite tools, but they all shared an intimate familiarity with dozens of tools and techniques. They had avoided the common pitfall of tool users everywhere: if all you know is a hammer, then everything looks like a nail. Focusing on a single tool or technique just won't work when it comes to weeds. It's important to step back from the technology and think about the broader strategy.

INTEGRATED PEST MANAGEMENT

During the last few decades, farmers, ranchers, gardeners, landscapers, and land managers of all types have moved toward a comprehensive strategy for controlling weeds and other pests. This approach, called Integrated Pest Management (IPM), stresses the inclusion of all relevant factors in deciding which techniques are best for dealing with a weed problem. Thus, it is important to consider factors such as the technique's effectiveness in accomplishing your goal, potential disturbance to the environment, the period of time required for effective control, and the direct cost of a treatment technique. It is also important to note that weed workers and land owners may weigh these factors differently depending on their land management goals and policies, the environmental setting, and personal val-

Some General Comments about Weed Control Techniques

The following general considerations apply to all of the control techniques discussed in this chapter:

Minimize soil disturbance. Many invasive plants rapidly move into disturbed areas. In sensitive areas, particularly those that haven't experienced much disturbance, choose control techniques that minimize the level of disturbance. The number of volunteers you are expecting at a work party will affect your choice of site, target, and technique. You don't want lots of people working in a sensitive area with digging tools. The disturbance and trampling could outweigh the gains from removing the invasive plants.

Avoid disturbing wildlife. Limit cutting trees, tree limbs, or very large woody shrubs during bird nesting season as this could disturb or destroy nests. For this reason, the local units of the National Park Service generally do not work on selected weeds in forested, riparian, grassland, and scrub habitats during the nesting season, roughly March 15 to September 1. In some cases, however, where the invasive plant threats are high, park managers conduct nesting surveys prior to removal activities. If nests are found, the project is often placed on hold until after the nesting season is over.

Anticipate erosion problems. Rice straw, wood chips, or permeable landscape fabrics may help reduce erosion problems in areas where weed removal techniques like digging or scraping will leave bare ground. Wattles combined with organic materials such as jute can also be effective. This is particularly important when banks or slopes are exposed. For steep slopes and creek banks it is important to outline an erosion control strategy prior to removing weeds. This strategy should also be approved by the landowner.

Revegetate when appropriate. Cleared areas may need to be revegetated with native plants, but it might not make sense to do so until the infestation is well under control. If the site will require intensive weed control following initial treatment, it may make sense to wait a little bit longer before replanting. The new plantings will be vulnerable to damage during weed control operations. This is particularly true when working with sites infested with Cape ivy or French broom, both of which can require extensive follow-up treatment to deal with resprouting vine fragments or dense seed flushes. In the case of controlling annual grasses, planting shrubs (if appropriate to the environmental setting) can suppress weeds over time as the shrubs establish. Revegetation with locally appropriate plants is an art in itself and is not covered in this handbook.

ues and preferences. Consequently, they may ultimately choose different strategies for controlling the same weed problem.

How might this work with wildland weeds? Let's say you have a big, long-standing patch of French broom. You might use Weed Wrenches to remove the "old-growth" French broom, but that's just the first step. All that newly exposed ground will come up thick with broom seedlings during the next spring. Using a Weed Wrench on the seedlings would be impractical, and it would take a lot of volunteer labor to remove thousands of little seedlings by hand. So your next step might be to use a hoe or McLeod to cut back the seedlings or to ask park staff to spray the dense patch of broom seedlings with herbicide, or to flame it using a propane torch. Do this a couple of years in a row, and the density of broom seedlings might fall low enough for you to rely on hand labor again. An exclusive reliance on a single tool would be less effective in this case. An integrated approach, relying on multiple methods, best addresses the problem and helps native plants reclaim the area.

The four main methods used in IPM are cultural control, mechanical control, biological control, and chemical control. In general terms, cultural control is the least disruptive to the environment. The impact on the environment depends on the circumstances—all four control methods can cause significant impacts. You can minimize such impacts by learning which tools and techniques work best in particular situations. As someone who will be working mainly with volunteers, you may focus exclusively on mechanical control, but it's important to know what other methods are available as well.

Cultural Control

Cultural control refers to cultivation practices that limit weed populations. In traditional IPM, with its focus on cultivated environments like gardens and fields, cultural control includes a wide range of important techniques that help reduce pest problems: choosing pest-resistant plants, choosing the right plants for the right soil and water conditions, rotating crops, and companion planting. Other agricultural practices such as grazing, burning, flooding, mowing, disking, and mulching are examples of cultural control that can address wildland weeds. These cultural techniques can play an important role in an IPM approach to invasive plants in the Bay Area, but for the most part they're beyond the scope of this handbook.

Nevertheless, it's important to point out how effective cultural control techniques can be. Grazing, for example, is considered by some to be the only effective management tool for controlling annual ryegrass in large areas. Goats are often used in such situations. Utilizing goat grazing requires extensive planning. Will you manage them using fencing or herding? Are you willing to sacrifice any of the native plants in the area to be grazed? How long should the

animals graze? The goats will eat almost everything. Other things to think about: the biology of the targeted weeds, the size and density of the infestation, and site conditions, particularly topography. Such considerations are important not only for goat grazing, but also for nearly every other control technique, including cultural ones.

Mechanical Control

For thousands of years, perhaps since the dawn of agriculture, humans have been using simple hand tools to remove weeds or simply pulling them by hand. Such methods can be very effective in controlling small populations of invasive plants, particularly where the weeds are intermixed with native plant communities, or adjacent to sensitive water bodies or rare plant populations.

There are other ways to physically remove weeds. In addition to the hand tools discussed below under “Key control techniques,” large machines may be used to remove weeds. Special harvester boats gather up aquatic weeds and heavy-duty mowers have been designed to move through woody brush. Common construction tools like backhoes and bulldozers are sometimes used to pluck out large plants. Commercial logging equipment can be used to remove invasive trees. However, mechanical control, especially using heavy equipment, is not without risk. It can cause significant disturbance to soil and vegetation and can also introduce weed propagules and pathogens such as the one that causes Sudden Oak Death.

Biological Control

In a farm or garden, biological control can involve releasing beneficial organisms like ladybugs or lacewings that can reduce insect pest numbers. Biological control can also mean creating habitat for such beneficial organisms so that they can keep pest populations in check.

In the case of wildland weeds, classical biological control refers to the importation of host-specific insects or pathogens from the native range of introduced pest plants. (The lack of predation from such co-evolved species is one of the chief reasons that invasive plants can so effectively outcompete native plants.)

Once such organisms are located, extensive research is undertaken to ensure that they will feed only on the targeted weed and not on native plants or crop plants. There have been cases where classical biocontrol organisms have dramatically reduced invasive plant populations, but there are also a few cases where the introduced organism has expanded beyond controlling the intended weed and now affects native plant populations. Researchers at a USDA lab in the East Bay city of Albany are evaluating biocontrol agents for yellow starthistle, brooms, and Cape ivy.

Chemical Control

Herbicides are chemicals—usually synthetic—that kill plants or stunt their growth. Some herbicides are selective (clopyralid, for example, is used to kill yellow starthistle without harming grasses and most other forbs), while others are more general. Herbicides can be applied in many ways at many scales, from aerial spraying over large infestations to discrete brushing on individual plants. Extensive permitting regulates the use of herbicides, especially around surface water.

Liability concerns and state laws and regulations limit the unsupervised use of herbicides by volunteers, but a few Bay Area weed projects have set up programs in which supervised volunteers do use them. Whether operating in a voluntary capacity or for hire, on public or private lands, those using herbicides for wildland weed control must know all state and local regulations. You must understand how to read herbicide labels, the legal description of how the herbicide may be used. You must have landowner permission for the application. And on public lands, you must be trained by an applicator licensed by the state's Department of Pesticide Regulation. Some basic information on common herbicide treatments that have proven useful to some Bay Area weed workers is provided later in this chapter and also in the species accounts in the next chapter.

Environmental toxicologists study how herbicides and other chemicals behave in the environment, including their adsorption to soil particles, their ability to get into groundwater, their influence on other nearby plants through their roots, their rate of decay, and their level of toxicity to humans and wildlife. A good compendium of such information can be found in the Weed Control Methods Handbook on the Web site of the Nature Conservancy's Wildland Invasive Species Team.

KEY CONTROL TECHNIQUES

There are perhaps hundreds of tools that have been used by weed workers at one time or another, but they can be classified into fewer than a dozen major categories. In this section, we describe the fundamental techniques that Bay Area weed workers find most useful.

Pulling

Hands and strong backs are great “tools” for pulling weeds. The human body, despite thousands of years of experience pulling weeds by hand, is nevertheless susceptible to injury when doing so. The back is particularly vulnerable. Protect it using the technique you learned while hauling heavy boxes: lift with your legs, not your back. Wrists and forearms are also sensitive to injury. You can avoid repetitive stress injuries by varying your technique: switching from arm to arm, shifting from kneeling on one leg to the other leg, etc.

There is no single right or healthy way to pull weeds by hand, but you can encourage your volunteers to pay attention to their backs and other sources of discomfort. If it's uncomfortable, they should try another position or use a different tool.

Specialized tools like the Weed Wrench rely on leverage to help you pull woody stems right out of the ground. The Weed Wrench has a tall vertical handle connected to moveable jaws set on a base that rests on the ground. As the handle is pulled back, the jaws close around the woody stem and the base becomes a fixed point against which the plant can be levered out of the ground. These come in several sizes. The ones with longer handles and bigger jaws are needed to pull larger plants, but they are much heavier and awkward to carry very far.

Sometimes, in order to pull larger weeds out of the ground, you will rely on other types of tools to help you gain access to the roots or to loosen the surrounding soil. Shovels, mattocks, hand picks, and Pulaskis can be used to loosen a root ball and to sever tough roots. Pruners, loppers, saws, and other cutting tools can be used to cut roots or to trim branches that block access to the base of the plant.

To minimize soil disturbance when working with small plants, use one hand to hold the soil in place around the base of the plant while pulling with the other hand. Clumps of invasive grasses can be gathered into one hand while you use a soil knife in the other to cut an ice-cream cone shape around the base of the grass. Whenever a plant comes up with soil attached to the roots, shake it gently, preferably close to the ground and right above where you removed the plant. Don't forget that invasive plant seeds thrive in disturbed soil! So minimize disturbance when you can.

Digging

Digging is often done in combination with pulling. When removing yellow starthistle by hand, for example, it often won't come up until you use a digging tool to loosen the plant's roots from the soil. This may also be true when pulling large broom plants with a Weed Wrench. Digging tools from hand trowels to large shovels are useful for such tasks.

For the smaller plants, digging tools like trowels, soil knives, dandelion diggers, and even old screwdrivers and paring knives can be useful. Here your weed work most closely resembles gardening: weeding a newly planted area, attempting to eradicate an invasive plant population (that is, when you have to get every last plant and seedling), or the like. Using such techniques can be quite labor-intensive, so be sure that you will have enough labor to achieve your goal. If not, it may be better to choose a different goal, for instance, trying to control the yellow starthistle by mowing instead of trying to pull every last one. But that's not

to be discouraging! Steady and persistent hand weeding over time can lead to dramatic success.

The most tenacious plants may not respond to pulling or cutting. Sometimes you just have to dig them out. Weed workers sometimes dig out big pampas grass clumps, for example, or the rhizomes of pepperweed or periwinkle. If the digging is extensive, it's wise to talk with the land manager's environmental compliance specialist. There may be archeological concerns that will limit the amount of digging you can do, particularly in areas of known archeological significance. Digging can cause irreparable harm to artifacts.

Long-handled tools like shovels or spades may tempt you to pry weeds out of the ground using leverage rather than digging them out. This may work in some conditions, but it can cause greater soil disturbance and damage the tool. Many shovels aren't sturdy enough to handle being used as a lever. There's a reason Tom Ness used steel in his Weed Wrench! (He developed the Weed Wrench while working on French broom in the Marin Headlands.) Consider using a long steel pry bar if you want to pry stubborn weeds out of the ground, limiting your use of shovels to lighter duty.

Picks and mattocks can be useful in rocky soils, or when the target plant has thick roots. Safety is particularly important with such tools. They should be carried head down, not over the shoulder. Keep well clear of others as you work. Swing the tool with knees bent and feet apart, so that you cannot slice into your shin. Swing from just above shoulder height and let the weight of the falling tool do most of the work.

When digging out plants, it's best to leave the soil on-site by shaking it gently from the roots and to avoid leaving large holes. Digging can cause considerable disturbance, so be certain that you have a plan to deal with the other weeds that may come in following disturbance. Visit the site again every few months to remove any weeds that have colonized the disturbed soil. If you stay on top of it, you can keep the early successional weeds under control relatively easily.

Scraping

Scraping tools are used to target seeds and small weeds or to create containment lines. Like digging, scraping is a form of soil disturbance, so make sure to deal with weeds that establish following scraping. Scraping tools can again be useful in that regard. Pattern hoes and oscillating hoes can be used to cut invasive plant seedlings and other small weeds just below the surface of the soil. McLeods and mattocks can do the same job. Tools with claws are especially useful for removing shallow roots from loose soil or duff.

Scraping is often undertaken to prepare a site for revegetation. Scraping a wild radish patch early in the season, not long after the radish seeds have germinated, will kill that batch of new radish plants and give you time to plant native

plants instead. Some prefer to scrape the area twice or three times in a season to reduce the weed seedbank before planting natives in the scraped area. Take steps to minimize the potential for erosion during the critical time between scraping and planting. If there are native plant seedlings or plantings in the area, hoeing should be done by more experienced volunteers who can recognize the native plants.

Cutting

For some plants, cutting them off at or near ground level is the best way to kill them. This way you avoid soil disturbance and don't have to mess with tenacious roots. This works best with species that don't resprout, but there are techniques that work with those that do. A tree can be cut at the base with pruners (if it is a small sapling), with loppers (a bit bigger), with a pruning saw (bigger still), or with a chain saw (much bigger). You might use all of these tools in a single day. Your choice about which tool to use will depend on many variables, particularly safety issues.

There are lots of different cutting tools and each one has an important role to play in your toolkit. Choosing the right one often depends on biological considerations, safety issues, and efficacy. Over the years, weed workers have developed several key techniques that involve cutting woody plant tissue in some manner. Here are some of the most useful ones.

Cutting. For some plants, cutting them off at ground level is sufficient to kill them. Monterey pine trees, for example, do not resprout as long as they are cut low enough. Cutting can also be a first step in preparing a plant for complete removal later. For instance, weed workers may use a chainsaw to trim back pampas grass to a point where they can dig it out of the ground. Infestations of weedy vines, which twine through woody thickets but are rooted in the soil, often require extensive use of cutting tools to clear away the thickets before the vines can be completely removed.

Grinding or macerating a cut stump. Stump grinding or macerating can also be used to prevent stump sprouts. Though grinding machines are expensive to rent and can be awkward to use in wildlands, some Bay Area weed workers have used them. Stumps are typically ground to a depth of about two feet below the ground. If only a few stumps need grinding, some weed workers remove enough soil around the base of the trunk so that they can cut it just below ground level without getting the chainsaw bar in the dirt. Some practitioners macerate cut stumps to inhibit sprouts. They do this by using a chainsaw to make cuts in a grid pattern (one- to two-inch squares) approximately two to four inches deep in the cut surface of the stump.

Tarping a cut stump with landscape fabric or black plastic. In this treatment, the stump is cut low and level, then covered tightly with landscape fabric to prevent it from getting any sunlight. The fabric is spread at least two to three feet beyond the edges of the root crown to prevent resprouts from photosynthesizing. Care is necessary to make sure that individual pieces of fabric have enough overlap so that resprouts can't squeeze up between the seams. Because seams tend to be a source of failure, avoid using tarps with seams if you can. The fabric is staked down every few feet—or even every six inches—with U-shaped wire staples to make sure the tarp is securely fastened. Some weed workers even dig a trench around the target and completely bury the edges of the tarp. Covering stumps is feasible only for small areas and needs to be checked two to three times a year to make sure that sprouts haven't burst through the fabric or emerged around the edge. Cut stumps may require up to a year or more of covering to prevent resprouting. The fabric can also be covered with mulch to improve the aesthetics.

Treating a cut stump with herbicide. Many plants, including blue gum eucalyptus and acacia, resprout vigorously after being cut. Repeated cutting may eventually sap the plant of its vigor, but it requires intensive follow-up work, and is seldom efficient unless you have extensive volunteer resources available to prevent resprouts from establishing. That's why many weed workers treat the cut stump with an herbicide such as triclopyr or glyphosate. Practitioners use a high concentration of herbicide—no more than 50 percent, according to some—and apply it immediately upon cutting since the plant tissue heals rapidly, inhibiting uptake of the herbicide. The herbicide needs to be applied only to the exposed cambium, the living tissue in the trunk. It's wasted anywhere else. Unless aesthetics or safety are problems, cut the stump flat at a height of eight to ten inches. Then if it resprouts even after treatment, the stump can be cut again and retreated with herbicide. If aesthetics are a concern, stumps can be cut low and level and, once the herbicide has had a chance to work, covered with a thin layer of mud or brush to reduce the visual impact of newly cut trees.

Girdling, frilling, and drilling. These techniques all take advantage of the vulnerability of the cambium in order to kill a standing tree without felling it. The plant will die if this narrow band of living tissue encircling the entire tree just under the bark is damaged in such a way that it cannot transport water and nutrients between the roots and the rest of the tree. If a small section remains uninjured, however, the plant will keep growing and perhaps even heal the wound over. In most cases, it is preferable to cut down trees, but girdling and the like can be useful in relatively inaccessible areas where the dead tree will become a snag that will be useful to wildlife. These techniques should not be used if the standing dead tree will become a safety hazard or an aesthetic problem, or if it is in an urban

setting that could generate controversy. Girdling involves cutting through the bark and the cambium all the way around the trunk, and is often done using a chainsaw. Frilling accomplishes the same goal without using power tools. Cut long slices downward through the bark to the cambium and then peel them downward. Frilling tends to lose its effectiveness on trees larger than two feet in diameter because their bark becomes too thick for peeling. Another technique, which can be even more efficient and effective, involves drilling small holes in the bark and injecting herbicide. You need to know the proper herbicide type, concentration, and amount. Some practitioners have found that when drilling and injecting herbicide, a 50 percent solution of glyphosate works best. As with all herbicide treatments, this treatment requires supervision, training, and a prescription from a state-certified applicator.

Weed whipping. The next two techniques rely on power tools to increase the number of plants you can cut. As a result, they can be more effective and efficient in certain situations, but also more dangerous. Weed whipping offers the cutting power of a lawn mower but can reach tight spots a mower won't. It relies on a more powerful version of a tool familiar to many homeowners and known variously as a weed whip, weed whacker, or string cutter. A brushcutter, a larger and more powerful version of the weed whip, can be fitted with nylon string, rigid plastic cutting blades, or a wide variety of steel blades ranging in suitability from brush to small trees. A gas-powered motor spins a cylinder at the end of a long metal tube. When a canister containing nylon string is attached to the cylinder, the brushcutter can be used for cutting grasses, seedlings, or herbaceous plants like yellow starthistle. The nylon string doesn't work very well when the vegetation is wet. If the area is perpetually damp, or the vegetation is thicker than can be cut using nylon string—even the newer versions that are reinforced with steel or Kevlar—consider using other techniques. The rigid plastic blades can be very effective with tougher herbaceous weeds or small brush seedlings.

Brushcutting. When fitted with a metal blade, a brushcutter can be very effective in opening up areas covered by tall stands of woody invasive species up to two inches in stem diameter. Brushcutting tends to be used with larger infestations and in places where plants have become overgrown. This can be used as a way to prepare a site for pulling plant roots with a Weed Wrench—in which case, don't cut the stems so low that the Weed Wrench won't be able to grab them—or treating the cut stumps with herbicide. It is sometimes a challenge to move plants that you have just cut so that they are not in your way for cutting other plants. A second person can help with this, but it presents obvious safety concerns. The engine is often loud and the metal blade can throw stones and other debris, so

operating a brushcutter (or working near one) requires extensive protective gear and safety training. For the operator, chaps, helmet, face screen, and ear protection are *de rigueur*. These hazards, particularly the noise, require you to be very sensitive to the safety and comfort of park visitors as well. Using a brushcutter along a busy trail is to be avoided. The metal blade can also throw sparks when it hits rocks, so avoid its use in dry conditions when the fire hazard is high; use plastic blades or string in such conditions.

Mowing. Gas-powered mowers, especially the heavy-duty types used by maintenance divisions in park and open space agencies, can provide some control of certain invasive plants in grassland situations. Yellow starthistle, for example, when mown just as it begins to flower, can be knocked back significantly if done for two to three years in a row. Mowing to prevent seed set can keep some invasives from spreading while you reduce the size of the infestation with other methods. Timing is key. Mowing after invasive annual grasses have gone to seed obviously won't help. Mowing can also present problems if the target plant's seeds can continue to ripen even after being cut off (many thistles) or will reroot or resprout from cut stems (Cape ivy). A tractor-mounted mower can be effective on large parcels. Many different sizes can be rented and delivered to the site. A trained operator is required, as is a site that has been cleared of barbed wire, rocks, and other things which could get caught in the blades. Mowing is often best done in combination with other techniques, like hand pulling subsequent seedlings if they're not too numerous.

Applying Herbicides

There are several simple techniques for weed workers applying herbicide in situations where the landowner or manager has established the appropriate protocols and procedures to comply with pesticide regulations. These techniques require training and supervision by a licensed applicator and should not be undertaken without landowner approval and training certification. Before using such techniques, consider posting signs notifying the public that herbicides are being applied in a particular area. (Depending on the jurisdiction, this may be required by law or regulation.)

Cut-stump treatment. The role of this technique is described in the cutting section above. Herbicide at high concentration is applied to the cut face of the stump either by painting it on with a small brush or by spraying it on using a small bottle like those used to mist houseplants. Because you have direct access to the cambium, the amount of herbicide required is low, especially given the size of the plant. There is little danger of the herbicide contacting other plants directly when using this treatment.

Foliar spray. This technique delivers herbicide to a plant through its foliage, so it uses herbicide less efficiently than in the cut-stump treatment. Because the herbicide is being sprayed, there is the possibility of contacting non-target plants, which can result in undesired damage if you're using a non-selective herbicide like glyphosate. Many applicators use a backpack sprayer, which typically carries several gallons of diluted herbicide. The sprayer tank is kept pressurized by pumping a lever, and herbicide is sprayed from a wand. Wind conditions are always measured, because you are prohibited from spraying in any breeze over a low threshold to avoid drift. To ensure sufficient uptake into target plants it is necessary to cover their leafy surfaces thoroughly. This is easy on small plants, and harder on larger plants. Foliar spray tends to be ineffective on plants that have leaves with thick waxy cuticles.

Wicking. A wicking wand has a sponge on the end that is used to wipe herbicide onto a plant. This can be used for a foliar treatment, in which it has the advantage of getting less herbicide on non-target plants, but the disadvantage of taking more time to coat all surfaces. Wicking wands can also be used for basal bark treatments on woody plants, where herbicide is painted around the bark at the base of the main trunk. This treatment uses special additives that allow the herbicide to penetrate the bark and move into the root system.

A Few Other Techniques

A few additional control techniques are hard to classify. These include:

Solarizing. This technique takes advantage of the vulnerability of plant tissue to extreme heat. A clear plastic tarp allows sunlight to penetrate but traps the heat. In sunny climates the heat can be high enough to kill the plants under the tarp. In practice, the technique is identical to that used in covering a cut stump with landscape fabric, but in this case a clear plastic covering is used. (See Tarping treatment for details.) Solarizing may require up to a year or more of covering to kill the plants underneath the tarp. This technique is ineffective in foggy coastal areas, but weed workers in the East Bay and other areas with hot summers may find it useful for controlling small infestations of certain herbaceous weeds. Some practitioners prefer black plastic, finding it more effective than clear plastic even in inland areas as well as along the coast.

Flaming. Like solarizing, this treatment also relies on the vulnerability of plant tissue to heat. In this case, a propane torch is used to speed up the process. Some weed workers have found that it can be quite effective in controlling the thousands of French broom seedlings that emerge after a large stand has been

removed. Others have recently cited success with poison hemlock. However, its true potential is yet unknown, since this agricultural weed control technique is only now being adapted to wildland weed species and conditions. Stay tuned! As experience accumulates, it's likely to become an important and effective tool for controlling herbaceous invasive plants or small shrub seedlings. Flaming has several advantages, including avoiding ground disturbance, extending the season to include wet and cold weather (using it keeps you warm), and providing greater selectivity than herbicides (it works only on very young plants). Technique, timing, and safety issues are key concerns. The seedlings are not actually burned, but rather heated to the point at which the water in the plant cells boils and ruptures the cells. (Some weed workers describe this technique as “blanching” rather than “flaming,” and if you know your cooking terms you know why.) This stage is not always obvious to the torch operator, so it can be a difficult technique to learn properly. It is best to learn from someone practiced in the art. This treatment should be used only when it is raining or immediately thereafter. For obvious reasons, a propane torch should not be used in wildlands when there is any risk of fire whatsoever. Like many of the techniques described in this book, it is important to gain approval from the land owner or manager prior to implementation, and in this case consultation with your local fire department is a wise precaution.

Mulching. Mulching can be effective for smothering small infestations of herbaceous weeds like kikuyu grass or Harding grass that are hard to control using other techniques. Cover it first with a weed barrier—landscape fabric, nylon, plastic, even cardboard or old carpet—and then place three to six inches of rice straw or wood chips on top of that. Some people prefer fabric over plastic because of its superior ability to let water infiltrate into the soil and prevent erosion problems. Be sure to get *weed-free* mulch. Once the plants underneath are dead, removing the weed barrier will allow you to revegetate the area with native plants. If the barrier material is biodegradable, you can also plant directly into the fabric, cutting small holes to insert plants. Using an organic mulch can alter soil conditions, so this treatment should be used only in areas that have been highly altered already.

Managing Debris Appropriately

Whether pulled, dug, or cut, invasive plants are still invasive plants. Dealing with such debris is an important and often underestimated dimension of weed work. This is especially true for plants like Cape ivy, which has an almost miraculous ability to regenerate from the smallest bits and shreds. (It's so tough that it's been known to resprout even after being bagged in black plastic and left in the sun for months in the heat of a Central Valley summer!) When making plans about how to manage invasive plant debris, take into account considerations like the plant's biol-

ogy, vehicular access to the site, available resources, and site aesthetics. Before embarking on a weed project, always ask yourself: what am I going to do about the debris? Here are some common techniques for dealing with invasive plant material:

Leaving on-site. This is the simplest method. Pull up the plant and leave it right there. It works only if your target plant cannot reroor or resprout, occurs in low densities, and decomposes quickly, as is the case with many herbaceous plants. If you're working on small, dispersed pioneer populations, this strategy often makes good sense.

Piling on-site. This treatment is commonly used for dense stands. By piling the debris in a few stacks rather than scattering it across the entire site, you will free up space for native plants to begin regenerating. (Building high stacks can also provide you and your volunteers with a visible sense of accomplishment—take pictures of your group in front of the debris pile at the end of the day!) Some weed workers pile debris in such a way that they can burn the stacks later in the year, during late fall or early winter, for example. (As with all land management involving prescribed fire, it's important to consult with the local fire department and obtain all appropriate permits.) Others have found that wood and brush piles can provide valuable habitat for wildlife. Aesthetic concerns may compel you to stash debris away out of sight, but this can lead to new infestations if you're not careful. Debris piles often need to be monitored for resprouts and hiding them can make them hard to relocate. If your target is a resprouting vine like Cape ivy, it is often best to cut a containment line around the debris or pile it in the middle of a large tarp. Bucking and tarping on top can also help. In such situations you can separate clean, completely uninfested woody debris (which won't resprout) from herbaceous debris containing Cape ivy. This will reduce the number of Cape ivy-infested piles, and it will be easier for you to deal with resprouts if they're not entangled with branches. Whatever approach you use, monitor regularly for resprouts for several years.

Avoid piling dead plant material in areas where target weeds are likely to grow. For example, if the target quickly colonizes moist soils, consider placing debris in upland areas.

Hauling off-site. This treatment is feasible only when the site is easy to access by vehicle. It is a useful option when working with tree debris or weeds like Cape ivy that have the ability to resprout from the tiniest stem. Hauling and dumping fees can be quite expensive, so be sure to estimate accurately the volume of debris before choosing this technique. For plants that spread by seed, you can reduce the amount of debris by cutting and bagging the seed heads from the invasive plant before removal. This is sometimes done with pampas grass, but only in outlier popula-

tions. When invasive plants are still in the early stages of invasion, it is also often worthwhile to bag plants that may contain viable seeds. Better to haul a few bags away than to take a chance that the viable seeds will reinfest the site. And of course, you want to make sure that the destination site for your hauled debris is not likely to be the source of further infestations (landfills are generally fine, as are composting operations as long as they are hot enough to kill weed seeds or fragments).

Chipping on-site. This treatment can be useful if you are dealing with tree debris and the site is easy to access by vehicle. Branches up to three to four inches in diameter can be chipped into the back of a truck or, if ecologically appropriate, left on-site. Larger pieces of wood can be hauled away for lumber or firewood or left on-site. Like chainsaws and brushcutters, using a chipper requires training and careful safety practices. Make sure you have trained operators prior to using chippers.

TOOL SAFETY, CARE, AND SELECTION

Using a tool safely depends on knowing how to use it properly. Some tools, like a trowel or a dandelion digger, are easy to figure out on your own. Even if you don't quite get it right the first time, you can't inflict much damage on yourself (though one weed worker reported getting a bad blister on his palm the first time he used a dandelion digger without gloves!). Your margin of error for safety is much smaller when working with power tools or tools with sharp blades. That's why it is best to insist on proper training in tool use and safety.

Those working with volunteer weed workers often rely on manual tools because it is possible to train volunteers to use them safely and properly in a relatively short time. Teaching someone how to use a Weed Wrench takes no more than five minutes. Using a Weed Wrench is not without risk, but the infrequent injuries that can occur are relatively minor—bruises, bumps, and backaches mostly. As this example illustrates, many manual tools have two important advantages over other tools: they are relatively simple to use and the risks of their use are relatively minor. (That said, even simple tools like hand picks can be quite hazardous in the hands of a rambunctious crowd of teenagers. Remember one of the ABC lessons in chapter 3: know your Audience!)

It is true that volunteers can be taught how to safely use manual tools with sharp blades. Using a machete is straightforward—it's a simple and very effective tool in brush—but the consequences of an accident are much more severe than they are when using other tools. That's why very few weed workers who work with volunteers use machetes. They choose tools more appropriate for the skill level of their volunteers, even if this means avoiding tools that may be more effective in objective terms (that is, when used by an experienced worker).

Choosing the right tool for the job is not just a decision about technology, but also about sociology. Chapter 4 contains additional considerations about tool safety and use when working with volunteers.

All weed workers using power tools should receive careful training in tool safety, use, and care. For public agencies who are willing to allow volunteers to use power tools—and such agencies are in the minority—this often takes the form of an all-day or half-day workshop.

A well-made tool can last a long time if it is cared for. And a well cared-for tool is also a safer tool. Tool care is often a neglected art, though, which has led exasperated managers to take several approaches for dealing with the problem. One approach is to dedicate the last fifteen minutes of a work party to tool care and cleaning. (Removing seeds and soil from tools and boots is important when dealing with invasive plants because otherwise there's a chance that you and your tools will be transporting invasive plant seeds.) Or you can set aside one work day every few months to paint, repair, and sharpen your tools. Some programs find dedicated volunteers or staff members who enjoy tool care to take responsibility for tool maintenance.

If you have responsibility for choosing tools, choose high-quality ones. Cheap tools usually fall apart rapidly under the stress of vigorous weed work. (On the other hand, you may be better off with relatively lightweight tools, especially if you work with children.) You may choose to purchase or borrow a variety of tools for your work parties—all kinds of volunteers are then likely to find something they're comfortable with—or focus on just a few types of tools, simplifying your planning and training.

WEED WORKERS' TOOLS EXPLAINED

Tool	Target	Considerations
PULLING		
Weed Wrench	tap-rooted shrubs, small trees	works best in winter and spring when soil is moist; can cause soil disturbance; works best with vertical rather than horizontal taproots
pliers	seedlings, narrow-stemmed plants	easy to carry; easy to lose
McLeod, rake	vines	
DIGGING		
round-point shovel		standard multi-purpose shovel; long handles increase leverage; some may prefer short handles
spade		flat-edged, short-handled shovel; only marginally useful
transplanting spade, or sharpshooter		long narrow-bladed shovel, effective on deep root systems; forged steel work ones are much better than cheap stamped steel; if careful, can be used to lever plant out of the ground
trowel	small plants	useful for planting or transplanting small plants; good tool for children
soil knife	small, tap-rooted plants	point penetrates pliable ground easily; serrated blade lets you cut what you can't dig; creates less soil disturbance than trowel
dandelion digger	small, tap-rooted plants	
mattock	deep-rooted plants	requires proper training
Pulaski		a favorite all-purpose tool for many weed workers; useful for grubbing out or cutting down almost any plant; can be used for frilling and girdling; light-weight versions available
hand pick		one-hand tool for smaller scale weed removal
digging bar, rock bar		useful for loosening hard soil and rocks deep below the surface; can bend if used for prying
pry bar		useful for prying up roots

Tool	Target	Considerations
SCRAPING		
McLeod, cultivator fork, other tools with tines	mats of invasive perennials in monoculture, including grasses	McLeods are a good multi-use tool for scraping surface debris from the ground, hacking out small roots, and raking small brush; requires follow-up for resprouts and seedlings; requires some training
pattern hoe	seedlings and small plants	requires basic training
oscillating hoe	seedlings and small plants	can push or pull, providing versatility; requires basic training
CUTTING WOODY PLANTS		
pruners	woody stems <1/2 inch in diameter	anvil pruners (one sharp blade and one flattened one) require less force to cut the same stem than bypass pruners (sharpened blade slides past curved blade); inexperienced users can ruin bypass pruners by twisting them in the cut; bypass pruners can make cleaner cut
loppers	woody stems 1/2–2 inches; tree and shrub limbs; stalks of large herbaceous vegetation	loppers come in two basic types too: anvil and bypass (see above); longer handles allow for greater leverage when cutting through woody stems; can be ruined if used inappropriately; requires some basic training
pruning saw	woody stems <10 inches in diameter	some come in a folding version; a favorite tool for many weed workers; can get pinched in large branches if not careful
hatchet, ax	large shrubs, small trees	useful when you don't have access to a pruning saw or chain saw; let the falling weight of the tool do the work; position your feet so that you won't accidentally hit your legs if you miss; dangerous tool in inexperienced hands; also used for frilling and girdling
Pulaski	large herbaceous plants, large shrubs, small trees	can be used like an ax to cut, frill, or girdle, can be used to hoe out root pieces; requires training for both safety and technique
bow saw	woody stems <18 inches in diameter	available in many sizes; useful for sawing through limbs and small trees; used primarily for large blocks of wood like logs; commonly used in trail work
limbing saw	woody stems <18 inches in diameter	mostly used by arborists for small limbs

Tool	Target	Considerations
chainsaw	woody stems	versatile but noisy and requires extensive safety training; helpful and safer to work with a swamper to remove debris and provide assistance when required
brushcutter	woody stems <4 inches in diameter using steel blade	versatile but noisy and requires safety training; helpful and safer to work with a swamper to remove debris and provide assistance when required; should not be used on steep or very rocky slopes

CUTTING HERBACEOUS PLANTS

weed whip	small areas of grasses, herbaceous annuals, or perennials	versatile but noisy and requires safety training; useful for light-duty selective mowing in grasslands
brushcutter	grass or seedlings using nylon string or rigid plastic blades; vines or groundcover using toothed steel blades	versatile but noisy and requires safety training; helpful and safer to work with a swamper to remove debris and provide assistance when required; should not be used on steep or very rocky slopes
mowers	grass or herbs	useful in large, flat areas
machete	almost anything	too dangerous for common use; requires proper training in both sharpening and user technique; must be regularly and expertly sharpened; a dull machete is more likely to cause injury
scythe	grass	not commonly used anymore, but can be a very effective tool, if sharp and used properly, in uniform grasslands; difficult to learn proper techniques for sharpening and use
hand scythe	grass; inflorescence removal before seed dispersal	relatively safe, good for cutting grass in sensitive areas; not appropriate for large-scale control
Swedish brush ax	brush and small woody stems < 4 inches diameter	relatively safe, but any sharp-edged tool entails risk; requires proper training
Japanese sickle		relatively safe, but any sharp-edged tool entails risk; requires proper training
pocket knife	shrubs and small trees	can be used for girdling when no other tool is available; versatile multi-use tool that can come in handy

OTHER

flaming equipment (propane torch and portable tank)	small seedlings, soon after germination	safety an issue; best conducted in wet season; may require multiple treatments in one season as germination is staggered
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Tool	Target	Considerations
landscape fabric, black plastic (6 or 10 mil)	clonal mats of vines and grasses	use plastic rather than fabric when moisture barrier is needed; use fabric to allow moisture percolation into the soil; 6 mil breaks down in about a year in sun; 10 mil lasts at least twice as long
wire staples		staples can be used for securing fabric edges when the ground is pliable; otherwise dig a trench and bury the edges; requires long-term commitment of 1–2 years; must be well-fastened to endure weathering 1–2 years; not for use in high-wind environments; aesthetics may be an issue
wheelbarrow, plastic bag, woven polypropylene bag, tarp		all can be used for hauling vegetative material; wheelbarrows can be bulky and unwieldy to handle on pickup trucks; plastic bags rip easily; some prefer to use strong tarps, which can be lifted at the corners and dragged or carried
rake		useful in areas with high visitor use; flexible rakes useful for cleanup; hard rakes useful for piling debris
push broom		useful in areas with high visitor use
hay fork, scooping fork, ensilage fork		great for loading or unloading vegetative material
static kernmantle rope		knowing a few basic knots turns a length of rope into an assist for short climbs, a loop for dragging brush, and a multitude of other uses

WEED WORKERS' TOOLS ILLUSTRATED

(note: drawings are not to scale)



**weed
wrench**



McLeod



**oscillating
hoe**



**round-point
shovel**



**fire
rake**



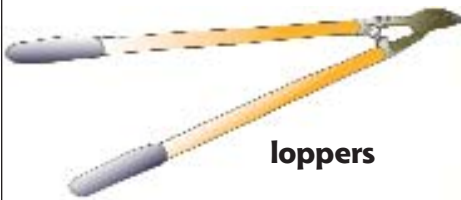
rake



Pulaski



hand pick



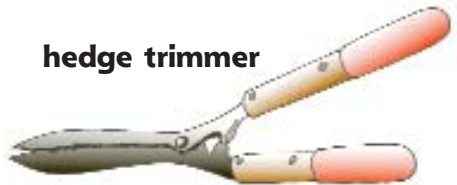
loppers



small loppers



hand saw



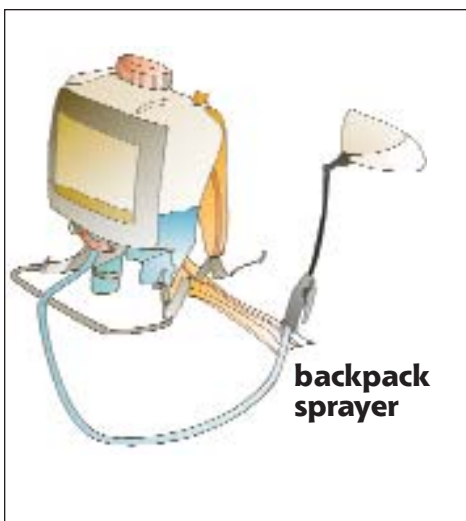
hedge trimmer



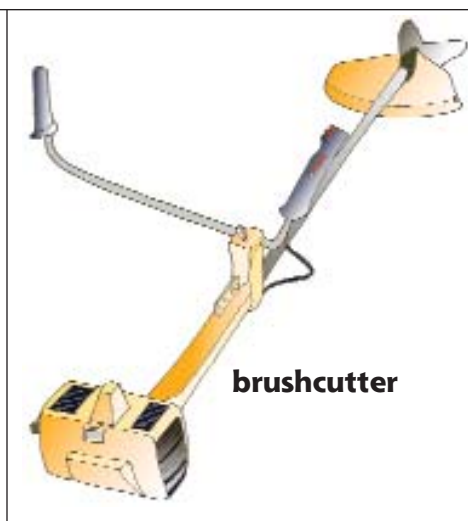
machete



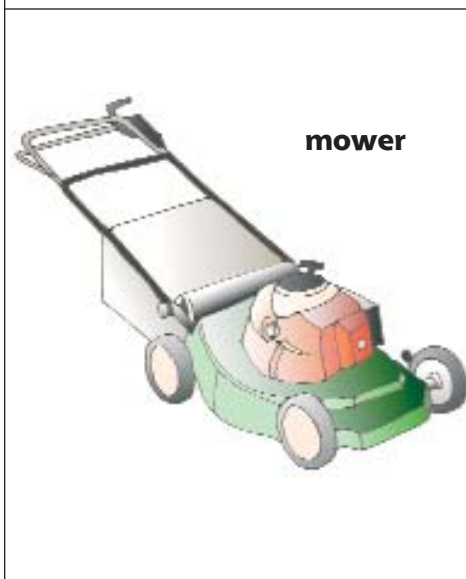
soil knife



**backpack
sprayer**



brushcutter



mower



**weed
flamer**