Range Management & Brush Busters

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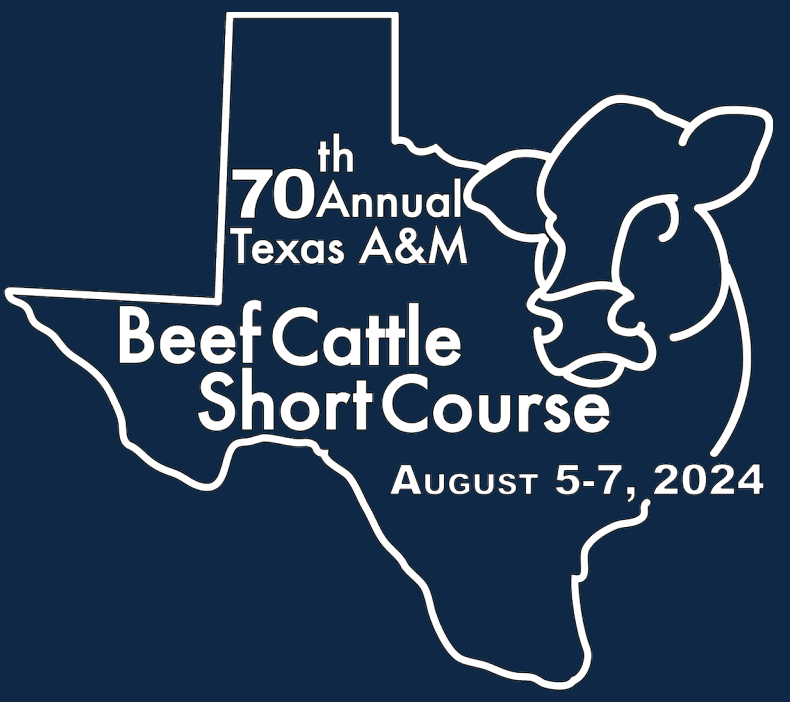

Range Management and Brush Busters

CAPITAL FARM CREDIT

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Texas Agricultural Extension Service
THE TEXAS A&M UNIVERSITY SYSTEM

Drought

Charles R. Hart
Associate Professor and Extension Range Specialist, The Texas A&M University Sytem

Droughts occur almost everywhere and have plagued agriculturalists for centuries. At any one time, there may be several ongoing, severe droughts throughout the world. The way you define drought probably depends on your business. For example, if you are a rancher, you'll probably be in tune to forage growing conditions and not just precipitation totals. Precipitation is the most common way of defining drought, however.

True drought has been defined as 75 percent or less of the average yearly rainfall. Moving from East to Far West Texas, this level of drought occurs from 16 to 45 percent of the time, respectively. In most of Texas, droughts last for only 1 year, except in the Trans-Pecos where chances are higher for consecutive years of drought. Even if you don't use the 75 percent criterion, there is below-average rainfall 2 of every 5 years in the Trans-Pecos.

Risks and Uncertainty Associated with Drought

- **Reduction in long-term carrying capacity**.
  The devastating effects of long-term drought can last for many years. If grazing continues after forage resources have been depleted, problems are compounded. Plants that are stressed from lack of rain are much more vulnerable to grazing damage and may die. This can make the recovery of rangeland from drought a much longer process. The hardest part to deal with is the uncertainty about when a drought might break.

- **Reduction of income.**
  Many ranchers believe they cannot afford to sell livestock during drought. Bank notes, taxes and other overhead expenses still must be paid. So, their income is reduced because they aren't selling stock. They also have lower calf/lamb/kid crops, decreased gains, and increased feed and medical expenses.

- **Deciding how and when to de-stock.**
  Eventually, most ranchers realize they must sell stock to make it through a long drought. However, de-stocking is an uncertain undertaking. Ranchers may ask: When do I begin reducing livestock numbers? What animals should I sell first? When is it costing me more to feed than to sell the animals? How long will the drought last and how many livestock should I sell? Market prices during and after drought may be uncertain, as are the prices and availability of feed.

- **Loss of herd genetics from de-stocking.**
  Many ranchers have spent a lifetime improving herd genetics, developing the perfect crosses, or tightening up breeding seasons. Selling livestock during a drought can be a major setback in reaching these goals. Ranchers must compare these setbacks with the possibility of long-term damage to the range resource.

What You Can Do to Reduce Risk

- **Maintain as much carryover forage on the ground as possible.**
  The soil beneath your feet is one of the most critical resources of your ranch. This resource needs protection and care. Maintaining as much forage residual on the ground as possible during drought will protect the soil from erosion and help insulate plants from the extreme heat that lack of moisture creates.

- **Maintain a flexible herd composition.**
  Flexibility, or the ability to de-stock, must be built into a livestock herd. The core breeding herd, those animals that you do not want to sell, should not compose the entire herd if you are stocked to capacity. A rule of thumb is to have 40 to 60 percent of your herd as "stocker" type animals. These animals can be defined as any livestock you are not afraid to sell when necessary. Even during non-drought years forage supplies vary. More or less forage may be produced from one year to the next. Building flexibility into your herd will help you match animal demands with forage supply on an annual basis.

- **Use light to moderate stocking rates to reduce the severity of droughts.**
  With lower stocking rates, you will have surplus forage that can be used as an insurance policy in case less forage is produced the next year. The better the condition of the rangeland when a drought begins, the faster the land will recover.

- **Use deferment to lessen the effects of drought.**
  Plants need periodic rest from grazing regardless of environmental conditions. Deferring a pasture from grazing during the growing season, or for an entire year every 3 to 5 years, will produce more vigorous plants. Vigorous plants can survive and recover from droughts much more easily than plants weak from overgrazing.

- **Have a systematic stock reduction plan before droughts occur.**
  Systematically reducing animal numbers can make the effect of drought less severe. This is accomplished by early stock reductions that stretch existing forage supplies and continue periodically to keep animal numbers in balance with forage supply. To do this you must understand livestock demand and keep up with existing forage conditions and supplies.

- **Use forage inventories to make stock reduction decisions.**
  Periodic pasture forage surveys can help you make timely and accurate stock reductions. The use of photo-point monitoring techniques increases the accuracy of visual evaluations. If you have a good understanding of annual rainfall patterns, you will be able to estimate the probability of growing additional forage at any given time during the year.

- **Plan for drought during the wet years.**
  Strategies for surviving a drought should be developed before a drought occurs. Decide when you will start feeding and when you will sell livestock. Plan ahead to keep "forage reserve" pastures you can use during drought conditions. Decide whether you will use flexible herd or moderate stocking rate. Practice risk management rather than crisis management; be proactive rather than reactive.

- **Know the costs of feeding versus de-stocking.**
  Consider in advance the costs associated with feeding versus de-stocking during drought. Use different price scenarios for livestock and feed to determine the upper and lower limits of each.

- **Identify other sources of income for times of drought.**
  Diversification of income can lessen the financial burden of droughts. Hunting leases, if structured correctly, can provide a consistent means of income. Look for other ways to produce income from your land. Broadening your perspective from ranch management to natural resource management may open new doors.

- **Consider the income tax consequences of livestock liquidations.**
  Tax laws change from year to year so ranchers should keep up to date on tax laws related to livestock liquidations. If the federal or state government declares your area a drought disaster area, you may receive assistance in the form of feed resources, tax breaks or loans.

- **Know how to manage poisonous plants.**
  Many plants toxic to livestock are not consumed when other forage is available. When droughts reduce the amount of desirable forage, livestock may be forced to eat such plants. Know which plants on your land are poisonous to livestock and be able to recognize the symptoms of poisoning so that you can catch problems before disasters occur.

- **Know how to manage during the recovery period.**
  Plants weakened by drought need additional rest to recover. Stocking rates should remain lower for a period of time so plants can recover. The length of time needed for recovery depends on the severity of the drought and the amount and timing of rainfall following the drought.

Other publications in this series:

L-5368, Making Better Decisions
L-5375, Common Brush and Weed Management Mistakes
L-5373, Will You Succeed as a Rangeland Manager?
L-5377, Forage Quality and Quantity
L-5374, Rangeland Health and Sustainability
L-5369, Toxic Plants on Rangelands
L-5376, Seeding Rangeland
L-5372, Types of Risk
L-5371, Common Grazing Management Mistakes

More information on droughts and management of rangelands is available from your county Extension agent or from the internet at http://farwest.tamu.edu/rangemgt/drought.htm.

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Extension publications can be found on the Web at: http://texaserc.tamu.edu

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Reading Your Landscape: Are Your Pastures Healthy?

Larry D. White, Barron S. Rector and K. Brian Hays
Professor and Extension Range Specialist; Associate Professor and Extension Range Specialist;
and Extension Assistant-Water Conservation; The Texas A&M University System

Water has always been a major limiting factor on Texas rangelands. Every drought reminds us that forage production is not guaranteed every year and that management must be prepared for the inevitable forage shortfall even if livestock are properly stocked for the normal year. Climatic risk has to be managed to prevent the degradation of resources, maintain or improve resources for the future, prevent non-point source pollution, and reduce financial risks.

While the amount and timing of rainfall are important, the productivity of rangeland is more closely tied to the amount of soil moisture captured when it rains and the presence of desirable plant species to use that moisture. There are tools to help you analyze the history of rainfall on your property and estimate the probability of receiving different amounts of rainfall throughout the year. One is the Rainfall Analysis software available from the Texas Agricultural Extension Service. However, it is your current and past management practices that determine how much rainfall penetrates the soil, the kinds of plants on your land, and the amount of runoff, sediment, and non-point source pollutants that leave your property.

Where Does Your Rainfall Go?

Factors that affect where rainfall goes are the type and density of vegetative cover; the intensity of a storm; the amount of moisture in the soil before the storm; the capacity of the soil to hold water; and the slope of the land. These factors affect how much moisture evaporates, infiltrates or runs off the land, and the velocity of runoff water.

While you can not change some of these factors, your management does determine the condition of the soil and the vegetation, and that can make the difference between capturing rainfall for the production of desirable rangeland plants or seeing your land erode and your forage disappear. If you correctly "read" the condition of your rangeland, you can make timely management decisions to protect your resources.

How Do You Determine Pasture Health?

Knowing what to look for is the key to reading your landscape. Managers must monitor both current conditions and changes over time to determine if damage to the soil, plant communities, and water resources is occurring; if past decisions are producing expected results; and whether management should be changed to correct problems before they become critical.

The first indicator of range or pasture health is vegetative cover both the amount of vegetation and the species composition. Good vegetative cover, with little bare

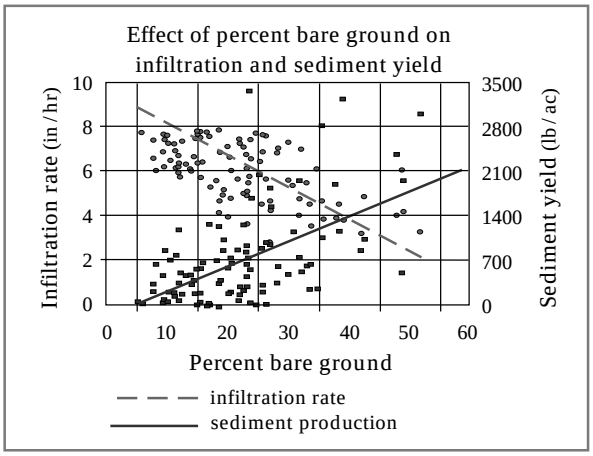

Figure 1. A simple pace transect can be used to monitor the amount of bare ground and plant cover to estimate the infiltration rate and sediment yield from a 6-inch storm. (This graph was adapted from "Hyrodlogic interrrelationships with vegetation and soil as affected by selected livestock grazing systems and climate on the Edwards Plateau," 1985, a PhD dissertation by T. L. Thurow, Texas A&M Univeristy.)

ground, slows the movement of water across the land and lessens the impact of raindrops on the soil surface. The greater the raindrop impact and the faster the water moves, the more soil will be dislodged and carried away. The slower the movement of surface water, the more time there is for it to soak into the soil. By monitoring the amount of bare ground on your land and the evidence of erosion, you can determine how your management is affecting the soil surface (Fig. 1).

A certain amount of vegetative cover should be left ungrazed at all times. This is called the threshold residue. It varies with plant species, soil type and climate, and it determines the amount of rainfall captured and the potential for future grass production (Fig. 2). Ten to 17 inches of rainfall can produce as little as 1,100 to 1,800 pounds of forage, or as much as 4,000 pounds of forage, depending on the amount of residue left ungrazed. Your management tool is to adjust your live-

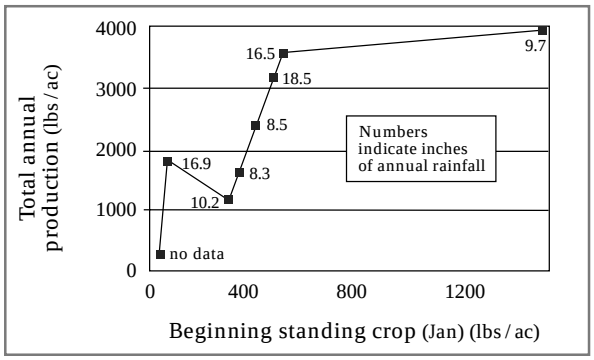

Figure 2. The amount of forage left ungrazed determines next year's forage production. The most important thing is not how much rain you get, but how much soil moisture you trap for future plant growth. (No rainfall data were available for one location.)

stock stocking rate seasonally so that the threshold residue is not removed.

The kinds (species) and classes (grasses, forbs, etc.) of plants determine the amount of rainfall that will be intercepted by foliage and evaporate back to the atmosphere, or that will reach the soil surface (where it may either infiltrate the soil or run off). Being able to identify the plants on your land is very important. Plants reflect the environment produced by your management and the natural climatic and soil factors of your property.

Monitoring plants with photo points can help document seasonal and annual changes in the landscape and pinpoint problem locations. For more information about this topic, see "Range Monitoring with Photo Points," L-5216, available from the Texas Agricultural Extension Service.

The second indicator of the health of your landscape is the soil surface. Large areas of bare ground, pedestaled plants, litter dams, rills and gullies are signs that rainfall is running off the land rather than infiltrating the soil. Another danger sign is stream bank erosion, which often occurs when riparian vegetation (the vegetation along rivers and streams) is inadequate to stabilize the bank against flowing water. Riparian vegetation is important for maintaining natural stream channels. Closely checking stream bank stability and riparian zone vegetation can help you recognize a problem with the land upstream.

How Can You Maintain Healthy Range Resources?

Know what is happening on your land. Check for signs of increasing bare ground, reduced litter, lower forage production, changing plant species, and stream bank erosion. These signs tell you that rainfall is not being effectively captured and that sediment losses are reducing the soil's productivity and water-holding capacity. Then you can quickly change your management before the next storm further degrades your property. Learning to read your landscape will pay off in greater productivity now and sustainable productivity in the future.

Other publications in this series:

L-5367, Increasing Bare Ground Indicates Poor Watershed Health
L-5365, Are Your Streams Healthy
L-5364, Know Your Plants to Protect Your Watershed

For further information:

Hanselka, C. W. and L. D. White. 1986. Rangeland in dry years: drought effects on range, cattle, and management. In R.D. Brown (ed.), Livestock and wildlife management during drought. Cesar Kleberg Wildlife Research Institute, Texas A&I University, Kingsville, Texas.

L-5216, Range Monitoring with Photo Points, Texas Agricultural Extension Service.

L-5141, Do You Have Enough Forage? Texas Agricultural Extension Service.

Rainfall Analysis software. Contact the Extension Rangeland Ecology and Management group at (979) 845-2755.

For additional range information see: http://texnat.tamu.edu

For additional risk management information see: http://trmep.tamu.edu

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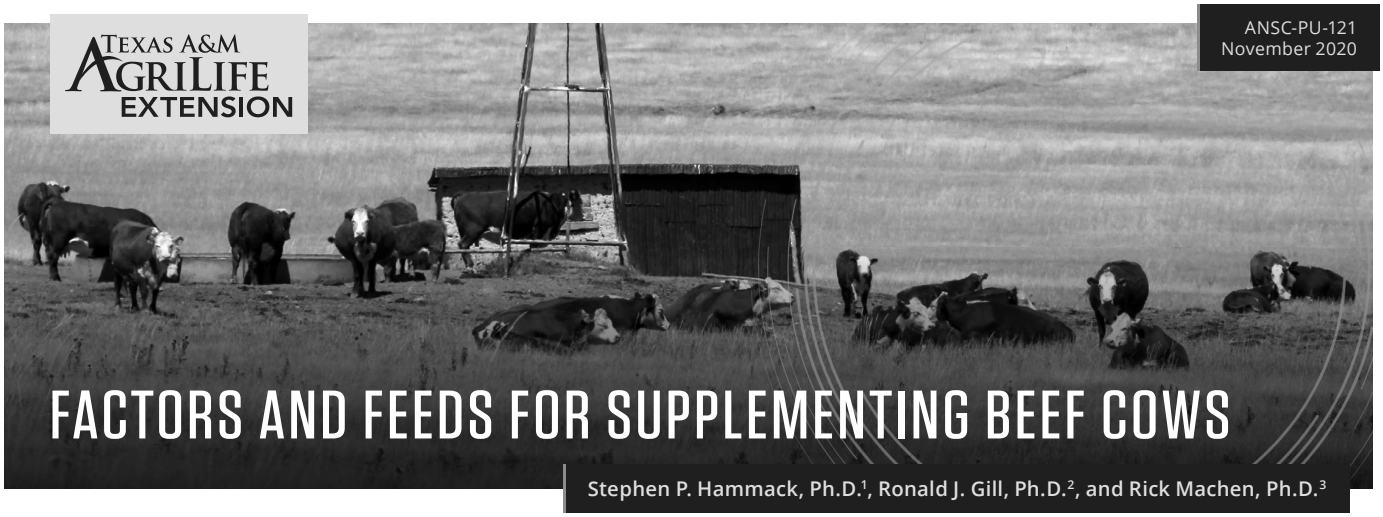

FACTORS AND FEEDS FOR SUPPLEMENTING BEEF COWS

Stephen P. Hammack, Ph.D.[1], Ronald J. Gill, Ph.D.[2], and Rick Machen, Ph.D.[3]

A beef cow requires energy, protein, minerals, and vitamins in her diet. What determines nutrient requirements? What determines if supplementation is warranted?

A female performs several functions, including body maintenance, activity, weight gain, reproduction, and milk production, which all require nutrients. The amount of nutrients required depends on body size, environmental conditions, how far an animal travels, any desired weight change, stage of gestation, and milk production level. Beef cows are maintained primarily by grazing forages on pasture and rangeland. Nutritional value (i.e., quality) and quantity of available forage determines if nutrients need to be supplemented to optimize performance. During most of the year, warm-season forages could be deficient in some minerals. So, most situations should include at least year-round provision of mineral supplement. Vitamin A, which is typically deficient in dry, dormant, or weathered forages, should be provided if suspected to be deficient for more than 30 days. Since deficiencies can be corrected relatively inexpensively, compared to protein and energy, mineral and vitamin supplementation should be a high priority.

After addressing mineral and vitamin needs, protein and energy should be considered. Forage protein and energy content vary seasonally. Dormant, warm-season forages typically become deficient in protein during mid-summer and winter, and often are energy deficient in winter. Energy deficiency also can be a function of limited availability of forage, rather than inadequate content of energy.

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FACTORS AFFECTING SUPPLEMENTATION

Six primary factors affect the type and amount of supplement that a beef cow may require.

Forage Quantity. The amount of available forage affects any potential need for supplementation. If forage becomes limited and cows cannot eat their fill daily, performance (i.e., reproduction, milk production, body weight maintenance) will suffer. As forage supply declines, animals have less opportunity to selectively graze and their diet quality weakens. Balancing forage supply and animal demand is the most important factor affecting the need for and type of supplement that may be required.

Forage Quality. Forage with less than 7 percent crude protein (CP) is considered low in quality due to its low protein and low digestibility—less than 50 percent total digestible nutrients (TDN), which is a measure of energy available to the animal. Poor-quality forage usually is found in dormant perennial plants or dead annual plants, which contain a higher ratio of stems to leaves. Since forage quality and consumption are positively related, nutrient deficiencies limit forage consumption. Because both consumption and nutrient content of poor-quality forage are low, supplementation often is needed.

Medium-quality forage (7 to 11 percent CP and 50 to 57 percent TDN) eliminates or markedly reduces need for supplementation, especially among non-lactating and short-bred cows.

High-quality forage (above 12 percent CP and 57 percent TDN, containing more leaf than stem) can be consumed in larger amounts and usually precludes any need for supplement—except for high-milking cows in low body condition (e.g., fatness). However, forage of high quality but limited quantity, a common situation in early spring when cows "chase" short green grass, may require supplementation to balance energy and protein intake.

Daily intake potential ranges from as low as 1.5 percent of body weight for very low-quality forage to near 3.0 percent for very high-quality forage, with 2.0 to 2.5 percent being typical.

Body Condition. Body condition influences supplementation requirements. Body Condition Score (BCS) is an excellent and practical assessment of prior diet quality and recent nutritional status (see links below for visually evaluating BCS). Low body condition (less than BCS 4) markedly increases need for supplementation, and completely fulfilling this need often is cost prohibitive. Therefore, allowing cows to reach low body condition should be avoided if feasible. Moderate body condition (BCS 4 to 5) greatly reduces or eliminates supplement needs. With exception of minerals, fleshy, higher body condition cows (BCS equal to or higher than 6) generally need little supplement, if any.

Body Size. Potential for forage consumption is related to body size—the best measure of which is weight. Therefore, as a result of their ability to eat more, larger animals may not require more supplement than smaller animals. Adjustments to stocking rate and allowing adequate amounts of forage per cow may offset differences in body size, but will increase land cost per cow and reduce production per acre. If forage is limited or insufficient in quality, larger cows will require more supplement.

Milk Production. Cows with greater potential for milk production have higher body maintenance requirements year-round, not just during lactation. Higher-milking cows may consume more forage, but often not enough to completely satisfy their nutrient demand. When forage quality is inadequate, higher-milking cows need more supplement (i.e., anywhere from 50 to 100 percent more may be required for high- versus low-milking cows of the same body size).

Age. Females less than 4 years old are still growing and require extra nutrients. Their body size is smaller than mature cows, therefore younger animals do not consume as much forage. Consequently, heifers and young cows require a higher quality, more nutrient-dense diet than mature cows and often require more and different supplements.

INGREDIENTS AND SUPPLEMENTS TO PROVIDE PROTEIN AND ENERGY

Ingredients

Oilseed Meals. Cottonseed, soybean, sunflower, linseed, and peanut meals are the most common sources used in supplements to provide high-protein and medium- to high-energy. Although relatively costly per pound, they often are the least expensive on a cost per unit CP basis. These ingredients provide natural supplemental protein to support rumen microbes and sustain forage intake. Oilseed meals in particular are suitable for non-lactating cows in moderate to good flesh (BCS 4 to 5) consuming adequate amounts of low-protein, medium-energy forages.

Other Co-products. In addition to oilseed meals, other co-products often are used in supplements for cattle on pasture or range. These include low- to medium-protein, medium-energy, low-starch products such as wheat mids, soybean hulls, and rice bran. Readily digestible starch can interfere with forage digestibility. Therefore, these low-starch co-products are good supplements for grazing cattle. Other potential ingredients are medium-protein, high-energy products such as brewers grains, distillers grains, and corn gluten feed. Some of these are available either wet or dry. When considering high-moisture ingredients, proximity to the source can affect feasibility of their use.

Grain. Corn and grain sorghum are energy-dense ingredients commonly included in supplements for grazing cows. Other grains used less frequently include oats, wheat, and barley. Grains typically are the least expensive ingredients based on cost per unit TDN.

Whole Seed. While cottonseed, soybean, and other oilseeds usually are processed to produce meal and oil, they also can be fed as whole seeds. These are considered moderate in protein at 15 to 25 percent CP but high in energy due to their high-fat content (e.g., oil remains in the seed). Whole cottonseed in particular often is used as a supplement for grazing cattle. Handling seed to feed cattle is the main limitation for using it. If delivery is economically available, it is one of the best supplements for cows.

Supplements

The success or failure of a supplementation program for grazing beef cows primarily depends on quantity and quality of available forage being supplemented. Mismatches between these forage factors and type of supplement will reduce both animal performance and financial return.

Note: Where recommended pounds of supplements appear later, they are based on cows weighing 1,300 pounds in BCS 5. Any variation from these determinants should be considered.

High-protein Cubes. Protein cubes usually are made from oilseed meals and contain 38 to 41 percent CP. They typically are fed on the ground and often are the most economical and practical means for providing supplemental protein to grazing cows. These cubes generally should be fed at a daily rate of 1 to 3 pounds. Oilseed-meal cubes in particular are suitable for dry cows in moderate to good flesh when they have access to a sufficient quantity of low-protein, medium-energy forages.

Range/Breeder Cubes. These are commonly 20 percent CP, but range from 12 to 32 percent CP. They are designed to provide a combination of both protein and energy to be fed in larger daily amounts (3 to 6 pounds) than high-protein supplements. If the ingredients are readily available and producers have equipment for mixing and feeding, a mix of 1/3 oilseed meal and 2/3 cracked or ground grain is approximately equivalent to a 20 percent cube. A mix of about 3/4 meal and 1/4 grain is the approximate equivalent of a 32 percent cube.

Some cubes include non-protein nitrogen (NPN), usually in the form of urea, as a nitrogen source for potential synthesis of rumen microbial protein, which cows can digest. (Considerable variation exists in how much of this potential is converted to protein.) Cubes with low crude fiber (below 10 percent), which is listed on feed tags, generally are highest in energy and usually contain added minerals and vitamins. They often are marketed as "breeder" cubes rather than as lower-quality "range" cubes.

Blocks and Tubs. The primary advantage of block and tub supplements is continuous access and self-limiting consumption. Nutrient content and expected intake can differ considerably among these products. Be sure to read the label to determine expected consumption by grazing cattle. These supplements are relatively expensive based on cost per unit of nutrients provided. Generally, they will not correct for large nutrient deficiencies, nor support higher levels of animal performance. Adequate forage should be available to

avoid potential over consumption of these supplements and the associated health problems. Placement of supplement also will affect consumption—products offered near water or loafing areas will experience greater consumption.

Pressed blocks. Pressed blocks (the most common being a 33-pound product) are formed much like cubes. Ingredients are conditioned with steam and pressed together under high pressure. Protein content may range from 20 to 40 percent CP. Mature cattle generally consume 1 to 4 pounds daily depending on the hardness of the block and number of blocks offered.

Chemically Hardened. These supplements are manufactured by combining liquid and dry ingredients into a slurry and pouring it into a container. Protein content is generally 20 to 30 percent CP. Hardness (which regulates daily intake) is determined by the reaction of a metal oxide (such as calcium oxide) with water. Once hard, these products do not change shape. Expect consumption rates of 1 to 3 pounds per day.

Low-moisture Tubs. In this manufacturing process, liquid ingredients are heated to 240°F to 280°F (cooked), subjected to a vacuum to remove moisture, combined with dry ingredients, and poured into plastic or metal containers. Protein content can range from 10 to 40 percent CP. Containers must remain upright because this product will change shape. Typically, supplement consumption across the herd is uniform. However, daily intake tends to be the lowest of any supplement at 0.5 to 1.5 pounds per day among the block and tub options.

Liquid Supplements. Most cattle managers who use liquid supplements depend on a retailer for product distribution. Therefore, liquid supplements can be the least labor-intensive supplementation option. Industry experience suggests that liquid supplements are most effective when offered year-round. Consumption will vary depending on quality and quantity of available forage and cow nutrient requirements. Liquid supplements are fed in open-top or lick-wheel containers and can vary widely in composition and nutrient content.

Co-products from several industries (i.e., molasses, corn steep liquor, condensed corn distiller's solubles, and more) form the base of liquid supplements. Protein content ranges from 16 to 40 percent CP—a significant portion of which may come from non-protein nitrogen (urea). In contrast to dry supplements, fat content can be 10 percent or greater. Some liquids are fortified with a complete mineral/vitamin package. As is true for any supplement, adequate forage (or hay) must be available. Also, supplement containers should not be allowed to empty because possible over consumption after re-filling could cause health problems, some severe.

Hays and Silages. High-quality hays such as alfalfa can be used as supplements. These medium-protein (usually 15 to 20 percent CP), medium-energy sources can be limit-fed in place of one of the previously discussed supplements. These hays also can be fed free choice, although doing so results in inefficient use of supplemental protein and can be costly. Low-protein, medium-energy silages such as corn and sorghum also can be used as supplements, or full-fed during drought and other harsh weather conditions if suitable facilities and equipment are available.

SUPPLEMENTATION STRATEGIES

Supplementation (e.g., protein and energy, hay, and mineral) is almost always among the three largest variable costs for a cow/calf enterprise. To minimize supplementation, forage supplies should be used logically. In general, hay (excluding alfalfa and others when used as a supplement) should not be limit-fed with standing forage. Limit-feeding of hay encourages cows to reduce grazing and fails to use pasture or range while forage quality remains reasonably good. For example, available forage for grazing might include some introduced pasture (such as coastal bermudagrass), some native range, and some hay. As forage supply diminishes, instead of allowing access to all three forages at the same time, introduced pasture could be grazed, followed by native range, and hay fed last. Thereby, each forage is utilized most efficiently and hay use is postponed until late winter to early spring when green, high-quality forages emerge but are limited in quantity.

No two years, seasons, or herds are alike, therefore, general recommendations are only a guideline. Usually, non-lactating mature cows in medium or higher body condition on typical dormant warm-season grazing or low-quality hay often need only 1 to 2 pounds per day of a high-protein supplement. (On extremely low-quality forage, such as tallgrass prairie in winter, 3 to 4 pounds of high-protein supplement may be needed.) In contrast, thin, non-lactating mature cows on this grazing or hay may require 3 to 4 pounds per day, but from a medium-protein, high-energy supplement. After calving, all of these amounts essentially should be doubled.

Due to the small quantity offered and the cow's ability to recycle and conserve nitrogen, daily feeding of high-protein supplements such as cottonseed meal cubes is not required. Instead, weekly requirements can be divided and fed every other day, twice a week, or possibly as infrequently as once a week, depending on the specific supplement and amount required. Less frequent feeding of these supplements facilitates grazing, often is more efficient, and can help reduce variability in consumption among animals. However, combination protein-energy supplements, especially breeder/range cubes and meal-grain mixes that are required in larger amounts, generally should be fed daily to no more infrequently than every other day for best forage and supplement use, higher animal performance, and greatest efficiency.

Perhaps the most common supplement for grazing cows is a 20 percent CP breeder cube (high or all-natural protein and low crude fiber). Breeder cubes often are a compromise for the common situation of low-quality forage and low to medium body condition. To effectively manage grazing cow weight and condition, 20 percent cubes must be fed in adequate amounts as discussed above. With the exceptions of facilitating weight loss in fleshy cows and using cubes as bait to gentle, move, or handle cattle, there are few situations where feeding smaller amounts of breeder cubes is applicable. If a producer is unwilling or unable to assume the cost for the required amounts of these cubes (or their nutritional equivalent), then a lower amount of a higher-protein supplement should be fed. However, it is important to realize that optimum body condition, reproduction, and productivity will not be realized and financial returns will decline if nutrient requirements are not met.

A Power Point presentation on Body Condition Scoring is available at: *http://animalscience.tamu.edu/wp-content/uploads/sites/14/2012/04/beef-bc-scoring.pdf*. Other publications on beef cow nutrition and other topics on beef cow management can be accessed at: *https://animalscience.tamu.edu/livestock-species/beef/publications/*.

TEXAS A&M AGRILIFE EXTENSION

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8-02

RangeDetect Series

Forage Quality and Quantity in Texas — Managing Nutrition in Range Beef Cattle

Robert K. Lyons, Richard V. Machen and Jerry W. Stuth*

Cattle nutritional management is a major challenge for range beef producers. Objectives of this management are to maintain animal productivity, minimize feed costs and preserve the forage resource. To accomplish these objectives, producers must match forage quality and supply with animal needs while still leaving enough forage residue to ensure healthy plants and rangelands. Nutritional management is complicated by changing forage quality and quantity.

This publication discusses:

- Forage quality trends in various regions of Texas.
- Tools to analyze the nutritional environment of cattle and differentiate between forage quality and availability problems.
- Nutritional management strategies.

Forage Quality

Forage quality is typically expressed in terms of protein content and digestibility or energy content. Several factors influence forage quality—plant species, plant part, stage of maturity and growing conditions. The value of a specific forage quality for a grazing animal depends on animal species, size and physiological state. For example, 7 percent crude protein may be good enough for a dry cow but not sufficient for a cow at peak lactation.

Forage Quantity

Although forage quality is important, the amount of forage available to a grazing animal is equally important. If forage is high in quality but scarce, animals may have trouble consuming enough forage to meet nutritional requirements and may use excess energy searching for it.

Grazing animals, including cattle, are selective in what they choose to eat. Studies have reported instances where as much as 80 percent of the diet came from 1 percent of the forage standing crop. Therefore, forage available to a grazing animal is that part of the forage that an animal chooses to eat. When less forage is available, animals may become less selective in the plants they choose, which can cause problems if toxic plants that are usually not eaten are present.

Estimating Forage Diet Quality

It is relatively easy to obtain an estimate of nutritional value of hay by taking and sending a core sample to a lab for analysis. Estimating the diet quality of the forage consumed by a grazing animal is more complicated because grazing animals, especially under rangeland conditions, select among a number of plant species and try to select specific plant parts, primarily green leaves.

In the late 1940s, scientists investigated the possibility of using fecal analysis to estimate forage diet quality of grazing cattle and sheep. This approach was based on the concept that forage residue in feces represents what the grazing animals ate.

In the late 1980s, Texas scientists began using near infrared reflectance spectroscopy (NIRS), a rapid analysis technique, to analyze feces to estimate forage diet crude protein and digestibility. Forage diet quality estimates presented in this publication were obtained using NIRS analysis of cattle feces. Regional forage estimates were obtained from samples submitted to the Grazingland Animal Nutrition Lab at Texas A&M University over a 10-year period.

*Associate Professor and Extension Range Specialist; Associate Professor and Extension Livestock Specialist; and Professor–Department of Rangeland Ecology and Management, The Texas A&M University System

Regional Cattle Forage Diet Quality Trends

Regional monthly average crude protein and digestibility estimates are shown in Figures 1-10. Highest overall diet quality occurred in the East Texas Pineywoods (Figure 1), Post Oak Savannah (Figure 2), Blackland Prairie (Figure 3) and Cross Timbers (Figure 4) regions. In general, forage quality tended to peak for both crude protein and digestibility around April (Figures 1-10). For the Post Oak Savannah (Figure 2), this peak was from March to April, compared to April and May for the Blackland Prairie (Figure 3). In the High Plains (Figure 9), an initial peak occurred from April through June with an additional peak in August. Peaks in the Trans Pecos occurred in April and again in July-August (Figure 10).

Crude protein and digestibility estimates vary among regions throughout the year (Table 1). Following the spring peaks, crude protein declined fairly rapidly and steadily in regions with the highest peak estimates (Figures 1-4). In most regions, digestibility did not decline as rapidly as crude protein. One exception to this tendency was in the Post Oak Savannah (Figure 2).

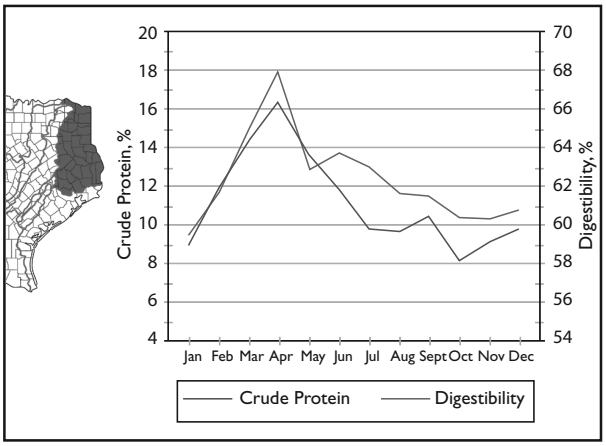

Figure 1. East Texas Pineywoods

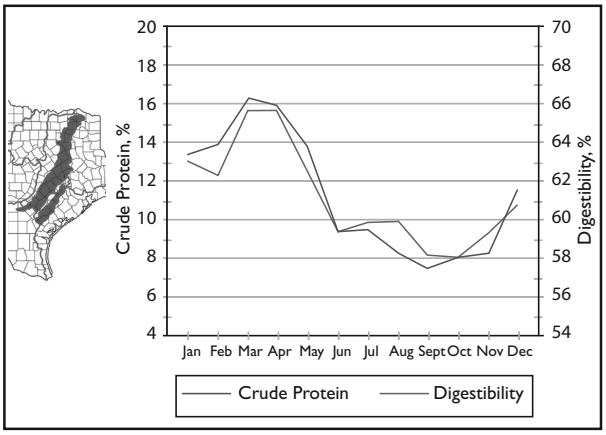

Figure 2. Post Oak Savannah

Average monthly high crude protein levels among regions ranged from 10 to 16 percent. In comparison, average monthly low crude protein levels were fairly similar among regions, with a range of 7 to 9 percent and mostly 7 to 8 percent, except for the South Texas Plains. All regions had maximum crude protein estimates of 19 to 30 percent, while minimum estimates ranged only from 2 to 4 percent. (See Table 1.)

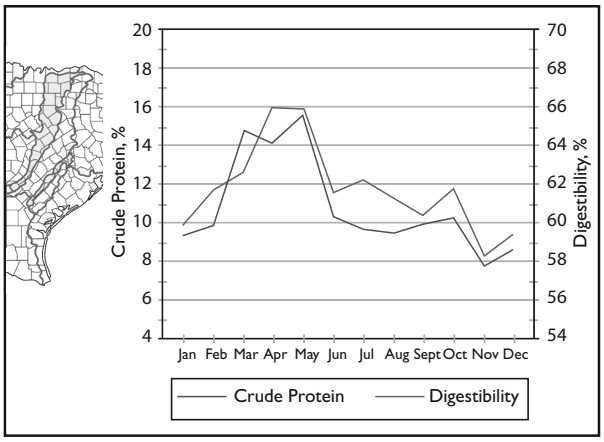

Figure 3. Blackland Prairie

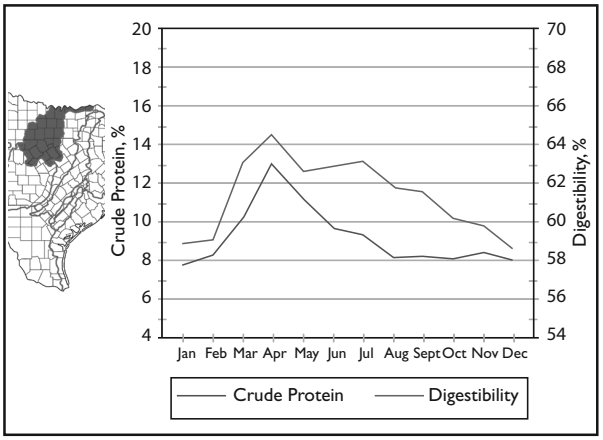

Figure 4. Cross Timbers

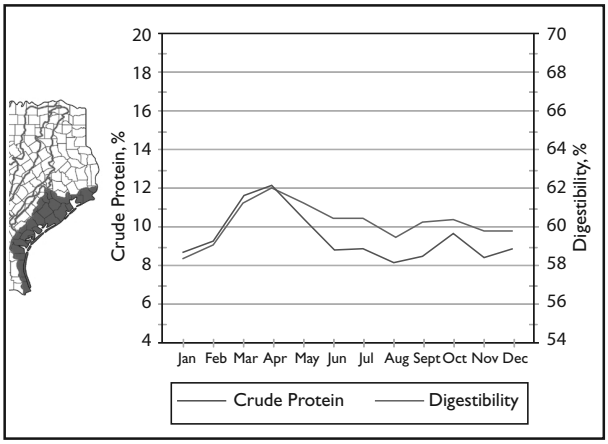

Figure 5. Gulf Coast Prairie

Average high monthly digestibility estimates ranged from 62 to 68 percent among regions. Average low monthly estimates ranged from 58 to 60. Maximum estimates ranged from 71 to 80 percent, and minimum estimates from 44 to 54. (See Table 1.)

Monthly crude protein and digestibility estimates varied by region depending on regional conditions and individual ranch situations. Average monthly crude protein estimates (Figure 11) differed among regions by 7 to 8 percent from March through May. In other months, these differences were 3 to 5 percent. Average monthly digestibility (Figure 12) differed among regions by 8 to 9 percentage points from April through June and by 3 to 6 percent in other months.

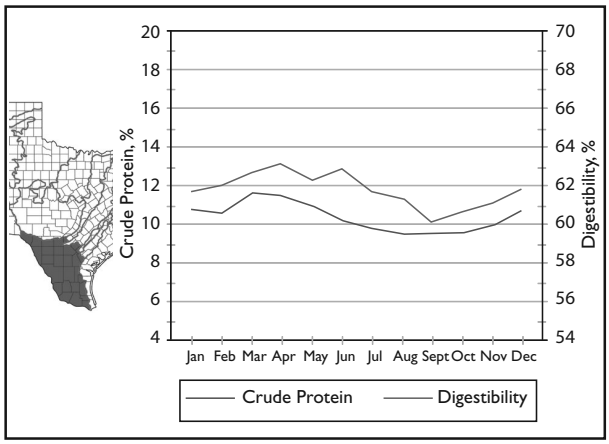

Figure 6. South Texas Plains

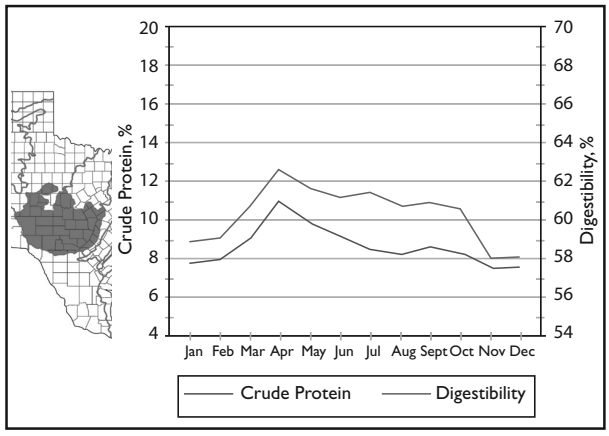

Figure 7. Edwards Plateau

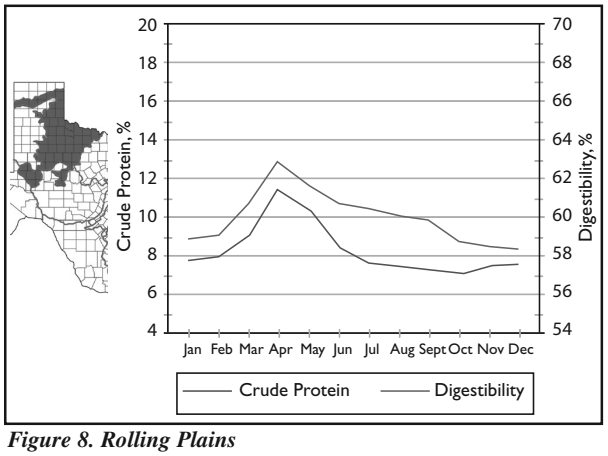

Figure 8. Rolling Plains

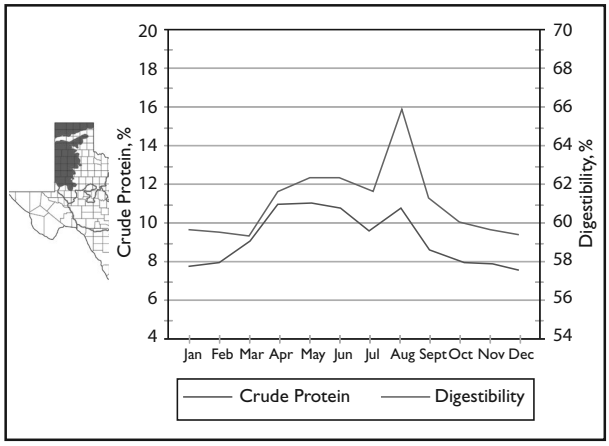

Figure 9. High Plains

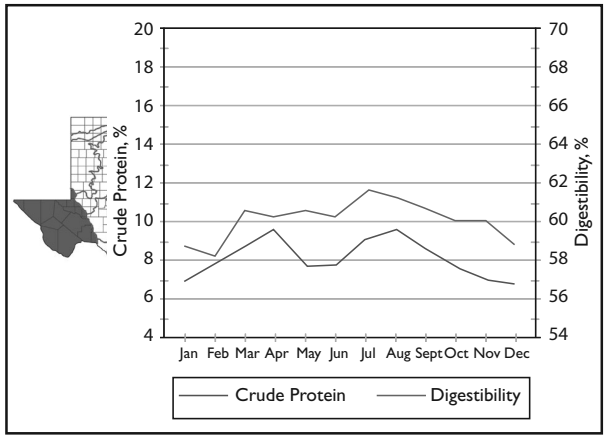

Figure 10. Trans Pecos

Estimating Forage Availability

Estimating the pounds of grass in a pasture is relatively simple and can be done by clipping samples, which is simple but not necessarily enjoyable, or by visually estimating grass quantities. Although these estimates are useful for management practices such as prescribed burning and watershed management, such estimates may not be as valuable in determining forage available to grazing animals. If estimates of pounds of grass are not made for the grass species animals are eating or going to eat, they can be misleading in terms of nutritional management.

Extension demonstrations have used a nutritional analysis system to estimate forage intake, an indicator of forage availability. This system includes 1) NIRS fecal analysis to estimate forage diet quality, 2) the Nutritional Balance Analyzer (NUTBAL PRO) computer software to estimate animal performance, and 3) visual cow body

Table 1. Average high and low, maximum and minimum crude protein and digestibility estimates within regions.								
Region	Crude protein, %				Digestibility, %			
	Average		Maximum	Minimum	Average		Maximum	Minimum
	High	Low			High	Low		
East Texas Pineywoods	16	8	23	3	68	60	76	54
Post Oak Savannah	16	7	28	3	65	58	76	49
Blackland Prairie	16	8	24	4	66	58	71	53
Cross Timbers	13	8	20	4	65	59	75	52
Gulf Coast Prairie	12	8	19	3	62	58	74	52
South Texas Plains	12	9	30	4	63	60	80	53
Edwards Plateau	11	7	22	3	63	58	76	44
Rolling Plains	12	7	30	4	63	60	80	53
High Plains	11	7	21	4	66	59	82	53
Trans Pecos	10	7	28	2	62	58	74	50

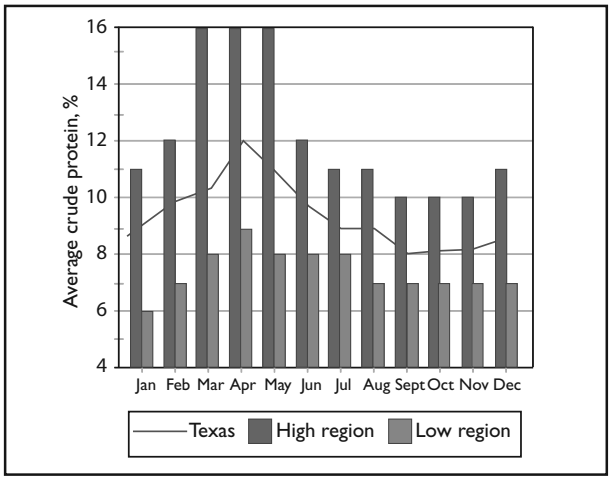

Figure 11. Monthly estimates of average range beef cattle diet crude protein for Texas and high and low regions of the state

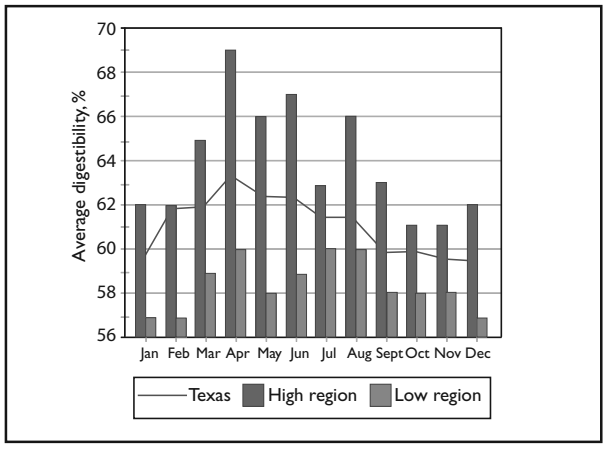

Figure 12. Monthly estimtes of average range beef cattle diet digestibility for Texas and high and low regions of the state

condition scoring to estimate forage intake. In these demonstrations, apparent forage intake was estimated by adjusting NutBal forage intake to match animal performance. Using this system provided a means of distinguishing between forage quality and forage availability as a source of nutritional problems.

Figure 13 illustrates the use of this system to estimate apparent forage intake on a South Texas Plains ranch. Apparent forage intake increased until May, then declined with dry conditions and fluctuated with rainfall. This pattern suggests that the cows were selective in what they grazed and that the availability of preferred forages fluctuated.

Results from a demonstration conducted in the eastern Edwards Plateau show the importance of forage availability. This demonstration was conducted for a 3-year period during which fecal samples and body condition scores were taken monthly in both spring-calving and fall-calving herds. These herds were on the same ranch with the same range sites and terrain but in different pastures.

Spring- and fall-calving herd forage quality trends were similar to each other and to general Edwards Plateau trends (Figure 7). However, body condition scores were lower for the spring-calving herd (about 5) than for the fall-calving herd (5.5) from weaning through breeding.

Although a condition score of 5 is generally considered acceptable, why would fall herd condition scores be higher, since these two herds were on the same ranch and range sites? The answer appears to be forage intake (Figure 15 and Table 2). Comparing these two herds from the second month after weaning (December/July) through the second month of the calving season (March/October), the spring-calving herd had an apparent forage intake deficit of 6 to 11 pounds per day (average 8.25 pounds) compared to a 1- to 5- pound per day deficit for the fall herd (average 2.5 pounds).

Table 2. Comparison of forage quality, stock density, body condition score changes and apparent forage intake deficits for spring-calving (SC) and fall-calving (FC) herds on the same Eastern Edwards Plateau ranch grazing the same range sites in different pastures.

	Crude protein, %		Digestibility, %		Stock density, ac/cow		Body condition score change		Apparent forage deficit, lbs/day	
Physiological state	**SC**	**FC**	**SC**	**FC**	**SC**	**FC**	**SC**	**FC**	**SC**	**FC**
Weaning (Oct/May)	8.0	9.5	59	61	9	36	0	0.4	-11	-5
Dry & bred (Nov/Jun)	6.4	7.8	58	60	10	34	0.4	-0.1	0	-6
Dry & bred (Dec/Jul)	6.5	7.7	58	60	10	21	-0.2	0.1	-11	-5
Dry & bred (Jan/Aug)	6.8	8.1	57	60	11	32	-0.1	0.2	-7	-2
Calving (Feb/Sep)	8.1	7.9	60	60	18	37	-0.1	-0.1	-6	-2
Calving (Mar/Oct)	9.1	7.3	60	59	14	35	-0.3	-0.1	-9	-1
Calving & breeding (Apr/Nov)	12.2	6.8	63	58	19	31	0.4	-0.2	0	-2
Breeding (May/Dec)	9.0	7.6	61	58	11	31	-0.3	-0.2	-5	-6
Breeding (Jun/Jan)	7.4	7.1	59	58	11	34	-0.1	-0.4	-2	-12

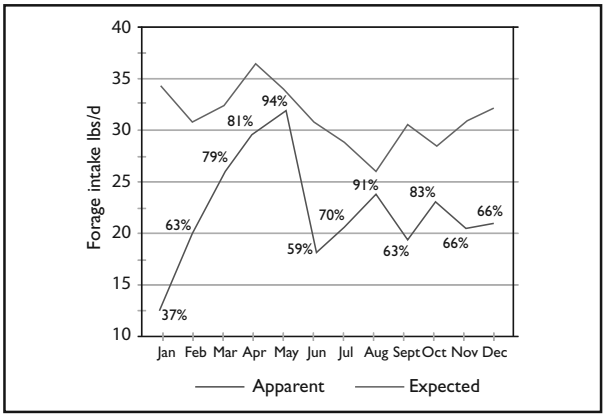

Figure 13. Example of seasonal fluctuatins in apparent forage intake on a South Texas Plains ranch over a 2-year period. Apparent forage intake approaches expected forage intake as the growing season progresses to May and then fluctuates with rainfall. (Percentages above the line indicate the portion of expected intake reached by apparent forage intake.)

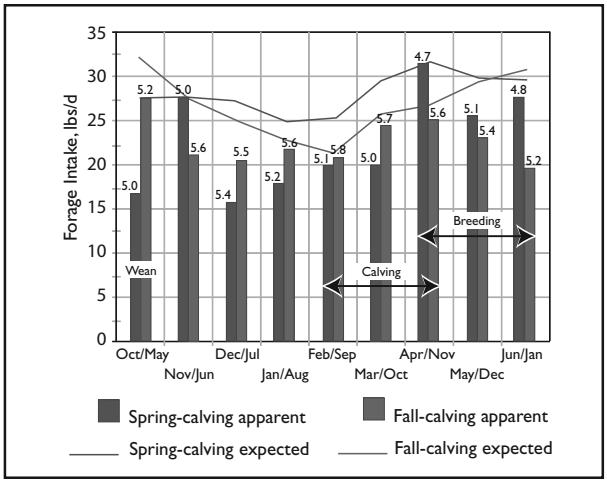

Figure 14. Expected verus apparent forage intake for spring-calving and fall-calving herds at the same physiological state on the same eastern Edwards Plateau ranch over a 3-year period. (Numbers above bars indicate cow body condition score.)

Since average estimated forage quality for the two herds was similar for this period (Table 2), why would apparent forage intake be so different? In this case, the answer appears to be stock density (acres per cow at a given time). From weaning through breeding, the spring herd had a stock density of 1.6 to 4 times greater (average of about 20 acres less per cow for the spring herd) than the fall herd. For the period from December/July through March/October, the spring herd was stocked at a density 2.3 times greater (average of 18 acres less per cow) than the fall herd. Therefore, higher stock density resulted in less available forage and less forage intake for the spring-calving herd.

Body condition score in the fall-calving herd decreased from 5.6 to 5.2 during breeding. Apparent forage intake declined steadily during this period. (See Figure 14.) This breeding season occurred from November through January, a period of little or no forage growth. Therefore, fall-calving cows need to be at better than body condition score 5 at calving to withstand these kinds of losses and remain in acceptable body condition during breeding.

Strategic Supplemental Feeding

Supplemental feeding should enhance forage intake and/or correct deficiencies in forage quality. Both time of day and frequency of feeding can affect forage use efficiency. Timing feeding according to cow physiological state is important to achieve an efficient supplemental feed response.

Supplemental feed should not be offered during major grazing periods. An example from Extension result demonstration work using the nutritional analysis system described above illustrates this point (Figure 15). During this analysis period, the rancher was asked to manage supplemental feedings in the normal manner for the ranch. In year 1, supplemental feed was offered to cows at about 8 to 9 am. In year 2, no supplemental feed was offered. Forage quality was the same for the two years. Apparent forage intake in year 2, when no supplement was offered, is higher than in year 1, suggesting that feeding during the morning major grazing period in year 1 interrupted grazing and reduced forage intake.

Research has shown that feeding frequency affects grazing behavior. Cows fed daily stay closer to and longer at feeding areas. Cows fed once a week graze more of the pasture. Once-a-week feeding can be done only with a high protein feed (greater than 30 percent). However, high energy feeds, especially high starch feeds, may cause digestive upsets if fed only once a week.

To illustrate timing of supplemental feeding for optimum efficiency relative to cow production stage, spring- and fall-calving schedules were analyzed with the NutBal program. Using estimated forage diet quality and apparent forage intake from the eastern Edwards Plateau herds described above and a central Edwards Plateau herd, this analysis indicated that the only period where supplemental feed could be used efficiently (in small quantities) to improve cow body condition was during the period from weaning to calving. This conclusion agrees with standard recommendations. Cows have a lower physiological demand during this period and can, therefore, convert excess nutrient intake to body reserves.

Tables 3 and 4 provide estimates of supplemental feeding requirements (assuming a 41 percent crude protein, 75 percent TDN supplemental feed analysis) for these calving schedules for a 0.5 body condition score gain or maintenance during four 30-day periods from 120 days pre-calving to calving. Supplemental feed estimates differ depending on forage quality and/or availability on individual ranches and for individual herds. For example, for the eastern Edwards Plateau spring- calving schedule, there is only one 30-day period where supplemental feed could efficiently improve body condition by one-half score. For the central Edwards Plateau spring-calving herd schedule, there are two periods where efficient gain appears possible. The large amounts of supplemental feed needed closer to calving illustrate that waiting until the last minute to attempt to increase body condition score is neither economical nor feasible. Therefore, the feeding strategy would be to improve condition score where it is efficient to do so and feed for maintenance or slower gains during other periods. In many instances in these examples, maintenance required no feed. Therefore, it is crucial that body condition scoring be used as a guide to any feeding program.

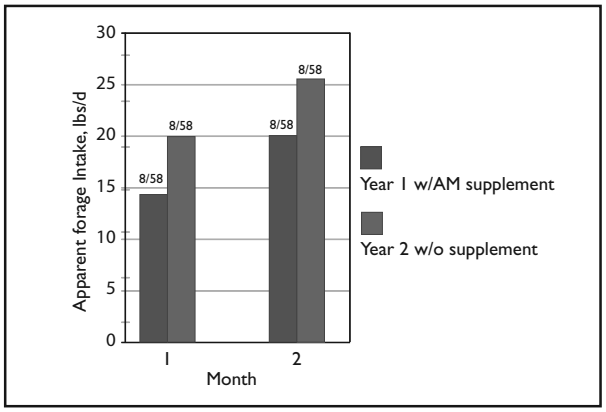

Figure 15. Supplemental feeding during a major grazing period reduces forage intake by interrupting grazing. (Numbers above bars indicate estimated crude protein and digestibility.)

Management Recommendations

- Average regional trends serve as a good indication of changes in the diet quality of grazing beef cattle. However, ranches and even pastures within ranches may vary from these averages as evident from the large range of reported values within any single month. More individualized information can be obtained from fecal analysis.
- Stocking rates and stock densities can have a marked influence on forage availability and, therefore, forage intake. Forage availability is equally as important as forage quality in nutritional management. Using the nutritional analysis system of NIRS fecal analysis, NutBal computer software and body condition scoring can help distinguish between forage quality and forage availability problems.
- Because the fall-calving breeding season occurs during a period when forage quality is declining and/or less available, these cows need to be in better than a 5 condition score at calving to withstand probable condition score losses following calving and remain in acceptable body condition during breeding.
- Do not offer supplemental feed during major grazing periods during the day. Offer supplemental feed during midday to avoid interfering with grazing.
- Consider feeding supplemental feed once a week to improve pasture grazing distribution and use. With once-a-week feeding, provide a high protein (>30 percent) supplement.
- Concentrate efforts to improve body condition on the period between weaning and calving. Use historic body condition scores as a guide to what can be expected. Use current body condition scores to decide how to manage supplemental feeding.

Table 3. Examples of spring-calving (March) supplemental feeding strategies from Extension result demonstrations assuming a 41 percent crude protein, 75 percent TDN supplemental feed analysis.

		30-day performance goal and estimated supplemental feed requirement		
Location	**Days pre-calving**	**0.5 BSC gain**	**Maintenance**	**Suggested feeding strategy**
Eastern Edwards Plateau Ranch	120	1	0	feed for gain if needed
	90	6.7	0	maintenance or slower gain
	60	7.8	1.7	maintenance or slower gain
	30	6.6	1.2	maintenance or slower gain
Central Edwards Plateau Ranch	120	2	0	feed for gain if needed
	90	1.3	0	feed for gain if needed
	60	5.5	0	maintenance or slower gain
	30	8	1.7	maintenance or slower gain

Table 4. Examples of fall-calving (September) supplemental feeding strategies from Extension result demonstrations assuming a 41 percent crude protein, 75 percent TDN supplemental feed analysis.

		30-day performance goal and estimated supplemental feed requirement		
Location	**Days pre-calving**	**0.5 BSC gain**	**Maintenance**	**Suggested feeding strategy**
Eastern Edwards Plateau Ranch	120	4.5	1.4	maintenance
	90	1.4	0	feed for gain if needed
	60	3.5	0	feed for gain if needed
	30	3	0	feed for gain if needed
Central Edwards Plateau Ranch	120	5.5	0	maintenance
	90	2.2	0	feed for gain if needed
	60	8.7	0	maintenance or slower gain
	30	12.4	1.2	maintenance or slower gain

For more information

L-5359, “Forage Quality Photo Guide: Evaluating Diet Quality Selected by Grazing Beef Cattle Using Photographic Guidelines.” Texas Cooperative Extension.

L-5385, “Interpreting Grazing Behavior.” Texas Cooperative Extension.

L-5400, “Stocking Rate: The Key Grazing Management Decision.” Texas Cooperative Extension.

E-102, “Using Body Condition Scores to Manage Range Cows and Rangeland.” Texas Cooperative Extension.

L-5409, “Livestock Grazing Distribution: Considerations and Management.” Texas Cooperative Extension.

B-6067, “Supplementation Strategies for Beef Cattle.” Texas Cooperative Extension.

B-1526, “Body Condition, Nutrition and Reproduction of Beef Cows.” Texas Cooperative Extension.

Grazingland Animal Nutrition Lab: *http://cnrit.tamu.edu/ganlab/*

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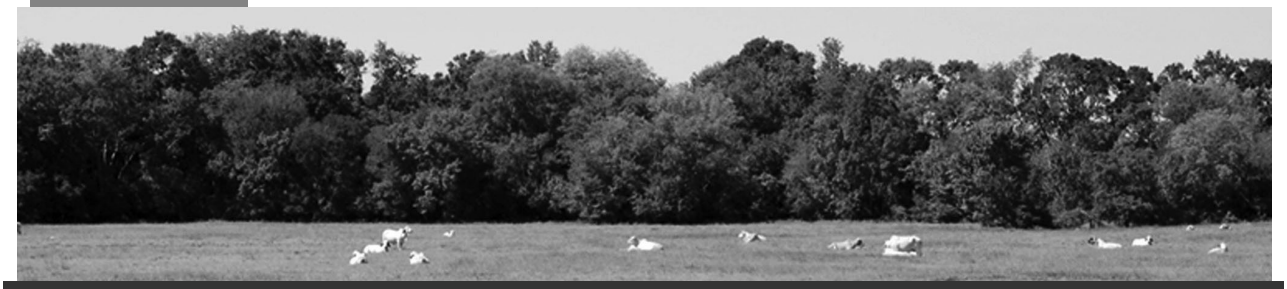

Estimating Grazeable Acreage for Cattle

Jason C. Hohlt, Robert K. Lyons, C. Wayne Hanselka and David McKown*

*Natural Resources Conservation Service; and Professor and Extension Range Specialist, Professor and Extension Range Specialist, and Extension Assistant, The Texas A&M System.

Stocking decisions can be difficult to make. Forage supplies vary from season to season and from year to year, and with more brush on our rangelands than ever before, old stocking rates may be of little value. Many land managers are also realizing that their cattle use only a portion of the land available. The goal of recent research was to determine why cattle use some areas but not others and how ranchers can use such information to estimate the number of grazeable acres they have.

How Grazeability was Studied

Research using cattle fitted with Global Positioning System (GPS) collars shed light on how cattle behave in response to different features of the landscape. The research was conducted on ranches in different regions of Texas to demonstrate the influence of landscape features such as brush density, rock cover, surface slope, water and forage species on livestock grazing. Test sites were in the Davis Mountains, Edwards Plateau and South Texas Plains.

Digital aerial photographs of the test ranches and overlays showing the various ecological sites within each photograph were obtained. An ecological site is an area of land with specific physical characteristics that differs from other kinds of land in the types and amounts of vegetation it produces. Descriptions of these ecological sites define certain landscape features. For example, an ecological site designated as gravelly redland has 36 percent or less surface rock cover. The ecological site maps and aerial photographs enabled researchers to predict which areas cattle would not use because of their apparent brush and rock cover, slope, or inaccessibility. (Landowners can contact a local USDA Natural Resources Conservation Service office for help acquiring digital aerial photographs and ecological site overlays for their property.)

Next, areas that appeared ungrazeable from the maps were observed on the ground. Observers measured brush density and rock cover and determined the herbaceous plant species growing in each area. Again, researchers predicted grazeability from their ground observations.

To test the map and ground observation prediction methods, researchers fitted cattle with GPS collars and recorded their positions for 23 days. Collars were programmed to take a position fix every 5 minutes and are accurate to within 10 to 16 feet of the true location. As Table 1 shows, both map estimates and ground estimates were fairly accurate, as validated by the actual GPS locations of cattle on the ranches. However, ground observation is clearly the more accurate method for predicting the grazeability of an area.

Table 1. A comparison of the accuracy of predicting grazeable areas from map and ground estimates, as validated by GPS studies.

Research area	Map estimates, % correct	Ground estimates, % correct
Edwards Plateau	80	93
South Texas Plains 1*	67	-
South Texas Plains 2	92	92
South Texas Plains 3	88	100
Average	82	95

*No ground observation was done at this site.

What the Research Shows

Brush Density

While aerial photographs can give a general estimate of the brush cover on your property, they do have limitations. If photographs are taken at the time of year when brush plants such as mesquite have dropped their leaves, the extent of brush cover may not be apparent. Photographs are helpful in pinpointing areas that might be too brushy for cattle so that these areas can be checked on the ground. There is often more brush in the pasture than can be seen on an aerial photograph.

Actual brush density should be checked and scored in several areas on the property. Walk a straight line through each area and assign a brush density score every 20 steps. Use Figure 1 as a guide in determining brush density scores.

The GPS collar research showed that, overall, **only 25 percent of areas with a brush density score of 3 were visited by cattle, and that cattle completely avoided areas with scores of 4 or 5 (Fig. 2).** This relationship was true in both the Edwards Plateau and South Texas Plains, regions with very different brush species.

Figure 1. Brush density scores.

BDS = 0
(no brush present, foreground clear to tree line)

BDS = 1
(very light brush, only a few scatted plants)

BDS = 2
(light brush, brush common, but mobility or access not limited)

BDS = 3
(brush thick enough to limit mobility, but cattle can maneuver through it)

BDS = 4
(brush thick, mobility possible only in pathways)

BDS = 5
(very thick brush, mobility through it nearly impossible)

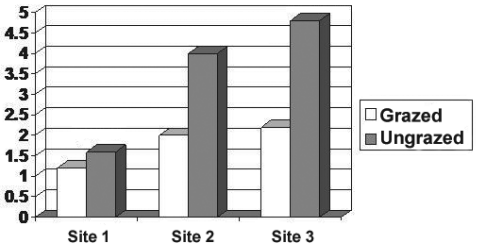

Figure 2. Average brush density scores of grazed and ungrazed areas at three research sites in the South Texas Plains.

Rock Cover

With ecological site descriptions you can identify areas where rock cover might be a problem and spot-check these on the ground at the same time you determine brush density scores. Walk a 300-foot line through the area. At 20-foot intervals, place a PVC frame on the ground as a guide. Examples of various rock cover percentages are shown in Figure 3. The frames used in this study had an outside measurement of about 29 inches and were divided into quarters to make it easier to visualize percent rock cover. To build a frame you will need tubing, four 90-degree elbows, four tees and one cross fitting.

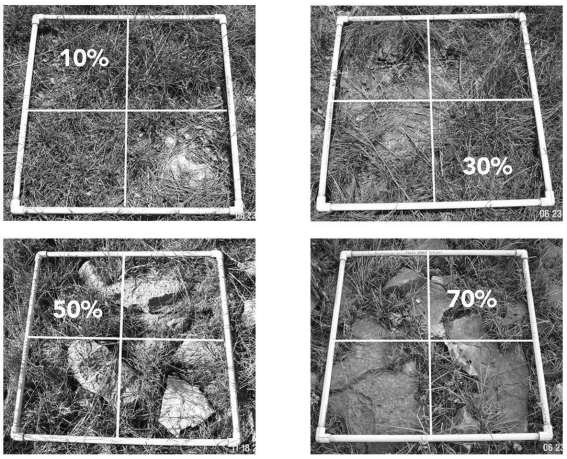

Figure 3. Rock cover percentages.

The GPS collar study showed that **cattle tend to avoid areas with 30 percent or more rock cover.** When determining a rock cover percentage, remember that if an area is uncomfortable for a person to walk on, it will also be uncomfortable for cattle.

Slope

Percent slope is calculated as the change in elevation over a 100-foot distance. Cattle prefer flat areas or broad, gentle slopes and are usually deterred by steep slopes. In the GPS collar study at the Davis Mountains site, **95 percent of cow locations were on slopes of 11 percent or less**. Table 2 shows how slope affects whether or not cattle will use an area. Ecological site descriptions can help you identify areas where slope could limit cattle use.

Table 2. Expected effect of slope on cattle use.

Percent slope	Percent reduction in use
0-10	0
10-30	30
31-60	60
> 60	100

Water

The distance cattle have to travel to find water affects their use of a pasture. In general, **cattle graze within about 1 mile of water**, as was shown in the Davis Mountains study where about 73 percent of cow locations were within a 1-mile radius of either of the two water sources available.

Forage

Another consideration when determining grazeable acreage is what cattle will and will not eat. So you will need to be able to identify some of the major plant species, especially grasses. Grasses such as threeawn (*Aristida* spp.), red grama (*Bouteloua trifida*) and Texas grama (*Bouteloua rigidiseta*) are very unpalatable to cattle. Cattle will avoid areas dominated by these species if more palatable grasses are available elsewhere. Likewise, cattle will not use areas with heavy concentrations of certain perennial weeds such as goldenweed (*Isocoma drummondii*) and wolfweed (*Leucosyris spinosa*).

The frequency of herbaceous species was estimated at the South Texas Plains locations. No dominant grasses emerged as attractants or deterrents in grazed or ungrazed areas. However, at two of these locations the average number of herbaceous species was greater in the grazed areas (Fig. 4).

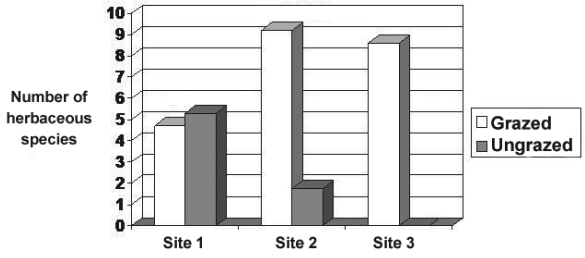

Figure 4. The number of herbaceous species was generally greater in grazed areas than in ungrazed areas at the South Texas locations.

Although there was little difference in the number of herbaceous species within the grazed and ungrazed areas at site 1, the grazed areas did have less Kleberg bluestem, a relatively unpalatable grass. It may be that cattle avoid this grass when possible.

Accessibility

Some areas of pastures may have low brush density scores, little rock cover, adequate water, gentle slopes and palatable forage species, but still not be grazed because they are inaccessible. These areas may be surrounded by dense brush, heavy rock cover and/or steep slopes. Aerial photographs with ecological site layers and descriptions can be very helpful in identifying such areas. If possible, creating roads or trails into these areas will make them more accessible to cattle.

How to Use this Information

Begin by visiting your local NRCS office and requesting up-to-date aerial photographs of your property. There is no charge for these photographs. NRCS personnel can also provide ecological site overlays for the aerial maps and help you figure out how many acres of each kind of ecological site there are. Use these maps and overlays to identify areas that might have dense brush, extensive rock cover or steep slopes. Then, check these areas on the ground; calculate brush density scores and rock cover percentages and make note of the abundance of various forage species. Also verify the accessibility or inaccessibility of suspect areas on the maps.

Here are typical ecological sites, with their surface rock and slope characteristics, for the Edwards Plateau and South Texas Plains regions.

Table 3. Typical ecological sites in the Edwards Plateau and their rock and slope characteristics.

Ecological site	Surface rock, %	Slope, %
Deep redland	7	0-5
Redland	7	0-5
Gravelly redland	≤36	1-12
Low stony hill	≤50	0-15
Steep rocky	35-65	15-45 (some 20-60)

Table 4. Typical ecological sites in the South Texas Plains and their surface rock and slope characteristics.

Ecological site	Surface rock, %	Slope, %
Clay loam	0	<3
Claypan prairie	0	0
Gray sandy loam	0	<2
Lakebed	0	<1
Sandy loam	0	0-5
Tight sandy loam	0	0-3

Use these guidelines to estimate the number of grazeable acres you have.

Total acreage available		_____
Subtract acres with brush density scores of 3 or higher.	–	_____
Subtract acres with 30 percent or more rock cover (unless already subtracted for brush density).	–	_____
Subtract acres dominated by undesirable plants (unless already subtracted for brush density and/or rock cover).	–	_____
Subtract acres with slopes of 10 percent or more (unless already subtracted for brush density, rock cover and/or undesirable plants).	–	_____
Subtract acres 2 miles or more from water (unless already subtracted).	–	_____
Total Grazeable Acreage	=	_____

The Importance of Estimating Grazeable Acreage

It is often possible to increase the amount of grazeable acreage by controlling brush, improving access to certain areas or adding water sources. Seeding rangeland with desirable grass species is another option. So taking time to estimate your grazeable acreage might prove beneficial by revealing management measures that would improve the productivity of your land.

But the major benefit is in determining the proper stocking rate. As this research shows, the number of grazeable acres on a ranch may be much lower than the total acreage, which can have a dramatic effect on stocking rate. At one Edwards Plateau ranch (Fig. 5), the GPS collar study revealed that cattle were using only 39 percent of the total area. The ranch had been stocked at 20 acres per cow based on total acreage, but the effective stocking rate was 9 acres per cow.

By using these guidelines, you will be able to estimate the number of grazeable acres on your property. Then you should make stocking decisions on the basis of the amount of forage available on that acreage.

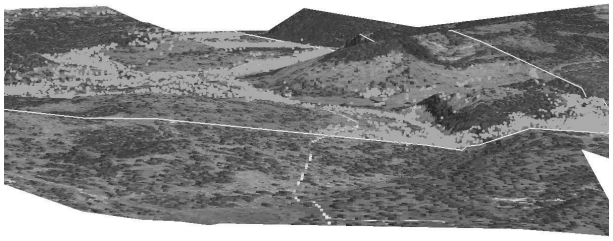

Figure 5. In this three-dimensional photograph, the green dots are cattle locations. Areas with no dots are mostly within the Steep Rocky ecological site or surrounded by this site, which had the most rock cover and slope and the greatest brush density.

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RWFM-PU-047 11/22

GRAZING AND BROWSING: HOW PLANTS ARE AFFECTED

Robert K. Lyons and C. Wayne Hanselka*

Grazing can have a neutral, positive or negative effect on rangeland plants, depending on how it is managed. Land owners and managers can better protect rangeland plants, and, in turn, other rangeland resources, if they understand:

- The effects of grazing and browsing (eating the leaves and young twigs of trees and shrubs) on individual plants and plant populations.
- The indicators that show which plants are in danger of overuse by grazing and browsing animals.
- The grazing management practices that help preserve the rangeland resource.

Understanding these factors and knowing the available management options allows landowners and managers to make better decisions about which actions are best for a particular site and when to take action. Timely action can preserve the long-term health of the rangeland as well as the viability of livestock and wildlife operations.

INTERACTIONS BETWEEN RANGE PLANTS AND RANGE ANIMALS

Rangelands are ecosystems that have adapted to withstand such disturbances as drought, flood, fire, and grazing. All disturbances affect plants to some extent, either directly or indirectly, depending on the timing, intensity, and frequency of the disturbance. Generally, the more diverse the vegetation, the better rangeland can withstand disturbance.

Rangeland plants provide nutrients—proteins, starches and sugars—to grazing and browsing livestock and wildlife. These nutrients, or plant foods, are produced by photosynthesis. Because photosynthesis occurs only in green plant tissue and mostly in the leaves, a plant becomes less able to produce food, at least temporarily, when its leaves are removed (defoliation) by grazing and browsing animals.

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Products of photosynthesis are just as important to plants as they are to animals. Like all other living things, plants need food to survive and grow. The food that plants make for themselves through photosynthesis is used for major plant functions such as surviving dormancy, growing new roots, growing new leaves in the spring, and replacing leaves lost to grazing or browsing.

Most native rangelands evolved under grazing. Therefore, rangeland plants have developed the ability to withstand a certain level of grazing or browsing. Although grazing animals do disturb rangeland, research has shown that rangelands gain few benefits when livestock are totally excluded for long periods.

WHAT HAPPENS TO A PLANT AFTER GRAZING OR BROWSING?

Grazing affects not just the leaves, but also other parts and functions of plants, including the root system, food production after defoliation, and the destination of food products within the plant after defoliation.

Food reserves and the root system

When a plant's leaves are removed, its roots are also affected. Excessive defoliation makes the root system smaller.

Removal of too many leaves has a profound effect on the root system (Figure 1). Research on grasses has demonstrated that when 80 percent of the leaf is removed, the roots stop growing for 12 days. When 90 percent of the leaf is removed, the roots stop growing for 18 days. Root growth drops by half when 60 percent of leaf is removed.

As root growth is reduced or stopped, root volume decreases (Figure 2). Plants with smaller roots have less access to water and other nutrients in the soil needed to manufacture food. A smaller root system also makes plants less drought resistant.

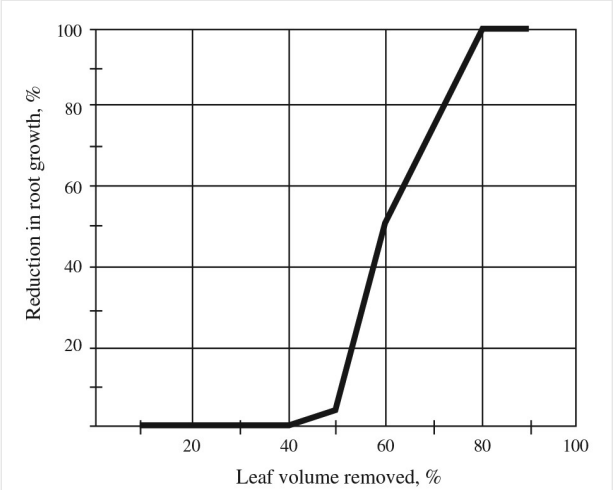

Figure 1. The effect of leaf removal on the root growth of a grass. With 80 percent leaf removal, roots stopped growing for 12 days; with 90 percent removal, root growth stopped for 18 days.

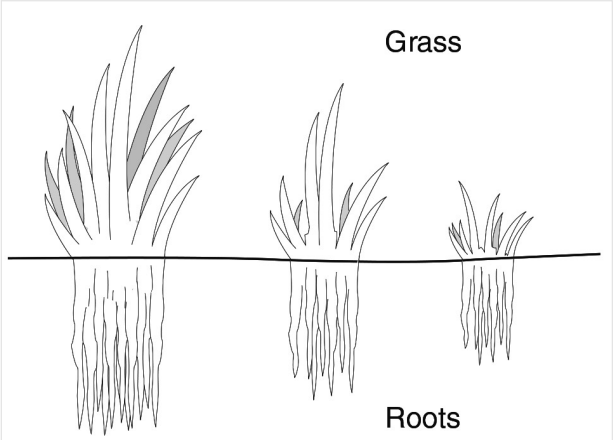

Figure 2. Heavy, frequent defoliation stops root growth and reduces the size of the root system. It reduces the plant's ability to absorb water and other nutrients, thus making the plant less drought resistant and less able to manufacture food.

Early research demonstrated that roots lose stored foods after defoliation. These observations led to the conclusion that the roots and crown of grasses were major sources of food for the initiation of growth after defoliation.

However, recent information indicates that, at least in grasses, stored foods are not as important in initiating this growth. Although food reserves decline in grass roots after defoliation, these reserves do not appear to be sent to the food-producing parts of the plant.

Recent research indicates that this decline in food stored in grass roots after defoliation results from a combination of:

- Remaining leaves sending less of the food they manufacture to the roots, and
- Roots themselves using the root food reserves.

In addition, studies involving grass crowns have shown that this part of the plant stores only about a 3-day supply of food reserves. This finding indicates that this part of the plant does not supply enough food to promote significant growth after defoliation.

If roots do not contribute stored food to promote growth after defoliation, where does the plant get this food?

Food production after defoliation

Grazing and browsing decrease, at least temporarily, a plant's food production by reducing the amount of green plant material available to produce food. Other factors affecting food production after grazing or browsing include the amount, kind, and age of plant material (leaf, sheath, stem) remaining on the plant.

For example, grass leaf blades, whether mature or young, often produce food at a higher rate than leaf sheaths (the leaf base enveloping the stem) or stems. In addition, young leaves produce food at higher rates than older leaves. Therefore, the more leaf material left after grazing, the faster grasses recover from grazing.

In many plant species, including some grasses, the leaves on grazed or browsed plants produce food at higher rates than leaves of the same age on plants that have not been grazed or browsed. In plants where it occurs, this process happens over several days in leaves remaining on a grazed or browsed plant and in new leaves developing after grazing or browsing. This process is one way that some plants partially cope with grazing or browsing.

Destination of food products after defoliation

Plants use the foods they produce for growth and maintenance. Any excess food is sent from the food-producing plant parts to other parts both above and below ground, where it is stored.

Once a plant has been defoliated, it may change the destination of its food products. The destination of that food varies with plant species. In some species, more food is sent to growing shoots and less to roots. This process occurs for a few days until the food-producing tissues can be reestablished. In some grass species,

more food products may even be sent to the more active food-producing leaf blades rather than to less active leaf sheaths.

A plant's ability to send food products to new shoots after defoliation can help it quickly reestablish its food-producing parts. Plant species that have this ability are better able to tolerate grazing.

In investigations of grazing tolerance, researchers compared two western grass species that had different levels of grazing tolerance. They found that after defoliation, the grazing-tolerant species sent more food products to new leaves and fewer products to the roots. In contrast, the grazing intolerant species sent large amounts of food products to the root system. This finding helps explain why some grasses are better able to resist grazing.

HOW DO PLANTS COPE WITH GRAZING AND BROWSING?

The ability of plants to survive grazing or browsing is called grazing or browsing resistance. The most grazing-resistant plants are grasses, followed by forbs (herbaceous plants other than grass), deciduous shrubs and trees, and evergreen shrubs and trees.

When a grass seedling develops, it produces a primary tiller, or shoot. This primary tiller has both a main growing point and secondary growing points located at or below ground level.

Additional tillers can develop from secondary growing points at the base of a tiller. Tillers can also develop from buds at the nodes of stolons (above-ground lateral stems, such as in buffalograss) or rhizomes (below-ground lateral stems, such as in Johnsongrass) of grasses with these structures.

Cool-season grasses begin growth in the fall, maintain some live basal leaves through winter, and continue growth in the spring. Tillers produced in the fall are exposed to cold and can produce seedheads in spring. Tillers initiated in the spring usually do not produce seedheads.

In comparison, warm-season grasses produce new tillers in late summer and early fall. Although these young tillers die back when exposed to frost, their buds will produce new tillers the following spring.

Tillers of most grasses live only one to two years. Individual leaves usually live less than a year and most only a few months.

A plant can produce leaves only at an intact growing point. As long as that growing point is close to the ground, it is protected from being eaten (Figure 3). At some point, most grasses elevate at least some of their growing points to produce tillers, or shoots, that have seedheads.

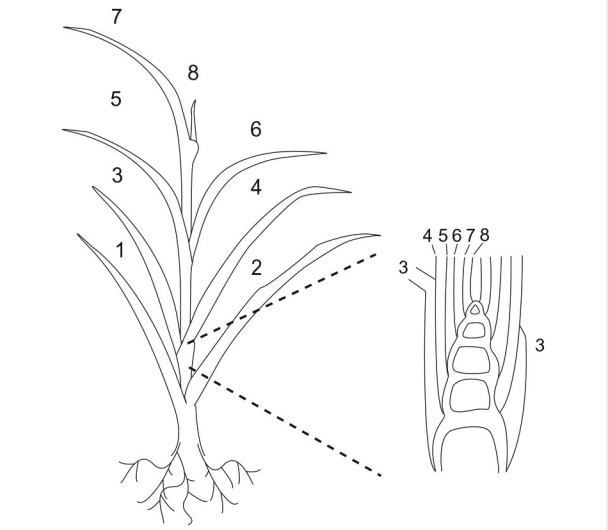

Figure 3. This illustration represents a grass tiller (or shoot) and its main growing point. On the left are the grass tiller and eight leaves, numbered 1 to 8. On the right is an enlargement of the area near the base of this tiller where the main growing point is located. All the leaves shown have developed from this growing point. As long as the growing point is close to the ground as shown here, it is safe from being eaten and can continue to produce leaves for the life of the tiller (1 to 2 years).

Tillers stop producing new leaves when a seedhead develops from the growing point or when the growing point is eaten. Plants then must depend on other tillers to continue producing new leaves or wait until basal buds produce new tillers.

Excessive grazing of a grass plant when its growing points are elevated reduces new leaf production, and therefore, the ability of the plant to produce food and tolerate grazing. Destruction of the growing point also prevents seed production and production of new seedlings. Grasses should be rested from grazing periodically to allow them to produce leaf material to feed the plant and to allow seed production.

Timing of growing point elevation varies among grass species (Table 1). For example, growing points of buffalo grass and other sod-forming grasses remain close to the ground, giving these grasses high grazing resistance.

Little bluestem and sideoats grama keep their growing points close to the ground until just before seedheads emerge. Although this strategy protects growing points from being eaten for a longer period, these two grasses produce many tillers with seedheads, which means that many growing points are exposed. The combined effect

TABLE 1. EXAMPLES OF GROWING POINT ELEVATION AND GRAZING RESISTANCE FOR SOME COMMON RANGE GRASSES.		
GRASS SPECIES	GROWING POINT ELEVATION/REPRODUCTIVE TILLER RATIO	HEAD4
Buffalograss	Remain close to ground	High
Little bluestem	Elevation late w/ large number reproductive tillers	Moderate
Sideoats grama	Elevation late w/ large number reproductive tillers	Moderate
Switchgrass	Elevation early	Low
Yellow indiangrass	Elevation early	Low
Johnsongrass	High proportion of reproductive tillers	Low

of delayed elevation and the production of many tillers with seedheads gives these two grasses moderate grazing resistance.

Yellow indiangrass and switchgrass elevate their growing points above ground level soon after growth begins. This early elevation results in low grazing resistance.

Grasses with low (yellow indiangrass and switchgrass) to moderate (little bluestem and sideoats grama) grazing resistance require more care in grazing management. This care can be accomplished in several ways.

One way to manage these low- to moderate-grazing resistant grasses is to lower grazing pressure by stocking fewer animals to allow some plants to escape grazing.

Another method is to make sure that pastures with these grasses are rested from grazing every 3 or 4 years during the growing season to allow the plants to produce seed.

Still another method that has been used successfully is intensive-early stocking. With this approach, grazing animals are stocked at higher than normal numbers for the first part of the growing season and then removed from pastures for the rest of the growing season. This approach has typically been used with stocker (young steer and heifer) operations.

Johnsongrass is an interesting contradiction. Because it produces strong rhizomes (underground stems), it should be resistant to grazing. However, Johnsongrass also produces a high proportion of reproductive stems, which cancels the advantage of rhizome production and results in lower grazing resistance.

The growing points of forbs, like those of grasses, remain close to the ground early in the growing season. Forb species that elevate growing points early are less resistant to grazing.

For woody plants, growing points are elevated above ground and, therefore, are easily accessible to browsing animals. If these growing points are removed, lateral buds are stimulated to sprout and produce leaves. However, woody plants replace leaves relatively slowly.

Grazing avoidance and grazing tolerance

Grazing resistance can be divided into avoidance and tolerance (Figure 4). Grazing avoidance mechanisms decrease the chance that a plant will be grazed or browsed. Grazing tolerance mechanisms promote growth after grazing or browsing.

Grazing resistance factors can be related to plant anatomy, plant chemistry or plant physiology:

- Anatomical features that help plants resist being grazed include leaf accessibility (leaf angle, leaf length), awns or spines, leaf hair and/or wax, tough leaves, grass species with more vegetative stems (fewer growing points exposed) than reproductive stems, and the ability to replace leaves, which depends on growing points.
- Chemical factors of grazing resistance include those compounds that make plants taste bad, toxic, or hard to digest.
- Physiological factors include sending new food products to new leaves, water-use efficiency, and root growth and function.

Competition and grazing

Competition from neighboring plants for soil nutrients and water affects plant response to defoliation. Studies have shown that when competition is reduced, leaf growth in defoliated plants can be similar to that in nondefoliated plants. Competition can be reduced by 1) lowering grazing pressure by stocking fewer animals and 2) resting plants from grazing.

If competition is not reduced, new leaf growth may not occur because of a lack of available nutrients to grow new leaves. Therefore, plants that are grazed severely while neighboring plants are not grazed or grazed less severely are at a competitive disadvantage.

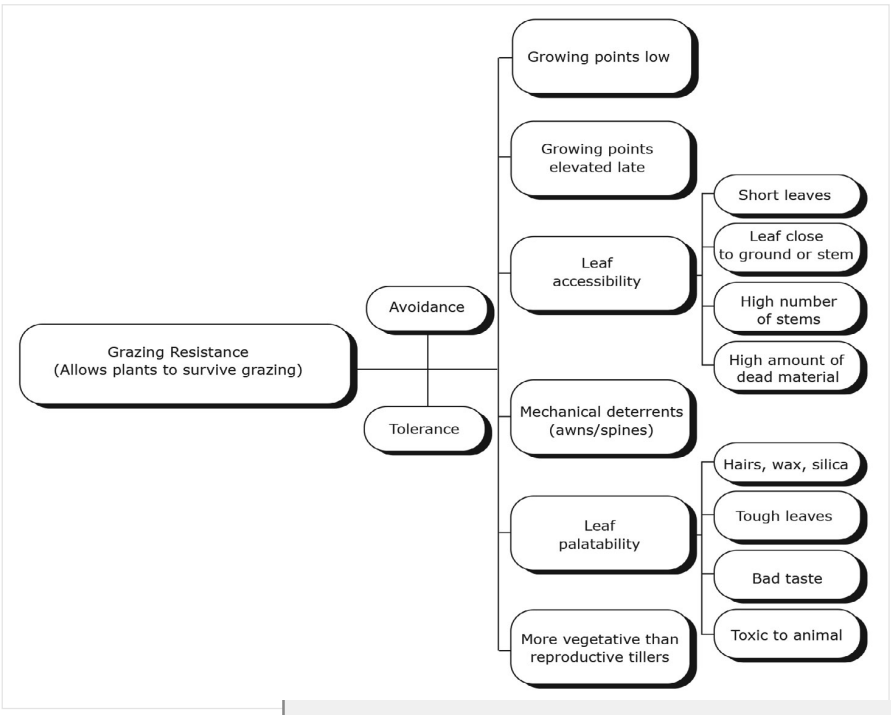

Figure 4. Examples of plant grazing-resistance mechanisms.

become more abundant. From a livestock perspective, proper management involves controlling browsing livestock numbers and controlling access to browse plants to provide rest from browsing. From a wildlife standpoint, proper management involves harvesting animals when wildlife census numbers and browse use signs indicate a danger to the browse resource.

Just as with grasses, browse species can be managed to promote and maintain key species, that is, the preferred plants that make up a significant part of the production of browse available for animals to eat. This task is accomplished by controlling animal numbers and providing rest from browsing.

Do plants benefit from grazing?

It is not clear if plants benefit from being grazed. Certain species may benefit from grazing but not necessarily from being grazed. For example, plants may benefit indirectly from removal of competition or from the creation of a favorable environment for seed germination or directly from removal of self-shading or removal of inactive leaves.

Some grazed plants experience compensatory photosynthesis (food production). However, this response does not mean that the plants benefit from being grazed, only that they have ways to cope with grazing.

BROWSE MANAGEMENT CONSIDERATIONS

Browsing animals such as goats and deer prefer certain browse species. Preferred species vary with natural regions (such as the Edwards Plateau, Rio Grande Plain, Trans Pecos, etc.) of Texas. However, Texas kidneywood and Texas or Spanish oak are examples of highly preferred species; live oak represents a moderately preferred species; and ashe juniper (blueberry cedar) and mesquite are examples of low-preference species.

Without proper management, the more desirable browse species can disappear because of these preferences, while less desirable or undesirable species

HOW TO DETERMINE IF THE RANGE IS BEING OVERUSED

Managers can use browse indicators to help make management decisions about the browse resource. These indicators include degree of use, hedging, and the presence or absence of seedlings.

Degree of use is the amount of the current season's growth that has been removed by browsing animals. It is best observed at the end of the growing season in late fall for deciduous plants and late winter for evergreens. When determining degree of use, consider only current season growth by comparing browsed twigs with unbrowsed twigs.

Browse use can be divided into three levels of current season growth removal: light use is marked by less than 40 percent removal; moderate use ranges from 40 to 65 percent removal; and heavy use is more than 65 percent removal.

Moderate use on key browse species is the correct management goal. When use approaches the upper limit of moderate use for key species, browsing pressure should be reduced by 1) resting areas from browsing livestock use or reducing livestock numbers and/or 2) reducing wildlife numbers.

Hedging is a plant response to browsing marked by twigs that have many lateral branches. A moderate

degree of hedging is acceptable (Figure 5) because it keeps browse material within easy reach of animals and stimulates leaf and twig growth.

However, excessive hedging produces short twigs with smaller than normal leaves and twigs. Eventually, entire plants can die from excessive hedging.

Figure 5. A moderate degree of hedging as shown on this Texas kidneywood plant, a highly desirable browse species, is acceptable.

Another indicator of excess browsing pressure is the hedging of low-preference plants such as agarita (Figure 6). When animals consume plants they do not normally eat, it usually means that not enough of their preferred food is available.

To provide forage, browse plants must be within reach of browsing animals (Figure 7). As hedging increases, the lower branches disappear and a browse line develops. A browse line is the height on trees or shrubs below which there is little or no browse and above which browse cannot be reached by animals.

Figure 6. The hedging on agarita, a low-preference browse plant, indicates excessive use.

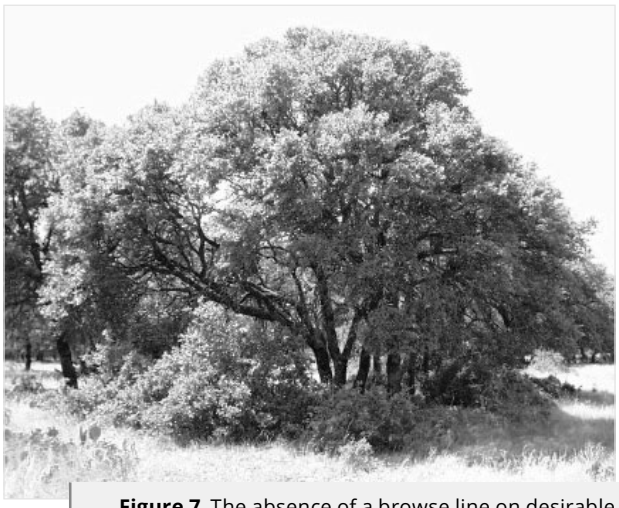

Figure 7. The absence of a browse line on desirable woody species indicates that forage is accessible to animals and that the number of animals is probably in balance with the supply of browse.

Areas where trees or shrubs have a highly developed browse line have a park-like appearance. In the early development of a browse line, light begins to show through the lower vegetation. With continued browsing pressure, a distinct browse line develops (Figure 8). Development of browse lines on low-preference plants such as ashe juniper (blueberry cedar) also indicates excessive use of the range (Figure 9).

The height of browse lines depends on browsing animal species. For example, white-tailed deer usually browse to about 3 to 4 feet, goats to about 4 to 5 feet, and exotic wildlife species to 6 feet and more.

To keep woody plant populations healthy, plants must be allowed to reproduce. Therefore, the presence of seedlings of desirable browse plants is another indicator that managers can use to check for range overuse.

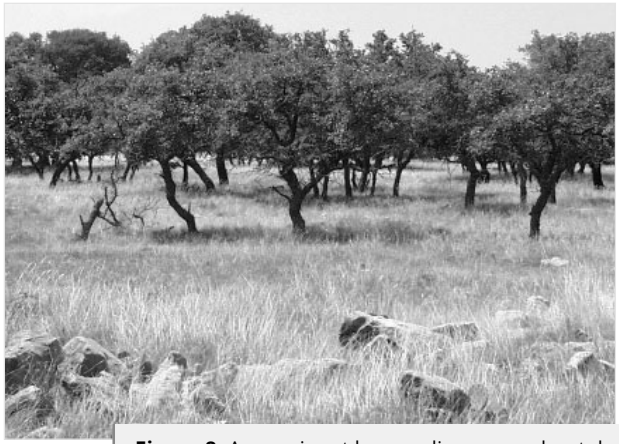

Figure 8. A prominent browse line on moderately preferred browse species such as live oak is an indication of past overuse.

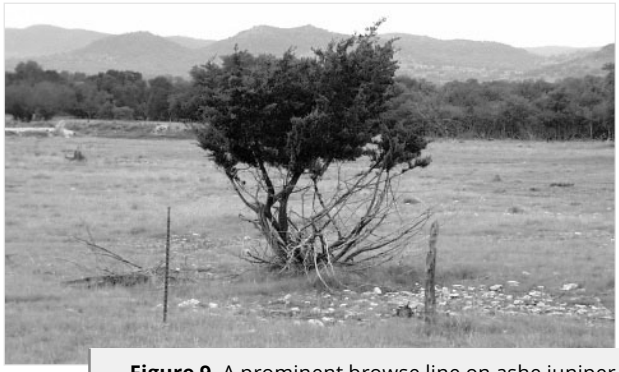

Figure 9. A prominent browse line on ashe juniper (blueberry cedar), a low-preference plant, is an indication of severe overuse of the browse resource.

MANAGEMENT CONSIDERATIONS

Regardless of whether a ranch's production goal is livestock or wildlife, plants feed these animals and protect the soil from erosion. A good steward should aim to conserve the soil and plant resources so that animals are produced in a way that can be sustained over time.

To influence the effect of grazing disturbances on range plants, managers can control three factors of grazing or browsing:

- Intensity refers to the amount of grass or browse that is eaten. It is the most important factor because it affects the amount of leaf available for food production as well as the amount of root system in grasses and the production of seed.
- Timing of grazing affects plants more severely at certain stages of their development. The most critical grazing period is usually from flowering to seed production. Although the least critical period is dormancy, leaving plant residue is important even during dormancy. Research and demonstration work have shown that removing high quantities of forage during dormancy is almost as detrimental to plant productivity as during active growth periods.
- Frequency refers to how often plants are grazed or browsed. Animals tend to come back to the same plants to graze or browse during a growing season. If a plant is repeatedly defoliated, it can be weakened and may die.

To manage grazing and browsing and protect the range resources, managers should:

- Observe the status of and changes in grasses, forbs, and woody species as well as in livestock or wildlife. Make adjustments when either the range plants or animals show signs that the range is being overused.
- Rest grasses periodically, but not at the same time every year. Grasses differ as to when growing points are elevated, making it difficult to find one optimum rest period for all species.
- Leave enough residual forage ungrazed to keep plants healthy and to capture rainfall. The best way to prevent excess rainfall runoff is to maintain adequate ground cover. When the range has enough plant material to promote water infiltration into the soil, less rainfall is required to produce forage.
- Note when the more palatable key species start to show overuse. Grazing and browsing animals are selective: They graze or browse the most palatable forage species first and often. If the more palatable species are overused and disappear, the plant species that survive will be those that can best resist grazing. Animals often avoid eating plants that are abundant but not palatable; instead, they spend time and energy searching for plants that are more palatable but scarce. Therefore, overuse of more palatable species can reduce animal performance.
- Adjust livestock and wildlife browsing by reducing animal numbers and/or resting pastures when you notice more than moderate use or excessive hedging on desirable brush plants and before the development of browse lines.

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HOW MUCH FORAGE DO YOU HAVE?

C. Wayne Hanselka and Allan McGinty*

Forage production varies considerably, depending on rainfall, season of the year and past and present grazing management. Since forage production is unpredictable, forage supply must be monitored and compared to current and predicted forage requirements. For proper management of range resources, animal numbers must be balanced with current forage supply. Forage supply information also can be used to forecast a potential forage shortage or surplus and make needed stocking rate adjustments.

Ranchers often conduct forage surveys informally while riding through their pastures during daily livestock management tasks. Many of them have the experience and observational skill to notice general changes in forage quality and quantity, but having more quantitative information will improve stocking rate decisions and help avoid overuse or underuse of forage resources. Overuse can damage range resources and lead to a crisis situation with fewer livestock marketing alternatives. Underuse can reduce ranch revenue.

This forage survey procedure is easy to use and provides unbiased estimates of the forage supply, requires minimum sampling time, and provides specific information for improving stocking rate grazing management decisions. The only materials required are a range site map (aerial photograph), plot frame, grass shears, paper sacks, drying oven, camera, weigh scales, notepad (data sheet), pencil and calculator. AgriLife Extension publication *Photo Guide to Forage Supplies on Texas Rangelands, RWFM-PU-080* can be used in the field.

WHEN SHOULD FORAGE SUPPLIES BE SURVEYED?

Forage supplies should be monitored visually throughout the year. However, more detailed information might be required before important decisions are made. Since forage production is unpredictable, forage surveys should be conducted at the end of normal forage production cycles. This allows the rancher to estimate immediately how long the accumulated forage supply will last during expected non-growth periods.

Late June-early July and late October-early November surveys are recommended for rangelands that normally receive spring and fall rains. Surveys for summer rainfall areas, such as the Trans-Pecos region of Texas, are best conducted in late October-early November. A March evaluation is needed in all regions to document the forage lost over the winter because of grazing and weathering. Forage remaining in March might have to last until mid-summer if spring rainfall is less than normal.

SEVEN STEPS FOR CONDUCTING A FORAGE SURVEY

1. Determine grazable acres per range site and pasture.

Using a recent aerial photograph and soil survey information, draw the pasture and range site boundaries. Include non-grazable areas, such as lakes, roads, homestead, thick brush, inaccessible terrain and unproductive areas. It might be necessary to inspect each range site to estimate unproductive acreage, including brush mottes or thickets not observable on the aerial photograph. Determine total acres for each range site; then calculate grazable acreage by subtracting non-grazable acreage from the total.

2. Select the appropriate plot size that matches the type of vegetation to be sampled.

Construct the plot frame using a 3⁄8-inch reinforcement rod (welded) or 1⁄2- to 3⁄4-inch PVC pipe with inside dimensions as shown in Table 1.

TABLE 1. SUITABLE PLOT SIZE AND ASSOCIATED CONVERSION FACTORS.

PLOT AREA	LENGTH PER SIDE	CONVERSION FACTOR
4.00 ft^2	24.0 in	680 * wt in ounces = lbs/ac
9.00 ft^2	36.0 in	302 * wt in ounces = lbs/ac
4.50 ft^2	25.6 in	600 * wt in ounces = lbs/ac
9.07 ft^2	36.1 in	300 * wt in ounces = lbs/ac
1.00 ft^2	39.0 in	10 * wt in grams = kg/ha (lb/ac)

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TABLE 2. MOISTURE CONVERSIONS (PERCENT DRY MATTER)					
PLANT TYPE	INITIAL GROWTH TO HEADING	HEADED OUT TO FLOWERING	SEED RIPE: LEAF TIPS DRYING	STEMS PARTLY DRY	DORMANT
Mid grasses	40	55	65	90	95
Short grasses	45	60	80	90	95
Forbs	20	40	60	90	100

3. Locate representative areas in each range site.

Because they will be sampled to determine the forage supply, these areas should be representative of the average grazing use for the range site. Do not sample adjacent to bed grounds, water points, mineral/ feeding locations or areas that are seldom grazed.

4. Develop a representative photo guide.

A photographic reference of known forage quantities for the various range sites on the ranch is used to improve estimation consistency between samples. The photo guide represents the variation of forage supply conditions that will be observed in the pastures. Use approximately 10 photographs of known forage quantities arranged from the lowest to the highest quantity. (See *Photo Guide to Forage Supplies on Texas Rangelands, RWFM-PU-080*.)

In the representative range site areas, select plot locations that have different quantities and species mixtures. Place the plot frame over the vegetation to be photographed. The frame perimeter should be clearly visible in the photograph (e.g., the PVC pipe used in the sample photo guide). Because only vegetation rooted in the plot should be sampled, separate vegetation into or out of the plot frame. Each photograph should indicate height, density and cover of vegetation. High contrast black-and-white photographs are recommended.

Stand to photograph the plot. Fill the frame with the plot and include a notepad or small dry erase board with identifying information in the photograph. After photographing the plot, make any important notes and clip all the standing herbaceous vegetation rooted within the plot to the soil surface. Do not include dead plant material on the ground. Place the clipped vegetation in a properly labeled paper bag (pasture name, date, range site and plot number) for drying and weighing.

Calculate the dry weight in pounds per acre represented by the forage in the plot by weighing each sample to the nearest gram or tenth of an ounce. Heat the bag containing the clipped forage sample in a microwave set on high for 30 seconds.

Re-weigh the bag and sample and record the new weight. Continue to heat the bag for another 30 seconds and re-weigh it until the sample stops losing measurable weight. Subtract the weight of the bag and then use Table 1 to convert weight to pounds per acre. Do not microwave samples for more than 30 seconds at a time to avoid spontaneous combustion.

Samples also may be placed in a shaded, dry area for several days until dry. Although not as accurate, estimates also can be obtained by using a Moisture Conversion Table (Table 2). Finally, determine dry weight (less sack weight) in grams or ounces. Pounds per acre equal grams or ounces per plot multiplied by the appropriate conversion factor shown in Table 1. A photo guide of actual forage supplies in pounds per acre can be developed by taking a series of these photographs.

5. Sample each representative area.

The forage survey on each representative area involves four basic steps: tossing the plot frame, estimating the forage quantity in the plot, determining the samples needed and correcting estimates. In each representative area, walk in a selected direction and toss the plot frame every ten paces. Avoid biasing where the frame hits. Because samples should represent actual conditions, bare spots and different quantities of forage should be sampled. Use the photo guide to estimate the amount of forage in each plot and record information about the site. The more samples you take, the more accurate your estimate will be.

6. Determine the forage supply.

After completing the forage survey, calculate the average estimated pounds per acre of forage for each range site per pasture. This is determined by multiplying grazable acres by the average pounds per acre of forage. Sum all range sites per pasture to calculate the total pounds of forage per pasture.

7. Determine animal unit days of available grazing.

An animal unit is based on the metabolizable energy requirements (17.3 mega calories per day) for a 1,000-pound cow in the last third of pregnancy.

TABLE 3. INTAKE CONVERSIONS FOR VARIOUS CLASSES OF LIVESTOCK	
LIVESTOCK	CONVERSION FACTOR
Sheep	3.0% * body wt
Goats	4.0% * body wt
Stocker cattle	3.0% * body wt
Dry cow	2.0% * body wt
Lactating cow	2.5% * body wt

This requirement converts to a daily forage intake of almost 20 pounds (2 percent of body weight) of 53.6 percent digestible forage. This requirement increases to 2.5 percent of body weight for lactating cows and 3 percent for stocker cattle (Table 3).

Minimum forage thresholds are an important factor to consider when balancing existing forage supplies with livestock numbers (Table 4). They represent the amount of forage that should be present at all times to protect the soil surface from rainfall impact, to slow water movement across the soil, to moderate soil temperatures and to sustain the growth of forage plants.

TABLE 4. OPTIMAL AMOUNTS OF NONGRAZED FORAGE FOR DIFFERENT TYPES OF RANGELAND			
DESERT	SHORTGRASS	MIDGRASS	TALLGRASS
250 lb/ac	300–500 lb/ac	750–1,000 lb/ac	1,200–1,500 lb/ac

To calculate the animal unit days of available grazing, subtract the residue to be left in a pasture (Table 4) from the total pounds of dry forage in that pasture (using the photo guide). For example, 800 pounds of total forage – 500 lbs/ac residue = 300 lbs/ac. The calculation represents the pounds of forage available for use by grazing animals. Unfortunately, grazing animals are only about 50 percent efficient in utilizing the available forage, so multiply the pounds available by .5 to determine the amount of actual forage that will be consumed by livestock (e.g., 300 lbs/ac x .5 = 150 lbs/ac consumed).

Finally, multiply the pounds of forage to be consumed by the grazable acres in the pasture, and then divide by the pounds of forage per head per day for the species and type of livestock to be grazed (Table 3). For example,150 lbs/ac x 100 acres = 15,000 lbs of forage; 15,000 lbs of forage divided by 20 lbs/day = 750 animal unit days of grazing if using 1000 lb dry cows.

Remember two key points: (1) revise your estimates every time it rains and new forage growth occurs, and (2) this technique is more accurate when predicting forage supplies a few weeks ahead as compared to months.

The number of animal unit days of available grazing per pasture can then be used to determine if the forage supply is adequate for the planned stocking rate until reqrowth is expected. Also, the average number of animal units that will be grazed during this time can be determined. Total days that the forage supply will last at the current stocking rate are determined by dividing the planned number of stock units into the animal unit days of available grazing.

CONCLUSION

Using this forage survey procedure, while training the "eye" and using photo guides to estimate forage supplies, should help improve grazing management decisions and reduce the damage that over-grazing can cause. Timelier destocking during drought will help keep plants healthy for future growth. Soil with good vegetative cover traps rainfall effectively and is less apt to erode. Rather than waiting until the forage supply is gone, a forage supply survey will help forecast whether a change in stocking rate is appropriate. This allows better planning to meet crisis situations.

ACKNOWLEDGMENT

This publication was originally written by Larry D. White, Extension Range Specialist Emeritus, and Calvin Richardson, currently with the Texas Parks and Wildlife Department. Their efforts and the assistance of many ranchers and agency personnel in developing the bulletin are appreciated.

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RangeDetect Series

Stocking Rate: The Key Grazing Management Decision

Robert K. Lyons and Richard V. Machen*

Without question, stocking rate is the most important grazing management decision a rancher makes. Stocking rate is the amount of land allotted to each animal for the entire grazeable portion of the year. Stock density is the number of acres allotted to each animal at a specific point in time. Carrying capacity, on the other hand, is the maximum long-term stocking rate that can be sustained without detrimental effects on the land resource. A number of factors must be considered when establishing a stocking rate. These factors include animal species, size and physiological stage, size of the pasture or ranch, and number of grazeable acres. Ranches differ in annual rainfall, forage production, forage species, brush cover, topography, water distribution, and kind of livestock. All of these factors affect stocking rates.

When cattle have a choice, annual diets consist of 80 percent or more grass and usually no more than 10 percent browse (leaves and twigs from brush). Cattle make limited use of slopes greater than 10 percent or areas more than 2 miles from water. Therefore, when establishing a stocking rate for cattle, very brushy areas, steep areas, and areas too far from water must be excluded to determine the number of grazeable acres.

There are two perspectives to stocking rate. One is the land resource. The second is animal performance. Because of animal forage preferences, it is possible to be properly stocked from a resource conservation perspective and over-stocked in terms of animal performance.

Forage Production Considerations

Rainfall and Forage Production

For most of Texas, rainfall is the most important determinant of forage production. If rainfall is equal across various sites, then the soils and forage species combinations of a site are the most important factors in a site's forage production potential.

Resource managers tend to look at average rainfall as a benchmark. However, relying on average rainfall amounts is risky because rainfall across most of Texas is highly variable from year to year (as the recent drought reminds us). The farther west in the state, the more variable annual rainfall becomes. Annual rainfall totals and averages can be deceptive. One huge rain over a short period of time can increase total rainfall for the year with minimal effect on soil moisture and forage production. In Figure 1, total annual rainfall, average annual rainfall, and drought level (drought is considered to be 75 percent of average annual rainfall) are illustrated for Dimmit County, Texas from 1931 to 1994. For most years in this example, rainfall is either above or below average. In fact, for at least half the years, annual rainfall was below average. Furthermore, in this example there is only about an 11 percent chance that total rainfall within any one year will be within 1 inch of the long-term annual average. So, if a rancher bases stocking rate on average annual rainfall, the range will be overstocked at least half the time.

A major goal in grazing management must be to leave enough forage in a pasture to protect the soil and maintain plant vigor (Table 1).

Table 1. Suggested forage residue levels for maintaining soil stability and plant vigor.

Vegetation type	Pounds/acre	Stubble height (inches)
Tallgrass	1200-1500	12-14
Midgrass	750-1100	6-8
Shortgrass	300-500	2-3

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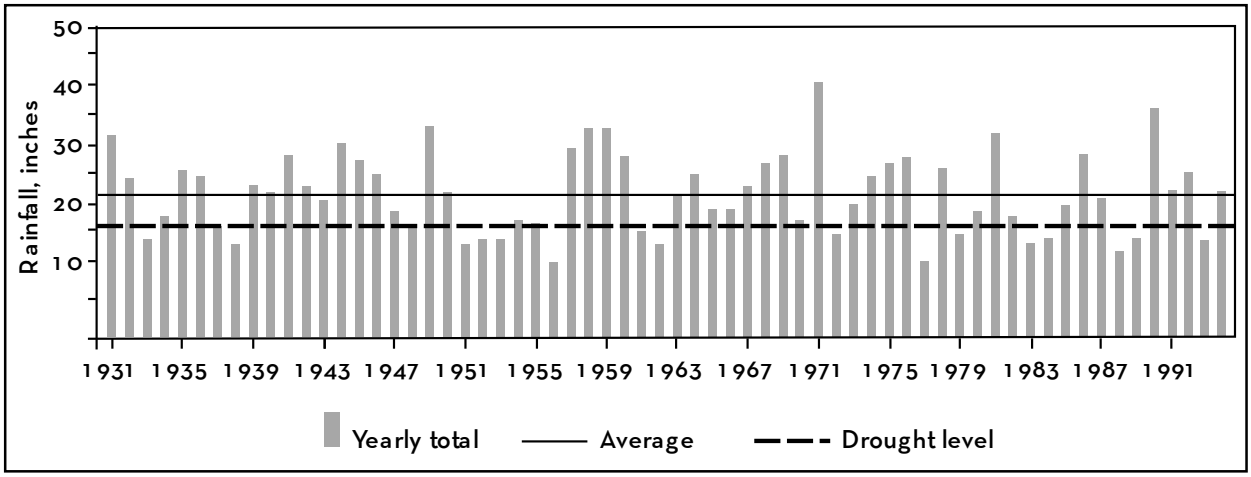

Figure 1. In this example of rainfall variability in Dimmit County, Texas, total annual rainfall for at least 50 percent of the years was below the average annual rainfall. In addition, there is only an 11 percent chance that annual rainfall for any one year will be within 1 inch of the annual average.

Forage residues affect future forage production. Figure 2 illustrates relationships among forage residue, rainfall, and forage production. In this example, leaving 500 pounds of residue produced twice as much forage as leaving only 100 pounds. Furthermore, leaving 1500 pounds of residue produced as much forage as 500 pounds of residue even though rainfall was far less. Areas with greater residue are more efficient at capturing and retaining rainfall.

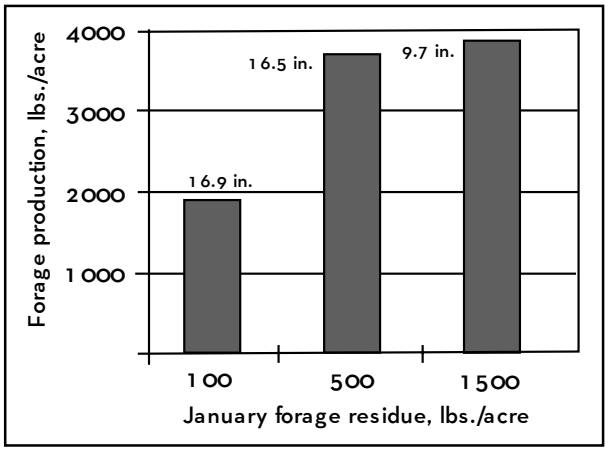

Figure 2. Effect of forage residue on forage production. Numbers above bars indicate rainfall.

Conduct forage inventories in late June or early July, October and March to estimate available forage and make stocking adjustments. For cattlemen, grass is the primary production goal and it must be managed properly to sustain long-term productivity. Too often a blanket stocking rate is used for a county or region when the stocking rate should be tailored to each grazing management unit, whether a pasture or an entire ranch.

What Does a Given Stocking Rate Mean?

The old rule of thumb "take half, leave half" is well publicized, but may not be well understood. This rule applies to average annual forage production. It does not mean that half the forage can be allotted to grazing animals. Part of what is taken will go to the animals, but part will disappear through trampling, decay and insect damage. This disappearance is usually about 25 percent of the average annual production. Therefore, only 25 percent is left for the grazing animal.

As an example, let's assume that a rancher is using a stocking rate of 20 acres per animal unit per year (AUY).

An animal unit consumes 26 pounds of forage per day, or 9,490 pounds per year.

(26 x 365 = 9,490)

The rancher has allotted 20 acres to produce the 9,490 pounds of forage needed per AUY. Therefore, each acre must produce 475 pounds of forage yearly to support grazing.

(9,490 ÷ 20 = 475)

If 475 pounds represents 25 percent of the total forage needed (because 25 percent of the total will be lost to trampling, etc., and 50 percent will be left as residue), then the total forage production will need to be 1,900 pounds per acre.

(475 x 4 = 1,900)

In this example, 950 pounds of forage per acre would be left to maintain soil stability and plant vigor.

Range Sites

Range sites are areas with distinctive combinations of soils, land features, and natural vegetation. Range sites differ in the kinds and amounts of forage they produce

and in their carrying capacity. The comparison in Table 2 illustrates this point.

Table 2. Differences in carrying capacity between two range sites, both in excellent condition.

Range site	Favorable year, acres/animal unit	Unfavorable year, acres/animal unit
Clayey bottomland	8	13
Gravelly ridge	13	25

Range Condition

Range condition is a numerical score comparing current plant composition with pristine (believed to exist before the occupation of European man) plant composition. Table 3 compares carrying capacities for the various range condition classes of one range site.

Table 3. Carrying capacities for different range condition classes for one range site.

Range condition	Acres/animal unit year
Excellent	10-15
Good	16-20
Fair	21-28
Poor	29-40

Livestock Considerations

Not Every Cow is An Animal Unit

Resource management professionals are sometimes asked to recommend a stocking rate for a particular area or particular kind of grazing livestock. These recommendations are typically based on one cow or animal unit per "x" acres. However, not every cow is an animal unit. In fact, an animal unit, like most units of measure, is arbitrary. The definition of an animal unit has continually changed. Currently, the most widely accepted definition of an animal unit is a mature, 1,000-pound cow and her calf, representing an average daily dry matter forage intake of 26 pounds. This average daily forage intake can also be expressed as a percentage (2.6 percent) of the cow's body weight. Stocking rate recommendations should be based more on potential forage intake than on numbers of animals. If you know the potential forage intake of a particular species of livestock, you can determine the total forage production needed to leave an adequate amount of residue.

Cow Size

The mature size of beef cows has steadily increased since the 1950s. Today's "average" beef cow probably weighs 1,150 to 1,200 pounds. Therefore, these cows are not equivalent to one animal unit. Different size cows require different stocking rates.

For example, if the estimated stocking rate for a 1,000-pound cow is 20 acres, the **estimated stocking rate for the 1,150-pound cow** (assuming both have the same forage intake rate of 2.6 percent of body weight) is found as follows:

1,150 pounds x 0.026 = 30 pounds forage intake per day ÷ 26 pounds forage per animal unit = 1.15 animal units per cow

Therefore, 1.15 animal units per cow x 20 acres per animal unit = **23 acres per 1,150-pound cow.**

Cow Body Condition

Estimating forage intake from a cow's weight can cause some degree of error if the cow's body condition score is not considered. Weight per body condition score (about 8 percent of weight at a body condition score of 5) varies from about 72 pounds for a 900-pound cow to about 104 pounds for a 1,300-pound cow. For example, a cow weighing 1,000 pounds at a 5 body condition score would weigh about 840 pounds at a 3 body condition score or 1,160 pounds at a 7 body condition score. The fact that this cow is lighter or heavier because of body fat content does not mean she will consume less or more forage than when she weighs 1,000 pounds. By using a condition score 5 weight for cattle, these calculations can be standardized, and forage intake can be estimated relative to intake potential as animal size (gut capacity) increases.

Cow Productivity

Another factor that creates differences in stocking rate estimates is production level. Cows that produce heavier calves usually produce more milk, and therefore, eat more forage. These cows need more acres to satisfy their forage demand and still leave the proper amount of forage residue. Average annual forage intake rates of 2.6, 3.0 or 3.5 percent can be achieved by beef cows with low, medium or high milk production levels, respectively. Cows are certainly capable of eating even more. For example, one dairy cow was documented to have a dry matter intake rate of 7 percent of body weight.

If the estimated stocking rate for a low-milking, 1,000-pound cow is 20 acres, a high-milking, 1,000-pound cow might need 27 acres. If the high-milking cow also weighs 1,150 pounds, the estimated stocking rate would be 31 acres per cow.

Setting Stocking Rates for Different Kinds of Livestock

When determining stocking rates for sheep and goats, range managers usually use the rule of thumb that five sheep or six goats equal one animal unit, implying that this number of sheep or goats consumes the same amount of forage as a 1,000-pound cow and her calf consuming forage at the rate of 2.6 percent of the cow's weight. By using body weights and appropriate forage intake rates for each species, more specific stocking rates can be determined. For sheep, a typical forage intake rate is 3.0 to 3.5 percent of body weight. Goats typically have a forage intake rate of 4.0 to 4.5 percent of body weight. Again, highly productive animals would have intake rates at the high end of the range. To illustrate this approach, calculate the animal unit equivalent for Boer goats weighing 130 pounds and having a forage intake rate of 4 percent.

Estimated forage consumption for these goats is 5.2 pounds of dry forage per day.

(130 pounds x 0.04 =5.2 pounds)

This means that it would take about five of these goats to equal one animal unit. (26 pounds per animal unit ÷ 5.2 pounds per goat = 5 goats per animal unit)

Determining stocking rates for combinations of animal species is controversial. The controversy centers around whether to consider diet overlap between species.

The conservative approach assumes different animal species eat the same plants and have 100 percent diet overlap. With this approach, total carrying capacity is simply determined according to animal numbers and animal units for each species. The rationale for this approach is that carrying capacity varies with terrain, season, weather and other factors, and therefore, diet overlap is too variable to try to estimate.

A second approach is to try to account for diet overlap. Most Texas studies suggest that potential diet overlap for cattle and goats is about 50 percent. In theory, then, these two species would not compete directly with each other. The following calculations estimate stocking rate for these two species using the diet overlap approach.

A ranch has an estimated carrying capacity of 100 animal units and the rancher wants to stock 100 Boer goats weighing 130 pounds as in the example above (5 Boer goats per animal unit) along with cows.

(100 Boer goats ÷ 5 goats/animal unit =
20 animal units)

(20 goat animal units x 0.5 diet overlap with cattle =
10 goat animal units)

(100 animal units - 10 goat animal units =
90 cow animal units)

If cows to be stocked weigh 1,150 pounds at body condition score 5, each cow is about 1.15 animal units (see calculation above).

(90 cow animal units ÷ 1.15 animal units per cow =
78 cows)

Estimated stocking rate: 78 1,150-pound cows and 100 130-pound Boer goats

If diet overlap is not considered, the total animals stocked in this example would be:

100 Boer goats ÷ 5 goats/animal unit =
20 goat animal units

100 animal units - 20 goat animal units =
80 cow animal units

80 cow animal units ÷ 1.15 animal units/cow =
70 cows

Estimated stocking rate: 70 1,150-pound cows and 100 130-pound Boer goats

Balancing Forage Supply and Demand

Flexible Stocking Rates

Many successful ranchers maintain flexibility in stocking rates. Flexibility is essential because rainfall is unevenly distributed both within and across years. In fact, records indicate that in one of every two years less than average rainfall will be received. Stocking based on average rainfall and forage production will overstock a ranch about 50 percent of the time. To be flexible, some managers devote 40 to 80 percent of their carrying capacity to stocker cattle and 20 to 60 percent to a cow-calf operation. This approach avoids the forced liquidation of the breeding herd in dry years.

Stocking Rate and Animal Performance

Heavy stocking rates are detrimental to both land resources and livestock performance. Over time, heavy stocking causes the more palatable and productive forage species to disappear. These desirable forages are replaced by less productive, less palatable plants that capture less rainfall, thus lowering the capacity of the soil to store moisture and increasing the risk of erosion.

Over the short term, a heavy stocking rate may lower forage quality by removing green foliage and forcing animals to consume more dead, standing forage. Over the long term, a heavy stocking rate removes almost all edible forage so that only immature plants remain. While this immature forage is high quality, there isn't enough of it. In grazing, both forage quality and forage quantity are important, and both affect livestock productivity and net profits.

Figure 3 illustrates the classic relationships among stocking rate, individual animal performance, gain per acre, and net profits. In the tallgrass prairie example shown here, individual animal gain decreases as stocking rate increases, while gain per acre increases. Net profits increase to a point, then decline. In contrast, in the midgrass prairie example represented in Figure 4, net returns decline rapidly from a peak at 5 acres per steer.

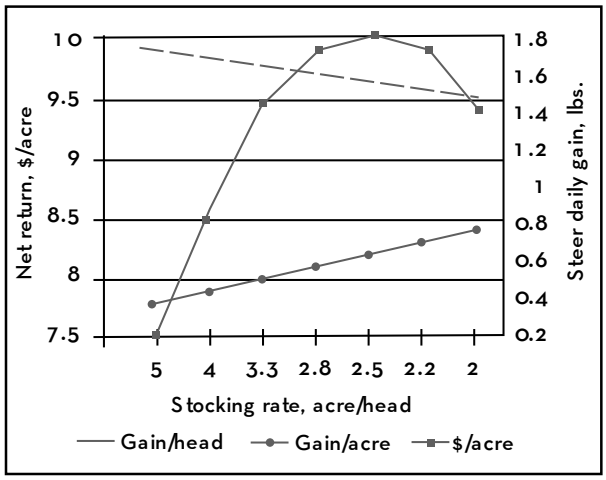

Figure 3. Relationships among stocking rate, individual steer gain, gain per acre, and net profits for a tallgrass prairie site.

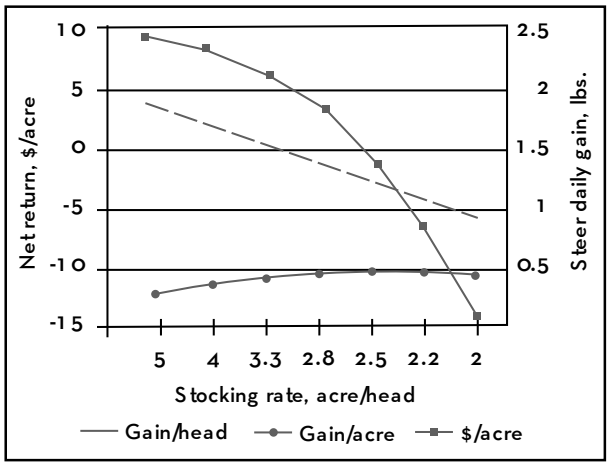

Figure 4. Relationships among stocking rate, individual steer gain, gain per acre, and net profits for a midgrass prairie site.

The effect of stocking rate also can be seen in cow performance. Figure 5 shows average body condition scores over 3 years at weaning, calving and breeding for spring- and fall-calving cows managed at different stock densities (acres per cow at a given point in time) on the same ranch. Body condition scores were higher for the fall-calving herd during each of these periods, particularly at calving. Cows in the spring herd were unable to improve body condition from weaning to calving. Fall-calving

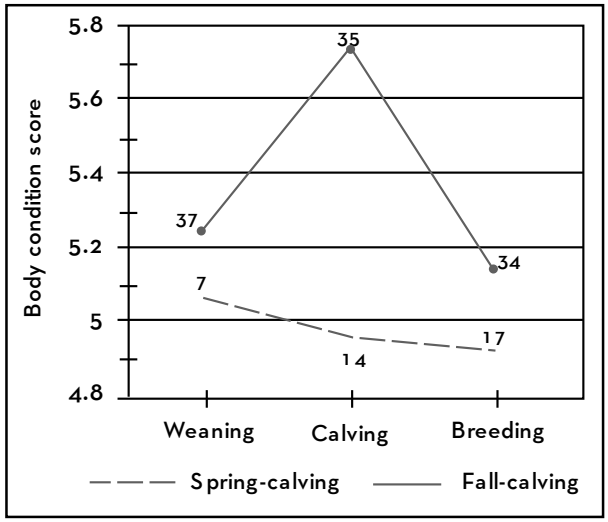

Figure 5. Effect of stock density (acres per cow for a given point in time) on cow body condition score in spring- and fall-calving herds on the same Hill County ranch. Numbers above lines indicate the stock density.

cows had two to five times more acres available per cow than spring-calving cows. The differences in body condition scores between the two herds were due mostly to differences in stock densities and related forage availability. The higher stock density (fewer acres per cow) in the spring-calving herd resulted in less available forage and lower condition scores. Spring herd condition score at breeding was about the same as at calving because these cows calved when forage quality was improving. Fall herd condition scores declined from calving to breeding because forage quality was declining during this period.

Forage Preference/Type Differences

Grazing/browsing livestock have forage preferences that can affect stocking rates. Research has shown that as much as 80 percent of a grazing animal's diet can come from as little as 1 percent of the forage standing crop.

Research in Oklahoma suggests that steer gain decreased at different rates on tallgrass and midgrass sites. With the same levels of decreasing forage availability, decline in weight gain was about four times faster on midgrass prairie. Reasons for these differences are not clear, but probably relate to forage preferences.

Animal adaptation to a forage type can have a significant effect on animal performance. For example, cattle are grazers, with about 80 percent of their annual diet consisting of grass. Cattle are not physically equipped to eat browse (leaves and twigs from woody vegetation). Therefore, stocking rates that force cattle to eat browse can drastically reduce forage intake. Figure 6 illustrates the effect of browse consumption on potential forage intake of steers grazing South Texas rangeland.

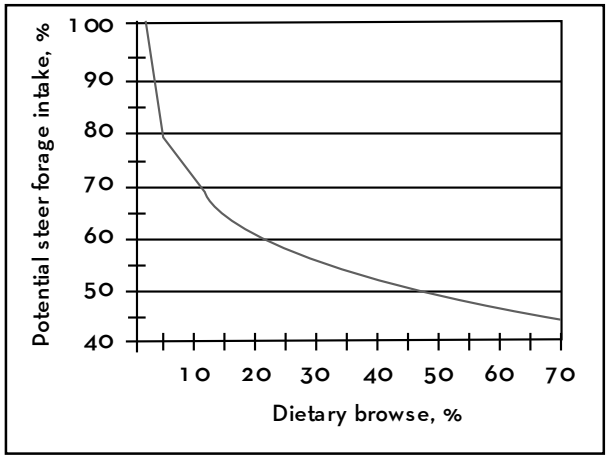

Figure 6. Effect of browse consumption on potential forage intake of beef steers grazing South Texas rangelands.

Recommendations

Although timing, intensity and frequency of grazing are important, stocking rate is the most important grazing management decision. Because stocking rate affects animal productivity, net profits, and the renewable range resource, it should be tailored to each pasture and ranch. Remember, to make maximum use of rainfall, leave enough forage residue or stubble to capture rainfall as soil moisture. Rainfall, forage production, and forage use by grazing animals are not static. Consequently, stocking rate flexibility is the key to sustainability and to protecting the range resource.

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WILDLIFE MANAGEMENT AS AGRICULTURE USE FOR PROPERTY TAX VALUATION IN TEXAS

Larry A. Redmon[1] and James C. Cathey[2]

Texas is known for its natural resources ranging from grasslands in the north, brushlands in the south, piney woods in the east and the Chihuahuan desert in the west. These open space lands provide aesthetic and economic benefits through ecosystem services like recreation, water supply, carbon sequestration, and nutrient cycling. In order to preserve open space lands and their value to all Texans, qualifying properties may be taxed at a lower rate than other properties, provided rural lands qualify for one of two types of special *appraisal* methods.

The first type of appraisal is called "Assessments of Lands Designated for Agricultural Use" authorized by Texas Constitution Article VIII, Section 1-d and described in Sections 23.41 through 23.47 of the Texas Tax Code. This type of appraisal is often referred to as 1-d appraisal. The other type of appraisal is called "Taxation of Certain Open Space Land" (OSL) authorized by Texas Constitution Article VIII, Section 1-d-1 and further described in Sections 23.51 through 23.59 of the code, also known as 1-d-1 appraisal. When most people speak in terms of the agricultural use tax valuation for ranches in Texas, they are generally referring to the OSL appraisal method (1-d-1). The Agricultural Use appraisal method (1-d) is appropriate only for lands devoted to full time agricultural operations wherein the owner's primary occupation and source of income is derived from the agricultural enterprise. The landowner's occupation and income is as important to the qualification as is the land's use. Open-space appraisal (1-d-1) is based solely on the primary use of the land with no consideration for the landowner's income or occupation. Lands approved for wildlife use and/or agricultural use pay the same amount of taxes, which are based on the productive value of the land rather than the land's market value.

Prior to 1995, lands managed solely for wildlife did not qualify for the property tax valuation as did lands designated for agricultural use or open-space use. A bill originating in the Texas House of Representatives, HB 1358, called for an amendment to the Texas constitution that added wildlife management to the list of qualifying agricultural practices. The bill would allow these properties managed for wildlife to also have property taxes based on land productivity rather than market value. House Joint Resolution 72 put the amendment to the Texas Constitution known as "Proposition 11" on the general election ballot and Texas voters passed it by a margin of nearly 2 to 1. Currently the state of Texas Tax Code contains the following language:

> "Agricultural use" includes but is not limited to the following activities: cultivating the soil, producing crops for human food, animal feed, or planting seed or for the production of fibers; floriculture, viticulture, and horticulture; raising or keeping livestock; raising or keeping bees for pollination or for the production of human food or other commercial products; raising or keeping exotic animals for the production of human food or of fiber, leather, pelts, or other tangible products having a commercial value; planting cover crops or leaving land idle for the purpose of participating in a governmental program, provided the land is not used for residential purposes or a purpose inconsistent with agricultural use; and planting cover crops or leaving land idle in conjunction with normal crop or livestock rotation procedure. The term also includes the use of land to produce or harvest logs and posts for the use in constructing or repairing fences, pens, barns, or other agricultural improvements on adjacent qualified open-space land having the same owner and devoted to a different agricultural use. ***The term also includes the use of land for wildlife management.***" (Texas Tax Code, Subchapter D, Sec. 23.51 (2).

When a landowner changes from a more traditional agriculture use, such as cattle production, to wildlife management agricultural use, the landowner must make application to the chief appraiser between January 1 and April 30 of the year in which the owner wants to implement the change to wildlife management

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agricultural use. The chief appraiser will determine if the land qualifies for wildlife management agricultural use. Once a property has been qualified for the OSL special tax appraisal, an owner who changes to the wildlife management agricultural use does not have to re-apply each year for open-space appraisal. The chief appraiser may require an annual report on a form prescribed by the Texas Parks and Wildlife Department (TPWD) describing how the wildlife management plan was implemented during the year. The law, however, does require an owner who changes the category of agricultural use to notify the chief appraiser. Likewise, an owner must notify the chief appraiser if land switched from wildlife management agricultural use back to another qualifying traditional agricultural use.

Many landowners who currently own property in Texas, or are considering the purchase of property in Texas, are not aware that managing for wildlife can qualify lands as OSL. This publication discusses some of the requirements associated with receiving the OSL special tax appraisal for lands managed for wildlife in Texas.

THE REQUIREMENTS

Land Qualification:

The first requirement for OSL special tax appraisal based on wildlife management use is that the land must have been qualified and appraised as open-space agricultural land in the year prior to conversion to wildlife management use. In other words, to qualify for open-space appraisal under the wildlife management use, the property must have already been qualified for OSL agricultural appraisal under Chapter 23, Subchapter D, or as timberland under Chapter 23, Subchapter E of the Texas Tax Code. Land that qualifies for the agricultural special appraisal under Section 1-d is not eligible for wildlife management use without first acquiring open-space appraisal based on Section 1-d-1. If the property does not currently qualify for the open-space agricultural appraisal, a five-out-of-seven-years qualification period is required to establish traditional agricultural operations and then submit for agricultural tax valuation before converting to a wildlife management agricultural use.

With passage in 2001 of House Bill 3123, the Legislature directed TPWD to develop standards for the qualification of OSL used for wildlife management and the comptroller to adopt these standards by administrative rule. Under the rule, the state initially was divided into four wildlife use appraisal regions based on ambient moisture available and assigned a range of ratios for required wildlife management use for lands in each specific region. Effective December 11, 2008, revised rules divided the state into 12 new regions (Fig. 1). The new appraisal regions were reorganized to more closely track the defined ecological regions as specified in the TPWD Wildlife Management Guidelines. If a county is in more than one ecological region, the region that comprises the majority of the county is selected. Other changes in the rules state that wildlife use requirements (also known as minimum acreage requirements) now apply both when the property has had a reduction in acreage in the year immediately preceding the application for wildlife management use or has subsequently had a reduction in acreage.

The chief appraiser in each county, with the advice and consent of the Appraisal District Board of Directors, now selects the wildlife use requirement from the allowable range of ratios based on the appropriate appraisal region. Minimum acreage ranges (Figure 1; Table 1), when applicable, are the same as before except for Terrell, Clay, and McCulloch counties which increased and Bee county that decreased. Changes result from the reorganization of appraisal regions. Existing properties in wildlife management were grandfathered and were not affected by these changes.

Ratios among regions are used by the chief appraiser in each county to determine the minimum acreage

Wildlife Use Requirement Ranges for Appraisal Districts (when applicable*)				
	Standard Acreage		*WMPA/ES Mgmt.*	
Appraisal Region	Min	Max	Min	Max
Blackland Prairie	12.5	16.7	10	11.1
Cross Timbers and Prairies	14.3	20	11.1	12.5
Edwards Plateau (Eastern)	14.3	20	11.1	12.5
Edwards Plateau (Western)	25	50	16.7	20
Gulf Prairies and Marshes (Lower Coast)	25	50	16.7	20
Gulf Prairies and Marshes (Upper Coast)	12.5	16.7	10	11.1
High Plains	25	50	16.7	25
Pineywoods	12.5	16.7	10	11.1
Post Oak Savannah	12.5	16.7	10	11.1
Rolling Plains	25	50	16.7	20
South Texas Plains	25	50	16.7	20
Trans Pecos	33.3	100	20	25

*If the number of acres in the tract of land is equal to or greater than the number of acres in the tract of land on January 1 of the preceding tax year, the tract of land is not subject to the wildlife use requirement.
34 Tex. Admin. Code §9.2005 (2009)

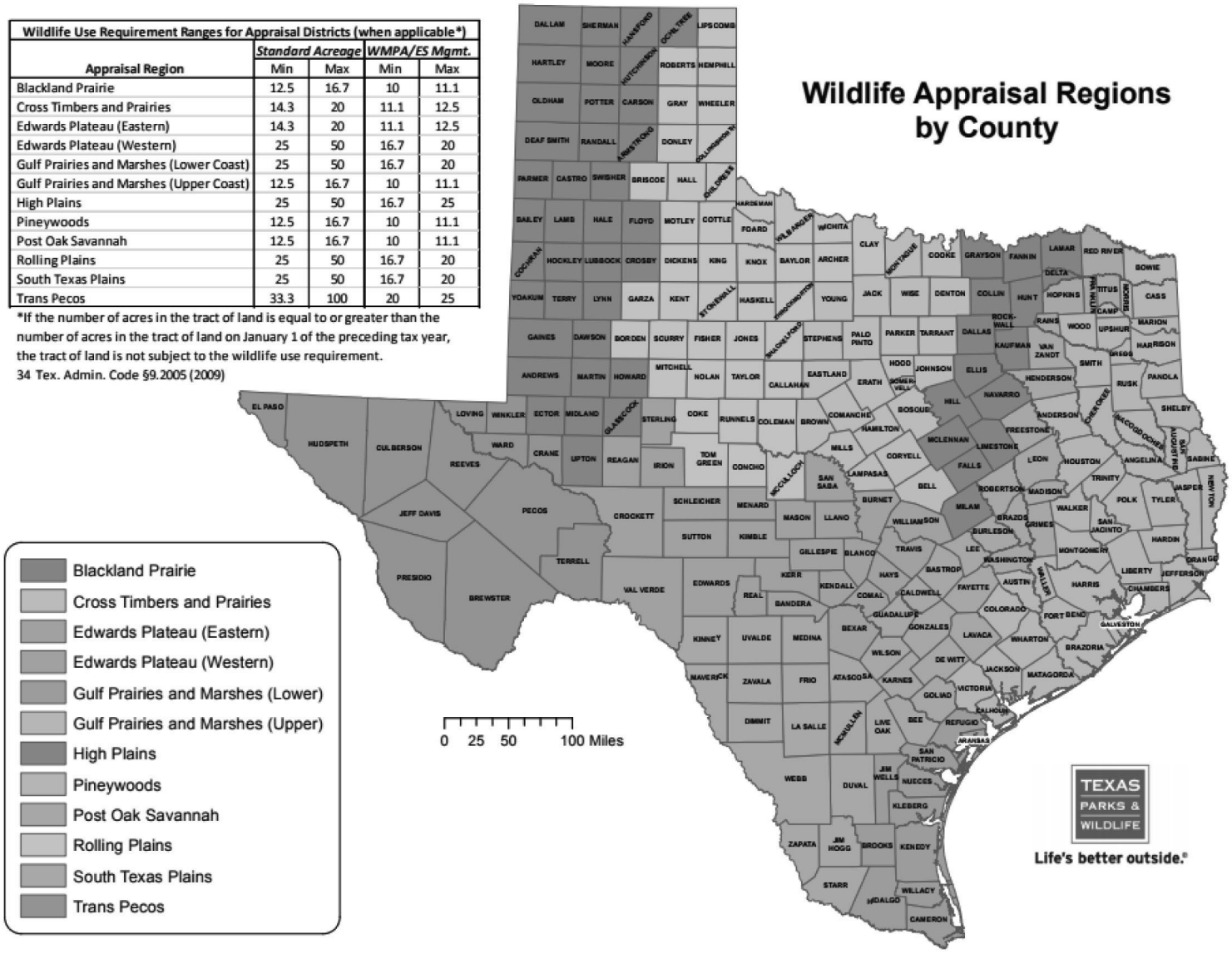

Figure 1. Standard acreages and wildlife mangement property owners associations (WMPA) / endangered species management minimum acreage by ecoregion and county for wildlife tax valuation in Texas.

Table 1. Ratios and minimum acreage for properties under standard acreages wildlife tax valuation in Texas.				
	Lower Ratio	Acreage	Upper Ratio	Acreage
Trans Pecos	97%	33.3	99%	100
High Plains	96%	25	98%	50
Lower Gulf Prairies and Marshes	96%	25	98%	50
Rolling Plains	96%	25	98%	50
South Texas Plains	96%	25	98%	50
Western Edwards Plateau	96%	25	98%	50
Eastern Edwards Plateau	93%	14.3	95%	20
Cross Timbers and Prairies	93%	14.3	95%	20
Blackland Prairie	92%	12.5	94%	16.7
Post Oak Savannah	92%	12.5	94%	16.7
Pineywoods	92%	12.5	94%	16.7
Upper Gulf Prairies and Marshes	92%	12.5	94%	16.7

size for a property to qualify for wildlife management use if the property has been reduced in size in the year immediately preceding the application for wildlife management use or has subsequently had a reduction in acreage. Ratios are calculated using the formula, (A-1)/A = R, wherein A is the total property size in acres and R is the ratio. For the purposes of determining the total property size (defined as a "tract" in the Texas Administrative Code), the property owner should consider the entire area of all contiguous parcels of land under common ownership. The presence of public roads and bodies of water does not affect the contiguity of the parcels of land.

As an example of how the ratios would work, a chief appraiser within the Upper Gulf Prairies and Marshes could select 94 percent as the ratio of a tract that is subject to the Wildlife Use Requirement. If a property owner had a 12.5-acre tract that is subject to the wildlife use requirement and applied for the valuation, the appraiser takes the 12.5, subtracts 1 and then divides by 12.5, which equals 92 percent – the lower ratio. To calculate the upper ratio in this scenario, the appraiser would takes 16.7, minus 1, and then divides by 16.7, which equals 94%. Usually, the higher ratio and its corresponding acreage serves as the minimum acreage requirement among counties (Table 1).

The qualifying minimum acreage size is likely the most confusing item when switching from traditional agricultural use to wildlife management agricultural use. The following scenarios will help landowners determine if their lands are eligible.

Scenario 1:

- Question 1: Does the land currently have agricultural use valuation?
  - Answer: Yes
- Question 2: Has the size of the property having agricultural use valuation been reduced since the last tax year?
  - Answer: No
- Next step: There is no minimum acreage required; apply for conversion to wildlife management agricultural use between January 1 – April 30.

Scenario 2:

- Question 1: Does the land currently have agricultural use valuation?
  - Answer: Yes
- Question 2: Has the size of the property having agricultural use valuation been reduced since the last tax year?
  - Answer: Yes
- Question 3: Does the land meet the minimum qualifying acreage set by the county chief appraiser? (refer to Table 1).
  - Answer: Yes
- Next step: Apply for conversion to wildlife management agricultural use between January 1 – April 30

Table 2. Ratios and Minimum Acreages for properties under wildlife tax valuation in Texas, having property owners associations, and threatened and endangered species considerations.				
	Lower Ratio	Acreage	Upper Ratio	Acreage
Trans Pecos	95%	20	96%	25
High Plains	94%	16.7	96%	25
Lower Gulf Prairies and Marshes	94%	16.7	95%	25
Rolling Plains	94%	16.7	95%	20
South Texas Plains	94%	16.7	95%	20
Western Edwards Plateau	94%	16.7	94%	20
Eastern Edwards Plateau	91%	11.1	95%	20
Cross Timbers and Prairies	91%	11.1	92%	12.5
Blackland Prairie	90%	10	91%	11.1
Post Oak Savannah	90%	10	91%	11.1
Pineywoods	90%	10	91%	11.1
Upper Gulf Prairies and Marshes	90%	10	91%	11.1

Scenario 3:

- Question 1: Does the land currently have agricultural use valuation?
  - Answer: Yes
- Question 2: Has the size of the property having agricultural use valuation been reduced since the last tax year?
  - Answer: Yes
- Question 3: Does the land meet the minimum qualifying acreage set by the county chief appraiser? (refer to Table 1).
  - Answer: No
- Next step: Stop the process as the land cannot qualify as wildlife management agricultural use.
- Exception: Some lands that are part of wildlife property associations or have threatened or endangered species habitats and meet acreage standards for a different set of Lower and Upper Ratios. These are used to create benefits for species of concern through sound wildlife management on smaller properties. As before, appraisers generally adopt the acreage limits associated with the Upper Ratio (Table 2). Here landowners should apply between January 1 – April 30.

Lands qualified for the wildlife management special tax appraisal prior to January 1, 2001 were grandfathered under existing OSL requirements provided they continued to meet all other requirements except size. After January 1, 2001 lands were subject to the new standards and regulations regarding sizes of recently subdivided land tracts that are eligible for qualification for the OSL wildlife management special tax appraisal. New standards for determining the appropriate size of property for wildlife management tax appraisal took effect on December 11, 2008 also grandfathered previously qualified tracts provided they continued to meet all other requirements. If a tract of land becomes reduced in size and no longer meets the minimum size requirement, the landowner could have the agricultural appraisal removed and may be subjected to a 5-year tax rollback for changing the primary use of the property.

Land use:

The second requirement for the property to be considered qualified for the OSL special tax appraisal is that the property must be "actively managed" to sustain a *breeding, migrating, or wintering population of indigenous wild animals for human use.* The word indigenous indicates the wildlife species must be native to Texas and is exclusive of exotic animals that may have been introduced purposely or accidentally. A *breeding-group* is a population of wildlife species large enough to live independently over several generations. This could be small mammals or bird species for smaller tracts of land or white-tailed deer and wild turkey on larger tracts of land. *Migrating* wildlife species are those moving between seasonal ranges while *wintering* species are those that may use the property during the winter.

Purpose of Wildlife Management:

The third requirement for the property to be considered for the OSL special tax appraisal is that the wildlife species must be managed for *human use*. *Human use* may include wildlife species that are used for food

or medicine as the result of harvest of the species for consumption. Human use of wildlife species also includes recreation and may involve either active or passive pursuits. Active pursuits may include hunting, observing wildlife, photography, and other recreational uses. The passive use of simply owning property and managing wildlife is likewise recognized as a qualifying human use. Note that unless the property is being used to manage wildlife for human use, the property will not qualify for the OSL special tax appraisal.

THE APPLICATION FOR OPEN-SPACE LANDS AGRICULTURAL APPRAISAL

Whenever a landowner decides to change their land use from agricultural to wildlife management, an Application for 1-d-1 (Open-Space) Agricultural Appraisal must be submitted to the appraisal district in the county in which the property is located. This form, along with a wildlife management plan, should be submitted between January 1 and April 30 of the year in which the change in land use is to take place. If the application is granted by the chief appraiser in the county, the landowner does not need to file the application again in later years unless the chief appraiser requests a new application, or if the decision is made to choose another agricultural use designation for the property.

THE MANAGEMENT PLAN

Another requirement for qualifying for the OSL special tax appraisal is for the landowner to submit a wildlife management plan (WMP) to the chief tax appraiser in the county between January 1 and April 30 of the tax year. The WMP should be submitted on the TPWD form (TPWD 885-W7000 1-D-1 Open Space Agricultural Valuation Wildlife Management Plan). The chief appraiser may accept, but not require, a management plan on another form. All required information, however, must be provided, which is called for on the official TPWD885-W7000 form for each tract for which wildlife management use qualification is sought. The practices and activities contained in the plan must be consistent with the practices and activities recommended in Guidelines for Qualification of Agricultural Land in Wildlife Management Use and the TPWD Comprehensive Wildlife Management Planning Guidelines for the ecoregion in which the property is located. The management plan may be entirely filled out and submitted by the landowner, or the landowner may choose to engage the services of a wildlife management professional to assist in completing the WMP.

MANAGEMENT PRACTICES

The law requires that landowners conduct specific management practices designed to enhance the target wildlife species. At least three of the following seven management practices must be performed each year on the property based on the wildlife management plans. Details regarding TPWD wildlife management practices required in each of 10 different ecological areas are listed in the Resources section later in this publication. Some of the ecological areas have been combined due to similar management practices for the areas.

Habitat Control (Habitat Management)

Wildlife habitat is dynamic, not static, requiring active management to benefit wildlife. Habitat management may require the clearing and management of brush or the conversion of introduced plant species to native species.

Therefore, this management practice is critical in maintaining the breeding population of various wildlife species. Depending on the target species to be managed, habitat management may take various forms and involves actively manipulating the land for the benefit of the species. Some of the qualifying activities for habitat control/management include:

- Grazing management;
- Prescribed burning;
- Range enhancement;
- Brush management;
- Forest management;
- Riparian management and improvement;
- Wetland improvements;
- Habitat protection for species of concern;
- Managing native, exotic and feral species; and
- Wildlife restoration.

Erosion Control

Land management activities that reduce soil erosion are desirable components of the overall management plan that meets the requirements of the Law. Qualifying erosion control activities include:

- Pond construction;
- Gully shaping;
- Streamside, pond, and wetland re-vegetation;
- Establishing native plants;
- Dike, levee construction or management, and water diversion.

Predator Control/Management

If there is a high number of predators having a significant negative impact on target wildlife species, attempts to control the predators qualifies as a management practice under the Law. Recall that non-game species like songbirds, birds of prey, and many others are protected by state and federal law. Some of the qualifying activities are:

- Mammal predator control;
- Fire ant control;
- Brown-headed cowbird control; and
- Grackle or starling control.

Providing Supplemental Water

Water is vital for all wildlife species. The development of supplemental water sources for wildlife species is a qualifying practice under the Law. Supplemental water may also be a seasonal development as in the case of moist soil management structures that provide seasonal water for migrating waterfowl. Supplemental water development activities that would qualify under the Law include:

- Marsh or wetland restoration or development;
- Managing well, trough and windmill overflow or installing new supplemental water sources; and
- Spring development and/or improvements.

Providing Supplemental Food

Most wildlife environments provide natural food. A landowner may provide supplemental food by way of habitat manipulation (e.g., brush clearing) or by providing supplemental forages or food that tends to augment the food that occurs naturally. Supplemental food activities that qualify under the Law include:

- Establishing food plots;

- Providing and maintaining feeder and mineral supplements; and
- Manage tame pasture, old fields and croplands to benefit wildlife species.

Providing Shelter

This term means actively creating or maintaining vegetation or artificial structures that provide shelter from the weather, for nesting and breeding sites, or for "escape cover" from predators. Providing shelter may be as simple as creating "snag" trees and/or brush piles, or by constructing structures such as nest boxes. Qualifying activities regarding providing shelter include:

- Installing nest boxes and bat boxes;
- Brush piles and slash retention;
- Managing fence lines;
- Managing hay meadow, pasture or cropland;
- Half-cutting trees and shrubs;
- Establishing woody plants and shrubs; and
- Developing natural cavities and snags.

Conduct Census Counts to Determine Population

Census counts are periodic surveys that help determine the population of a certain species or the number of different species occupying the property being managed for wildlife. Census counts are helpful in determining whether, or not management activities are enhancing wildlife populations. Different methods of obtaining population/species estimates include:

- Spotlight counting;
- Aerial counts;
- Daylight wildlife composition counts;
- Harvest data collection and record keeping;
- Browse utilization surveys;
- Census and monitoring endangered, threatened or protected wildlife; and
- Census and monitoring non-game wildlife species.

SUMMARY

Using wildlife management as an agricultural practice to qualify for the 1-d-1 Open Space Agricultural tax appraisal in Texas is not widely understood by many landowners or potential landowners. While it is relatively easy to switch from traditional agricultural uses such as cattle or hay production to wildlife management agricultural use, there are several guidelines that must be adhered to in order for the

property to receive the special agriculture tax appraisal based on wildlife management. The enjoyment associated with managing for wildlife, however, make the change in land use management worthwhil for many landowners. Landowners are reminded that to qualify for the special tax appraisal, the following issues must be addressed:

1. The property must have already been qualified as 1-d-1 Open-Space Agricultural Use land the year prior to changing to wildlife management.
2. The land must be used to support a sustaining breeding, migrating, or wintering population of indigenous wild animals. In other words, the *primary* use of the land must be for managing wildlife.
3. An application for 1-d-1 (Open Space) Agricultural Appraisal must be submitted showing the change in land use to wildlife management and submitted to the appraisal district in the county in which the property is located.
4. A Wildlife Management Plan for Agricultural Tax Valuation must be completed and submitted to the Central Appraisal District in the county in which the property is located.
5. If property has been reduced in size since the previous tax year, minimum tract size requirements must be met to qualify for OSL appraisal for wildlife management.

If you require additional information regarding wildlife management as an Open Space Land Agricultural special tax appraisal, contact your local appraisal district, Texas A&M AgriLife Extension Service, or the Texas Parks and Wildlife Department.

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The Comprehensive Wildlife Management Planning Guidelines developed by Texas Parks and Wildlife Department for each ecoregion can be found here and are intended to assist landowners in preparing a wildlife management plan for ad valorem tax purposes.

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Brush Busters® Workshop

Brush Busters®: A Common Sense Program for Rangeland Brush Management

Workshop Organizers: Dr. Megan Clayton, Extension Range Specialist, Uvalde and Dr. Barron Rector, Extension Range Specialist, College Station.

Landowners and managers in Texas face a series of growing problems. Brush is increasing. Herbicide costs and regulations are escalating. Ranch size is decreasing, changing or reducing brush control options. Urban encroachment is reducing control-options, especially broadcast aerial herbicide applications. Landownership patterns are changing. Ignoring brush on rangeland or improved pastures until it is dense and mature is a common error among landowners.

In response to these problems, the Brush Busters® program was developed. This program is an effective, user-friendly, do-it-yourself approach to brush management on rangeland that stresses use of individual plant treatment to reduce treatment costs, improve control effectiveness, limit damage to desirable livestock and wildlife food plants, and lengthen treatment-life of broad-scale practices where this program can be used for successful follow-up management. This program is highly selective and effective, environmentally-friendly, and usually much less expensive than conventional broadcast mechanical or herbicide control methods.

Brush Busters® methods make it possible to control brush in the seedling, sapling, or re-growth stages while it is most vulnerable, before it causes debilitation of desirable forage plants or accelerates soil erosion, and before brush produces seeds which may germinate and re-infest pastures. To date, the Brush Busters® program has targeted mesquite, pricklypear, huisache, saltcedar, yucca, Chinese tallowtree, Macartney rose, greenbriar, juniper, honey locust and cut-stump treatments for numerous woody plant species.

Brush Busters® methods are easily understood, even by those with little or no previous experience with brush management. We recommend only “select” treatments capable of killing at least 7 of 10 plants treated. Every attempt is made to keep equipment costs and complexity to a minimum, and whenever possible, to use non-restricted herbicides.

This workshop will provide detailed instructions and demonstrations of Brush Busters® methods for several species and for cut-stump treatments. Topics discussed will include application equipment, herbicides, adjuvants, timing, and treatment conditions for effective application of Brush Busters® methods. Each participant will receive Brush Busters® pamphlets that provide simple, three-step directions for effective control of each species. Participants will also receive 3 hours of pesticide applicator CEUs.

For more information, review the Brush Busters® publications behind this page. Thank you for attending and participating in the 2024 BCSC Cattleman’s College Program.

RWFM-PU-067 11/2021

BRUSH BUSTERS MIXING GUIDE:

Individual Plant Treatment Applications

Robert K. Lyons and Megan K. Clayton*

AMOUNT OF PRODUCT NEEDED FOR HERBICIDE MIXES USING PERCENT AND SPRAY VOLUME												
Total amount of herbicide mix desired	Product amount (%) needed for individual plant treatment applications											
	0.25%	0.5%	0.75%	1%*	1.5%	2%	3%	4%	5%	10%	15%	25%
	Amount of product											
1 gal	0.32 oz	0.64 oz	1 oz	1.28 oz	2 oz	2.56 oz	4 oz	5.12 oz	6.4 oz	12.8 oz	19 oz	32 oz
3 gal*	1 oz	2 oz	3 oz	4 oz*	6 oz	8 oz	11.5 oz	15.5 oz	19 oz	38.5 oz	58 oz	96 oz
5 gal	1.6 oz	3.2 oz	5 oz	6.4 oz	10 oz	13 oz	19 oz	26 oz	32 oz	64 oz	96 oz	1.25 gal
10 gal	3.2 oz	6.4 oz	10 oz	13 oz	19 oz	26 oz	38 oz	51 oz	64 oz	1 gal	1.5 gal	2.5 gal
14 gal	4.5 oz	9 oz	13.5 oz	18 oz	27 oz	36 oz	54 oz	72 oz	90 oz	1.4 gal	2.1 gal	3.5 gal
25 gal	8 oz	16 oz	24 oz	32 oz	48 oz	64 oz	96 oz	1 gal	1.25 gal	2.5 gal	3.75 gal	6.25 gal
50 gal	16 oz	32 oz	48 oz	64 oz	96 oz	1 gal	1.5 gal	2 gal	2.5 gal	5 gal	7.5 gal	12.5 gal
100 gal	32 oz	64 oz	96 oz	1 gal	1.5 gal	2 gal	3 gal	4 gal	5 gal	10 gal	15 gal	25 gal

***Spray Mix Example:** To prepare 3 gallons of a 1% herbicide leaf spray mixture with 0.25% non-ionic surfactant (NIS) and 0.5% blue dye: Add half the water volume to the tank, pour in the correct amount of herbicide (4 oz; see chart), add 0.25% NIS (1 oz; see chart), add 0.5% blue dye (2 oz; see chart). Add the remaining water volume and mix well.

Note: For leaf spray applications, add the recommended amount of non-ionic surfactant (NIS), methylated seed oil (MSO), or methylated seed oil-organo silicate (MSO-OS) according to product label specifications, using only water as the herbicide carrier. For stem or cut stump applications, recommendations include using either triclopyr ester with a diesel or basal oil carrier or Invora (mesquite only) and an MSO-OS adjuvant with water as a carrier.

128 oz = 1 gallon

*Professors and Extension Range Specialists, The Texas A&M University System

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HOW TO AVOID LUMPS WHEN TREATING CUT STUMPS:

Individual Plant Treatment Cut Stump Applications

Robert K. Lyons and Megan K. Clayton*

Woody plants are an important component of most Texas rangelands, providing food and cover for livestock and wildlife. However, if an area is too dense with woody plants, they compete with more desirable vegetation. Most woody plant species resprout profusely from belowground crowns or roots if aboveground growth is damaged or removed.

Here is an easy, inexpensive, and environmentally responsible method to control many species of woody plants using cut stump spray treatments. It involves spraying a small but potent concentration of herbicide directly onto cut stumps. Remember, controlling woody plants is not a one-time job. Both livestock and wildlife spread seeds, so monitor your land regularly to control unwanted seedlings.

This Brush Buster control method was developed and approved by professionals with Texas A&M AgriLife Extension Service and Texas A&M AgriLife Research, both agencies of the Texas A&M University System. Your results may vary, but you should usually be able to kill 76 to 100 percent of the trees you treat with little or no damage to desirable vegetation.

Brush Busters recommends two different spray mixes for cut stump applications depending on the target brush species. One spray mix is for many species of hardwoods, while the other is for redberry cedar. After treatment, you may leave the cut stems and branches on the soil as mulch or stack and burn them.

BRUSH BUSTERS CUT STUMP METHOD

When to apply: Anytime during the year, although best results occur during the growing season.

1. Prepare the Equipment

Almost any type of pump-up hand sprayer can be used, but the most efficient way to apply the stem spray to many trees is with a backpack sprayer.

Make sure the sprayer's nozzle has a small orifice. One such nozzle is called the ConeJet™ 5500-X1 (or X2–X3).

To cover the stump adequately with a sprayer attached to hydraulic shears (skid/steer loader), use an adjustable cone nozzle with a relatively large orifice, such as a ConeJet™ 5500-X12 nozzle.

2. Mix the Herbicide Spray

Select the appropriate spray mixture in the "Spray Mix" section on the next page according to which brush species will be treated.

3. Cut and Spray the Stump

Remove top growth using pruning shears, a sharp ax, brush cutter, chainsaw, hydraulic shears, loppers, etc.

Make a flat cut on every plant stem as close as possible to the soil surface, but not below the soil surface. Before spraying, brush any soil or sawdust off the cut stump surface.

Spray the stump immediately after cutting. Adjust the spray nozzle to deliver a coarse mist in a cone-shaped pattern. Hold the nozzle within 1 or 2 inches of the stump and spray the entire cut surface until it is wet, especially the outer edges. Spray any remaining stem from the cut to the ground level, almost to the point of runoff.

When using a spray system attached to hydraulic shears, position the spray nozzle directly over the cut stump, high enough to ensure all of the stump is within the spray pattern. Using the dye as an indicator, spray the entire cut surface of the stump almost to the point of runoff.

Keep These Points in Mind:

- Follow herbicide label directions.
- This method is best for plants with a single stem or a few stems growing from the base (redberry juniper never has single basal stems).
- Do not spray when basal stems are wet.
- After mixing the herbicide into the carrier (diesel or water), shake or agitate the solution vigorously.
- Cost of treatment rises rapidly as the number of woody plants and stems per acre increases. Download the Brush Busters Cost Calculator app to easily estimate treatment costs.

*Professors and Extension Range Specialists, The Texas A&M University System

BRUSH BUSTERS CUT STUMP SPRAY MIX OPTIONS

A. Spray Mix with Triclopry Ester for Hardwoods

Works well on: Algerita (agarito), baccharis, blackbrush, bois d'arc, bumelia, catclaw acacia, catclaw mimosa, Chinese tallow tree, elm, hackberry, huisache, lotebush (bluethorn), mesquite, all oaks, pricklyash (Hercules' club), saltcedar, Texas persimmon, winged elm, and yaupon.

Mixing instructions: A mixture of 15 percent triclopyr ester herbicide (trade names: Remedy Ultra, Clear Pasture, Triclopyr R&P, and Triclopyr 4EC) and 85 percent diesel fuel oil or vegetable oil is recommended (see mixing table below). Diesel fuel oil or vegetable oil act as coating agents and penetrants to ensure good herbicide coverage and absorption. Using vegetable oil instead of diesel fuel oil increases cost but may be desirable in some situations.

Pour the required amount of herbicide into a mixing container or spray tank, then bring to final volume with diesel fuel oil or vegetable oil. Vigorously shake or agitate to ensure thorough mixing. One ounce of Hi-Light™ blue dye can be added for each gallon of spray mix to help identify treated plants.

RECOMMENDED CUT STUMP SPRAY MIX FOR HARDWOODS HERBICIDE MIX OPTION (IN DIESEL OR BASAL OIL)

Ingredient	Concentration in Spray Solution	Tank Size		
		1 gal	5 gal	10 gal
Triclopyr ester herbicide	15%	19 oz	96 oz	1.5 gal
Hi-Light™ blue dye	1 oz/gal	1 oz	5 oz	10 oz

B. Spray Mix with Picloram for Redberry Cedar

Works well on: Redberry cedar (juniper). You do not need to spray the stumps with herbicide to kill blueberry cedar (Ashe juniper) or eastern red cedar.

Mixing instructions: A mixture of 4 percent picloram herbicide (trade names: Tordon 22K, Triumph 22K, Picloram 22K) in water is recommended for redberry cedar (see mixing table below). A high-quality (80 to 90 percent active ingredient) non-ionic surfactant ensures good herbicide coverage and absorption. Add a spray marking dye such as Hi-Light™ blue dye to mark the stumps that have been sprayed.

When mixing, add half the desired quantity of water to the spray tank. Then add the picloram herbicide, surfactant, and dye to the tank. Finally, use water under pressure to agitate and mix the spray, filling the tank to the final volume.

RECOMMENDED CUT STUMP SPRAY MIX FOR REDBERRY CEDAR HERBICIDE MIX OPTION (IN WATER)

Ingredient	Concentration in Spray Solution	Tank Size	
		1 gal	4 gal
Picloram herbicide	4%	5 oz	21 oz
Non-ionic surfactant	0.25%	0.32 oz	1.5 oz
Hi-Light™ blue dye	0.25%	0.32 oz	1.5 oz

RWFM-PU-112 11/2021

HOW TO BEAT HUISACHE:
Individual Plant Treatment Leaf and Stem Applications

Megan K. Clayton and Robert K. Lyons*

Huisache is a common plant on rangeland and pasture in the southern half of Texas. It is a tough, aggressive, noxious species that limits forage production and decreases the value of wildlife habitat.

Here are two three-step methods to control huisache; both are easy, inexpensive, and environmentally responsible. They involve spraying a small but potent concentration of herbicide directly on each plant to selectively control unwanted huisache. Remember, controlling huisache is not a one-time job. Both livestock and wildlife spread seeds, so monitor your land regularly to control unwanted seedlings.

These Brush Busters control methods were developed and approved by professionals with Texas A&M AgriLife Extension Service and Texas A&M AgriLife Research, both agencies of the Texas A&M University System. Your results may vary with weather and other plant conditions, but you should usually be able to kill 76 to 100 percent of the trees you treat.

These Brush Busters control methods depend on the tree shape and size. For huisache with three or less smooth bark stems coming out of the ground, the stem spray method may be a good option. For bushy huisache less than 6 feet tall with many stems at ground level, the leaf spray method may be the best option. Either method can be successful.

BRUSH BUSTERS LEAF SPRAY METHOD

Works well on: Huisache that have good leaf canopy and are less than 6 feet tall. This method is also known as high-volume foliar spraying.

When to apply: Begin in September after any late-summer growth has stopped, indicated by no new leaf growth at the end of stems. Good soil moisture and mature, healthy leaves are necessary for improved plant kill. Continue until November or when the soil temperature drops below 75°F at 12 inches deep.

1. Prepare the Equipment

Many types of sprayers work well for this method. Backpack sprayers are the most efficient for small acreage places or those with a high density of huisache trees. Larger places with lower densities may find ATV or UTV sprayers more efficient. Before you start spraying, make sure you have an adjustable cone nozzle, such as the Conejet™ 5500-X6 or X8 nozzle that can deliver a coarse spray with larger droplets to the top of a 6-foot tree.

2. Mix the Herbicide Spray

You can achieve 76 to 100 percent mortality by spraying with one of several herbicide options (see options A, B, or C in the table on the next page) under ideal conditions. To prepare the spray mix, add the selected herbicide to water. To make sure the foliage is coated thoroughly, add a high-quality (80 to 90 percent active ingredient) non-ionic surfactant (see table on the next page) to the spray mix or crop oil, methylated seed oil (MSO), or MSO-OS (organosilicone) adjuvant at manufacturer specified rates. Add a dye, such as Hi-Light™ blue dye, to mark plants that have been sprayed and ensure proper coverage.

3. Spray the Huisache

Adjust the nozzle to deliver a coarse spray in a wide pattern. Wet ALL the leaves of each huisache plant until the leaves glisten but not to the point of dripping.

Keep These Points in Mind:

- Follow herbicide label directions.
- For best results, do not spray when:
  - Rains have stimulated new growth at the end of the stems
  - Leaves are wet from rain or dew
  - Foliage shows damage from hail, insects, or disease
  - Working upwind of desirable trees, shrubs, or crops
- The cost of treatment rises rapidly as the brush becomes bigger and denser. Download the Brush Busters Cost Calculator app to easily estimate treatment costs.
- Controlling huisache is not a one-time job. You will need to monitor your land every year to check for new plants.

*Professors and Extension Range Specialists, The Texas A&M University System

RECOMMENDED LEAF SPRAY HERBICIDE MIX OPTIONS*						
	Ingredient	Concentration in Spray Solution	Tank Size			
			1 gal	3 gal	14 gal	25 gal
Option A	Grazon P+D, Gunslinger, Picloram+D, or Sendero	1%	1.28 oz	3.84 oz	18 oz	32 oz
Option B**	Invora**	1.5%	1.92 oz	5.76 oz	27 oz	48 oz
Option C	Graslan L	0.63%	0.8 oz	2.4 oz	11 oz	20 oz
Add to option A, B, and C	Non-ionic surfactant	0.25%	0.32 oz	1 oz	4.5 oz	8 oz
	Hi-Light™ blue dye	0.25 to 0.5%	0.32–0.64 oz	1–2 oz	4.5–9 oz	8–16 oz

*All leaf spray solutions are mixed in water.
**Invora is labeled for privately owned rangelands only *(excludes hayfields)* and requires Picolinic Acid Chemistry Training for all applicators.

BRUSH BUSTERS STEM SPRAY METHOD

Works well: For controlling young seedlings or older trees with three or fewer basal stems. Multi-stemmed huisache plants are much more difficult to control than younger trees or undisturbed plants.

Research and demonstrations have shown excellent results while using minimum amounts of herbicide.

When to apply: Anytime during the year, although best results occur during the growing season.

1. Prepare the Equipment

Almost any type of pump-up hand sprayer can be used, but the most efficient way to apply the stem spray to many trees is with a backpack sprayer.

Make sure the sprayer's nozzle has a small orifice. One such nozzle is called the Conejet™ 5500-X1 (or X2). Compared to standard nozzles, this nozzle can reduce the amount of spray applied by 80 percent, making the use of chemicals much more cost-effective.

2. Mix the Herbicide Spray

A mixture of triclopyr ester (trade names: Remedy Ultra, Clear Pasture, Triclopyr R&P, and Triclopyr 4EC) and diesel fuel oil is very effective for this method. Diesel acts as a coating agent to ensure good absorption. A basal bark (vegetable) oil may be used instead of diesel if desired.

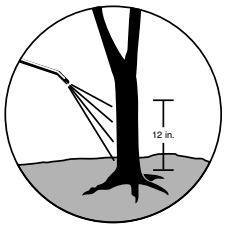
Recommended Herbicide Mix

Pour 25 percent triclopyr ester into the mixing container, then add diesel fuel to bring the mixture to the total volume desired. Agitate the mixture vigorously.

Huisache Type and Stem Diameter	% Triclopyr	Herbicide/ Gallon	Herbicide Carrier/Gallon
Smooth bark, stems up to 4 inches in diameter	25%	32 oz	96 oz diesel or basal bark oil
Add Hi-Light™ blue dye (optional)		0.32–0.64 oz	

3. Spray the Huisache

Adjust the sprayer nozzle to deliver a narrow, cone-shaped mist. Spray the mixture lightly but evenly on all the plant stems from the ground line up to 12 inches. Apply the mixture to all sides of every stem, but do not wet it so much that it runs off the stem and puddles.



Keep These Points in Mind:

- Follow the herbicide label directions.
- The cost of treatment escalates rapidly as brush becomes denser or the number of basal stems per plant increases. Download the Brush Busters Cost Calculator app to easily estimate treatment costs.
- Multi-stemmed or rough-barked plants are more difficult to control with this method.
- Do not spray when the basal stems are wet.
- After mixing the herbicide with diesel, shake or agitate the solution vigorously.
- This method is more difficult to apply if there is dense grass around the basal stems.

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HOW TO BEAT MESQUITE:
Individual Plant Treatment Leaf and Stem Applications

Robert K. Lyons and Megan K. Clayton*

The mesquite tree is one of the toughest, most noxious brush species on Texas rangelands. It thrives across the western two thirds of the state, both in rural pastures and on urban lots.

Here are two three-step methods to control mesquite; both are easy, inexpensive, and environmentally responsible. They involve spraying a small but potent concentration of herbicide directly on each plant to selectively control unwanted mesquite. Remember, controlling mesquite is not a one-time job. Both livestock and wildlife spread seeds, so monitor your land regularly to control unwanted seedlings.

These Brush Busters control methods were developed and approved by professionals with Texas A&M AgriLife Extension Service and Texas A&M AgriLife Research, both agencies of the Texas A&M University System. Your results may vary with weather and other plant conditions, but you should usually be able to kill 76 to 100 percent of the trees you treat.

These Brush Busters control methods depend on the tree shape and size. For mesquite with three or fewer smooth bark stems coming out of the ground, the stem spray method may be a good option. For bushy mesquite less than 6 feet tall with many stems at ground level, the leaf spray method may be the best option. Either method can be successful.

Honey Mesquite leaves and beans. *Courtesy of: TREES, SHRUBS AND WOODY VINES OF THE SOUTHWEST by Robert A. Vines, Illustrated by Sarah Kahlden Arendale, Copyright ©1960*

BRUSH BUSTERS LEAF SPRAY METHOD

Works well on: Mesquite plants that have good leaf canopy and are less than 6 feet tall. This method is also known as high-volume foliar spraying.

When to apply: Begin in spring, when mesquite leaves change color from light pea-green to a uniform dark-green; continue through July 31st for East and South Texas, while other parts of the state may be able to spray through September. If mesquite has been top killed by fire, hand cutting, herbicide methods, or any mechanical methods, allow two full growing seasons before using the Brush Busters leaf spray method.

*Professors and Extension Range Specialists, The Texas A&M University System

1. Prepare the Equipment

Many types of sprayers work well for this method. Backpack sprayers are the most efficient for small acreage places or those with a high density of mesquite trees. Larger places with lower densities may find ATV or UTV sprayers more efficient. Before you start spraying, make sure that you have an adjustable cone nozzle, such as the Conejet™ 5500-X6 or X8 nozzle that can deliver a coarse spray with larger droplets to the top of a 6-foot tree.

2. Mix the Herbicide Spray

You can achieve 76 to 100 percent mortality by spraying with one of several herbicide options (see options A, B, or C in the table on the next page) under ideal conditions. To prepare the spray mix, add the selected herbicide to water. To make sure the foliage is coated thoroughly, add a high-quality (80 to 90 percent active ingredient) non-ionic surfactant (see table on the next page) to the spray mix or crop oil, methylated seed oil (MSO), or MSO-OS (organosilicone) adjuvant at manufacturer specified rates. Add a dye, such as Hi-Light™ blue dye, to mark plants that have been sprayed and ensure proper coverage.

3. Spray the Mesquite

Adjust the nozzle to deliver a coarse spray in a wide pattern. Wet ALL the leaves of each mesquite plant until the leaves glisten but not to the point of dripping.

Keep These Points in Mind:

- Follow herbicide label directions.
- For best results, do not spray when:
  - Rains have stimulated new growth at the end of the stems
  - Leaves are wet from rain or dew
  - Foliage shows damage from hail, insects, or disease
  - Working upwind of desirable trees, shrubs, or crops
- The cost of treatment rises rapidly as the brush becomes bigger and denser. Download the Brush Busters Cost Calculator app to easily estimate treatment costs.
- Controlling mesquite is not a one-time job. You will need to monitor your land every year to check for new plants.

RECOMMENDED LEAF SPRAY HERBICIDE MIX OPTIONS*						
	Ingredient	Concentration in Spray Solution	Tank Size			
			1 gal	3 gal	14 gal	25 gal
Option A	Sendero	1%	1.28 oz	4 oz	18 oz	32 oz
Option B**	Invora**	1.5%	1.92 oz	5.76 oz	27 oz	48 oz
Option C	Remedy Ultra, Clear Pasture, Triclopyr R&P and Triclopyr 4EC	0.5%	0.64 oz	2 oz	9 oz	16 oz
	Pyramid R&P and Clopyralid 3	0.5%	0.64 oz	2 oz	9 oz	16 oz
Add to option A, B, and C	Surfactant	1/4%	0.32 oz	1 oz	4.5 oz	8 oz
	Hi-Light™ blue dye	1/4–1/2%	0.32–0.64 oz	1–2 oz	4.5–9 oz	8–16 oz

*All leaf spray solutions are mixed in water.
**Invora is labeled for privately owned rangelands only *(excludes hay fields)* and requires Picolinic Acid Chemistry Training for all applicators.

BRUSH BUSTERS STEM SPRAY METHOD

Works well: For controlling young seedlings or older trees with three or fewer basal stems. Multi-stemmed mesquite plants are much more difficult to control than younger trees or undisturbed plants.

Research and demonstrations have shown excellent results while using minimum amounts of herbicide.

When to apply: Anytime during the year, although the best results occur during the growing season. The Invora mixture (option B) is best applied late spring through summer.

1. Prepare the Equipment

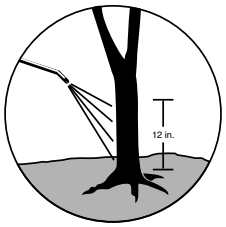
Almost any type of pump-up hand sprayer can be used, but the most efficient way to apply the stem spray to many trees is with a backpack sprayer.

Make sure the sprayer's nozzle has a small orifice. One such nozzle is the Conejet™ 5500-X1 (or X2). Compared to standard nozzles, this nozzle can reduce the amount of spray applied by 80 percent, making the use of chemicals much more cost-effective.

2. Mix the Herbicide Spray

For spraying mesquite stems, there are two mixture options.

For triclopyr ester applications (option A), pour the required amount of herbicide (trade names: Remedy Ultra, Clear Pasture, Triclopyr R&P, and Triclopyr 4EC) into the mixing container (concentration depends on mesquite stem diameter and bark roughness), and then bring to the desired total volume by addition of diesel fuel or basal bark oil, which act as coating agents to ensure good absorption. Shake vigorously to ensure thorough mixing.



For Invora stem applications (option B), fill the mixing container half full of water. Add Invora, a methylated seed oil organo-silicone (MSO-OS; 1 percent) adjuvant, and Hi-Light™ blue dye (0.25 to 0.5 percent). Then add water to the desired volume and mix well.

RECOMMENDED STEM SPRAY HERBICIDE MIXES				
	Mesquite Type and Stem Diameter	Herbicide	Herbicide/ Gallon	Herbicide Carrier/Gallon
Option A	Smooth bark 1.5 in or less	Triclopyr ester, 15%	19 oz	109 oz diesel or basal bark oil
	Smooth bark 1.5 to 4 in	Triclopyr ester, 25%	32 oz	96 oz diesel or basal bark oil
	Rough bark	Triclopyr ester, 25%	32 oz	96 oz diesel or basal bark oil
Add to option A	Hi-Light™ blue dye (optional)		0.32–0.64 oz	
Option B*	Smooth bark 4 in or less	Invora*, 15%	19 oz	109 oz water
Add to option B	MSO-OS Adjuvant		1.28 oz	
	Hi-Light™ blue dye		0.32–0.64 oz	

*Invora is labeled for privately owned rangelands only (*excludes hay fields*) and requires Picolinic Acid Chemistry Training for all applicators.

3. Spray the Mesquite

Adjust the sprayer nozzle to deliver a narrow, cone-shaped mist. Spray the mixture lightly but evenly on all the plant stems from the ground line up to 12 inches. Apply the mixture to all sides of every stem, but do not wet it so much that it runs off the stem and puddles.

Keep These Points in Mind:

- Follow all label directions.
- The cost of treatment increases as plant density and the number of stems per plant increases. Download the Brush Busters Cost Calculator app to easily estimate treatment costs.
- Rough-bark mesquites (usually older trees) are much harder to kill than smooth-bark mesquites.
- Multi-stemmed plants are more difficult to control with this method. It is best to use this on plants with three or fewer stems.
- Do not spray when the basal stems are wet.
- Dense grass around basal stems makes this method more difficult to apply.
- With triclopyr ester, use herbicides that contain 4 pounds per gallon of triclopyr acid equivalent (ae).

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HOW TO BRUSH OFF MINOR SPECIES

Individual Plant Treatment Leaf Application

Robert K. Lyons and Megan K. Clayton*

Brush species that can become local problems but are not widespread across the state include agarito, bumelia, catclaw acacia, catclaw mimosa, coyotillo, flameleaf sumac, lotebush, tasajillo, Texas mountain laurel, and whitebrush. These species typically occur in mixed-brush communities but have the potential to grow out of balance in some situations.

Here is a three-step leaf application method to control these species that is easy, inexpensive, and environmentally responsible. It involves spraying a small but potent concentration of herbicide directly on each plant to selectively control unwanted species. Remember, controlling brush is not a one-time job. Both livestock and wildlife spread seeds, so monitor your land regularly to control unwanted seedlings.

This Brush Busters control method was developed and approved by professionals with Texas A&M AgriLife Extension Service and Texas A&M AgriLife Research, both agencies of the Texas A&M University System. Your results may vary with weather and other plant conditions, but you should usually be able to kill 76 to 100 percent of the plants you treat.

BRUSH BUSTERS LEAF SPRAY METHOD

Works well on: Plants that have good leaf canopy and are less than 6 feet tall. This method is also known as high-volume foliar spraying.

When to apply: Begin in late spring through summer with mature, healthy leaves. Plants should have a full leaf canopy and good soil moisture, especially plants like whitebrush that lose their leaves during dry periods.

1. Prepare the Equipment

Many types of sprayers work well for this method. Backpack sprayers are the most efficient for small acreages or those with a high density of trees. Larger places with lower densities may find ATV or UTV sprayers more efficient. Before you start spraying, make sure that you have an adjustable cone nozzle, such as the ConeJet™ 5500-X6 or X8 nozzle that can deliver a coarse spray with larger droplets to the top of a 6-foot tree.

2. Mix the Herbicide Spray

You can achieve 76 to 100 percent mortality by spraying with 1.5 percent Invora herbicide under ideal conditions. To prepare the spray mix, add the appropriate amount of Invora herbicide to water. To make sure the foliage is coated thoroughly, add a high-quality (80 to 90 percent active ingredient) non-ionic surfactant (see table) to the spray mix or MSO-OS (organo-silicone) adjuvant at manufacturer specified rates. Add a dye, such as Hi-Light™ blue dye, to mark plants that have been sprayed to ensure proper coverage.

RECOMMENDED LEAF SPRAY HERBICIDE MIX OPTIONS*

Ingredient	Concentration in Spray Solution	Tank Size			
		1 gal	3 gal	14 gal	25 gal
Invora**	1.5%	1.92 oz	5.76 oz	27 oz	48 oz
Non-ionic surfactant	0.25%	0.32 oz	1 oz	4.5 oz	8 oz
Hi-Light™ blue dye	0.25–0.5%	0.32–0.64 oz	1–2 oz	4.5–9 oz	8–16 oz

*All leaf spray solutions are mixed in water.

**Invora is labeled for privately owned rangelands only (*excludes hayfields*) and requires Picolinic Acid Chemistry Training for all applicators.

3. Spray the Plants

Adjust the nozzle to deliver a coarse spray in a wide pattern. Wet ALL the leaves of each plant until the leaves glisten but not to the point of dripping.

Keep These Points in Mind:

- Follow the herbicide label directions.
- For best results, do not spray when:
  - Rains have stimulated new growth at the end of the stems
  - Leaves are wet from rain or dew
  - Foliage shows damage from hail, insects, or disease
  - Working upwind of desirable trees, shrubs, or crops
- The cost of treatment rises rapidly as brush becomes bigger and denser. Download the Brush Busters Cost Calculator app to easily estimate treatment costs.
- Controlling brush is not a one-time job. You will need to monitor your land every year to check for new plants.

*Professors and Extension Range Specialists, The Texas A&M University System

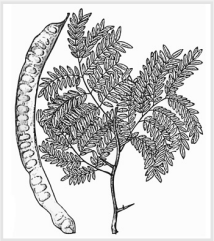
RWFM-PU-123 11/2021

HOW TO CONTROL HONEY LOCUST

Individual Plant Treatment Leaf Application

Barron S. Rector[1] and Megan K. Clayton[2]

Honey locust is a frequent invader in East and Central Texas as well as in creek bottoms and riparian areas throughout the state. Honey locust is native to Texas and can grow up to 100 feet tall, creating dense thickets that prohibit travel for livestock and wildlife. The trunk and branches of honey locust are densely thorny, with older trees having clusters of thorns on the bark. Although the leaves have little value for wildlife or livestock, the pods contain up to 30 percent sugar and are readily consumed.



Honey locust and beans. *Courtesy of: TREES, SHRUBS AND WOODY VINES OF THE SOUTHWEST by Robert A. Vines, Illustrated by Sarah Kahlden Arendale, Copyright ©1960*

This Brush Busters three-step leaf application method for honey locust control is easy, inexpensive, and environmentally responsible. It involves spraying a potent concentration of herbicide directly on each plant to selectively control unwanted honey locust. Remember, controlling honey locust is not a one-time job. Both livestock and wildlife spread seeds, so monitor your land regularly to control unwanted seedlings.

This Brush Busters control method was developed and approved by professionals with Texas A&M AgriLife Extension Service and Texas A&M AgriLife Research, both agencies of the Texas A&M University System. Your results may vary with weather, but you should usually be able to kill 76 to 100 percent of the trees you treat.

BRUSH BUSTERS LEAF SPRAY METHOD

Works well on: Honey locust plants that have good leaf canopy and are less than 6 feet tall. This method is also known as high-volume foliar spraying.

When to apply: Begin in late spring after the leaves mature and throughout the summer as long as the leaves remain healthy.

1. Prepare the Equipment

Many types of sprayers work well for this method. Backpack sprayers are the most efficient for small acreages or those with a high density of honey locust trees. Larger places with lower densities may find ATV or UTV sprayers more efficient. Before you start spraying, make sure that you have an adjustable cone nozzle, such as the ConeJet™ 5500-X6 or X8 nozzle that can deliver a coarse spray with larger droplets to the top of a 6-foot tree.

2. Mix the Herbicide Spray

You can achieve 76 to 100 percent mortality with one of several herbicide options (see "Options" in the table on the next page) under ideal conditions. If you have honey locust and mesquite in the same pasture, Sendero will provide a very high level of control on both species. If you have honey locust and prickly pear, MezaVue will control both species. GrazonNext HL, MezaVue, and Grazon P+D require a private applicator license, while Sendero is an unrestricted herbicide that does not require a license.

To prepare the spray mix, add the selected herbicide to water. To make sure the foliage is coated thoroughly, add a high-quality (80 to 90 percent active ingredient) non-ionic surfactant (see table) to the spray mix or crop oil, methylated seed oil (MSO), or MSO-OS (organo-silicone) adjuvant at manufacturer specified rates. Add a dye, such as Hi-Light™ blue dye, to mark plants that have been sprayed to ensure proper coverage.

3. Spray the Honey Locust

Adjust the nozzle to deliver a coarse spray in a wide pattern. Wet ALL the leaves of each honey locust plant until the leaves glisten but not to the point of dripping.

Keep These Points in Mind:

- Follow herbicide label directions.
- For best results, do not spray when:
  - Rains have stimulated new growth at the end of the stems
  - Leaves are wet from rain or dew
  - Foliage shows damage from hail, insects, or disease
  - Working upwind of desirable trees, shrubs, or crops
- The cost of treatment rises rapidly as brush becomes bigger and denser. Download the Brush Busters Cost Calculator app to easily estimate treatment costs.
- Controlling honey locust is not a one-time job. You will need to monitor your land every year to check for new plants.

[1] Associate Professor and Extension Range Specialist, The Texas A&M University System
[2] Professor and Extension Range Specialist, The Texas A&M University System

RECOMMENDED LEAF SPRAY HERBICIDE MIX OPTIONS*						
Option	Ingredient	Concentration in Spray Solution	Tank Size			
			1 gal	3 gal	14 gal	25 gal
A	Sendero	1%	1.28 oz	4 oz	18 oz	32 oz
B	GrazonNext HL	1%				
C	MezaVue	1%				
D	Grazon P+D or Gunslinger	1%				
Add to options above	Non-ionic surfactant	0.25%	0.32 oz	1 oz	4.5 oz	8 oz
	Hi-Light™ blue dye	0.25–0.5%	0.32–0.64 oz	1–2 oz	4.5–9 oz	8–16 oz

*All leaf spray solutions are mixed in water.

RWFM-PU-064 11/2021

HOW TO CONTROL MACARTNEY ROSE:

Individual Plant Treatment Leaf Spray Application

Megan K. Clayton and Robert K. Lyons*

Macartney rose, also known as Cherokee rose and rose hedge, presents severe management problems for livestock producers in Southeast Texas to the Middle Coastal Prairie. Imported from Asia in the late 1800s as a hedge for fencing purposes, the plant has escaped and naturalized.

Although dense stands can be somewhat controlled by using herbicides, mechanical methods, and prescribed burning, no single method has been totally effective. The most successful approach to control Macartney rose is to implement an integrated system using several methods applied sequentially. The plant is easiest to manage when there are a few single, small plants (disturbed or undisturbed).

Here is a three-step method to control Macartney rose that is easy, inexpensive, and environmentally responsible. It involves spraying a small but potent concentration of herbicide directly on each plant to selectively control unwanted rose. Macartney rose has some use as browse and for wildlife cover, but if it is allowed to establish dense colonies, the disadvantages greatly outweigh its limited merits.

This Brush Busters control method was developed and approved by professionals with Texas A&M AgriLife Extension Service and Texas A&M AgriLife Research, both agencies of the Texas A&M University System. Your results may vary with weather and other plant conditions, but you should usually be able to kill 76 to 100 percent of plants you treat.

BRUSH BUSTERS LEAF SPRAY METHOD

Works well on: Individual disturbed or undisturbed Macartney rose clumps:

- Undisturbed: Undisturbed plants that are 5 feet or less in height and diameter.
- Disturbed: Apply herbicide treatment to mowed or otherwise disturbed plants within 3 years of disturbance. Avoid spraying earlier than 9 to 12 months after mowing or when plants have high amounts of new growth. Expect poor control if plants are less than 3 feet tall when sprayed.

When to apply: Begin in the spring under good growing conditions when soil temperature reaches 75°F at 12 to 18 inches deep. Stop in late spring during flowering and hip (fruit) formation. Begin again late summer or early fall under good growing conditions, and continue until soil temperatures drop below 75°F.

1. Prepare the Equipment

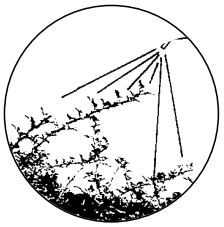
Many types of sprayers work well for this method. Backpack sprayers are the most efficient for small acreages or those with a high density of Macartney rose plants. Larger places with lower densities may find ATV or UTV sprayers more efficient. Before you start spraying, make sure you have an adjustable nozzle, such as the ConeJet™ 5500-X6 or X8 nozzle that can deliver a coarse spray with larger droplets to the top of a 5-foot clump.

2. Mix the Herbicide Spray

You can achieve 76 to 100 percent mortality by spraying with an herbicide containing picloram and 2,4:D (1:4; trade names Grazon P+D, Gunslinger, or Picloram+D) under ideal conditions. To prepare the spray mix, add the selected herbicide to water. To make sure the foliage is coated thoroughly, add a high-quality (80 to 90 percent active ingredient) non-ionic surfactant (see table on next page) to the spray mix or crop oil, methylated seed oil (MSO), or MSO-OS (organo-silicone) adjuvant at manufacturer specified rates. Add a dye, such as Hi-Light™ blue dye, to mark plants that have been sprayed and ensure proper coverage.

3. Spray the Macartney Rose

Adjust the nozzle to deliver a coarse spray in a wide pattern. Wet ALL the leaves of each Macartney rose plant until leaves glisten but not to the point of dripping. The spray pressures may need to be high to penetrate larger plants with heavier canopies.



*Professors and Extension Range Specialists, The Texas A&M University System

RECOMMENDED LEAF SPRAY HERBICIDE MIX*					
Ingredient	Concentration in Spray Solution	Tank Size			
		1 gal	3 gal	14 gal	25 gal
Picloram:2,4-D (1:4) herbicide	1%	1.28 oz	3.84 oz	18 oz	32 oz
Non-ionic surfactant	0.25%	0.32 oz	1 oz	4.5 oz	8 oz
Hi-Light™ blue dye	0.25–0.5%	0.32–0.64 oz	1–2 oz	4.5–9 oz	8–16 oz

*All leaf spray solutions are mixed in water.

Keep These Points in Mind:

- Follow herbicide label directions.
- For best results, do not spray when:
  - Rains have stimulated new growth at the end of stems
  - Leaves are wet from rain or dew
  - Plants are less than 3 feet tall after mowing
  - Foliage shows damage from hail, insects, or disease
  - Working upwind of desirable trees, shrubs, or crops
  - Flowers or fruits are present
  - Soil temperatures are below 75°F
- Cost of treatment rises rapidly as Macartney rose becomes bigger and denser. Download the Brush Busters Cost Calculator app to easily estimate treatment costs.
- Controlling Macartney rose is not a one-time job. You will need to monitor your land every year to check for new plants.
- Macartney rose usually grows on soils with a high clay content. Soil-applied herbicides are generally ineffective for controlling rose on these soils.

RWFM-PU-100
February 2023

HOW TO CONTROL PRICKLY PEAR AND OTHER CACTI:

Individual Plant Treatment Pad & Stem Application or Top Removal Method

Robert K. Lyons and Megan K. Clayton*

Prickly pear is a valuable rangeland plant, but it can form dense colonies and interfere with the movement and handling of livestock, decrease forage utilization, and compete with desirable vegetation. Prickly pear are extremely tolerant of drought and harsh conditions. Therefore, they thrive across Texas—especially in the western half of the state.

Here are two methods to selectively control prickly pear that are easy, inexpensive, and environmentally responsible. One involves spraying a small but potent concentration of herbicide directly on the pads and stems to selectively control unwanted prickly pear. The second method uses a mechanical option to simply remove the top part of the plant.

These Brush Busters control methods were developed and approved by professionals with Texas A&M AgriLife Extension Service and Texas A&M AgriLife Research, both agencies of The Texas A&M University System. Results may vary with weather and other plant conditions, but correct applications should usually be able to kill 76 to 100 percent of treated prickly pear pads.

Remember: Controlling prickly pear is not a one-time job. Both livestock and wildlife spread seeds and scatter pads that can root into new plants, so monitor your land regularly to control unwanted seedlings.

BRUSH BUSTERS PAD AND STEM SPRAY METHOD

Works well on: Relatively thin stands of prickly pear. Dense stands may benefit from a broadcast treatment first.

When to apply: Anytime throughout the year when there is adequate soil moisture, except during extremely cold weather. Absence of rainfall for extended periods after spraying may reduce plant mortality.

1. Prepare the Equipment

Many types of sprayers work well for this method. Backpack sprayers are the most efficient for small acreages or those with a high density of prickly pear. Larger places with lower densities may find ATV or UTV sprayers more efficient. An adjustable cone nozzle—such as the ConeJet™ 5500-X6 or X8 nozzle that can deliver a coarse spray—will be more efficient for smaller plants, while a fan-type nozzle may be best for larger plants.

2. Mix the Herbicide Spray

You can achieve 76 to 100 percent mortality by spraying with one of several herbicide options, including MezaVue (aminopyralid + picloram + fluroxypyr), Surmount/Trooper Pro (picloram + fluroxypyr), Tordon 22K/Triumph 22K/Picloram 22K (picloram), or PastureGard HL (triclopyr + fluroxypyr). To prepare the spray mix, add the selected herbicide at a 1 percent rate to water. To make sure the pads and stems are coated thoroughly, add a high-quality (80 to 90 percent active ingredient) non-ionic surfactant to the spray mix or crop oil, methylated seed oil (MSO), or MSO-OS (organo-silicone) adjuvant at manufacturer's specified rates (see table on next page). Add a dye, such as Hi-Light™ blue dye, to mark plants that have been sprayed and ensure proper coverage.

3. Spray the Prickly Pear

Adjust the nozzle to deliver a coarse spray in a wide pattern. Wet ALL the pads and stems of each prickly pear plant but not to the point of runoff. It is best to spray both sides of the pad for more consistent results.

Keep These Points in Mind:

- Follow herbicide label directions.
- Prickly pear may die very slowly—taking up to 2 to 3 years after application for potential plant mortality to occur.
- For best results, do not spray when:
  - Pads are wet from rain or dew.
  - Daily maximum air temperature has not exceeded 50 degrees F for at least 3 consecutive days.
  - Working upwind of desirable trees, shrubs, or crops.
  - Prickly pear growth is dense.
- Cost of treatment rises rapidly as prickly pear becomes bigger and denser. Download the Brush Busters Cost Calculator app to easily estimate treatment costs.
- Large prickly pear plants may be used as quail nesting sites where bunchgrass is limited or serve as a food source for deer or javelina.

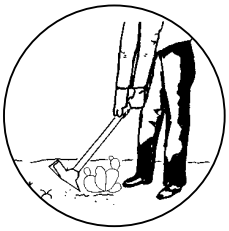
*Professors and Extension Range Specialists, The Texas A&M University System

RECOMMENDED PAD AND STEM SPRAY HERBICIDE MIX OPTIONS*					
Ingredient	Concentration in Spray Solution	Tank Size			
		1 gal	3 gal	14 gal	25 gal
MezaVue, PastureGard HL, Surmount/Trooper Pro, or Tordon 22K/Triumph 22K/ Picloram 22K	1%	1.28 oz	3.84 oz	18 oz	32 oz
Non-ionic surfactant	0.25%	0.32 oz	1 oz	4.5 oz	8 oz
Hi-Light™ blue dye	0.25–0.5%	0.32–0.64 oz	1–2 oz	4.5–9 oz	8–16 oz

*All spray solutions are mixed in water.

BRUSH BUSTERS TOP REMOVAL METHOD

Cut the main root of prickly pear 2 to 4 inches below the soil surface with a grubbing hoe or shovel. Remove the detached plants from the area or stack them on piles of brush. Remember: Any prickly pear pads that come in contact with the ground have the ability to root and become new plants.



RWFM-PU-055 11/2021

HOW TO MASTER CEDAR:

Individual Plant Treatment Leaf and Spot Spray Applications or Top Removal Method

Robert K. Lyons and Megan K. Clayton*

Cedars can be very aggressive and damaging woody plants on Texas rangelands. There are two major cedar species west of Interstate 35: redberry cedar and blueberry cedar.

It is important to know which species you have because treatments vary. As the names imply, blueberry cedar has blue berries, and redberry cedar has red berries. In addition, redberry cedar has small specks of white wax on its leaves and twigs. Blueberry cedar is more common in Central and South-Central Texas, while redberry cedar is more common in West, West-Central, and North-Central Texas. It is not uncommon for the two species to occur together.

Brush Busters recommends three ways to control cedar that are easy, inexpensive, environmentally responsible, and effective. Two herbicide treatments—leaf spray and soil spot spray—work best on cedar less than 3 feet tall. The top removal method, which involves cutting the tree at ground level, will control blueberry cedar, but redberry cedar must be grubbed (cut) below the soil surface.

These Brush Busters control methods were developed and approved by professionals with Texas A&M AgriLife Extension Service and Texas A&M AgriLife Research, both agencies of the Texas A&M University System. Your results may vary with weather and other plant conditions, but you should usually be able to kill 76 to 100 percent of trees you treat.

It is very important to control cedar as seedlings and saplings. Controlling mature cedars requires heavy equipment or large amounts of herbicides and is usually very expensive. Controlling cedar is not a one-time job. Livestock and wildlife spread the seeds easily, so you will need to check your land occasionally and treat unwanted seedlings.

BRUSH BUSTERS LEAF SPRAY METHOD

Works well on: Blueberry or redberry cedars that are less than 3 feet tall.

When to apply: Spring through summer when cedar is actively growing.

1. Prepare the Equipment

Many types of sprayers work well for this method. Backpack sprayers are the most efficient for small acreage places or those with a high density of cedar trees. Larger places with lower densities may find ATV or UTV sprayers more efficient. Before you start spraying, make sure that you have an adjustable nozzle, such as the Conejet™ 5500-X6 or X8 nozzle that can deliver a coarse spray with larger droplets.

2. Mix the Herbicide Spray

A mixture of picloram herbicide (trade names: Tordon 22K, Triumph 22K, or Picloram 22K) in water is very effective for this method. To make sure foliage is coated thoroughly, add a high-quality (80 to 90 percent active ingredient) non-ionic surfactant to the spray mix. Add a dye, such as Hi-Light™ blue dye, to mark plants that have been sprayed and ensure proper coverage (see table on next page).

3. Spray the Cedar

Adjust the nozzle to deliver a coarse spray in a wide pattern. Wet ALL the leaves of each cedar plant to the point of runoff.

Keep These Points in Mind:

- Follow herbicide label directions.
- For best results, do not spray when:
  - Leaves are wet from rain or dew
  - Working upwind of desirable trees, shrubs, or crops
- The cost of treatment increases rapidly as the density and size of cedars increase. Download the Brush Busters Cost Calculator app to easily estimate treatment costs.
- Large, mature blueberry cedar may be a nesting habitat for the endangered golden-cheeked warbler. If in doubt, contact the United States Fish and Wildlife Service before treating.
- Do not spray within 100 feet of known sinkholes or fractures that would allow herbicide to enter underground water aquifers.
- Do not treat large numbers of cedars beneath canopies or within three times the height or diameter of desirable trees such as oaks or pecans.

*Professors and Extension Range Specialists, The Texas A&M University System

RECOMMENDED LEAF SPRAY HERBICIDE MIX OPTIONS*					
		Tank Size			
Ingredient	Concentration in Spray Solution	1 gal	3 gal	14 gal	25 gal
Picloram herbicide	1%	1.28 oz	4 oz	18 oz	32 oz
Surfactant	0.25%	0.32 oz	1 oz	4.5 oz	8 oz
Hi-Light™ blue dye	0.25–0.5%	0.32–0.64 oz	1–2 oz	4.5–9 oz	8–16 oz

*All leaf spray solutions are mixed in water.

BRUSH BUSTERS SPOT SPRAY METHOD

Works well on: Blueberry or redberry cedars that are less than 3 feet tall.

When to apply: Late winter to mid-spring (ideally before expected rainfall).

1. Prepare the Equipment

Soil spot sprays should be applied with an exact-delivery handgun. This piece of equipment is available from most herbicide retail outlets. The handgun delivers a thin stream of predetermined volume when triggered. Adjust the handgun to deliver 2 milliliters (cc) for each pull of the trigger. If only a few plants are to be treated, a disposable syringe can be used. Thoroughly clean all spray equipment immediately after use.

2. Prepare the Herbicide

Velpar L™ is a recommended herbicide for soil spot sprays to control cedar. The herbicide is used undiluted by attaching an exact-delivery handgun or syringe to the herbicide container. Pronone Power Pellet™ can also be used. Each pellet is equivalent to 2 ml (cc) of Velpar L™.

3. Apply the Herbicide

Apply undiluted Velpar L™ or Pronone Power Pellet™ to the soil surface midway between the cedar stem and the canopy-edge. Apply 2 ml for every 3 feet of plant height or every 3 feet of plant canopy diameter (whichever is greater). If plant size requires more than a single 2 ml application, space applications equally around the plant. Apply each 2 ml dose to a single spot on the soil surface. On slopes, apply most of the herbicide on the uphill side of the stem.

Keep These Points in Mind:

- Follow herbicide label directions.
- Do not use on marshy or poorly drained sites.
- Do not use on clay soils.
- Do not apply to snow-covered or frozen ground.
- Do not apply within three times the height or canopy diameter (whichever is greater) of desirable trees such as oaks or pecans.
- Rainfall is required to "activate" Velpar L™ or Pronone Power Pellet™ in the soil. Plants will begin to show symptoms within 3 to 6 weeks of initial rainfall. One to three growing seasons may be required before plants die. During this time, cedars usually sprout new leaves several times.
- Grasses and weeds will be killed where each spot of Velpar L™ or Pronone Power Pellet™ is applied. Recovery may take 2 to 3 years.
- The cost of treatment rises rapidly as the density and size of cedar increases.

BRUSH BUSTERS TOP REMOVAL METHOD

Blueberry cedar: Remove the plant top at or near the ground line with a chainsaw, pruner, axe, etc. Seedlings (plants less than 2 feet tall) can be killed easily by hand grubbing.

Redberry cedar: Since redberry cedar re-sprouts, top removal will not effectively control plants that are over 8 to 10 years old. Redberry cedar seedlings (plants less than 2 feet tall) can be easily killed if they are grubbed below the basal "knob," located at or slightly beneath the soil surface.

RWFM-PU-059 05/22

HOW TO PUT A HALT TO SALTCEDAR

Individual Plant Treatment Leaf and Stem Applications

Megan K. Clayton[1], Barron Rector[2], and Joshua McGinty[3]

Saltcedar is one of the most invasive, hard-to-control woody plants in the world. Introduced from Eurasia into the western United States in the early 1800s, this plant rapidly spreads along rivers, lakes, and streams. Once established, it quickly chokes out desirable vegetation. Most important, saltcedar can draw water from underground aquifers—as much as 200 gallons per plant per day.

Here are two three-step methods to control saltcedar; both are easy, inexpensive, and environmentally responsible. They involve spraying a small but potent concentration of herbicide directly on each plant to selectively control unwanted saltcedar. Remember, controlling saltcedar is not a one-time job. Both livestock and wildlife spread seeds, so monitor your land regularly to control unwanted seedlings.

These Brush Busters control methods were developed and approved by professionals with Texas A&M AgriLife Extension Service and Texas A&M AgriLife Research, both agencies of the Texas A&M University System. Your results may vary with weather and other plant conditions, but you should usually be able to kill 76 to 100 percent of the trees you treat.

These Brush Busters control methods depend on the tree density and size. For low densities of smooth-barked saltcedar with few stems, the stem spray method may be a good option. For dense stands of saltcedar less than 6 feet tall, the leaf spray method may be more suitable. Either method can be successful.

BRUSH BUSTERS LEAF SPRAY METHOD

Works well: On saltcedar that have good leaf canopy and are less than 6 feet tall. This method is also known as high-volume foliar spraying.

When to apply: Begin in July and spray through September or until leaves begin to turn yellow.

1. Prepare the Equipment

You may use a pump-up garden sprayer, backpack sprayer, cattle sprayer, or sprayer mounted on a 4-wheel, all-terrain vehicle (ATV). Backpack sprayers and ATV sprayers will be more efficient if there are many plants to spray. Before you start spraying, make sure that you have an adjustable cone nozzle, such as the Conejet™ 5500-X6 or X8 nozzle that can deliver a coarse spray with larger droplets to the top of a 6-foot tree.

2. Mix Herbicides

You can achieve 76 to 100 percent mortality by spraying saltcedar with a mixture of the herbicides imazapyr (trade names: Arsenal®, Habitat® [aquatic product] and glyphosate (trade names: Roundup PowerMAX®, Rodeo® [aquatic product], Roundup WeatherMAX®, many generic formulations available). If spraying over water, it is important to select herbicides with an aquatic label.

The amount of glyphosate herbicide needed in the mix depends on the strength of glyphosate active ingredient (acid equivalent) in the container. This acid equivalent is noted underneath the percent of active ingredients on the front of the herbicide container label. Use the glyphosate conversion chart below to determine the amount of herbicide to include.

To prepare the spray mix, add 0.5 percent of imazypyr and the correct amount of glyphosate (see Conversion Chart) to water (see table below). To make sure the foliage is coated thoroughly, add a high-quality (80 to 90 percent active ingredient) non-ionic surfactant to the spray mix. Add a dye, such as Hi-Light® blue dye, to mark plants that have been sprayed and ensure proper coverage.

RECOMMENDED LEAF SPRAY HERBICIDE MIX OPTIONS*

Ingredient	Concentration in Spray Solution	Tank Size			
		1 gal	3 gal	14 gal	25 gal
Imazapyr	0.5%	0.64 oz	2 oz	9 oz	16 oz
Glyphosate	See Table Below				
Surfactant (if needed)	0.25%	0.32 oz	1 oz	4.5 oz	8 oz
Hi-Light™ blue dye	0.25–0.5%	0.32–0.64 oz	1–2 oz	4.5–9 oz	8–16 oz

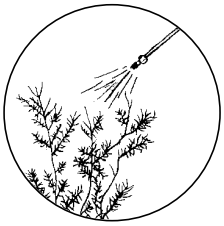
*All spray solutions are mixed in water.

GLYPHOSATE CONVERSION CHART

Glyphosate Acid Equivalent (lb/gal; not percent)	Concentration in Spray Solution	Tank Size			
		1 gal	3 gal	14 gal	25 gal
3 lb/gal	0.67%	0.85 oz	3 oz	12 oz	21.5 oz
4 lb/gal	0.5%	0.64 oz	2 oz	9 oz	16 oz
4.5 lb/gal	0.44%	0.57 oz	2 oz	8 oz	14.5 oz
4.8 lb/gal	0.42%	0.42 oz	2 oz	7.5 oz	13.5 oz

[1] Professor and Extension Range Specialist
[2] Associate Professor and Extension Range Specialist
[3] Associate Professor and Extension Agronomist

3. Spray the Saltcedar



Adjust the nozzle to deliver a course spray in a wide pattern. Wet ALL the leaves of each saltcedar plant until the leaves glisten but not to the point of dripping.

Keep These Points in Mind:

- Follow herbicide label directions.
- For best results, do not spray when:
  - Leaves have turned yellow
  - Rains have stimulated new growth at the end of the stems
  - Leaves are wet from rain or dew
  - Foliage shows damage from hail, insects, or disease
  - Working upwind of desirable trees, shrubs, or crops
- Check the imazapyr product label for restrictions on use related to endangered species and livestock grazing or haying.
- Where spray may contact aquatic environments, use glyphosate, imazapyr, and surfactants with appropriate aquatic labels
- The cost of treatment rises rapidly as the brush becomes bigger and denser. Download the Brush Busters Cost Calculator app to easily estimate treatment costs.
- Leave treated saltcedar undisturbed for two full years after treatment for best results.
- Controlling saltcedar is not a one-time job. You will need to monitor your land every year to check for new plants.

BRUSH BUSTERS STEM SPRAY METHOD

Works well: On low densities of saltcedar and larger, tree-type plants with few stems. Multi-stemmed saltcedar plants are much more difficult to control.

Research and demonstrations have shown excellent results while using minimum amounts of herbicide.

When to apply: Anytime during the year, although best results occur during the growing season.

1. Prepare the Equipment

Almost any type of pump-up hand sprayer can be used, but the most efficient way to apply the stem spray to many trees is with a backpack sprayer.

Make sure the sprayer's nozzle has a small orifice. One such nozzle is the Conejet™ 5500- X1 (or X2). Compared to standard nozzles, this nozzle can reduce the amount of spray applied by 80 percent, making the use of chemicals much more cost-effective.

2. Mix the Herbicide Spray

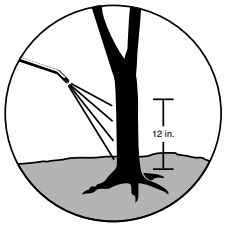
A mixture of triclopyr ester (trade names: Remedy® Ultra, Relegate®, Triclopyr 4E, Clear Pasture, Triclopyr 4EC, many generic 4 lb/gal a.e. formulations available) and diesel fuel oil is very effective for this method. Diesel acts as a coating agent to ensure good absorption. A basal bark (vegetable) oil may be used instead of diesel if desired.

Recommended Herbicide Mix

Pour 25 percent triclopyr ester into the mixing container, then add diesel fuel to bring the mixture to the total volume desired. Agitate the mixture vigorously.

Glyphosate Acid Equivalent (lb/gal; not percent)	Concentration in Spray Solution	Amount/gallon mix
Triclopyr ester	25%	32 oz
Diesel	75%	96 oz
Hi-Light™ blue dye (optional)	0.25–0.5%	0.32–0.64 oz

3. Spray the Saltcedar



Adjust the sprayer nozzle to deliver a narrow, cone-shaped mist. Spray the mixture lightly but evenly on all the plant stems from the ground line up to 12 inches. Apply the mixture to all sides of every stem, but do not wet it so much that it runs off the stem and puddles.

Keep These Points in Mind:

- Follow the herbicide label directions.
- The cost of treatment escalates rapidly as brush becomes denser or the number of basal stems per plant increases. Download the Brush Busters Cost Calculator app to easily estimate treatment costs.
- Multi-stemmed or rough-barked plants are more difficult to control with this method.
- Do not spray when the basal stems are wet.
- After mixing herbicide with diesel, shake or agitate the solution vigorously.
- This method is more difficult to apply if there is dense grass around the basal stems.

RWFM-PU-062 10/2021

HOW TO TAKE OUT TALLOW TREES:
Individual Plant Treatment Leaf and Stem Applications

Robert K. Lyons and Megan K. Clayton*

Chinese tallow trees have invaded and become dense on many upland and wetland sites in prairie and woodland communities of the Texas Coastal Prairie. Tallow trees establish easily, grow quickly, and produce large quantities of seed. The trees resprout quickly from crown and root buds when top-growth is mechanically removed.

Here are two three-step methods to control Chinese tallow trees; both are easy, inexpensive, and environmentally responsible. They involve spraying a small but potent concentration of herbicide directly on each plant to selectively control unwanted trees. Remember, controlling Chinese tallow trees is not a one-time job. The plant produces thousands of seeds that are relatively long-lived and spread by water, birds, and other animals. A tremendous number of seeds build up under parent plants, so monitor your land regularly to find and remove seedlings.

These Brush Busters control methods were developed and approved by professionals with Texas A&M AgriLife Extension Service and Texas A&M AgriLife Research, both agencies of the Texas A&M University System. Your results may vary with weather and other plant conditions, but you should usually be able to kill 76 to 100 percent of trees you treat.

Choose the Brush Busters method recommended for the number and size of plants you wish to control. If you have only a few plants, the stem spray method may work best. If you have many plants, but most are less than 6 feet tall, the leaf spray method may be a good option. Either method can be successful.

BRUSH BUSTERS LEAF SPRAY METHOD

Works well on: Chinese tallow trees that have good leaf canopy and are less than 6 feet tall. This method is also known as high-volume foliar spraying.

When to apply: Begin in April or May after tallow tree leaves mature and continue through September or until the leaves begin to turn yellow to red.

1. Prepare the Equipment

Many types of sprayers work well for this method. Backpack sprayers are the most efficient for small acreage places or those with a high density of trees. Larger places with lower densities may find ATV or UTV sprayers more efficient. Before you start spraying, make sure that you have an adjustable cone nozzle, such as the Conejet™ 5500-X6 or X8 nozzle that can deliver a coarse spray with larger droplets to the top of a 6-foot tree.

2. Mix the Herbicide Spray

You can achieve 76 to 100 percent mortality by spraying with an herbicide containing picloram and 2,4:D (1:4; trade names Grazon P+D, Gunslinger, or Picloram+D) under ideal conditions. To prepare the spray mix, add the herbicide to water (see table on the next page). To make sure the foliage is coated thoroughly, add a high-quality (80 to 90 percent active ingredients) non-ionic surfactant to the spray mix. Add a dye, such as Hi-Light™ blue dye, to mark plants that have been sprayed and ensure proper coverage.

3. Spray the Tallow Trees

Adjust the nozzle to deliver a coarse spray in a wide pattern.

Wet ALL the leaves of each tallow tree plant until the leaves glisten but not to the point of dripping.

Keep These Points in Mind:

- Follow herbicide label directions.
- For best results, do not spray when:
  - Rains have stimulated new growth at the end of the stems
  - Leaves are wet from rain or dew
  - Foliage shows damage from hail, insects, or disease
  - Working upwind of desirable trees, shrubs, or crops
- The cost of treatment rises rapidly as trees become bigger and denser. Download the Brush Busters Cost Calculator app to easily estimate treatment costs.
- Controlling Chinese tallow trees is not a one-time job. You need to monitor your land every year to check for new plants.

*Professors and Extension Range Specialists, The Texas A&M University System

RECOMMENDED LEAF SPRAY HERBICIDE MIX OPTIONS*					
		Tank Size			
Ingredient	Concentration in Spray Solution	1 gal	3 gal	14 gal	25 gal
Picloram:2,4-D (1:4) herbicide	1%	1.28 oz	3.84 oz	18 oz	32 oz
Surfactant	0.25%	0.32 oz	1 oz	5 oz	8 oz
Hi-Light™ blue dye	0.25–0.5%	0.32–0.64 oz	1–2 oz	5–9 oz	8–16 oz

*All leaf spray solutions are mixed in water.

BRUSH BUSTERS STEM SPRAY METHOD

Works well on: Young seedlings or older trees with three or fewer basal stems. Multi-stemmed tallow tree plants are much more difficult to control than younger trees or undisturbed plants.

Research and demonstrations have shown excellent results while using minimum amounts of herbicide.

When to apply: Any time during the year, although the best results occur during the growing season.

1. Prepare the Equipment

Almost any type of pump-up hand sprayer can be used, but the most efficient way to apply the stem spray to many trees is with a backpack sprayer.

Make sure the sprayer nozzle has a small orifice. One such nozzle is the Conejet™ 5500-X1 (or X2). Compared to standard nozzles, this nozzle can reduce the amount of spray applied by 80 percent, making the use of chemicals much more cost-effective.

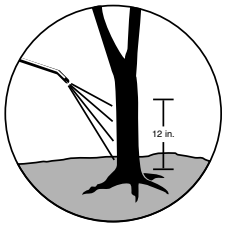
2. Prepare the Herbicide Spray

A mixture of triclopyr ester (trade names: Remedy Ultra, Clear Pasture, Triclopyr R&P, and Triclopyr 4EC) and diesel fuel oil is very effective for this method. Diesel acts as a coating agent to ensure good absorption. A basal bark (vegetable) oil may be used instead of diesel if desired.

The herbicide concentration will depend on Chinese tallow tree bark roughness. Pour the correct amount of herbicide into the mixing container, then add diesel fuel (or basal bark oil) to bring the mixture to the total volume desired. Agitate the mixture vigorously.

RECOMMENDED STEM SPRAY HERBICIDE MIXES				
	Tallow Tree Stem	Herbicide	Herbicide/ Gallon	Herbicide Carrier/Gallon
Option A	Smooth bark	Triclopyr ester, 15%	19 oz	109 oz diesel or basal bark oil
Option B	Rough bark	Triclopyr ester, 25%	32 oz	96 oz diesel or basal bark oil
Add to option A or B (optional)		Hi-Light™ blue dye	0.32–0.64 oz	

3. Spray the Chinese Tallow Trees



Adjust the sprayer nozzle to deliver a narrow, cone-shaped mist. Spray the mixture lightly but evenly on all the plant stems from the ground up to 12 inches. Apply the mixture to all sides of every stem, but do not wet to the point that it runs off the stem and puddles.

Keep These Points in Mind:

- Follow all label directions.
- The cost of treatment increases as plant density and the number of stems per plant increases. Download the Brush Busters Cost Calculator app to easily estimate treatment costs.
- Rough-bark tallow trees (usually older trees) are much harder to kill than smooth-bark plants.
- Multi-stemmed plants are more difficult to control with this method. It is best to use on plants with three or fewer stems.
- Do not spray when basal stems are wet.
- Dense grass around basal stems makes this method more difficult to apply.
- With triclopyr ester, use herbicides that contain 4 pounds per gallon of triclopyr acid equivalent (ae).

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HOW TO TAKE THE GREEN OUT OF GREENBRIAR:
Individual Plant Treatment Stem Application

Robert K. Lyons and Megan K. Clayton*

Greenbriar is a native, perennial, woody vine of the Smilax family. Individual plants may vary in leaf shape and color and in the number of spines they contain. Greenbriar may have underground stems and/or tubers. The canes or above-ground stems are soft and fleshy in the early stages of growth but quickly mature into stout, woody vines with tendrils for climbing trees, fences, and other structures.

The small, mostly yellowish-green flowers are borne in umbrella-shaped clusters from April through June and produce many small clusters of reddish to purplish to black berries.

Greenbriar, whether spined or spineless, often becomes a problem by forming large, almost impenetrable thickets that can prevent access by people and livestock.

There are no ground or aerial broadcast recommendations for effectively controlling greenbriar. Broadcast applications of various herbicides have not provided consistent control of this tough, woody vine. However, the following three-step method is easy to use, environmentally responsible, and effective. This method treats individual plants with a mixture of herbicide and diesel fuel oil or vegetable oil applied to basal stems.

This Brush Busters control method was developed and approved by professionals with Texas A&M AgriLife Extension Service and Texas A&M AgriLife Research, both agencies of the Texas A&M University System. Your results may vary, but you should usually be able to kill 76 to 100 percent of vines you treat.

Keep in mind that controlling greenbriar is not a one-time job. Greenbriar has hard-to-kill tubers and produces many seeds that will eventually produce new plants. Monitor your land regularly to control unwanted plants.

BRUSH BUSTERS STEM SPRAY METHOD

Works well on: Greenbriar growing on fence lines or where basal stems are easy to access for spraying.

When to apply: During winter, when most of the leaves are gone, and basal stems can be covered more easily with the spray mix.

1. Prepare the Equipment

Almost any type of pump-up hand sprayer can be used, but the most efficient way to apply the stem spray to many trees is with a backpack sprayer.

Make sure the sprayer's nozzle has a small orifice. One such nozzle is the Conejet™ 5500-X1 (or X2). Compared to standard nozzles, this nozzle can reduce the amount of spray applied by 80 percent, making the use of the chemicals much more cost-effective.

2. Mix the Herbicide Spray

A mixture of triclopyr ester (trade names: Remedy Ultra, Clear Pasture, Triclopyr R&P, and Triclopyr 4EC) and diesel fuel oil is very effective for this method. Diesel acts as a coating agent to ensure good absorption. A commercial basal bark (vegetable) oil carrier can be substituted for diesel if desired.

Recommended Herbicide Mix

Pour 25 percent triclopyr ester into the mixing container, then add diesel fuel to bring the mixture to the total volume desired. Agitate the mixture vigorously.

Ingredient	Concentration of Total Mix	Amount/ Gallon Mixed
Triclopyr ester herbicide	25%	32 oz
Diesel or basal bark oil	75%	96 oz
Hi-Light™ blue dye (optional)		0.32–0.64 oz

3. Spray the Greenbriar

Adjust the sprayer nozzle to deliver a narrow, cone-shaped mist.

Spray the mixture lightly but evenly on all plant stems from the ground level up to 12 inches. Apply the mixture to all sides of every stem, but do not wet it so much that it runs off the stem and puddles.

Keep These Points in Mind:

- Follow the herbicide label directions.
- The cost of treatment escalates rapidly as greenbriar becomes denser. Download the Brush Busters Cost Calculator app to easily estimate treatment costs.
- Do not spray when basal stems are wet.
- The best results occur during winter when more basal stems are exposed.
- After mixing herbicide with diesel fuel or basal bark oil, shake or agitate the solution.
- Controlling greenbriar is not a one-time job, and retreatment may be necessary.

*Professors and Extension Range Specialists, The Texas A&M University System

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HOW TO TAKE THE LUCK OUT OF CONTROLLING YUCCA

Individual Plant Treatment Whorl Applications

Robert K. Lyons and Megan K. Clayton*

Yucca infests about 19 million acres of Texas rangeland, mostly in the western two-thirds of the state. Some of the more than 30 yucca species in Texas are beneficial to livestock and wildlife. For example, deer and livestock relish the flowers and fruit of Spanish dagger yucca.

However, many species cause problems when they develop dense stands, consuming water and nutrients needed by more desirable plants. Examples of problem species include San Angelo yucca and twisted leaf yucca.

Yucca plants have one or more whorls of leaves growing from a common root crown. The leaves are long, straight, fibrous, sharply pointed, and covered with a thick wax.

Here are two Brush Busters whorl application methods to control yucca that are effective, easy to use, and environmentally responsible. One method uses a low-volume herbicide plus oil, while the other uses undiluted herbicide. These methods can enable you to remove the yucca without damaging desirable plants.

Controlling yucca is not a one-time job. Because livestock and wildlife spread the seeds, new plants will emerge continually. Check pastures periodically to control unwanted plants.

This Brush Busters control method was developed and approved by professionals with Texas A&M AgriLife Extension Service and Texas A&M AgriLife Research, both agencies of the Texas A&M University System. Your results may vary with weather, but you should usually be able to kill 76 to 100 percent of the plants you treat.

BRUSH BUSTERS HERBICIDE + OIL WHORL SPRAY

Works well: For controlling yucca and honey mesquite at the same time with the same treatment. Mesquite stem diameter must be less than 1.5 inches.

When to apply: Spring or summer during the growing season.

1. Prepare the Equipment

Almost any type of pump-up hand sprayer can be used, but the most efficient way to apply the spray to many plants is with a backpack sprayer.

Make sure the sprayer's nozzle has a small orifice. One such nozzle is the ConeJet™ 5500-X1 (or X2). Compared to standard nozzles, this nozzle can reduce the amount of spray applied by 80 percent, making the use of chemicals much more cost-effective.

2. Mix the Herbicide Spray

Use a mixture of triclopyr ester (trade names: Remedy Ultra, Clear Pasture, and Triclopyr 4EC) and diesel fuel oil or basal oil. Diesel acts as a coating agent to ensure that the herbicide covers the plant and is absorbed well.

Pour the required amount of triclopyr ester into the mixing container, then add enough oil to get the total desired volume. To identify plants already treated, add Hi-Light™ blue dye (0.25 to 0.5 percent). Shake vigorously until mixed thoroughly.

RECOMMENDED STEM SPRAY HERBICIDE MIX OPTIONS

Ingredient	Concentration in Spray Solution	Tank Size		
		1 gal	5 gal	10 gal
Remedy Ultra, Clear Pasture, Triclopyr 4EC	15%	19 oz	95 oz	1.5 gal
Diesel or Basal oil	85%	109 oz	4.25 gal	8.5 gal
Hi-Light™ blue dye (optional)	0.25–0.5%	0.32–0.64 oz	1.6–3.2 oz	3.2–6.4 oz

3. Spray the Yucca

Position the nozzle in the center of each whorl and spray for at least 2 seconds.

Keep These Points in Mind:

- If applied properly, the triclopyr ester + oil method is the least expensive method for controlling yucca. The cost rises if basal oil is used instead of diesel.
- Follow the herbicide label directions.
- Do not spray wet yuccas.

*Professors and Extension Range Specialists, The Texas A&M University System

BRUSH BUSTERS UNDILUTED WHORL SPRAY

Works well: For controlling only a few yucca plants or if applicator does not have a pump-up hand/backpack sprayer with the proper nozzle as used in the "Herbicide + Oil Whorl Spray" method.

When to apply: Spring or summer during the growing season.

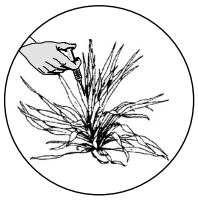
1. Prepare the Equipment

Use an application device that can measure and deliver individual 2 cc to 4 cc (milliliters) doses of herbicide. To treat a few yucca plants, you may use a disposable syringe.

When treating many plants, use an automatic syringe or exact-delivery handgun, such as a drench gun. Because these two devices connect to a reservoir (such as a drench bladder or herbicide container), you do not have to refill them manually.

Triclopyr ester, the active ingredient in herbicides for this method, corrodes plastics. After each use, thoroughly clean the syringe or drench gun with warm, soapy water and lubricate it with mineral oil.

2. Spray the Yucca



Apply undiluted triclopyr ester (trade names: Remedy Ultra, Clear Pasture, and Triclopyr 4EC) into the center of each whorl. Control at the 2-cc rate may drop 10 percent or more compared to the 4-cc rate.

Keep These Points in Mind:

- Follow directions on the herbicide label.
- Do not spray wet yuccas.
- Do not use premixed or ready-to-use triclopyr herbicides for this method.
- Clean application equipment thoroughly after each use.

RWFM-PU-375 11/2021

HOW TO TAME TEXAS PERSIMMON

Individual Plant Treatment Leaf and Stem Applications

Robert K. Lyons and Megan K. Clayton*

Texas persimmon is a common plant on rangeland and pastures in Central Texas, Edwards Plateau, Post Oak Savannah, South Texas Plains, and the Coastal Prairie. It is a deterrent to effective range management in some areas where densities become high.

Here are two three-step methods to control Texas persimmon that are easy, inexpensive, and environmentally responsible. They involve spraying a small but potent concentration of herbicide directly on each plant. Using these Brush Busters methods, you can selectively control unwanted Texas persimmon. Remember, controlling Texas persimmon is not a one-time job, so monitor your land regularly to control unwanted seedlings.

These Brush Busters control methods were developed and approved by professionals with Texas A&M AgriLife Extension Service and Texas A&M AgriLife Research, both agencies of the Texas A&M University System. Your results may vary with weather and other plant conditions, but you should usually be able to kill 76 to 100 percent of the trees you treat.

Additionally, these methods depend on the tree shape and size. For Texas persimmon with three or fewer well-defined, smooth-bark stems coming out of the ground, the stem spray method may be a good option. For bushy Texas persimmon less than 6 feet tall with many stems at ground level, the leaf spray method may be the best option. Either method can be successful.

BRUSH BUSTERS LEAF SPRAY METHOD

Works well on: Texas persimmon plants that have good leaf canopy and are less than 6 feet tall. This method is also known as high-volume foliar spraying.

When to apply: Begin in spring when leaves are mature. Most consistent results have been obtained before July 1st. Stop spraying if leaves fall off when the limbs are shaken. Good soil moisture and healthy leaves are necessary for improved plant kill.

1. Prepare the Equipment

Many types of sprayers work well for this method. Backpack sprayers are the most efficient for small acreages with a high density of Texas persimmon trees. Larger places with lower densities may find ATV or UTV sprayers more efficient. Before you start spraying, make sure you have an adjustable cone nozzle, such as the ConeJet™ 5500-X6 or X8 nozzle that can deliver a coarse spray with larger droplets to the top of a 6-foot tree.

2. Mix the Herbicide Spray

You can achieve 76 to 100 percent mortality by spraying with 2 percent Invora herbicide under ideal conditions. To prepare the spray mix, add the appropriate amount of Invora herbicide to water. To make sure the foliage is coated thoroughly, add a high-quality (80 to 90 percent active ingredient) non-ionic surfactant (see the table on next page) to the spray mix or MSO-OS (organo-silicone) adjuvant at manufacturer specified rates. Add a dye, such as Hi-Light™ blue dye, to mark the plants that have been sprayed and ensure proper coverage.

3. Spray the Texas Persimmon

Adjust the nozzle to deliver a coarse spray in a wide pattern. Wet ALL the leaves of each Texas persimmon plant until the leaves glisten but not to the point of dripping.

Keep These Points in Mind:

- Follow the herbicide label directions.
- For best results, do not spray when:
  - Rains have stimulated new growth at the end of the stems
  - Leaves are wet from rain or dew
  - Foliage shows damage from hail, insects, or disease
  - Working upwind of desirable trees, shrubs, or crops
- The cost of treatment rises rapidly as brush becomes bigger and denser. Download the Brush Busters Cost Calculator app to easily estimate treatment costs.
- Controlling Texas persimmon is not a one-time job. You will need to monitor your land every year to check for new plants.

*Professors and Extension Range Specialists, The Texas A&M University System

RECOMMENDED LEAF SPRAY HERBICIDE MIX OPTIONS*					
Ingredient	Concentration in Spray Solution	Tank Size			
		1 gal	3 gal	14 gal	25 gal
Invora**	2%	2.56 oz	8 oz	36 oz	64 oz
Non-ionic surfactant	0.25%	0.32 oz	1 oz	4.5 oz	8 oz
Hi-Light™ blue dye	0.25–0.5%	0.32–0.64 oz	1–2 oz	4.5–9 oz	8–16 oz

*All spray solutions are mixed in water.
**Invora is labeled for privately owned rangeland only (*excludes hayfields*) and requires Picolinic Acid Chemistry Training for all applicators.

BRUSH BUSTERS STEM SPRAY METHOD

Works well: For controlling young seedlings or older trees with three or fewer basal stems. Stems should be no larger than 4 inches in diameter. Multi-stemmed Texas persimmon plants are much more difficult to control than younger trees or undisturbed plants.

This method is known as the low-volume, basal-stem treatment technique. Research and demonstrations have shown excellent results using minimum amounts of herbicide.

When to apply: After leaves are mature and before June 15th.

1. Prepare the Equipment

Almost any type of pump-up hand sprayer can be used, but the most efficient way to apply the stem spray to many trees is with a backpack sprayer.

Make sure the sprayer's nozzle has a small orifice. One such nozzle is the ConeJet™ 5500-X1 (or X2). Compared to standard nozzles, this nozzle can reduce the amount of spray applied by 80 percent, making the use of chemicals much more cost-effective.

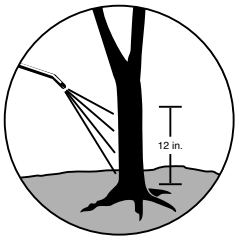
2. Mix the Herbicide Spray

A mixture of triclopyr ester (trade names: Remedy Ultra, Clear Pasture, Triclopyr R&P, and Triclopyr 4EC) and diesel fuel oil is very effective for this method. Diesel acts as a coating agent to ensure that the herbicide covers the plant and is absorbed well.

Pour the required amount of triclopyr ester into the mixing container, then add diesel fuel to bring the mixture to the total volume desired. To identify plants already treated, add Hi-Light™ blue dye (0.25 to 0.5 percent). Agitate the mixture vigorously to ensure thorough mixing.

RECOMMENDED STEM SPRAY HERBICIDE MIXES				
Ingredient	Concentration in Spray Solution	Tank Size		
		1 gal	5 gal	10 gal
Remedy Ultra, Clear Pasture, Triclopyr 4EC	25%	32 oz	1.25 gal	2.5 gal
Diesel or Basal oil	75%	96 oz	3.75 gal	7.5 gal
Hi-Light™ blue dye (optional)	0.25–0.5%	0.32–0.64 oz	1.6–3.2 oz	3.2–6.4 oz

3. Spray the Texas Persimmon



Adjust the sprayer nozzle to deliver a narrow, cone-shaped mist. Spray the mixture lightly but evenly on all the plant stems from the ground line up to 12 inches. Apply the mixture to all sides of every stem, but do not wet it so much that it runs off the stem and puddles.

Keep These Points in Mind:

- Follow the herbicide label directions.
- The cost of treatment increases as plant density and the number of stems per plant increases. Download the Brush Busters Cost Calculator app to easily estimate treatment costs.
- Multiple-stemmed plants or rough-barked Texas persimmon trees are more difficult to control with this method.
- Do not spray when the basal stems are wet.
- Dense grass around basal stems makes this method more difficult to apply.
- Use triclopyr ester herbicides that contain 4 pounds per gallon of triclopyr ester acid equivalent (ae).

TEXAS A&M AGRILIFE EXTENSION

ESC-046 9/20

QUICK REFERENCE FOR COMMON RANGELAND AND PASTURE HERBICIDES

Joshua McGinty, Vanessa Corriher-Olson, Megan Clayton, and Robert Lyons*

ACTIVE INGREDIENT(S)	TRADE NAME(S)	GRAZING RESTRICTIONS	HAY HARVEST RESTRICTIONS	RAINFAST INTERVAL	PESTICIDE APPLICATOR LICENSE REQUIRED?
2,4-D + aminopyralid	GrazonNext HL	None[1]	7 days[2,3,4]	2 hours	Yes
2,4-D + aminopyralid	PasturAll HL	None[1]	7 days[2,3,4]	2 to 4 hours[5]	Yes
2,4-D + dicamba	Weedmaster, Range Star, Outlaw, Latigo	None, except for lactating animals (7 days)	7 days	4 hours	Yes
2,4-D + picloram	Graslan L, Grazon P+D, Gunslinger	None, except for lactating dairy animals (7 days)	30 days	2 to 4 hours[5]	Yes
2,4-D + triclopyr	Crossbow, Everett	None, except for lactating dairy animals (next growing season)	None, unless feeding to lactating dairy animals (14 days)	6 hours[5]	Yes
2-4-D	2,4-D Amine 4 (several)	0 to 7 days (varies by manufacturer)	7 days	6 hours	Yes
2-4-D	2,4-D LV4 (several)	0 to 7 days (varies by manufacturer)	7 to 30 days (varies by manufacturer)	1 hour	Yes
2-4-D	2,4-D LV6 (several)	0 to 7 days (varies by manufacturer)	7 days	1 hour	Yes
Aminocyclopyrachlor + triclopyr	Invora	None[1]	Not labeled for hay production	1 hour	Yes[7]
Aminopyralid	Milestone	None[1]	None[2,3,4]	2 to 4 hours[5]	No
Aminopyralid + clopyralid	Sendero	None[1]	None[2,3,4]	4 hours[5]	No
Aminopyralid + florpyrauxifen-benzyl	DuraCor	None[1]	14 days to allow maximum herbicide activity[2,3,4]	2 hours	No
Aminopyralid + metsulfuron-methyl	Chaparral/Opensight	None[1]	None[2,3,4]	2 to 4 hours[5]	No
Aminopyralid + picloram + fluroxypyr	MezaVue	None[1], except for lactating dairy animals (14 days)	7 days to allow maximum herbicide activity[2,3,4]	4 hours[5]	Yes
Clopyralid	Clean Slate, Clopyralid 3, Pyramid	None	None	2 hours	No
Dicamba (DGA salt)	Clarity	7 days (1 pt/A), 21 days (2 pt/A), 40 days (4 pt/A)	37 days (1 pt/A), 51 days (2 pt/A), 70 days (4 pt/A)	4 hours	Yes
Dicamba (DMA salt)	Banvel	0 days	7 days	4 to 6 hours[5]	Yes
Dicamba + halosulfuron-methyl	Yukon	None	37 days	3 hours	Yes
Glyphosate	Glyphosate products (several)	0 to 8 weeks (varies by manufacturer)	0 to 8 weeks (varies by manufacturer)	4 to 6 hours	No
Hexazinone	Pronone Power Pellet	None (<600 pellets/A), 60 days (600 to 5,000 pellets/A), 1 year (>5,000 pellets/A)	None (<600 pellets/A), 60 days (600 to 5,000 pellets/A), 1 year (>5,000 pellets/A)	None	No

continued on next page

*Assistant Professor and Extension Agronomist, Associate Professor and Extension Forage Specialist, Associate Professor and Extension Range Specialist, and Professor and Extension Range Specialist

ACTIVE INGREDIENT(S)	TRADE NAME(S)	GRAZING RESTRICTIONS	HAY HARVEST RESTRICTIONS	RAINFAST INTERVAL	PESTICIDE APPLICATOR LICENSE REQUIRED?
Hexazinone	Velpar L VU	None, unless applying more than 4.5 pt/A (60 days)	38 days, unless applying more than 4.5 pt/A (60 days)	24 hours if soil is saturated	No
Imazapic	Plateau, Impose	None specified	7 days	1 hour	No
Imazapyr	Arsenal, Habitat, Imazapyr 2 SL	None	7 days	1 hour	No
Metsulfuron-methyl	Escort XP, Patriot, MSM 60	None	None	4 hours	No
Metsulfuron-methyl + 2,4-D + dicamba	Cimarron Max	None, except for lactating dairy animals (7 days)	37 days	4 hours	Yes
Metsulfuron-methyl + chlorsulfuron	Cimarron Plus	None	None	4 hours	No
Nicosulfuron + metsulfuron-methyl	Pastora	None	None	4 hours	No
Pendimethalin	Prowl H2O	None[6]	None[6]	None	No
Picloram	Tordon 22K, Triumph 22K, Picloram 22K	None, except for lactating dairy animals (14 days)	None, unless applying more than 1.0 qt/A (14 days)	2 hours[5]	Yes
Picloram + fluroxypyr	Surmount	None, except for lactating dairy animals (14 days)	None, unless feeding to lactating dairy animals (14 days)	4 hours[5]	Yes
Saflufenacil	Sharpen	None	None	1 hour	No
Sulfosulfuron	Outrider	None	Allow 2 weeks for best results	2 hours	No
Tebuthiuron	Spike 20P, Tebuthiuron 20P, Tebuthiuron 80WG	None	1 year	None	No
Triclopyr	Remedy Ultra, Pathfinder II, Triclopyr 4E	None, except for lactating dairy animals (next growing season)	14 days	6 hours[5]	No
Triclopyr + clopyralid	Prescott	None, except for lactating dairy animals (next growing season)	14 days, unless feeding to lactating dairy animals (next growing season)	2 hours	No
Triclopyr + fluroxypyr	PastureGard HL	None, except for lactating dairy animals (next growing season)	14 days	6 hours[5]	No

[1]Manure and urine from animals consuming grass or hay treated with this product may contain enough herbicide to cause injury to susceptible broadleaf plants.
[2]Hay from areas treated within the preceding 18 months can only be used on the farm or ranch where the product was applied unless allowed by supplemental labeling.
[3]Hay from areas treated within the preceding 18 months cannot be used for silage, haylage, baylage, and green chop unless allowed by supplemental labeling.
[4]Do not use hay or straw from areas treated within the preceding 18 months or manure from animals feeding on treated hay in compost.
[5]This is a general recommendation; rainfast interval is not specified on product label.
[6]According to supplemental label NVA 2016-04-195-0015.
[7]Picolinic acid chemistry training is required every 2 years.

TEXAS A&M AGRILIFE EXTENSION

ERM-1466
5/20

CHEMICAL WEED AND BRUSH CONTROL

REFERENCE GUIDE FOR RANGELAND




Chemical Weed and Brush Control

Reference Guide for Rangeland

*Robert K. Lyons, Megan Clayton, Larry Redmon, Barron Rector, Steven Evans, and Charles Kneuper**

This publication provides general suggestions for herbicides used to control brush and weeds on Texas rangelands. It also gives information on the levels of control expected. The information is presented in good faith, but no warranty, express or implied, is given. Weed and brush control results may vary tremendously if treatments are applied under less than optimum conditions.

Users of this publication may find the decision support system for rangeland weed and brush control technology selection—PestMan—helpful. PestMan is designed to recommend appropriate mechanical and chemical rangeland brush and weed control treatments for Texas and New Mexico. All herbicide treatments included in this publication are also included in PestMan, which helps in estimating costs and the economic impact of various treatment options.

How to use this guide

1. Find your problem weed or brush species in the Index on page 3.
2. Click on or touch the page number that corresponds to the plant to go to the page where it is listed; find the plant name in the first column on those pages.
3. See the second column on those pages for a list of suggested herbicides (these are active ingredients).
4. Choose herbicides based on:
   a. Whether you would like to make a broadcast application or treat individual plants (third or fourth column).
   b. Check the effectiveness (VH, H, M, and L), which tells you the percentage of plants you should expect to kill with that herbicide and rate. For percent kill ranges, see page 4.
   c. See the fifth column for the method to use—how to apply the chemical. This could be foliar, stem, cut-stump, aerial, etc.
5. The three columns on the right explain other details such as how much surfactant to use, when to treat the plant, and any exceptions. Be sure to read these before choosing an herbicide.
6. Go to page 5 and match the herbicide you chose for controlling the problem plant with product names you are more likely to know.
7. For tips on measuring and mixing herbicides, see page 6.

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Index

Control descriptions for weed and brush plants are located on the page numbers indicated. Carefully check the table. More than one control measure may exist.

Millions of acres of Texas rangeland support an excessive cover of woody plants and forbs. Dense stands of brush and weeds use valuable water for growth, reduce grass production, and cause soil erosion. Herbicides are an efficient and effective way to manage these noxious plants, control brush and weeds, improve the condition of rangeland, and maintain its productivity.

This publication lists current suggestions for herbicide use to control brush and weeds on rangeland. Some herbicides provide a high degree of control of certain species; however, seldom is a species eradicated. Consider other potential rangeland uses when developing a brush management program. Many trees, shrubs, and forbs are valuable as food and cover for wildlife and may be an important component in livestock diets. Therefore, a brush management program should provide for control methods that give optimum benefits to livestock and wildlife.

Herbicide application may increase the palatability of poisonous plants. Thus, they are more likely to be consumed by livestock. To prevent losses to toxic plants, do not graze herbicide-treated areas with poisonous plants present until the toxic plants dry up and lose their palatability.

Properly used herbicides are effective and safe. Misuse can result in poor brush and weed control, herbicidal drift, dangerous residues, or death of desirable plants. Listed below are points to follow for proper herbicide use:

- Identify the weed or brush species and evaluate the need for control.
- Consider the expected benefits, costs, and alternative control practices.
- Buy the suggested herbicide for the weed or brush species.
- Read and follow herbicide label directions for allowable uses, application rates, and special handling or mixing requirements.
- Provide and require the use of proper safety equipment.
- Calibrate spray equipment.
- Mix herbicides in a ventilated area, preferably outside.
- Spray under conditions that prevent drift to susceptible crops.
- Apply the herbicides at the suggested rate and time.
- Keep a record of the herbicide used, the time required to spray, weather conditions, rate of herbicide in the carrier, date, location, and the person using the herbicide.

The sprayer used must apply the correct quantity of herbicide mixture to a specific area. To calibrate spray equipment, see Extension publication EL-5465, *Weed Busters: Sprayer Calibration Guide*.

Suggestions on the use of herbicides made by the Texas A&M AgriLife Extension Service are based upon effectiveness under Texas conditions.

Broadcast and individual plant treatments are presented in Tables 6 and 7. Individual plant treatments are suited for controlling thin stands of brush and selective control. Broadcast treatments are useful for dense stands of brush and for weed control.

Suggested herbicides must be registered with and the labels approved by the Environmental Protection Agency. *Because the status of herbicide label clearance is subject to change, be certain that the herbicide is currently labeled for the intended use.*

The users are always responsible for the effects of herbicide residue on their livestock and crops, as well as for problems that could arise from drift or movement of the herbicide from their property to that of others. *Always read and carefully follow the instructions on the container label.*

Treatment control ratings

A control rating, based on the effectiveness of an herbicide treatment in controlling a target plant, has been assigned to each herbicide use suggestion. These ratings were determined from research and result demonstration data and from observations of commercial applications. The rating represents a degree of plant mortality of the target plant species when the treatment is applied properly under optimum conditions.

Table 1. Rating categories for herbicide treatments and degree of target plant mortality after treatment

Control rating	Percent of plants killed
Very high	76–100
High	56–75
Moderate	36–55
Low	0–35

Table 2. Common, chemical, and product names of herbicides*

Herbicide common name	Chemical name	Product name	Active ingredient or acid equivalent
aminocyclopryachlor:triclopyr amine (1:2)	6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylic acid, potassium salt See triclopyr amine	Invora	2 lb/gal
aminopyralid	2-pyridine carboxylic acid, 4-amino-3, 6-dichloro-2-pyrdine carboxylic acid, triisopropanolammonium salt	—	—
aminopyralid:2,4-D (1:8)	See aminopyralid and 2,4-D	GrazonNext HL	3.75 lb/gal
aminopyralid:clopyralid (1:4.6)	See aminopyralid and clopyralid	Sendero	2.8 lb/gal
aminopyralid:metsulfuron methyl (1:6.2)	See aminopyralid and metsulfuron	Chaparral	0.62 lb/gal
aminopryralid:picloram:fluroxypyr (1:2:2)	See aminopyralid, picloram, and fluroxypyr	MezaVue	2 lb/gal
clopyralid	3,6-dichloro-2-pyridinecarboxylic acid	Pyramid R&P, Sonora	3 lb/gal
2,4-D	(2,4-dichlorophenoxy) acetic acid	Weedar 64, Broad Range 55, Hi-Dep, Weedone LV4, Esteron 99, Unison, others	amine salts, free acids, and esters of variable concentration
dicamba	3,6-dichloro-2-methoxybenzoic acid	Banvel, Clarity, Vision	4 lb/gal
dicamba:2,4-D (1:3)	See dicamba and 2,4-D	Weedmaster, Banvel + 2,4-D, RangeStar, Outlaw	4 lb/gal
dicamba:2,4-D (1:1.3)	See dicamba and 2,4-D	Latigo	4 lb/gal
diesel fuel oil or kerosene	refined petroleum fractions	Several manufacturers	—
fluroxypyr	1-methylheptyl ester: ((4-amino-3,5-dichloro-6-fluoropyridin-2-yl)oxy)acetic acid	Vista XRT	2.8 lb/gal
glyphosate	N-(phosphonomethyl) glycine	Several, including Rodeo**, Roundup, Roundup Ultradry, Glyphosate 417	isopropylamine salt; concentration varies depending on the product
hexazinone	3-cyclohexyl-6-(dimethylamino)-1-methyl-1,3,5-triazine-2,4(IH, 3H)-dione	Velpar L, Pronone Power Pellet	2 lb/gal (Velpar L) 75% (Pronone Power Pellet)
imazapyr	2-[4,5-dihydro-4-methyl-4-(1-methylethy)-5-oxo-lH-imidazol-2-yl]-3-pyridinecarboxylic acid	Arsenal, Habitat**	2 lb/gal
metsulfuron methyl	methyl 2[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]amino] sulfonyl] benzoate	Escort, Clean Pasture, MSM 60DF	60%
metsulfuron:chlorosulfuron (3:1)	See metsulfuron methyl + 2-chloro-N-[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)aminocarbonyl] benzenesulfonamide	Cimarron Plus	48% metsulfuron 15% chlorosulfuron
metsulfuron:chlorosulfuron (1:1)	See metsulfuron: chlorosulfuron	Cimarron X-Tra	30% metsulfuron 37.5% chlorosulfuron
metsulfuron methyl dicamba:2,4-D (1:3)	See metsulfuron methyl, dicamba, and 2,4-D	Cimarron Max	60% (Part A) 3.87 lb/gal (Part B)
picloram	4-amino-3,5,6-trichloro-2-pyridinecarboxylic acid	Tordon 22K, Triumph 22K, Picloram 22K	2 lb/gal
picloram:fluroxypyr (1:1)	See picloram and fluroxypyr	Surmount	1.34 lb/gal
picloram:2,4-D (1:4)	See picloram and 2,4-D	Grazon P+D, Gunslinger, Picloram + D	2.5 lb/gal
picloram:2,4-D (1:4)	See picloram and 2,4-D	Graslan L	3.8 lb/gal
tebuthiuron	N-[5-(1,1-dimethylethy)-1,3,4-thiadiazol-2-yl}-N-N'-dimethylurea	Spike 20P, Spike 80 DF	20% (Spike 20P) 80% (Spike 80 DF)
triclopyr amine	3,5,6-trichloro-2-pyridinyloxyacetic acid, triethylamine salt	Garlon 3A	3 lb/gal
triclopyr ester	3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester	Clear Pasture, Pathfinder II, Triclopyr R&P, Remedy Ultra, Triclopyr 4 EC	0.75 lb/gal (Pathfinder II–ready-to-use formulation for stem sprays) 4 lb/gal (all others)
triclopyr:fluroxypr (3:1)	See triclopyr and fluroxypyr	PastureGard HL	4 lb/gal
triclopyr:2,4-D (1:2)	See triclopyr and 2,4-D	Crossbow	3 lb/gal

*Herbicides have been identified by the accepted Weed Science Society of America common name, and when practical, one or more product names.
**Aquatic label

Table 3. Common measurement conversions for use with herbicide applications

Liquid

1 gallon (gal) = 4 quarts (qt)
1 gal = 8 pints (pt)
1 gal = 16 cups (c)
1 gal = 128 ounces (oz)
1 gal = 3784.96 milliliters (ml)
1 quart (qt) = 2 pt
1 qt = 4 c
1 qt = 32 oz
1 qt = 946.24 ml
1 pint (pt) = 2 c
1 pt = 16 oz
1 pt = 473.12 ml
1 c = 8 oz
1 oz = 2 tablespoons (tbs)
1 oz =29.57 ml
1 tablespoon (tbs) = 3 teaspoons (tsp)
1 tbs = 0.5 oz
1 tbs = 14.79 ml
1 teaspoon (tsp) = 4.98 ml

Weight

1 pound (lb) = 16 oz
1 lb = 453.6 grams (g)
1 oz = 28.35 g
1 kilogram (kg) = 2.2 lb

Area

1 acre = 43,560 square feet (sq ft)
1 hectare (ha) = 2.471 acres

Table 4. Guide to quantity of herbicide formulation for total volume of spray mix

Total spray volume desired	Herbicide concentration desired for individual plant and spot treatment											
	0.25%	0.5%	0.75%	1%*	1.5%	2%	3%	4%	5%	10%	15%	25%
	Quantity of herbicide formulation											
1 gal	0.32 oz	0.64 oz	1 oz	1.28 oz	2 oz	2.56 oz	4 oz	5.12 oz	6.4 oz	12.8 oz	19 oz	1 qt
3 gal*	1 oz	2 oz	3 oz	4 oz*	6 oz	8 oz	12 oz	15.5 oz	19 oz	38 oz	57 oz	96 oz
5 gal	1.67 oz	3.33 oz	5 oz	6.5 oz	10 oz	13 oz	19 oz	26 oz	32 oz	64 oz	96 oz	1.25 gal
10 gal	3.33 oz	6.5 oz	10 oz	13 oz	19 oz	26 oz	38 oz	51 oz	2 qt	1 gal	1.5 gal	2.5 gal
25 gal	8 oz	16 oz	24 oz	32 oz	48 oz	64 oz	96 oz	1 gal	1.25 gal	2.5 gal	3.75 gal	6.25 gal
50 gal	16 oz	32 oz	48 oz	64 oz	96 oz	1 gal	1.5 gal	2 gal	2.5 gal	5 gal	7.5 gal	12.5 gal
100 gal	32 oz	64 oz	96 oz	1 gal	1.5 gal	2 gal	3 gal	4 gal	5 gal	10 gal	15 gal	25 gal

*Example: To prepare 3 gal of a spray mixture (herbicide, water, and surfactant) containing 1% herbicide, add 4 oz of herbicide.

Note: Add 0.25%–0.5% commercial, non-ionic surfactant or crop oil, or methylated seed oil according to product label for mixtures using only water as the herbicide carrier.

Table 5. Herbicides for controlling weeds on rangeland

Weed controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant/ spot treatment*			
African rue	hexazinone liquid	—	VH** 2 ml/plant	Use an exact delivery handgun to apply undiluted herbicide to soil surface at the edge of the plant canopy.	Spring–summer	Do not use on heavy clay or caliche soils.
	hexazinone pellet	—	1 pellet/plant	—		
	tebuthiuron 20% pellets	H 7.5 lb (1.5 lb)	—	—		
	imazapyr	H 32 oz (0.5 lb)	VH 0.5%	10–25 gal/ac for ground broadcast. Thoroughly wet foliage for individual plant treatment. Add 32–64 oz surfactant/100 gal water.	Late Sept–Oct (to first frost)	Apply to fall regrowth that is in good growing condition. Recommend using individual plant treatment when growing with desirable vegetation to reduce non-target damage. Imazapyr is a non-selective herbicide and will kill or damage desirable vegetation if sprayed.
Berlander lobelia, bitter sneezeweed, buffalobur, camphorweed, cocklebur, croton, horehound, marshelder (sumpweed, sulfaweed), prairie gerardia (see remarks), ragweed, smartweed, sunflower, thistles, western bitterweed (see remarks), western ragweed, others *(continued on next page)*	2,4-D amine or low volatile ester	VH** 16–32 oz (0.5–1 lb) 4 lb/gal product	VH 1% (4 lb/gal product)	2–4 gal water for aerial spray; 10–25 gal water for ground broadcast application. Thoroughly wet foliage for individual plant treatment. Add 32–64 oz surfactant/100 gal water.	Spring, weeds 4–6 in. high, good moisture conditions. Spray thistles in rosette stage.	With 2,4-D, use the amine formulation in areas with 25 in. of rainfall or more and the ester formulation in drier areas where no susceptible crops are nearby. **For western bitterweed control,** use 2,4-D low volatile ester or amine at 32 oz/ac before plants flower, temperature above 72° F, and soil moisture favors plant growth. When ¾ of plants are blooming, and/or temperature is less than 60°F, use dicamba:2,4-D (1:3), 2,4-D plus dicamba; picloram:2,4-D (1:4), (3.8 lb/gal product), picloram:2,4-D (1:4), (2.5 lb/gal product), aminopyralid:2,4-D (1:8) or 2,4-D plus picloram. **For prairie gerardia control,** use 48 oz/acre of 2,4-D or the low rate of dicamba:2,4-D (1:3), dicamba plus 2,4-D; picloram:2,4-D (1:4), (3.8 lb/gal product), picloram:2,4-D (1:4), (2.5 lb/ gal product) or picloram plus 2,4-D when plants are 4–6 in. high. Use 20 oz/acre of picloram:2,4-D (1:4), (3.8 lb/gal product; Do not apply more than 80 oz/acre per year), 32 oz/acre of picloram:2,4-D (1:4), (2.5 lb/ gal product) or 8 oz of 2,4-D/acre when plants are 6–10 in. high before flowering.
	dicamba:2,4-D (1:3)	VH 16–32 oz (0.5–1 lb)	VH 1%			
	dicamba:2,4-D (1:1.3) + 2,4-D amine or low volatile ester	VH 9–22 oz (0.28–0.69 lb) dicamba:2,4-D (1:1.3) + 14–32 oz (0.44–1 lb) 2, 4-D (4 lb/gal product)	—			
	dicamba + 2,4-D amine or low volatile ester	VH 4–8 oz (0.125–0.75 lb) dicamba + 12–24 oz (0.375–0.75 lb) 2, 4-D (4 lb/gal product)	VH 0.25% dicamba + 0.75 % 2,4-D (4 lb/gal product)			
	picloram:2,4-D (1:4), (3.8 lb/gal product)	VH 11–16 oz (0.3–0.5 lb)	VH 0.63%			
	picloram:2,4-D (1:4), (2.5 lb/gal product)	VH 16–24 oz (0.3–0.5 lb)	VH 1%			
	picloram + 2,4-D amine or low volatile ester	VH 8–24 oz (0.0625–0.1875 lb) picloram + 8–24 oz (0.25–0.75 lb) 2,4-D (4 lb/gal product)	VH 0.25% picloram + 0.5% 2,4-D (4 lb/gal product)			

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Weed controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant/ spot treatment*			
Berlander lobelia, bitter sneezeweed, buffalobur, camphorweed, cocklebur, croton, horehound, marshelder (sumpweed, sulfaweed), prairie gerardia (see remarks), ragweed, smartweed, sunflower, thistles, western bitterweed (see remarks), western ragweed, others *(continued from previous page)*	metsulfuron methyl dicamba:2,4-D (1:3)	VH Rate 1–Rate 2	—	2–4 gal water for aerial spray; 10–25 gal water for ground broadcast application. Thoroughly wet foliage for individual plant treatment. Add 32–64 oz surfactant/100 gal water.	Spring, weeds 4–6 in. high, good moisture conditions. Spray thistles in rosette stage.	Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
	picloram:fluroxypyr (1:1)	VH 24–32 oz (0.25–0.33 lb)	VH 1%			Use high end of rate range for camphorweed, marshelder, and smartweed.
	triclopyr:fluroxypr (3:1)	H 16–24 oz (0.5–0.75 lb)	VH 0.5%			Use high end of rate range for camphorweed, marshelder, and smartweed. Triclopyr:fluroxypr (3:1) efficacy on smartweed is marginal.
	aminopyralid:2,4-D (1:8)	VH 24 oz (0.70 lb)	—			—
	aminopyralid:metsulfuron methyl (1:6.2)	VH 2.0–3.3 oz (0.078–0.127 lb)	—			Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
Broomweed (annual or common), plantain (tallowweed), wild carrot *(continued on next page)*	2,4-D amine or low volatile ester	VH** 16–32 oz (0.5–1 lb) 4 lb/gal product	VH 1% (4 lb/gal product)	2–4 gal water for aerial spray; 10–25 gal water for ground broadcast application. Thoroughly wet foliage for individual plant treatment. Add 32–64 oz surfactant/100 gal water.	Spring, weeds less than 4 in. tall, good moisture conditions.	Use 2,4-D amine in areas with 25 in. of rainfall or more. Use 2,4-D low volatile ester in drier areas where no susceptible crops are nearby. Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year.
	aminopyralid:2,4-D (1:8)	VH 24 oz (0.70 lb)	—			
	aminopyralid:metsulfuron methyl (1:6.2)	VH 2.0-3.3 oz (0.078–0.127 lb)	—			
	dicamba:2,4-D (1:3)	VH 16–32 oz (0.5–1 lb)	VH 1%			
	dicamba:2,4-D (1:1.3) + 2,4-D amine or low volatile ester	VH 9–22 oz (0.28–0.69 lb) dicamba:2,4-D (1:1.3) + 14–32 oz (0.44–1 lb) 2, 4-D (4 lb/gal product)	—			
	dicamba + 2,4-D amine or low volatile ester	VH 4–8 oz (0.125–0.25 lb) dicamba + 12–24 oz (0.375–0.75 lb) 2,4-D (4 lb/gal product)	VH 0.25% dicamba + 0.75% 2,4-D (4 lb/gal product)			
	picloram:2,4-D (1:4), (3.8 lb/gal product)	VH 11–16 oz (0.3–0.5 lb)	VH 0.63%			
	picloram:2,4-D (1:4), (2.5 lb/gal product)	VH 16–24 oz (0.3–0.5 lb)	VH 1%			

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Weed controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant/ spot treatment*			
Broomweed (annual or common), plantain (tallowweed), wild carrot *(continued from previous page)*	picloram + 2,4-D amine or low volatile ester	VH 8–24 oz (0.0625–0.1875 lb) picloram + 8–24 oz (0.25–0.75 lb) 2,4-D (4 lb/gal product)	VH 0.25% picloram + 0.5% 2,4-D (4 lb/gal product)	2–4 gal water for aerial spray; 10–25 gal water for ground broadcast application. Thoroughly wet foliage for individual plant treatment. Add 32–64 oz surfactant/100 gal water.	Spring, weeds less than 4 in. tall, good moisture conditions.	Use 2,4-D amine in areas with 25 in. of rainfall or more. Use 2,4-D low volatile ester in drier areas where no susceptible crops are nearby. Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year.
	picloram:fluroxypyr (1:1)	VH 24–32 oz (0.25–0.33 lb)	VH 1%			
	triclopyr:fluroxypr (3:1)	H 16–24 oz (0.5–0.75 lb)	VH 0.5%			
	metsulfuron methyl dicamba:2,4-D (1:3)	VH Rate 1–Rate 2	—			Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
	metsulfuron methyl	VH 0.1 oz	—			
	metsulfuron: chlorosulfuron (3:1)	VH 0.125 oz	—			
	metsulfuron: chlorosulfuron (1:1)	VH 0.2 oz	—			
Broom snakeweed (perennial broomweed) *(continued on next page)*	picloram	VH 16–32 oz (0.25–0.5 lb)	VH 0.5%	2–4 gal water for aerial spray; 10–25 gal water for ground broadcast application. Thoroughly wet foliage for individual plant treatment. Add 32–64 oz surfactant/100 gal water.	During and after full flower stage in fall when growth conditions are good; or spring during peak plant growth when growth conditions are good.	Use 16 oz/ac picloram only in the fall. Use 32 oz/ac picloram in the spring. Poor control may be expected if dicamba:2,4-D (1:3) or dicamba:2,4-D mixture is used when growth conditions are less than ideal. Growth conditions should be optimum if picloram:2,4-D (1:4) or picloram:2,4-D mixture is used in the spring. Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year.
	picloram:2,4-D (1:4), (3.8 lb/gal product)	VH 43 oz (1.25 lb)	VH 0.63%			
	picloram:2,4-D (1:4), (2.5 lb/gal product)	VH 64 oz (1.25 lb)	VH 1%			
	picloram:fluroxypyr (1:1)	VH 48–96 oz (0.5–1.0 lb)	VH 1%			
	picloram + 2,4-D amine or low volatile ester	VH 16 oz (0.25 lb) picloram + 16–32 oz (0.5–1 lb) 2,4-D (4 lb/gal product)	VH 0.25% picloram + 0.5% 2,4-D (4 lb/gal product)			
	dicamba:2,4-D (1:3)	VH 32 oz (1 lb)	VH 1%			
	dicamba:2,4-D (1:1.3) + 2,4-D amine or low volatile ester	VH 9–22 oz (0.28–0.69 lb) dicamba:2,4-D (1:1.3) + 14–32 oz (0.44–1 lb) 2,4-D (4 lb/gal product)	—			
	dicamba + 2,4-D amine or low volatile ester	VH 8 oz (0.25 lb) dicamba + 24 oz (0.75 lb) 2,4-D (4 lb/gal product)	VH 0.25% dicamba + 0.75% 2,4-D (4 lb/gal product)			

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Weed controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant/ spot treatment*			
Broom snakeweed (perennial broomweed) *(continued from previous page)*	metsulfuron methyl	VH 0.6 oz	—	2–4 gal water for aerial spray; 10–25 gal water for ground broadcast application. Add 32–64 oz surfactant or 2 gal crop oil/100 gal water.	Optimum time is in the fall, but it may be applied in spring.	Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
	metsulfuron:chlorosulfuron (3:1)	VH 0.75 oz	—			
	metsulfuron:chlorosulfuron (1:1)	VH 1.2 oz	—			
	metsulfuron methyl dicamba:2,4-D (1:3)	H–VH Rate 1–Rate 2	—			
	tebuthiuron 20% pellets	VH 3.75 lb pellets (0.75 lb active ingredient)	VH 0.57 oz of pellets (0.033 oz active ingredient)/100 sq ft of ground area	—	Any time—optimum period is Oct 1–Apr 1 except in Trans-Pecos, where optimum period is May 1–Jul 1.	Use only on sand, loamy sand, sandy loam, loam, silt loam, silt, or sandy clay loam soils.
Bullnettle, Carolina horsenettle, dogfennel, silverleaf nightshade, upright prairie-coneflower, western horsenettle (treadsalve), yankeeweed (rosin weed)	picloram:2,4-D (1:4), (3.8 lb/gal product)	VH 20–32 oz (0.6–0.9 lb)	VH 0.63%	2–4 gal water for aerial spray; 10–25 gal water for ground broadcast application. Thoroughly wet foliage for individual plant treatment. Add 32–64 oz surfactant/100 gal water.	Spring (see remarks)	Spray bullnettle, Carolina horsenettle, silverleaf nightshade, and western horsenettle when plants begin to flower in the spring. Spray dogfennel and yankeeweed when plants are 8–10 in. tall. Spray upright prairie-coneflower when plants are 2–6 in. tall before flowering. Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year. Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
	picloram:2,4-D (1:4), (2.5 lb/gal product)	VH 32–48 oz (0.6–0.94 lb)	VH 1%			
	picloram + 2,4-D amine or low volatile ester.	VH 8–12 oz (0.125–0.1875 lb) picloram + 16–24 oz (0.5–0.75 lb) 2,4-D (4 lb/gal product)	VH 0.25% picloram + 0.50% 2,4-D (4 lb/gal product)			
	picloram:fluroxypyr (1:1)	VH 24–32 oz (0.25–0.33 lb)	VH 1%			
	metsulfuron methyl dicamba:2,4-D (1:3)	H–VH Rate 1–Rate 2	—			
	dicamba:2,4-D (1:3)	VH 32 oz (1 lb)	VH 1%			
	dicamba:2,4-D (1:1.3) + 2,4-D amine or low volatile ester	VH 9–22 oz (0.28–0.69 lb) dicamba:2,4-D (1:1.3) + 14–32 oz (0.44–1 lb) 2, 4-D (4 lb/gal product)	—			
	dicamba + 2,4-D amine or low volatile ester.	VH 8 oz (0.25 lb) dicamba + 24 oz (0.75 lb) 2,4-D (4 lb/gal product)	VH 0.25% dicamba + 0.75% 2,4-D (4 lb/gal product)			

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Weed controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant/ spot treatment*			
Bullnettle, silverleaf nightshade, western horsenettle (treadsalve)	aminopyralid:metsulfuron methyl (1:6.2)	VH 2.0–3.3 oz (0.078–0.127 lb)	—	2–4 gal water for aerial spray; 10– 25 gal water for ground broadcast application. Thoroughly wet foliage for individual plant treatment. Add 32–64 oz of surfactant/100 gal water	Spring (see remarks)	Spray bullnettle, silverleaf nightshade, and western horsenettle when plants begin to flower in the spring. Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
	aminopyralid:2,4-D (1:8)	VH 24 oz (0.70 lb)	—			
Common goldenweed, Drummond's goldenweed	2,4-D low volatile ester	VH** 64 oz (2 lb) 4 lb/gal product	VH 2% (4 lb/gal product)	2–4 gal water for aerial spray; 10–25 gal water for ground broadcast application. Thoroughly wet foliage for individual plant treatment. Add 32–64 oz surfactant/100 gal water.	Spring, when growth conditions are good.	Picloram:2,4-D (1:4), dicamba:2,4-D (1:3), and mixtures of dicamba:2,4-D and picloram:2,4-D are more effective than 2,4-D alone when growth conditions are less than optimal. Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year. Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
	dicamba:2,4-D (1:3)	VH 48 oz (1.5 lb)	VH 2%			
	dicamba:2,4-D (1:1.3) + 2,4-D amine or low volatile ester	VH 9–22 oz (0.28–0.69 lb) dicamba:2,4-D (1:1.3) + 14–32 oz (0.44–1 lb) 2, 4-D (4 lb/gal product)	—			
	picloram:fluroxypyr (1:1)	VH 32 oz (0.33 lb)	VH 1%			
	triclopyr:fluroxypr (3:1)	H 32–48 oz (0.5–0.75 lb)	VH 1%			
	metsulfuron methyl dicamba:2,4-D (1:3)	VH Rate 3	—			
	dicamba + 2,4-D amine or low volatile ester	VH 12 oz (0.375 lb) dicamba + 36 oz (1.125 lb) 2,4-D (4 lb/gal product)	VH 0.5% dicamba + 1.5% 2,4-D (4 lb/gal product)			
	picloram:2,4-D (1:4), (3.8 lb/gal product)	VH 32 oz (0.95 lb)	VH 1.3%			
	picloram:2,4-D (1:4), (2.5 lb/gal product)	VH 48 oz (0.94 lb)	VH 2%			
	picloram + 2,4-D amine or low volatile ester	VH 12 oz (0.19 lb) picloram + 24 oz (0.75 lb) 2,4-D (4 lb/gal product)	VH 0.50% picloram + 1% 2,4-D (4 lb/gal product)			

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Weed controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant/ spot treatment*			
Flathead sedge	dicamba:2,4-D (1:3)	VH 64 oz (2 lb)	—	Ground broadcast 20–30 gal per acre. Add 32–64 oz surfactant/100 gal water.	Spring or fall	Control may be enhanced if the stand is burned and/or shredded and allowed to regrow to a height of 12–15 in. before spraying. Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
	dicamba:2,4-D (1:1.3) + 2,4-D amine or low volatile ester	VH 9–22 oz (0.28–0.69 lb) dicamba:2,4-D (1:1.3) + 14–32 oz (0.44–1 lb) 2, 4-D (4 lb/gal product)	—			
	metsulfuron methyl dicamba:2,4-D (1:3)	VH Rate 2	—			
Garboncillo, threadleaf groundsel, woolly locoweed	picloram:2,4-D (1:4), (3.8 lb/gal product)	VH 32 oz (0.95 lb)	VH 1.3%	2–4 gal water for aerial spray; 10–25 gal water for ground broadcast application. Thoroughly wet foliage for individual plant treatment. Add 32–64 oz surfactant/100 gal water.	Fall, when growing conditions are good.	Herbicide application may increase palatability of these poisonous plants. Therefore, do not graze treated areas until the toxic plants dry up and lose their palatability. Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year. Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
	picloram:2,4-D (1:4), (2.5 lb/gal product)	VH 48 oz (0.94 lb)	VH 2%			
	picloram + 2,4-D amine or low volatile ester.	VH 12 oz (0.19 lb) picloram + 24 oz (0.75 lb) 2,4-D (4 lb/gal product)	VH 0.5% picloram + 1% 2,4-D (4 lb/gal product)			
	picloram:fluroxypyr (1:1)	VH 32 oz (0.33 lb)	VH 1%			
	triclopyr:fluroxypr (3:1)	H 32–48 oz (0.5–0.75 lb)	VH 1%			
	metsulfuron methyl dicamba:2,4-D (1:3)	VH Rate 2	—			
	dicamba:2,4-D (1:3)	VH** 32 oz (1 lb)	VH 2%			
	dicamba:2,4-D (1:1.3) + 2,4-D amine or low volatile ester	VH 9–22 oz (0.28–0.69 lb) dicamba:2,4-D (1:1.3) + 14–32 oz (0.44–1 lb) 2,4-D (4 lb/gal product)	—			
	dicamba + 2,4-D amine or low volatile ester	VH 12 oz (0.375 lb) dicamba + 36 oz (1.125 lb) 2,4-D (4 lb/gal product)	VH 0.5% dicamba + 1.5%, 2,4-D (4 lb/gal product)			

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Weed controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant/ spot treatment*			
Gray goldaster, narrowleaf goldaster	2,4-D low volatile ester	VH 32 oz (1 lb)	VH 1%	2–4 gal water as aerial spray. 10–25 gal water to make 10–25 gal/ac as ground broadcast. Thoroughly wet foliage for individual plant treatment. Add 32–64 oz surfactant per 100 gal water.	Spring, during bud stage (pre-bloom).	Bud stage usually occurs mid-May–early June. Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year. Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
	picloram:2,4-D (1:4), (3.8 lb/gal product)	VH 34 oz (1 lb)	VH 0.63%			
	picloram:2,4-D (1:4), (2.5 lb/gal product)	VH 51 oz (1 lb)	VH 1%			
	picloram + 2,4-D low volatile ester	VH 13 oz (0.2 lb) picloram + 26 oz (0.8 lb) 2,4-D (4 lb/gal produc)	VH 0.25% picloram + 0.50% 2,4-D (4 lb/gal product)			
	picloram:fluroxypyr (1:1)	VH 32 oz (0.33 lb)	VH 1%			
	triclopyr:fluroxypr (3:1)	H 16–24 oz (0.5–0.75 lb)	VH 0.5%			
	metsulfuron methyl dicamba:2,4-D (1:3)	H–VH Rate 1–Rate 2	—			
	dicamba:2,4-D (1:3)	VH 32 oz (1 lb)	VH 1%			
	dicamba:2,4-D (1:1.3) + 2,4-D amine or low volatile ester	VH 9–22 oz (0.28–0.69 lb) dicamba:2,4-D (1:1.3) + 14–32 oz (0.44–1 lb) 2,4-D (4 lb/gal product)	—			
	dicamba + 2,4-D low volatile ester	VH 8 oz (0.25 lb) dicamba + 24 oz (0.75 lb) 2,4-D (4 lb/gal product)	VH 0.25% dicamba + 0.75% 2,4-D (4 lb/gal product)			
Lespedeza	triclopyr	VH 16–32 oz (0.50–1 lb)	—	Ground broadcast 20–30 gal per acre with 32–64 oz surfactant/100 gal water.	June–Aug under good growing conditions.	Plants need to be 12–18 in. tall before spraying. Use the higher rate if plants are large, approaching maturity, or if the infestation level is high.
	metsulfuron methyl	H 0.5 oz	—			Begin application at flower bud initiation through full bloom. Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
	metsulfuron:chlorosulfuron (3:1)	H 0.7 oz	—			
	metsulfuron:chlorosulfuron (1:1)	H 1.0 oz	—			
	metsulfuron methyl dicamba:2,4-D (1:3)	H Rate 2	—			
	picloram:fluroxypyr (1:1)	VH 24–32 oz (0.25–0.33 lb)	VH 1%			
	triclopyr:fluroxypr (3:1)	VH 12–16 oz (0.38–0.5 lb)	VH 0.5%			

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Weed controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant/ spot treatment*			
Rayless goldenrod (jimmyweed)	metsulfuron methyl	VH 0.75 oz	—	2–4 gal water for aerial spray; 10–25 gal water for ground broadcast application. Add 32 to 64 oz surfactant/100 gal water. Thoroughly wet foliage for individual plant treatment. Add 32–64 oz surfactant/100 gal water.	Fall	Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
	metsulfuron:chlorosulfuron (3:1)	VH 1.0 oz	—			
	metsulfuron:chlorosulfuron (1:1)	VH 1.5 oz	—			
	picloram:fluroxypyr (1:1)	VH 96 oz (1.0 lb)	VH 2%			
	picloram	VH 32 oz (0.50 lb)	VH 1%			
Spiny aster (wolfweed)	picloram:2,4-D (1:4), (3.8 lb/gal product)	VH 20 oz (0.6 lb)	VH 0.63%	10–25 gal water for ground broadcast application. Thoroughly wet foliage for individual plant treatment. Add 32–64 oz surfactant/100 gal water.	Spring, during good moisture and growth conditions.	Shred plants during winter. Regrowth will have leaves. Apply herbicide when regrowth is 10–12 in. tall. Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year.
	picloram:2,4-D (1:4), (2.5 lb/gal product)	VH 32 oz (0.63 lb)	VH 1%			
	picloram + 2,4-D amine or low volatile ester	VH 8 oz (0.125 lb) picloram + 16 oz (0.5 lb) 2,4-D (4 lb/gal product)	VH 0.25% picloram + 0.5% 2,4-D (4 lb/gal product)			
	picloram:fluroxypyr (1:1)	VH 24–32 oz (0.25–0.33 lb)	VH 1%			
	triclopyr:fluroxypyr (3:1)	H 16–24 oz (0.5–0.75 lb)	VH 0.5%			
	dicamba:2,4-D (1:3)	VH 32 oz (1 lb)	VH 1%			
	dicamba:2,4-D (1:1.3) + 2,4-D amine or low volatile ester	VH 9–22 oz (0.28–0.69 lb) dicamba:2,4-D (1:1.3) + 14–32 oz (0.44–1 lb) 2,4-D (4 lb/gal product)	—			
	dicamba + 2,4-D amine or low volatile ester	VH 8 oz (0.25 lb) dicamba + 24 oz (0.75 lb) 2,4-D (4 lb/gal product)	VH 0.25% dicamba + 0.75% 2,4-D (4 lb/gal product)			
Threadleaf groundsel	metsulfuron methyl	VH 0.4 oz	—	2–4 gal water for aerial spray; 10–25 gal water for ground broadcast application. Add 32–64 oz of surfactant/100 gal water.	Fall	Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
	metsulfuron:chlorosulfuron (3:1)	VH 0.5 oz	—			
	metsulfuron:chlorosulfuron (1:1)	VH 0.8 oz	—			
	metsulfuron methyl dicamba:2,4-D (1:3)	VH Rate 2	—			

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Weed controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant/ spot treatment*			
Twinleaf senna (twoleaf senna)	picloram:2,4-D (1:4), (3.8 lb/gal product)	—	VH 0.63%	Thoroughly wet foliage. Mix with water and add 32–64 oz surfactant/100 gal spray mix.	Late spring, good moisture and growth conditions.	Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year.
	picloram:2,4-D (1:4), (2.5 lb/gal product)	—	VH 1%			
	picloram:fluroxypyr (1:1)	—	VH 1%			
	dicamba:2,4-D (1:3)	—	VH 1%			
Upright prairie-coneflower	metsulfuron methyl	VH 0.2 oz	—	2–4 gal water for aerial spray. 10–25 gal water for ground broadcast application. Add 32–64 oz surfactant/100 gal water.	Spring, before flower stalk development.	Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
	metsulfuron: chlorosulfuron (3:1)	VH 0.25 oz	—			
	metsulfuron: chlorosulfuron (1:1)	VH 0.4 oz	—			

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Table 6. Herbicides for controlling brush on rangeland

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Agarito, Bumelia, Catclaw acacia, Catclaw mimosa, Coyotillo, Flameleaf sumac, Lotebush, Tasajillo, Texas mountain laurel, Whitebrush	aminocyclopyrachlor: triclopyr amine (1:2)	—	VH 1.5%	Thoroughly spray foliage to wet but not dripping. Add 32–64 oz (0.25–0.5%) nonionic surfactant/100 gal water.	Late spring through summer with mature, healthy leaves.	Aminocyclopyrachlor:triclopyr amine requires specific picolinic acid chemistry training and certification before use. See label for additional site-use information and restrictions.
Ashe juniper (blueberry cedar)	hexazinone liquid	—	VH** 2 ml/3 ft height or canopy diameter, whichever is greater	—	Late winter through summer	Apply undiluted hexazinone liquid, picloram, or hexazinone pellets between the stem base and the edge of the canopy. Use an exact delivery handgun applicator to apply hexazinone liquid and picloram. If plant size requires more than a single 2 ml or 4 ml application of hexazinone liquid or picloram, or more than 1 hexazinone pellet, apply subsequent applications or pellets equally spaced around the plant. Do not use these treatments on marshy or poorly drained sites nor on soils classified as clays. Best results are expected on coarse-textured soils.
	hexazinone pellet	—	VH 1 pellet/3 ft height or canopy diameter, whichever is greater	—		
	picloram	—	VH 4 ml/3 ft height or canopy diameter, whichever is greater	—		
Ashe juniper (blueberry cedar), cholla, dog cactus, redberry juniper (redberry cedar), tasajillo	picloram	—	VH 1% H rating for cholla	Thoroughly wet foliage and stems or joints and stems for individual plant treatment. Mix with water and add 32–64 oz surfactant/100 gal spray mix.	Anytime	—
Baccharis (dryland willow, Roosevelt willow, seep willow or willow baccharis) *(continued on next page)*	2,4-D low volatile ester	H 48–96 oz (1.5–3 lb) 4 lb/gal product	H 1%	For aerial applications, minimum suggested total spray volume is 4 gal water for aerial spray; 15–20 gal water for ground broadcast. For individual plant treatment, thoroughly wet the entire foliage, stems, and trunks. Add 32–64 oz surfactant/100 gal water.	Spring, when leaves are fully expanded and dark green.	Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year.
	picloram:2,4-D (1:4), (3.8 lb/gal product)	—	H 0.63%	For individual plant treatment thoroughly wet the entire foliage, stems, and trunks. Add 32–64 oz surfactant/100 gal water.		
	picloram:2,4-D (1:4), (2.5 lb/gal product)	—	H 1%			
	dicamba:2,4-D (1:3)	—	H 1%			
	triclopyr ester	—	VH 1%			
	triclopyr:fluroxypr (3:1)	—	VH 0.5%			
	picloram:fluroxypyr (1:1)	—	VH 1%			

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Baccharis (dryland willow, Roosevelt willow, seep willow, or willow baccharis) *(continued from previous page)*	hexazinone liquid	—	VH** 2 ml/3 ft height or canopy diameter, whichever is greater	—	Late winter–summer	Apply undiluted hexazinone liquid, picloram, or hexazinone pellets between the stem base and the edge of the canopy. Use an exact delivery handgun applicator to apply hexazinone liquid and picloram. If plant size requires more than a single 2 ml or 4 ml application of hexazinone liquid or picloram, or more than 1 hexazinone pellet, apply subsequent applications or pellets equally spaced around the plant. Do not use these treatments on marshy or poorly drained sites nor on soils classified as clays. Best results are expected on coarse-textured soils.
	hexazinone pellet	—	VH** 1 pellet/3 ft height or canopy diameter, whichever is greater	—		
Baccharis (dryland willow, Roosevelt willow, seep willow, or willow baccharis), blackbrush, bois d'arc, catclaw acacia, catclaw mimosa, Chinese tallowtree, elm, greenbriar, hackberry, pricklyash (Hercules club), Texas persimmon (see remarks), winged elm, yaupon	triclopyr ester	—	VH 25% in diesel fuel oil	Apply to lower 12–18 in. of trunk to wet the trunk; do not spray to point of runoff. Apply completely around the trunk.	Anytime—optimum time is during growing season when plants have mature leaves.	This is a Brush Busters® low volume basal application method. A 5500-X1 adjustable cone nozzle is preferred. Use only on plants with smooth bark and a trunk diameter less than 4 in. For Texas persimmon, apply in spring after leaves mature but before June 15.
	triclopyr ester	—	VH 25% in diesel fuel oil 10% d,l-limonene (a penetrant) may be added to the mixture—see remarks	Apply to the trunk in a 3- to 4-in.-wide band near ground level or at line dividing smooth bark from corky bark. Apply completely around the trunk.	Anytime—optimum time is during growing season when plants have mature leaves.	This is commonly called the streamline basal application method. Use a straight stream nozzle. Use only on plants with smooth bark and trunk diameter less than 4 in. Addition of a penetrant to the mixtures aids with coverage around the trunk and increases the control for most species. Trade names for d,l limonene are Quick Step II, AD 100, Cide-Kick II, and Cide-Kick. Other penetrants may be effective but have not been tested on rangeland in Texas. For Texas persimmon, apply in spring after leaves mature but before June 15.
Bigelow shinoak (white shinoak)	tebuthiuron 20% pellets	VH 7.5 lb pellets (1.5 lb active ingredient)	VH 0.5 oz pellets (0.1 oz active ingredient)/ 100 sq ft of ground area	—	Anytime—optimum period is Oct 1–Apr 1.	For individual plant treatment, apply pellets evenly on the soil under the plant canopy and 1 ft beyond canopy edge.
Blackberry	picloram:fluroxypyr (1:1)	VH** 48–64 oz (0.5–0.67 lb)	VH 1–2%	Use at least 10 gal water/ac, but increased volume up to 25 gal/ac will improve coverage, and subsequent herbicide penetration into the plant. Add 32–64 oz surfactant/100 gal spray mix.	Apply when leaves are fully expanded and the foliage is dark green, either before first flower or after fruit drop. Do not treat blackberries in the same year after shredding or burning.	—
	triclopyr:fluroxypr (3:1)	H 24–32 oz (0.75 to 1.0 lb)	VH 0.5–1%			

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Blackbrush	aminopyralid:metsulfuron methyl (1:6.2)	VH 3.3 oz (0.127 lb)	—	For aerial applications, suggested total spray volume is a minimum of 4 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. For ground broadcast applications, the suggested total spray volume is 10–25 gal/ac. Use water + surfactant, crop oil or methylated seed oil.	Fall applications	Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
Blackbrush, guajillo	tebuthiuron 20% pellets	H 10–15 lb pellets (2–3 lb active ingredient)	VH 0.5 oz pellets (0.1 oz active ingredient)/45 sq ft ground area or 2–4 in. stem diameter	—	Anytime—optimum period is Oct 1–Apr 1.	Use higher rate on deep soils with higher clay content. For individual plant treatment, apply pellets evenly on the soil under the plant canopy and 1 ft beyond canopy edge. Best results are expected on coarse-textured soils.
Blackjack oak, bois d'arc, elm, hackberry, lotebush, post oak, pricklyash (Hercules club), whitebrush (beebrush, beebush), willow, winged elm	hexazinone liquid	—	VH 4 ml/3 ft canopy diameter or height, whichever is greater	—	Late winter–summer	Apply undiluted hexazinone liquid or hexazinone pellets to soil surface between the stem base and the edge of the canopy. Use an exact delivery handgun applicator to apply hexazinone liquid. If plant size requires more than a single 4 ml application of hexazinone liquid, or 2 hexazinone pellets, apply subsequent applications or pellets equally spaced around the plant. Do not use these treatments on marshy or poorly drained sites nor on soils classified as clays. Best results are expected on coarse-textured soils.
	hexazinone pellet	—	VH 2 pellets/3 ft canopy diameter or height, whichever is greater	—	Anytime—optimum period is Oct 1–Apr 1.	
Blackjack oak, post oak, winged elm	tebuthiuron 20% pellets	VH 10 lb pellets (2 lb active ingredient)	VH 0.5 oz pellets (0.1 oz active ingredient)/45 sq ft of ground area or 2–4 in. of stem diameter	—	Anytime—optimum period is Oct 1–Apr 1.	For individual plant treatment, apply pellets evenly on the soil under the plant canopy and 1 ft beyond canopy edge.
Blackgum, sweetgum, and other hardwoods	triclopyr:2,4-D (1:2)	—	H 4% in diesel fuel oil	Apply to freshly cut surface of stump immediately after cutting.	Anytime—best results when soil is dry.	—
Burrobrush	picloram	—	VH 1%	Thoroughly wet foliage for individual plant treatment.	Apr–Jul	Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year.
	picloram:2,4-D (1:4), (3.8 lb/gal product)	—	VH 1.3%			
	picloram:2,4-D (1:4), (2.5 lb/gal product)	—	VH 2%			
Catclaw mimosa	tebuthiuron 20% pellets	H** 3.75 lb pellets (0.75 lb active ingredient)	VH 0.5 oz pellets (0.1 oz active ingredient)/100 sq ft of ground area or 2–4 in. of stem diameter	—	Anytime—optimum period is May 1–Jul 1 in Trans-Pecos and Oct 1–Apr 1 in rest of state.	Use only when brush is growing on sand, loamy sand, or sandy loam soil. For individual plant treatment, apply pellets evenly on the soil under the plant canopy and 1 ft beyond canopy edge.

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Cenizo	tebuthiuron 20% pellets	VH 3.75 lb pellets (0.75 lb active ingredient)	VH 0.5 oz pellets (0.1 oz active ingredient)/100 sq ft of ground area or 2–4 in. of stem diameter	—	Anytime—optimum period is Oct 1–Apr 1.	For individual plant treatment, apply the pellets evenly on soil under the plant canopy and 1 ft beyond canopy edge.
Chinese tallowtree	picloram:2,4-D (1:4) (3.8 lb/gal product)	VH 80 oz (2.4 lb)	VH 0.63%	5–15 gal as aerial spray or 10–25 gal for ground broadcast application. Thoroughly wet foliage for individual plant treatment. Add 32–64 oz surfactant/100 gal water.	Spring or fall	Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year.
	picloram:2,4-D (1:4) (2.5 lb/gal product)	VH 128 oz (2.5 lb)	VH 1%			
	picloram + 2,4-D amine	VH 32 oz (0.5 lb) picloram + 64 oz (2 lb) 2,4-D (4 lb/gal product)	VH 0.25% picloram + 0.5% 2,4-D (4 lb/gal product)			
	picloram:fluroxypyr (1:1)	VH 80 oz (0.84 lb)	VH 1%			
	picloram	VH 32 oz (0.5 lb)	VH 0.5%			
	picloram + triclopyr ester	VH 32 oz (0.5 lb) picloram + 16 oz (0.5 lb) triclopyr ester	VH 0.5% picloram + 0.25% triclopyr ester			
	hexazinone liquid	—	VH 4 ml/3 ft canopy diameter or height, whichever is greater	—	Late winter—summer	Apply undiluted hexazinone liquid, tebuthiruon 20% pellets, or hexazinone pellets to soil between stem base and the edge of the canopy. Use an exact delivery handgun applicator to apply hexazinone liquid. If plant size requires more than a single 4 ml application of hexazinone liquid, or 2 hexazinone pellets, apply subsequent applications or pellets equally spaced around the plant. Do not use these treatments on marshy or poorly drained sites nor on soils classified as clays. Best results are expected on coarse-textured soils.
	hexazinone pellets	—	VH 2 pellets/3 ft canopy diameter or height, whichever is greater	—		
	tebuthiuron 20% pellets	—	VH 0.5 oz pellets (0.1 oz active ingredient)/45 sq ft of ground area or 2–4 in. of stem diameter	—	Anytime—optimum period is Oct 1–Apr 1.	
	triclopyr ester	—	VH** 15% in diesel fuel	Apply to lower 12–18 in. of trunk to wet the bark, but not to point of runoff. Apply completely around the trunk.	Anytime—optimum time is during growing season when plants have mature leaves.	Use only on plants with a smooth bark and/or a trunk diameter less than 4 in. This is a Brush Busters® low volume basal application method. A 5500-X1 nozzle is preferred.
	triclopyr ester	—	VH 25% in diesel fuel			
Christ thorn	triclopyr ester	—	VH 1%	Add 32–64 oz surfactant/100 gal water. Thoroughly wet foliage.	Early summer	—
	triclopyr ester + picloram	—	VH 0.5% triclopyr ester + 0.5% picloram			

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Common or eastern persimmon	dicamba	L 64 oz (2 lb)	H 1%	Ground broadcast 15–20 gal water. Thoroughly wet foliage for individual plant treatment. Add 32–64 oz surfactant/100 gal water.	Spring, when leaves are fully developed.	—
	picloram:fluroxypyr (1:1)	—	VH 1 to 2%			
Creosotebush, tarbush, whitethorn acacia	tebuthiuron 20% pellets	H 3.75–5 lb of pellets (0.75–1 lb active ingredient)	VH 0.5 oz pellets (0.1 oz active ingredient)/ 100 sq ft of ground area	—	Anytime—optimum period is May 1–Jul 1.	Use 5 lb pellets/ac when soil is a loam, silt loam, silt, sandy clay loam, or clay loam. Use low rate when soil is a sand, loamy sand, or sandy loam. Do not treat mountainside or gravelly ridges with slopes of 7% or more. Do not treat if soils have a cation exchange capacity greater than 30 meq/100 grams (commonly called "gyp" soils). For individual plant treatment, apply pellets evenly on soil under the plant canopy and 1 ft beyond the canopy edge.
Eastern redcedar	picloram	—	VH** 4 ml/3 ft height or canopy diameter, whichever is greater	—	Spring or fall	Apply undiluted hexazinone liquid, picloram, or hexazinone pellets to soil surface between the stem base and the edge of the canopy. Use an exact delivery handgun applicator to apply hexazinone liquid and picloram. If plant size requires more than one 4 ml application of hexazinone liquid or picloram, or more than 2 hexazinone pellets, apply subsequent applications or pellets equally spaced around the plant. Do not use these treatments on marshy or poorly drained sites nor on soils classified as clays. Best results are expected on coarse-textured soils.
	hexazinone liquid	—	VH 4 ml/3 ft height or canopy diameter, whichever is greater, or 1 in. trunk diameter	—	Late winter through summer	
	hexazinone pellet	—	VH 2 pellets/3 ft height or canopy diameter, whichever is greater, or 1 in. trunk diameter	—		
Elm, granjeno (spiny hackberry), hackberry, pricklyash, (Hercules club), yaupon	tebuthiuron 20% pellets	—	VH 0.5 oz pellets (1/10 oz active ingredient) per 45 sq ft of ground area or 2–4 in. of stem diameter	—	Anytime during year-optimum period is Oct 1–Apr 1, except in Trans-Pecos, where optimum period is May 1–July 1.	Apply pellets evenly on the soil under the plant canopy and 1 ft beyond canopy edge.
Huisache, lotebush	tebuthiuron 20% pellets	—	L 0.5 oz pellets (1/10 oz active ingredient) per 45 sq ft of ground area or 2–4 in. of stem diameter	—		
Flameleaf sumac *(continued on next page)*	picloram:2,4-D (1:4), (3.8 lb/gal product)	—	VH 0.63%	For aerial applications, the minimum suggested total spray volume is 4 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. For ground broadcast applications, the suggested total spray volume is 10–25 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. Thoroughly wet foliage for individual plant treatments. Add 32–64 oz surfactant/100 gal water.	Late spring, when leaves mature.	Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year.

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Flameleaf sumac *(continued from previous page)*	picloram:2,4-D (1:4), (2.5 lb/gal product)	—	VH 1%	For aerial applications, the minimum suggested total spray volume is 4 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. For ground broadcast applications, the suggested total spray volume is 10–25 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. Thoroughly wet foliage for individual plant treatments. Add 32–64 oz surfactant/100 gal water.	Late spring, when leaves mature.	Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year.
	picloram:fluroxypyr (1:1)	H 48–96 oz (0.5–1.0 lb)	VH 0.75%			
	picloram	H 16–32 oz (0.25–0.5 lb)	VH 0.5%			
	picloram + triclopyr ester	H 16 oz (0.25 lb) picloram + 8 oz (0.25 lb) triclopyr ester	VH 0.25% picloram + 0.25% triclopyr ester			
	picloram + 2,4-D amine or low volatile ester	—	VH 0.25% picloram + 0.5% 2,4-D (4 lb/gal product)			
Giant reed	imazapyr	VH 64 oz (1 lb)	VH 0.5%	Use a minimum 20–30 gal/ac total volume of ground broadcast applications and a minimum 15 gal/ac for aerial. When using individual plant applications, spray plants to runoff. Add 1% MSO to individual plant treatments and 32 oz/ac for broadcast applications.	Spray when plants are actively growing during the summer or fall with a minimum 3 ft plant height.	Do not mow plants for 3–4 mo. after treatment. When exposure to aquatic environments is possible, use an herbicide with aquatic label.
Greenbriar	dicamba + 2,4-D low volatile ester	—	H** 1.5% dicamba + 3% 2,4-D (4 lb/gal product) in diesel fuel oil	Thoroughly wet stems with diesel/herbicide mix.	Winter	Use as dormant stem treatment. Constant agitation is needed to maintain proper mixture.
Hardwoods with a diameter of >1 in. except mesquite and huisache	2,4-D amine	—	H Undiluted	Use tree injector or other injecting equipment. Apply in cuts spaced 2 in. apart at base of trees. Apply until 2,4-D runs from each end of cut.	Summer or winter	—

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**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Honeylocust	picloram:2,4-D (1:4), (3.8 lb/gal product)	—	VH 0.63%	For aerial applications, the minimum suggested total spray volume is 5 gal/acre. Use water plus surfactant, crop oil, or methylated seed oil. For ground broadcast applications, the suggested total spray volume is 20–25 gal/acre. Use water plus surfactant, crop oil, or methylated seed oil. Thoroughly wet foliage, but not to the point of dripping, for individual plant treatments. Add 32–64 oz of surfactant per 100 gal. For IPT, thoroughly spray foliage but not to dripping. Add 32–64 oz of surfactant per 100 gal.	Late spring after leaves mature through summer.	Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year. Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
	picloram:2,4-D (1:4), (2.5 lb/gal product)	—	VH 1%			
	aminopyralid: picloram:fluroxypyr (1:2:2)	—	VH 1%			
	aminopyralid:clopyralid (1:4.6)	H 28 oz (0.61 lb)	VH 1%			
	aminopyralid:2,4-D (1:8)	H 33.6 oz (0.98 lb)	VH 1%			
	picloram:fluroxypyr (1:1)	M–H 48 oz (0.5 lb)	—			
	aminopyralid:metsulfuron Methyl (1:6.2)	M–H 3.3 oz (0.127 lb)	—			
Huisache *(continued on next page)*	aminocyclopyrachlor: triclopyr amine (1:2)	VH 36–48 fl oz (0.56–0.75 lb)	VH 1.5%	For aerial applications, use at least 4 gal/ac. total spray volume. For dense canopies, carrier volume may be increased to 10 gal/ac. For ground broadcast applications, suggested total spray volume is 10-25 gal/ac. Use 4–5 fl oz/ac MSO or MSO-OS (organosilicone surfactant) spray adjuvant. For best results, use nozzles and pressure setting to deliver a mean spray droplet diameter within the range of 350 to 450 microns. For IPT, thoroughly spray foliage to wet but not dripping. Add 32–64 oz (0.25–0.5%) nonionic surfactant/100 gal water.	The best results are achieved in the fall months (typically late September–November 1). Do not spray when soil temperature at a depth of 12 in. is below 75° F. For optimum root-kill, do not spray when >25% of the leaf canopy is damaged due to insects, disease, or hail. Apply with good soil moisture conditions and a full, healthy leaf canopy. May be best after cumulative rainfall of 4 in. or more during the 4 weeks prior to treatment or 3 in. or more during the 2 weeks prior to treatment.	Aminocyclopyrachlor:triclopyr amine requires specific picolinic acid chemistry training and certification before use. See label for additional site-use information and restrictions. Higher plant-kill can be expected for trees under 7 ft. tall. If plants are shredded, wait until regrowth is 3 ft. tall or higher before treatment. Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year.
	aminopyralid:clopyralid (1:4.6) + picloram	M-H 28 fl oz (0.61 lb) + 32 fl oz (0.5 lb)	—			
	aminopyralid:2,4-D (1:8) + picloram:2,4-D (1:4) + picloram	M-H 34 fl oz (0.99 lb) + 72 fl oz (1.4 lb) + 13 fl oz (0.2 lb)	—			
	picloram + triclopyr ester	L–M 32 oz (0.5 lb) picloram + 16 oz (0.5 lb) triclopyr ester	H 0.5% picloram + 0.5% triclopyr ester			
	picloram + clopyralid	L–M 32 oz (0.5 lb) picloram + 11–21 oz (0.25–0.5 lb) clopyralid	H 0.5% picloram + 0.5% clopyralid			
	picloram:fluroxypyr (1:1)	L–M 96 oz (1.0 lb)	H 1%			

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**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Huisache *(continued from previous page)*	picloram	L–M 32 oz (0.5 lb)	H 1%	For aerial applications, use at least 4 gal/ac. total spray volume. For dense canopies, carrier volume may be increased to 10 gal/ac. For ground broadcast applications, suggested total spray volume is 10-25 gal/ac. Use 4–5 fl oz/ac MSO or MSO-OS (organosilicone surfactant) spray adjuvant. For best results, use nozzles and pressure setting to deliver a mean spray droplet diameter within the range of 350 to 450 microns. For IPT, thoroughly spray foliage to wet but not dripping. Add 32–64 oz (0.25–0.5%) nonionic surfactant/100 gal water.	The best results are achieved in the fall months (typically late September–November 1). Do not spray when soil temperature at a depth of 12 in. is below 75° F. For optimum root-kill, do not spray when >25% of the leaf canopy is damaged due to insects, disease, or hail. Apply with good soil moisture conditions and a full, healthy leaf canopy. May be best after cumulative rainfall of 4 in. or more during the 4 weeks prior to treatment or 3 in. or more during the 2 weeks prior to treatment.	Aminocyclopyrachlor:triclopyr amine requires specific picolinic acid chemistry training and certification before use. See label for additional site-use information and restrictions. Higher plant-kill can be expected for tress under 7 ft. tall. If plants are shredded, wait until regrowth is 3 ft. tall or higher before treatment. Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year.
	picloram:2,4-D (1:4), (3.8 lb/gal product)	—	VH 0.63%			
	picloram:2,4-D (1:4), (2.5 lb/gal product)	—	VH 1%			
	aminopyralid:clopyralid (1:4.6)	—	VH 1%			
	aminopyralid:metsulfuron methyl (1:6.2)	L 3.3 oz (0.127 lb)	—	10–15 gal water as aerial spray; 10–20 gal water as ground broadcast. Add 32–64 oz surfactant/100 gal water.	Fall, under good moisture conditions.	Because of metsulfuron methyl in the formulation, this herbicide is not recommended on bahiagrass pastures for weed and brush control.
	aminopyralid:metsulfuron methyl (1:6.2) + triclopyr ester	M–H 3.3 oz (0.127 lb) aminopyralid:metsulfuron methyl + 16 oz (0.5 lb) triclopyr ester	—			
	aminopyralid:2,4-D (1:8)	L 24–34 oz (0.70–0.98 lb)	—			
	aminopyralid:2,4-D (1:8) + triclopyr ester	L 24 oz (0.70 lb) aminopyralid:2,4-D + 16 oz (0.5 lb) triclopyr ester	—			
	triclopyr ester	—	H 15% in diesel fuel oil	Apply to lower 12–18 in. of trunk to wet the trunk; do not spray to point of runoff. Apply completely around the trunk.	Anytime—optimum time is growing season when plants have mature leaves.	This is a Brush Busters® low volume basal application method. A 5500-X1 adjustable cone nozzle is preferred. Use only on plants with smooth bark and a trunk diameter less than 4 in.
	triclopyr ester	—	VH 25% in diesel fuel oil			
Lotebush	triclopyr ester	—	VH 15% in diesel fuel	Apply to lower 12–18 in. of the trunk to wet the bark. Do not spray to point of runoff. Apply completely around the trunk.	Anytime—optimum time is during growing season when plants have mature leaves.	This is a Brush Busters® low volume basal application method. Use a 5500X1 adjustable cone nozzle.

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

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Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Macartney rose (mowed and other disturbed stands within 3 years of disturbance)	2,4-D amine	L** 64 oz (2 lb) 4 lb/gal product	L 1% 4 lb/gal product	5–15 gal water as aerial spray; 25–30 gal water as ground broadcast. Thoroughly wet foliage and stems for individual plant treatment. Add 32–64 oz surfactant/100 gal water.	Spring before Jun 1, good growth conditions.	Avoid spraying earlier than 9–12 mo. after mowing or when plants have high percentage of new growth. Poor control may be expected if plants are <3 ft tall when sprayed. Repeat treatment when necessary. Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year.
	picloram:2,4-D (1:4), (3.8 lb/gal product)	H 80 oz (2.4 lb)	VH 0.63%		Spring or fall, good growth conditions.	
	picloram:2,4-D (1:4), (2.5 lb/gal product)	H 128 oz (2.5 lb)	VH 1%			
	picloram + 2,4-D amine or low volatile ester	H 32 oz (0.5 lb) picloram + 64 oz (2 lb) 2,4-D (4 lb/gal product)	VH 0.25% picloram + 0.5% 2,4-D (4 lb/gal product)			
	2,4-D low volatile ester	L 64 oz (2 lb) 4 lb/gal product	L 1% (4 lb/gal product)		Fall, under good moisture conditions, before Nov 1.	
Macartney rose (undisturbed stands)	2,4-D amine	L 128 oz (4 lb) 4 lb/gal product	L 1% (4 lb/gal product)	5–15 gal water as aerial spray; 25–30 gal water as ground broadcast. Thoroughly wet foliage and stems for individual plant treatment. Add 32–64 oz surfactant/100 gal water.	Spring, before June 1, good growth conditions.	Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year.
	picloram:2,4-D (1:4), (3.8 lb/gal product)	H 80 oz (2.4 lb)	VH 0.63%		Spring or fall, good growth conditions.	
	picloram:2,4-D (1:4), (2.5 lb/gal product)	H 128 oz (2.5 lb)	VH 1%			
	picloram + 2,4-D amine or low volatile ester	H 32 oz (0.5 lb) picloram + 64 oz (2 lb) 2,4-D (4 lb/gal product)	VH 0.25% picloram + 0.5% 2,4-D (4 lb/gal product)			
	2,4-D low volatile ester	L 96 oz (3 lb) 4 lb/gal product	L 1% (4 lb/gal product)		Fall, good moisture conditions, before Nov 1.	—
Mesquite, huisache	hexazinone liquid	—	M–H** 4–8 ml/3 ft of canopy diameter or height, whichever is greater	—	Late winter–summer	Apply undiluted hexazinone liquid or hexazinone pellets to soil surface between the stem base and the edge of the canopy. Use an exact delivery handgun applicator to apply hexazinone liquid. If plant size requires more than a single 4 ml application of hexazinone liquid, or 2 hexazinone pellets, apply subsequent applications or pellets equally spaced around the plant. Do not use these treatments on marshy or poorly drained sites nor on soils classified as clays. Best results are expected on coarse-textured soils.
	hexazinone pellet	—	M–H 2–4 pellets/3 ft of canopy diameter or height, whichever is greater	—		

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**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Mesquite (basal stem diameter ≤1.5 in.)	triclopyr ester	—	VH 15% in diesel fuel oil or basal bark oil	Apply to lower 12–18 in. of trunk to wet the trunk; do not spray to point of runoff. Apply completely around the trunk.	Anytime—optimum time is during growing season when plants have mature leaves.	This is a Brush Busters® low volume basal application method. Use a 5500X1 adjustable cone nozzle. Use only on plants with smooth bark and a trunk diameter <4 in.
Mesquite (basal stem diameter >1.5 in.)	triclopyr ester	—	VH 25% in diesel fuel oil or basal bark oil			
Mesquite (basal stem diameter ≤1.5 in.)	triclopyr ester	—	VH 15% in diesel fuel oil 10% d,l limonene (a penetrant) may be added to the mixture—see remarks	Apply to the trunk in a 3- to 4-inch-wide band near ground level or at the line dividing smooth bark from corky bark. Apply completely around the trunk.	Anytime—optimum is in the growing season when the leaves are mature.	This is commonly called the streamline basal application method. Use a straight stream nozzle. Use only on plants with smooth bark and a trunk diameter <4 in. Add a penetrant to the mixture to improve coverage around the trunk. Trade names for d,l limonene are Quick Step II, Cide-Kick, Cide-Kick II and AD 100. Other penetrants may be effective but have not been tested on rangelands in Texas.
Mesquite (basal stem diameter >1.5 in.)	triclopyr ester	—	VH 25% in diesel fuel oil 10% d,l limonene (a penetrant) may be added to the mixture—see remarks			
Mesquite (basal stem diameter ≤4 in.)	aminocyclopyrachlor: triclopyr amine (1:2)	—	VH 15% in water carrier + 1% MSO-OS	Apply to lower 12-18 in. of trunk to wet the trunk, but do not spray to the point of runoff. Apply completely around each basal stem. Add 1% MSO-OS (organosilicone surfactant) to the water carrier spray mix.	Late spring through summer. This is a Brush Busters low volume basal application method. Use a 5500X1 or X2 adjustable cone nozzle. Use only on plants with smooth bark and a trunk diameter less than 4 in.	Aminocyclopyrachlor:triclopyr amine requires specific picolinic acid chemistry training and certification before use. See label for additional site-use information and restrictions.
Mesquite (seedlings and saplings)	triclopyr ester	—	VH 5% in diesel fuel oil	Apply to the lower 12–18 in. of trunk to point of runoff but not to the point of puddling.	May–Aug	This is a Brush Busters® low volume basal application method. Use a 5500X1 adjustable cone nozzle.
Mesquite, huisache, twisted acacia	diesel fuel oil, kerosene	—	H	Apply to the base of the trunk from 12–18 in. above soil surface down to soil surface. Apply until the solution puddles on the soil surface.	Anytime the soil is dry and pulled away from the trunk.	Apply sufficient oil to penetrate to the plant bud zone. Diesel fuel oil does not evaporate as fast as does kerosene.
	triclopyr ester	—	VH 2% in diesel fuel oil			
Mesquite, Christ thorn, and other hardwoods (cut stumps)	triclopyr ester	—	VH** 15% in diesel fuel oil or basal bark oil	Thoroughly spray the cut surface as well as the bark from the cut to ground level but not to the point of runoff.	Anytime, except when snow or water prevents spraying to the ground line.	This is a Brush Busters® cut-stump application method. Apply with a backpack or knapsack sprayer using low pressures and an adjustable cone nozzle (5500X1 to 5500X3). Hydraulic shears equipped with a large orifice nozzle such as a 5500X12 can also be used for this method.
	triclopyr:fluroxypr (3:1)	—	VH 10% in diesel fuel oil or basal bark oil			

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Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Mesquite (cut stumps)	aminocyclopyrachlor: triclopyr amine (1:2)	—	VH 8 to 10% in water carrier + 1% MSO-OS	Thoroughly spray the cut surface as well as the bark from the cut to ground level but not to the point of runoff. Add 1% MSO-OS (organosilicone surfactant) to water carrier spray mix.	Anytime, except when snow or water prevents spraying to the ground line. This is a Brush Busters cut-stump application method. Apply with a backpack or knapsack sprayer using low pressure and an adjustable cone nozzle (5500X1 to X3). Hydraulic shears equipped with a large orifice nozzle such as a 5500X12 can also be used for this method.	Aminocyclopyrachlor:triclopyr amine requires specific picolinic acid chemistry training and certification before use. See label for additional site-use information and restrictions.
Mesquite *(continued on next page)*	aminocyclopyrachlor: triclopyr amine (1:2)	VH 24–36 fl oz (0.375–0.56 lb)	VH 1.5%	For aerial applications, use at least 4 gal/ac. total spray volume. For ground broadcast applications, the suggested total spray volume is 10–25 gal/ac. Use 4–5 fl oz/ac. MSO or MSO-OS (organosilicone surfactant) spray adjuvant. For best results, use nozzles and pressure settings to deliver a mean spray droplet diameter within the range of 350 to 450 microns. For IPT, thoroughly spray foliage to wet but not dripping. Add 32–64 oz (0.25–0.5%) nonionic surfactant/100 gal water.	Late spring through mid-summer with mature (dark green) leaves. Optimum period begins when soil temperature at a depth of 12 in. reaches 75° F and continues for 45 days thereafter. For optimum root-kill, do not spray if white flowers or bean elongation are observable, if >25% of the leaf canopy is damaged due to insects, disease, or hail, if soil temperatures are less than 75° F 12 in. deep, or if new vegetative growth is present due to recent rains.	Aminocyclopyrachlor:triclopyr amine requires specific picolinic acid chemistry training and certification before use. See label for additional site-use information and restrictions.

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Mesquite *(continued on next page)*	aminopyralid:clopyralid (1:4.6)	H 28 oz (0.61 lb)	VH 1%	For aerial applications, use at least 4 gal/ac. total spray volume. For ground broadcast applications, the suggested total spray volume is 10–25 gal/ac. Use 4–5 fl oz/ac. MSO or MSO-OS (organosilicone surfactant) spray adjuvant. For best results, use nozzles and pressure setting to deliver a mean spray droplet diameter within the range of 350 to 450 microns. For IPT, thoroughly spray foliage to wet but not dripping. Add 32–64 oz (0.25–0.5%) nonionic surfactant/100 gal water.	Late spring through mid-summer with mature (dark green) leaves. Optimum period begins when soil temperature at a depth of 12 in. reaches 75° F and continues for 45 days thereafter. For optimum root-kill, do not spray if white flowers or bean elongation are observable, if >25% of the leaf canopy is damaged due to insects, disease, or hail, if soil temperatures are less than 75° F, 12 in. deep, or if new vegetative growth is present due to recent rains.	Aminocyclopyrachlor:triclopyr amine requires specific picolinic acid chemistry training and certification before use. See label for additional site-use information and restrictions.
	clopyralid	M–H 11–21 oz (0.25–0.5 lb)	VH 1%			
	triclopyr ester + picloram	M 8–16 oz (0.25–0.5 lb) triclopyr + 16–32 oz (0.25–0.5 lb) picloram	M–H 0.5% triclopyr + 0.5% picloram			
	triclopyr ester + dicamba	L 8–16 oz (0.25–0.5 lb) triclopyr + 8–16 oz (0.25–0.5 lb) dicamba	M 0.5% triclopyr + 0.5% dicamba			
	triclopyr ester + clopyralid	M–H 4–16 oz (0.125–0.5 lb) triclopyr + 5–11 oz (0.125–0.25 lb) clopyralid	VH 0.5% triclopyr + 0.5% clopyralid			
	picloram + dicamba	M 16–32 oz (0.25–0.5 lb) picloram + 8–16 oz (0.25–0.5 lb) dicamba	H 0.5% picloram + 0.5% dicamba			
	picloram + clopyralid	M–H 16–32 oz (0.25–0.5 lb) picloram + 11–21 oz (0.25–0.5 lb) clopyralid	VH 0.5% picloram + 0.5% clopyralid			
	triclopyr ester + clopyralid + picloram	M–H** 4–8 oz (0.125–0.25 lb) triclopyr + 5–11 oz (0.125–0.25 lb) clopyralid + 32 oz (0.5 lb) picloram	—			Recommended for mixtures of mesquite and pricklypear or tasajillo cactus.

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Mesquite *(continued from previous page)*	aminopyrlid:clopyralid + picloram	H 28 oz (0.61 lb) aminopyrlid: clopyrlid + 16–32 oz (0.25–0.5 lb) picloram	—	For aerial applications, use at least 4 gal/ac. total spray volume. For ground broadcast applications, the suggested total spray volume is 10–25 gal/ac. Use 4–5 fl oz/ac. MSO or MSO-OS (organosilicone surfactant) spray adjuvant. For best results, use nozzles and adjust the pressure setting to deliver a mean spray droplet diameter within the range of 350 to 450 microns. For IPT, thoroughly spray foliage to wet but not dripping. Add 32–64 oz (0.25–0.5%) nonionic surfactant/100 gal water.	Late spring through mid-summer with mature (dark green) leaves. Optimum period begins when soil temperature at a depth of 12 in. reaches 75° F and continues for 45 days thereafter. For optimum root-kill, do not spray if white flowers or bean elongation are observable, if >25% of the leaf canopy is damaged due to insects, disease, or hail, if soil temperatures are less than 75° F, 12 in. deep, or if new vegetative growth is present due to recent rains.	Recommended for mixtures of mesquite and pricklypear or tasajillo cactus. The tank mix of aminopyralid: clopyralid plus picloram also controls mesquite better in South Texas mixed brush habitat than does aminopyrlid: clopyralid alone.
	aminopyrlid:clopyralid + triclopyr ester	H 28 oz (0.61 lb) aminopyrlid: clopyrlid + 8–32 oz (0.25–0.75 lb) triclopyr ester	—			
	clopyralid (see remarks)	H 21 oz (0.5 lb)	VH 1%		Aug 1–Sep 30 with a soil temperature of 75°F or more at a depth of 12 in. Do not apply after a frost has occurred.	Use only in Bandera, Blanco, Burnet, Coryell, Edwards, Kendall, Lampasas, Montague, Real, Val Verde, and Wise Counties and the counties north and west of the named counties.
	picloram	—	VH 128 oz (2 lb)	Applied with a carpeted roller.	Late spring–Aug with mature (dark green) leaves. Best control during the period that begins when soil temperature at a depth of 12 in. reaches 75°F and continued for 45 days thereafter; when clopyralid is used alone or in a tank mix the period should continue for 60 days after soil temperature reaches 75°F.	Mesquite should be <6 ft tall and should pass under carpeted roller without breaking the main stem. Mix recommended quantity of herbicide with water to make 8 gal mixture. Add 3–6 oz surfactant for each 8 gal mixed.
	clopyralid	—	VH 84 oz (2 lb)			
	picloram + clopyralid	—	VH 64 oz (1 lb) picloram + 43 oz (1 lb) clopyralid			

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Mesquite (suppression and weed control)	2,4-D amine or low volatile ester	L 32–28 oz (2–4 lb)	M 2% (4 lb/gal product)	For aerial applications, the minimum suggested total spray volume is 4 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. For ground broadcast applications, the suggested total spray volume is 10–25 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. Thoroughly wet foliage for individual plant treatments. Add 32–64 oz surfactant/100 gal water.	Late spring–mid-summer with mature (dark green) leaves. Optimum period begins when soil temperature at a depth of 12 in. reaches 75°F and continues for 45 days thereafter. If treatment is applied before optimum soil temperatures, efficacy rates will be lower and multiple applications over a period of years may be necessary to maintain less than 10% canopy cover.	Treatments will control many weeds. Use of a treatment with a low control rating may result in multi-stem growth form that may be more difficult to control in the future. Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year. Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
	picloram:2,4-D (1:4), (3.8 lb/gal product)	L 20–32 oz (0.6–0.9 lb)	—			
	picloram:2,4-D (1:4), (2.5 lb/gal product)	L 32–48 oz (0.6–0.9 lb)	—			
	dicamba:2,4-D (1:3)	L 32–48 oz (1–1.5 lb)	—			
	metsulfuron methyl dicamba:2,4-D (1:3)	L Rate 1–Rate 2	—			
	picloram + 2,4-D amine or low volatile ester	L 8–12 oz (0.125–0.1875 lb) picloram + 32–48 oz (1–1.5 lb) 2,4-D (4 lb/gal product)	—			
	dicamba + 2,4-D amine or low volatile ester	L 8–12 oz (0.25–0.375 lb) dicamba + 24–36 oz (0.75–1.125 lb) 2,4-D (4 lb/gal product)	—			
	triclopyr ester	L 16–32 oz (0.5–1 lb)	M 1%			
	dicamba	L 16–32 oz (0.5–1 lb)	M 1%			

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Mesquite, western honey	triclopyr ester + clopyralid	—	VH 0.5% triclopyr ester + 0.5% clopyralid	For aerial applications, the minimum suggested total spray volume is 4 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. For ground broadcast applications, the suggested total spray volume is 10–25 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. Thoroughly wet foliage for individual plant treatments. Add 32–64 oz surfactant/100 gal water.	The preferred application time is spring to early summer, 40–90 days after bud break. Spray with minimum soil temperature of 75°F at 12–18 inch soil depth. Soil moisture should be adequate for plant growth. Not all years provide adequate conditions for spraying. In certain early season drought years with late summer rains, there is an opportunity for spraying in July and August. This occurs when summer rains provide sufficient soil moisture that allows mesquite foliage to recover from drought or other damage and develop healthy and robust leaf growth.	Western honey mesquite is most common in the western part of the Trans-Pecos region of Texas. Do not spray after major rain (usually at least 1 inch of rain) that causes light green leaves until all leaves have returned to uniform dark-green (approx. 2–3 weeks). Foliage should be robust, dark green, and undamaged. Do not spray foliage damaged by drought, frost, hail, wind, insects, and browsing.
	aminopyrlid:clopyralid + triclopyr ester	H-VH 28 oz (0.61 lb) aminopyrlid: clopyrlid + 8 oz (0.25 lb) triclopyr ester	—			
	aminopyralid:clopyralid	M-H 28 oz (0.61 lb) aminopyrlid: clopyrlid	—			Suggested for ground broadcast
Mixed brush—South Texas (includes several of the following: blackbrush, catclaw acacia, granjeno or spiny hackberry, guajillo, huisache, mesquite, pricklypear, retama, skunkbush, tasajillo, twisted acacia *(continued on next page)*	picloram + triclopyr ester	M** 32 oz (0.5 lb) picloram + 16 oz (0.5 lb) triclopyr ester	H 0.5% picloram + 0.5% triclopyr ester	For aerial applications, the minimum suggested total spray volume is 4 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. For ground broadcast applications, the suggested total spray volume is 20–25 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. Thoroughly wet foliage for individual plant treatments. Add 32–64 oz surfactant/100 gal water.	Late spring–mid-summer with mature (dark green) leaves. Optimum period of application begins when soil temperature at a depth of 12 in. reaches 75°F and continues for 45 days thereafter; with the clopyralid tank mix the period should continue for 60 days after soil temperature reaches 75°F. If mesquite has 10% canopy cover or less, application may be made in spring or fall.	The mixture of 32 oz picloram + 21 oz clopyralid or 32 oz picloram + 28 oz aminopyrlid:clopyralid will usually provide better results than the 32 oz picloram + 11 oz clopyralid mixture. Mixtures will control most weeds.

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Mixed brush—South Texas (includes several of the following: blackbrush, catclaw acacia, granjeno or spiny hackberry, guajillo, huisache, mesquite, pricklypear, retama, skunkbush, tasajillo, twisted acacia *(continued from previous page)*	picloram + clopyralid	M 32 oz (0.5 lb) picloram + 11–21 oz (0.25–0.5 lb) clopyralid	H 0.5% picloram + 0.5% clopyralid	For aerial applications, the minimum suggested total spray volume is 4 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. For ground broadcast applications, the suggested total spray volume is 20–25 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. Thoroughly wet foliage for individual plant treatments. Add 32–64 oz surfactant/100 gal water.	Late spring–mid-summer with mature (dark green) leaves. Optimum period of application begins when soil temperature at a depth of 12 in. reaches 75°F and continues for 45 days thereafter; with the clopyralid tank mix the period should continue for 60 days after soil temperature reaches 75°F. If mesquite has 10% canopy cover or less, application may be made in spring or fall.	The mixture of 32 oz picloram + 21 oz clopyralid or 32 oz picloram + 28 oz aminopyrlid:clopyralid will usually provide better results than the 32 oz picloram + 11 oz clopyralid mixture. Mixtures will control most weeds.
	picloram + dicamba	M 32 oz (0.5 lb) picloram + 16 oz (0.5 lb) dicamba	H 0.5% picloram + 0.5% dicamba			
	aminopyralid:clopyralid + picloram	M 28 oz (0.61 lb) aminopyrlid:clopyralid + 16–32 oz (0.25–0.5 lb) picloram	—			
	aminopyralid:clopyralid + triclopyr ester	M 28 oz (0.61 lb) aminopyrlid:clopyralid + 8–32 oz (0.25–0.75 lb) triclopyr ester	—			
Mixed brush—Davis Mountains (includes catclaw acacia, catclaw mimosa, and whitebrush)	tebuthiuron 20% pellets	M** 7.5–10 lb of pellets (1.5–2 lb active ingredient)	H 0.5 oz of pellets (0.1 oz active ingredient)/50–100 sq ft of ground area	—	Anytime—optimum period is May 1–Jul 1.	Use 10 lb pellets/ac when soil is a loam, silt loam, silt, sandy clay loam, or clay loam. Use low rate when soil is a sand, loamy sand, or sandy loam. For individual plant treatment apply pellets evenly on soil under the plant canopy and 1 ft beyond the canopy edge.
Mohrs shinoak	tebuthiuron 20% pellets	VH 5 lb of pellets (1 lb active ingredient)	VH 0.5 oz of pellets (0.1 oz active ingredient)/100 sq ft of ground area	—	Anytime—optimum period is Oct 1–Apr 1.	Use only when oak stand is predominantly Mohrs shinoak. These stands are generally found in Coke, Mitchell, Nolan, Sterling, and Taylor Counties. For individual plant treatment, apply pellets evenly on the soil under the plant canopy and 1 ft beyond canopy edge.

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**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Pricklypear, tasajillo	aminopyralid: picloram:fluroxypyr (1:2:2)	H 32 oz (0.5lb)	VH 1%	For aerial applications, the minimum suggested total spray volume is 4 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. For ground broadcast applications, the suggested total spray volume is 10–25 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. Thoroughly wet foliage for individual plant treatments. Add 32–64 oz surfactant/100 gal water.	Anytime—best results have been obtained with late summer through fall applications.	Use 1 pt/ac picloram only on High Plains where no brush overstory is present. Late summer or fall applications, especially with fluroxypyr, will provide best results, but aerially spray in the winter or early spring if heavy overstory of woody plants is present or if damage to live oak is a concern. Picloram:2,4-D (1:4), (3.8 lb/gal product): Do not apply more than 80 oz/acre per year.
	picloram	H** 16–32 oz (0.25–0.5 lb)	VH 1%			
	picloram:fluroxypyr (1:1)	H 64 oz (0.67 lb)	VH 1%			
	picloram:2,4-D (1:4), (3.8 lb/gal product)	H 80 oz (2.4 lb)	VH 1.3%			
	picloram:2,4-D (1:4), (2.5 lb/gal product)	H 128 oz (2.5 lb)	VH 2%			
	triclopyr: fluroxypyr (3:1)	—	VH 1%			
	fluroxypyr	—	VH 0.5%			
	prescribed burn + picloram	VH** 8–16 oz (0.125–0.25 lb)	VH 1%	For individual plant treatment, thoroughly wet all pads and crowns that survive the fire. Use a water carrier and add 32–64 oz surfactant/100 gal water.	After burn, when new pads are 3 in. tall. If new pads do not develop, spray by Apr 30.	Carry out prescribed burn Dec–Mar. Sufficient fine fuel with good fuel continuity should be present to provide a uniform burn with moderate to high intensity. Spray the burned area within 5 mo. of the burn but no later than Apr 30 (May 31 if new pads do not develop by Apr 30). Use 8 oz picloram when the prescribed burn is sufficiently intense to brown-out most pricklypear pads with <10% of the pricklypear green 2 wk after the burn. Use 16 oz picloram following moderate-intensity burn with more than 10% of the pricklypear green 2 wk after the burn. The prescribed burn + picloram treatment is not recommended for the Rio Grande Plains land resource area.
Redberry juniper (redberry cedar) *(continued on next page)*	hexazinone liquid (plants <6 ft tall)	—	VH 2 ml/3 ft height or canopy diameter (whichever is greater)	—	Late winter–summer	Apply undiluted hexazinone liquid or hexazinone pellets to soil surface between the stem base and the edge of the canopy. Use an exact delivery handgun applicator to apply hexazinone liquid. If plant size requires more than a single 2 or 4 ml application of hexazinone liquid, or 1 hexazinone pellet, apply subsequent applications or pellets equally spaced around the plant. Do not use these treatments on marshy or poorly drained sites nor on soils classified as clays. Best results are expected on coarse-textured soils.

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Redberry juniper (redberry cedar) *(continued on next page)*	hexazinone pellet (plants <6 ft tall)	—	VH 1 pellet/3 ft height or canopy diameter (whichever is greater)	—	Late winter–summer	Apply undiluted hexazinone liquid or hexazinone pellets to soil surface between the stem base and the edge of the canopy. Use an exact delivery handgun applicator to apply hexazinone liquid. If plant size requires more than a single 2 or 4 ml application of hexazinone liquid, or 1 hexazinone pellet, apply subsequent applications or pellets equally spaced around the plant. Do not use these treatments on marshy or poorly drained sites nor on soils classified as clays. Best results are expected on coarse-textured soils.
	hexazinone liquid (plants >6 ft tall)	—	H 4 ml/3 ft height or canopy diameter (whichever is greater)	—		
	hexazinone pellet (plants >6 ft tall)	—	H 2 pellets/3 ft of height or canopy diameter (whichever is greater)	—		
	picloram	—	VH** 4 ml/3 ft of height or canopy diameter (whichever is greater)	—	Spring–fall, before expected rainfall.	Apply undiluted picloram to the stem base at or near the ground line. Use an exact delivery handgun applicator to apply the 4 ml dose. If plant size requires more than a single 4 ml application, space subsequent applications equally around the plant. Do not use on marshy or poorly drained sites nor on soils classified as clays.
Redberry juniper (cut stumps)	picloram	—	VH 4% in water	Spray the sides of the stump and the cut surface, including the cambium, immediately after cutting, to thoroughly wet the stem and root collar area, but not to the point of runoff. Add 32–64 oz surfactant to 100 gal spray mix.	Anytime, except when snow or water prevent spraying to the ground line.	This is commonly called the cut stump application method. Apply with a backpack or knapsack sprayer using low pressures and a solid cone or flat fan nozzle. Add 32–64 oz surfactant/100 gal water.
Retama	picloram + triclopyr ester	L–M 32 oz (0.5 lb) picloram + 16 oz (0.5 lb) triclopyr ester	H 0.5% picloram + 0.5% triclopyr ester	For aerial applications, the minimum suggested total spray volume is 4 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. For ground broadcast applications, the suggested total spray volume is 20–25 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. Thoroughly wet foliage for individual plant treatments. Add 32–64 oz surfactant/100 gal water.	Spring, with mature foliage or fall with good soil moisture and foliage.	
	picloram + clopyralid	L–M 32 oz (0.5 lb) picloram + 11–21 oz (0.25–0.5 lb) clopyralid	H 0.5% picloram + 0.5% clopyralid			
	picloram:fluroxypyr (1:1)	L–M 96 oz (1.0 lb)	H 1%			
	picloram	L–M 32 oz (0.5 lb)	H 1%			

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Running live oak	tebuthiuron 20% pellets	VH 5–10 lb pellets (1–2 lb active ingredient)	VH 0.5 oz pellets (0.1 oz active ingredient)/50–100 sq ft of ground area	—	Anytime—optimum period is Oct 1–Apr 1.	Use low rate on brush 2–8 ft tall. Use 7.5 lb pellets/ac when brush is 2–8 ft tall on rolling or hummocking site and when live oak plants are 8 ft or taller without understory species such as yaupon. Use 10 lb pellets/ac when live oak plants are taller than 8 ft and an understory of yaupon and other species is present. For individual plant treatment, apply pellets evenly on the soil under the plant canopy and 1 ft beyond canopy edge.
Sacahuista	tebuthiuron 20% pellets	—	H 0.25 oz pellets (0.05 oz active ingredient)/plant	—	Anytime—optimum period is Oct 1–Apr 1 except in Trans-Pecos, where optimum period is May 1–Jul 1.	Apply pellets evenly on the soil under the plant canopy near the stem base.
Saltcedar	imazapyr	VH** 64 oz (1 lb)	VH 1%	Minimum 10 gal/ac for aerial or ground broadcast sprays. Thoroughly wet foliage for individual plant treatment. Add 32–64 oz surfactant/100 gal water.	Jul–Sep, or until leaves begin to turn yellow.	When exposure to aquatic environments is possible use aquatic labels of imazapyr and glyphosate (see Table 2). Imazapyr alone or in combination with glyphosate will cause damage to desirable plants if contacted by the spray mix.
	imazapyr + glyphosate	VH 32 oz (0.5 lb) imazapyr + 16 oz (0.5 lb) glyphosate	VH 0.5% imazapyr + 0.5% glyphosate			
	triclopyr ester	—	VH 25% in diesel fuel oil	Apply to lower 12–18 in. of trunk to wet the trunk; do not spray to point of runoff. Apply completely around the trunk.	Growing season when trees have mature leaves.	This is a Brush Busters® low volume basal application method. Use a hollow cone nozzle with XI orifice.
Sand sagebrush	2,4-D low volatile ester	H 32 oz (1 lb) 4 lb/gal product {up to 64 oz (2 lb) for ground broadcast}	VH 1% (4 lb/gal product)	For aerial applications, the minimum suggested total spray volume is 4 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. For ground broadcast applications, the suggested total spray volume is 20–25 gal/ac. Use water + surfactant, crop oil, or methylated seed oil. Thoroughly wet foliage for individual plant treatments. Add 32–64 oz surfactant/100 gal water.	May 1–Jun 15 under good growth conditions with plants fully leafed.	Do not spray when plants are defoliated by late freeze, hail, or unfavorable growth conditions. Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
	metsulfuron methyl dicamba:2,4-D (1:3) + 2,4-D low volatile ester	H Rate 1 metsulfuron methyl dicamba:2,4-D (1:3) + 16 oz (0.5 lb) 2,4-D (4 lb/gal product)	—			

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Sand shinnery oak	tebuthiuron 20% pellets	VH 3.75–5 lb of pellets (0.75–1 lb active ingredient)	VH 0.5 oz of pellets (0.1 oz active ingredient)/100 sq ft of ground area	—	Anytime—optimum period is Oct 1–Apr 1 except in Trans-Pecos where optimum period is May 1–Jul 1.	Use 3.75 lb pellets/ac in southern High Plains and Rolling Plains. Use 5 lb pellets/ac in eastern Panhandle north of Prairie Dog Town Fork of the Red River. For individual plant treatment, apply pellets evenly on the soil under the plant canopy and 1 ft beyond canopy edge.
	tebuthiuron 80DF	H–VH 1.25 lb (1.0 lb)	—	Apply by mixing with water and using ground equipment equipped with straight stream nozzles spaced 3–6 ft apart delivering a total spray volume of 20–30 gal/ac.	Anytime—optimum period is Oct 1–Apr 1 except in Trans-Pecos where optimum period is May 1–Jul 1.	Use the closer spacing of nozzles when treating high densities of sand shinnery. Applications will result in damage to grass directly under each nozzle that can persist for 1–3 yr. Agitation is important to dissolve and maintain tebuthiuron 80DF in solution during application.
Saw palmetto	metsulfuron methyl dicamba:2,4-D (1:3)	H–VH Rate 2 or Rate 3 (see remarks)	—	For ground broadcast applications, the suggested total spray volume is 15–30 gal/ac. Use water + surfactant, crop oil, or methylated seed oil.	Mid–late summer (August)	Rate 2 applications generally result in "high" control levels the first year after treatment, improving to "very high" by the second year after treatment. Rate 3 applications can be expected to produce "very high" control levels by the first year after treatment. Do not mow treated areas for at least 1 year. Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
Texas Persimmon	aminocyclopyrachlor: triclopyr amine (1:2)	—	VH 2%	Thoroughly spray foliage to wet but not dripping. Add 32–64 oz (0.25–0.5%) nonionic surfactant/100 gal water.	Late spring through summer with mature (dark green), healthy leaves. Applications before July 1st have been the most effective and consistent.	Aminocyclopyrachlor:triclopyr amine requires specific picolinic acid chemistry training and certification before use. See label for additional site-use information and restrictions.
Whitebrush (beebrush, beebush)	tebuthiuron 20% pellets	VH** 5–7.5 lb of pellets (1–1.5 lb active ingredient)	VH 0.5 oz of pellets (0.1 oz active ingredient)/50–100 sq ft of ground area	—	Anytime—optimum period is Oct 1–Apr 1 except in Trans-Pecos, where optimum period is May 1–Jul 1.	Use 5 lb pellets/ac on sand, loamy sand, or sandy loam soils. Use 6.25 lb pellets/ac on soils with 20 to 30 percent clay. Use 7.5 lb pellets/ac on areas with grass production >1,500 lb/ac or on areas where mesquite, Texas persimmon, or other woody plants have a canopy cover of 20% or more with whitebrush that is 6 ft tall or taller. For individual plant treatment apply pellets evenly on the soil under the plant canopy and 1 ft beyond canopy edge.

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low

Brush controlled	Herbicide (common and chemical names, Table 2)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for individual plant)	Time to apply	Remarks
		Broadcast rate per acre	Individual plant treatment*			
Yaupon	aminocyclopyrachlor: triclopyr amine (1:2)	—	H–VH 1.5%	Thoroughly spray foliage to wet but not dripping. Add 32–64 oz (0.25–0.5%) nonionic surfactant/100 gal water.	Late spring through summer with mature (dark green) and healthy leaves.	Aminocyclopyrachlor:triclopyr amine requires specific picolinic acid chemistry training and certification before use. See label for additional site-use information and restrictions.
Yucca (species)	aminocyclopyrachlor: triclopyr amine (1:2)	—	H–VH 1.5%	Thoroughly wet the center whorl of each individual yucca. Add 32–64 oz (0.25–0.5%) nonionic surfactant/100 gal water.	Late spring through summer with mature, healthy leaves.	Aminocyclopyrachlor:triclopyr amine requires specific picolinic acid chemistry training and certification before use. See label for additional site-use information and restrictions.
	triclopyr ester	—	H 2% in diesel fuel oil	Spray the center of each individual whorl of leaves to the point of runoff.	Anytime	Complete coverage of leaves is not necessary. The crown of each plant must be thoroughly wet with the herbicide mixture.
		—	H 2% in 1:5 diesel fuel oil:water emulsion		May–Sep	Use emulsifier and agitate to maintain emulsion. Complete coverage of leaves is not necessary. The crown of each plant must be thoroughly wet with the herbicide mixture.
		—	VH 15% in diesel fuel oil	Use an adjustable cone nozzle (X1 orifice) and spray a 2-second burst into each whorl.	Spring–summer	Direct spray into the center of each whorl.
		—	H Undiluted 2–4 ml per plant whorl	Use an exact delivery handgun set at 2 or 4 ml/whorl dose.		
		—	VH Undiluted	Use an adjustable cone nozzle (XI orifice) and spray a 2-second burst into each whorl.		
	metsulfuron methyl dicamba:2,4-D (1:3) + 2,4-D low volatile ester	H Rate 2 metsulfuron methyl dicamba:2,4-D (1:3) + 16–24 oz 2,4-D (4 lb a.i./gal product)	—	Crop oil concentrate, modified seed oil, or modified seed oil/ organosilicone are the preferred adjuvants. For aerial applications, a minimum of 4 gal/ac total spray volume is recommended.	Spring–fall before frost	A second follow-up application of metsulfuron methyl dicamba:2,4-D (1:3) at Rate 1 or Rate 2 + 2,4-D low volatile ester at 0.5–0.75 lb a.i./ac within 2 yr of the initial application may be required to control yucca seedlings and regrowth from rootstocks. Because of metsulfuron methyl in the formulation, these herbicides are not recommended on bahiagrass pastures for weed control.
	metsulfuron: chlorosulfuron (3:1) + 2,4-D low volatile ester	H 0.675 oz metsulfuron: chlorosulfuron (3:1) + 32 oz 2,4-D (4 lb a.i./gal product)	—			

*See Table 4 for mixing information.
**Treatment control ratings: VH – Very High; H – High; M – Moderate; L – Low