

## Chapter 20

# Manual, Mechanical, and Cultural Control Methods and Tools

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There are many land management scenarios where chemicals are not the ideal choice for controlling invasive plants. More often than not, the best approach is the use of integrated pest management involving a variety of control methods. Maximizing the value of mechanical, manual, and cultural control methods with the added benefit of selective herbicides can offer the best results in many situations. It is important to choose durable and tested tools when utilizing manual and mechanical control as these labor intensive methods can be very time consuming. Down time due to use of inadequate tools can result in missed deadlines and often in poor mortality rates which require expensive retreatments. Land managers should also be aware of cultural methods of integrated pest management which are often overlooked. Mulching, soil solarization with plastic film, thermal weed control, water level manipulations, prescribed burning, and prescribed grazing are cultural methods that can play a key role in the reduction of invasive plant populations.

## I. Introduction

Due to the sensitivity of some native species to herbicides, manual, mechanical, and cultural control methods are widely used to manage invasive plants in natural areas. However, except in cases where the entire plant (above ground stems and root systems) can be removed, most of these methods represent short term solutions for land clearing that are used along with chemical control

methods. Once above ground stems and root systems have been removed, it is much easier to control germinated seedlings and other regrowth with herbicides.

## II. Manual Control Methods and Tools

Manual removal is best suited for smaller plants with a shallow root system that are growing in loose soil [e.g., Chinese privet (*Ligustrum sinense* Lour.)]. As such, manual removal is expensive and time consuming, but can be used as a component of invasive plant control (Figure 1).



Figure 1. Hand removal of invasive plants. Image by Steven Manning, Nashville, Tennessee.

Hand pulling or grubbing is often the quickest and easiest way to halt invaders when first spotted and can be a very effective tool for volunteers. However, roots that break off during extraction will sometimes resprout. Manual removal can also cause unwanted soil disturbance which can result in conditions favorable to invasive plant reinvasion. Frequent visits over the course of several years are often necessary for success with manual control.

### A. Digging Tools

Digging tools rely on either operator weight or strength to uproot non-native plants from the ground. Available products range from 6:1 to 24:1 pulling power. For example, with a minimum 12:1 ratio, if the operator applies 10 lbs of body weight to the end of the handle, he or she is applying initially 120 lbs. of uprooting force to the plant. Some brand names include the Weed Wrench™ (Figure 2), Honeysuckle Popper™, Root Talon™, and Extractigator™.



Figure 2. Weed wrench for pulling invasive plants out of the ground. Image by Steven Manning, Nashville, Tennessee.

## B. Mattocks

Mattocks are the tool of choice when manual control is required. A mattock with an ax on one end of the cutting tool and the digging tool on the other is preferred over a pick ax when controlling invasive plant species. For species that readily re-sprout from the roots [e.g. Beach vitex (*Vitex rotundifolia* L. f.)], the entire root system should be removed. However, for species with root crowns [e.g., Kudzu [*Pueraria montana* (Lour.) Merr. var. *lobata* (Willd.) Maesen & S. Almeida], it is only necessary to remove the crown and any rooted vine nodules (Figure 3).



Figure 3. Manual removal of kudzu crowns by the South Carolina Kudzu Coalition, Spartanburg, S.C. July 2, 2007. Image by Randy G. Westbrooks, U.S. Geological Survey, Whiteville, North Carolina.

### C. Hand Clippers and Loppers

Hand clippers and loppers are required when mechanically controlling climbing vines or small multi-stemmed woody species (Figure 4). Always follow the vine or stem to the point where it emerges from the ground. If you are unable to unearth the stem, cut as closely to the ground as possible and remove debris. To effectively control most non-native species, it is necessary to apply an appropriate herbicide to the wound. When this is not an option it will be necessary to repeatedly cut when resprouts appear until there is no regrowth.



*Figure 4. Hand loppers. Image by Steven Manning, Nashville, Tennessee.*

### D. Machetes

Machetes are useful tools for stem injection and in certain scenarios, cutting and treating. Various machetes are available on the market (Figure 5). Good qualities in a machete include solid handles and easy to sharpen blades. Sharpening tools should be taken to the field and repeatedly used to ensure the most efficient and safest use.



*Figure 5. Machetes. Image by Steven Manning, Nashville, Tennessee.*

## E. Girdling Tools

Both manual and gas powered girdling tools are available on the market that are created specifically for girdling trees (Figure 6). Other tools such as chain saws and axes can also be effective. Girdling severs the bark, inner bark, and some the sapwood in a ring extending entirely around the trunk of a tree to stop sugar and water movement. If the ring is wide and deep enough it will keep the girdled area from growing back together. This technique does not work on all non-native tree species. Often it is necessary to add an herbicide to the area of the trunk that has been girdled to ensure effective treatment. Girdling may result in additional hazards as subsequent dead standing trees decay and fall over time. Therefore girdling is not recommended in high use areas (along trails or around structures).



*Figure 6. The 'ringer' – an effective tool for girdling thin barked invasive trees. Image by Steven Manning, Nashville, Tennessee.*

**Note:** A chemical application is often necessary after girdling for many hard to treat plants.

## III. Mechanical Control Methods and Equipment

Mechanical treatments complement herbicide control and sometimes increase efficiency. Mechanical control ranges from the use of chain and brush saws, to mowers, bulldozers, and specialized logging equipment to remove woody plants. Follow up with other control methods is essential after the use of mechanical methods because disturbance of the soil creates favorable conditions for invasive plant regrowth from seeds and root fragments (Figure 7). It may also be necessary when using non selective larger mechanical tools to prepare a plan for replanting the site. Mechanical removal with larger equipment may not be appropriate in natural areas because of disturbance to soils and nontarget vegetation.

Although ineffective by themselves to achieve eradication, mechanical treatments can give added kill of herbicide weakened plants and have a place in an integrated pest management program. The stumps and stems of non-native trees, shrubs, and bamboos can be treated with herbicides immediately after cutting to

kill roots. Disking and root raking, if applied correctly, can dislodge herbicide damaged woody roots and large runners, leaving them to dry and rot.

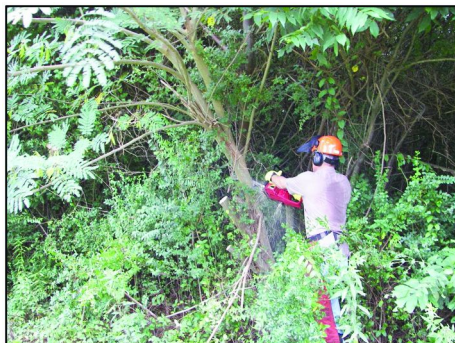


When using mechanical methods, be prepared to follow up to maintain regrowth from broken roots and missed stems.

*Figure 7. Broken roots left by mechanical control methods – roots that can resprout if not removed or otherwise treated. Image by Steven Manning, Nashville, Tennessee.*

### **A. Chain Saws, Brush Saws, and Mowers**

Cutting woody and herbaceous plants by chain saw, brush saw, or mowers remove only aboveground plant parts without killing the roots. String trimmers can reduce infestation densities and injure thick waxy leaves to improve herbicide uptake and effectiveness (Figure 8).



*Figure 8. Lee Patrick, Invasive Plant Control, Inc., Nashville, TN, cutting down a Mimosa tree (*Albizzia julibrissin* Durazz.) with a chain saw. Image by Randy G. Westbrooks, U.S. Geological Survey, Whiteville, North Carolina.*

## B. Mulching Machines (Land Clearing Machines)

Mulching machines are best used in nonselective scenarios where the cost of selective control is far too prohibitive and may result in non-action for the project. Mulching machines are land clearing tools that can cut through dense stands of non-native woody plants at a rate of 2 - 4 acres per day for a one man operated machine (Figure 9). When the cost for control utilizing cut and treat methods is prohibitive, one solution in non-sensitive areas is to initially use a mulching machine and follow up the next growth season with a foliar application to resprouts. Because only the above ground portion of the plant is disrupted, this method requires substantial follow up herbicide treatments to effectively control a site.



*Figure 9. Mulching machine. Image by Steven Manning, Nashville, Tennessee.*

## C. Grubbers

Grubbers are sharp, U-shaped blades mounted on the front of crawler tractors, wheel loaders, excavators, or farm tractors to uproot individual trees or large shrubs (Figure 10). Tractor size and type depend on the size of trees to be grubbed and the type of terrain. Units are available commercially, but many are fabricated in welding shops. Some units clamp the tree and pull the tree from the soil. Grubbers are also good brush thinning tools. Farm tractors with small, three-point-hitch grubbers are popular for use on limited acreages of previously cleared areas. Grubbing is not practical in rocky soil or when tree densities are more than 250 per acre over extensive acreages.



*Figure 10. Grubbing machine. Image by Steven Manning, Nashville, Tennessee.*

#### **D. Bulldozers**

Heavy equipment such as bulldozers can be used to uproot non-native plants but can be very damaging to the soil and surrounding vegetation. Bulldozers (or tracked tractors) are made in a range of sizes, and smaller sizes have been effectively used for woody invasive plant removal. Highly developed bulldozer attachments equip them for residual tree sheering and piling, soil preparation, tree planting, and fire line plowing. Use of bulldozers can be effective along fencerows and some right-of-ways but are not the preferred tool in sensitive natural areas.

#### **E. Mechanical Root Raking and Disking**

Mechanical root raking and disking can actually intensify and spread infestations of invasive plants with runners by chopping them into resprouting segments and transporting them on the equipment (Figure 11). Fireplows can also spread invasive plant rhizomes and roots. However, root raking, piling, brush mowing, mulching or burning may be the only way to start controlling dense infestations of multiple woody invasive plants.



*Figure 11. Kudzilla – kudzu root raking machine. Kudzu Coalition, Spartanburg, S.C. Image by Randy G. Westbrooks, U.S. Geological Survey, Whiteville, North Carolina.*

## IV. Cultural Control Methods and Equipment

Long term control of non-native invasive plants requires not only controlling the problem plants but creating a system that prevents establishment of undesirable species. Numerous cultural practices can be utilized to effectively control non-native plants. Prescribed burning and water level manipulation are cultural practices that can reduce invasive plant populations.

### A. Mulching

Mulching blocks light, preventing weed germination and growth. Some mulch materials require a thicker application layer to block all light. One effective mulching method is using both cardboard and organic mulch. This treatment can be effective for dense groundcovers by completely covering and overlapping edges of the treatment area with cardboard. Cover cardboard with organic mulch and create water holes where water pools. The cardboard can be left to compost in place and will suppress all vegetation underneath.

### B. Soil Solarization with Plastic Film

Plastic films such as black polythene sheeting are considered mulch for weed control by absorbing most ultraviolet, visible and infrared wavelengths. They can be used to suppress invasive weed growth but are not considered a long term option. If this method is chosen it is beneficial to use a product made from biodegradable material.

## C. Thermal Weed Control

Thermal weed control techniques (through flaming, hot water, and steam) typically apply heat directly to the unwanted vegetation, and quickly raise the temperature of the moisture in the plant's cambium cells (Figure 12). The rapid expansion of this moisture causes the cell structure to rupture, preventing nutrients and water from entering the stalk and leaves, with dieback resulting in most plant species. However, thermal weed control methods are costly and slow and do not provide residual weed control. These methods also use large amounts of energy per unit area which causes air pollution. While thermal control methods have no apparent negative impacts on surface or underground water, the energy input for thermal weed control is much higher than that for chemical control.



*Figure 12. Propane burner for weed control. Image by Steven Manning, Nashville, Tennessee.*

### 1. Flaming

Flaming heats plant tissues rapidly to rupture cells but not burn them. Flaming equipment can be purchased in a variety of sizes from walk behind to tractor hitch models. Best results are obtained under windless conditions as winds can prevent the heat from reaching the target weeds. Flaming is a good tool for small infestations along trail edges but must be conducted regularly to address the entire invasive seed bank.

## 2. *Hot Water*

Hot water weed control is advantageous to flaming because it poses little danger of starting uncontrolled fires. Leaves and shoots of treated plants will change color and die-back within a couple of days of treatment, but many non-native plants will regenerate since the roots are not sufficiently damaged. Thus, repeated applications are necessary. Hot water treatment equipment is commercially available; however such equipment requires large amounts of water and energy, which is costly. While the option is not practical on a large scale, it can be an effective tool for spot treatments in environmentally sensitive areas.

## 3. *Steam*

Steam offers several advantages over hot water in that it uses less water and may provide better leaf penetration. Like hot water treatments, steaming can be a beneficial tool for controlling nonnative plants when utilized on small infestations and spot treatments where herbicides cannot be used. Steam treatments eliminate fire risks and flame damage to sensitive environments. Also no smoke is produced when weeds are steamed rather than flamed. The disadvantages include the consumption of a high rate of fuels needed to operate equipment plus it is a time consuming method. This method also destroys microbes within the soil due to high water temperatures.

## D. Prescribed Burning

Prescribed burning is the deliberate use of fire under specified and controlled conditions to achieve a resource management goal. Most states train burn specialists through a Certified Prescribed Burn Managers Program and require that them to have some sort of liability insurance protection as well (Figure 13). Like all other invasive treatments, prescribed burning requires special skills and experience, including smoke management, for effective and safe implementation. Resprouts of trees, shrubs, and vines that are top-killed by burning or brush mowing can be more easily treated with foliar sprays, often the most cost-effective way to use herbicides. Herbicide applications should be delayed after burning, disking, or mowing to permit adequate resprouting of target plants and, thereby maximizing herbicide uptake and effectiveness. With mechanical and burning treatments, take precautions, such as burning in late winter or spring leaf-out, to minimize the period of bare soil. The most effective time for controlling woody invasive plants and their seedlings with fire is after plants have initiated growth in spring.



Figure 13. Prescribed burning. Image by Steven Manning, Nashville, Tennessee.

Prescribed burning can also destroy invasive plant seeds. Burning can prepare the site for effective herbicide applications by clearing debris and revealing application hazards, such as old wells and pits.

#### **Prescribed Burning Safety**

Prescribed burning requires hard hats, fire resistant shirts, fire shelter, eye protection, fire resistant pants, gloves and hearing protection.

### **E. Water Level Manipulation**

In areas where water level can be manipulated, flooding or draw downs can reduce invasive plant species in aquatic and wetland habitats, but is usually not effective as stand-alone treatment. This method is species and site specific. Land use history and species ecology are critical in understanding the effects of fire and flooding on the resulting plant species composition. Past practices affect soil structure, organic content, seed bank and species composition.

### **F. Prescribed Grazing**

Prescribed grazing is a type of biological control that relies on cattle, sheep, goats, and horses to reduce infestations. Grazing is a potential control treatment when the target species is palatable and not poisonous to the animal. This method rarely yields eradication and may actually spread seeds [(e.g., tropical soda apple in pastures (*Solanum viarum* Dunal)].

All herbivores could theoretically be biological control agents, but in reality most herbivores released against invasive plants are insects. Development of

biological controls takes years and cannot be relied upon solely to control invasive plant problems in the eastern U.S. Purple loosestrife is one of the few eastern US species with a successful biocontrol agent in place. Introduction of animals such as cattle, sheep and goats can be used to suppress the growth of certain invasive plants (e.g., kudzu). However, herbivores represent a non-selective option, and often require supplementary nourishment and protection (e.g., fences and guard dogs). As shown in Figure 14, **goats** are regarded as concentrated feeders that can be used to control primarily woody vegetation such as shrubs and low hanging tree limbs (browse). **Sheep** are intermediate feeders that are used primarily for control of forbs (broadleaf herbs other than grass). **Livestock** are roughage feeders that are used primarily for control of grasses (Figure 14).

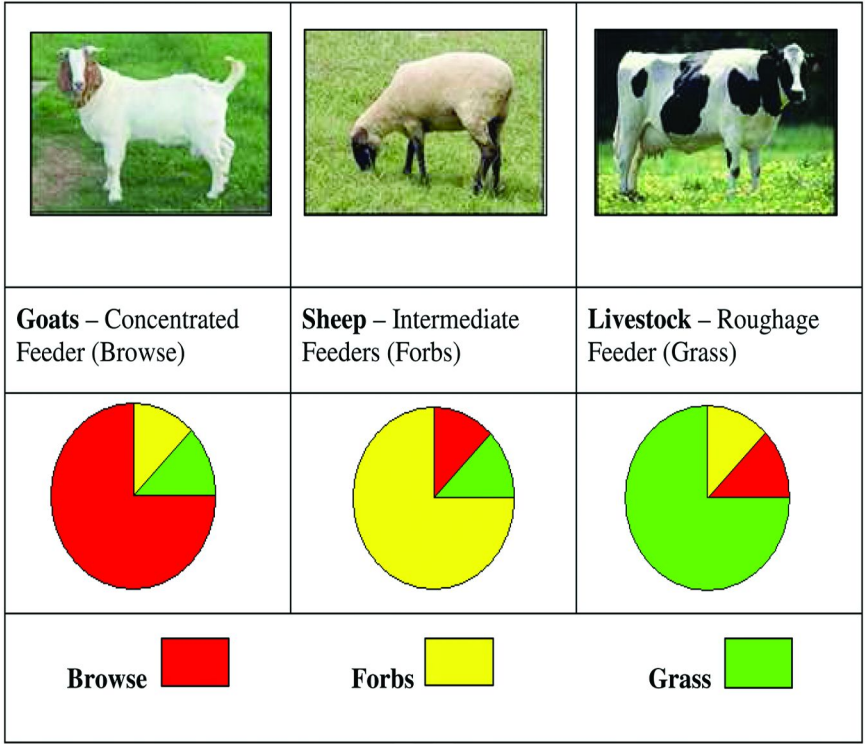


Figure 14. Prescribed grazing by different herbivores. Images by Steven Manning, Nashville, Tennessee.

## V. Summary

Manual, mechanical, and cultural control methods are widely used to manage invasive plants in natural areas. Manual control methods are best suited for control of smaller plants with a shallow root system. Manual control methods and tools include hand pulling, grubbing, digging tools, mattocks, hand clippers, loppers, mattocks, and girdling tools. Mechanical control methods are often used to complement herbicide treatments. Mechanical control ranges from the use of chain saws and brush saws, to mowers, bulldozers, and specialized logging equipment to clear vegetation from large areas. Mechanical removal with larger equipment may not be appropriate in natural areas because of disturbance to soils and non-target plants. Long term control of non-native invasive plants requires not only management of problem plants but creating a system that prevents further establishment of other undesirable species. Cultural practices that help to achieve this goal include mulching, soil Solarization with plastic film, thermal weed control (e.g., flaming, hot water, and steam), prescribed burning, water manipulation, and prescribed grazing with domesticated herbivores (e.g., cattle, sheep, goats, and horses). Maximizing the use of manual, mechanical, and cultural control methods with the added benefit of selective herbicide treatments can offer the best results in many situations.