

CHAPTER 7: Managing Herbaceous Broadleaf Weeds with Targeted Grazing

By Bret Olson and Karen Launchbaugh

Bret Olson is Professor of Range Ecology in the Animal and Range Sciences Department at Montana State University. *Karen Launchbaugh* is Associate Professor of Rangeland Ecology at the University of Idaho in the Rangeland Ecology and Management Department.

10 KEY POINTS

- Most broadleaf weeds were brought from Eurasia to North America, where they are spreading rapidly across public and private land.
- Millions of dollars spent on herbicides and biological control address only the symptoms of the spread, not the cause.
- These weeds can be highly nutritious, and many are readily grazed by livestock during the growing seasons.
- The age and breed of livestock best used to tackle herbaceous weeds will depend on the grazing situation.
- Broadleaf weeds are most susceptible to grazing damage when they are initiating flower production and rapidly elevating flower stalks.
- The number of days to graze in a year depends on the target broadleaf weed and the surrounding vegetation.
- Broadleaf plants are generally most nutritious during their rapid growth phase when high water and nutrient uptake facilitates cell expansion.
- Secondary compounds in broadleaf weeds may reduce palatability by causing negative digestive consequences.
- The period of highest nutritional need for ewes and nannies generally coincides with the time of highest forage value in the weeds.
- Biological control and targeted grazing may be combined for an enhanced effect in controlling broadleaf weeds.



VEGETATION MANAGEMENT OPPORTUNITIES

The invasion of rangelands, forests, and pasturelands by herbaceous broadleaf plants is one of the greatest conservation and land management challenges of our modern era. Since the beginning of trans-oceanic travel, North America has been open to invasion from alien plants. Many of these invasive plants originated in regions that have been subjected to a long history of human habitation. Most co-evolved with agricultural practices, including intense livestock grazing by sheep and goats. This background has resulted in plants with enhanced invasive traits and an ability to thrive in disturbed systems. Problematic herbaceous (non-woody) broad-leaved weeds are forbs including leafy spurge, spotted knapweed, yellow starthistle, Canada thistle, houndstongue, whitetop, kudzu, and toadflax, among others. Exotic herbaceous weeds pose significant threats to livestock production and the integrity of native plant communities. Weed invasions most often result in reduced biodiversity, increased soil erosion, degradation of wildlife habitat, and reduced carrying capacity for livestock.¹⁷

Most of these invasive weeds were brought to North America from Eurasia and continue to spread across the continent despite millions of public and private dollars spent on herbicides and biocontrol. These control methods address the symptom, not the cause, of the weed problem. The cause of their spread stems from an imbalance between the plant community composition and the selective grazing patterns of the dominant livestock species grazing these communities – cattle. By avoiding these plants and selectively grazing native forbs and grasses, the native plants are put at a disadvantage when competing with weeds for limited soil water and nutrients. Consequently, composition of many plant communities has shifted from native species toward a preponderance of undesirable, weedy species, often creating solid stands of weeds. Grazing broadleaf weeds with sheep or goats has the potential to reduce their spread and control current infestations. Increasing the use of targeted grazing with sheep and goats could address a fundamental cause of weed invasions and restore balance to native communities

Criteria for Animal Selection

By nature, cattle are not prolific weed eaters, partly because their large mouths and tongues make it difficult to strip leaves and consume small flowerheads of many weeds. Plus, cattle have less effective digestive

and metabolic systems to detoxify the deleterious plant compounds often found in weedy forbs. A few practitioners have been able to overcome the apparent physical limitations of using cattle to manage broadleaf weeds with proper diet training.¹⁹ In contrast, sheep naturally prefer forbs over grasses and grasses over shrubs, so they make good candidates for consuming weedy forbs in a weed-control context. However, sheep also graze grasses, which some cattle producers dislike, limiting opportunities to use sheep for weed control in cattle pastures. Goats generally prefer shrubs over forbs or grasses. So they compete less with cattle for grasses, but they also readily consume shrubs and small trees, which may be undesirable in some places, like wooded riparian areas.

Grazing animals seek variety just as humans do. Livestock may graze in *cyclic* patterns, consuming considerable amounts of a weed during one feeding grazing period, followed by low weed consumption in the following period. For example, sheep have been observed grazing substantial amounts of weeds one evening with little consumption of that weed the following morning. This could simply result from a desire for variety, or it could reflect the time needed for the rumen microorganisms of the host animal to process secondary compounds they have consumed.

Breed Considerations

Few studies have compared whether certain breeds of sheep or goats are better weed eaters than others. In North Dakota, consumption of leafy spurge by Columbia, polypay, rambouillet, and Suffolk sheep was assessed in 1999 and 2000 (Kronberg, unpublished data). Although differences among breeds were apparent during some weeks, overall differences were not consistent across the seven-week trial. The researchers concluded that any of these common breeds of sheep will graze leafy spurge effectively.

White-face breeds may be more appropriate for a herded situation as they are more gregarious and form a tighter flock. Black-face sheep work well under permanent fence, which may limit their utility for large-scale weed control. Goat breeds also vary in their tendency for forming tight herds, a behavior that can be influenced by training and the production setting. For example, goats that are penned at night and graze under the direction of a herder tend to graze more closely as a herd than free-ranging goats of the same breed. A breed may also be selected based on the desired level of winter or summer hardiness. Meat or fiber characteristics must also be considered, unless the producer runs wethers or dry open females (that is non-lactating females without kids or lambs) with the primary goal of weed control.

Animal Age and Experience

Are young animals more likely to graze weeds than older animals? It depends. Young animals are curious and seek novelty. On the other hand, young animals also rely on their mother and other adult females as role

models for learning what to graze or avoid. This can be beneficial if the role model readily consumes weeds. A tendency to eat or avoid a plant can be passed from generation to generation, for better or for worse.

In southwestern Montana, research assessed whether yearling sheep exposed to leafy spurge as lambs grazed it more readily than yearlings that had not been exposed to it as lambs.¹⁴ Also assessed was whether this difference, if present, persists through the grazing season. Experienced yearlings spent more than twice as much time grazing leafy spurge in early summer compared with naive yearlings, but neither group actively selected the plant (it was less than 5% of their diet). This may reflect that the associated cool-season grasses were highly palatable and nutritious in early summer. In addition, these yearlings did not have mature role models to influence their diet selection, positively or negatively. By mid summer, both groups were grazing leafy spurge, up to 45% of their diets. These findings indicated that: 1) there may be an advantage to using experienced sheep on leafy spurge, but perhaps only in early summer, and 2) inherent dietary preferences for forbs, such as leafy spurge, are strong in sheep.

The importance of social models was exemplified on a ranch along the Yellowstone River in eastern Montana, where a band of sheep was purchased to graze leafy spurge (personal communication). The sheep did not consume spurge for two years, until they were accidentally mixed with a band of sheep that readily consumed leafy spurge. The inexperienced band then learned that spurge was a nutritious and acceptable forage.

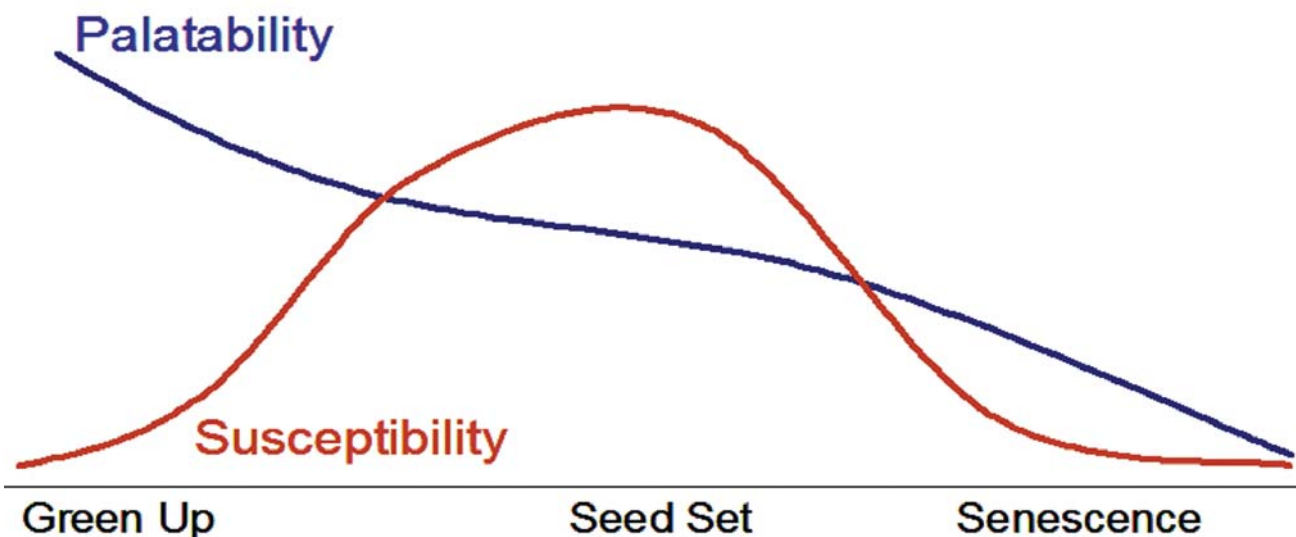


Figure 1. General curve depicting the time during the growing season when herbaceous broadleaf plants are susceptible to damage from grazing or browsing and when they are generally most palatable to herbivores.

Grazing Strategies to Meet Ecological Objectives

When to Graze

The loss of plant material to grazing herbivores, including insects, wildlife, and livestock, is a natural condition with which all plants evolved. Some plants have developed natural survival tactics. The ability of a plant to survive and recover from grazing varies depending on how much material is lost and when plants are defoliated. Shortly after herbaceous plants begin growing in the spring they tend to have low susceptibility to damage from grazing. However, as they grow, the potentially damaging effects of grazing increase until after the plant has set seed and started shutting down growth for the season during senescence (Figure 1). The plant's risk of being grazed is partly determined by how palatable it is to grazing animals. Generally, plants are palatable when they are young and nutritious. Plants tend to become less palatable as they grow and mature. How palatable a plant is depends on the herbivore doing the selecting. For example, goats find yellow starthistle palatable throughout the season, even when it has spines around the seedhead. Cattle, on the other hand, will select yellow starthistle when it is young and bolting, but will avoid it when it starts producing spines and flowering.

Ideally, weeds should be grazed when they are most susceptible and relatively palatable. Generally, forbs are most susceptible to grazing when they are initiating flower production and rapidly elevating their flowering stalks – a phase called “bolting.” Grazing weeds when they are bolting may be most detrimental to them and the best time for their control. There is just one potential problem with this strategy. Native desirable forbs and grasses may also bolt or begin flowering at the same time as weeds, making them equally susceptible. If the grazing animal prefers these native plants over the weed, they could be placed at a competitive disadvantage, allowing the weed to invade the site more rapidly. Selecting the most effective time for grazing to control weeds requires careful attention to when the weed is palatable relative to associated plants and when desirable plants in the community are most susceptible to grazing.

An alternative is to alter season of use so that desired species are not grazed year after year when they

are most susceptible. This may lessen the impact on the associated weeds, but at least it will reduce seed production by the weeds and reduce long-term harm to desired species.

How Long to Graze

The number of days to graze in a year depends on the characteristics of the target weed and the surrounding vegetation. The general goal is to graze at a frequency and intensity that will be most detrimental to the weed and most beneficial to the surrounding desirable vegetation. Exactly how this goal is accomplished will depend on the situation and the skill and knowledge of the person making grazing management decisions. The most common grazing strategies involve concentrating animals in relatively small areas for a few days and then moving them onto another area when defoliation objectives are met. In many cases, grazing prescriptions will involve returning to an area that was grazed earlier in the season to graze the regrowth of the target plant, preferably when desired species are dormant.

The number of years of grazing required for weed control varies, but will nearly always involve several consecutive years. The initial two to five years will focus on weed suppression based on the response of the target weed and surrounding plant community. After the target plant has been reduced to an acceptable level, grazing may be applied at a lower rate (fewer animals) and/or less frequent level for landscape maintenance. Targeted grazing is not a one-time and then walk-away tool – it is a long-term landscape enhancement commitment.

Animal Production Considerations

The animal production consequences of using grazing to manage weeds must be considered and monitored. Despite the potential biological efficacy of using sheep and goats to manage weeds, targeted grazing may not be used widely until it is shown to be compatible with production goals.^{11, 12} Sheep grazing some weeds, like leafy spurge, may outperform their counterparts on non-infested rangelands.⁴ However, using animals to control weeds with low nutritional value, like mature whitetop, could cause weight loss and hinder production. Such situations may require short-term contract grazing or grazing by animals that can tolerate low nutrients, such as wethers or dry open females.

Forage Quality of Weeds

Broadleaf weeds can be highly nutritious and many are readily grazed during the growing season (Table 1). Plants are generally most nutritious during their rapid growth phase, when high water and nutrient uptake facilitate cell expansion. For cool-season plants, this period is usually in spring to early summer. Nutrient concentrations then begin to decline. The plants become more fibrous as stems elongate, leaves age and become less digestible, and soluble nutrients and carbohydrates are diverted to developing seeds and to roots for storage. Cool-season plants usually go dormant in mid summer. For warm-season plants, peak nutrient concentrations and growth occur later than for cool-season species, in mid to late summer, but trends in nutritional value are the same. If precipitation is abundant in early fall, cool-season plants may initiate new leaves and stems, regrowth that is as nutritious as spring growth and readily consumed by grazing animals.

Although some weeds are high in fiber, imparting greater resistance to tearing and presumably reducing palatability, many are similar to native grasses and forbs in fiber, nutrient value, and digestibility. Further, weeds as a group have similar moisture content as native species. In fact, many weeds, such as leafy spurge and spotted knapweed, remain greener, more succulent, and more nutritious longer into summer than associated native plants.⁵

Quality Considerations

Many broadleaf weeds have an acrid (e.g., oxeye daisy, burdock) or bitter taste (spotted knapweed) or a noxious smell, at least to humans. Bitter tastes and noxious smells are often associated with significant amounts of secondary compounds. Grazing animals rarely avoid plants simply because they have a strong or bitter flavor. If the plant tastes bad, causes nausea, or is toxic to the animal, it will be avoided when the animal encounters it in the future. Alternatively, if a plant does not taste bad, does not cause nausea, or is not toxic, it will be subsequently ingested (*for more information see Chapter 2*).

Once eaten, a plant's first line of defense has failed. It may contain secondary compounds that affect a second line of defense focused at the rumen microbial population. The compounds can alter the composition of rumen bacteria, fungi, and protozoa and/or the level of rumen microbial activity. Digestion may be slowed or reduced if secondary compounds kill rumen microbes or shift the composition of rumen microbial populations. This will result in negative post-ingestive consequences, reducing the preference for and the subsequent intake of the plant. A change in diet is probably the most important factor influencing numbers and relative proportions of different microbial species in the rumen,²¹ partly because ruminal bacteria vary widely in nutrient requirements, and partly because they have different tolerances or abilities to metabolize plant secondary compounds. Negative effects on microbial activity, resulting in negative post-ingestive feedback, may explain why some ruminants limit their consumption of certain weeds.

Secondary compounds may reduce plant palatability by causing negative digestive consequences when eaten. For example, leaves and flowers of spotted knapweed contain high concentrations of cnicin, a secondary compound.^{9,13} Although levels of crude protein and digestibility of leaves and flowerheads of spotted knapweed are higher than those for stems, rumen microbial activity for those plant parts is lower than for stems,

Table 1. Nutritive value of several common broadleaf weeds expressed in terms of fiber (Neutral Detergent Fiber) and protein (Crude Protein) through the growing season (R.A. Frost et al., unpublished data).

Weed Species	Growth Stage			
	Rosette	Bolting	Flowering	Seedset
	----- % Fiber -----			
Dalmatian Toadflax	29-32	41-47	47-51	47-54
Hawkweed	36-39	32-36	47-52	45-48
Houndstongue	31-32	32-37	47-51	47-55
Rush Skeletonweed	25-29	38-44	57-62	56-58
Spotted Knapweed	30-35	35-38	42-46	58-62
Sulfur Cinquefoil	46-48	42-49	47-51	47-55
Tansy Ragwort	35-40	28-34	48-51	—
Whitetop	20-21	23-26	34-35*	—
Yellow Starthistle	32-37	34-37	41-48	50-57
	----- % Protein -----			
Dalmatian Toadflax	12-18	9-12	5-7	5-7
Hawkweed	13-14	9-10	4-7	4-6
Houndstongue	26-29	13-16	8-10	6-9
Rush Skeletonweed	22-25	13-16	8-9	7-8
Spotted Knapweed	10-16	10-14	7-8	3-5
Sulfur Cinquefoil	14-16	9-11	6-7	4-5
Tansy Ragwort	15-16	12-14	8-9	—
Whitetop	27-30	27-30	18-20*	—
Yellow Starthistle	14-17	11-14	4-6	4-6

*sample collected very early flower

*sample collected very early flower

presumably because of the presence of cnicin.¹³ In contrast to spotted knapweed, the high nutritive value of leafy spurge in early summer appears to counteract, to a certain extent, negative effects associated with its secondary compounds.¹⁶

The Role of Supplements

Supplementing grazing animals with energy and nutrients may enhance the ability of rumen microbes to digest a weed and process associated secondary compounds. Improving the animal's nutritional state could also enhance detoxification capabilities and reduce toxic effects, which could lead to increased intake of foods that contain toxins. Though supplements may be useful in some situations to encourage the consumption of weedy herbaceous plants, few studies have revealed consistent benefits. Still, it is generally recommended that animals be supplemented with salt and other minerals to keep them healthy and in good condition.

Production Cycle Considerations

Most sheep-lamb operations breed their ewes in November or December and lamb in April or May. The nutritional demands of adult ewes and nannies are highest shortly after they give birth and start producing milk. This time of high nutritional demand generally coincides with the time of highest forage value in weeds.

Targeted grazing strategies may complement production goals as long as the weeds targeted for control have nutritional value and do not have high levels of secondary compounds. Further, young animals are highly influenced by their dams and, later, their peers, which may enhance their consumption of certain plants and reinforce their avoidance of other plants. The key to using mother-young combinations is to ensure that adult females of the flock or herd readily consume the desired weed, a behavior that can be passed on to subsequent generations.

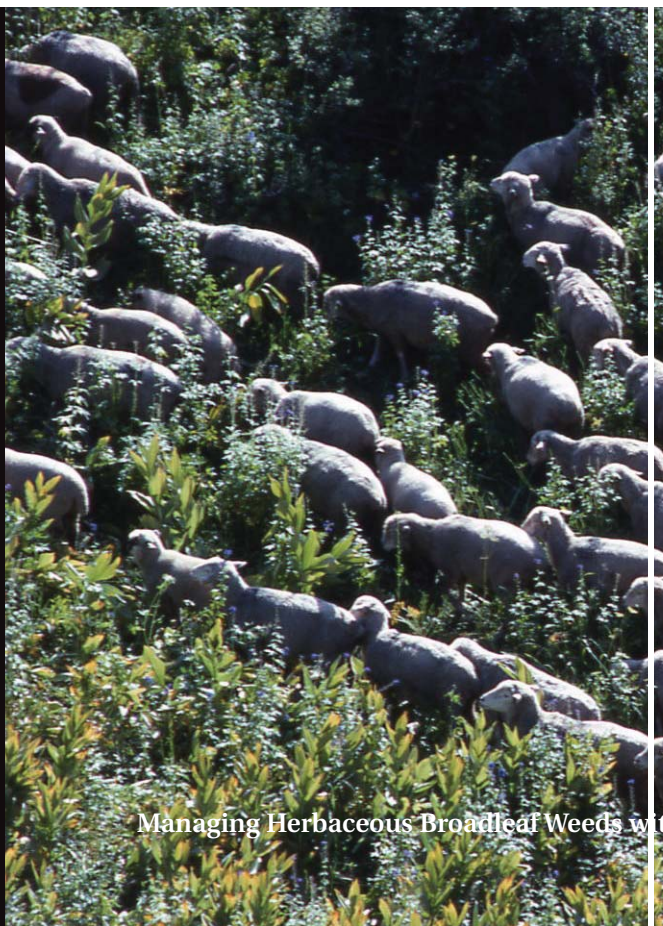
Mature wethers and dry ewes or nannies have low nutrient requirements, making them useful for managing weeds in settings where forage quality is low, such as grazing fibrous weeds in late fall or winter. These animals may also be effective when the grazing prescription calls for heavy stocking rates designed to encourage intake of low quality forages.

Effectiveness and Integrated Management

Grazing is seldom combined with other weed control methods to create integrated weed management strategies, but there is ample opportunity for integration.¹⁵ Grazing has occasionally been applied with mowing, herbicides, or biocontrol agents to increase the effectiveness or longevity of these strategies.



Photo: ASI



Managing Herbaceous Broadleaf Weeds with Targeted Grazing



Photo: ASI

Targeted Grazing in Combination with Herbicides

Applying herbicides to control weeds on rangelands and pastures should be followed by proper grazing management. Integrating grazing and herbicides can be restricted by how long grazing must be withheld after herbicide application. There are many situations where grazing and herbicides can be used in tandem to increase weed mortality. For example, sheep and goat grazing has been combined with herbicide applications to provide leafy spurge control better than either herbicides or grazing alone.^{8,10} This synergistic effect can be achieved by using herbicides to weaken the plant followed by strategic grazing to serve as a *multiple stressor* to hasten weed demise or slow recovery from the herbicide. Another approach is to apply heavy grazing to reduce and weaken the weeds' root system. The weeds are then allowed to regrow, followed by an application of herbicides. This strategy may increase weed mortality and enhance herbicide effectiveness.

Integrating Targeted Grazing and Insect Biocontrol

Biological control and targeted grazing, both effective weed management tools, may also be combined for enhanced effect. Targeted sheep grazing has been combined with introduced flea beetles to control leafy spurge.^{2,6} However, beyond leafy spurge, little is known about how these techniques might be integrated into an effective weed management strategy.¹⁵ Grazing can create conditions that make plants more susceptible to damage from biocontrol agents. For example, grazing above 50% use reduces root biomass.³ This effect, combined with the added stress of herbivory from host-specific biocontrol insects, could additively or synergistically weaken the plant. Grazing might also enhance the effectiveness of biocontrol by reducing seed output, which is often observed among defoliated plants.^{7,18} By reducing seed production with grazing, seed-feeding biocontrol insects would have fewer available seedheads from which to select, increasing success of attack on remaining seedheads. Further, removing dense canopies of shade will create warmer conditions for the feeding and reproduction of biocontrol insects, which are cold-blooded and have higher activity rates with warmer temperatures.

On the other hand, ill-timed and poorly managed grazing can be detrimental to biocontrol insects. Grazing, especially late in the season, can directly remove beneficial insects inhabiting stems or seedheads. Sufficient plant material must be maintained when biocontrol insects are first introduced into a landscape. Maintaining plant material in nursery sites can be essential to getting these insects established in the year of their release.

Potential Cost of Targeted Grazing

The cost of targeted grazing to control broadleaf herbaceous weeds varies with each situation. One must consider how effective targeted grazing is likely to be in a particular setting, how long the grazing will be required to have the desired effect, the cost of transporting animals to the site and applying the required grazing treatment, and the value of forage or other resources that will be gained from reduced weed dominance.

There is more information about using sheep for leafy spurge control than for any other livestock-weed interaction. Using sheep as a leafy spurge control method is economically feasible and effective across many management settings.¹ For example, in south-central Montana, a band or two of sheep have been rotated rapidly across leafy spurge-infested private lands for the last 15 years. The instructions for the herders are to "take the yellow out," or remove seedheads, before the sheep consume considerable amounts of grass. The ewes and lambs thrive, the sheep producer is provided an incentive for the extra management involved, and the willing landowners receive weed control, which has enhanced grass production for their cattle. In 2004, the actual costs for controlling leafy spurge with sheep in Montana were less than \$1 per acre. In one situation, a county had to spray some ridge areas infested with leafy spurge with a helicopter because the sheep were not in the area and could not travel to that site in a timely manner. Those costs were \$45 per acre. Obviously, sheep grazing provides an economically viable alternative for leafy spurge control. Because leafy spurge is clonal with a deep, extensive root system, it is still present in the project area. Sheep grazing may not eradicate leafy spurge, but its density and vigor are much lower than at the beginning of this project.

FINAL THOUGHTS

Herbaceous weeds can invade and threaten healthy rangelands, forests, and pasturelands. Recent success in the use of sheep and goats to control some herbaceous weeds, such as leafy spurge, has fueled interest in grazing for weed control.^{12, 20} If these herbaceous weeds were palatable and preferred by herbivores they would not be considered weeds and would be only a minor part of plant communities as they are in their countries of origin. These plants are usually not *invasive* in their home countries because they are kept in check by natural insect enemies, pathogens, and grazing herbivores. Sheep and goats show particular promise in management of broadleaf weeds because they naturally select these forb-type plants. Carefully managed grazing holds potential for weed control in situations where traditional methods, including mechanical, cultural, biological, and chemical, are restricted by environmental or economic constraints.¹² As our understanding of targeted grazing grows, this tool will gain an important role in integrated systems aimed at managing broadleaf herbaceous weeds.

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