BRUSH MANAGEMENT FOR WHITE-TAILED DEER

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Photo by Timothy Fulbright

A Joint Wildlife Technical Publication
of the
Caesar Kleberg Wildlife Research Institute
Texas A&M University-Kingsville
and
Texas Parks and Wildlife

2001

layout, design, and editing by Alan M. Fedynich

Printing of this publication was funded, in part, by Texas Parks and Wildlife.

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ABSTRACT

Brush provides cover and food for deer. Optimal deer habitat includes a mixture of brush-covered land and openings free of brush. Brush management can improve white-tailed deer habitat when applied to create a landscape with woody plant canopy interspersed with openings. Openings should be surrounded by brush that provides screening and thermal cover for deer. We recommend that openings range in size from 10-40 acres. Brush management should generally not be applied to habitats already containing a mixture of brushland and openings. Approaches to brush management include mechanical, biological, pyric (fire), and chemical methods. Mechanical methods are the most widely applied, and are divided into plant removal and top removal methods. Prescribed burning is the most economical and ecologically sound approach to brush management. All methods provide temporary suppression of brush, creating the need for long-term planning and long-term budgeting for repeated treatments to maintain brush suppression.

INTRODUCTION

Mesquite and other woody plants have long been a feature of the Texas landscape. Native Americans used mesquite wood for cooking 6,000 years ago. Travelers and explorers encountered mesquite from South Texas north to the headwaters of the Red River during the early and mid-1800's. Woody plants became a progressively more prominent part of the landscape as settlers from Europe established ranches and grazing by domestic livestock became the primary land use. Brush was a predominant feature of many Texas landscapes by the first part of the 20th century. Brush was viewed as a nemesis by ranchers because it competed with grasses, reducing the yield of forage for cattle and other domestic livestock. Various methods of reducing or "controlling" brush and increasing grasses were developed and employed extensively during the second half of the 20th century.

Although livestock producers often held woody plants in low regard, the increase in white-tailed deer densities in Texas during the early part of the 20th century was attributed by some observers to the increase in brush. White-tailed deer prefer landscapes consisting of interspersed woodland and openings. Brush management can be used to create openings in landscapes covered by continuous woodland. Brush management is to white-tailed deer as a prescription drug is to humans–it is beneficial when needed for a cure and when administered in the proper amount, but an overdose can have deleterious results. Proper application of brush management is based on knowledge of the habitat requirements of white-tailed deer, the effects of brush management on the ecology of plant communities and landscapes, and the differing impacts of the various types of brush management. Many of the basic principles in this bulletin are applicable throughout the State of Texas, however, our focus is on South Texas, the Edward's Plateau, and the region of northern Mexico that borders Texas.

HABITAT REQUIREMENTS OF WHITE-TAILED DEER

We use brush to mean relatively low-growing woody plants, such as mesquite, and succulents, such as *Yucca* and cacti. Brush is characteristic of vast tracts of white-tailed deer habitat in the southwestern United States and northern Mexico. Although brush is often considered undesirable by cattle ranchers, it is an important component of deer habitat.

The basic habitat requirements of white-tailed deer are food, water, cover, and space. Brush provides food in the form of browse (leaves and twigs) and mast (fruits, berries, and nuts). Succulent fruits and leaves and pricklypear cactus pads may be a source of water in addition to other nutrients. Brush provides several types of cover, including hiding cover where deer feel safe from predators, bedding cover, and thermal cover that provides shade during summer and insulation from cold during winter.

Browse is a staple food of white-tailed deer and is generally consumed throughout the year. As a forage class, forbs are preferred by deer more than browse. Many

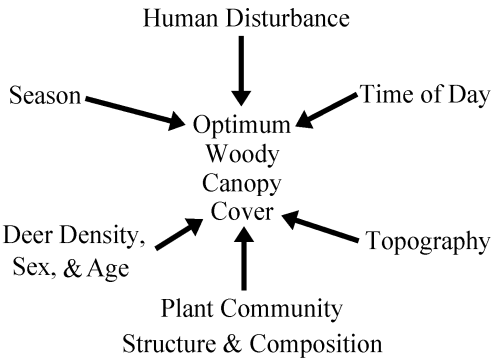

Figure 1. Optimal woody cover is determined by several interacting factors.

forbs preferred by deer are "cool season" plants that grow best during cooler parts of the year. During these times, forbs are a major item in deer diets. When heat and lack of rainfall limit the amount of forbs available, browse becomes the mainstay of deer diets. Thus, browse often acts as a nutritional bridge over periods of low rainfall or warm temperatures when availability of forbs is low. Mast, such as mesquite beans and acorns, is seasonally available and may at times form a substantial and nutritionally important portion of white-tailed deer diets.

Defining the optimum percent brush canopy cover for white-tailed deer habitat has been a subject of debate among wildlife biologists. Optimum canopy cover for deer is complex and too variable for a simple definition. Woody canopy cover requirements of deer vary seasonally with deer density, sex, and age, plant community structure and composition, topography of the landscape, amount of human disturbance, and time of day (Fig. 1).

Shade provided by a heavy overhead canopy may be important to deer for thermoregulation (Fig. 2). Temperatures during summer are much cooler beneath woody canopies than in clearings. Soil surface temperatures during July are up to 45° F cooler beneath the canopy of large mesquites than in areas free of a woody

Figure 2. Woody cover that provides shade may be particularly important in areas where temperatures remain warm for extended periods of time. Photo by Timothy Fulbright.

canopy. During hot summers in South Texas, deer may remain bedded in dense shade for most of the daylight hours. In a South Texas study, no relationship existed between total brush canopy cover and deer use of the habitat during January and November. During summer, deer use was greatest in areas with the greatest woody canopy cover (97%) and declined with declining percent woody canopy cover. Woody cover that provides shade may be particularly important in areas such as South Texas where temperatures remain high for extended periods of time. During cold winters, woody canopies help deer to remain warm by insulating them against heat loss and by protecting them from wind.

Mature bucks spend much of their time in areas with greater than 85% brush canopy cover (Fig. 3). In a South Texas study, mature bucks did not use areas where brush was less than 15 feet tall. For other deer sex and age classes, brush should exceed 3-4 feet in height to provide optimum hiding cover. Deer feel secure when

Figure 3. Mature bucks spend much of their time in areas with greater than 85% brush canopy cover. Photo by Timothy Fulbright.

the spatial arrangement of the habitat enables them to always be within 75 yards of hiding cover.

Habitat use by white-tailed deer may differ between sexes depending on season (parturition, rut, winter-spring, summer) and population density. Females with fawns utilize areas with denser brush than males based on research by John Kie and Terry Bowyer on the unhunted Welder Wildlife Refuge in South Texas. Females nursing fawns require higher concentrations of nutrients than bucks, yet nutritious forbs deer prefer were less abundant in areas of dense brush where does spent most of their time. Kie and Bowyer speculated that does use areas of dense brush to avoid predators despite the paucity of desirable forbs. Differences in habitat use between sexes are less pronounced at high deer population densities than at moderate population densities.

White-tailed deer densities are often greatest in relatively lush habitats along bottomlands and drainage areas. In a South Texas study, deer preferred mesquite-dominated drainage habitats during fall, spring, and summer. Sugar hackberry-dominated habitats were preferred during winter. The tall vegetation in these areas provides preferred loafing and bedding sites and should remain undisturbed.

Deer prefer clearings with little or no woody cover for early morning, evening, and nighttime feeding. Landscapes that provide optimum deer habitat should have clearings dominated by forbs and grasses interspersed in surrounding brushland.

Management planning should be done on a landscape scale rather than a "pasture" scale. Managing white-tailed deer habitat based on a "rule-of-thumb"

prescription for clearing brush may result in leaving brush that is inadequate for screening cover, thermal cover, bedding cover, food, or other needs. Managers should be careful not to destroy local areas of dense brush, or areas supporting large, mature single-stemmed mesquites needed for thermal cover by deer. Clearing an entire pasture may destroy a critical habitat component and reduce the ability of the surrounding landscape to support deer. Clearing a portion of a drainage system may impact a relatively small percentage of a ranch, however, fragmentation and loss of that vitally important habitat may reduce deer densities on the ranch.

Management planners should ensure that sufficient amounts of each habitat type required by deer remain on the landscape following brush management. Management planning should focus on interspersion of clearings and stands of brush on an area. If there are not enough clearings to meet the needs of deer, or they are poorly interspersed, then clearings could be created as long as interconnected woody cover remains. Conversely, if stands of brush are not interconnected and clearings are too large, a manager may decide to allow brush to reestablish in selected areas to create a mosaic of interconnected stands of brush. Ensuring that communities dominated by woody plants are interconnected and are available to deer in all parts of the landscape is more important than attempting to clear an arbitrarily determined percentage of the landscape.

ECOLOGICAL CONCEPTS

Plant communities are stands of vegetation that can be distinguished from other stands of vegetation by the particular group of plant species they contain. Each different plant community is associated with a characteristic set of environmental conditions. Soil types and moisture availability are the most important environmental conditions that influence plant species composition. The same distinct group, or community, of plant species will reoccur on the landscape wherever environmental conditions are similar. Plant communities are named by the plant species that dominate them. For example, a live oak-cedar community often dominates rocky hillsides in the Texas Hill Country, and a pecan-hackberry community may dominate deep bottomland. In South Texas, wherever there are caliche ridges there is a guajillo-blackbrush-cenizo community.

Severe disturbance to vegetation may cause the existing community to be replaced by a different community. For example, if a four-flowered trichloris and mesquite-mixed brush community is plowed up, the plant community that grows on the plowed ground might consist of doveweed, sunflowers, and prickly poppy (Fig. 4). The “pioneer” or early-successional doveweed, sunflower, and prickly poppy community will eventually be replaced by a different community through the process of ecological succession. In the traditional model of succession proposed by Frederick Clements, communities appear and then are replaced by new communities until a community appears that is similar to the original that existed before the disturbance occurred.

The traditional model of succession may not apply in semiarid and arid environments. In these environments, disturbance to vegetation by forces such as plowing or heavy grazing may result in replacement of the original plant community by a new plant community that is relatively stable in time and differs in plant composi-

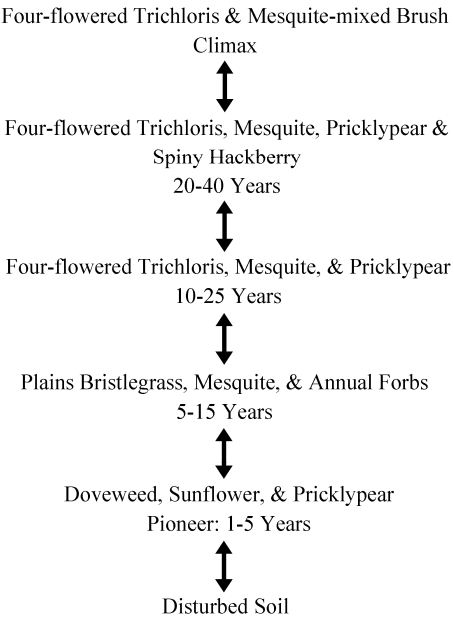

Figure 4. Hypothetical stages in succession and range of years that each stage persists on a clay loam soil in South Texas.

tion from the original community. For example, on upland soils in South Texas, root plowing may convert a species-rich mesquite-mixed brush community to a species-poor community that persists indefinitely with no successional trend toward the original mixed brush community.

Disturbance is a natural factor in ecosystems. Before colonization by Europeans, natural disturbances such as fire and grazing created a mosaic of different successional stages across the landscape. Colonization and ranching have altered the natural dynamics of ecosystems that were important in maintaining a mosaic of different successional stages. Establishment of ranching and other land uses resulted in the reduction in occurrence of natural disturbances such as wildfire. Livestock grazing is more uniformly distributed across the landscape and less seasonal than grazing by bison and other wildlife before colonization.

Manipulation of succession is an important part of habitat management. Human-imposed disturbances such as brush management may mimic natural disturbances on landscapes where natural disturbance regimes have been inhibited. White-tailed deer prefer habitats where portions of the landscape are periodically disturbed, and thus may be benefitted by human-imposed disturbances that result in a variety of successional stages in portions of the landscape.

Not all wildlife species benefit from periodic disturbances. Certain wildlife species exist only in habitats where disturbance is minimal. Examples of two species found in the undisturbed brushland of South Texas include the ocelot, which is an endangered cat and the chachalaca, which is a pheasant-like bird. Both species live in incredibly dense brush and may not survive if that brush is removed or disturbed by mechanical or chemical means.

Habitat requirements of **all** wildlife species should be considered when planning brush management for deer. Brush and other components of deer habitat, as well as the deer themselves, are an integrated part of an ecosystem. An ecosystem consists of all the living organisms and their nonliving surroundings, including the air, water, rocks, and soil. The living organisms within an ecosystem interact with each other, and organisms also interact with their nonliving surroundings. Nutrients, such as nitrogen, cycle through the ecosystem (Fig. 5). Plants and animals die, and decompose, returning nitrogen to the soil. Plants then remove the nitrogen from the

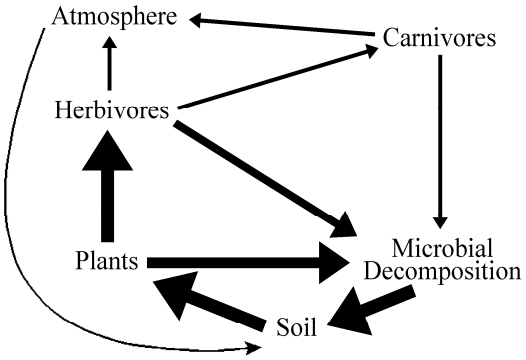

Figure 5. The nitrogen cycle in an ecosystem.

soil, and it is passed to deer and other herbivores when they eat the plant. When plants and animals die, the cycle starts over again.

An understanding that each part of an ecosystem interacts with all other parts is critical for habitat managers. If one part of an ecosystem is affected, all other parts are affected and will react in some manner. For example, clearing brush not only affects deer, but it may alter nutrient cycling by making soil nutrients more available to grasses and forbs. Removing nutrients by grazing too many cattle may ultimately result in nutrient depletion.

Sometimes the effect of an action on one part of the ecosystem produces unanticipated and undesirable side effects in other parts of the ecosystem. Brush clearing to improve habitat for deer might also result in loss of soil nutrients, palatable browse and mast-producing shrubs, and nesting habitat for a songbird species. For example, the microenvironment beneath large, mature mesquites is cooler during summer and higher in soil nutrients than the surrounding habitat dominated by grasses and forbs. Birds perch in mesquites and deposit seeds of palatable shrubs such as spiny hackberry, which become established in the more favorable habitat beneath mesquite. Removing large tracts of mature mesquites disrupts this process by which spiny hackberry and other species of palatable shrubs become established. Knowledge of individual plant species and their role in the ecosystem is important when making management decisions. Brush management planning must be based on the ecosystem concept and all possible ramifications must be considered.

Habitat fragmentation is detrimental to many wildlife species. Wildlife populations need a sufficiently large core area of habitat to exist. The size of core area needed varies among wildlife species and is poorly defined for most species. It may be only a few acres for collared lizards or tens of thousands of acres for mountain lions. Species cease to exist when urbanization, agriculture, and other causes of habitat loss reduce the amount of habitat past the minimum threshold core area size or when connectivity of habitat patches is disrupted.

Corridors of habitat that connect core areas of habitat allow for movement of animals among populations. Destruction of these corridors isolates populations. If the population is decimated by disease or other factors, immigration from other core habitat areas to replenish the population will not be possible. Habitat managers should be careful to ensure that core areas of habitat are connected by habitat corridors. Streams, creeks, rivers or drainage areas often serve as corridors for animals to move from one important habitat to another.

BRUSH MANAGEMENT BASICS

General Concepts

Manipulating canopy cover and density of brush may improve white-tailed deer habitat by: (1) reducing competition between woody and herbaceous plants resulting in increased yield of herbaceous vegetation, (2) providing openings to serve as focal areas for feeding activity, and (3) increasing nutritional quality, accessibility, and palatability of browse by stimulating growth of immature sprouts from crowns and stem bases. When the goal of brush management is to improve deer habitat, brush management should be designed to foster a landscape containing the optimum structure, spatial arrangement, and dispersion of habitat requirements of deer. Optimum habitat for white-tailed deer will include:

- a landscape of interconnected areas dominated by woody plants interspersed with openings, with the percentage of each depending on plant species composition and structure, topography, and amount of human disturbance;
- natural or artificially-created openings of 20-40 acres surrounded by brush that provides shade in summer or protection from cold in winter (thermal cover);
- areas of habitat dominated by diverse, dense brush with tall screening cover and 85% or greater woody plant canopy;
- areas of hiding cover behind which deer are concealed;
- brush-lined drainage areas that are continuous throughout the landscape and provide loafing areas, bedding areas, and corridors for movement between habitat patches; and
- areas that support browse, pricklypear, forbs, and mast-producing plant species preferred by white-tailed deer.

Achieving optimum dispersion (even distribution of habitat features across the landscape) and juxtaposition (close proximity of required habitat features) should be a goal of brush management. There are several decisions to make before using brush control to improve deer habitat.

- What are my long-range goals and objectives? Is the objective to increase forage for livestock, improve the habitat for wildlife, or both? A long-range goal with specific objectives should be established before altering the habitat. Consider the long term effects or implications before manipulating the habitat–a hastily or poorly planned program may not have the desired results.

- Is brush management really necessary? Many landscapes in their natural state possess an optimum combination of these habitat features, so brush manipulation could degrade habitat quality for wildlife. Too often, the decision to control brush is based on a desire to "do something" or a perceived need rather than a biological need for habitat improvement.

- Am I willing to do something that will have long-term consequences? Previous efforts at mechanical brush control that were not followed by periodic maintenance have, in many instances, resulted in landscapes consisting of denser brush than existed before brush control was applied. Overgrazing compounds the negative impacts of brush control, particularly when follow-up maintenance treatments are not applied (Fig. 6). In many cases, habitat improvement will yield greater rewards in these previously treated areas than in habitats not previously disturbed by brush control and overgrazing.

- How can I apply brush management in a manner that provides optimum habitat for deer? Brush management is often applied in a manner convenient to the equipment operator. Cleared strips are an example of a brush management

Figure 6. Overgrazing compounds the negative impacts of brush control. Photo by Timothy Fulbright.

design convenient to equipment operators and less expensive for the landowner. Long, cleared strips may also provide easier working and gathering of livestock. However, strips result in habitat fragmentation and a loss of connectivity between wooded areas. In the long run, if the goal is improving the habitat for deer and not for livestock, it is better to avoid long cleared strips. A patchwork or mosaic design that leaves brush-dominated portions of the landscape interconnected is more desirable, even if it is more costly to apply (Fig. 7). A well-thought-out and well designed plan to create a landscape that possesses well interspersed and juxtaposed habitat features needed by deer is a critical first step that should be taken before any brush management operation. Brush management reduces the quality of habitat for white-tailed deer when applied without proper planning and without regard to habitat features required by deer.

- Can I afford the cost of periodic maintenance of the areas that I have treated? All brush management methods are only temporarily effective. Follow-up treatments are critical. Brush management planning must include setting aside funds to periodically retreat areas where brush has been manipulated. Long-term effects of brush management should be given equal consideration to short-term effects in management plans.

- Are soils and rainfall suitable for brush management? Certain ranches may have soils unsuitable for manipulation or rainfall may be too low. Root plowing saline soils may bring salts to the surface and inhibit plant growth. Certain soils are more prone than others to invasion of unpalatable native plants such as goldenweed and exotic grasses such as Kleberg bluestem and buffelgrass following disturbance. Mechanical brush management should be avoided in areas supporting populations of invasive plants because soil disturbance may cause them to spread aggressively.

Figure 7. A patch pattern (left photo) of brush management leaves greater interconnectivity among brushy areas than a pattern of long strips (right photo). Aerial photographs courtesy of the U.S. Geological Survey.

Figure 8. Dense brush along the drainage was left intact in the photo on the left. Brush along the drainage in the photo on the right was cleared, resulting in fragmentation of brush tracts on either side of the cleared area. Aerial photographs courtesy of the U.S. Geological Survey.

The objective of brush management to improve habitat for deer should be to create a habitat mosaic that maximizes the value of the landscape as habitat. Soils, plant community composition, past management history, and objectives of the landowner vary greatly from one ranch to the next. Consequently, the best approach to manipulating brushy rangelands to enhance white-tailed deer habitat varies from ranch to ranch. Management plans for improving habitat for white-tailed deer should therefore be based on the following general concepts that can be modified and adapted to fit specific circumstances.

- Clear small (about 20 acres) irregularly shaped patches and have them scattered throughout the landscape. Leave corridors of brush separating the patches that are, at a minimum, sufficiently wide to conceal deer during winter when screening ability of the vegetation is at its lowest.

- Areas of tall, dense, diverse brush with canopy cover greater than 85% should be interspersed throughout the landscape to provide cover for mature bucks.

- Avoid disturbing brush in and along natural drainage areas (Fig. 8).

- Use the brush control method best suited to the habitat. In South Texas, root plowing is not recommended because it reduces plant species diversity and destroys the cover of native grasses and forbs on certain soils.

Mechanical Brush Management

Methods of mechanical brush management can be divided into **plant removal** or **top removal** (Table 1). Methods of plant removal include grubbing individual plants, root plowing, discing, railing, cabling, chaining, bulldozing, and variations of these methods. These techniques only temporarily reduce canopy cover and density of woody plants. For even the most severe treatment (root plowing), brush reestablishes to the degree that re-treatment is necessary within 10-20 years. Reestablishment occurs because seeds of woody plants remain in the soil even if all

Table 1. Pros and cons of mechanical, chemical, biological, and pyric brush control methods.

Method	Pros	Cons
Mechanical		
Root plowing and root plowing followed by raking	most effective temporary approach to killing brush; increases herbaceous vegetation at least temporarily	expensive; reduces brush diversity; reduces deer densities when done on large areas; soil disturbance may increase goldenweed and other undesirable plants
Chaining, cabling, railing	less expensive and less harmful to diversity than root plowing; increases herbaceous vegetation at least temporarily	may result in greater brush density and cover if not periodically repeated; suppresses brush for a shorter period of time than root plowing
Discing	less expensive and less harmful to diversity than root plowing; increases herbaceous vegetation at least temporarily; may improve infiltration of water	may exacerbate invasion of exotic grasses, goldenweed, and unpalatable forbs
Roller chopping, aerating, mowing, shredding, base shearing	less expensive and less harmful to diversity than root plowing; roller chopping and aerating may improve infiltration of water; increases herbaceous vegetation at least temporarily	must be retreated every 3-5 years; results in multi-stemmed regrowth and denser stands of brush; repeated roller chopping may result in loss of highly palatable shrubs such as kidneywood
Grubbing	effective control on small areas; can be used to selectively remove undesired species	too labor-intensive to apply on large areas
Biological		
Cattle	decreases grass cover and may result in increases of forb and shrub cover; redistributes nitrogen	requires intense planning; excessive grazing can reduce cover of grasses and forbs, increase soil erosion, and facilitate an increase of unpalatable plants
Goats	may be applied at a low cost	may damage nontarget plants; behavioral aversion exists between goats and deer; deer and goats compete for forage
Insects	species-specific control; may minimize damage to other plants in the community	seldom completely eradicates a species; available for only a limited number of species
Fire	inexpensive; does not damage herbaceous vegetation when applied properly; does not reduce woody diversity	must have sufficient fine fuel; construction of firelines and availability of a fire crew are critical; liability insurance recommended; use of a Certified Prescribed Burn Manager is recommended
Chemical	no soil disturbance; ability to target problem species; useful as a preparatory treatment before prescribed burning	forb biomass may be reduced for up to four years after treatment; many brush species are resistant to herbicides; herbicide applicator's license required

woody plants are killed and because animals facilitate dispersal of seeds to treated areas. Discing, railing, cabling, chaining, and bulldozing are more temporary than root plowing with re-treatment usually needed within 10-12 years.

In root-plowed areas with certain soils, reestablishment of preferred browse species is limited. Mesquite, huisache, twisted acacia, and hog plum replace highly palatable browse species such as spiny hackberry, brasil, and Texas kidneywood. Consequently, the woody plant community that develops on root-plowed land is poorer habitat for deer than the plant community that existed before root plowing.

Discing, railing, cabling, chaining, and bulldozing do not reduce woody plant diversity to the degree that root plowing does. A long-term effect of chaining on many soils is an increase in woody plant canopy well beyond the canopy cover that existed before. Chains and cables are not effective in controlling multi-stemmed shrubs with flexible stems, such as guajillo, because they tend to ride over the plants without uprooting them. Discing, railing, cabling, and chaining may also increase pricklypear by breaking apart and spreading the pads, which then take root. These mechanical treatments should be done during periods of hot, dry weather to minimize spread of pricklypear.

Unpalatable plants such as goldenweed may increase dramatically on rangeland where the soil surface has been disturbed by root plowing, discing, railing, cabling, chaining, and bulldozing. Exotic grasses such as buffelgrass and Kleberg bluestem also invade areas where the soil has been disturbed. Goldenweed, buffelgrass, and Kleberg bluestem form dense stands that inhibit growth of forbs eaten by white-tailed deer. Brush management methods that cause soil disturbance should be avoided in areas where seed sources of these species are present or nearby.

Top removal treatments include roller chopping (Fig. 9), aerating, and shredding. These treatments do not kill brush, but only remove top growth of the plants. Roller chopping and shredding may loosen soils compacted from livestock grazing and increase water infiltration. Top removal causes basal sprouting of many woody plant species, especially those in South Texas. For example, top removal of

Figure 9. Roller chopper pulled by a crawler tractor. Photo by Timothy Fulbright.

single-stemmed mesquites results in multi-stemmed regrowth. The multi-stemmed regrowth resulting from top removal is less desirable for wildlife habitat and for livestock grazing. Avoid top removal of mesquite if possible. In contrast, top removal of non-sprouting shrubs such as blueberry juniper is an effective control technique. In the Edwards Plateau, the base shearer or skid steer (Fig. 10) is an excellent tool for selectively clearing regrowth juniper without damaging the shallow soils found

Figure 10. A base shearer being used on juniper. Photo by Richard B. Taylor.

in the area. Follow-up treatments are very important and must be repeated every two or three years to maintain suppression of woody plants.

Repeated top removal treatments result in loss of kidneywood, which is a shrub that is extremely palatable to white-tailed deer. The same may be true of other "ice cream" plant species. Enough stands of brush should be left in a management area that any deer in the area will have access to brush that is protected from disturbance by brush management. This will ensure that deer have access to highly palatable browse plants.

Mechanically clearing large tracts of deer habitat (1,000 acres or more) without leaving portions of the landscape with adequate woody cover substantially reduces white-tailed deer use. Root plowing large areas is the most destructive brush control method to white-tailed deer habitat. Root-plowed areas may support an abundance of forbs when rainfall is adequate, and these may attract deer; however, during drought deer do not utilize root plowed areas because browse is not available. Clearing large areas by other methods, such as chaining, also reduces deer use until brush becomes reestablished.

Biological Brush Management

Biological brush management may be the least understood method. Succeeding generations of landowners and ranchers have, often unconsciously, manipulated rangelands biologically. The concept underlying biological brush control is to use the

plant's natural enemies such as animals, insects, organisms, or disease to kill brush or reduce its abundance. A host-specific biological agent that will directly destroy the host plant or weaken it to allow attack by secondary pathogens is required for effective biological control. This technique may sound appealing to environmentally-conscious people; however, it may cause ecological and economic problems. To avoid potential problems, careful planning and research should precede any attempt to begin biological control.

The use of insects in biological control has had limited success. Common examples of insects used for biological control include mesquite twig girdlers, conchuela, walkingsticks, blue cactus borers, caterpillars, moths, and leaf cutter ants (Fig. 11). The blue cactus borer, cactus bug, and cochineal insects suck the juice out of pricklypear thus increasing the plants susceptibility to secondary pathogens. In some areas, forage production for livestock has increased because of defoliation

Figure 11. Leaf cutter ant carrying a shrub leaf. Photo by Noel Troxclair, Jr., Ph.D.

of mesquite by certain caterpillars. Defoliation of creosotebush by the walkingstick has had a similar effect. While the use of insects for controlling woody plants in Texas has been limited, there has been success in the northwestern U.S. using leaf beetles against the introduced Klamathweed. Also, the moth borer has been used to control pricklypear in Australia.

A major concern of using insects is the potential effects on nontarget plant species and ecological imbalance that may result by artificially adding another species to the ecosystem. For example, the conchuela insect reduces seed production in honey mesquite, but is also a pest of cotton–what may curb mesquite establishment on a ranch may cause havoc on a neighboring farm.

The most effective agents for biological control of woody plants are livestock. Generally, livestock are not host specific and therefore affect a variety of plant species. In the Edward's Plateau, sheep and goats are extremely effective in controlling

brush. Goats have been used to control woody plants and increase herbaceous forage production. When combined with other control techniques such as fire, goats can be used to decrease juniper density. Sheep and goats must be carefully managed when used in biological brush management. If their numbers are too great they can be devastating for white-tailed deer because deer, sheep, and goats have similar nutritional requirements and foraging habits. Cattle may also be used to reduce the cover of grasses and increase forbs.

Prescribed Burning

Fire is one of the most effective habitat management techniques and is the oldest and least expensive option available (Fig. 12). Fire is nature's tool for maintaining diversity in ecosystems and controlling woody plants, and serves many roles in habitat management. Humans have used it in ceremonies, hunting, managing habitat,

Figure 12. Prescribed burning is one of the most effective habitat management techniques. Photo by Richard B. Taylor.

and controlling insects. The western two-thirds of Texas was once dominated by grasslands that were maintained, at least in part, by fire. As colonization increased, natural fires were suppressed by settlers and overgrazing by domestic livestock reduced fire fuel loads. This enabled woody plants to mature to seed-bearing age and to increase in density. While mechanical and chemical control methods have been used to try and replace shrubland with grassland, these techniques are expensive, difficult to maintain, and have had only temporary or limited success. Although fire has been around for eons, the science of prescribed burning is relatively recent. The basic concept, however, of burning off old, dry vegetation to allow for new growth for animals to utilize has remained the same.

Prescribed burning is commonly used in rangeland maintenance, as a follow-up to, or in combination with mechanical or chemical treatments. Many woody plant species re-sprout from the base following top growth removal by roller chopping, mowing, or other treatments. Fire removes these sprouts, causing the plant to re-sprout again, which is beneficial for white-tailed deer; however, re-sprouting of

certain plants such as mesquite may be undesirable. Non-sprouting woody plants, such as blueberry juniper (cedar), are easily killed by fire and have modest value for white-tailed deer.

Fire can benefit white-tailed deer by increasing palatability, utilization, availability, and nutrient levels of forage plants. It removes accumulated litter and exposes the ground, which allows granivorous wildlife access to seeds. Fire also assists in germination of many herbaceous plants such as annual forbs. Shortly after a burn when fresh, succulent regrowth occurs, deer will heavily utilize these burned areas.

Since fire can be dangerous to life, livestock, and property, safety is the most important aspect when planning a prescribed burn. A fire boss is needed to coordinate and organize any prescribed burning program. Several people should be available to assist with the burn, and communication between each other is essential. A water truck should be available in case the fire gets out of control. Tools needed also include 2-way radios, matches, drip torches, flappers, chainsaws, repair tools, and shovels.

Adequate ground cover or litter is essential for a successful prescribed burn and is frequently the most limiting factor. A minimum fuel load of 2,000-3,000 pounds of fine fuel (dry grass) per acre is generally required to carry a successful burn. The majority of burning in Texas is done during January, February, and March. Burning in the late summer is relatively new in South Texas and the Edwards Plateau but may be effective in suppressing woody plant growth and stimulating forb growth. More research is needed to make good recommendations and accurately provide prescriptions for summer burns.

For best results and to ensure an adequate fuel load, pastures should not be grazed by livestock during the growing season before the burn. After a burn, the pasture should be free of livestock for 60-90 days to allow the vegetation to recover. It is important to remember that prolonged heavy grazing may inhibit production of the necessary fuels for a successful prescribed burn, even with deferment for a growing season before the burn. In addition to an adequate fuel load, air temperature, humidity, soil and plant moisture content, plant growth stages, wind speed, and wind direction affect the intensity of the fire. A minimum of 20% humidity is necessary to keep the fire under control and a light wind (minimum 5-7 miles per hour) is needed to keep it moving. Generally, a high fuel load with low humidity, high temperature and low wind speed increases the intensity of the fire. If a topkill or suppression of woody plants is the goal, an intense (hot) fire is desired; however, extremely hot fires are not recommended for wildlife management. Only a few woody plants that occur in Texas are killed outright by fire, unless they are young seedlings. If limiting woody plant losses while removing the ground cover is the goal, a "cool" fire may be desired. High humidity, low air temperature, and higher wind decreases the intensity and effect of fire on plants and is therefore considered a cool fire.

Wind speed and direction have a major impact on fire intensity, burn direction, and safety before, during, and after the burn. A headfire is a fire that goes with the wind, whereas a backfire burns into the wind. Headfires are generally more intense than backfires. The effectiveness of fire on various plants depends on growth stage of the plant. Seed-producing forbs, grasses, woody seedlings, and woody re-sprouts

may have different optimum times for burning. Many cool-season forbs that are eaten by deer germinate in the fall. Late winter-early spring burns will kill forb seedlings and benefit grasses. Summer and late fall-early winter burns generally favor forbs at the expense of grasses. Knowing the effects of fire on plants and the time of year is essential when managing for wildlife.

Optimum weather for a prescribed burn in winter is 25-40% relative humidity and an ambient temperature less than 80° F with a wind speed of 5-15 miles per hour. Since most burning is done in winter, the best time to burn is a few days after a cold front when the wind shifts back to the south. In humid areas such as the Coastal Prairie, burns are conducted the day after a norther to take advantage of the low humidity. Once winds shift back to the southeast, humidity is too high for an effective burn. To prevent smoke from accumulating near the ground as a result of temperature inversions, fires should be ignited after 9 am.

Firelanes should be established around the perimeter of the targeted area (Fig. 13). Firelanes are usually created using tractors, bulldozers, or motorgraders but can be as simple as using existing caliche or ranch roads. The desired width of a

Figure 13. Firelines should be established around the perimeter of the area to be burned. Photo by Timothy Fulbright.

firelane depends on factors such as brush type, terrain, and fuel loads. To increase the width of the firelane, it is extremely important to start a backfire or blackline on the downwind side. In addition to fencelines, make sure all electric transmission and telephone poles, buildings, and other structures are safeguarded. Backfiring from a wetline around these areas may be successfully used.

While prescribed burning is an effective management technique, it requires knowledge and skill. Prescribed burning is not as simple as throwing a match and watching the pasture burn, which could be a very dangerous and potentially costly practice. Long-range goals and a carefully written plan are necessary for a successful burning operation. Burning should be conducted only with the assistance of qualified personnel. There are many qualified people to assist with prescribed burns

including the Natural Resources Conservation Service, Texas Parks and Wildlife, and the local county extension agent.

State law requires notification of the Texas Natural Resources Conservation Service before a prescribed burn is conducted. It is recommended to contact various people and agencies including neighbors, local Fire and Sheriffs Departments, and the Department of Public Safety if the burn is within a mile of a public road. When monitoring weather and fire conditions, it is important to keep in contact with the U.S. Weather Service, Texas Natural Resource Commission, and the Air Quality Control Board because they can be extremely helpful.

Cost of prescribed burning varies depending on individual circumstances and ranches and may range from $1-10 per acre depending on topography, firelane construction, equipment, and personnel. Follow-up burns and future burns are cheaper. Do not attempt to burn all pastures in a single year, but rather create a mosaic of varying successional stages of vegetation. Plan to burn specific pastures on a 3-5 year rotation, however, factors such as weather and ecotype may make yearly burning schedules and rotations difficult.

The Texas Prescribed Burning Coalition was formed in 1998. The coalition obtained passage and the Governor's signature on the Texas Prescribed Burning Act in 1999. The act created the Texas Prescribed Burning Board, which is housed at the Texas Department of Agriculture. The Texas Prescribed Burning Board has written the rules for the Texas Certified Prescribed Burn Manager Program. The Program requires a 1-week training course and $1 million liability insurance. The training program addresses all aspects of fire safety and control and is available regionally at a nominal cost. The certification program operates training and certification classes in five regions of Texas: Rio Grande Plains and Gulf Coast Prairies, Trans-Pecos and Edward's Plateau, Panhandle and North Texas, Central Texas and Blackland Prairies, and East Texas Piney Woods.

Chemical Brush Control

Herbicides have been used successfully to control brush, selected woody plants, and weeds. Herbicides are chemicals that affect the physiology of plants enabling them to kill or severely diminish growth of the plant. The life and severity of the treatment depends on many factors such as the herbicide used, plant morphology, soil type, time of year when plants are growing or flowering, and rainfall. Compared to mechanical brush control, the effective response time of plants to herbicides is slower and less dramatic. Responses to chemical treatments begin with an initial defoliation followed by a gradual top kill of the woody plant. Forb abundance is often reduced for 2-3 years following herbicide treatment. Eventually, forb production increases and may ultimately exceed pretreatment levels.

The reduction in forbs following application of herbicides may result in movement of deer out of the treated area. Deer use will resume when forb populations recover. Removal of too much browse by herbicide application may also detrimentally affect deer habitat. Many herbicides used to control brush are species selective, thus adequate browse is often available for deer following herbicide application.

Herbicides are classified according to their specific functions such as their chemical composition, mobility within the plant, method of plant entry, physiologi-

cal action, selectivity, and method of application. While certain herbicides kill only the foliage, leaving a root system to re-sprout, others kill the entire plant.

Three basic types of herbicide application include **direct foliage application, basal application, and soil application**. Foliage-applied herbicides are targeted directly to leaves and stems of plants (Fig. 14). They can kill leaves and stems and are directly absorbed into the stems and trunks and translocated throughout the plant. Basally-applied herbicides are similar to those applied to foliage except

Figure 14. A carpet roller is one method of foliar application of herbicides. Photo by Timothy Fulbright.

they are applied to stems and trunks from groundline to 10-12 inches above the soil. Soil-applied herbicides allow the chemicals to enter the root system after a rainfall. The herbicide is then transferred throughout the plant cells, thus killing the plant. Direct application to foliage may produce quicker results as opposed to soil applications that may be diluted through rainfall, washed away from the root zone, or leached. Herbicides can be applied as aerial or ground broadcasts in spray or pellets and can be applied over large areas or applied as individual plant treatments. Herbicides are often used in areas where soil is shallow and highly erodible, and mechanical brush control is not feasible. Herbicides can also be used effectively for spot treating fencelines or individual non-preferred plants.

Chemicals can be harmful and dangerous to humans, livestock, and wildlife if not handled and applied correctly. The applicator should always read the labels of any herbicides before use, and laws and regulations must be followed. Certain herbicides may require a Private Applicators License to purchase, use, or to supervise the use of restricted products. Dead trunks and branches of woody plants that remain following chemical treatment may appear unsightly and aesthetically unpleasant; however, they (tree skeletons) provide wildlife habitat for certain species of birds, small mammals, and insects.

Cost of chemical treatment may range from $5-70 per acre depending on factors such as brush density, long term goals, herbicide used, and method of application.

Although most chemical treatments have a 5-7 year treatment life, follow-up spot treatments and prescribed burning may be required after two years. Prescribed burns are an excellent follow-up to chemical treatments.

We caution against using herbicides to treat extensive areas of wildlife habitat or sites with large, mature, single-stemmed mesquites. Herbicides are an effective pretreatment to prepare and enhance sites for prescribed burns in a patchwork pattern of burned areas interspersed in untreated brush. Cover of unpalatable forbs such as broom snakeweed, goldenweed, and camphor daisy that reduce yields of palatable forbs can be reduced with herbicides.

Management Planning

The objective of brush management should be to create a habitat mosaic that maximizes the value of the landscape for white-tailed deer. The landscape should include all habitat needs of deer including browse, mast, forbs, screening cover, thermal cover, clearings, and wooded drainage areas. Developing a thorough management plan with clear, specific objectives is essential for successful, long-term management of white-tailed deer habitat. Management plans should integrate wildlife habitat management, wildlife population management, and livestock grazing management. The management plan should include a map of the ranch that identifies areas to be treated and when they will be treated. An itinerary for follow-up maintenance treatments must be included along with the method of treatments. Budgeting for brush management should include funds for the initial treatment and set-aside funds for periodic follow-up treatments. Follow-up treatments may include an integrated approach, such as a herbicide treatment or aeration followed by prescribed burns at 2-3 year intervals. Brush management without follow-up treatments results in habitat degradation, not habitat improvement.

Soils, plant community composition, past management history, and objectives of the landowner vary greatly among ranches. Brush management plans for improving habitat for white-tailed deer should therefore be based on general concepts that can be modified and adapted to fit specific circumstances. Treatments selected should also be based on the soils and vegetation present.

ACKNOWLEDGMENTS

The authors thank Dr. Fred C. Bryant, Dr. D. Lynn Drawe, Dr. Robert Lyons, Mr. David Mabie, Mr. Donald C. Ruthven, III, Dr. Tim Ginnett, and Mr. David Synatzske for reviewing early drafts of this bulletin.

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