Brush Sculpting – A Decade Later

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THE EVOLUTION OF BRUSH SCULPTING

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I coined the phrase "brush sculpting" back in 1997 as the idea of "the planned, selective control of brush to enhance wildlife habitat." While I coined the phrase, the concept was not original with me, or particularly new. Ranch managers and biologists had been promoting brush management as a wildlife-friendly practice, especially in south Texas since at least the 1970s.

Brush sculpting as a thought process had its roots in "brush management", a concept of range pioneers like Charles Scifres, Wayne Hamilton, and Richard Connor of Texas A&M University. Scifre's 1977 book "Brush Management" heralded an advance from the paradigm of "brush control" which had been touted since the 1960s. Prior to that time, "brush eradication" was the idea, but resilient brush species like mesquite eventually dissuaded the use of "eradication." During the 1970s wildlife concerns, especially white-tailed deer, were becoming an integral part of brush management. Sam Beasom, Jack Inglis, Wayne Hanselka, Tommy Hailey and others were espousing the idea that brush control, if properly restrained, could be a powerful tool for managing habitat for deer. Fred Guthery championed the idea of brush management for quail in his 1987 book "Beef, Brush, and Bobwhites" which has become a quail-cult classic. The notion that various tools of destruction could be reborn as tools of reconstruction was championed by Aldo Leopold in his 1933 classic "Game Management" when he stated "the creative use of the same tools that have heretofore destroyed wildlife habitat, namely the axe, plow, cow, fire, and gun, can also be used to restore game populations." On Texas rangelands, Leopold's "axe" is a metaphor for brush control.

The brush control paradigm remained strongly entrenched in the minds of many ranchers until about 10 years ago, especially in the Rolling Plains, where wildlife did not enjoy their celebrity status as in South Texas and the Edwards Plateau. On April 19, 1995 (a date I vividly recall because of the Federal Building bombing in Oklahoma City), I was in a roundtable discussion with 20 or so ranchers and Texas A&M faculty in Vernon, Texas. The question of the day to the area leaders was "what issue most constrains your ranching that Texas A&M might be able to alleviate?"

Almost without exception the pariah was brush, most notably mesquite. Rancher after rancher railed about how brush impeded their livestock gathering, reduced grazing capacity, and overall squelched their opportunity for profits. I can remember one fellow smiling as he lamented "I know it's probably not cost-effective, but I love to get on that D-7 and give it hell!" Surely we all need our stress therapy. When it came my time to speak (I was at the end of the line), I proclaimed "what you folks need is a 'Brush Appreciation Day." The irony drew no chuckles at the time. In fact the crowd had the same pallid stare as when I'd addressed a similar group in Ft. Stockton in 1991 with the notion of having a "Predator Appreciation Day." Both groups confused the definitions of "appreciate," as they conjured only "to value or admire highly" while I lean more towards "to judge with heightened awareness" and "to be cautiously or sensitively aware of."

But back to 1997 and a fledgling name of "brush sculpting." In March of 1997, I attended the annual convention of the Texas & Southwestern Cattle Raisers Association in Ft.

Worth. As I walked the aisles of the tradeshow, I came upon a booth with photographs of brush sculpting that I could not have painted any better if I'd tried. I struck up a conversation with Mike Gibbs, a rancher from La Pryor who headed up a company called "Land Enhancement Services." Our conversation culminated in a friendship and collaboration over the next decade. I dub Mike Gibbs as the "original Brush Sculptor" whose tools were a Caterpillar and a roller chopper instead of a trowel and bronze.

In September of 1997, Extension sponsored two "Brush Sculptors" symposia—one in Uvalde and the other in Abilene. The proceedings of those symposia are available online at http://texnat.tamu.edu/symposia/sculptor/index.htm and serve as a valuable reference for any aspiring Brush Sculptor. Since that time, it has been gratifying to see how the phrase "brush sculpting" has been adopted by stakeholders. It was a concept that was both timely and trendy.

Now, a decade later, brush sculpting is still timely. Wildlife have continued to shape land management philosophy, and prices, across Texas rangelands, even in the Rolling Plains. And with recent technologies, most notably Global Positioning Systems (GPS), implementing brush sculpting plans has been made easier and more efficient.

Today, we celebrate, commemorate, and demonstrate the philosophy and practice of brush sculpting. As times change, those practices and philosophies will also evolve.

KING RANCH HABITAT MANAGEMENT: PAST, PRESENT, AND FUTURE

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King Ranch has a long history of habitat and brush management dating back to the early 1900's. Innovation and leadership have been the forefront of King Ranch management throughout its 155 years of existence. Aside from leading the cattle and horse industries for decades, King Ranch was the first to experiment with brush control and mechanical habitat management techniques. In 1915, King Ranch began the first mechanized attempts at habitat improvements, which eventually led to the development of the rootplow in 1935 (Figure 1). Shortly thereafter, the ranch purchased two tree dozers in the early 1940's to assist with brush management on the ranch.

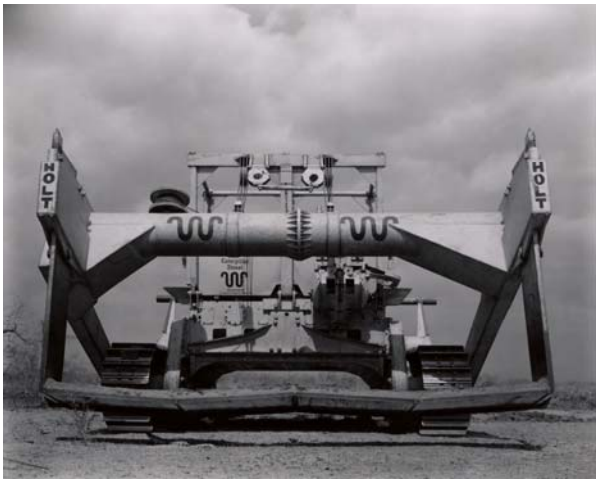

Figure 1. The King Ranch root plow.

Up until 1951, the ranch utilized its two tree dozers and continued development and refining of the rootplow to treat vast amounts of acreage from brush encroachment. In 1951, the first of two side-by-side D-8 dozers was developed and implemented on the ranch. One year later, another of what would soon be named the "twin 8's" was developed and put into action. The twin 8's were two D-8 dozers welded together, creating a massive machine equipped with a 20+ foot rootplow that funneled brush between the tracks right in the path of the plow. The twin 8's would reign through the '50's and into the mid-60's. In 1962, the first two of five D-9 dozers equipped with 14-foot rootplows were purchased. The sixties began the "Twenty year Reign of the Plow" with a fleet of five D-9 dozers moving from pasture to pasture destroying upwards of 30,000 acres a year (Figure 2). However, destruction wasn't the only use for the five D-9's on the ranch. Seeder boxes were attached to the back side of each dozer and grasses such as Kleberg Bluestem, Buffel, and Rhodes were scattered between the dozer and rootplow to re-seed all ground touched by the plows. Back then, it was thought that the rootplow served many functions, such as to control brush encroachment, provide aeration for groundwater filtration, and reseeding of the aforementioned grasses. Land was cleared on King Ranch and reseeded to provide adequate grazing for its 40,000 plus head of Santa Gertrudis cattle. Wildlife management remained secondary to cattle up until the 1970's.

Figure 2. D9 dozers rootplowing in 1970.

The D-9's continued to reign for two decades until the 1980's when King Ranch changed its philosophy on reinvesting its oil and gas monies back into the ranch. It was then that the ranch sold all of its D-9's and began to contract out most of its brush management. As budgets were cut and money became tight, brush management objectives switched from the costly rootplowing to a more cost-effective quick fix double-chaining method. Double-chaining became the pre-dominant mechanical method of brush control throughout the '80's and '90's, and even into the 21st century.

New technologies, management goals, and personnel began a new age in brush management on King Ranch leading into the 21st century. Management focus shifted from purely cattle management to a systems management approach, with the goal of optimizing bobwhite quail, white-tailed deer, and cattle. Habitat management on King Ranch was now heavily scrutinized by management personnel and planning was essential for maintaining 825,000 acres of pristine lands. Since the goal was to optimize quail, cattle, and deer, philosophies on how much or how little brush to leave had to change compared to past goals on the ranch. A crew of experts in both the range and the wildlife communities was brought together to evaluate all research and prior knowledge of habitat management for these three species. In 1999, an overall brush management plan was developed to try and optimize habitat management for the three species of most importance to King Ranch. The plan centered around creating open space for cattle and quail, leaving edge and escape cover for deer and quail, and creating a brush pattern that was economically viable to treat large acreages (Figure 3). Global Positioning Systems (GPS) and Geographic Information Systems (GIS) were utilized as new technologies to lower the cost of treatments, increase efficiency, and create an assortment of habitats desired by the ranch. A thorough evaluation of soils, brush canopy cover, and overall pasture analysis was conducted before treatments were applied.

The rootplow was no longer the first choice of brush control on King Ranch. All mechanical and chemical brush management techniques were evaluated and the best option at that time was chosen for each pasture on the brush plan that year. Controlled burning became an

integral part of brush plans as a maintenance tool after a mechanical or chemical treatment had been applied. All brush plans were approved by the Range Manager, Area Cattle Manager, Natural Resource Manager, and Vice-President of Ranching and Wildlife Operations before treatments were applied.

Figure 3. Aerial view of brush sculpting on the King Ranch (left) compared to untreated on the right.

So what does the future hold for King Ranch and its Range Management Operations? Rising costs of mechanical brush control have forced the ranch to pursue chemical treatment options and rely more heavily on controlled burning to maintain brush canopy cover. Mechanical treatments are only applied in areas with greater than 60 percent canopy cover, or where chemical treatments are not applicable (i.e. close to croplands) to minimize soil disturbance. Controlled burning has become a major tool for creating a mixture of successional stage habitats to benefit both cattle and wildlife. Finally, King Ranch Range Operations are focusing on forage inventories and habitat monitoring, to better predict forage biomass and brush encroachment tendencies across the ranch. Innovation and leadership come with successes and failures over time. King Ranch has always been at the forefront of agricultural innovation and a leader in the ranching industry. There are three principles that King Ranch has identified over the decades in range and habitat management: 1.) brush control is a process, not a project; 2.) capitalize on your successes' and re-evaluate your failures, and finally; 3.) be cognizant of your goals and confident in your planning.

HISTORY OF BRUSH CONTROL ON THE LAZY B RANCH, BROWN COUNTY, TEXAS

EDDIE BOND, Lazy B Ranch

For years we have fought the battle of brush control. We were always at the mercy of the dozer operator as to when he could get to us and if it was going to be too wet or too dry. In 1983 the ranch bought a D4-E Caterpillar with a grubber and rake (Figure 1). We no longer had to wait our turn, but we were still plagued with the issue of it being too wet or too dry with too small of a machine. We also inherited the problem of moving between three properties without a suitable way to do so. Nevertheless, we grubbed when conditions would permit and raked when it got too dry to grub. We worked on the premise that if it wasn't an oak or pecan tree, it needed to go. I was also told that if we buried the grubber and dragged the roots out until we reached the next tree it would allow all of the rain water to soak in. It worked great, with minimal re-growth, but it made it impossible to drive a vehicle across the pasture and it was risky at best to ride a horse through it after the grass came up. This practice continued until 1986 when I left the ranch.

Figure 1. The Lazy B Ranch caterpillar with dozer blade.

In 1996 I came back to find that the mesquites had made much more headway than I had. The only thing that had remained was the thousands of holes I had created with the dozer ten years earlier. Armed with a 4-wheeler and backpack sprayer filler with Remedy and diesel I continued the battle on a somewhat smaller scale. It was a new tool, but it did not replace the dozer.

In the fall of 2000 I learned about the practice of using a skid loader equipped with a tree shear and poison sprayer. Mick Hammond of Abilene New Holland let us try out a loader and shear. It was great. A mesquite could be cut off at ground level and the trunk sprayed immediately with a minimum of ground disturbance. I had finally found the perfect machine. The only problem was that I was on standby to go to Saudi Arabia and the ranch did not want to purchase a piece of equipment that might sit idle for a year or more.

By 2002 things had settled down and I was home to stay so the ranch purchased its first skid loader. It was a New Holland LS 180 with a hydraulic tree shear (Figure 2). This unit allowed me to cut and poison from 60 to 80 trees an hour depending on size and density. After purchasing a bug counter, to gauge how much poison was left by the number of trees cut, I was in tree killing heaven and whatever spare time I had I spent on the loader. The loader would operate 18 to 20 hours on eighteen gallons of diesel and you could drive over the area without falling off into any holes except for those fore mentioned from 16 years earlier. Life was good.

Figure 2. The Lazy B Ranch New Holland LS 180 with a hydraulic tree shear.

In 2005 I attended Dr. Rollins Quail Masters class. There I learned just how much quail habitat I was destroying and met Rory Borroughs who introduced me to the art of brush sculpting. No longer would I enter a pasture and clear cut everything standing. I learned to love algarito, lime prickly ash, lotebush, and persimmon. I even started to like some mesquite and prickly pear, not a lot but more than I did before. I was then able to channel a full fledged hatred to juniper to fill the void.

Pastures became a canvas that needed to project a 3-D image of patterns and shapes upon completion rather than a flat plain devoid of beneficial plants and trees. The desire was there but the eye was not. I would ride through the pasture and try and get an image in my minds eye of how the brush cuts should be laid out. After covering the area with the loader, it did not look anything like what I had pictured. The next step was to try and work it horseback with a roll of surveyors tape. The motes started to look better, but it still was not what I wanted. I thought that if I worked on it long enough the “eye” would come.

In March of 2007 we purchased one of the new Marsh Industries rotary hydraulic saws from Mick Hammond of Abilene New Holland. It was awesome; the unit has a thirty six inch rotary blade with carbide tipped teeth and two nine gallon poison tanks. The sprayer is located behind the blade as on the shear and worked off the same electric control. Depending on size and density I could cut and poison from one hundred and fifty to two hundred and fifty trees an hour. This unit allowed me to get in closer around Live Oak trees to cut out the Juniper and even cut between trees if they were not to close together. I was again in tree killing Heaven, but I still did not have the “eye”.

Dr. Rollins introduced me to the "eye" in the Spring of 2007 through a GPS class. There we were introduced to the plotting, measuring, distance finding, and shaping capabilities of GPS driven devices. That was where I met the person that possessed the knowledge of the "eye", Eric Redeker of Landitude, Inc. Mr. Redeker showed us equipment and programs that placed the "eye" in front of the operator in the form of a GPS, light bar, and computer screen. After attending another of Dr. Rollins GPS classes later in the summer, I was convinced.

In October 2007, Mr. Redeker delivered and helped me install a Raven Envisio Plus Guidance System, Raven Phoenix 200 sub-meter GPS, and a General Dynamics Itronix Duo-touch Tablet PC loaded with the ESRI ArcPad and ESRI ArcView programs. Mr. Redeker also provided me with the necessary mounts, cables, and accessories needed for our application. This also included a one forth inch thick dome which Mr. Redeker had fabricated to protect the GPS from falling trees and low branches. After a weekend of instruction and Eric's cell phone number stored in my cell phone, it was time to apply the new found knowledge to the land. The first project was to clear cut a three quarter mile long by fifty yard wide swath along a fence line that was loaded down with neighbors deer stands and obvious places where humans rather than hog or deer had traveled. The end of the clear cut was on the edge of a hill, and to my amazement and great satisfaction the cut lay perfectly parallel to the fence line. It did not keep them from hunting on us, but it sure did make it easier to catch them.

In December 2007, our local NRCS office informed us that our technique was approved for brush control under EQIP. Since I work on the loader when I have spare time we opted for a two year program. We obtained a new L180 and the saw was moved to the other property and the old LS 180 and shear remained on the home place. The capability to map and measure made it possible to overlay the map of the areas to be treated so as to work all of the prescribed area and not too much of the outlying area.

While working on phase one I was confronted with cutting and clearing a particularly rough and brushy area for a new fence line. A survey had shown that we had acreage on one of our neighbor's property. It was not much, but it did have a stock tank and deep soil among the rocks. All that there was to go by was three surveyor stakes and a tree lover that demanded that we did not cut too many of their trees down for the fence. By taking a GPS point on the center corner stake, I was able to measure the distance to the other stakes. An extreme distance of swath was entered into the Envisio Guidance System, and by following the light bar a line was cut to within one foot of the eastern stake. By repeating the process the fence line was cut to within sixteen inches of the northern stake. If you are sitting close to Eric Redeker and hear him groan it is because that is probably not the correct formula for the process.

The first phase of the Conservation Plan Map has been completed, measured, and certified and I am now working on the 2009 phase. There have been over 100,000 trees cut by the saw, an additional 88,000 trees cut by the shear and countless numbers of whitebrush cut and sprayed by both. Thus far I can retrace what little regrowth we have had to operator error from not spraying the stump to laying down larger trees and covering small trees.

BRUSH SCULPTING CONSIDERATIONS FOR LIVESTOCK

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The paramount consideration for planning brush treatment is the ability to manage the rangeland post-treatment over the number of years of treatment life. In order to manage, there must be a method in place in which relevant information is collected and analyzed, where plans follow from decisions, and actions follow plans to prevent inappropriate future use. Without a way to manage it is better to allow the brush to continue to protect the underlying soil, native seed bed and biodiversity. Post-treatment use is tied to treatment life, and the only reliable way to ensure appropriate use is to consistently monitor rangeland status and use the information to make adjustments. This requires enough flexibility in the grazing plan to be able to defer as long as necessary. Within a pasture, if grazing distribution can not be managed well enough to prevent inappropriate use in treated areas, then the entire pasture must be deferred as long as necessary.

Clearing brush over large areas can be effective, and historically this was most efficient for aerial applications, but clearing patches and paths, or smaller areas and connecting trails may be more effective today. In contrast to a plan to clear a large area for forage production, an approach that connects existing usable areas may be better as long as sufficient control of grazing distribution can be maintained. While it may seem obvious, when treating an area to allow for grazing, it is important that the area is, or can be made, usable according to other distribution limiting factors like slope, terrain surface, and distance to water. Examination of past grazing plans and, in particular, seasonal or area specific deficiencies can help prioritize treatment alternatives.

Selective brush treatment for logistical considerations can be beneficial. While we tend to think of treating areas for livestock grazing, treatment can also be useful for handling livestock. For example, clearing brush along a fence line that is often used for cattle drives can help ensure that the drive keeps moving. Even the best laid grazing plans can be disrupted by unexpected wildfires. Strategically treating strips of brush as fire breaks or areas where fires can transition from brush fires to grass fires may be an effective way to mitigate forage loss. Big brush problems often start as small brush problems and treating brush specifically to prevent or arrest the spread of brush can be extremely effective, especially when treated with appropriate urgency.

Sometimes brush is cleared for another purpose, for example, a utility right of way. These changes in brush cover may alter grazing distribution patterns so it is important to consider how or even if these changes need to be mitigated. GIS and geographic data have put considerable analytical capability at the fingertips of managers for a wide range of management decisions. While GIS is useful for planning projects like brush treatment, it is also useful for routine decisions like making and adjusting grazing plans, often the precursor to a brush control project.

A robust geographic model is a starting point, but it is the thought process and reasoning that the GIS tool is meant to serve. The GIS helps encourage spatial thinking and decision making regarding brush management, but managers should strive to use their own knowledge,

training (formal and informal), experience and insight to come up with additional factors, issues or questions to guide the use of GIS.

GIS works with layers of information, each of which have a certain degree of error. The result of GIS analysis should not be expected to be error-free, but rather a qualified answer given the available information. Results produced from a GIS should be verified and field validated to ensure they meet the test of "common sense."

BRUSH SCULPTING CONSIDERATIONS FOR WHITE-TAILED DEER

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Forty to fifty years ago it was not unusual for a landowner to tell a bulldozer operator to start pushing brush at the front gate and to stop when he came to the back fence. Livestock, mainly Hereford and black baldy cattle, were the priority users of rangeland in that era. Today, however, large block clearings are not often seen because of increasing land values for recreational use, the high cost of clearing methods and changes in land ownership values.

Brush sculpting as a tool to manage the extent and pattern of brush management is now used by virtually all land managers to create cost effective habitat for wildlife and livestock. When it comes to managing brush removal or brush control for white-tailed deer (*Odocoileus virginianus*) habitat the first question is, do you need brush management and how much brush should be removed? The answer depends upon each landowner's goals and objectives. A landowner who favors livestock or quail as their main objective will want to clear more brush than one who favors habitat for white-tailed deer. Rangelands that contain 10-20 percent low shrubby brush well distributed over the area favor bobwhites and cattle but will result in fewer deer staying on the property. White-tailed deer habitat that contains 40-60 percent canopy of brush is necessary and desirable for deer but may appear too brushy to a cattleman.

Intensive deer habitat managers may want to follow sound advice such as the "Nelle 30:300 Rule". Attributed to NRCS wildlife biologist Steve Nelle in San Angelo, the rule for intensive deer managers is to clear no more than 30 percent of the brush and have no openings wider than 300 feet, i.e. a deer is never more than 50 yards from cover. This type of brush management will be very mosaic in shape with long linear clearings. Total area of this type clearing is normally five to ten acres each but should not be over 30 acres in any single clearing. The brush patterns should be placed in the best soils on the ranch leaving desirable brush within the cleared area for food and cover. Patterns should take advantage of topographic features clearing where the landscape is level to slightly rolling and avoiding any clearing in riparian areas, steep slopes, extremely rocky areas, draws, saddles, ridges or headers. Al Brothers, considered the father of modern white-tailed deer management, proposes to never clear more than 50 percent of the acreage and if managing for trophy bucks, never clear more than 25 percent of the area while using good brush patterns. Sanctuary areas where large bucks can hide in dense untreated brush should be scattered over the area and may include up to 30-40 percent of the area managed.

An evaluation of the native forbs and browse species on the area will help decide if range seeding following brush sculpting will be necessary. Looking for relic clumps of desirable grasses and forbs within the treatment area will reveal if an adequate seed source is present to allow nature to re-vegetate the area with desirable perennial forbs and grasses. There are several choices for perennial forbs to use in range seeding mixes with "Hondo" velvet bundleflower (*Desmanthus velutinus var. Hondo*) being the newest release. Other perennial forbs to include in mixes include Illinois bundleflower (*Desmanthus illinoensis)*, bush sunflower (*Simsia calva*), Maximilian sunflower (*Helianthus maximiliani*) and Engelmann daisy (*Engelmannia pinnatifida*). There may be additional perennial forbs used regionally; check with your local

Natural Resources Conservation Service office, Texas AgriLife Extension Service or Texas Parks and Wildlife Department personnel for recommendations.

Landowners who wish to manage equally for white-tails and livestock will have to make concessions to optimize the brush canopy. The area cannot be maximized for one without harming the habitat for the other. Clearing 40-60 percent of an area with moderate to dense brush will increase herbaceous vegetation for livestock while retaining the minimum amount of woody cover for deer. Areas managed as such will not wean the heaviest calves nor maintain the highest deer densities but will be optimized for both.

The use of Geographic Information Systems (GIS) and Global Positioning Systems (GPS) has allowed brush sculpting benefitting deer to be accomplished with detail and accuracy never imagined forty years ago. The days of walking across a pasture with a compass and flagging ribbon laying out parallel brush strips are just about over. While this method still works the ability to target the better soils and slope of the land with GIS makes the new methods far easier and more efficient to design and layout. With GIS you can design the brush strips on your computer monitor, calculate the acreage involved and see what the overall patterns will look like before the dozer engine is even started. You can load these patterns into your GPS unit and walk the brush clearing boundaries ground truthing the brush patterns to see if they "fit the land" as you planned.

Deer managers should be conservative with the amount of brush removal. More can always be taken later but desirable browse is slow to reestablish if initial efforts are too aggressive. In the end it comes down to utilizing appropriate brush sculpting methods to manipulate the brush to meet your habitat management goals.

FENG SHUI FOR QUAIL: SCULPTING BRUSH-DOMINATED RANGELANDS FOR QUAIL IN WEST TEXAS

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The 3 most important factors that affect bobwhite (*Colinus virginianus*) and scaled quail (*Callipepla squamata*) in west Texas are 1) weather, 2) grazing management, and 3) brush management. As the weather is largely out of our control, we seek to tailor grazing and brush management to benefit our target species, be they black baldies or bobwhites, white-faced steers or white-tailed deer. Prerequisite to such strategies is an understanding of the role that brush and brush management plays in quail management. In the preface of his classic *Game Management*, Leopold (1933) argued that "game populations can be restored by the creative use of the same tools which have heretofore destroyed it - axe, plow, cow, fire, and gun". Four of those tools deal directly with habitat management, and in the Rolling Plains none is more important than "the axe", i.e., brush management. Guthery's (1986) handbook *Beef, Brush, and Bobwhites* underscores the importance of brush management as a tool for manipulating quail habitat.

The term cover may connote any of the following habitat needs: thermal, escape, loafing, screening, and in some situations nesting. Thermal cover allows animals to cope with temperature extremes. Access to suitable winter coverts (e.g., plum thickets) help protect quail from hypothermia. For summer thermal relief, deciduous trees (e.g., a chittam [*Bumelia lanuginose*] thicket) are preferred. Escape cover is rather generic and can probably be satisfied by any species of brush of sufficient density. The need for, and value of, escape cover varies with factors like topography, human disturbance (e.g.,hunting), and brush density.

Loafing cover is especially important for bobwhite and scaled quail. Quail spend most of the daylight hours under such cover to thermoregulate and minimize exposure to various predators (Hiller and Guthery 2005), especially raptors. Important quail coverts in the Rolling Plains include sandplum (*Prunus angustifolia*), skunkbush (*Rhus trilobata*), littleleaf sumac (*R. microphylla*), lotebush, elbowbush (*Forestiera pubescens*), are made of lotebush, sandplum, chittam, sumacs (littleleaf [*Rhus microphylla*] and skunbush [*R. trilobata*]), elbowbush (*Foresteria pubescens*), shinoak (*Quercus havardii)*, wolfberry (*Lycium berlanderi*), catclaw mimosa (*Mimosa biunciferae*), and some mesquites, especially the ones that look like large mushrooms. One should be able to throw a softball in the air from one covert to the next.

As brush management decisions are contemplated, landowners are encouraged to develop an "appreciation" for brush (Rollins and Cearley 2004). I refer to 2 connotations of the word "appreciate": first, the idea of "judging with heightened awareness" and second, "being critically or sensitively aware of". An appreciation for brush may require a new way of thinking. The decisions of when, where, how, and how much brush would be cleared were contemplated historically only under the brim of a cowboy hat (i.e., cattle production). However over the past decade there has been more interest in accommodating wildlife needs when contemplating brush control. The metaphor of the "camouflaged cowboy hat" has become increasingly popular on Texas rangelands as the headwear for contemporary land management decisions.

Feng Shui for Quail:
Feng shui is the ancient Chinese art of manipulating and arranging your surroundings to attract positive life energy, or Chi, so that it flows smoothly. It is the practice of placement and arrangement of space to achieve harmony with the environment. Feng shui evolved from the belief that people are affected (for better or worse) by their surroundings. I submit the same concerns are of interest to quail, and thus for quail managers. Applied landscaping is the basis of any brush sculpting plan. It can be conducted at different spatial levels, including the:

- landscape level
- individual clearing level
- plant community level
- plant species level
- individual plant level

Applied landscaping is a mix of art and science, and the end product is limited only by the creativity of the sculptor, the ability of the contractor to implement the design, and perhaps the pocketbook of the landowner.

Feng shui for quail for quail is built around the concept of "usable space" (Guthery 1997). Populations of game birds can attain their density potential when individuals can use any part of a pasture at any time. The philosophy of usable space provides a framework for the patterns applied in brush management. Usable space essentially asks the question "how much of my property is 'usable' by a bobwhite over the entire year (365 days)?" Usable space is determined by the arrangement of *permanent* cover, and brush is a cog therein.

While large-scale brush control is detrimental to quail, more judicious approaches can benefit quail. The concept of brush sculpting (Rollins et al. 1997) promotes the planned, selective control of brush to enhance wildlife habitat. As Guthery (1999) noted, there is a certain amount of slack in habitat prescriptions for quail. Areas with taller grasses need less brush to be habitable for bobwhites than areas lacking taller grasses. Brush sculpting can be used to enhance habitability and huntability of the landscape for quail. Excessively dense stands of mesquite or juniper are not very attractive to quail or quail hunters. Reducing brush canopies to perhaps 15 to 20% canopy cover (on grazed rangelands) and 5 to 10% (on ungrazed or lightly grazed rangelands) can maintain or improve habitability while enhancing hunter access.

Treatment Options:
The brush sculptor has basically 2 options: chemical (e.g., herbicides) or mechanical (e.g., bulldozing). A third method, prescribed fire, can be used, but typically in a maintenance mode. Generally mechanical means are preferable because they can be more selective, and increase forb production caused by soil disturbance. However, mechanical means are typically 2-4 times more expensive than herbicides. Applications of herbicide by individual plant treatment (IPT) can provide a level of selectivity similar to that achieved by mechanical methods. Care should be taken when the spray mixture includes herbicides such as picloram that result in more broad-spectrum control of woody plants. Including picloram in a mesquite spraying mixture will kill desirable shrubs like netleaf hackberry.

Recommendations for Quail:
Bobwhites need interspersed areas where more than 2 vegetation types come together. Such intermingled habitats allow birds to forage while remaining close to cover. Some of the factors that affect quail response to a given level of clearing likely include (a) topography, (b) brush community before and after clearing, (c) method of brush control implemented, (d) hunting pressure, and (e) scale of treatment. While prescriptions for bobwhite habitat are not exact (Guthery 1999), Guthery and Rollins (1997) and Rollins and Cearley (2004) recommended the following guidelines when sculpting bobwhite habitat:

- Sites that are cleared should be no more than about 80 yards wide; this keeps all points within 40 yards of woody cover;

- No more than 80% of the pasture should be treated;

- Areas of woody cover to be spared from clearing should be at least 100 square feet in size;

- Preserve mottes, not just single trees; any mesquite with other shrubs growing under it should be retained;

- Retain patches of taller-growing brush as they are more effective as summer coverts;

- One should be able to throw a softball from one loafing covert to the next after clearing;

- When controlling prickly pear, use fire as a tool for thinning prickly pear as appropriate. Use a reduced rate of picloram following the burn, applying picloram with a more targeted technology (e.g., boomless nozzle or behind a roller-chopper) in a mosaic pattern so that perhaps 30% of the prickly pear remains untreated.

- Post-treatment grazing management is an important management consideration. Quail are more sensitive to grazing management in areas where more brush has been cleared. Prickly pear should be maintained in areas where overgrazing and drought have been or are currently problems.

Lamentations in Brush Sculpting:
Brush management can be one of the best things for quail habitat, but historically it has been one of the worst. A prerequisite for any brush sculpting is a vision of what you want the final product to look like. For bobwhites, my general landscape is guided by 2 rules of thumb: (a) quail houses on the landscape about a softball throw apart, and (b) ability to see my bird dogs *most* of the time. Mistakes in planning brush management can have long-term negative impacts on wildlife diversity and abundance on a particular site. Proceed with a deliberate thought process before implementing any brush control project—as the carpenter advises "measure twice, and saw once."

I'm high on on-site experimentation. If a landowner asks me what I think of this practice or that, I encourage them to try it, at least on a portion of their ranch. But, you should always have a means by which to evaluate your results over time. Did quail numbers increase? Was hunting

made more enjoyable? I recommend you consider the Texas Quail Index (http://teamquail.tamu.edu) as a means of assessing quail response over time.

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INFLUENCE OF WILDLIFE MANAGEMENT ON TEXAS LAND MARKETS

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For most of this country's history, the price of an acre of rural land depended on its agricultural potential—that is what crops and livestock could be produced on the property. However, the days of cow-driven land values appear to be over for most of rural Texas. Recreational potential is what it is all about. Buyers want Mother Nature at her best: rolling hills, lakes, creeks and scenic vistas. And they want to hunt, fish and watch wildlife.

This appetite for recreation has helped drive Texas rural land markets to record levels. Through 2007, Texas land prices soared to 224 percent of the 2002 price. That change amounts to a compound appreciation rate of more than 17 percent annually. Early 2008 reports indicate that Texas land markets saw prices continue the upward trend but at a slower pace. The 2008 statewide price moved 5 percent higher than the 2007 full year price, rising from $2,190 to $2,302 per acre. The first half median price amounted to an 8 percent increase over the 2007 first half price of $2,137 per acre. However, analysis of local trends revealed that land markets did continue to display increasing prices on a broad front.

The real or inflation adjusted price of $440 per acre in 1966 dollars pushed past the 2007 record level of $424, marking a 4 percent increase over the 2007 year-long price. Nominal prices shown in Figure 1 reflect the actual prices paid while real prices represent those nominal prices adjusted for inflation to 1966 dollars.

Figure 1. Texas Rural Land Prices -- First Half 2008

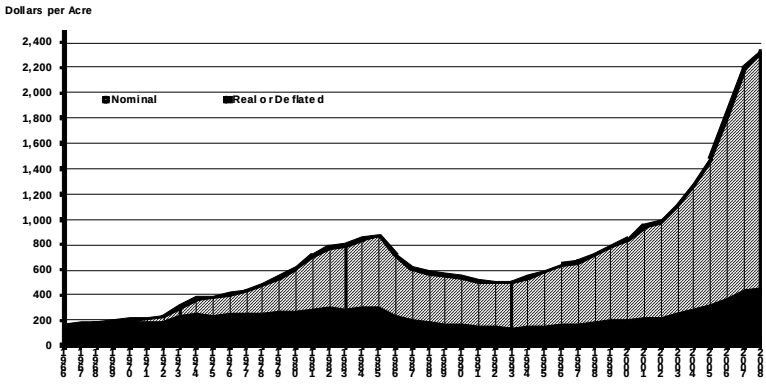
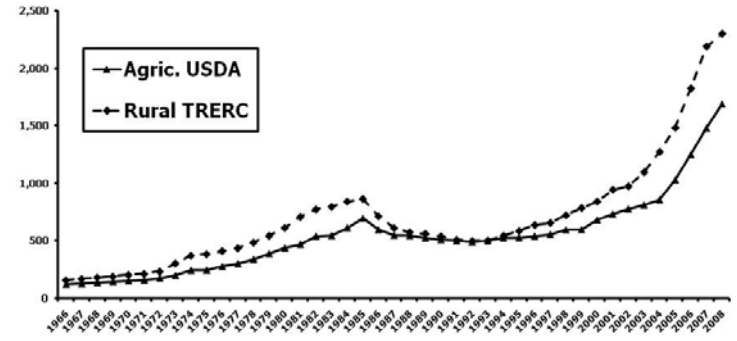


Figure 2 shows the price of Texas rural land compared to the USDA estimate or farmland values for Texas. The difference between these two estimates results from a difference in

emphasis. The USDA estimate is designed to capture the value of agricultural land to farmers and ranchers. The Real Estate Center rural land estimate shows the results of an analysis of thousands of actual sales of land in rural markets. The USDA estimates exclude crop and livestock value influences; the Center estimates include sales reflecting all value influences.

Figure 2. Texas Land Prices
Rural Vs Agricultural



Source: Real Estate Center at Texas A&M University

Agricultural USDA estimates of average value of agricultural land
Rural TRERC Price based on sales of rural acreage statewide as reported by the Real Estate Center

Surveys of real estate professionals indicated that farmers and ranchers were the dominant group of land buyers from 1986 through 1992. Both before 1986 and after 1992, recreational buyers composed the largest group of buyers in land markets throughout Texas. Between 1986 and 1992 Texas land prices converged to the farmland value estimated by USDA. However, after 1992, the growing population of recreation-motivated buyers propelled rural land prices to levels higher than the underlying agricultural value. That difference reflects the influence of recreational demand in setting land prices. In the first half of 2008, the Center's rural land price exceeded the USDA farmland value by approximately 36 percent. The 2007 gap was even greater.

Reporting on local conditions in land markets at the end of 2007, members of the American Society of Farm Managers and Rural Appraisers made the following comments (see the publication at http://recenter.tamu.edu/data/rland/ASFMRA07.pdf):

- Ranches are being purchased for recreational use only. The only time a rancher is in the market is due to a 1031 exchange to replace land he has sold. Demand is very strong for large ranches, with a limited number of properties being offered for sale. (Panhandle and South Plains)

- Rental demand for pasture and recreational leases exceeds the supply. (North East Texas and Piney Woods)

- As the demand for recreational property in out-lying areas has increased, the differences associated with land types and uses, i.e., quality of pasture, etc., are having less impact on price. (Coastal Prairies and Brazos Bottom)

- Recreation and investment continued to be the main sources of demand. Buyers include successful businessmen in the various sectors enjoying economic prominence including, oil and gas, real estate and others. (Hill Country, South Texas, Coastal Plains)

- Recreational use of land, primarily hunting, continues to be a primary influence in the mind of buyers. Investment is also a significant motivating factor and is often in conjunction with recreational use. (Blacklands, Post Oak Belts and Hill Country)

Together, this array of comments indicates the current importance of recreation, especially hunting in setting market prices of land throughout the state.

Some specific information on land management plans on value appear in articles published by the Real Estate Center and are available at the following website: http://recenter.tamu.edu/pubs/pubsSearch.asp?tid=43. Specifically see ***Westward Ho! Recreational Buyers Explore New Territory*** by Middleton & Gilliland and ***Where the Deer and the Antelope Pay*** by Gilliland & Vine

Knowledgeable real estate market participants estimate that open pasture typically sells for about 40 percent of the price of good hunting country. In addition, even a fundamental wildlife management plan typically adds $75 to $150 per acre to land value. Clearly, managing land to promote wildlife habitat enhances value. For additional information on Texas land markets see the reports at: http://recenter.tamu.edu/data/datarl.html

INTEGRATED BRUSH MANAGEMENT SYSTEMS

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A common mistake ranchers have historically made is to select one brush management method as "the best" and assume this "single treatment" approach would solve their brush problem forever. The truth is that effective brush management is a long-term process and there is no single "best" brush management strategy for every rancher, for every pasture within a ranch, or for every range site or soil type within a pasture. Effective brush management must be based upon sound ecological and economic principles. Controlling brush in its seedling or sapling phase makes more sense ecologically and economically than waiting until it thickens, matures, and causes degradation of the herbaceous understory. Furthermore, brush management strategies should involve the sequential application of combinations of mechanical, chemical, biological, and fire treatments rather than repeated applications of any single treatment.

The Integrated Brush Management Systems (IBMS) concept recognizes the potential values of certain quantities of woody plants, cacti, and forbs (weeds) to livestock, wildlife, and real estate values. When planning your brush management program, some important principles should be kept in mind. First, simply controlling the existing population of brush will not provide a long-term solution to the problem. Every brush management treatment has its unique set of strengths and weaknesses. Initial treatments must be carefully selected, then followed up with a set of carefully selected, and properly applied, maintenance treatments that are synergistic or complimentary to the initial treatment. Second, brush management treatments will rarely result in the expected recovery of desirable vegetation or the expected economic response unless proper grazing management is simultaneously implemented. Third, achieving a satisfactory, long-term, sustainable solution to brush problems hinges upon our ability to accurately access the root cause of the problem and restore the normal ecological processes of energy flow, nutrient cycling, and the hydrological (water) cycle.

The term "integrated brush management systems" may seem intimidating, but it simply indicates that a plan is followed in which the application of an array of brush control practices is coordinated by the manager in an orderly fashion. The five steps in designing and implementing a brush management system include: 1) establishing the management objective for the rangeland or ranch resource; 2) assessing or inventorying the resources; 3) selection of treatment alternatives; 4) implementation of the plan; and 5) monitoring the results of the plan and feedback.

Establish the Management Objective:

The first step is to clearly identify the objective or goal for the rangeland or ranch. This is done by the landowner, or the managing partner, executor, executive, or administrator, depending upon the ownership status of the land. The objective should be carefully matched to the managerial capabilities and capital resources of the manager/owner. Landowners who plan to turn over their land to heirs should involve the heirs in this process. Establishing the objective gives direction to the planning process. Some flexibility should be maintained at this phase. For example, a new landowner might initially have the objective of establishing a profitable hunting lease enterprise, then later switch to a combination of hunting and a cow/calf operation after

learning from the "inventory" (discussed below) that his resource lacked the capability to produce sufficient deer, turkey and/or quail.

Inventory the Resource:
This inventory provides information to determine if brush control is necessary to achieve the management objective, where control should be applied, the brush species that will be targeted, and information critical for selecting treatment alternatives (such as plant density and size). The inventory should include aerial photos and all available information on soils, topography, roads, fences, water developments, range sites, range condition, trend, current carrying capacity, current wildlife population densities, age/sex distributions, etc. By determining current condition of range sites, stocking rate data can be combined with projected vegetation changes following brush treatments to project economic outcome of treatment.

Selection of Treatment Alternatives:
A wide array of initial (reclamation) and follow-up (maintenance) treatment alternatives is available for most brush problems. The process of selecting treatment alternatives is readily facilitated by the user-friendly Expert System for Brush and Weed Control Technology (EXSEL) which is available free of charge at http://cnrit.tamu/rsg/exsel/. The resource manager should objectively evaluate all potential treatments based upon (1) biological effectiveness, (2) characteristic weaknesses, (3) expected treatment life and forage response, (4) application requirements and practicality for the particular situation, (5) the density, age, and size of the specific brush problem being considered, (6) the resprouting ability of the target brush species, (7) the degree of selectivity needed, (8) secondary effects that could create new problems, and (9) their maintenance requirements. Grazing management and wildlife habitat conservation must be planned concomitantly with brush management. Optimum response from many brush management procedures requires closely timed deferments from grazing, which may require a planned grazing system, combining livestock herds, and/or short-term leasing of grazing off the ranch. Use of prescribed fire usually requires a pre-fire and post-fire deferment from grazing. Wildlife habitat concerns must be addressed during the planning and implementation of brush management strategies to conserve or improve the real estate value of the land and the potential for recreational or personal hunting. Valuable game animals such as white-tailed deer and upland game birds require certain amounts of brush for escape, screening, or thermal cover. Anyone planning brush management should learn to identify plants that are important habitat components for these animals. Selective brush control treatments should be utilized to the maximum extent possible on sites where these plants occur in limited abundance.

Economic Analysis of Alternative Treatments:
Where two or more alternative brush control treatments or treatment combinations may be technically feasible and facilitate achievement of the management objective, it is prudent to select the one which is most profitable, poses the least risk, or best matches the landowner's desire for the post-treatment appearance of the landscape. Estimates of costs for labor, equipment rental, contractor charges, herbicide, equipment, etc. will be fairly easy to obtain. Expected revenue will be based upon the expected forage production response to the treatments as this affects livestock carrying capacity, reproductive efficiency, the number of game animals that can be harvested, the price that can be charged for hunting leases, etc. Benefit response curves can be constructed to show the differences between treated and untreated areas over the planning period. Assistance from qualified consultants will usually be necessary to develop

these curves for economic analysis. Partial budgeting can be used to compare the net changes in revenue and costs for each alternative treatment. Additional criteria that may be used include accumulated net present value, internal rate of return, benefit-cost ratio, and number of years to capital recovery.

Implementation of the Plan:
A brush management plan can only be successful if properly executed. Specifications for all treatments must be clearly expressed and understood by all involved personnel. Each area to be treated should be clearly marked on the ground and on aerial photos. Equipment must be mechanically sound, adequately powered, properly equipped, and capable of installing treatments according to specifications. Timing is extremely critical for certain treatments such as prescribed fire and aerial spraying, so arrangements must be made well in advance. Management must make the necessary livestock movements and/or acquire additional livestock to take advantage of additional forage production so the enterprise can profit. Contingency plans should be developed to use in the event an uncontrollable factor prevents the scheduled application of a treatment. Accurate records must be kept on treatment costs and dates.

Monitoring:
Monitoring is the process of making observations, gathering data, and keeping accurate records after implementation of the brush management treatments have been initiated. Establishing permanent photo points can be helpful in recording vegetation changes over time following treatments. Records will be kept on responses of livestock, wildlife, variable costs, brush response, forage response, etc. These records provide feedback that allows the manager to evaluate progress and assess the effectiveness of applied treatments. Results from monitoring may provide the basis for adjustments to the original plan of action, or may influence modification of the original objective. Finally, monitoring activities should feed both biological and cost/income data into an economic assessment to calculate actual versus projected returns from the brush management plan.

Suggested Reading:

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TECHNOLOGICAL ADVANCEMENTS IN BRUSH SCULPTING

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Modern brush sculpting typically involves a three phase process: planning, implementation and evaluation. All three phases have changed substantially over the past ten years in response to new technological innovations. Initially, when brush sculpting was beginning to gain popularity among range and wildlife managers, planning consisted mostly of scouting areas on the ground and physically marking plants or groups of plants that were to be removed or protected using flagging tape or marking paint. Heavy equipment operators would then use these visual markers to determine where brush was to be removed. Following implementations, range and wildlife managers would verify on-the-ground if their planned treatment had been implemented properly. Unfortunately, this approach had a number of limitations: it was extremely time consuming to physically mark all treatment areas, there was no way to envision what the end result would be prior to implementation, managers needed to be on the jobsite at all times to answer questions regarding the marked areas, estimating the cost of implementation was nearly impossible, quantification of the amount of area cleared was extremely difficult, and it was difficult to know if areas that were to be left untreated were cleared by accident.

Advances in mapping and navigation technologies have changed the methodologies used by modern brush sculptors, enabling them to address many of the challenges encountered by the pioneers of this innovative brush management technique. Geographic Information Systems (GIS) is a mapping technology that allows land managers to combine multiple pieces of map-based information and develop brush sculpting plans that take into account many variables that may or may not be evident on the ground (brush type, brush density, soils, elevation, subsurface hazards, etc.). The plans that are assembled within a GIS can also help to minimize risk (e.g. erosion or shifts in plant communities post-treatment), while at the same time improving the likelihood that the treatment will achieve the management goals (e.g. improving wildlife habitat). During the planning phase, the GIS enables land managers to envision what the end result will be as well as to quantify the number of acres that are to be treated. As a result, changes can be easily made to the plan for the purpose of increasing or decreasing the treatment acreage based on budgetary or management constraints. These plans can then be used to secure government cost-share funding (e.g. EQIP or WHIP), communicate with locating services (e.g. 1-800-DIG-TESS) to determine where subsurface utilities are located, and to get accurate bids from contractors.

Once the GIS-based brush sculpting plans have been finalized, they can be uploaded to field computers equipped with Global Positioning Systems (GPS), which are mounted in either the cab of the tractor or within the cockpit of the aircraft. These field computers allow operators to see exactly where they are relative to the planned treatment and other important landmarks (e.g. fence lines, roads, drainages, pipelines), eliminating the need to physically mark areas on the ground. During implementation, GPS track logs can be recorded or other third-party software (e.g. Landitude Land Manager Heavy Equipment) can be used to record information about where the operator implemented a treatment. The data collected by the GPS within the field computers can then be brought back into the GIS to determine how many acres were actually treated, if planned treatment areas were left untreated, and to determine if areas that

were to be left untreated were treated by accident. In the event government cost share funding was secured for the project, the GPS data collected by the operator can also be used to aid in the certification of treated acreage by the funding agency and reduce the amount of time required to process the request for cost-share reimbursement.

Information is the key to good decision making. Geographic Information Systems is a powerful tool that not only enables natural resource managers to generate new brush sculpting plans, but also enables them to track the response of previous treatments over time. The data collected using GPS and field computers during the implementation of brush sculpting treatments can be incorporated back into the original GIS database so that it can be later used for monitoring the response of the vegetation over time. Additionally, this historical data can be used in planning follow-up treatments such as burning, grazing, and herbicide application. Advances in mapping and navigational technologies have greatly improved both the accuracy and efficiency of brush sculpting and have reduced dependency on less ecologically friendly block or swath treatments, which were used mainly because it was near impossible to compute the number of treated acres within irregularly shaped treatment areas. The elimination of physical markers on the ground has opened up brush sculpting methodologies to aerial applicators (e.g. aerial herbicide), something that was impossible prior to the advent of GPS and field computers equipped with mobile GIS software due to the fact that physical markers like paint and flagging are not visible from the air. New software advances have made it possible for both land managers and equipment operators to track their progress and efficiencies on brush sculpting projects, thereby improving their ability to estimate the cost of future brush sculpting projects. To learn more about these technologies and the figures contained in this abstract, please visit www.ckwri.tamuk.edu/IALC and http://www.landitude.com

Figure 1. Equipment operator reviewing the brush management plan on a field computer mounted inside the cab of a tractor.

Figure 2. Brush sculpting plan overlaid on custom flown vertical color infrared aerial photography (flown May 4, 2004 by Aerial Viewpoint).

Figure 3. Post-treatment vertical natural color aerial photography (flown March 1, 2006 by Lanmon Aerial Photography, Inc.) showing how well the plan was implemented using GPS and mobile GIS software running on a field computer mounted inside the tractor cab.

Figure 4. South facing post-treatment oblique aerial photograph of the treatment area (flown on March 1, 2006 by Lanmon Aerial Photography, Inc.).

MAPPING YOUR RANCH – WHAT ARE THE OPTIONS?

CHAD REED, NRCS District Conservationist, Lamesa, Texas

The options today for mapping a ranch are varied and many. The best technique may well depend on how much time and input one is willing to give and how much training one is willing to endure. There are simple tools that allow for a limited scope of mapping and simple small scale maps. An example would be Google Earth. There is also very complicated and involved software, known as GIS software that will allow for the most detailed and in depth mapping and analysis tools. Examples of this would be commercial soft ware such as ESRI's ArcMap.

The USDA agency known as the Natural Resources Conservation Service (NRCS) is by many considered a leader in agricultural mapping services using the commercial software ArcGIS from ESRI. The mapping services offered by the NRCS are a part of the conservation planning process which is the task for which the NRCS is most noted. The conservation planning process involves a nine step procedure which results in a detailed plan of operations and a detailed map and scheme of all planned items. An example is brush management patterns (or brush sculpting) that can be a simple as needed or as complex as needed. The end result can be used in a paper format or an electronic format to be used (or uploaded) by the contractor or applicator.

Another tool which can be accessed via the web is Web Soil Survey (WSS). By accessing WSS a person can locate their area of interest (AOI), draw in the boundaries via simple web based GIS tools. The end result can be soils information, analysis and ecological site descriptions which can all be downloaded in booklet style and printed as many times as needed. WSS returns a custom soil survey which can also be used as a simple mapping tool. In the near future, NRCS will also offer a web based application known as Customer Self Service (CSS) in which more detailed and complex mapping tools will be provided.

Conservation planning services are offered in all NRCS offices. Contacting the local office in your area will get you started toward a conservation plan and mapping services.

INNOVATIONS IN BRUSH SCULPTING - HERBICIDES

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Eleven years has passed since the introduction of the Brush Sculpting concept. Since that time there have been several important innovations related to our use of herbicides to sculpt brush, but not in areas most people would expect.

Eleven years later we have no new "magic bullet" herbicide for sculpting brush. In fact, we have added only one new herbicide to our rangeland tool box, that being aminopyralid (sold under the trade names Milestone and GrazonNext). This herbicide has significant activity on broadleaf weeds, but has yet to have a significant role in woody plant control.

Eleven years later we have no new adjuvant that significantly improves the performance of our herbicides. We still basically use the same adjuvants as in the past, those being oil:water emulsions, surfactants, crop oils, methylated seed oils, etc.

Eleven years later, with one small exception, we have no new application method or piece of equipment that significantly improves our ability to sculpt brush on rangeland with herbicides. We essentially use the same nozzles and spray devices we have used for years. The one exception has been the development of a ground broadcast application method for tebuthiuron using the Spike 80 DF formulation to treat sand shinnery. There has been some recent interest in the use of a new aerial herbicide delivery system that uses an "electro-static boom" to charge herbicide spray particles and potentially improve herbicide deposition. As of this date this technology is unproven on rangelands for brush control.

The most important innovations using herbicides to sculpt brush on rangeland have nothing to do with nozzles, spray booms, adjuvants or herbicides, but rather with new technologies to help plan and apply herbicides and most importantly a quantum leap in information available over the internet.

GPS/GIS represent technologies that were available 11 years ago, although in a form that was expensive, crude and hard to use. Today these technologies have been refined and they are now much more widely available and affordable. For example, GPS guidance equipment in an aircraft is now the rule rather than the exception. Ground equipment can be equipped with GPS guidance units for less than $1,000.00 that are simple to use, and accurate to within a few inches. Contractors are available that provide full GIS planning services for ranches and NRCS has trained their personnel to provide GIS planning support for landowners.

But the single most important innovation over the past 11 years in terms of herbicides and brush sculpting has been related to information availability and transfer. Today with a few key strokes on a home computer a rangeland owner/manger can access a vast array of free information to assist with decisions related to his specific brush sculpting needs. For example, there are multiple web sites devoted to aiding the user with plant identification. There is a web site called the "AgriLife Bookstore" where an individual can freely access almost all publications from Texas AgriLife Extension Service. A landowner can use the NRCS "Web Soil Survey" to view aerial photography of his ranch and then locate and map the ranch soil types and

ecological sites. One of the newest web sites is called "PestMan" that acts as a brush control consultant, providing site specific brush control recommendations (herbicide, fire and mechanical) and an economic analysis of treatment options.

Following is a list of web sites that should be of special interest to Brush Sculptors:

- **Brush and Weeds of Texas** (http://rangeweb.tamu.edu/ctrp/public/)
- **Noble Foundation Plant Image Gallery** (http://www.noble.org/webapps/plantimagegallery/)
- **Pat Bales Plant Site** (http://www.geocities.com/sananspl/index.html)
- **Native Plants of South Texas** (http://uvalde.tamu.edu/herbarium/index.htm)
- **Texas Natural Resource Web Site** (http://texnat.tamu.edu/plant.htm)
- **Texas Extension Publications** (http://agrilifebookstore.org)
- **Texas Goldmine Applied Extension Research and Demonstrations** (http://goldmine.tamu.edu/)
- **Brush Busters** (http://tcebookstore.org) or (http://texnat.tamu.edu/range_wildlife.htm)
- **Brush Sculptors** (http://texnat.tamu.edu/range_wildlife.htm)
- **USDA/NRCS Web Soil Survey** (http://websoilsurvey.nrcs.usda.gov/app/)
- **Google Earth** (http://earth.google.com/)
- **Revegetation Equipment Catalog** (http://reveg-catalog.tamu.edu)
- **PestMan** (http://cnrit.tamu.edu/pestman)

Our greatest limitation to the proper application of the Brush Sculpting concept or to improved management of Texas rangelands in general is not the need for new technologies. Our greatest limitation is lack of adoption and use of already proven technologies. We no longer have the excuse of limited access to information.

INNOVATIONS IN BRUSH SCULPTING: MECHANICAL TREATMENTS

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After ten plus years, brush sculpting is no longer a foreign phrase or concept to anyone. It has earned its place in land management arenas. Mechanical innovations in brush sculpting lean more towards the application of various treatment options and increased operator awareness as opposed to the development of new machines and equipment. Mechanical tools available to land managers are basically the same as they were 70 years ago with the exception of the modernization of equipment. Additionally, GIS and GPS technologies give individuals the ability to intricately design and implement sculpting projects.

Brush sculpting is the selective removal of brush in natural designs to improve the habitat and meet management goals. To create the best habitat there must be a plan developed to address all four components across the landscape. The four components are: (1) food, (2) cover, (3) water, (4) usable space. Beauty is definitely in the eye of the beholder. As one studies various properties, some are "sculpted" more aggressively than others! The familiarization of brush sculpting has, in some cases, created opportunities for individuals who may lack a thorough understanding of habitat components and their interactions. Successful implementation of a proper brush sculpting plan is more than a knowledgeable operator willing to strictly adhere to the plan. It requires the operator have the ability and desire to identify a variety of plant species and have a comprehensive understanding of their roles within the habitat. Careless implementation of sculpting practices could have negative long term impact to the habitat. The days of clearing all brush from fence to fence are largely in the past.

Mechanical treatments provide land owners and managers the most selectivity for sculpting brush; however, they are usually the most expensive option. There are two basic groups of mechanical treatment options: (1) broadcast treatments and (2) individual plant treatments. There are whole plant and top removal options within both categories (See Table 1 for a list of mechanical practices). Even within some broadcast type treatments (e.g., rootplowing), the operator has the opportunity to leave desirable brush species and/or mottes. There are instances where eliminating the plant or group of plants is not the best option. Changing the plant's growth form could be beneficial by creating better cover or lowering the level of available browse.

Table 1. Broadcast mechanical treatment options.

Whole Plant Removal	Top Removal
Rootplowing	Shredding
Regrowth Plowing	Aerator
Deep Disking	Roller Chopper
Chaining	Skimming

A new tool applied to grubbing treatments over the last decade is the use of hydraulic excavators. This application has been successful because excavators are more efficient for grubbing (as opposed to a dozer), reduce the amount of ground disturbance, and allow for greater selectivity in removing brush.

Every property and every project is unique and requires attention to detail. Identifying and protecting preferred sites and plants across the landscape and relaying that information to quality contractor/operator(s) is critical to mechanically sculpt optimum habitat. Even with new technology and improved, more efficient machines, the final product is determined by the equipment operator and their understanding of the spatial arrangement of basic habitat components. While there are no exact rules, there are some general guidelines to consider when implementing a sculpting project. Keeping these guidelines in mind will increase your likelihood of success:

- You can always take more (it is much harder to grow brush than remove it!)
- Plan your work and work your plan
- Generate a good map for the project(s)
- Keep it natural, contour your designs. Contours create more "edge", besides there is nothing in nature that is a straight line—avoid straight lines
- Know your plants, and how to manipulate them
- Know your operator(s)
- Sculpt the habitat to fit wildlife, don't sculpt to fit the hunter
- Flag the field—clearly mark project area(s) (flagging tape is inexpensive, tractor time is not)
- Openings no greater than 10 acres
- Stay out of drainages and avoid "honey holes"
- Do not create open distances greater than 300' long and 150' wide
- Have daily communication with the contractor and/or operator(s)
- Brush mottes left should be at least the size of a compact car; single plants are not as valuable

There are no magic potions or silver bullets for properly managing our land resources. It requires continued effort and application of numerous practices and techniques. Always remember that brush management is a process, not a project.

USING FIRE AND HERBICIDES FOR VERTICAL BRUSH SCULPTING

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Most brush sculpting manipulates brush density on the landscape. From an aerial view the landscape pattern may alternate between areas of undisturbed brush, areas completely cleared or areas partially cleared to create a savanna. Because the pattern alternates laterally on the landscape, I refer to this as "lateral" brush sculpting. Lateral brush sculpting can be achieved easily, although sometimes at high cost, with mechanical treatments or herbicide sprays. Prescribed fire is limited in its capacity for fine resolution lateral brush sculpting because it travels where it can find fuel and not necessarily where one wants it to go. With proper fire guards, usually a bladed line that requires heavy equipment, fire can be used to create patches of burned vs. unburned land. However, the degree of resolution of such lateral sculpting depends on how much the owner wants to invest in fire guards. If multiple strips, bands and patches are needed, it is usually easier to mechanically clear the strips rather than cut a fire guard around the border of each strip or patch and then burn. In fact, I know of no case where this latter option of creating fine resolution brush sculpting with fire has been employed.

The Concept of "Vertical" Brush Sculpting:

There is another aspect to brush sculpting that may be considered, called "vertical" brush sculpting, where the canopies of individual trees, in particular mesquite, are groomed vertically, as opposed to manipulating tree density within a stand as is done with lateral brush sculpting. In a sense, vertical brush sculpting is closer in concept to sculpting by artists where a block of stone is chiseled from top to bottom to produce a single sculpted piece. If Michelangelo were to undertake vertical brush sculpting, he would go from tree to tree with a chain saw, loppers or chisel, working on each tree individually to achieve a vertical shape rather than deciding to either "keep" a tree or eliminate it, as lateral brush sculpting operations do today.

The basic idea of vertical sculpting is to reduce the foliage on mesquite trees, yet still maintain apical dominance and thus avoid the long-term negative effects of basal sprouting which can ultimately turn a stand into a multi-stemmed thicket that is worse for grasses that the woodland was before treatment. Vertical sculpting generates several positive effects on the landscape. First, it reduces the competitive effects of mesquite on grasses so more grass will grow. Second, the partially top-killed canopies increase herbaceous species diversity because some grass and forb species grow better near or beneath mesquite than in open spaces. Third, the presence of a low density of mesquite as a savanna may enhance soil fertility through nitrogen fixation and organic carbon additions. Fourth, the reduced canopy foliage increases visibility for livestock management. Of course, it is not as good as a completely open pasture, but the limitation of basal sprouting maintains the increased visibility for a longer period of time than a treatment that top-kills mesquite and stimulates resprouting. Fifth, the partially defoliated canopies create more shade opportunities for livestock. Sixth, the partially top-killed canopies still provide some screening cover for wildlife.

This paper presents two relatively inexpensive methods to apply vertical sculpting and essentially convert a woodland thicket to a savanna almost instantaneously without having to go

from tree to tree with a chainsaw. One involves the use of low-intensity fires and the other is the use of a low rate of clopyralid ("Reclaim") herbicide alone.

Vertical Sculpting Mesquite with Low Intensity Fires:
Low-intensity winter fires may be used as a first step for vertical brush sculpting and conversion of mesquite thickets to savannas. Trees partially topkilled by low intensiy fires tend to retain foliage in the upper portions of the canopy. Lower-positioned canopy growing points are killed but primary basal support stems are not killed. Overall amount of foliage per tree is reduced compared to preborn levels, yet apical dominance is maintained and basal resprouting is limited (Figure 1). The amount of living foliage that remains on the partially topkilled tree a low intensity fire has direct bearing on whether the tree maintains apical dominance or shifts into a basal sprout mode. Most trees that retain at least 40% of pre-burn foliage maintain apical dominance; below this threshold foliage amount, apical dominance is lost and basal sprouting is stimulated (Ansley and Jacoby 1998).

Figure 1. Mesquite treated with a low intensity fire showing the reduced mesquite canopy foliage and very little basal resprouting.

Creating a mesquite savanna from thickets using low-intensity fires will take time and repeated burning and should be part of a long-term management plan. We estimate that three to four fires in a 10 to 20-year period will be needed. However, almost any fire, regardless of intensity, will topkill mesquite trees that are less than 3 ft. tall. Thus, these smaller plants will basal resprout. It may be necessary to treat these plants with herbicides via Brushbusters IPT techniques or with mechanical grubbing to reduce density of these smaller plants. However, retention of some basal sprouting plants are probably necessary for quail habitat.

High intensity fires will topkill mesquite and stimulate resprouting. Such regrowth will create a mesquite thicket if no post-fire maintenance practices are utilized (Ansley and Castellano 2006). In this regard, high intensity fire is no better that a topkilling herbicide or mechanical treatment such as chaining or shredding. For this reason, a manager should have clear long-term goals before applying a high intensity, topkilling fire or any topkilling treatment for that matter.

Vertical Sculpting Mesquite with Clopyralid:
The current aerial spray recommendation of a mixture of clopyralid (Reclaim) and triclopyr (Remedy) herbicide, usually at 0.25 lb/ac + 0.25 lb/ac, achieves adequate root-kill (60-80%) and topkills surviving mesquite plants. This treatment is favored by livestock producers who seek to restore pastures to grassland. In time, however, most surviving mesquite basal sprout into multi-stemmed regrowth and must be re-treated (Ansley and Castellano 2006).

Low rates of clopyralid alone at 1/4 or 3/8 lb/ac yield moderate mesquite root-kill (20-40 %) so the stand is thinned. However, most surviving plants are not completely and are partially topkilled, retaining some foliage in the canopies (Figure 2). This partial topkilling preserves apical dominance and inhibits basal resprouting (Ansley et al. 2003). Over time, mesquite that survive clopyralid treatments are few-stemmed, have elevated and not basal canopy foliage, and are much less of a problem in terms of competition with grasses than they were before treatment.

Figure 2. Mesquite treated with 0.38 lb/ac of Reclaim (clopyralid) showing the reduced mesquite canopy foliage and little basal resprouting 4 years after treatment. The person in the center of the photo would not be seen prior to treatment due to thick mesquite foliage.

Figure 3 depicts effects of a high-intensity top-killing fire, a low-intensity savanna fire, and a low rate of clopyralid on vertical brush sculpting. A high-intensity fire (top) will provide temporary suppression of mesquite before basal sprouting dominates. A low-intensity fire (middle) partially topkills mesquite by killing lower growth points but apical dominance is maintained. The bottom of the figure shows a combination of an initial low-rate of clopyralid followed by a low-intensity fire to thin foliage to the maximum level (30-40% of initial levels), yet still maintain apical dominance. The herbicide/fire option should accelerate mesquite savanna development over the use of low-intensity fires alone.

A "Messy" Landscape – Good or Bad?
At first glance, vertical brush sculpting may appear "messy" and disappointing when viewed though eyes that want to see nicely manicured brush-free lanes alternating with wooded thickets, like a golf course. Each tree has a different amount of foliage and this foliage is located on

different portions of the canopy (Figures 1 and 2). However, this messy kind of landscape may be ideal for certain kinds of wildlife and plants. We don't know for certain the effects of vertical sculpting, but it makes sense that a highly diversified and more "messy" landscape would be attractive for many wildlife and plant species. This treatment, of course could be mixed with regular sculpting to create even more diversity on the landscape.

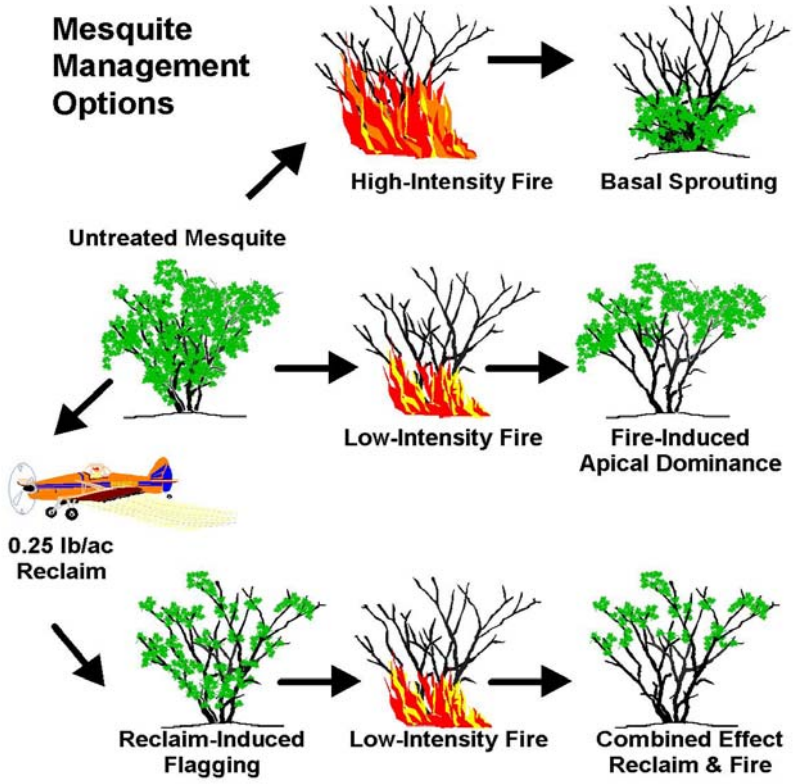

Figure 3. Illustration of effects of high and low-intensity fires and a low rate of Reclaim (clopyralid) followed by low-intensity fires on mesquite canopy foliage and basal sprouting.

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TARGETED GRAZING FOR BRUSH SCULPTING

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Grazing by wild and domestic animals is a powerful natural force working in all ecosystems. The kind and abundance of plants that characterize any plant community are a result of the climate, soils, and herbivores including insects, wildlife, and livestock that inhabit that place. The ability of herbivory to shape plant communities has been demonstrated time and time again as humans have managed the grazing of domestic livestock. For better or worse, livestock grazing has been applied for thousands of years in ways that change plant communities. Along with fire, grazing is the oldest vegetation management tool.

Today, livestock grazing as an effective tool to address contemporary vegetation management challenges is being rediscovered. There are now many examples of using targeted grazing to control invasive exotic weeds, reduce fire risk in the wildland-urban interface, and find chemical-free ways to control weeds in organic agriculture. The challenge of converting livestock grazing from a ubiquitous land use into a powerful vegetation sculpting tool requires a paradigm shift for both land managers and livestock producers. Generations of stockmen and scientists have focused their efforts on improving the production efficiency of sheep, goats, and cattle for food and fiber production. Recognizing that left unchecked, livestock grazing often resulted in the deterioration of pastures, early grazing management focused on mitigating these adverse effects so that forage could be grazed in a sustainable manner. Today's paradigm will harness the powerful ability of livestock grazing to change the botanical composition of grazing lands and use it to manage and control undesirable plants. The natural power of herbivory and the knowledge of how grazing influences vegetation communities can be skillfully combined to convert livestock grazing into a powerful tool for vegetation management.

Targeted grazing is the application of the right species (cattle, sheep or goat) of livestock at the right time, duration, and intensity to accomplish vegetation or landscape goals. The major difference between good grazing management and targeted grazing is that targeted grazing refocuses outputs of grazing from livestock production to vegetation and landscape enhancement. The concept of a target requires a target (i.e., problem plant) to focus on and then aims something (i.e., livestock that prefer that plant) at the target to accomplish the desired outcome. The land manager must understand the ecophysiology of the target plant including seasonal variations in palatability and susceptibility to grazing, as well as differences in preference for the plant by different livestock species and how husbandry practices can affect their preferences.

Targeted grazing should be considered as another tool in the kit for constructing desirable ecosystems. It can and should be used in combination with other technologies, such as burning, mechanical control and herbicides. Most of these traditional management tools have significant economic, ecological, or social implications that limit their application. Brush and vegetation control using chemical and mechanical treatments is often uneconomical on low value rangelands. However, by integrating these initial treatments with targeted grazing the treatment life can often be lengthened to provide a favorable economic return. An example of this is shown in Figure 1. In this instance all the Juniper was cleared from the Texas AgriLife Research Station at Sonora in 1950. Goats were removed from pastures at different times and the density of

juniper measured 50 years latter. This study indicates that large juniper tree increase at the rate of about 65 trees for each decade that a pasture did not have goats.

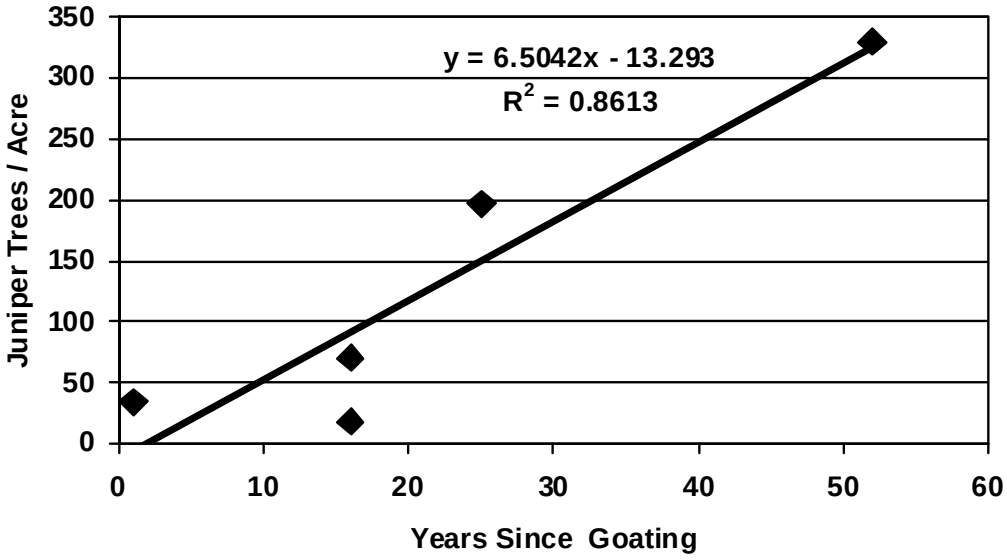

Figure 1. The effect of goat browsing on juniper density at the Texas AgriLife Research Station in Sonora. For each decade that goats were removed from the pasture the number of large juniper trees increased by 65 per acre.

Livestock grazing, like any tool, can be misapplied and cause harm instead of repair. Overgrazing has often been implicated in range deterioration and brush encroachment. In contrast targeted grazing can be used to direct succession to a desired state based on an understanding of plant-herbivore interactions. The most important skill for all people applying targeted grazing for vegetation management is patience and commitment. The effects of correctly applied targeted grazing are generally slow and cumulative. A minimum of three years is usually required before noticeable differences in perennial herbaceous weeds are apparent. Browse may take much longer. Once management objectives are obtained, managers must be prepared to modify their grazing from the system in use when the problem occurred, or surely it will return.

Effective grazing programs for vegetative management require a clear statement of the kind of animal, timing, and rate of grazing necessary to suppress troublesome plants and maintain healthy landscapes. A successful grazing prescription should: 1) cause significant damage to the target plant; 2) limit damage to the surrounding vegetation; and 3) be integrated with other control methods as part of an overall landscape management strategy. Developing a successful grazing prescription requires a great deal of site-specific ecological information and animal management skill.

Incorporating grazing management into vegetation management plans has been recognized as one of the key components in successfully addressing weed problems. Using grazing animals to control noxious plants is a readily available approach because it is already the

dominant use of rangelands and may be as simple as switching to the appropriate species of livestock for the current botanical composition of the land. However, making targeted grazing an active part of vegetation management programs will require greater dedication and commitment to grazing management techniques. More information on this topic is available at: http://sheepindustrynews.com/Targeted-Grazing/target.pdf.

THE DIGITAL PLANT PRESS – PLANT IDENTIFICATION IN THE CYBER AGE

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As a deer hunter or wildlife manager you have complete familiarity with these words: Boone and Crocket, drop tine, and buck:doe ratio. But how familiar are you with words such as Skunkbush sumac, Bumelia and Engelmann daisy? The biggest influence during the life of any deer is the quality of the native habitat in which that deer lives and secures nourishment. It is accepted that in order to grow large healthy deer they need three things: nutrition, age and genetics. The next frontier for deer aficionados is learning how to recognize and identify plants that deer consume for nutrition.

Short of enrolling in a botany class or joining the local garden club what can be done to learn plant identification (ID)? Carrying a stack of plant ID books on the pickup seat or handing the unknown to a local plant expert used to be the common methods for identification. While these methods still produce positive results, you can take advantage of modern methods such as the digital camera, flat bed scanner, and use of e-mail and internet resources to self learn plant identification. Today, with a digital camera that fits in your shirt pocket you can take a high quality photo of a plant, download it to your computer and e-mail it to your plant expert and he or she will see the plant exactly as you did. As a bonus, most digital cameras come with a macro setting which can take extreme close-up photos for capturing small details in flowers or leaves. You also have an image of the plant that can easily be reproduced months or years later to share with others.

The use of color scanners to produce a life-like plant image has been in use for just a few years; however, you will be amazed at the three dimensional effect of the plant picture. To get the best print quality use medium or higher priced matte or glossy photo paper. These scanned images can be saved as a jpg and e-mailed the same as a digital photo. With a scan or high resolution digital photo you can zoom in on the image on your monitor with little loss of detail or image quality.

When scanning plants for collection, remember that it can be difficult to obtain a quality image of plants with white or very small flowers. Additionally, plants with very large or bulky parts can cause problems with letting too much light into your scan. Taking pictures of these types of plants might be the better option when putting together a quality collection of plant images.

When scanning plant images, there are two options you can utilize that will allow you to add the image to your plant collection. The first option allows you to scan only the plant in order to create an image that can be inserted into a document. Another option requires that you attach the plant to a printed document before scanning, so that the finished product already has the plant

data you wish to include with your collection. Trim large plants or fold the longer stems to fit on the scanner, set the resolution to 300 dpi, close the lid to reduce stray light, and scan. The two options are outlined below.

Scanning Plant Images for Use in Other Documents:

1. Place the plant you want to scan directly onto the glass of the scanner.
2. Open the HP Director software and click on the Scan Document button.
3. When the Scan Document dialog box opens, select Text & Image as Graphic so that your scan will be in color and then click the Scan button.
4. If you are happy with the scanned image, click the Accept button. The Save As dialog box will open and you will need to navigate to the location in which you would like to save your plant images. Your C: drive is the best option. Use the Save as type: drop down arrow and select Jpeg Image. Click the Save button. You now have a .jpg file that can be inserted into other documents.
5. At this point, you will need to open the document in which you want to insert the plant image and complete the pertinent plant data you wish to include in your plant collection.
6. To insert the scanned plant image, choose Insert, Picture, From File and navigate to the .jpg file of the plant image and select it. Click on the Insert button. Move and adjust the image to fit the document you are using. You can utilize the Picture Toolbar for more options in changing the look of the image.
7. When you are satisfied with the document you have created for your plant collection, save the file.

Scanning a Document for Plant Collections

1. Open the document you are using to record pertinent plant data for the plants in your collection and complete the data for the plant you have on hand. Print the document. *Note: If you wish to simply write in the plant data, you can keep blank forms printed and ready for use.*
2. Affix the plant to the printed document so that the pertinent data is still visible.
3. Place the document and the plant directly on the scanner glass.
4. Open the HP Director software and click on the Scan Document button.
5. When the Scan Document dialog box opens, select Text & Image as Graphic so that your scan will be in color and then click the Scan button.
6. If you are happy with the scanned image, click the Accept button. The Save As dialog box will open and you will need to navigate to the location in which you would like to save your plant collection. Your C: drive is the best option. Use the Save as type: drop down arrow and select PDF (*.pdf). Click the Save button.

Online plant identification resources were unknown just over ten years ago. Today there are numerous web sites that show photos of identified grasses, forbs and woodies with several photos of each species. They highlight the entire plant, which includes close up of the leaves, flowers, stems, fruit and even the bark of trees.

The following web sites are highly recommended for plant identification:

- http://plants.usda.gov/,
- http://www.bio.utexas.edu/courses/bio406d/,
- http://uvalde.tamu.edu/herbarium/index.htm, http://www.noble.org/WebApps/PlantImageGallery/Index.aspx,
- http://texnat.tamu.edu/plant.htm.

There are even a couple of books on important native plants used as deer food that are available online or free by mail:

- *White-tailed Deer their foods and management in the cross timbers* by Ken Gee and Mike Porter of the Noble Foundation, http://www.noble.org/Ag/Research/Wildlife.htm and,

- *White-tailed deer food habits and preferences in the cross timbers and prairie region of Texas* by Jim Dillard et al., Texas Parks and Wildlife Department, http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_rp_w7000_1017.pdf

Ask your local NRCS, Extension or TPWD personnel for a list of their favorite plant ID web sites. Another new technique if you know the name of a plant is to go into either search engines Google or Yahoo, click on the Images button, then type in the common or scientific name and you will see a variety of images of that plant. Good plant identification books are still the bread and butter ID resources for most experienced plant folks, but digital and cyber methods are here to stay. Knowledge of plants and their value as food must be learned by all land managers.

BRUSH BUSTERS – COMMON SENSE APPROACH TO INDIVIDUAL PLANT TREATMENTS

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The development of Individual Plant Treatment (IPT) technologies for treating various brush species on Texas' rangelands has definitely changed over the last ten years. This change has occurred mainly in response to: a) changes in land ownership with ensuing changes in goals and objectives for manipulating the landscape, b) improvements in both application technology and equipment, its availability and ease-of-use for landowners/managers, and c) more effective and selective range herbicides that can be prescribed to target certain plants without undue harm to non-targeted species.

Individual plant treatment is mostly just that. However, as is often the case, individuals of a certain plant may be difficult to distinguish from one another, and the group or cluster of plants is treated as an individual 'entity'. For example, several individual plants of pricklypear may grow inter-mingled as a cluster in which the individuals are not readily apparent. This cluster is then treated as an 'individual'. In reality, this is 'spot spraying' if we use the Texas Department of Transportation (TXDOT) terminology.

One of the major differences in using broadcast applications versus IPT is how the herbicide is mixed with the carrier before spraying. In broadcast applications, we normally measure and mix the herbicides based on a certain amount of chemical needed on a per acre basis. Broadcast rates are usually given as a volume (such as ounces, pints, or quarts) or weight (as ounces or pounds) of herbicide required per acre. Then the herbicide is mixed with the carrier in the tank according to the number of acres that the 'load' is expected to cover, given the calibrated total volume of spray per acre.

On the other hand, IPT rates are typically given as a volume-to-volume ratio (v/v) of herbicide-to-carrier, i.e., as a percentage of the total volume of spray mix that is made up by the herbicide. For example, a 15 % v/v rate of Remedy herbicide in diesel for IPT basal stem applications is calling for a spray mixture that is made up of 15 % Remedy by volume with the balance of the mix being 85% diesel by volume to equal the total volume of mix, or 100%. Then only a certain amount (as per instructions) of this mixture of 15% Remedy plus 85% diesel is sprayed as recommended on the individual basal stems of each target plant.

If you remember your math in converting percentage values to decimals, and if you know how much total volume of mix that you need, then the amounts of herbicide and carrier to create the proper mix are easily calculated. Using the example above, if I desired to make a full 3-gallon mix of the 15% Remedy in diesel to use in my backpack sprayer for basal stem applications on young mesquite trees, I would multiply the total volume of the spray mix [{converted to fluid ounces}which would be 3 gallons X 128 fluid ounces/gal = 384 fluid ounces] times the decimal value of the percentage of herbicide required. Thus, 384 fluid ounces X 0.15 = 57.6 fluid ounces of Remedy needed and the balance of 384 less 57.6 = 326.4 ounces of diesel. This mix could then be sprayed on the stem bases of individual trees as per instructions listed in the guide, regardless of the amount of acreage covered with that volume of mix {**Caution:** the herbicide label may restrict the total volume that can be applied per acre per

year – i.e., this restriction could limit the total area that you could treat if plant densities and/or stem counts are high and you might exceed the total volume permitted per acre}. Continuing this example, the total number of individual plants that a certain volume of mix can cover is highly dependent on the number of basal stems per plant, stem size and the recommended amount of spray volume to use per stem. If stem numbers are too great to efficiently utilize basal stem applications, then another application approach is warranted.

Using a 'common sense' approach will often dictate what type of IPT application is suitable. Perhaps a soil applied herbicide or a foliar application of herbicides would be more feasible. Common sense Brush Busters technologies are designed to select the best herbicide to use with the most practical application method to best fit your situation. Brush Busters recommendations include proper timing of applications as well as suggestions on application technique, equipment needs and "points to keep in mind." Brush Busters provides the best IPT recommendations in a tri-fold leaflet format that is user friendly and readily available through several web sites.

Several web sites where you can access Brush Busters information:

- http://agrilifebookstore.org NOTE: follow links to agriculture, rangeland, brush control
- http://texnat.tamu.edu
- http://essmextension.tamu.edu/publications/rangeland.htm NOTE: go to "browse all range publications" and it links into the AgriLife Bookstore web site.

Brush Buster leaflets are available for the most common and problematic brush species. Leaflet titles and publication numbers are listed here for your use:

- Brush Busters – How to Beat Mesquite, L-5144
- Brush Busters – How to Estimate Costs for Controlling Small Mesquite, L-5291
- Brush Busters – How to Master Cedar, L-5160
- Brush Busters – How to Estimate Costs for Controlling Small Cedar, L-5292
- Brush Busters – How to Take Care of Pricklypear and Other Cacti, L-5171
- Brush Busters – How to Estimate Costs for Controlling Pricklypear, L-5290
- Brush Busters – How to Put a Halt to Saltcedar, L-5398
- Brush Busters – How to Avoid Lumps When Treating Cut Stumps, L-5421
- Brush Busters – How to Take the Luck Out of Controlling Yucca, L-5424
- Brush Busters – How to Take the Green Out of Greenbriar, L-5466
- Brush Busters – How to Manage Macartney Rose, L-5427

BANDED APPLICATIONS OF SPIKE 80 DF HERBICIDE FOR SAND SHINNERY OAK CONTROL

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Sand shinnery oak (also called Havard oak or shin oak) is a deciduous shrub that occurs on about 2.5 million acres of rangeland with deep sandy soils in the Rolling Plains, High Plains, and northern Trans Pecos regions of Texas. It also occurs in eastern New Mexico and Oklahoma. Dense stands of sand shinnery oak are highly competitive with desirable grasses and forbs for soil water. Monocultures of shin oak often develop where shin oak-infested rangelands have been subjected to excessive grazing pressure. Sand shinnery oak is a resprouting species, capable of sending up new shoots from the basal stems and shallow, underground horizontal stems if the canopies are removed mechanically or killed by fire or herbicides. The leaves and acorns of shin oak have some grazing value for livestock, and the plant provides food and cover for deer, turkey, feral hogs, quail, prairie chickens, and other wildlife species. However, the new leaf buds, early spring leaves, and acorns contain high concentrations of tannins and are toxic to cattle, sheep, goats, and other animals if consumed in considerable quantities.

The only effective herbicide treatment that has been available (prior to July 2004) for sand shinnery oak control in Texas has been Spike 20P, a 1/8-in. diameter, pelleted formulation containing 20% by weight of tebuthiuron. The recommended rate of Spike 20P has been 3.75 to 5 lb/acre (0.75 to 1 lb/acre a.i. tebuthiuron). These rates have most often resulted in very high levels of plant kill. The "secret" to achieving high levels of woody plant kill with tebuthiuron is to create high concentrations of the herbicide in columns deep into the plant root zone.

Broadcast applications of Spike 20P are usually made with fixed-wing aircraft or helicopters equipped with positive metering devices that spread the pellets uniformly over broad swath widths. Cost for aerial application of Spike 20P at 1 lb a.i./acre has been about $45 to $50/acre. Spike 20P pellets may also be broadcast applied to limited acreages with Solo backpack blowers carried either on a worker's back or on an all-terrain vehicle or jeep. The cost for this herbicide formulation is high because the pelleting process is expensive and costs for shipping from the site of manufacture in South Africa to the site of use is high because of the bulk and high weight of the clay used to make the pellets.

Ranchers and wildlife biologists recognize that extensive monocultures of shin oak are not conducive to their management goals and objectives. Many ranchers object to broadcast applications of Spike 20P from airplanes and helicopters because of the hazard of killing desirable trees and shrubs, such as hackberry, littleleaf sumac, bumelia (chittam) and post oak. Today, many ranchers are interested in "selective" brush control, in creating mosaic patterns of brush and herbaceous vegetation (grasses and forbs), i.e., in "sculpting" their brush infestations so as to improve the aesthetic, wildlife habitat, grazing, and real estate values of their rangeland.

In April 2003, I installed a preliminary, trial to determine if tebuthiuron applied as a liquid formulation in widely spaced bands would control shin oak on one of my ranches in western Jones County, TX. I applied Spike 80WP (wettable powder) at 1 lb a.i./acre with straight-stream nozzles spaced 40 in. apart on a 20-ft boom-type sprayer. My theory was that

this application method would create high concentrations of tebuthiuron in bands 40 in. apart deep into the shin oak root zones. My goal was to create strips or patches of grass interspersed within the "forest" of shin oak and associated desirable woody plants. I maneuvered the tractor so as to avoid damaging my hackberry, bumelia, post oak, and littleleaf sumac to the best of my ability. Dow AgroSciences representative viewed this preliminary trial 6 months later and were so impressed they asked me to conduct a formal experiment with a new formulation of tebuthiuron, Spike 80 DF (dry flowable). After 2 growing seasons, the shin oak mortality was about 99% in my treated strips and patches, and the grass response was phenomenal!

The objectives of the formal experiment were to: (1) determine the efficacy of tebuthiuron applied in bands 3 ft apart vs. 6 ft apart at rates of 1 lb vs. 2 lb a.i./acre for shin oak control; (2) determine how far shin oak was controlled beyond the treated plots; and (3) determine minimum width of buffer zones to leave between banded tebuthiuron applications and desirable woody plants.

The experiment was installed on the David Estes Ranch on the eastern edge of Fisher County, TX. Soils on the deep sand range site were Brownfield fine sands. Oaks were the dominant plants on the study site, and included broad areas of sand shinnery oak in a mosaic with motts of shin oak X post oak hybrids, scattered post oak trees, hackberry, pricklyash, bumelia, and skunkbrush sumac.

Herbicide treatments applied on April 12, 2004 included tebuthiuron (Spike 80DF) in a water carrier at 1 and 2 lb a.i./acre in bands 3 ft apart and in bands 6 ft apart. Herbicides were applied with a 12-ft boom sprayer powered by a PTO-driven pump mounted on a rubber-tired farm tractor. The straight-stream nozzles were made by drilling a 1/16-in. diameter hole through round brass plates which were placed within the brass nozzle caps. The tractor was operated in 3rd gear at 2100 rpm for all treatments and pressure on the spray boom was maintained at 10 psi for all treatments. The total volume of spray solution applied was 6.5 gal/acre for the 6-ft nozzle spacing and 12.8 gal/acre for the 3-ft nozzle spacing.

The experiment was arranged as a completely randomized design with 3 replications of each treatment. Plot sizes were 30 by 300 ft for the 3-ft nozzle spacing and 36 by 300 ft for the 6-ft nozzle spacing. Steel "T" posts were used to mark the plots. Wide, untreated buffer strips were left between treated plots so the effect of the herbicide on shin oak and other woody plants adjacent to the treated areas could be evaluated.

The plots were evaluated on September 29, 2005 (17 months after treatment). The effective swath width was measured several times for each plot and these measurements were averaged. Two workers estimated percent apparent shin oak stem mortality and their estimates were averaged. There was no evidence of lateral movement of lethal dosages of tebuthiuron great distances within the horizontal stems of sand shinnery oak, but increasing the tebuthiuron application rate from 1 to 2 lb a.i./acre tended to extend the effective swath width slightly. For example, within the 3-ft nozzle spacing, the 1 lb/acre rate resulted in an effective swath width of 29 ft compared to a 33 ft swath width for the 2 lb/acre rate. Similarly, within the 6-ft nozzle spacing, the 1 lb/acre rate resulted in a 31.7 ft effective swath width compared to a 36.3 ft effective swath for the 2 lb/acre rate. At 17 months after treatment there were some symptoms of

tebuthiuron phytotoxicity to shin oak several feet beyond the borders of treated plots, but these plants were still fairly healthy.

All treatments resulted in high levels of shin oak mortality. At the 3-ft nozzle spacing, mortality averaged 97.1% and 99.7% for the 1 and 2 lb a.i./acre rates, respectively. At the 6-ft nozzle spacing, mortality averaged 84.3% for the 1 lb a.i./acre rate compared to 99.6% for the 2 lb a.i./acre rate. Results from this experiment suggest that Spike 80DF applied at 1 lb a.i./acre with straight-stream nozzles spaced 3 ft apart should provide sufficient shin oak control to satisfy the management objectives of most ranchers.

A few post oak trees as far as 35 ft from the edge of treated areas were killed as were a few hackberry trees as far as 20 ft away. Lesser symptoms of tebuthiuron phytotoxicity were observed in post oaks as far as 40 ft, hybrid oaks as far as 20 ft, and hackberry as far as 20 ft from the treated plots. Based upon these observations, it would seem prudent to stay 80 to 100 ft away from desirable trees when using banded applications of Spike 80DF.

Banded applications of Spike 80DF herbicide provide ranchers another tool to "sculpt" their sand shinnery oak-infested rangeland with equipment that is readily available and not excessively expensive. Based on my experience, equipment that would help the operator discern where he had treated, such as foam swath markers or GPS units, would definitely be helpful. Dow AgroSciences obtained a Supplemental Labeling for Spike 80DF in July 2004 for banded application for woody plant control in rangeland, permanent pastures, fencerows, and clearings for wildlife habitat.

PATCH-BURN-GRAZING AS AN APPROACH TO CREATE QUAIL-FRIENDLY LANDSCAPES IN WEST TEXAS

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Herbivores utilize rangelands in a non-random manner, in both space and time. Long-term overstocking of semiarid rangelands has decreased natural heterogeneity, often resulting in degraded plant communities. Livestock-focused restoration efforts have developed systematic grazing strategies to minimize the deleterious impacts of non-random distribution (i.e., spot grazing) of livestock use by altering the timing, rate and extent of animal induced impacts. However, the increasing importance of non-traditional uses of rangelands has lead to goal-based alterations in landscapes that integrate the perceived needs of livestock and wildlife to arrive at an optimal multiple-use landscape matrix.

Goals for managing rangelands in the southern Great Plains are changing from strictly livestock grazing to more emphasis on wildlife-based recreation, especially for white-tailed deer (*Odocoileus virginianus*) and quail (northern bobwhite [*Colinus virginianus*]). The increasing economic importance of wildlife (e.g., hunting leases) over the last 15 years has resulted in a paradigm shift that impacts the present and future management of Texas' rangelands. Income generated from hunting leases is equally as (often more) important as income from grazing leases on rangelands in the western two-thirds of Texas. As this paradigm shift continues, managers are re-assessing heretofore recommended methods of land management, i.e., large-scale brush control and rotational grazing schemes. Hence more wildlife-friendly approaches like brush sculpting (Rollins et al. 1997) and patch grazing (Fuhlendorf and Engle 2002) are technologies that need greater adoption by landowners in Texas.

However, management for wildlife habitat should not ignore the need to manipulate plant communities in a sustainable, effective manner. For example, prickly pear (*Opuntia* spp.) can be an important component of quail habitat in the Rolling Plains (Rollins 2007), but densities can become too thick for both wildlife and livestock enterprises. Ranchers often seek to control prickly pear using herbicides (i.e., picloram [Tordon]), prescribed burning, or a tandem application of picloram following a fire. The latter treatment usually provides >95% control (Ueckert et al. 1988), but undesirable effects on quail habitat (i.e., collateral damage to forbs and netleaf hackberry (*Celtis reticulata*; Rollins 2007) tarnish this treatment for quail managers.

An innovative approach to managing livestock grazing to achieve desirable patches of vegetation for quail involves the use of patch burn-grazing (Fuhlendorf and Engle 2001). Burning small patches on the larger landscape concentrates grazing pressure. Such localized spot grazing promotes greater floral and structural diversity which should benefit a quail's need for feeding and brooding habitat interspersed with nesting and escape cover. Only small portions (e.g., 10%) of the pasture are burned annually, with new patches burned in successive years. Hence, grazing use is "rotated" without the need for additional cross-fencing.

The two primary management practices that affect quail in Texas are grazing management and brush management (Rollins 2007). While a plethora of studies have been

conducted on grazing and brush control in Texas (e.g., Scifres 1980, Kothmann et al. 1975), most were conducted to evaluate the response of livestock forages, and impacts to wildlife were not considered. Accordingly, we lack an understanding of response curves of key plants for quail, e.g., crotons (*Croton spp.*) and western ragweed (*Ambrosia psilostachya*), to various disturbances. Today's land managers need such information to make informed decisions on brush and grazing management.

The integration of patch-burning and focused grazing to create a patchy environment should enhance usable space for bobwhites, and other early- and mid-successional wildlife species. Similarly, cattle will graze scorched prickly pear and provide some level of control.

At the Rolling Plains Quail Research Ranch in Fisher County, we recently implemented a research effort to evaluate the impacts of patch-burn-grazing on quail habitat. Specifically, we seek to (1) quantify the responses of plants, livestock, arthropods, and wildlife (i.e., bobwhites, small mammals) to patch disturbances and (2) demonstrate patch-disturbance as a means of (a) enhancing landscapes for bobwhite quail and (b) achieving non-chemical control of prickly pear in the Rolling Plains of Texas. The project will monitor vegetation and arthropod dynamics, and livestock and wildlife distribution patterns, in response to patch disturbances as well as take observations relating to soil/site stability.

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LOW INTENSITY FIRE PRESCRIPTIONS FOR BRUSH SCULPTING

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It is extremely important to monitor weather while burning, not only for safety reasons but to achieve desired effects on brush. Weather conditions during fires have a profound effect on fire behavior and subsequent response of mesquite to fire. When effects of several winter fires were compared on two north Texas ranches, the Waggoner and Y Ranch, percent of mesquite plants in a stand that were completely topkilled increased with increasing air temperature (Figure 1). Topkill decreased with increasing relative humidity (RH), but this relationship was found only on the Y Ranch and not the Waggoner sites. The Y Ranch sites were dominated by warm-season grasses which were dormant at the time of burning. Fuel moisture of these grasses was subject to changes in RH. In contrast, the Waggoner plots had an abundance of cool-season grasses (Texas wintergrass, Japanese brome) which were green at the time of burning and less affected by changes in RH (Ansley et al. 1998).

Prescription for Low-intensity Savanna Fires

Wright and Bailey (1982) identified the most desirable weather and fuel conditions to produce high intensity mesquite-topkilling fires. However, alternate guidelines are needed if savanna is the management goal. The ideal goal for the low intensity "savanna" fire prescription is to create a fire that is of sufficient intensity to cause partial top-kill and thus reduce foliage, but will also preserve apical dominance in taller trees.

Winter low-intensity fires (January-March) that produced the desired "savanna" effect on dormant mesquite were successfully conducted within fine fuel amount between 1300 and 3000 lb/ac, air temperature between 55 and 68^{o}F, relative humidity between 30 and 50%, and wind speed between 8 and 12 mph (Table 1). A moderate wind speed was needed to move low-intensity flame fronts because fires were conducted under relatively high RH and low air temperatures. Wind speeds of 12-18 mph were used if RH was greater than 40% and air temperatures were less than 60 ^{o}F (Ansley and Jacoby 1998).

Often, low-intensity headfires were conducted in mornings, when air temperatures were cooler and RH was higher, than during afternoons. Under lower fine fuels (1000-1500 lb/ac), some savanna fires were successfully conducted in afternoons. Fine fuel below 1000 lb/ac often burned completely, but there was no apparent damage to mesquite foliage. Similarly, backfires produced little effect on mesquite and were not viewed as a desirable means of applying fire for mesquite sculpting. In contrast, herbaceous fine fuels greater than 3500 lb/ac, or RH less than 30% under most fuel amounts generated top-killing fires.

Conditions required for low-intensity headfires are very similar to those recommended by Wright and Bailey (1982) for burning perimeter fireguard areas (i.e., blacklines) prior to burning a large area, with the exception that we desired higher wind speed in order to send the flame front as a head fire instead of a flanking or backfire. Light and variable winds were **undesirable** for winter low intensity headfires.

It is important to note that *only narrow time windows of opportunity exist for low intensity fires* - either early in the morning or late in the evening. Because of these time constraints, one cannot afford to spend a lot of time backfiring fire guards. Blacklines should be burned out several days or weeks earlier so one can apply the prescribed low intensity headfire when air temperature and RH are optimum and can complete such a burn within an hour. To burn the fireguards ahead of time, one must have parallel roads or dozer lines on at least one and preferably two downwind sides of the area to be burned (see Wright and Bailey 1982).

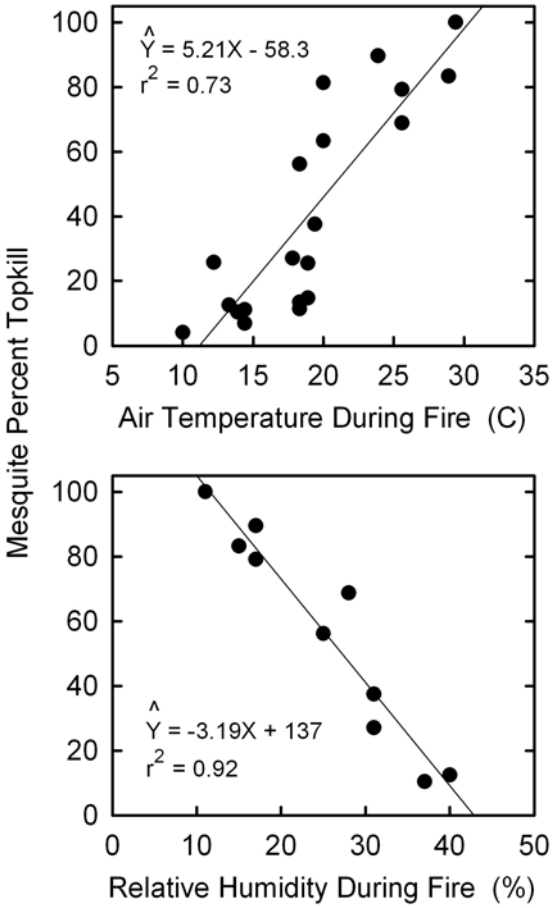

Figure 1. Relationship between air temperature or relative humidity just prior to a fire and percent of mesquite trees in a stand completely top-killed by the fire. Each point represents a different fire. Fine fuel loads of all fires ranged from 2000 to 3500 lb/ac. All fires were first-burn winter fires (adapted from Ansley et al. 1998).

Low Intensity Summer Fires?

Low intensity summer fires may have greater potential than winter fires to reduce mesquite foliage to desired levels, but the risk of complete topkill of the canopy is greater. The time window of opportunity to burn is even smaller with summer fires and is probably limited to only a few hours after sunrise. In most cases a low intensity summer fire can only be accomplished between 7 and 10 AM. Alternatively, a low intensity summer fire could be done on limited acreage after sunset if air temperatures move below 90 F and RH moves above 30%.

Another way to achieve low intensity summer fires is to burn as a backfire. However, this could realistically only be accomplished on very small acreages. One possible advantage of using low intensity fires in summer rather than winter months would be if the management goal was to preserve the mesquite overstory, yet kill prickly pear cactus (*Opuntia* spp.). Prickly pear appears to be much more susceptible to summer than to winter fires (Ansley and Castellano 2007).

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