Cultural Control Strategies

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Cultural control strategies use specific techniques to manipulate the environment to improve the growing conditions for desirable species while reducing weed populations.

MULCHING

Mulches of wood chips, straw, grass clippings, paper, rocks, rubber, black plastic, or landscape fabric can be used to control weeds. Mulching is typically done on relatively small areas where the application can be monitored. Mulching works best on annual weeds and cannot control some perennial weeds because their extensive food reserves allow them to continue to grow up through the mulch.

Wood chips are often used in forestry / wildland settings where woody weeds and undesirable vegetation can be shredded into wood chips and left onsite as mulch. In order to be effective as a weed barrier, the mulch should be 3 – 6 inches thick.

Landscape fabrics are also used as mulches but are more commonly used on a smaller scale as they tend to be more expensive. These fabrics are heavy, sometimes woven and are made of polypropylene or other weather-resistant materials. Water passes through them slowly and many are made to prevent weeds from growing through them.

When using organic mulches like wood chips, straw, or grass make sure the material comes from a weed free source and / or does not contain any weed seeds or fragments.

BURNING

The most effective fires for controlling invasive plant species are typically those administered just before flower or seed set, or at the young seedling/sapling stage. Sometimes prescribed burns that were not originally designed to suppress an invasive species have that happy side effect. But in some cases, prescribed burns can unexpectedly promote an invasive, such as when their seeds are specially adapted to fire, or when they resprout vigorously. These prescriptions must be modified or other management actions taken to undo or reverse the promotion of the invader.

Most successful weed control efforts that result from burning are due to the restoration of historical (natural) fire regimes, which had been disrupted by land use changes, urban development, fire breaks, or fire suppression practices. Many prescribed burn programs are, in fact, designed to reduce the abundance of certain **native** woody species that spread into unburned pinelands, savannas, bogs, prairies, and other grasslands. Repeated burns are sometimes necessary to effectively control weedy plants, and herbicide treatments may be required to kill the flush of seedlings that germinate following a burn.

Spot-burning invasive weeds with a propane torch can be cheaper and easier than implementing a prescribed fire (permits are still required), but is only effective when the infestation is small. Spot-burning can be used to burn individual plants, groups of plants in a small area, or to ignite brush piles. Propane torches can be used in areas where there is little or no fine fuel to carry a prescribed burn, and can also be used to kill plants when conditions are wet.

Prescribed Burning and Herbicides

Some invasive species have underground storage organs that resprout vigorously after fire, and/or seeds whose germination is stimulated by fire. Some of these species may not be possible to control with fire, but some can be controlled with repeated burns and others may be especially vulnerable to herbicides after a burn. Resprouts or seedlings that are 1 to 3 months old are often especially sensitive to herbicides.

Timing of Burn

The timing of a burn can strongly affect the fire's impact on native and exotic plant populations. For example, in California's Carrizo Plain Natural Area, Meyer & Schiffman (1999) determined that warm-season prescribed burning (late-spring and fall) was most effective for reducing abundance of Mediterranean annual grasses. Native plant cover and diversity also increased significantly following warm-season prescribed burns. Winter burns, however, did not affect the abundance of native plants, and exotic plant cover was only moderately reduced.

Timing was also key in controlling smooth brome *(Bromus inermis*) and encouraging the growth of native grasses in Nebraska and Minnesota (Willson & Stubbendieck 2000). Timing prescribed burns so that they occurred at the time of tiller (aboveground lateral stem) elongation, yielded an immediate and persistent reduction in both tiller density and biomass of smooth brome.

Burning in Extensively Disturbed Areas

Not all burn treatments in wildlands are beneficial. When fires become too intense, crown-fires and death of native plants that typically survive fires can result. If temperatures are too hot, soil organisms and seeds, even those of species that require fire stratification for germination, may perish, and valuable soil nutrients may be volatilized or otherwise lost. In extensively disturbed areas of southwest Australia, fire actually enhanced the invasion of weeds along roadsides, and resulted in an overall decrease in the abundance of native species (Milberg & Lamont 1995). Schwartz & Heim (1996) reported that fire was at best moderately successful for garlic mustard (*Alliaria petiolata*) control in Illinois forests, and Luken & Shea (2000) determined that repeated prescribed burning had no significant effect on garlic mustard in Kentucky. In both cases, however, the burns were detrimental to native herbaceous species, reducing both density and richness. Even three years after the initial burns, native plant composition did not recover to pre-burn values.

Preventing Spread of Weeds

Keep all equipment, trucks, and engines clean of weed seeds. After each burn, and before moving to another site, be sure to clean (hose-off) all equipment, tools, and clothing used. This will minimize changes of carrying weed seeds directly to a new site where a fire might provide perfect conditions for their establishment.

Examples of weeds that have been controlled by prescribed fire, and the effects of burning on these weeds.

Scientific Name	Common Name	Effects of Burning	Reference
Bromus inermis	Smooth brome	▪ burning at time of tiller elongation, yields an instant and persistent reduction in tiller density and biomass	Willson 1990 Willson & Stubbendieck 2000
Bromus japonicus	Japanese brome	▪ litter accumulation aids in the growth of Japanese brome; burning once every 5 years will reduce litter and *B. japonicus* cover	Whisenat 1990
Centaurea maculosa	Spotted knapweed	▪ repeated burning will reduce spotted knapweed, but it is often difficult to get a burn to carry through dense knapweed patches ▪ burning is only effective where regrowth of native species is vigorous	Mauer 1985 Watson & Renney 1974
Cirsium arvense	Canada thistle	▪ fewer thistles were seen in years following a burn than before or year of the burn ▪ late spring burns (May-June) are most detrimental – thistles may increase the first year following a May burn, but will decline within 2 growing seasons; immediate reductions in thistles occur following a June burn ▪ early spring burns can increase sprouting and reproduction ▪ during first 3 years of control efforts, burning should be conducted annually	Evans 1984 Hutchinson 1992 Sather 1988 Smith 1985
Dipsacus sylvestris	Teasel	▪ in sparse stands, late spring burns are effective ▪ little control is provided by burning in dense stands, because fire will not carry through ▪ burning works best in conjunction with other means of control	Glass 1991
Euphorbia esula *Euphorbia cyparissias*	Leafy spurge Cypress spurge	▪ fire stimulates vegetative growth ▪ fire followed by herbicide treatment has been effective, because the regrowth is more vulnerable to herbicides ▪ late fall herbicide application of picloram and 2,4-D followed by a fall burn resulted in 100% control after 2 years of treatment	Biersboer & Koukkari 1990 Cole 1991a
Hypericum perforatum	St. John's Wort	▪ fire tends to increase stands	Crompton et al. 1988

Scientific Name	Common Name	Effects of Burning	Reference
Lysimachia nummularia	Moneywort	▪ best to burn in spring when moneywort is green and native vegetation is dormant ▪ regular burning regime for several years will be needed for control	Kenney & Fell 1992a
Melilotus alba & *Melilotus officinalis*	White sweet clover & Yellow sweet clover	▪ at least two burns are necessary for control ▪ increase in abundance in first year after burn ▪ burning in late spring of the second-year as the shoots elongate, results in a kill of second year plants prior to flowering and seed set ▪ mulching was found to be more effective than late spring burning ▪ dormant season burns stimulate germination and increase the chance that plants will survive to produce seeds ▪ dormant season burns can be used in conjunction with mowing or clipping in summer of the following year as plants flower	Cole 1991b Eidson & Steigmann 1990 Kline 1983 Schwarzmeier 1984 Turkington et al. 1978
Pastinaca sativa	Wild parsnip	▪ fire removes ground litter and standing litter, providing favorable conditions for the development of parsnip rosettes ▪ periodic burning may help maintain the vigor of native plants to allow them to better compete with parsnip	Eckardt 1987 Kenney & Fell 1992b
Phalaris arundinacea	Reed canarygrass	▪ growing season fires may reduce vigor and help control the spread ▪ growing season burns may give native species a competitive advantage	Apfelbaum & Sams 1987 Henderson 1990
Phragmites australis	Phragmites	▪ burning will not reduce growth unless the roots burn ▪ burning removes phragmites leaf litter, allowing seeds of other species to germinate ▪ burning in conjunction with chemical control has been found effective ▪ burn with caution, since spot fires can occur up to 100 feet from burning phragmites	Beall 1984 Marks 1986
Typha spp.	Cattail	▪ fire provides little or no control unless the roots are burned ▪ drawdown followed by burning and then flooding to a depth of 8 – 18” will provide control	Apfelbaum 1985 Nelson & Dietz 1966

GRAZING

Grazing can either promote or reduce weed abundance at a particular site. By itself, grazing will rarely, if ever, completely eradicate invasive plants. However, when grazing treatments are combined with other control techniques, such as herbicides or biocontrol, severe infestations can be reduced and small infestations may be eliminated. Grazing animals may be particularly useful in areas where herbicides cannot be applied (e.g., near water) or are prohibitively expensive (e.g., large infestations). Animals can also be used as part of a restoration program by breaking up the soil and incorporating in seeds of desirable native plants.

When not properly controlled, however, grazing or other actions of grazing animals (wallowing, pawing up soil) can cause significant damage to a system, and promote the spread and survival of invasive weeds. Overgrazing can reduce native plant cover, disturb soils, weaken native communities, and allow exotic weeds to invade. In addition, animals that are moved from pasture to pasture can spread invasive plant seeds.

In general, the specific weed and desirable native plants will determine the number and species of animal grazers and the duration and frequency of grazing. A grazing plan should be developed in situations where prescribed grazing is desirable, and this plan must be tailored to fit the specifics of the site.

ANIMAL CHOICE

Cattle, goats, sheep, and even geese may be used to control weeds. Cattle will graze invasive grasses, can trample inedible weed species, and can incorporate native seeds into soil. Horses can also be used to control invasive grasses, but horses tend to be more selective than cattle. Geese are also useful for the control of invasive grasses, but are more subject to predation than other animals. Predation problems in many areas may dictate the type of grazing animals that can be used.

Sheep and goats prefer broadleaf herbs and have been used to control leafy spurge (*Euphorbia esula*), Russian knapweed (*Acroptilon repens*), and toadflax (*Linaria* spp.). These animals appear to be able to neutralize the phytochemicals toxic to other animals that are present in these and other forbs (Walker 1994). Goats can control woody species because they can climb and stand on their hind legs, and will browse on vegetation other animals cannot reach (Walker 1994). Goats additionally, tend to eat a greater variety of plants than sheep.

Sheep can be useful in the control of spotted knapweed (*Centaurea maculosa*), kudzu (*Pueraria lobata*), and oxeye daisy (*Chrysanthemum leucanthemum*) (Olson and Lacey 1994). Sheep are not recommended for the control of St. John’s wort (*Hypericum perforatum*) or senecio (*Senecio* spp.) as these plants can be toxic.

Sheep do not graze an area uniformly. Consequently, a method (i.e: herding, fencing, or the placement of salt licks) should be employed to concentrate activities in an area (Olson and Lacey 1994). Sheep often need a period of adaptation before they will start to consume a new forage type. This process can be expedited by using herds as opposed to individual animals because sheep will follow the lead of their peers. Finally, leafy spurge seeds can remain viable after passing through the digestive tracts of sheep. Animals should therefore be kept out of uninfested areas until nine days after the last leafy spurge is consumed (Olson and Lacey 1994). Both sheep and goats are well adapted for grazing in steep or rocky terrain.

Plant availability, hunger, and previous experience can determine a grazer's selection of food plants (Walker 1994). Differences in vegetation quality may cause an animal to eat one species in one situation and to ignore the same species in another. A period of adjustment is generally required to get a grazing animal to eat a new type of forage (Walker 1994). It is therefore helpful to find animals previously experienced with the target weed.

Finding grazing animals to use for weed control is frequently a problem in the U.S., particularly when sheep or goats are needed. Land managers are sometimes forced to make use of the animals available in the immediate area, especially since transportation costs can be excessive.

TIMING & DURATION OF GRAZING

Animals should be brought into an infested area at a time when they will be most likely to damage the invasive species without significantly impacting the desirable vegetation. Grazing during seed or flower production can be especially useful. On the other hand, some weeds are palatable only during part of the growing season. For example, cheatgrass (*Bromus tectorum*) is preferred in spring before seed heads develop, but avoided by cattle once it has begun to set seed because the seed heads have stiff awns that can puncture the mouth and throat tissue of livestock (Carpenter & Murray 1999). Grazing will often result initially in an increase in stem density and root buds, but repeated grazing should lead to reduced stem densities in the longer term (Olson 1999).

Grazing should be closely monitored and the animals promptly removed when the proper amount of control has been achieved and/or before desirable native species are impacted. Consequently, land managers must be flexible and have control over herd movements. Lack of control can result in overgrazing of desirable species, which can enhance weed infestations or allow new weed species to become established. The necessary flexibility is not always possible with commercial herds.

In most cases, several years of intensive grazing followed by annual brief periods of grazing by the same grazing species is required to gain and maintain control of an infestation. However, gains achieved by grazing goats and sheep one year will not be maintained by cattle-only grazing in subsequent years because cattle tend to graze different types of plants.

ANIMAL FENCING & MOVEMENT

The containment and movement of grazers within and between infested areas is necessary for the successful implementation of an appropriate grazing plan. Temporary fencing erected to contain animals in a particular area may be suitable for goats and sheep, but is often inadequate for cows and horses. More stable and expensive barbed wire fencing may be required to contain these larger animals. Salt licks have been used successfully to concentrate animal impact in a particular area.

SOLARIZATION

Soil solarization is the technique of placing a cover (usually black or clear plastic) over the soil surface to trap solar radiation and cause an increase in soil temperatures to levels that kill plants, seeds, plant pathogens, and insects. In addition, when black plastic or other opaque materials are used, sunlight is blocked which can kill existing plants (Katan et al. 1987). Soil solarization however, can cause significant biological, physical, and chemical changes in the soil that can last up to two years, and deter the growth of desirable native species.

Soil solarization is used in horticulture and for a few high value agriculture crops like strawberries. This method has not been used extensively for weed control in natural settings. The effectiveness of soil solarization depends, in part, on how susceptible weed seeds are to temperature increases. It is most effective against winter annual weeds that germinate under cool conditions (Elmore 1990). Summer annuals and other species adapted to higher temperatures, which germinate during warmer parts of the year, are less susceptible.

Soil solarization is most effective during the summer months, and may be less effective in cooler climates (DeVay 1990). The higher the temperature, the more quickly a kill is achieved. Solarization is effective only if done in wet soil. Where soils are typically dry, they must first be irrigated until soil from the surface to 50 to 60 cm deep is at field capacity (Grinstein & Hetzroni 1991).

Polyethylene plastic film is the most useful for soil solarization (DeVay 1990). Less expensive thin films (1-1.5 mil) are more effective than thick films (2, 4, and 6 mil). Clear and black films both trap infrared radiation that is re-radiated from the soil surface, therefore keeping the soil hot. Transparent film allows more radiation to reach the soil than black films, as it lets visible light in, causing even greater temperature increases. Because black films exclude visible light however, they stop photosynthesis, which can be enough to kill some young annuals and perennials given sufficient time (Elmore 1990). Double layers of film have been found to increase soil temperatures by three to ten degrees over single layers (DeVay 1990).

Soil solarization is beneficial in that it releases nutrients that are tied up in the organic component of the soil, and that it can kill unwanted plants without the use of chemicals (Stapleton 1990). However, solarization leaves an open substrate that can be readily invaded by new organisms, both native and non-native once the plastic is removed (Stapleton 1990). The influx of nutrients that results from solarization can be advantageous to restoration efforts, but can promote aggressive, ruderal plants that typically thrive in nutrient-rich soils.