RAWHIDE

proceedings of
A Symposium on

Ranching
Aimed at
Wildlife
Habitat
Improvement and
Diversification of
Enterprises

August 4-5, 2003
Abilene, Texas

August 7-8, 2003
Alpine, Texas

Sponsored by:
Texas Cooperative Extension
Texas A & M University:
Department of Wildlife and Fisheries Sciences
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Edited by:
Kenneth A. Cearley

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WHY RAWHIDE?

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Mid-morning in late December of 2001, while sitting on the side of a hill, watching for deer movements on the terrain below, my mind drifted from deer hunting and I began to contemplate the needs of ranchers that could be addressed by wildlife management oriented programming that I might lead in the coming years. What struck me then as a major concern, and remains today, is being able to "stay on the place". Not just living there– you may prefer to live in town and only visit– but keeping the business afloat– staying in business.

As one who has been involved in ranching most his working life, I am keenly aware of the challenges associated with making ends meet with a ranching operation. For some, the lure to take the drastic measure of selling all or part of the place to relieve the financial strain is enticing. The result, of course, could be (and is, all too often) further fragmentation of the land because the place isn't kept in one piece. But, the most immediate negative consequence is that of losing the lifestyle so cherished by most in ranching. No doubt, there are more efficient and lucrative ways to make money. But the ranching life is its own reward many times. And that stands to be lost if economic solutions are not found– and soon, for many.

Ironically, enjoyment of the ranching heritage is one of the things which must be used to a great degree to safeguard the further existence of ranching. The types of people who value ranching are myriad and constitute a growing opportunity for making a significant financial contribution. Hunters generally appreciate ranching, assuming the land is being well cared-for. Many people, whether hunters or not, who must make their living in large metropolitan areas, savor the opportunity to get away and experience the quietness, the solitude, the surroundings of ranch life. They are interested in learning about the ins and outs of the operation, and are anxious to share in some of the knowledge that makes a ranch successful. These and others are willing to pay for some level of access in order to experience a world different from their own.

Much of the attractiveness of ranches is the wildlife that exists there. Integral to successful enterprises which make the most of these populations economically is sound range management, which may include some level of plant community manipulation for the benefit of wildlife. This symposium is designed to help those involved in rangeland enterprises, whether traditional livestock ranching, absentee landowners, first-time landowners, and anyone interested in good land stewardship, to consider managing purposefully, as the name states, for wildlife habitat improvement and diversification into new areas of ranch (rangeland)-based enterprises. Such a strategy could very well result in healthier rangelands and a stronger financial picture for the whole operation. In other words, the maintenance of a cherished lifestyle, protection against further fragmentation (spelled divide, subdivide, etc.) of the landscape, which would make wildlife management and range management even more difficult as time goes on.

By way of this symposium we hope to strengthen the state of ranching, thereby the rangelands that are the very source of the existence of that enterprise. By conveying proven management practices for some of the most often utilized income producing species on west Texas rangelands, and offering some innovative ideas for diversification into additional enterprises, we trust that ranching operations will be bolstered financially and the potential for sustainability will be enhanced.

RANGELAND HEALTH - THE CORNERSTONE OF WILDLIFE HABITAT IMPROVEMENT

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Introduction

Without definition rangeland health would take a variety of meanings depending on an individuals perceptions and the situation. For example, many would define healthy rangeland as being a beautiful, central Texas landscape in the spring, with the land blanketed in bluebonnets and Indian paint brushes, framed in live oak, each tree appearing as if pruned and shaped for a home lawn. Others might think of lush, green, spring pastures, awash in grass, all of even height, seeds heads gently waving in the breeze. In fact, neither represent healthy rangeland. In the first example, a landscape dominated by bluebonnets and Indian paint brushes illustrates rangeland with poor plant diversity, with a lack of perennial herbaceous vegetation to protect the soil surface and provide forage for livestock and/or wildlife. Those "pruned" live oaks appear as such because of severe browse lines, symptomatic of overuse by either goats or deer. In the second example, the green, spring pasture, covered in grass of even height, with mature seed heads, represents rangeland dominated by annual grasses, such as rescue grass and little barley. Grasses that will wilt with the first hint of heat and lack of moisture. Grasses that will soon be gone, leaving the soil surface unprotected, vulnerable to erosion from the first major spring thunderstorm.

Range health as defined by the Society for Range Management is "the degree to which the integrity of the soil, vegetation, water and air, as well as the ecological processes of the rangeland ecosystem, are balanced and sustained." To put this formal definition in laymen's terms, healthy rangeland has soil which is protected by plant cover year round, showing no evidence of accelerated erosion, that supports a diverse, native plant community, dominated by perennials, that captures and stores every drop of rainfall possible, leaving little to flow down draws and ephemeral streams.

Range Health Classification

Range health can be broken down into three categories, those being; 1 - Healthy; 2 - At-Risk; and 3 - Unhealthy. In general, "healthy" rangelands have very little bare ground (Figure 1). The plant community is diverse, but dominated by perennial plants that provide year-long

Figure 1. Healthy Rangeland

protection to the soil. There are significant amounts of plant litter on the soil surface and organic matter within the soil. Soil structure is stable ensuring maximum rainfall infiltration rates. There is no evidence of accelerated erosion, no plant debris dams, pedicelling of plants, or sharp, denuded gullies. Plants are not over used by livestock or wildlife, there are no distinct browse lines on woody plants and the plant community shows evidence of new seedlings recruitment.

As rangelands degrade and move into the "at-risk" category the plant community begins to change (Figure 2). There are fewer and fewer plant species present, taller grasses are replaced by shorter grass species, perennials are replaced by annuals, grasses in general are replaced by broad-leaf herbaceous plants (weeds).

Figure 2. At-risk rangeland

Desirable forage plants show evidence of excessive use, browse lines begin to occur on woody plants, and patch grazing by livestock becomes commonplace. Soils begin to show evidence of accelerated erosion as indicated by pedicelled plants, a symptom of sheet erosion. Plant debris dams are evident following rain, a result of movement of water across the soil surface. There is less litter on the soil surface, because it is washed downslope, collecting at the bases of plants or in the bottom of draws.

When rangelands reach the "unhealthy" category, plant communities are now dominated by annuals, present during rainy seasons, absent during dry periods, which leaves the soil surface bare and unprotected from raindrop splash (Figure 3). Soils have lost most of their organic

Figure 3. Unhealthy rangeland

matter content, which in turn leads to poor aggregate stability and clogging of pore space during rainfall events. In essence the bare soil has turned into concrete that sheds rainfall instead of allowing infiltration of water into the soil profile. What plants are present are significantly pedicelled, and sharp, denuded gullies are visible.

The Consequences

Unfortunately when rangelands reach the "unhealthy" category they are often unrecoverable for all practical purposes, especially in the western, more arid regions of Texas. Total plant production and cover on "unhealthy" rangelands is many times reduced as compared to "healthy" rangeland. The kinds of plants are no longer present that slow the movement of water across soils, which in turn causes erosion. Plant roots are lacking that provide access or pathways for water movement through the soil surface and throughout the soil profile. The overall result is accelerated erosion and declining rainfall infiltration rates.

Most rangelands have relatively shallow soils. Soil depth is one of the single most important factors impacting plant growth and production under arid to semi-arid conditions. One foot of soil can store approximately 3 to 4 inches of water. To loose one inch of soil due to erosion can seriously degrade the production capability of a soil only 10 to 12 inches deep. One inch or more of soil can be lost in one rainfall event. Lost soil cannot be replaced.

Not only do "unhealthy" rangelands suffer from soil loss but they also are negatively impacted by deterioration of soil structure. Without adequate plant production and cover, soil organic matter contents decline. Without soil organic matter, soils have no mechanism to maintain soil structure, to insure clear pore space for movement of water into and through the soil. The soils "seal over", shedding water instead of absorbing and storing water.

The destructive process described above is often called "desertification." I have personally witnessed desertification of rangeland caused by over use and/or drought, usually a combination of the two. Once this process begins, it is often self sustaining, ever increasing, and non-reversible, through traditional management. The complete elimination of grazing does not halt or reverse the downward spiral. It is my opinion that many of these areas would not recover even if protected from all grazing for several generations. Once rangelands reach this level, only expensive reclamation practices such as ripping, contour furrowing and re-seeding will recover these areas, but even these practices will not replace lost soil.

Warning Signs

There are some basic warning signs that rangeland owners/managers should be aware of that indicate rangelands at-risk or in an "unhealthy" state. Most of these warning signs appear in degree. Thus, it is important to notice them as early as possible, before long-term damage occurs.

Pedicelled Plants. One of the most common warning signs are pedicelled plants. When the grass plants on a site each sit on a small pedicel of soil, it is a sign of sheet erosion (Figure 4). Each plant's roots and crown protect the soil directly underneath, but the soil between plants is washed away with each rainfall event. It is possible for unprotected soil to lose more than an inch of topsoil during a single rainstorm. It may take centuries to replace that inch of soil through natural processes. The

Figure 4. Pedicelling

less soil there is, the less water the soil can store, which results in fewer and less productive plants.

Bare Ground. Large areas, or increasing areas of bare ground are a symptom of "unhealthy" or "at-risk" rangeland. The soil must be covered with vegetation or mulch to protect it from the impact of rain. Unprotected soil erodes easily and forms crusts. This reduces the amount of water that can infiltrate the soil profile to support plant growth and recharge aquifers.

Annual Plants. If rangelands are abused, as through overgrazing or drought, perennial plant species will gradually be replaced by annual species. Annual plants have short life cycles that permit them to grow only during favorable conditions. Unfortunately, they do not provide dependable continuous protection to the soil surface, nor do they provide dependable and sufficient forage for livestock and wildlife.

Browse Lines. If there is a distinct absence of woody vegetation from ground level to a height that browsers such as goats and deer can reach, it is a sign that woody plants are being consumed at too great a rate (Figure 5). This reduces plant diversity and overall rangeland health. The strength of rangeland ecosystems is their diversity of plant and animal species. Diversity protects the health and sustainability of the system over time.

Gullies and Steep, Denuded Stream Beds. Gullies and stream banks that are devoid of vegetation are another sign of excessive erosion and poor rangeland health. Vegetation on stream banks holds soil and slows the flow of water. To correct the formation of gullies and steep stream banks, the land manager must slow the movement of water through these areas. It is also necessary to correct the factors that led to their development in the first place.

Monitoring

Figure 5. Browse lines

Most rangeland owners and managers keep records. They maintain financial records, rainfall records, wildlife harvest records, and livestock production records. These records have many purposes. One purpose is to maintain an objective history of past performance, understanding that memory is not accurate for this task. A second purpose is to track changes over time and identify trends that allow the owner/operator to evaluate management decisions and make changes accordingly. Unfortunately, few rangeland owners/operators keep any records in terms of the health of their rangelands over time, even though that rangeland is the basis for all production and income, whether it be livestock or wildlife. They rely on memory to evaluate change over time, even though rangelands are extremely dynamic due to yearly and seasonal change.

Monitoring rangeland is important because it improves the owner/managers ability to make proper decisions. Rangelands are very complex. Any given pasture may be composed of several different range sites, each with different plant communities. Each plant community has its own mix of grass, forb and woody plant species. This mix of species changes over time due to the impact of weather, seasons, brush and weed management, and grazing pressure by livestock and wildlife.

The mix of plant species and their quality and quantity within each community dictate the potential of rangeland to produce livestock, wildlife, water and other products. To monitor rangeland health it is not required that an individual know the names of every plant growing in the pasture. Simply knowing the major and most important species will suffice, as well as understanding in general that taller grasses are more desirable than shorter grasses, that perennials are generally more desirable than

annuals and that bare ground is NOT desirable.

Exclosures

Simple monitoring can be achieved by building small exclosures, no more than a few hundred square feet in area, that prevent grazing by livestock (Figure 6). Monitoring the differences inside and outside each exclosure over time, can be of help evaluating past grazing management decisions. Pictures or notes can be used to document these changes.

Photo Points

Figure 6. Exclosure

Photo-points provide a means of monitoring rangeland health with a minimum of input in terms of time and expense. There are basically two types of photo-point monitoring situations: 1) annual photos for long-term monitoring of range condition and health over years, and 2) seasonal photos for monitoring short-term management impacts such as stocking rates, changes in forage standing crop or responses to weed and brush control practices.

When to Take Photographs. Photographs should be taken to best illustrate the situation and repeated at least once a year at the same time each year. Fall, before the first killing frost, is the desired time for photographs taken annually. Monitoring can be more intensive if desired. For seasonal monitoring, you may want to take photographs in late winter or at spring green up, mid-summer and at frost, or before and after grazing a pasture or when controlling brush.

Where and How Many Photo-Points. Multiple range sites (areas capable of supporting different plant community types) may be found within individual pastures. These range sites can be identified using county soil survey manuals or with the help of your local County Extension Agent or Natural Resources Conservation Service personnel. All major range sites should be monitored using photo-points. The actual number established within each range site will depend on the acreage involved and the purpose of monitoring. In most cases, two to five photo-points per range site will give acceptable results.

Photo-points for monitoring grazing should not be situated close to water or in the back of the pasture. They should be selected to represent the range site in general and the use that site receives by grazing animals. Other photo-points may be located to monitor specific "problem" situations (i.e. stream bank erosion, sensitive riparian areas, recovery following wildfire).

Remember that the photo-points you select now will be used to characterize a much larger area for a long period of time. Selecting areas that truly represent the range site as a whole is critical to an effective monitoring program. Photo-points can be located along ranch roads if desired. These roads also can be used for spotlight deer surveys and routine pasture observations. Sites should be reasonably accessible since you will be returning year after year. Balance accessibility with the need for representative photo-points.

What Type of Photos Should be Taken. Two types of photographs are generally used. Photographs taken from a "near" vertical position are best to show details of the soil, litter and vegetation. These vertical photos will show changes in cover, bare ground, pedestaling of plants, litter and vegetation for small areas within permanently located plots. Detailed vertical photos are very specific and less representative of the landscape compared to scene photographs.

Scene photographs show much larger areas that include the general landscape, brush, grass, terrain and soil. By photographing the scene with the bottom of the photo no further than 10 feet away, the foreground can show herbaceous species, cover, litter, bare ground, etc.

How to Set Up a Photo-Point. Once the location of a specific photo-point is selected it should be permanently marked by driving a steel fence post or metal stake (re-bar) into the ground. Spray the marker with highly visible paint. A sprayed fence post nearby can be used to help locate the plots. Rocks piled around the re-bar can prevent injuries to animals or vehicles. Identify the location of each photo-point on the ranch/pasture map or aerial photograph.

Detailed notes that describe the situation should be taken for each photo-point. This may include compass bearing and distance from a highly visible landmark or GPS

coordinates if available.

With a felt pen and a yellow paper pad (white is too bright), make a plot sign to include in the photo plot/scene. The sign should have some identification (pasture name, range site, etc.) concerning the specific plot/scene being photographed and the date. It also can include other information, but to be legible it should be kept as short as possible.

Vertical Photographs. One to several photo-points can now be established in this area by placing a plot frame on the ground. A convenient frame can be made by two 6-foot folding carpenter's rulers folded at their 3- foot position and placed to face each other, collectively forming a square. PVC pipe joined with elbows also may be used. Once the plot is placed on the ground, the corners should be marked by driving 1- foot sections of re-bar rods into two opposite plot corners. This allows the exact relocation of the plot for future observations. Place the plot sign on the ground next to the plot frame before photographing.

Stand so your shadow is not cast over the photo plot (Figure 7). Take the picture by standing as close to the plot frame as possible while still including all the plot frame and the yellow pad in the picture. Try to take as vertical a picture as possible.

Scene Photographs. Landscape (scene) photographs also can be taken from the steel post or re-bar marker. Simply

Figure 7. Vertical monitoring photo

stand at the post and take one picture facing each of the cardinal directions, using a compass to accurately frame each shot. If you wish to only take a single scene photograph at each location, place your plot identification at the base of the steel post or re-bar. When taking the photograph stand about 10 feet from the plot marker in a predetermined and recorded direction. Include the plot identification and plot marker in the bottom of the photograph.

Repeating Photographs.

- Identify on your work calendar the dates repeat photographs need to be taken.
- Have all your photographs organized for easy viewing and for adding additional years in sequence on the same storage sheet.
- Have an updated map showing the location of each photo-point.
- Carry your map and previous photographs of the plots to be photographed when re-photographing the plots. Use the previous photograph to locate the exact scene or photo location.
- Retake the photograph with proper plot identification exactly encompassing the same scene using the same procedures.
- Use a data information sheet to record any of your observations before leaving each location. This data information sheet should include the plot ID, date, pasture, and any notes you may wish to make concerning species of plants present, general observations, concerns, etc.

Storing Slides and Photographs. If you use slide film, write the date, photo-point number, and management unit on the edge of the slides after they are developed. If print film is used, record the same information on an adhesive label and affix the label to the back of the print. Prints (3"x5") can be stored in sheets holding five photographs per page or use one 3"x5" card to index each print on the page. If you are using a digital camera, pictures can be processed as either prints or slides or maintained as digital graphic files. Using a digital camera will allow you to easily send your pictures to others over the internet. Your data sheets/information and maps for each location should be kept with your photographs.

Interpreting Photographs. When you compare photographs for a specific photo-point over time, look for changes in the amount of forage, brush, weeds, bare ground, litter and evidence of erosion; for changes in the types of plants found in the photographs (plot); and for the absence or presence of specific plants. You will find that records, i.e. grazing use, brush management and rainfall will be invaluable in interpreting these photographs.

Summary

Range health is the cornerstone for both livestock and wildlife production systems. Landowners/managers must be able to identify "healthy," "at-risk," and "unhealthy" rangeland. They should have some type of range health monitoring system in place to evaluate their management decisions and the impact of drought over time, and to make changes early, before rangelands enter the downward spiral of desertification.

INNOVATIVE TOOLS FOR RANCH PLANNING

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Abstract: Information is essential to planning. Whether you are planning for existing ranch operations or for new ways to diversify income, you will start by gathering, organizing, and analyzing information. Modern tools can create a variety of visual aids, clarifying information and variables to help you make decisions, increase productivity, and save time. Geographic information systems (GIS), a mapping technology, provide the framework for all geographic information synthesis. Global positioning systems (GPS) record the locations (coordinates) of different features of the land. Combined, these tools answer critical questions, so you can make informed decisions and effective plans.

Introduction

The operations, health, and improvement of a property depend on the managers' daily decisions. These decisions are based on information and experience, both of which can be made more useful and effective through new mapping technologies. Visual aids are very helpful to land managers and the experts with whom they consult.

Governments and large businesses have used these spatial (geographic) technologies for years, and it's time for private landowners to benefit. Access to these tools has become much easier and less costly.

Together, GIS and GPS create valuable management tools, including maps produced from various views of information about a property. Later, you'll want to seek a thorough explanation of how to use this technology. For now, we'll go over what tools are available, how they can help, and why they are important.

Geographic Information Systems

Geographic Information Systems (GIS) is a computerized method of viewing and analyzing multiple map layers of data pertaining to a defined location. GIS is designed to produce maps depicting information about a geographic area (a ranch). The information is stored in tables such as spreadsheets or databases, then the map is created from the information or the information is derived from the map, depending on which is already available. GIS begins with basic map layers. Base layers might include topography, aerial photography, soils, roads, streams, utility lines, school districts, and counties. Most, if not all, of the base map layers may be obtained free of charge from government agencies via the internet.

GIS can be simple or complex, depending on the type of map layers you choose and the level of information that supports those layers. Instead of focusing on the technological aspects, here we'll address the many ways GIS can benefit ranch planning and why they are important.

Mapping

A map is almost always the final product of a GIS. The value of good maps should not be overlooked; a picture is worth a thousand words when you're explaining a ranch plan to others. By demonstrating the improvements and resources on your ranch in one comprehensive system, you'll save time and increase efficiency.

Landowners have always used maps. The most familiar are the United States Geological Survey (USGS) topographic maps- probably the most popular, inexpensive, and easily attainable maps that landowners have of their properties. You may have several of these taped together if your land extends further than the map sheet. You may have drawn lines and boundaries directly on the map, along with any other features of interest. These maps are not easily reproduced, they can be too large or too small, and they don't always show enough detail. They're hard to update as you make improvements, and measuring with them is tedious and inaccurate. GIS solves all these problems. However, the work done to produce your current maps is not wasted; they can be scanned and imported into the GIS data, where they'll later be refined.

Many years ago, the Soil Conservation Service produced very valuable maps on a base layer of aerial photographs. These are outdated. Like the USGS maps, they are difficult to copy, hard to update, etc. With GIS, you can replace them. Aerial photographs from the mid 1990's are available of the entire state of Texas, free of charge, in a digital (computerized) format. GIS treats aerial photography as a layer of information; therefore, new photography is easily added. Most ranch features can be detected from those images. For example, roads, streams, houses, barns, tanks (ponds), and trees will show up on the photograph, and later on the map. You can also take

a look at features on adjoining properties which may affect operations on your land. A bird's-eye view of the surrounding vegetation can help with wildlife assessment and management.

Recently, the Natural Resources Conservation Service converted most of the County Soil Surveys to a digital format, so it's compatible with GIS and can be layered onto your maps. When you do a forage assessment, you can use a map of the soil types and range sites within each pasture.

GIS allows you to customize your maps, so only selected information is shown. In other words, layers can be turned on or off to create an appropriate map for your purpose, viewable on the computer and in print. Large color maps with aerial photography as the base layer serve as a good general working map; for visitors, a small black and white map showing only fence lines, roads, streams, gates, and windmills may be better. Delineating where a hunter can and can't hunt is a lot better than pointing outside and saying, "go here, but don't go there." With this technology, you can just give them a map.

Inventory

GIS maintains the location of features and the information about those features that exist on your land; in other words, an inventory. Features include fences, roads, pipelines, windmills, oil wells, tanks, water troughs, deer blinds, wildlife observation points, vegetation, areas of brush removal, etc. All these are represented as layers of information, placed over the top of base layers.

Ranchers and managers know what features they have and where they are, but sometimes they only keep that information in their heads. In order to communicate with employees, absentee landowners, family members, heirs, hunters, visitors, lawyers, and bankers, a formal system is better. Written and visual inventories also guard against the loss of information. When a rancher dies or leaves the ranch, future generations need to know how the property was managed. Also, a good inventory increases the real value of your land.

Measuring

GIS can measure things. How many acres are in each of your pastures? How many miles of fence and pipeline do you have? How many acres are used to produce hay? How many acres are covered in brush? Portraying and measuring all this will help you to plan. You can map whole systems of pipe, troughs, and tanks for measurement and effectiveness studies; costs and benefits can be assessed before you begin a project.

Monitoring

Monitoring activity on the ranch is extremely valuable. You can generate maps showing how much livestock is in which pastures at any time. Imagine having a map updated monthly to show the information that you usually keep only in a notebook. Carrying capacity can also be more easily assessed and monitored. You can keep a record of each assessment as a history of changes. We all know that carrying capacity shrinks and expands as dirt tanks fill and dry up. Now you can measure the changes in usable acreage under every circumstance. You can map the acreage usable both with and without these unimproved water sources, and thereby avoid over-grazing around improved sources. Rainfall records, fertilizer applications, and brush removal can also be mapped for a visual display.

Analysis

The ability to combine layers of information and create new information distinguishes GIS from other mapping software packages. For instance, when you decide where to eradicate brush for cattle grazing, there are several factors you consider. You might need to know which areas have the most productive soil types, which are within one mile of a water source, and which have less than twenty degrees of slope. GIS layers all this information and analyzes it to find areas that fill all three criteria. Next, you can find dense brush within those locations and calculate the acreage to analyze the cost of treating it.

These extremely helpful and powerful analyses represent the more complex side of GIS. You can decide how simple or complex you want your system to be.

Global Positioning System

Global Positioning System (GPS) is a constellation of twenty-four satellites which orbit the earth at an altitude of 12,000 miles, transmitting signals to allow a GPS receiver anywhere on earth to calculate its own location. The coordinates are stored inside the receiver. Using an inexpensive GPS receiver, locations of features on your ranch can be collected and downloaded to a computer, which will put them on your map.

Think of GPS data as a layer of locations within a GIS. For example, locations of windmills can be obtained by traveling to the windmill, taking a "waypoint" with the GPS receiver, then downloading that coordinate into the GIS to create a windmill feature on your map. The name, depth, diameter, and well log data of that windmill can be entered and labeled at the same time.

GPS is also used for navigation. For directions, just enter the coordinates of the location you need to find or navigate back to a previously collected point. Also, GPS indicates distance and speed of travel. Some receivers can indicate elevation.

The main difference between GPS receivers lies in their levels of location accuracy. Higher-end units will return exact locations within an inch. Inexpensive units have an accuracy level of ten to thirty feet, which will suffice for the purposes of most ranch mapping.

Contrary to belief, GPS receivers are easy to use. You can save time by teaching cowboys and employees to use them, since they are already in the field and can capture the necessary data as they come across it, instead of making a special trip. The hardest part (and it's not very hard) is getting the information from the unit to the computer, and somebody else can do that.

Conclusion

GIS and GPS provide information to ranchers in a usable format, to aid in decision making. There is too much information about your ranch to keep only in your head. Tools can help with the assimilation, analysis, and display of that information.

The ranch planning process requires a fundamental knowledge and an understanding of the assets. Begin with a basic, simple system, and see how it helps. The investment is worthwhile, even for just a simple ranch inventory.

These innovative tools will help you answer important questions. Where is the best place to put a water line? To spray brush? To improve grasses? To move cattle? Where should you build a viewing shed? These answers will show you what investments and improvements will have the greatest return.

The potential of GIS and GPS has not been fully exploited. As time goes by, more and more information will become available to help a manager manage more efficiently. The information age is here to stay, and it will only get bigger. Most of the gains in agriculture over the last century have been in machinery, and biology/information technology will be as powerful as those have been. Soon it will be as invaluable as the truck and trailer is now.

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ECONOMIC PERSPECTIVES OF THE STOCKING RATE DECISION

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Introduction

Proper management of rangelands is vital to protect future ranch production and profitability. These lands are the basis of livestock grazing, wildlife habitat, watersheds, and other important uses with rural individuals and communities highly dependent upon them. Further, rangelands represent the most valuable asset in many landowner's portfolios. As such, it requires more than a casual approach to ensure that this resource remains productive in a business environment dominated by volatile livestock markets and unpredictable weather.

Grazing management is the foundation of forage based livestock production since it affects both the animal, plant health, and productivity. It is widely acknowledged that the setting and fluctuation of livestock stocking rates represents the most important management decision for ranchers. Management of domesticated livestock has definite carryover impacts on the available resources to support native wildlife populations. While most rangeland managers seek to improve the resource base they mange, this is not easily accomplished due to habitat fragmentation, habitat changes due to the spread of invasive and non-native plants, the prevalence of short-term structured land lease arrangements, and limited control over fixed cost structure. Rather than feeling overwhelmed by these uncontrollable factors, the prudent land manager will acknowledge these issues and develop approaches with built-in contingency plans.

Common Grazing Management Mistakes

Every landowner, at some point, has surveyed the land management decisions of others and cast judgement. Perhaps, the grass isn't always greener on the other side of the fence. White et al. (2000) compiled a checklist of the more common grazing management mistakes. The most frequent mistakes included: failure to change from the historical stocking rate; failure to leave a forage reserve; failure to understand the true harvest efficiency of annual forage available to livestock; failure to adjust stocking rates to the actual grazable area; failure to base stocking rates on the preferred forages of the livestock; failure to defer pastures; thinking that the more livestock grazed, the higher the profit; thinking that mixed livestock can not be grazed together; failure to timely reduce stock during drought conditions; and failure to prevent animals from grazing toxic plants. While it is difficult, if not impossible, to avoid some of these errors, ranchers should be aware of the pitfalls that result from these management blunders.

Economic Considerations

There is no simple way to make ranching profitable. Livestock production suffers from the low-margin nature of all commodity businesses. Most of the profits accrue from value-added activities performed at higher levels of the production system. This implies that one of the most useful financial management activities a rangeland manager can undertake is cost control. Specifically, producers should focus on controlling grazing and feed costs, which can account for 40 percent of variable costs. One way this can be achieved is by placing a priority on balancing animal numbers with forage supply. At this point, it is important to recognize the difference between stocking rate and carrying capacity. Stocking rate refers to the actual number of animals grazed, which may not match forage production. The long-term carrying capacity of rangeland refers to the average stocking rate a given amount of land can support for several years without damaging the land and forage resource. In short, stocking rate is controlled by management but carrying capacity is dictated by the composition of the land.

A balance between stocking rate and range utilization is necessary for the effective conversion of range forage to range production capabilities (White and McGinty, 1992). If stock remain in a pasture too long without adequate forage, long-term carrying capacity for both livestock and wildlife may be severely reduced. Economic results will include reduced income from: degraded health and vigor of livestock females, delayed breeding and extended kidding/lambing/calving seasons, lower kid/lamb/calf crops, decreased weight gains, and/or increased supplemental feeding. Loss of rangeland productivity also affects wildlife habitats through reduced diversification of plant species, increased competition for the available plant species, and slower recovery following extreme weather influences. When forage supply can no longer meet demand, reducing stocking rates pays big

dividends: desirable forage plants incur less damage; supplemental feeding costs are reduced; and encroachment of toxic plants is lessened (Hart and Carpenter, 2001).

Likewise, there are economic ramifications to understocking rangelands. The fixed costs (taxes, overhead, maintenance, etc.) of an operation are expected to be covered by a combination of livestock and other revenues. Lighter stocking rates means that each animal unit is burdened with higher per-unit fixed cost liabilities.

Time Horizon and Leasing Arrangements

A rangeland manager's approach to stocking rates is greatly influenced by the time horizon upon which they are basing their decisions. Annual stocking rate decisions affect the quality and quantity of forage production. Over time, cumulative grazing management decisions affect the productivity and health of the rangeland and financial prospects. Stocking rates affect short-term cash flow because of the impact on individual animal performance, number of marketable animals, supplemental feed and labor costs, etc.. Long-term, stocking rates dictate future ranch profitability through the influence that they have on range condition and trend.

With much of U.S. rangeland operated by someone other than the landowner, there is potential for rangeland misuse. If the person making the stocking rate decision does not have a long-term perspective, the economic incentives would lead to higher stocking rates than would otherwise be desirable. The conflict between the decisions made by a resource manager with a short-term perspective and those that would be made by a manager with longer-term perspectives should be resolved through the lease agreement.

An all-too-common grazing lease agreement is one structured on a per-acre basis. This is the most simple type of agreement, but simplicity comes with a price. Without proper checks or management guidelines, this type of lease provides the incentive to overstock the rangeland in order to extract the maximum amount of forage the land will provide. Rangelands in drought-prone regions are especially vulnerable because they require longer periods of time to recuperate from poor stocking rate decisions and/or adverse weather.

A more preferred lease agreement would limit, or at a minimum, recognize the carrying capacity of the rangeland and provide incentives (penalties) for compliance (non-compliance). Another beneficial lease term would involve specified periods of grazing inactivity or prescribed rotation based on forage inventory levels. Grazing management involves a number of decisions including the kinds and numbers of animals to be stocked, and the distribution and timing of grazing. A properly structured lease agreement should incorporate all of these considerations in order to remove any conflict between the objectives of the rangeland owner and the rangeland operator. The caveat is simple, landowners cannot afford to jeopardize their long-term productivity for short-term economic gains - especially if the short-term gains accrue to someone else.

Livestock as Range Manipulation Tools

The common tools for rangeland manipulation are often generalized as fitting into one of four categories: the cow, the plow, the ax, and fire. As the only one of these mechanisms for rangeland management that reproduces and gains weight, livestock are especially attractive. It is widely understood that different livestock and wildlife species prefer different plant species. This implies that a diverse animal population and mix requires a diverse plant community. A good system of grazing is one that manipulates animals to achieve the maximum amount of sustainable animal and forage production at a low cost.

One opportunity for rangeland managers is to capitalize on the complementary nature of livestock dietary preferences. This opportunity is lost when excessive grazing pressure forces livestock to pursue less preferred forages. It is this scenario that creates a competitive situation between livestock species and/or between livestock and wildlife. A proper understanding of the range resource and the wildlife resource base allows for the matching of livestock species to the vegetation and habitat. One specific strategy is to place cattle in habitats where grass is readily available and to place goats in areas that have a high proportion of woody (browse) plants (Lyons and Machen, 2001). An extension of this strategy is to account for wildlife populations and their dietary requirements before determining appropriate stocking rates.

Flexibility and Diversity

As flexibility decreases usually risks increase, and expenditures to compensate for prior poor management decisions may be necessary. When developing a plan for reducing stocking rates, the most important factor may be herd mix (Hart and Carpenter, 2001). In areas where droughts are common, breeding herds should constitute no more than 50 to 70 percent of the total carrying capacity of the ranch during normal years. The rest of the herd should be yearlings or stocker animals. It is generally not financially sound for commercial livestock operators to replace their supplemental feed program with an approach that provides feed as a substitute for

inadequate forage.

Because forage production can vary as much as 100 percent between years, the proper stocking rate should differ as well. The stocking rate is proper only when the number of animals grazed on a given area results in maintaining or improving the range resource (White and Troxel, 1995). Overgrazing can occur under any type of grazing system (continuous or rotational). Under continuous grazing, over-grazed pastures become dominated by short-grass species and soils become visible between stands of plants allowing erosion to occur. Under rotational grazing, over-grazed plants do not have enough time to recover to the proper height between grazing events. The result is the same, loss of preferred grass species and diversity and increased erosion potential. Additionally, if livestock numbers are based primarily on the average carrying capacity, the range will be over-grazed in dry years and under-grazed during wet years. To achieve maximum production and profit, livestock numbers must be matched to current and projected forage levels, not to an average carrying capacity.

Another source of flexibility lies in selection of appropriate livestock species. It is highly unlikely that one individual livestock specie will continuously reward range resource managers with the highest economic return every year. Likewise, a diverse rangeland habitat does not restrict the resource manager to one type of livestock or wildlife specie. Since different animals prefer different types of forage, this implies that appropriate range resource utilization can include a mix of livestock and wildlife enterprises. Proper adjustment of livestock mix and intensity coupled with fair consideration for wildlife can reduce financial risk for the operator as well as foster improved range management.

The use of wildlife has continued to grow as a viable source of revenue for many traditional livestock producers. Wildlife revenues can provide a cushion against poor livestock prices and appear to be more resilient to many forces which restrain the livestock production environment. In many cases, wildlife revenues have replaced livestock revenues as the major bread-winner on the range. As wildlife grows as a source of revenue, so too should managerial attention and accommodation for their habitat. Primarily, this involves ensuring an adequate quantity and diversity of those forage species preferred by the wildlife specie (deer, turkey, quail, etc.). It should be recognized that capitalizing on wildlife revenues may require a different set of managerial skills than those necessary for effectively managing livestock. A balance must be obtained between the rangeland manager's willingness to provide a rewarding outdoor experience for people and the economic incentives it produces.

Prescriptions for Management

Guarding against overstocking of pastures follows the same prescriptions that rangeland managers must follow to cope with drought. Hart (2000) summarized these strategies for drought risk management. These have been slightly modified to more specifically address general stocking rate guidelines:

- Maintain a flexible herd composition.
- Use light to moderate stocking rates with contingency plans to capitalize on forage availability.
- Incorporate pasture deferment to allow rangelands to recuperate between grazing periods.
- Develop a systematic stock reduction plan in the event of drought.
- Use forage and resource base inventories to make stocking rate decisions.
- Recognize the trade-offs between short-term and long-term range management perspectives.
- Incorporate incentives (penalties) into the lease agreement to ensure compliance with longer-term objectives.
- As revenue from wildlife grows, increase managerial attention to their needs.

Conclusion

Rangeland is a ranch's main resource for producing income and other benefits. The use of the range affects all other ranch resources (land, animals, personnel, facilities and finances). Coordination of forage utilization with forage growth through control of animal numbers usually determines the success or failure of other range practices and the economic stability of the operation (Heady, 1975). Rangeland ecosystem understanding has increased dramatically during the past 20 years due to research, education, and escalation of management experience; however, rangeland conditions often regress under adverse weather influences and improper management decisions.

Rangeland conditions can be preserved and enhanced if the landowner can avoid the common grazing management mistakes, recognize the true costs and benefits of proper grazing management, and align their objectives with incentives for the rangeland operator. A substantial component of the successful grazing management system is in the "mind set" of the rangeland manager. The land should be viewed as the primary asset with livestock being treated as manipulation and

management tools. The appropriate stocking rate should be flexible in both species composition, livestock mix, and intensity. Additionally, wildlife should be given their "fair share" of consideration when making livestock decisions based on their financial (or other) contributions to the overall business. If all of these considerations are entertained, the result should be a productive and sustainable rangeland enterprise.

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CONSERVATION PROGRAMS AVAILABLE THROUGH NRCS

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Abstract: Conservation programs to conserve natural resources on private lands are available from the USDA's Natural Resources Conservation Service. NRCS offers landowners and operators technical assistance to identify and correct natural resource concerns. Extensive conservation problems can often be corrected or improved with the use of conservation programs which can include cost share payments, annual rental payments or incentives. Which program will fit your type of operation and resource problems can be determined by a visit with your local NRCS field office staff.

Introduction

NRCS and its partners are working with landowners in Texas on a voluntary basis to conserve natural resources on private lands. The Natural Resources Conservation Service was formed in 1935 as the Soil Conservation Service to address resource concerns related to erosion of the Dust Bowl during the early thirties. Our duties now include assistance to protect, develop and wisely use our soil, water and other natural resources. A major activity is providing one-on-one technical assistance with landowners and operators. Most counties have a field office staffed with one or more conservationists, who will meet with you on your land, listen to your conservation problems and offer treatment alternatives. You choose which alternative or none that fits your operation. There is no charge for this service. Some conservation problems may be extensive requiring long-term commitments in time and money to solve a problem. As an incentive to conserve natural resources cost-share assistance is available to help get needed conservation practices accomplished.

Cost-share programs

The Environmental Quality Incentives Program (EQIP) provides cost-share and technical assistance to landowners and operators to install conservation practices on agricultural land. EQIP may cost-share up to 75% of the cost of certain conservation practices although counties may individually set any rate up to 75%. Changes for EQIP in 2003 will include counties selecting one or two conservation practices upon which to concentrate the available funding in that county. Practices selected will typically be those that show the most environmental benefit per dollar spent. EQIP contracts last one year after the last cost-shared practice is completed with a maximum length of 10 years.

The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who wish to improve wildlife habitat. WHIP provides technical assistance and up to 75% cost-share assistance to establish and restore fish and wildlife habitat on private lands. WHIP contracts generally last from 5 to 10 years. WHIP has proven to be a very popular and effective program across the country. By targeting wildlife habitat improvements WHIP provides assistance to conservation minded landowners who might not qualify for other USDA conservation programs.

The Conservation Reserve Program (CRP) is a voluntary program currently administered by the Farm Service Agency that offers annual rental payments and cost-share assistance to establish permanent cover on eligible cropland. The program encourages landowners to plant long-term resource-conserving covers to improve soil, water and wildlife resources. CRP also stabilizes crop prices received by the farmer by reducing surplus crop production. Cost-share assistance not to exceed 50% is available for establishing the permanent cover. Contract duration is between 10 and 15 years. New eligibility rules for 2003 is that the land can now be farmed with normal farm equipment and that the land has been in seeded grass, summer fallow or agricultural crops in 4 of the 6 years from 1996-2001. Schedule a visit to your local FSA office for further details.

Continuous Conservation Reserve Program (CCRP) allows landowners to implement certain high-priority conservation practices such as riparian buffers, filter strips and grassed waterways on eligible land. Offers are automatically accepted provided the acreage and producer meet certain eligibility requirements. Acceptable land is cropland that was planted or considered planted to an agricultural commodity 4 of the 6 crop years from 1996-2001, which is also physically and legally capable of being planted in a normal manner to an agricultural commodity; or marginal pastureland that is suitable for use as a riparian buffer. Contract length can be between 10 and 15 years. Landowners receive annual rental payments, cost-share to implement practices and a one time signing bonus for enrolling the land.

The Wetlands Reserve Program (WRP) provides technical and financial assistance to eligible landowners to address wetland, wildlife habitat, soil, water, and related natural resource concerns on private lands in an environmentally beneficial and cost-effective manner. The program provides an opportunity for landowners to receive financial incentives to enhance wetlands in exchange for retiring marginal land from agriculture.

New Program

The Conservation Security Program (CSP) is a voluntary program that provides financial and technical assistance for the conservation, protection and improvement of soil, water, air, energy, plant and animal life, and other conservation purposes on tribal and private lands. The program provides payments for producers who practice good stewardship on their agricultural lands and incentives for those who want to do more. More details will be available in the coming months about this program and others being developed.

Source

Additional information on these and other programs can be found at the Texas NRCS web site at www.tx.nrcs.usda.gov or your local NRCS office.

CONSERVATION PROGRAMS AVAILABLE THROUGH USDA-NRCS

SONNY VELA, District Conservationist, USDA Natural Resources Conservation Service, Marfa, TX

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Introduction

The United States Department of Agriculture - Natural Resources Conservation Service (USDA-NRCS) is a non-regulatory agency assigned to provide technical assistance to private landowners and operators and to implement the conservation programs outlined in the current Farm Bill. The USDA-NRCS, works through your local Soil and Water Conservation District (SWCD), which is a recognized unit of state government, and its Board of Directors is comprised of local landowners whom have been elected to represent the conservation interests of other local landowners that reside in the District.

The unofficial motto of the NRCS is Conservation through Partnerships. This unique partnership between federal, state, and local units of government allows the NRCS to exist, and is meant to assist the SWCD's in carrying out their conservation programs on private lands, assist in information and education programs, and recognize conservation leaders at the local, state and national levels.

As a result of the locally led conservation initiative of your SWCD, the NRCS is used as a vehicle to provide adequately equipped and trained personnel to work directly with the farmers and ranchers within the SWCD. The NRCS is then used to promote and deliver conservation measures on private lands on a voluntary basis.

What can the NRCS do for you?

The role of NRCS is to lead individuals and/or groups through the conservation planning process to ensure that the objectives of the landowner and natural resources are addressed. NRCS personnel have the ability to plan, design, and oversee the construction and application of conservation practices on privately owned or operated lands to ensure that they are installed to serve the intended purpose. It is this ability that will assure the landowner/manager of the integrity and quality of the conservation practice being installed on their property.

NRCS can assist you with things like: development of a grazing system, wildlife management plan, water distribution (pipeline or pond) plan and design, crop rotation sequences, fertilizer and/or nutrient management plans, land leveling designs, brush management plans and recommendations, wildlife census and harvest recommendations, seeding rates and recommendations, total resource management plans, and everything in between.

Every NRCS field office in Texas maintains a local Field Office Technical Guide that contains information on practice specifications, guidelines and management information that is tailored to the local resource needs. NRCS personnel work closely with other natural resource agencies (both state and federal) and universities to ensure that new technology and information are included in the field office technical guide and made available to local landowners and operators.

The work of the NRCS is varied, but chances are that we can help. If we do not have the information specific to your needs it is likely that we can put you in contact with someone who does.

Programs

The NRCS has many programs that can be accessed by private landowners, as well as the general public (qualifications for some programs are limited to agricultural producers). They are listed below for your review and consideration.

Conservation Technical Assistance (CTA)

Technical assistance is by far the most popular program that NRCS has to offer. CTA is nothing more than having your questions answered.

- Do I need a conservation plan for my farm or ranch?
- What kind of pipe do I need to use to get the water from here to there?
- Do I need to level this field if I'm going to plant cotton?

- If I build a pond here, will it hold water?
- How big of a trough do I need to water my cows?
- Can my deer numbers be improved, and if so, what do I need to do?
- I'd like more quail on my ranch, what can I do to accomplish this?
- Which direction do I need to run my rows for more efficient irrigation?
- What can I do to stop this gully from getting any bigger?
- Have I selected the proper stocking rate for my ranch?
- What kinds of soils are on my property?
- What can I do to control erosion caused by my roads?

Questions like these all deal with Conservation Technical Assistance. This is what we do. We help you formulate a plan of action specific to your farm or ranch and give you information that you can follow to help accomplish your objectives without compromising your natural resources.

We are able to go out and design and stake that pond, rip line, brush area, waterway, etc. and are able to check it. This way, you and your contractor know that it was done correctly. We can tell you what kind and amount of chemical to use for your brush concerns.

NRCS employee skills are diverse. Engineering, agronomy, range and wildlife management, soil conservation, and plant taxonomy are only some of the skills available from your local NRCS Field Office staff. Admittedly, we are not experts, but we do have the staff, resources, and over 60 years of experience as a land management agency available to help us assist you. Your questions are always answered privately, discreetly, and confidentially.

Basically, if it deals with soil, water, air, plants or animals, we have the tools in place, which might be able to help you. As a federal agency, you have paid for the services of NRCS through your tax dollars, so there is never a direct bill from NRCS for CTA, and because of our partnership with your local SWCD Board, your interests, privacy, and concerns are always monitored by your elected representatives.

Cost Share Programs

The federal government recognizes that conservation practices are expensive to implement. The federal government also recognizes that private landowners hold a big stake in assuring that the public is certain of an abundant and inexpensive food supply, and that the foundation of all commerce and trade is directly or indirectly linked to agriculture. This same government also recognizes that in order for our country to strive to be world leaders in agriculture, wildlife, medicine, education, trade, business, industry, and all other aspects of society, that the natural resources of this country need and deserve protection.

As a result, several cost share programs have been written into law during the most recent Farm Bill to help offset some of the expenses associated with protecting the nation's natural resource base on private lands.

If a person is interested in making application to participate in a cost share program there are some steps that can make this process much easier.

- First, contact the local Farm Service Agency (FSA) office to determine if all of the farm records are current.

- Second, investigate if there are any person or land eligibility requirements for a particular program.

- Third, have a basic conservation plan on file with the local SWCD that outlines the conservation objectives of the operating unit to determine which program would best address the resource needs.

Some of the most commonly used cost share programs that are applicable to landowners and operators in the Trans-Pecos are listed for your review and consideration.

Environmental Quality Incentives Program (EQIP)

EQIP is a program that is available for agricultural commodity producers. Farmers and ranchers qualify for this program. Basically, this program helps defray the cost of applying certain conservation practices on your property. EQIP acts as a financial incentive to apply a particular conservation practice on your land.

Each year the Program Delivery Group and the Local Work Group convene to determine the conservation priorities for each county. Priorities and program delivery can vary by county boundary. After the priorities have been established in your county, the Local Work Group decides which conservation practices will address these priorities. At this point ranking criteria are developed and applications are accepted for participation in the program. Cost share and incentive rates are also established using this procedure.

To find out which practices have been listed as priorities

in the county in which your farm or ranch is located, contact your servicing NRCS office.

For more information on EQIP contact your local NRCS office or try the web at www.tx.nrcs.usda.gov/programs/

Wildlife Habitat Incentives Program (WHIP)

WHIP is a program that helps defray the cost of certain conservation practices for the benefit of wildlife habitat improvement. Priority in this program is given to conservation practices that specifically deal with habitat improvement (i.e. brush management, seeding with native species).

Applications are ranked based on habitat restoration, likelihood of success, degree of restoration, benefits to threatened and endangered species, cost per acre, benefits to society and percent of the operating unit entered in the program.

For more information on WHIP contact your local NRCS office or try the web at www.tx.nrcs.usda.gov/programs/

Conservation Reserve Program (CRP)

Cropland:

CRP is a program where a farmer leases their field(s) to USDA in exchange for the farmer to grow a permanent stand of grasses and shrubs for a minimum of 10 or 15 years. In addition to planting and growing a permanent stand of grass, other practices available for conservation farming are available. In return, the farmer receives a yearly rental fee for the use of his/her land to grow grass and shrubs. The farmer is responsible for converting its use from cropland to CRP, and is eligible for cost-share assistance in doing so. Rental rates are based on the erosive and/or productive nature of the soils located on site.

Marginal Pastureland - Riparian Forest Buffers (CP-22):

In Far West TX, land classified as marginal pastureland shares a very striking resemblance to land classified as rangeland. Several ranches have successfully used this designation for protection on riparian buffers. Like CRP on cropland, this provision allows for third order streams to become eligible for participation in the CRP program.

Like the CRP on cropland, the buffer program offers rental payments to owners who are willing to protect and in some cases enhance riparian areas of their farms or ranches. Although the rules limit some agricultural producers from participating, it is an avenue that you may want to explore for your farm or ranch.

If the stream or creek running through your property qualifies, you can enroll the area immediately (up to 180 feet on either side) of the creek channel into CRP. This area will then be leased to USDA for a set price for 10 or 15 years.

Presently, there is a sign-up bonus, called the SIP or Signing Incentive Payment available in an effort to attract more participants. This bonus is equal to the amount of $100/ac for a 10-year contract or $150/ac for a 15-year contract. The acres used to determine the SIP are strictly limited to the riparian areas of qualified streams and creeks.

This program is meant to eliminate undesirable species in the riparian areas (i.e. salt cedar) while maintaining, improving, or enhancing these areas. In some cases, tree removal, fences, or construction of watering facilities can be cost shared.

For more information on CRP contact your local NRCS office or try the web at www.tx.nrcs.usda.gov/programs/

TEXAS PARKS & WILDLIFE DEPARTMENT'S PRIVATE LANDS ASSISTANCE PROGRAM

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The Wildlife Division of the Texas Parks & Wildlife Department (TPWD) is known by many landowners and land managers in West Texas for its Wildlife Management Areas (Elephant Mountain, Black Gap, Sierra Diablo, Ocotillo), pronghorn permit issuance program, and responsibilities associated with game regulations. Considerably fewer land managers are familiar with TPWD's Private Lands Assistance Program or the Landowner Incentive Program.

The Private Lands Assistance Program provides free technical assistance to landowners. Technical assistance may involve deer surveys (helicopter or spotlight), harvest management, wildlife habitat recommendations, cost-share and financial incentive programs, and assistance in applying for a wildlife management tax valuation. The technical assistance may involve a single ranch visit or, depending on the needs of the landowner, assistance may involve repeated ranch visits over several years. With regard to survey activities, the assistance effort is normally conducted on a one-time basis for educational purposes. The land manager is responsible for surveys in subsequent years, although the assisting biologist can continue to provide annual harvest recommendations based upon survey data and harvest records provided by the land manager. Depending on landowner preference, assistance may be in the form of verbal recommendations, written recommendations, or a written management plan.

The Landowner Incentive Program, (LIP) provides technical guidance and cost share assistance up to 75% directly to the landowners interested in protecting these resources. This program is specifically designed to help with the conservation and management of threatened and endangered species or rare and declining species of plants and animals and their habitats.

Project proposals must contribute to the enhancement of at least one rare species or habitat type in a significant way. A wildlife biologist can work with the landowner to develop a management plan for any project. Projects should have the on-the-ground work completed with 3 years. All projects must be sent to Austin, TX for a review by an 11 person advisory committee for biological soundness.

Prior to entering a ranch and providing technical assistance, biologists must provide the landowner with a form that is to be signed by the landowner requesting assistance. This 1-page form simply provides written permission for the biologist to come onto the ranch and provide the type of management assistance that is of interest to the landowner. More importantly, the form describes (in bold print) a relatively new law enacted in September 1995 that concerns "privacy of information." This piece of legislation (HB 2012) has greatly assisted the landowner, and has indirectly assisted TPWD biologists. The important benefit of this law is that it provides for privacy of information that West Texas landowners value while providing the assisting biologist with a clear mandate regarding any information collected (eg., survey data) and any plant or animal species observed. More specifically, any information collected in response to a landowner request for technical assistance is strictly "confidential and may not be disclosed." The only time this information could ever be used or released is through written permission by the landowner.

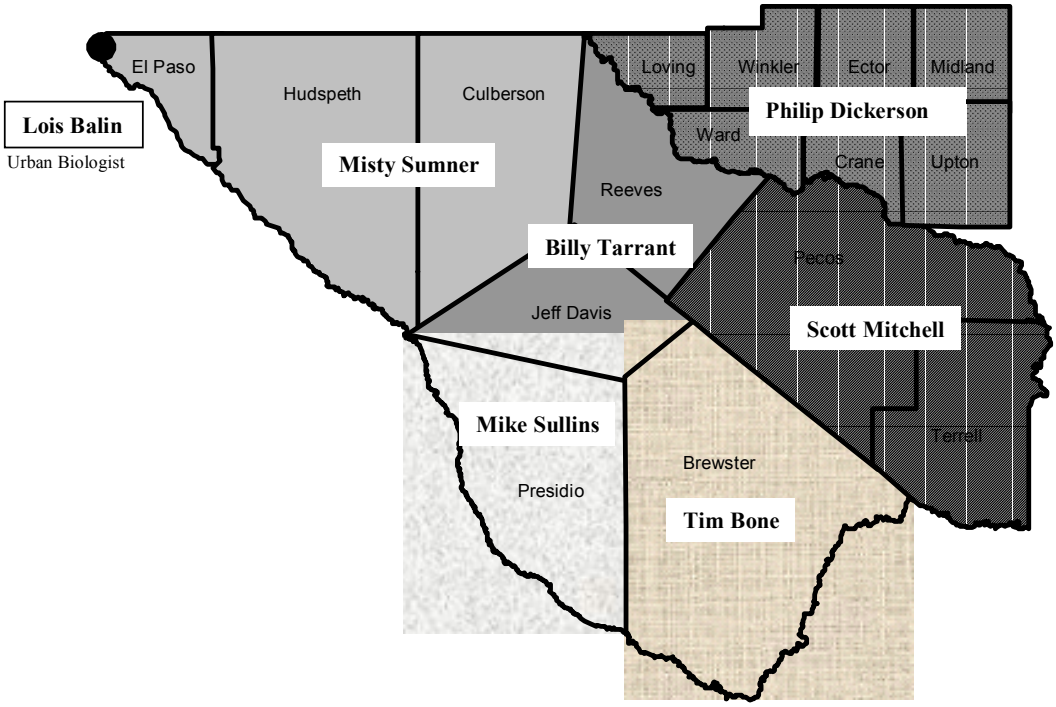
Technical Guidance Biologist for the Trans-Pecos, Calvin Richardson, has the responsibility of providing technical assistance for private landowners across the 16 counties shown on the attached map. Assistance may involve big game surveys, harvest recommendations, maintenance of harvest records, and habitat recommendations that may involve water distribution, grazing management, predator management, supplemental feeding, brush management, riparian management, prescribed fire, and many other practices. In addition to their other duties, local TPWD biologists are available to provide technical assistance in their areas of responsibility. Some of these additional duties include state wildlife surveys, harvest data collection, regulation development and revision, research, permit issuance, and public education. TPWD Private Lands Biologist, Philip Dickerson (Midland), performs many of these same duties and provides technical assistance on a district-wide basis concerning cost-share and financial incentive programs. TPWD Wildlife Diversity Biologist, Dave Holdermann (Alpine), provides technical assistance on a district-wide basis concerning rare species of animals and plants. Lois Balin (El Paso)

is the Urban Biologist and provides technical assistance regarding urban wildlife issues. She also assists local state and city parks with habitat improvement projects.

Mike Hobson is the District Supervisor and is stationed in Alpine.

TEXAS PARKS & WILDLIFE TECHNICAL ASSISTANCE

Counties of Responsibility for Trans-Pecos District Biologists



District-wide Responsibility

Calvin Richardson
Technical Guidance Biologist
Midland

Mike Hobson
District Supervisor
Alpine

Dave Holdermann
Wildlife Diversity Biologist
Alpine

SOURCES OF TECHNICAL ASSISTANCE

TPWD Wildlife Division - District 1

Brewster County

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Jeff Davis and Reeves Counties

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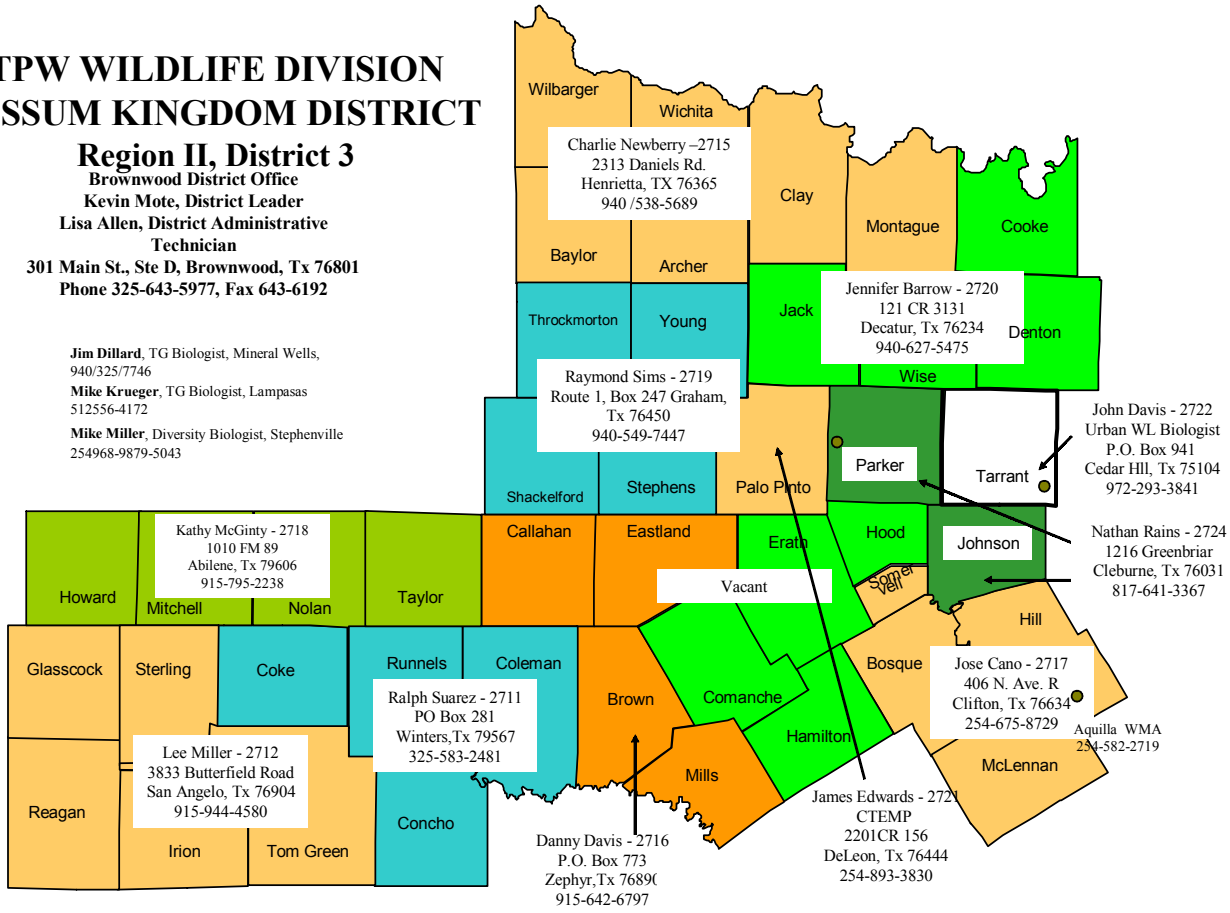

HABITAT NEEDS - WHITE-TAILED DEER

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Abstract: The economics of livestock production combined with the prolonged effects of drought have made traditional ranching difficult and uncertain. Deer hunting is providing a stable and profitable use of rangeland and many ranching operations are shifting toward long term wildlife oriented enterprises and depending less on livestock. White-tailed deer respond very favorably to habitat that provides good brush cover and a good stable food supply. Landowners should be very careful and conscious about brush control and grazing management and their effect on deer populations and deer habitat.

Introduction

Traditional livestock ranching in the western half of Texas has suffered some major hardships during the last several years. Costs of production are high and continue to increase. For most cow-calf operations, costs exceed revenues and producers are not making money. The average cow-calf operation is losing $0.99 per acre, with an average loss of $20 per cow according to Southwestern SPA data for 1991 to 2000. The ongoing drought has devastated millions of acres. Loss of grasses and deterioration of ranges has seriously decreased the potential for profitable grazing. Overstocking and continuous grazing practices of the past have exaggerated and prolonged the effects of drought. Spending money for traditional ranch improvement practices such as brush control, fencing and water development has become difficult to justify. Most observers are not optimistic that the economic situation for livestock ranching in this area will improve substantially in the near future.

Despite these major difficulties, there is a very bright economic outlook in ranching. The demand for deer hunting continues to be strong and prices for hunting are on a long-term steady increase. The production of deer does not require the high costs associated with livestock ranching. Although some costs certainly do exist to run a good hunting operation, net returns are generally good and not subject to the up and down cycles of the cattle market. Deer numbers and deer hunting have remained amazingly stable in the midst of the worst drought in over 50 years. Even though drought conditions do reduce the quality of antlers, deer hunters generally continue to go hunting each year and pay seemingly high lease prices regardless of rainfall. Most observers agree that strong demand for hunting and other wildlife related enterprises will continue in the near future.

The economic benefits of ranching for the production of wildlife appear to be good enough to warrant a major shift in land use and land management. In the past, livestock concerns were the driving force that dictated how land was managed and what practices were implemented. The well being of wildlife was often a low priority, and tradeoffs that may have harmed wildlife were accepted. Many ranch operations are now shifting away from the traditional livestock production practices of the past. A more balanced approach to ranch management involves wildlife and livestock as equal in importance. In many cases, wildlife has become the primary economic use of the resource. This is certainly true of many of the newer kind of landowners, but is also becoming true for many old time traditional ranch operations.

One of the keys to success in this shift toward economically sustainable wildlife ranching is to gain a good understanding of the habitat requirements of white-tailed deer. Deer respond very positively as these habitat requirements are fulfilled and they respond negatively if these requirements are poorly met. Prices received for hunting are largely dependent upon the quantity and quality of deer. How the land is managed determines a great deal about the size and quality of the deer herd. The habitat requirements of deer will be described based on their need for cover, food and water.

Cover

The single most important thing that sets land apart as good white-tailed deer habitat is the abundance and distribution of brush. Deer are secretive animals by nature. They prefer to be in the midst of or in close proximity to protective brushy cover most of the time. They feel most at home where they can quietly step into the shadow of a tree or bush or quickly disappear into a maze of shrubbery. The most experienced deer hunters know this and are often willing to pay a premium for large tracts of moderate to dense brush. The right amount of cover is important for supporting good stable deer numbers and a lack of adequate cover can preclude the establishment of the desired deer density.

In addition to their secretive nature, deer require brush for

regulation of body temperature. Just like humans, livestock or pets, deer need protection from the extremes of cold and heat. Dense brush provides such "thermal cover" both in the cold of winter and the heat of summer.

Another type of cover needed by deer is fawning cover. Dense tall grass provides concealment of newborn fawns from predators for the critical first few days of life. Without adequate fawning cover, loss to predators can be high. Normally, however, moderate losses to predation are acceptable or even beneficial since they help keep deer numbers in balance.

Various biologists, scientists and deer managers have attempted to discover just how much brush deer really need. Dr. Tim Fulbright, a highly regarded range and wildlife scientist with the Caesar Kleberg Wildlife Research Institute in Kingsville has summarized what he thinks the ideal amount of brush is. He describes an optimal distribution of brush as: 60% or greater canopy of brush across 60% of the landscape; natural or artificially created openings on 40% of the landscape; some areas of extremely heavy, tall and diverse brush with 85% or more canopy; thick, uninterrupted brush lined drainage areas (draws and creek bottoms). A key point made by Fulbright is that many existing brushy pastures already have this desirable combination of thick cover with scattered natural openings. In these cases, no brush control is recommended if optimum deer habitat is desired.

Al Brothers, the renowned and undisputed authority on practical deer management in Texas emphasizes the importance of good brush for the well being of a quality deer herd. He says that brush control should never be done on more than 25% of the land if quality deer are an important consideration. This rule of thumb is made in the context of South Texas, where thick brush often dominates mile after mile. According to this recommendation, 75% or more of the land should be composed of brushy cover, while up to 25% could be opened up in small, narrow strips, bands or odd-shaped clearings. If quality deer are not an important consideration, Al states that up to one half of the land can be opened up and half left in thick brush. The reason for the different recommendation relative to quality deer is that mature bucks especially require larger tracts of dense cover. Younger bucks as well as does and fawns will use areas of thinner brush, but big bucks like thick brush.

A scientific study to document the effects of brush control on deer density was conducted in Central Texas by researchers at Texas Tech in the 1980's. The authors concluded that even 70 and 80% levels of brush control did not cause a decline in the deer population. The study however was flawed in several important ways and limited in its applicability and should not be used as the basis to recommend brush control intensity.

A telling example of the impact of excessive brush control is found on a medium sized west Texas ranch. The ranch supports an average density of about 15 acres per deer. On two-thirds of the ranch, brush control was conducted in a pattern, while on the other third, all brush was retained. On the side of the ranch where brush control was done, about 60% of the brush was removed in a pattern intended to benefit deer. Creeks, draws and travel ways were left in brush strips on 40% of the acreage. Now, after many years of observations, surveys and hunting, the rancher has concluded that two-thirds of the deer live on one-third of the ranch where no brush control was done. One-third of the deer live on the two-thirds of the ranch where the brush control was conducted. This works out to a density of 7.5 acres per deer where brush was retained and 30 acres per deer where the brush control pattern was carried out. The net results are a fourfold difference in deer density.

This author's own observations on more than 100 helicopter deer surveys on more than a million acres provides additional indications of the relationship of brushy cover to deer populations. In general these observations show that deer numbers are strong where moderate to dense brush dominates the landscape. Where brush is thin, deer populations are thin. Mature bucks tend to concentrate in the larger tracts of the thickest brush. Where brush control is done, deer numbers generally decline in proportion to the amount of brush removed. These generalizations will not hold true 100% of the time. Each ranch is unique and each situation is different, but these observations gained over 25 years on many different ranches demonstrate the importance of good brush cover to good deer populations.

The 40 year evolution of brush control patterns in South Texas is possibly the best practical evidence that indicates how much brush deer need. In the 1960's, when cattle prices were good and rootplowing was cheap, the proper management of deer habitat was not economically important. It was common in those days to clear strips 600 to 1000 feet wide and leave brush strips 100 to 300 feet wide. The ratio of clearing was usually in excess of 70%. Creeks were usually not retained in brush. Much prime habitat was damaged during that era.

In the 1970's, as prices for deer hunting were increasing, many ranchers began to be more conservative in their brush control efforts. It was common in that era to clear in a 50% pattern. Strips of 300 to 500 feet wide were cleared with equal sized brush strips left in between. Some consideration was given to leaving a narrow band of brush along draws.

In the 1980's, the economics of ranching was changing. Deer hunting income was reliable and continued to increase and many ranches were deriving half or more of their income from hunting. Brush control was being more carefully contemplated and planned out, especially with regards to deer habitat. Rootplowing was done in narrow strips of 200 to 300 feet wide with alternating strips of brush 400 to 500 feet wide. A clearing ratio of 30 to 40% was commonly used. Wider buffers of brush were intentionally left intact along all major and minor draws and creeks.

During the 1990's, the ranching economy was becoming even more dependent upon hunting. Prices for quality deer leases continued to increase. Most ranchers had re-considered the role of brush control and its impact on deer habitat. Hunters were applying pressure to landowners to maintain the best possible habitat in return for high lease prices. Much brush control was curtailed. Highly planned and specialized brush management patterns became the norm. Straight strips were used less and less. Series of contoured strips or odd-shaped clearings no more than 150 or 200 feet wide were designed to fit into the landscape. Brush was left intact across 70% or more of each pasture and clearings made up no more than 30%.

These progressive changes in brush control were made by ranchers who realized that good deer habitat means good brushy cover. The high cost of brush control was also an important factor. Costs of over $50 per acre (an investment of over $1000 per cow) could not be offset by increased returns from grazing.

This emphasis on the need of brushy cover should not be over-stated to imply that the thickest brush is always the best deer habitat. Vast expanses of extremely thick and nasty brush do not provide the best habitat. Deer also need openings (either natural or man made) scattered within the brush. These openings are the primary places where the more desirable forbs will be produced. Carefully planned, conservative brush control can often be done in a way to improve or at least maintain deer habitat. Poorly planned or excessive brush control will diminish the value of deer habitat and cause a reduction in deer numbers.

Food

In addition to their requirement for plenty of brushy cover, deer also need plenty of good year-round nutrition. A good quality diet for deer means a protein level of 13 to 16%, an energy content of 65 to 70% TDN and high levels of certain minerals, especially phosphorus. A plentiful amount of forage is just as important as good quality feed. Nutritious forage needs to be present in adequate volume so that deer can consume their average daily requirement of about 3.5% of their body weight. This means that a 100 pound doe would need to consume an average of about 3.5 pounds per day (on a dry weight basis), and a 180 pound buck would need to consume about 6 pounds per day depending on the season of the year. This translates to about 1300 to 2200 pounds per year for this sized deer. To state it very simply - deer eat lots of feed, and it needs to be of high nutritional quality.

Deer are able to meet this high nutritional demand by being very selective browsers and nibblers. They have the instinctive ability to discern which plants provide the best nutrition during each season of the year and if given a choice, they will eat only the new, fresh growth of those plants.

Forbs (broadleaf herbaceous plants, weeds and wildflowers) are generally the most preferred and most nutritious kind of plant for deer. Desirable perennial forbs that come back from the root each year should be abundant in good deer habitat and should be present on virtually every square yard. A combination of cool season and warm season forbs is desirable. Table 1 lists some of the desirable perennial forbs that should be common across good deer habitat in the Rolling Plains and Edwards Plateau.

Browse (leaves and tender twigs of woody plants) is the next major category of deer forage. Browse is not generally as high in nutrition as forbs, but it is often present in large amount. Because woody plants are more deeply rooted and drought hardy, browse is considered the more stable source of deer food and usually makes up the bulk of the deer diet in Texas. Table 2 lists some of the desirable browse plants for the Rolling Plains and Edwards Plateau. It is noteworthy to remember that even some so called "noxious brush" species are readily eaten by deer. Even though they may not be as preferred as some of the more desirable shrubs, brush species can be very important in the diets of deer. Some of the brush species commonly eaten by deer include mesquite, cedar, pricklypear, persimmon and pricklyash. Mistletoe, which is most often found growing on mesquite is a highly preferred and desirable evergreen deer food.

Mast (fruits, seeds, and flowers of woody plants) are readily eaten by deer whenever it is available. Mast often contains excellent energy levels and can be very critical sources of nutrition in summer and early fall. The problem with mast is that it is not reliable and is not available for long periods. Table 3 lists some of the more important kinds of mast used by deer in the Rolling Plains and Edwards Plateau.

Grasses do not usually make up a significant part of the

deer diet except for brief periods of the year. Perennial warm season grasses are generally low in protein and energy for most of the year and do not meet the nutritional requirements of deer. Cool season grasses, especially annuals are more beneficial.

To summarize the feeding habits of deer, it is safe to say that deer prefer to eat desirable forbs, but will also readily eat mast when it is available. When forbs and mast are not available, deer eat browse the rest of the time along with a small amount of grass. The best way to insure good reliable deer nutrition is to manage habitat to provide the greatest possible diversity of vegetation. Deer need to be able to exercise their ability to select the most desirable kind of plant each day of the year. The greatest variety of plant life will allow deer to be most selective.

If the habitat is adequate to provide good amounts of such high quality deer forage, then deer will perform extremely well. Does will give lots of milk and fawn crops will be consistently high (60 to 80%). Body condition will be good and deer will often have good deposits of fat. Bucks will have large bodies and good antlers relative to their age. The incidence of spike bucks will be low and most bucks will attain 8 points by their second year. At maturity, bucks that have received this kind of good nutrition will normally have impressive antlers. Gross Boone and Crockett scores for mature bucks of 120 to 140 will be common under this kind of good natural nutrition, and scores in excess of 140 are not uncommon.

The unnaturally high numbers of extremely large, trophy bucks killed across Texas these days is largely a product of free choice, year round supplemental feeding with high protein deer pellets. While this method of artificial nutritional enhancement produces impressive results, it is very expensive and cannot be economically justified for most operations.

Under ideal conditions, deer would receive adequate amounts of high quality nutrition 365 days a year. However, such ideal conditions are not always present across the western half of Texas. Many factors arise that limit the volume and/or the quality of deer food. If rainfall is poor, plant growth is stunted and nutritional quality and quantity is reduced. If deer numbers are too high, the more preferred plants will be chronically over-grazed and will loose vigor and production. Deer will then not be able to choose such a high quality diet and will be forced to eat less and less nutritious plants. Competition with livestock (especially sheep and goats) and exotics will cause the same loss of desirable plants, loss of nutritional quality and loss of habitat carrying capacity. If less desirable brush such as cedar becomes too thick, it will decrease the availability of desirable browse and forbs.

The most common reasons for poor and inadequate deer nutrition are excessive deer numbers, excessive livestock numbers, continuous grazing, excessive numbers of exotics and excessive brush control. Attention to these factors will greatly improve the nutritional status of a deer herd.

Fortunately, deer are very adaptable creatures and can cope well under less than ideal conditions. Deer can survive for long periods on a poor quality diet. Even during the ongoing drought and with deteriorated ranges, deer populations have remained fairly stable and have even increased in places. Antler quality of bucks has remained good enough for deer hunters to continue hunting and paying good lease prices.

Water

Deer need to have access to permanent water, adequately distributed across their habitat. The rumen of deer must maintain a 60 to 70% content of water in order for digestion to occur. If deer are short on water, they will stop eating. Although there are periods of the year when deer can derive their water needs from succulent forages, they normally drink water most of the year. Permanent water, spaced about one mile apart is a desirable interval and will insure that deer have to travel no more than about one-half mile to drink. If livestock are moved out of an area, it is important to maintain water for deer. Deer will vacate large areas for long periods of time if their water sources dry up.

Summary

- Good brushy cover is important for maintaining desirable numbers of deer.
- Dense cover is especially important for holding mature bucks.
- Good, stable, high quality food is important for maintaining good antler development and reproduction. (The way to a buck's antlers is through his stomach)
- Deer need brush - they eat it and they live in it.
- Deer numbers and deer quality are largely dependent on how the land is managed.
- Brush control and livestock grazing are the two most important considerations in managing habitat.
- Deer are a legitimate agricultural product, and deer management is a legitimate agricultural use of the land.

Table 1 Desirable Perennial Forbs for White-tailed Deer in Edwards Plateau and Rolling Plains

Dayflower	Velvet bundleflower	Sensitivebriar
Bloodberry	Hairy tubetongue	Evolvulus
Penstemon	Primrose	Larkspur
Texas nightshade	Trailing ratany	Wild mercury
Heath aster	Knotweed leaflower	Windflower
Spiderwort	Milkwort	Prairie clover
Engelmanndaisy	Bladderpod sida	Snoutbean
Bushsunflower	Rock daisy	Maximilian sunflower
Prairie acacia	Snakeherb	Lazy daisy
Illinois bundleflower	Gaura	Low menodora

Table 2 Desirable Browse for White-tailed Deer in Edwards Plateau and Rolling Plains

White honeysuckle	Roemer acacia	Roughleaf dogwood
Texas sophora	Elbowbush	Bois-d' arc
Texas mulberry	Carolina snailseed	Western soapberry
Possumhaw	Old man's beard	Flameleaf sumac
Spanish oak	Grapevine	Skunkbush sumac
Kidneywood	Greenbriar	Littleleaf sumac
Mistletoe	Ephedra	Live oak
Hackberry	Redbud	Shin oak
Bumelia	Virginia creeper	Willow
Elm	Wild plum	Fourwing saltbush

Table 3 Desirable Mast for White-tailed Deer in Edwards Plateau and Rolling Plains

Acorns	Grapes
Mesquite beans	Mulberry fruit
Pricklypear fruit	Wild plums
Yucca stalks and flowers	Catclaw beans
Cedar berries	Bumelia fruit
Persimmon fruit	Hackberry fruit
Mexican buckeye fruit	Honey locust beans
Sumac fruit	Dewberry fruit
Western soapberry fruit	

HABITAT NEEDS - DESERT MULE DEER

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Abstract: Ranching in the Trans Pecos has always been beset by difficulties, but the extended drought and unfavorable economics have made profitable livestock production nearly impossible. Mule deer hunting presents a golden opportunity to keep land in economic production. Desert mule deer are hardy animals and able to survive under harsh conditions and drought. Mule deer numbers and antler quality respond favorably when habitat is properly managed. An adequate supply of food is the most critical aspect of mule deer habitat. Maintaining adequate water distribution is also critical. The ranges and habitats of the Trans Pecos region will begin to recover and improve more rapidly if livestock grazing is curtailed.

Introduction

Traditional livestock ranching in the Trans Pecos region of Texas has suffered extreme and prolonged hardship for the last decade or more. The ongoing drought is possibly the worst in over 100 years and has decimated millions of acres. Livestock production has come to a virtual standstill across much of the region due to a lack of forage. For those in the higher elevation grasslands who still have some grass and cattle, costs of production are high and continue to increase. For most cow-calf operations, costs exceed revenues and producers are not making a profit. Loss of grasses and deterioration of ranges has seriously damaged the potential for profitable grazing. Overstocking and continuous grazing practices of the past have exaggerated and prolonged the effects of drought. Spending money for traditional ranch improvement practices such as brush control, fencing and water development has become nearly impossible to justify. Most observers are not optimistic that livestock ranching in this area will improve substantially in the near future. In fact many believe that ranching in this area has changed forever and will never fully recover to past levels.

Despite these major hardships, there is a bright glimmer of economic hope in ranching. The demand for mule deer hunting continues to be strong and prices for hunting are on a long- term steady increase. The production of deer does not require the high costs associated with livestock ranching. Although some costs are incurred to run a good hunting operation, net returns are generally good and not subject to the up and down cycles of the cattle market. Mule deer numbers and deer hunting potential declined somewhat in the early years of the drought, but have rebounded some in the past two years. Despite the harsh conditions, the deer population has remained amazingly stable. Even though drought conditions do reduce the quality of antlers, deer hunters generally continue to go hunting each year and pay seemingly high lease prices regardless of rainfall. Most observers agree that strong demand for hunting and other wildlife related enterprises will continue in the near future.

The economic benefits of ranching for the production of wildlife appear to be good enough to warrant a major shift in land use and land management. In the past, livestock concerns were the driving force that dictated how land was managed and what practices were implemented. The well being of wildlife was often a low priority, and tradeoffs that may have harmed wildlife were accepted. Many ranch operations are now shifting away from dependence on traditional livestock production. A more balanced approach to ranch management involves wildlife and livestock concerns as equally important. In many cases, wildlife has become the primary economic use of the land, taking precedence over livestock considerations.

One of the keys to success in this shift toward economically sustainable wildlife ranching is to gain a good understanding of the habitat requirements of desert mule deer. Deer respond favorably as these habitat requirements are fulfilled and they respond negatively if these requirements are poorly met. Income received from hunting is largely dependent upon the numbers and quality of mule deer and land management has a significant effect on the size and quality of the deer herd. The habitat requirements of deer will be described based on their need for food, water and cover.

Food

In order for bucks to grow large antlers and in order for does to produce good fawn crops, mule deer need good year-round nutrition. A good quality diet for deer means a protein level of 13 to 16%, an energy content of 65 to 70% TDN and high levels of certain minerals, especially phosphorus. An adequate amount of forage is just as important as good quality feed. Nutritious forage needs

to be present in adequate volume so that deer can consume their average daily requirement of about 3.5% of their body weight. This means that a 120 pound doe would need to consume an average of about 4 pounds per day (on a dry weight basis), and a 200 pound buck would need to consume about 7 pounds per day depending on the season of the year. This translates to about 1500 to 2500 pounds per year for this sized deer. To state it very simply - deer eat lots of feed, and it needs to be of high nutritional quality.

Mule deer are able to meet this high nutritional demand by being very selective browsers and nibblers. They have the instinctive ability to discern which plants provide the best nutrition during each season of the year and if given a choice, they will eat only the most nutritious portions of those plants.

Forbs (broadleaf herbaceous plants, weeds and wildflowers) are generally the most preferred and most nutritious kind of plant for deer. Desirable perennial forbs that come back from the root each year should be abundant in good deer habitat. A combination of cool season and warm season forbs is desirable. Table 1 lists some of the desirable perennial forbs that should be common across good mule deer habitat in the Trans Pecos. Annual forbs such as filaree, tallow weed or peavine are desirable, but are present only in years of abundant rainfall. This is such a rare occurrence in the Trans Pecos, that annual forbs are not important in the big picture.

Browse (leaves and tender twigs of woody plants) is the next major category of deer forage. Browse is not generally as high in nutrition as forbs, but it is often present in large amount. Because woody plants are more deeply rooted and drought hardy, browse is considered the more stable source of deer food and usually makes up the bulk of the mule deer diet. In desert regions, various succulent plants are very important for mule deer and are often lumped together with browse. Table 2 lists some of the desirable browse plants in the Trans Pecos. It is noteworthy to remember that even some so called "noxious brush" species are readily eaten by deer. Even though they may not be preferred like the more desirable shrubs, brush species can be important in the diets of deer. Some of the brush species commonly eaten by mule deer include cedar, catclaw mimosa, whitethorn acacia, mariola, pricklypear, and lechuguilla.

Mast (fruits, seeds, and flowers of woody plants) are readily eaten by deer whenever it is available. Mast often contains excellent energy levels and can be very critical sources of nutrition in summer and early fall. The problem with mast is that it is not available for long periods and may not be available each year. Table 3 lists some of the more important kinds of mast used by mule deer in the Trans Pecos.

Grasses make up 5 % or less of the mule deer diet on a yearlong basis. Except for brief periods of the year, grasses are an insignificant part of their diet. Perennial grasses are generally low in protein and energy for most of the year and do not meet the nutritional requirements of mule deer.

To summarize the feeding habits of mule deer, it is safe to say that they prefer to eat desirable forbs, but will also readily eat mast when it is available. When forbs and mast are not available, deer eat browse and succulents the rest of the time and only a very small amount of grass. Table 4 summarizes three different mule deer diet studies conducted in the Trans Pecos. The best way to insure good reliable deer nutrition is to pray for rain. Beyond that, habitat should be managed to provide the greatest possible diversity of vegetation. Deer need to be able to exercise their ability to select the most desirable kind of plant during each time of the year. The greatest variety of plant life will allow deer to be most selective. Mule deer accomplish this by moving to different types of terrain throughout the year and moving in response to rainfall.

If the habitat is present to provide adequate amounts of high quality deer forage, then mule deer will generally perform well. Does will give plenty of milk and fawn crops will be good (40 to 80%). Body condition will be good and deer will often have good deposits of fat. Bucks will have large bodies and good antlers relative to their age. At maturity, bucks that have received this kind of good nutrition will normally have desirable and impressive antlers.

Under ideal conditions, deer would receive adequate amounts of high quality nutrition 365 days a year. However, such ideal conditions are rarely present across most of the Trans Pecos. Many factors arise that limit the volume and/or the quality of deer food. If rainfall is poor, plant growth is stunted and nutritional quality and quantity is reduced. Competition with livestock and exotics will cause a reduction of desirable plants, a reduction in nutritional quality, a loss of habitat carrying capacity and a reduction in deer numbers.

Fortunately, mule deer are very adaptable creatures and can usually survive under stressful conditions and for long periods on a poor quality diet. Even during the ongoing drought and with deteriorated ranges, mule deer populations have remained remarkably stable across much of the region and have even increased in places. Antler quality of bucks has remained good enough for deer hunters to continue hunting and paying good lease

prices.

Densities of mule deer in the Trans Pecos have ranged from 50 acres per deer to more than 500 acres per deer. These differences are largely the result of habitat type and food supply. Areas that support higher deer numbers are the more diverse and more rugged habitats, usually at higher elevations. Areas that support a very low density of mule deer are the vast creosote bush and tar bush flats between the mountains. There is little that can realistically be done to improve these flats.

It has become extremely popular in white-tailed deer range to provide year round supplemental feed with high protein pellets. Large numbers of trophy bucks are being produced with this practice as well as very high fawn crops. While this method of artificial nutritional enhancement produces impressive results, it is very expensive and cannot be economically justified for most operations. However, some limited use of supplemental feeding for mule deer may be useful and justifiable to maintain populations and enhance fawn crops during extremely stressful periods.

The best way to help insure an adequate and reliable food supply for mule deer is to minimize or eliminate the potential competitive conflicts between livestock and deer. In dry, harsh situations where grass is in limited supply, cattle are competitive with mule deer and will eat browse, succulents, mast and forbs. One cow will often eat far more deer food each day than each deer will eat. In order for the range and habitat to begin to recover and to allow deer to have maximum access to available nutrition, livestock grazing should be curtailed. In some places this may mean a reduction in livestock to keep in balance with available grass production. In other places this means the removal of livestock until ranges recover and grass production will justify grazing.

In areas that support a good diversity and abundance of food plants, but where the population has suffered due to excessive predation, control of coyotes and mountain lions is often needed to help deer numbers recover. Predator control is expensive, however some opportunity exists to market predator hunting.

Water

Mule deer should have access to permanent water, adequately distributed across their habitat. The rumen of deer must maintain a 60 to 70% content of water in order for digestion to occur. If deer are short on water, they will eat less. Although there are periods of the year when mule deer derive their water needs from succulents, they normally drink water much of the year. Permanent water, spaced about two miles apart is an adequate interval and will insure that deer have to travel no more than about one mile to drink. Closer spaced water is desirable in rough terrain and where higher numbers of deer exist. If livestock are moved out of an area, it is vital to maintain water for mule deer and other wildlife. Deer will vacate large areas for long periods of time if their water sources dry up.

The construction of "guzzlers" has been used to provide better water distribution in areas where traditional water development is not feasible. Rainfall catchments of 500 to 1500 square feet will generally yield enough water even in drought years to keep water permanently available in 2000 to 3000 gallon covered storage tanks. In some cases where excellent habitat exists, but no water is present, the installation of guzzlers or other water development may be a cost effective practice.

Cover

Desert mule deer inhabit a wide variety of habitat types from densely wooded forests in the mountains to barren greasewood (creosote bush) flats to open grasslands. The abundance and distribution of brushy cover is far less important to mule deer than to white-tailed deer. Unlike white-tailed deer that prefer to stay close to dense brushy cover, desert mule deer seem to be content in open habitat knowing they can retreat into miles and miles of unbroken terrain. Mule deer apparently thrive equally well with abundant cover or with sparse cover. Rough topography undoubtedly provides an added degree of security, which probably decreases the importance of brush. In flat terrain, in the absence of topographical relief, the presence of at least moderate brush is desirable. The minimum cover requirements for mule deer are not well known, but a lack of cover is not considered to be a problem in the Trans Pecos.

Where both species co-exist on the same property, mule deer tend to segregate themselves in the rougher, more open terrain and white-tails prefer to inhabit the draws, canyons, flats and bottoms which support heavier brush. A continued increase in brush in these areas will favor white-tailed deer possibly at the expense of mule deer. Brush control may be desirable to shift the habitat in favor of mule deer.

In true mule deer country where no white-tailed deer exist, brush control probably has little actual benefit to improve mule deer habitat. The use of tebuthiruon (Spike pellets) to control creosote, tarbush, catclaw mimosa and whitethorn acacia is commonly recommended to help restore grassland. Although grassland restoration is needed across the region, this herbicide is non-selective and will also injure or kill a number of associated shrubs and forbs including desirable species. For this reason it

should be used with caution and in moderation if mule deer are an important consideration.

Mule deer also use brush and topographic features for regulation of body temperature. Just like humans, livestock or pets, deer need protection from the extremes of cold and heat. In the absence of rough, broken terrain, brush provides such "thermal cover" both in the cold of winter and the heat of summer.

Another type of cover needed by deer is fawning cover. Areas of taller grass provide concealment of newborn fawns from predators for the critical first few days of life. Without adequate fawning cover, loss to predators can be high.

Summary

- The Trans Pecos is a harsh environment and desert mule deer are well suited to the harsh conditions.
- Mule deer respond positively when habitat is intentionally managed to favor a good, stable food supply.
- Mule deer respond poorly when habitat is neglected or over-grazed.
- Cattle and deer are competitive, especially in harsh environments during drought.
- The curtailment of grazing is needed in many areas to hasten the recovery of habitat
- Maintaining water distribution is critical for mule deer.
- Adequate cover is normally not a limiting factor for mule deer.
- In areas where white-tailed deer and mule deer coexist, brush control may be warranted to shift the advantage to mule deer.
- Supplemental feeding and/or predator control may be warranted in some cases to promote the recovery of adequate deer populations.
- Deer are a legitimate agricultural product, and deer management is a legitimate agricultural use of the land.

Table 1 Desirable Perennial Forbs for Desert Mule Deer in the Trans Pecos

Showy menodora	Hibiscus	Snakeherb
Gaura	Texas snoutbean	Spiderling
Heath aster	Evolvulus	Wild mercury
Primrose	Parry ruellia	Globemallow
Prairie acacia	Rockdaisy	Spurges
Bushsunflower	Hairy tube-tongue	Wild buckwheat
Bundleflower	Milkwort	Greenthread
Sida	Knotweed leafflower	Bluets

Table 2 Desirable Browse for Desert Mule Deer in the Trans Pecos

Hackberry	Mormon tea ephedra	Willow
Mountain mahogany	Old man's beard	Whitethorn acacia
Fendler bush	Sticky selloa	Gregg ash
Ceanothus	Littleleaf sumac	Silktassel
Fourwing saltbush	Skunkbush sumac	Range ratany
Winterfat	Evergreen sumac	Kidneywood
Butterflybush	Guayacan	Red oak
Skeletonleaf goldeneye	Apache plume	Shin oak
Roemer acacia	Desert myrtle croton	Gray oak
Narrowleaf forestiera	Western soapberry	Feather dalea

Table 3 Desirable Mast for Desert Mule Deer in the Trans Pecos

Mesquite beans	Persimmon fruit
Pricklypear fruit	Mexican buckeye fruit
Cholla fruit	Sumac fruit
Yucca stalks and flowers	Western soapberry fruit
Lechuguilla stalks	Grapes
Sotol stalks	Catclaw beans
Cedar berries	Hackberry fruit
Acorns	

Table 4 Summary of Desert Mule Deer Diets in the Trans Pecos

Black Gap WMA 1972 – 1974 (Brownlee, Texas Parks and Wildlife Department)		Guadalupe Mountains 1967 - 1971 (Kittams et al.)		Longfellow Ranch 1977 (Ratliff, Sul Ross State Univ.)	
Browse	24%	Browse	69%	Browse	50%
Succulents	45%	Succulents	14%	Succulents	Trace
Forbs	29%	Forbs	16%	Forbs	45%
Grass	2%	Grass	1%	Grass	5%
Major Browse		**Major Browse**		**Major Browse**	
Whitethorn acacia	6%	Roemer acacia	30%	Mohr shin oak	12%
Guayacan	3%	Catclaw mimosa	8%	Littleleaf sumac	8%
Skeletonleaf goldeneye	3%	Silver dalea	5%	Gregg dalea	6%
Roemer acacia	2%	Redberry juniper	3%	Redberry juniper	6%
Cenizo	2%	Apache plume	3%	Roemer acacia	5%
Unknown	4%	Little walnut	2%	Mariola	4%
		Feather dalea	2%	Skeletonleaf goldeney	2%
Succulents		Whitethorn acacia	2%	Feather dalea	2%
Lechuguilla	24%	Mountain mahogany	2%		
Candelilla	14%	Littleleaf sumac	2%	**Major Forbs**	
Pricklypear	4%	Skunkbush sumac	2%	Sticky selloa	6%
Sotol	2%	Desert myrtle croton	2%	Longstalk greenthread	5%
Yucca	1%			Spurge	4%
		Succulents		Bluets	4%
Major Forbs		Sotol	5%	Tallow weed	1%
Perennial spurge	8%	Pricklypear	4%	Broomweed	1%
Milkwort	3%	Lechuguilla	4%	Bladderpod	1%
Sticky selloa	2%	Cholla	1%	Rock daisy	1%
Bladderpod	2%			False ragweed	1%
Menodora	1%	**Major Forbs**		False nightshade	1%
Unknown	9%	Hairy tubetongue	3%	Hairy tubetonge	1%
		Texas snoutbean	2%	Milkwort	1%
		Lambsquarter	2%	Whitlow wort	1%
		Mexican sagewort	1%	24 other forbs	17%
		Wild buckwheat	1%		
		Sida	1%		
		Unknown	2%		

POPULAR APPROACHES TO QUAIL MANAGEMENT

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Abstract: The rangelands of west Texas historically afford some of the best, and currently most stable, bobwhite (*Colinus virginianus*) populations anywhere. Bobwhite habitat in the Rolling Plains is affected primarily by rainfall and rangeland management for livestock. Range management practices (e.g., brush management, grazing management) can be prescribed to benefit bobwhite habitat, but a large part of potential quail range suffers from overgrazing and excessive brush control. Income generated from quail hunting in this region currently rivals or exceeds that generated from grazing leases. Accordingly, more landowners are beginning to temper traditional land management goals and incorporate more quail-friendly practices (i.e., "brush sculpting", reduced stocking rates). The current demand for quail hunting affords an excellent opportunity to promote (and subsequently have adopted) management practices that will hopefully sustain the heritage of quail hunting in this region for some time.

Introduction

I'm a quailaholic. They say admitting your addiction is the first step to effecting a cure. I think about quail at least daily, usually at least hourly. I think about quail when I drive, when I'm at church, and when I'm asleep. I am vulnerable to a quail attack daily. And I'm one of the fortunate few whose avocation and vocation are one and the same. Since 1996, I have written some 375 popular articles about wildlife management, appearing in outlets like Livestock Weekly, Farmer-Stockman, Quail Unlimited, and The Cattleman. I try to cover the waterfront of wildlife interests, but my biases are thinly veiled; 156 (42%) of those articles have been solely or mainly about quail.

When it came time to write an article on quail management for these symposia proceedings, I perused my anthology of popular articles as a menu of topics. Space limitations preclude me from waxing on all of them in their entirety. If I mention a phrase or idea in this paper that you'd like more information about, send me an e-mail, and I'll provide you a copy of that particular article.

Sometimes I think everyone should value quail as highly as I do, and I wind up preaching at brush arbors about the evils of this or that quail-nemesis. Sometimes I'm guilty of assuming that just because my world revolves around quail, that yours should too. Mea culpa. Take the following admonitions for what they are. If quail are of interest to you, then apply these guidelines and thought processes ad libitum.

My "to-do" list for aspiring quail managers would include the following 5 points:

1. appreciate the needs of quail every day of the year;
2. appreciate how your management affects quail habitat (pro or con);
3. learn how to read the rangeland for quail habitat;
4. learn how to use plant succession to enhance quail habitat;
5. strive to become a quail manager, not a quail miner.

Preacher Paul's Precautionary Professions

My preacher's name is Paul. He's an avid hunter, and a fine evangelist. He talks in language that I can understand, and he keeps my attention during his sermons. Often while he's preaching on sin or salvation, he'll cite passages that make me think of quail management. Perhaps you can relate.

If Paul ever starts a sermon with "now, I want y'all to know that I'm not mad at *anybody* here", the crowd starts squirming. We know the lesson is likely to hit close to home; Paul's telling us not to take it personal.

I often invoke this profession whenever I begin to "preach" about the sins of overgrazing. Many ranchers in Texas know they're overstocked, for whatever reason. Perhaps it's the drought, or desert termites, or greed, or ignorance of how to assess grazing capacity. I'm not mad at any of them, but they need to realize that overgrazing is a concern of biblical proportions for quail across much of Texas.

One of Paul's favorite maxims is that "*you're free to choose your actions, but you're not free to choose the consequences*." This warning should accompany every ranch management decision, and promote critical thinking about the "what ifs" that permeate our strategies. Remember what I call Rollins' Revision of Newton's 3rd

Law of Motion "to every action there are *many* reactions; some are apparent, others more transparent." If your management impacts plant diversity, it will affect wildlife diversity. Seek to understand the trade-offs.

Appreciating Quail

Back in 1991, I convened a group of county Extension agents in Ft. Stockton to discuss an idea for a new program. I told them of my plans to initiate a series of "*Predator Appreciation Days*." Their pallid stares, and deafening silence, confirmed my suspicions. They thought I'd flipped my lid. I then asked one of them to take a dictionary and read the definitions for the word "*appreciate*." They range from "*to value highly*" and to "*increase the worth of*" to another context of "*to judge with heightened awareness*" and "*to be cautiously or sensitively aware of* ."

Over the course of the next 10 years, I coordinated various "appreciation" days, including predators, feral hogs, brush, deer, and of course quail. The first ever Quail Appreciation Day (QUAD) which was held on the James Currie Ranch in Glasscock County on October 1, 1998. Since then 40 QUADs have been conducted; I've learned something at every one of them.

Anyone who "appreciates" (i.e., values or admires highly) quail, should learn to "appreciate" (be cautiously or sensitively aware) of a quail's daily dilemmas each and every day of the year (not just during hunting season), and then "appreciate" (judge with heightened awareness) how his land management strategies affect quail (pro and con).

As opposed to coyotes and feral hogs, quail are easy to appreciate. I challenge you to find someone who bears a grudge against a bobwhite. They don't prey on sheep or chickens, don't uproot peanut crops, and don't hinder sideoats grama production or cattle roundups. I believe that most ranchers think more dearly about their bobwhites or blue quail than they do the deer which reside on the ranch.

Back in 1992, I read an article by Lenny Brennan, a Florida quail researcher a the time (now with the Caesar Kleberg Wildlife Research Institute), who claimed that bobwhites would be extinct in the southeastern U.S. by 2005. "Malarkey" I remember thinking to myself, and I reveled in the fact that 1991-92 quail season was a very good one in west Texas. But I ruminated on Brennan's dire prediction as I followed my setter. And the thought of a Texas' landscape devoid of quail whistles haunted me (and continues to do so).

"Why is it that we never consider rationing until we see the bottom of the barrel?" – Abraham Lincoln

Aldo Leopold cautioned that "the urge to comprehend must precede the urge to reform." We must seek to diagnose and understand the problem before we can apply a remedy. I encourage you to become a student of quail, and even more so, the landscape (biotic and abiotic) in which quail operate.

Habitat Ergonomics

Every movement needs an anthem. For quail managers, that anthem is Lynyrd Skynyrd's *Free Bird*. *Free Bird* is required listening for those who attend a Bobwhite Brigade or other quail management program that I conduct. The tune blasts across a jambox while the listeners stare at a dead quail lying before them just prior to dissecting the bird. I ask them to listen until they discover lyrics that set the stage for quail management. The answer lies in the refrain "*and this bird you cannot change*." While we may crossbreed our cattle to better fit the environment, we're stuck with the quail we have. Thus we must make the habitat fit the bird, not vice versa.

Quail are six-ounce bundles of adaptations that allow them to survive in a wide variety of habitats. Their paranoia keeps them afloat in a sea of potential predators. But adaptations can also serve as chains. Take the bobwhite's white breast meat; it provides adequate energy for short, powerful flights, but it runs out of gas (i.e., energy) quickly. Thus the quail must rely upon its legs, not flight, for its daily locomotion. The chain invoked on the quail means that all of its habitat requirements must be within walking distance.

Thus the concept of *habitat ergonomics*. I use the term ergonomics to indicate a structural change aimed at enhancing one's work effort by making the item "fit" the body. Chances are your workplace has been the recipient of ergonomic improvements in the last 10 years. Look at your computer mouse and how it fits the curvature of your hand. How about the bucket seats in your pickup truck?

In order to make the best fit between quail (or other wildlife) and their habitats, we need to consider ergonomics. Take brush clearing for example. Brush provides both food and shelter for bobwhites, and its distribution across the landscape is the single most important habitat consideration for quail in Texas (my opinion). Habitat ergonomics dictate that we clear brush in such a manner that we not only maintain our quail population, but hopefully increase it. Thus we intersperse clearings with strips or mottes of brush with the goal of

making 100% of the landscape usable by quail.

Ergonomics requires a knowledge of the organism's physical and physiological constraints. Quail prefer to be within fifty yards of brush; it's their security blanket. Thus the distance between strips of brush should not exceed twice that, i.e., 100 yards. But there are interactions between brush and other habitat elements. If the grass cover is abundant, less brush is needed; if grass is scarce (as is the case typically during droughts), more brush cover is desirable.

At the Bobwhite Brigade, we play a game called "*Run for Your Life*." It involves using hula hoops as loafing coverts (e.g., lotebushes) and allowing the quail (cadets) to forage for various foods (various candies). After a few casual feeding forays (i.e., no presence of predators), two hawks are introduced into the equation. An athletic cadet serves as an "accipiter" hawk (e.g., a Cooper's hawk, or what I call an "F-16") while a slower moving cadet assumes the role of a "buteo" hawk (e.g., red-tailed hawk or what I call a "B-29"). Rules of the game are that you're fair game to a hawk unless you can make it to the security of a lotebush (hula hoop).

At the outset of the game, there are 10 to 15 hula hoops scattered strategically between the quail and their food sources, making them relatively impervious to hawk attacks. In fact the "hawks" soon become frustrated at their inability to capture prey despite an abundance of quail. But quail life gets complicated when a rancher decides there's too much brush, so he strikes up his imaginary D7 caterpillar and takes out most of the lotebushes. Suddenly the scales tip to the favor of the raptors, and quail take it on the chin. The more brush that is removed, the more vulnerable the quail become.

But the students learn that it's possible to "sculpt" the habitat in such a way that relatively little brush is required to allow the quail to survive in the presence of the hawks. Using this knowledge of habitat ergonomics, the students begin to see the possibilities of managing rangelands for both cows and quail on the back forty.

Appreciate quail habitat

Guthery's concept of "usable space" is the underpinning of habitat management. Quail managers seeking to increase quail abundance should seek to maximize the percentage of the landscape that is habitable to quail. Under this maxim, managers should seek to increase the quantity of quail habitat, not the quality of quail habitat. To evaluate usable space on your ranch, imagine stepping onto 100 randomly selected points on your ranch. How many of those would be "usable" to a quail 365 days a year? If a particular point is not usable, what prevents it from being so? Too little brush? Too much brush? Too little grass cover? Recognizing the weak link in the chain should dictate your game plan for enhancing quail abundance.

In his 1933 classic *Game Management*, Leopold argued that "game populations can be restored by the creative use of the same tools that have heretofore been used to destroy it, namely the axe, plow, cow, fire, and gun." Four of those deal directly with habitat management. In west Texas, the "axe" takes the form of brush management; the "plow" represents farming practices (and related USDA farm programs, e.g., Conservation Reserve Program), the "cow" takes the form of livestock management, and "fire" comes in the form of prescribed burning. Relative to the "axe" and "cow", the "plow" and "fire" pale in comparison for quail managers in west Texas, so I'll dismiss the last two items in this discussion..

A Quail's Game Strategy

I often introduce myself as the "second D. R. from the small town of Hollis, Oklahoma. Perhaps you've heard of the first: legendary football coach Darrell Royal. It's been thirty years since I've tread the boy's locker room at Hollis High School where Royal played. But there's one little sign that I can remember that adorned a bulletin board therein. I don't know the author's name, perhaps it was Coach Royal, or perhaps one of his mentors. For sure the short message underscored Coach Royal's philosophy about football.

"*If your team scores, you may win.*
If your opponent's team scores, you may lose.
If you opponent never scores, you will never lose.
Defense wins ball games."

I think quail embody such a philosophy. Team Bobwhite has a potent offense. With clutch sizes of twelve to fourteen eggs, and the ability to re-nest up to three times, the colin clan has the potential to put points on the board. But their opponents are many, and hungry. A Bobwhite Brigade cadence sizes up the situation.

"*A quail's life is full of tests.*
Many critters break up their nests.
Possums, skunks, and raccoons too;
It's enough to make a bobwhite blue."

One of the first axioms that I levy on Bobwhite Brigade cadets is the statement that "*every living, breathing moment of a quail's life is dictated by the threat of predation*." So, given our plight, what do we do about it?

Now, the mention of predator control in professional

quail management circles is about as popular as the forward pass was to football when it was first introduced. In recent years, my graduate students have evaluated the efficacy of short-term, intensive blitzkriegs (i.e., "surgical strikes" using cage traps) to determine if such "trap blocks" enhance quail survival or nesting success. To date (as suggested by studies in Tom Green and Parker counties), they have not. It seems that as fast as we can immobilize the opponents, they send in replacements. In one study, we removed 35 to 60 varmints (mostly raccoons) from study areas of about one square mile, but could not detect that we had any lower varmint population when we stopped trapping thirty days later. The bench is well-stocked with raccoons, and we wound up digging a hole in the ocean.

Our offensive strategy has sputtered. We need a better defense. Defense to a nesting quail comes in the form of an abundance of potential nesting sites across the landscape. A quail can never go head to head with its opponent; it will always lose on the line of scrimmage. In order to score, mama quail must incorporate some confusion . . . trick plays if you will. She must learn to scramble.

Our studies suggest a quail's best odds for nesting successfully are found on playing fields of natural turf, but too often the sites ring of "astroturf", i.e., green, but very short. Give a quail at least 300 opportunities per acre, i.e., or in our case, a football field (which is basically an acre), and you've done about all you can do to prop up your offense. That means a potential nesting clump (a basketball-sized bunchgrass or a No. 2 washtub-sized clump of prickly pear) about every four strides.

But here's the real key. Such nesting habitat has to be available *across* the landscape, not just in the endzones. A recent Quail Appreciation Day in northeast Texas (Red River County) underscores this keystone. Fifteen "dummy" nests were constructed on a five-acre field that supported pretty good nesting cover (broomsedge bluestem) on April 14. Eighteen days later, only one of those had avoided being "sacked." It was a rout.

While the fans in the crowds were yelling for predator control, it would likely have been ineffective in this case. If you force a quail to nest in only a five-acre parcel of an otherwise uninhabitable landscape, you've telegraphed your play to your opponents. So, while it's easy to blame fire ants or a burgeoning raccoon population for the quail's losing record in that part of the state, the specter of habitat fragmentation is pervasive. The islands of quail habitat that remain increasingly function as "cemetery habitats." As the number of suitable nesting clumps decreases on the landscape, so does the quail's odds of completing a pass (i.e., hatching a nest). Too often, quail find themselves in a "third and long" situation, and their opponents stand ready and able to intercept their feeble passes.

I'm thankful that we still have large areas of suitable quail habitat out here in west Texas. But the trend over time is to become increasingly fragmented, and that bodes poorly for quail.

Factors Affecting Quail Habitat

Several factors impact the quantity and quality of habitat for quail in the Rolling Plains, namely:

1. weather,
2. brush management,
3. grazing management, and
4. desert termites.

Of these, only brush and grazing management (i.e., stocking rates) are under the direct control of the land manager. Weather accounts for about half of the variability seen in south Texas bobwhite populations, and the impacts are likely similar in west Texas (especially those areas receiving less than 25 inches of precipitation annually).

Play Ball for Quail

Most of my free evenings are spent exercising my bird dogs and me. It's a good way to unwind, yet still ponder quail happenings without the telephone ringing. But from about 1980 to 1991 there was a period in my life where I was bird dog-less. Proving that "nature abhors a vacuum", something filled my void: slow-pitch softball. Now that I've got bird dogs again, I haven't stepped on a softball diamond in nearly 10 years. But recently something hit me to search for similarities between the two pastimes. Hence, I offer the "Softball Habitat Evaluation Technique" (SHET) for evaluating quail habitat.

Remember the dimensions of a softball field. It's 60 feet between bases, 46 feet from pitcher's mound to home plate, and usually about 270 feet down the right field line. The area contained within a softball field is about 2 acres, and that contained within the infield is about 0.1 acre. There are 10 defensive players instead of nine as in baseball.

Here's my recommendations for quail habitat based on the SHET model. Saddle up ol' blaze and carry a softball with you to apply this to your back forty "stadium". You may want someone to go along with you as a scorekeeper.

Behold the softball, which represents a quail. Every time it's thrown up in the air, someone wants to whack it, and it's defenseless. It is designed for short flights and it takes a real "flight" to carry it more than 300 feet. Pretty much everything it's going to encounter within an hour is within a two acre area. When the game starts, it always seems to head towards one of the bases.

Here's a "pitch" for better nesting cover. If you can toss the softball the distance of 46 feet and still see the ball in your pasture, then your grazing is too close for good quail cover. Lighten up on your stocking if you are a fan of quail. A suitable clump of perennial bunchgrass (e.g., little bluestem) about the size of home plate works for bobwhites. Prickly pear should be about the size of both batter's boxes to be useful as nesting cover. Manage for at least 20 potential nesting clumps within the area prescribed by the infield diamond.

Now let's "cover" some other bases. You should strive for at least ten quail houses (e.g., lotebushes) spread across the field. Putting one where ever defender would be standing would be a good approach. The proper placement of one's defense is key in softball; and so it is with quail. If you can't throw a softball (in the air, roll doesn't count) from one quail house to another, consider improving woody cover by half-cutting mesquites. Good quail houses should be about the area of both batter's boxes together; their height should be between maximum strike range (about chest high) to maximum pitching arc (12 feet).

When a quail comes up to hit (i.e., be the batter) everybody it looks at is trying to get him "out." Such it is in quaildom; death from above and death in the tall grass. But there are some areas on the diamond where the quail is safe (i.e., the bases). The closer the bases, the more secure the runner is.

There are about 12-15 people in the dugout, and about the same in a covey. As long as they're in the dugout, they're safe. But sooner or later, each one must face his destiny against the opposing team. They can't win if they don't score (i.e., reproduce).

Finally, there's a fellow called the umpire. He dictates the flow of the game, and interprets the rules. He decides what's fair and foul; who's safe and who's out. He decides if a game is called because of weather or darkness. Opposing managers often beseech him to see things their way, but ultimately, it's his call, and his alone. That individual, my friend, is you.

Scoring Quail Habitat

The Texas Quail Index (TQI) is a five-year demonstration that was initiated this past May in thirty counties and seven of Texas Parks and Wildlife Department's Wildlife Management Areas. The objective of the demonstration is to see if anything can be measured during the summer that will accurately predict how many quail one might flush in December. Observers count quail along a ten-mile route and measure various other quail-related happenings (e.g., dummy nest success) along the route.

One of the measurements is a collection of photo points taken at one-mile intervals. The cooperators send the photographs in to me (a total of 22 photographs per site), and I rate each photograph on a scale from "1" (pitiful) to "10" (perfect). The resulting average "score" is my expert opinion of their "habitat quality."

For the summer of 2002, I scored over 600 photographs. A total of five received the perfect "10." Now I've asked the cooperators to do their own scoring, and we'll see how their rankings of their particular site and my appraisals jibe. Perhaps they will be more forgiving in their evaluations. After all, they know the sites better than I do; perhaps there's something about the particular site that evokes great memories of a covey rise in years past. My appraisal tends to be more cold-hearted, analytical, and perhaps more objective.

Dr. Jerry Cooke of Texas Parks and Wildlife Department remarked to an audience in Alpine last summer that "you love all of your ranch, deer only love parts of it." Ditto for quail. The more closely you can overlay your perceptions of the back forty with a quail's perception, the more "usable space" you can claim for quail.

When I score a quail habitat visually, I look first across the landscape. I'm looking for the proper kinds of brush cover and its interspersion across the habitat. Then I look downward to assess the herbaceous (grass and forbs) component. I'm looking for evidence of nesting habitat and a diverse plant community to provide seeds and insects.

For the TQI, I devised a 10-point scoring system. As I look at each photograph, I give up to three points for the brush component, up to three points for the herbaceous layer, and up to three points for the degree of interspersion. The last point I list as "intangible". To receive it, the site has to especially pique my attention as a veteran quail hunter. It's where I'd put my dogs on the ground first.

A photograph of a "10" can be seen at the TeamQuail website (http://teamquail.tamu.edu). Now, this one isn't part of the TQI but it gives you an idea of my exacting standards when it comes to praising quail habitat. A summary of the TQI data for 2002 is available in an

Excel spreadsheet at the TQI website. We will be enlisting new cooperators for the 2004 season, so if you're interested in participating, drop me an e-mail (d-rollins@tamu.edu) for more information.

Rollins' Rules of Succession

I distill the discipline of range management down to two essentials: (1) know your plants, and (2) know how to manipulate them. These tenets hold whether one's management goal is bobwhites or black baldies, white-faced steers or white-tailed deer. The former implies a working knowledge of one's production factory (e.g., plants) while the latter implies some shade-tree mechanical abilities in applied plant ecology. Know which plants are important to your target species, and then know how to manipulate plant succession with the "axe, plow, cow, and fire."

Know Your Plants

Two years ago I was on the Tongue River Ranch in Cottle County for a wildlife field day. I was scheduled to discuss quail habitat management to the crowd on Saturday morning. At some point along the tour I was to evangelize about plants important to quail, and how to blend cattle, brush and bobwhites.

As tours sometimes do, this one got bogged down on the first stop, thus crimping the times for other would be morning speakers, including me. Our caravan of some 40 vehicles had driven about 10 miles from the headquarters in Depression-like clouds of dust. Here we were an hour late and still having to drive the dusty road back to lunch for the chuckwagon-style barbecue dinner that awaited us. Somehow I didn't think folks would be too interested in my waxing eloquent on Illinois bundleflower and lotebush.

Hurriedly I grabbed a "bouquet" of important quail plants with intentions of taking only ten minutes to hopefully pique somebody's interest in quail botany prior to the brisket. Looking around, I grabbed a handful of western ragweed, a straggly lone broomweed, and yanked several culms of little bluestem. Ever so gingerly I dug up a buffalobur with my pocketknife being careful to avoid most of its needle-like spines. I completed my bouquet with kochia, a branch of wild plum, and a fully-armed sandbur plant.

Back at the headquarters, a hungry and somewhat restless group lent me their ears, but I could tell their attention would be short-lived. I pronounced I needed ten minutes to describe my quail bouquet.

First I pulled the western ragweed. I appealed to their sense of hunger as I preached some good from a lowly weed. Year in and year out, seeds of western ragweed are the number one fall-winter food item for bobwhites in north Texas. To frame the moment, I quoted Ralph Waldo Emerson who asked "*and what is a weed but a plant whose virtues have yet to be discovered*?"

Next I teased out the buffalobur. Hardly anybody knows it by that name; to most it's just that yellow sticker weed. I harp on the importance of being able to name the plants below one's feet. If you can't name them, you never see them. I bemoaned the fact that every County Agent has posters hanging on their office walls depicting "Common Weeds in Pastures" and how that poster might appropriately be renamed "Top Quail Food Plants." The seeds of buffalobur are one of the main reasons bobwhites and blue quail hang around corrals and other areas of disturbed soil. Its black lava-rock like seeds will grace many a quail's crop over the winter months.

To complete my trilogy on seeds, I pulled out the Illinois bundleflower. This "weed" gathers a few "ahs" from the crowd when they learn it's a perennial legume. Legumes are the royalty among quail plants, that is until you remind the crowd that mesquite is also a legume. I brag on the sandy soils of the eastern Panhandle as home to more desirable quail legumes than any other region I know. I also reminded them not to spend much time looking for Illinois bundleflower in a grazed pasture; it's too much of a delicacy to continuously stocked cattle.

Next I bring out the greenery, i.e., kochia. As somebody spouts that it must be a good seed-producer for quail, I discount its value for seed. It occupies an even more noble niche than producing seed: I know of no other plant that grows grasshoppers like kochia. Hence it is to quail chicks as Gerber is to our own neophytes.

Making the leap from food to cover, I offered up the sandbur for inspection. Then I retold how the Wheeler County farmer had challenged me to speak favorably about it at a similar tour 13 years ago. I recalled how Extension range specialist J. F. Cadenhead had spared me the embarrassment of being backed into a corner when he proclaimed *"they slow down bird dogs, don't they*?" Ever since, Cadenhead's Corollary has reminded me that quail do not live by food alone. Even such unsavory specimens as prickly pear and catclaw gain favor when viewed through this paradigm.

It was easy for me to brag on the next plant, common broomweed. In my opinion nothing heralds a bumper quail crop like an ocean of broomweed. Such "bad" broomweed years (I love'em!) do more than anything to insulate (spell that "predator proof") quail from an army of enemies. I told the crowd that November and

December rains on bare soil bringeth forth good broomweed canopies.

As the penultimate plant, I displayed the little bluestem to the crowd, perhaps one-fourth of which recognize it as a bluestem. I cite a statistic from the Packsaddle Wildlife Management Area about 100 miles north where little bluestem accounted for 98% of the bobwhite nests recorded there over a five-year study. Its function, and other bunchgrasses like it, is to provide a "nursery" for some 14 eggs and an obliging hen. I stress that an abundance of such nesting clumps of bluestem is the single best measure of predator control for quail. Imagine being able to throw your lariat from one bluestem clump to the next; that's about the threshold of 250 clumps per acre.

Finally, I spoke in reverence about the branch of sand plum. When the good Lord invented "quail houses" for west Texas, he had two plants in mind: lotebush and sandplum. Plum thickets the size of your gooseneck trailer are quail Hyatts. To optimize quail habitat, you should be able to throw a softball from one quail house to the next.

Seeds of Good Fortune

A weak link for most landowners relative to wildlife management is their inability (or disinterest) in plant identification. Most county Extension agents get two questions about plants: (1) what is it, and (2) how do you kill it? I encourage students of wildlife to be a bit more curious about their photosynthetic friends.

J. E. Weaver spent his career studying the ecology of the tallgrass prairies back in the 1930s. He stated that "Nature is an open book for those willing to read. Upon each grass-covered hillside is revealed the history of the past, the conditions of the present, and the hope for the future." May we endeavor to be better range readers. Indeed reading is fundamental.

Seeds are the currency of life for most game birds. About 70 percent of quail's annual diet consists of seeds. So, can you name the ten most important seeds for quail or dove on your property? If not, why not? I'd wager that seeds of ragweed, doveweed, sunflower, buffalobur, panic grasses, pigweed, prickly poppy, hackberry and mesquite will be represented. And fifty or more other species depending on where you're at.

Dove season offers a good opportunity to begin one's own personal seed collection. Collect the crops and spill the seeds out into a Styrofoam cup (I use an empty shotshell box) to where they can air dry for a week or so. Then separate them by species until you've collected fifteen or twenty seeds of each species. Now place them by species in those cellophane coin holders that coin collectors use (the size used for nickels or quarters works well). Label them appropriately and catalog them in the plastic notebook sleeves used to store color slides. You've just created your own personalized seed collection!

When it comes to identifying the various seeds, take a look at the quail seed collection on the TEXNAT website (http://texnat.tamu.edu). This seed resource was prepared by Garrett Anderson, a senior at Menard High School, and a graduate of the Bobwhite Brigade. A great online resource for plant identification is the Noble Foundation's Plant Gallery (www.noble.org).

As you find seeds you can't identify, seek assistance from your local county agent, NRCS office, or send them to me (Texas Cooperative Extension, 7887 U.S. Hwy. 87 N., San Angelo, TX 76901-9714). If you've got a digital camera with good macro-focusing capabilities, take a close-up of the seeds and e-mail them to me (d-rollins@tamu.edu).

There's a saga unfolding on your back forty, and it's begging for attention. I encourage you to hone your plant vocabulary, and the alphabet therein starts with seeds.

Booms, Busts, and Broomweed

Jackson (1962) characterized bobwhite irruptions in the lower Rolling Plains of Texas as an interaction among drought, livestock grazing practices, plant succession and periodic episodes of heavy rains. His explanation of the situation may be described as a 5-step process.

1. A drought of several years, coupled with livestock overgrazing, depletes much of the habitat, hence most of the bobwhite population. The relict population of bobwhites survives in what I refer to as "honeyholes", i.e., those "source" habitats that provide relatively drought-resistant habitats. These bobwhites "are in a sense selected stock and to a degree adapted to a lack of cover". I refer to them as "Yogi Quail" (i.e., they're smarter than you're average quail) and suggest that they are disproportionately adult birds.

2. A year of average rainfall promotes secondary succession on the bared soils, resulting in expanses of annual forbs (e.g., doveweed, buffalobur) useful to quail. The habitat is "functional [but] unstable." The nutritional situation is good and the predator population has lagged during the dry years. Bobwhites undergo a "lateral" increase and occupy sites across the landscape.

3. A year of excessive rainfall breaks the drought. The

landscape is now covered with a dense canopy of common broomweed which provides excellent winter ground cover yet is open at quail-level for easy travel. "Now the range is all bobwhite habitat as regards cover" (Jackson 1962). The quail increase is rapid (a "vertical" increase).

4. A year of normal rainfall follows with good moisture carryover from the previous year. The bobwhite population explodes and occupies all marginal habitats (even roadsides). Meanwhile plant succession has advanced to a stage less desirable to bobwhites (e.g., mostly grasses) and the quail population is left "out on a limb" and probably competing for food with an irruptive rodent population.

5. The bobwhite population crashes if food or cover fails before spring. Dry years set in and continue. Conditions revert again to phase 1.

Jackson used bobwhite population irruptions in 1942 and 1958 as the basis of his observations. His data were based largely on hunting preserve records on number of quail harvested. The 1987 irruption is the one that most hunters of "my" era use as a benchmark. This irruption conforms very well to Jackson's "model." Dry conditions prevailed from 1983-84, and range conditions were deplorable. Accentuating the dilemma for quail was the bitter cold winter of 1983-84. Bobwhites were (apparently) absent from many of my favorite haunts in southwestern Oklahoma (Harmon County). I estimate that bobwhites made up less than 20% of the quail population during the 1984-85 hunting season; scaled quail comprised the remainder. Rains fell in the fall of 1984 and resulted in a "good" broomweed stand in 1986. The lateral increase occurred. More rains fell in 1986 and resulted in a bumper broomweed year in 1987. The vertical increase occurred and a banner quail year was the result.

Ode to broomweed

"*I pledge allegiance to common broomweed,*
and to the cover for which it provides.
One canopy, overhead, continuous,
maximizing usable space for quail.

I submit that the most visible herald of a banner quail year in the Rolling Plains is a "broomweed" year. And, while the broomweed seeds can be a major diet item during such years, I suspect broomweed's major contribution to quail is by making virtually all the range landscape "usable space" (Guthery 1997).

A dense canopy of broomweed probably provides a measure of predator-proofing for bobwhites that is unavailable during other phases of Jackson's model. The best predictor of bobwhite abundance is the previous year's abundance. This suggests that some quail management dogma (e.g., "you can't stockpile quail") is malarkey. Broomweed probably helps increase overwinter survival thereby increasing density of birds available for the breeding season.

In summary, I propose that the ultimate effect of rainfall for quail may simply be an increase in herbaceous cover that provides a strategic advantage to the prey, be they cotton rats or bobwhites. Better survival of breeding birds, coupled with higher nesting success, may provide the mechanism to put the "boom" back into quail crops. Oddly enough, it may be the droughts for which we should be thankful, for they may be as important to the boom-bust phenomena as the "wet" years. The drought "cocks the hammer" for quail booms (i.e., bares the soil) and the rain pulls the trigger.

Prickly Paradigms

"Many ranchers do declare,
they've got too much prickly pear.
It's a thorny plant that they despise,
but it sure looks good through a quail hen's eyes."
- Bobwhite Brigade cadence

I've only been to Washington twice. The first time was the more memorable. I spent the night in a overpriced, low-rent motel room a couple of blocks north of the White House. There was a fire escape ladder right outside the window, and I didn't sleep a wink. I could just envision some drug-crazed mugger sneaking in through the window and slitting my throat. It wasn't a risk-free neighborhood. I was glad to make it back to Oklahoma alive.

Perhaps that's the way a quail feels during the nesting season. Call it a form of "bobwhite flight" from the crime and corruption on the back forty. Just as their suburban human counterparts put bars on their windows and deadbolts on their front doors, so do quail apparently seek some measure of protection from break-ins.

During a jackrabbit hunting safari back in 1986, my son Travis (then five years old) posed a painful question to me. He was trying to keep up with me and stumbled from one clump of prickly pear to another. His low-top boots didn't offer much protection, and he was to the point of tears when he asked "Daddy, why did God make cactus anyway?" Out of the mouths of babes. It was a decade later before I had that one figured out.

Only one of 189 bobwhite nests reported by Val Lehmann on the King Ranch during the 1940s was

situated in prickly pear. Apparently things get more "western" as one goes west young hen. Philip Carter studied bobwhite and blue quail nesting habits in Irion County in 1993-94. Prickly pear was the most common nesting site, with 12 of 21 bobwhite nests and 8 of 12 blue quail nests. He did not measure availability of prickly pear versus bunchgrass sites; perhaps the quail were nesting in prickly pear in proportion to its availability, as opposed to actively seeking it out. Perhaps.

Following up on Carter's observations of the proclivity for quail in west Texas to seek prickly abodes, another graduate student, Stacey Slater, tested whether nests situated in prickly pear were more successful than those situated in grass microhabitats. He used "dummy nests" (i.e., three chicken eggs) to evaluate nesting survival on ranches in Coleman, Cottle, Crockett, Fisher, Reagan, Shackelford, Sterling, and Tom Green counties. Every odd-numbered nest was situated in prickly pear while even-numbered nests were situated in the most abundant, suitably-sized bunchgrass. He also estimated the number of suitable nesting clumps (prickly pear and bunchgrass) along each nest transect.

Slater's studies found that nests situated in prickly pear enjoyed higher survival than nests located in bunchgrass. Hardly rocket science, eh? The cactus spines appeared to provide some mechanical protection against nest muggers, at least up to a point. Once a transect offered more than about 280 suitable bunchgrasses per acre, there was no difference in nest survival between grass and cactus nests. That threshold suggests that if sufficient grass nests are on the landscape, the searching efficiency of nest predators can be diluted.

The quail-cactus trilogy was completed when Fidel Hernandez monitored bobwhite nesting ecology on four sites in Shackelford County during 1997-98. Hernandez speculated that the Irion County quail were nesting in cactus due to its availability, and not actually selecting for it. Bunchgrasses are typically less abundant in Irion County (about 18 inches precipitation) as opposed to the more mesic Shackelford County (about 26 inches precipitation). Shackelford County quail range frequently offers the Cadillac nesting cover for bobwhites, i.e., little bluestem. A study in western Oklahoma found that 98% of the quail nests there were in little bluestem.

Hernandez located and monitored 81 quail nests; 47 were located in bunchgrasses, 24 in cactus, and 10 in shrubs. Given the relative densities of bunchgrasses and cactus, Hernandez concluded "it appears that bobwhites were selecting for prickly pear as a nesting substrate." Nests situated in the center of a prickly pear clump (protected on all sides) were more successful than those situated along the outer perimeter of cactus.

If we extend Hernandez' figures on nest success by nesting cover, 38 of 100 quail nests situated in bunchgrass should hatch, whereas 58 of 100 nests situated in prickly pear would hatch. Quail nesting in cactus averaged 53 percent better survival than those nesting in bunchgrass.

While south Texas ranchers seem to appreciate prickly pear (e.g., cow fodder during droughts), their counterparts in the Rolling Plains and west Texas are less affectionate towards it.

If I seem hooked on *Opuntia*, forgive me. I tend to think like a quail, and hence empathize with their prickly paradigms. Yes, I know it can get too thick and make perambulations through the prickly forest a pain. I'd rather hunt in bunchgrass habitats, and likely my dogs would too (although they negotiate thick prickly pear with amazing adeptness). I don't have a clue how much prickly pear one needs to adequately protect quail nests. Nor whether we can strip spray or checkerboard control the pear with minimal effects on quail. These trials have not been conducted.

Ralph Waldo Emerson asked rhetorically "and what is a weed but a plant whose virtues have yet to be discovered." In a perfect world, perhaps prickly pear would never be missed as nesting substrate. "But here in the real world" dry weather, overgrazing, and vermin proliferation tilt the odds against quail. I don't begrudge them for seeking security for their nurseries. That night in Washington made me appreciate their dilemma.

Brush Sculpting for Quail

The three most important factors that affect various wildlife species in west Texas are 1) weather, 2) grazing management, and 3) brush management. As the first is largely out of our control, we seek to tailor our grazing and brush management to benefit our target species, be they black baldies or bobwhites, white-faced steers or white-tailed deer.

When it comes to brush management, I encourage landowners to heed the "carpenter's advice", i.e., "measure twice and saw once." Ideally, a brush management plan should incorporate the habitat needs of wildlife *a priori*, i.e., the plan should be in place before the bulldozer is unloaded or the spray plane is en route.

A Bobwhite Brigade cadence says it this way:

If you think quail are neat.
Then don't clear all that mesquite.

Loafing cover, plum and lote,
save a little, don't miss the boat!

Brush provides food and shelter for quail. Especially important is the role that brush plays as "loafing coverts" or "quail houses". A quail house should be about the size of your pickup truck. It should be dense above and open at quail's eye height. Good quail houses in this area include lotebush, sandplum, skunkbush, littleleaf sumac, agarito, catclaw (mimosa and acacia), chittam, elbowbush, whitebrush, allthorn, javelinabrush, fourwing saltbush, and some mesquites (those that have "umbrella-like" growth, not upright).

The amount of brush that a quail needs varies with the amount of grass cover available. The more grass, the less brush is required; the less grass, the more brush is required. Regrettably, we tend to find ourselves in the latter situation more than the former, so be deliberate as you clear more than 80% of any given tract.

When sculpting for quail, my rules of thumb include (a) "quail houses" (i.e., a lotebush or other thicket) should be no further than a softball's throw apart, and (b) I should be able to see my bird dogs *most* of the time! Picture a softball field; now strive for a quail house at each of the defensive player positions (i.e., about 10 per 2 acres). Typically target only mesquite, cedar, and willow baccharis for control, and leave any mesquites with other shrubs growing up through them.

But here in the real world, things don't always work out according to plans. Someone invariably comes up to me after a meeting lamenting the fact that their father's perception of brush didn't conform to today's economic environment, and the importance of wildlife enterprises. "Can I build some brush piles or something to make up for the lack of brush" they ask?

I'm not a big fan of brush piles. They're a poor substitute for a lotebush or plum thicket. In my opinion, brush piles offer more habitat for the quail's enemies (e.g., skunks and raccoons) than they do quail. Recently a landowner in Coleman County told me he'd spent most of the winter burning brush piles, per my recommendation. He estimated that he flushed raccoons from about thirty percent of the burned piles. The trend was highest near his farm ponds.

That said, brush piles can and do provide loafing cover for quail in the absence of other coverts. If you're making brush piles, build a frame out of pipe or fence posts and set them atop concrete blocks so that the resulting brush will be suspended about 10 inches off the ground.

If you've removed the big mesquites, but have a crop of multi-stemmed resprouts coming on, you can take the opportunity to improve their structure for quail by "half-cutting" them. Half-cutting involves scoring the tops of smooth-stemmed mesquite branches (usually those less than two inches in diameter) with a limb saw. Push downward as you cut to break the limb. Select trees that have five to ten limbs so that the resulting tree looks like an umbrella.

The best time of the year to half-cut mesquites is during April when the limbs are quite flexible. Half-cut five to fifteen mesquites over an area the size of a basketball court, then move about 250 yards and repeat the process.

One other option is to make some tee-pee shelters using cut mesquites. Take the stump ends of cut trees and prop the cut end up into a live tree. Place 4 or 5 such cut limbs/trees until you form a teepee.

More information on "Brush Sculpting" and half-cutting is available at http://texnat.tamu.edu.

Cows and Quail

In October 2002, I had the opportunity to speak to the directors of the Texas and Southwestern Cattle Raisers meeting in Kerrville. I was more than a bit anxious as to how they would receive my thoughts on grazing and quail, as west Texas had been mired in drought for at least five years, and much of the quail range looked like linoleum.

I introduced the concept of "under-grazing" to the crowd. I defined it as "the conscious decision to leave more grass standing than suggested by historical grazing paradigms." I suggested the concept of "grass sculpting" as a first cousin of the Brush Sculptors program aimed at tailoring brush to accommodate both wildlife and livestock needs. If the next ten years could see "grass sculpting" become common jargon in west Texas as much as "brush sculpting" has been in the last five years, the quail would give a hearty "amen!"

Whether my proposition of reduced stocking rates is viewed as heresy or genius depends on where you find yourself along a continuum of ranch goals. If you're on the far left (i.e., cows only, no interest in quail), then I'm a blasphemer. If you're on the far right (quail only, no interest in cows) and quail leases have sustained the ranch through the dry times, my message is more saintly.

I'm not calling for an "either-or" situation, but an optimization. And I submit that the optimal enterprise mix will be realized at a light to moderate stocking rate;

often significantly lower than what's practiced now across much of west Texas. A lower stocking rate would improve gain per animal, reduce winter feed costs (typically the greatest variable cost in a cow-calf operation), reduce production and marketing risks, and enhance quail habitat.

For the economics argument, I cited Dr. Richard Conner, a well-known rangeland economist at Texas A&M. "Bottom line, moderate stocking rates produce only slightly less average net returns per acre and with much less income variation compared to heavy stocking rate." Conner bases his conclusions on several long-term data sets.

There's still a lot of work and research ahead to fine tune the stocking rate and quail equations. And perhaps there's sufficient demand for a limited supply of quail that the market won't select for under-grazing. Or maybe the drought is over, and we'll never see dry times again, thus rendering grazing impacts more innocuous to quail. Or maybe the illogical economics that have placed the demand for quail over cows was just a short-term craze. You make the call.

So, is livestock grazing required, optional, permissible, or contradictory if one's goal is to enhance quail habitat? For the area we're considering (i.e., western half of Texas) I submit that grazing is a permissible, but not prerequisite, activity for attaining one's quail habitat goals. Over a typical 10-year period, grazing (at the customary stocking rates) in this area might be an asset two years out of ten, neutral three years out of ten, and a liability five years out of ten. The question that will become increasingly topical is "how can livestock grazing be *prescribed* in order to improve quail habitat?"

Prescribed grazing

Prescribed grazing must be considered analogous to prescribed burning, i.e., a management activity conducted for a *specified* purpose under a given set of circumstances. Just as a prescription for a headfire varies among burn objectives, fuel types and weather conditions, so must a grazing prescription address management goals, specific wildlife needs and weather conditions.

Prescribed grazing will generally involve either a "rapid" rotational system (i.e., 8 or more paddocks) or a "slow" rotation with a lighter stocking rate. One way to accommodate the flexibility for prescribed grazing is to stock the ranch with no more than 70% cow-calf and 30% with stocker animals. Dealing exclusively with stockers may be the best route for the landowner strictly interested in quail. The stockers offer the flexibility to manipulate stocking rates quickly in order to fine-tune habitat needs. Such flexibility is critical for modifying stocking rates during dry times.

Someone (perhaps the grazing lessee) always reminds me that "country can get too 'thick' for quail you know", implying the importance of bare ground, and that grazing is critical to maintaining such. Where annual rainfall is less than 30 inches or so, bare ground is rarely a factor in quail management in my opinion.

Lack of suitable nesting cover is a weak link over much of Texas' quail range. In order to foil nest predators, a nesting hen should have access to suitable nest sites across the landscape. At least 250 nesting clumps per acre (e.g., little bluestem), about the size of a basketball, are considered to be the best defense against nest depredation.

Contrary to the goal of most grazing managers, "spot grazing" is a desirable outcome from the quail's standpoint. Heavier grazed portions of the pasture promote food-producing species like western ragweed and buffalobur. But such areas need to be interspersed with adequate nesting cover.

One's goal should be to optimize plant species diversity, and especially those plants deemed important for quail. This may involve timely grazing during a particular season of the year, or total deferment for much of the year. The grazing cow can be one of the best tools for managing wildlife habitat, but in many cases it has been the worst.

Just about any tool in the manager's toolbox can be used to either construct, or destroy, depending on the artisan who wields it. Livestock grazing is no different.

Appreciate quail hunters

In November of 2001, I traveled to Amarillo. My luncheon date was to address a group of lenders, lawyers, land entrepreneurs, and landowners about the impacts of wildlife on land values in the Golden Spread. A "blue norther" had struck during the night, and as I left Paducah headed northwest in the pre-dawn, I knew I was poorly dressed for the occasion.

I had a tie in my clothes bag, but no sports coat or blazer. After all, I'd been out of the office for over a week, and my thoughts when I'd left San Angelo focused more on quail and deer hunting than on "work." The only warm outerwear I had in the truck was a camouflage sweatshirt and a fluorescent orange insulated hunting jacket. As I wound through the headwaters of the Red River, an idea

hit me that might serve double duty: to stave off the arctic wind, and to introduce my topic.

I left the tie in my bag, grabbed my hunting coats, and attacked the situation of the moment. When I was introduced as a leading quail expert, I whispered to myself what I always do following such declarations "there's a lot about quail that I don't understand." I walked to the corner of the room, and in a deliberate manner, donned the camouflage sweatshirt and then the orange coat. Talk about a fashion clash; one reeked of visibility, the other hinted of obscurity.

As I sported the hunter orange coat, I referred to how visible the hunting opportunities were becoming in the Texas Panhandle. "Thar's gold in them thar hills" I proclaimed, "and in those brushy canyons and cottonwood draws." It comes in six-ounce ingots called quail, and in 10-point settings atop a deer's head.

The brushlands and canyons east of the Caprock are home to some incredible white-tailed and mule deer, as are the breaks of the Canadian that bisect the High Plains from west to east. Game birds, including bobwhite and blue quail, wild turkey, and pheasants range throughout the tailwater pits, cottonwood draws and sandy soils. The playa lakes that dot the plains, to borrow a phrase from cajun Justin Wilson, are often "black black black with duck."

The chambers of commerce for struggling communities are beginning to open their eyes to the colors of camo, orange caps, and greenbacks. And the realtors have homed in on the lure of wildlife as a motive for land transactions like turkeys flocking to a corn feeder. The brushiest pasture is worth more on today's rural real estate market than the best dryland cropland. "We don't sell ranchers to ranchers anymore" one realtor has told me, begrudgingly acknowledging the changing of the guard relative to land values from ranching to hunting.

In these respects, the future for hunting and for landowners to capitalize on hunting in this area is indeed "bright."

Then I removed the orange coat to reveal the camo sweatshirt. There's another perspective on the issue that would just as soon keep the wildlife variable more cryptic. If you've enjoyed hunting access to a property for many years, for free, the writing on the wall isn't favorable. When you have to watch as some rich folks from the big city are hunting what was formerly "yours", there is a sense of despair. You don't blame the landowner, but your situation certainly doesn't allow you to match their antes for hunting rights.

Another group that is beginning to disdain hunter orange, and the accompanying green they sport, are stockmen who operate on leased land. "New" landowners, who likely tow dog trailers more than goosenecks, are less likely to be compelled to turn a buck from grazing revenues, and may value the grass more for nesting cover than fodder. The grazing lessee sometimes gets pinched.

And the inflated land values by demand for hunting have driven land prices well beyond the inflection point for anything approaching cost-effectiveness, at least using traditional economics. But the new landowners view the venture as recreation, and just like gardening, recreation isn't usually bound by the chains of cash flow or cost-effectiveness.

And finally, there's the landowners themselves. Modest by nature, they typically shun the publicity of bright orange, and would just as soon blend in to the local surroundings. Back in 1988, I was at a meeting in Throckmorton to visit with a small group of ranchers. The mood was one piqued mostly by apathy, as the blossoming of deer and quail hunting for this region was just about to hit the exponential phase of its growth curve (which it has in the last several years). One rancher asked the question "why do we want to encourage more people [by promoting the hunting] to come to Throckmorton County? Seems to me there are plenty here already." The migration of "come heres" isn't always appreciated by the "been heres."

Where you stand on an issue surely depends upon where you sit. And the clothes definitely make the man, and how he views land management in today's economy. Our task is to tailor our existing wardrobe to best fit today's fashion.

My message to the group from that point on was that the historical paradigm for the area's rangelands (i.e., cattle grazing) was compatible with the new kids on the block, provided "you know when to say when." One can't maximize grazing potential and nesting cover at the same time. Similarly, it likely doesn't make sense (cents?) to wage a vendetta against brush when there may be more bucks in a quail than a calf. Preserve your options.

I left them with the metaphor of the camouflaged cowboy hat. Blending the traditional paradigm (ranching cows) with the notion of ranching people, quail, and whitetails, is not a one-size-fits-all situation. Craft your Stetson with the amount of mottling that is appropriate for your ranch goals, not only for today's fashion, but tomorrow's as well.

Then hold on to your hat, as the winds of change are always gusting.

Quail Escargot

Occasionally I do some private consulting work for well-heeled (often nonresident) quail hunters who want to buy a "quail ranch." When they call me about "where should I look" I suggest a belt of country about one hundred miles wide stretching from Sweetwater, Texas to Woodward, Oklahoma.

At "Quail Appreciation Days" which I conduct across Texas, I often ask ranchers to compute the relative worths of a calf and a quail. In other words, how many quail does it take to equal the profit in a calf, or conversely how many calves does it take to equal the profit in a quail? Considerable head scratchin' commences as the cypherin' begins.

According to recent figures, three-fourths of Texas cow-calf producers in the "SPA" (Standardized Performance Analysis) database net less than $50 per cow unit. At a stocking rate of 25 acres/animal unit, that figures to a net return of $2.00/acre (yours may be much higher, I hope it is). If you've got quail, and are working just a little to market your quail lease, I'd wager your return is equal or higher than two bucks per acre.

Recently we surveyed 250 members of Quail Unlimited who reside in Texas to determine their spending habits relative to quail hunting. The average QU member spent $10,354 in pursuit of quail during calendar year 1999. Of that $2,900 was in lease fees. The other two major expenses were on-site vehicles ($2,112) and dog-related ($2,004). He owns an average of six bird dogs and expenses per dog were $438 annually.

I often refer to bobwhites as six-ounce ingots of gold, referring to their economic value. Using the expenses cited above, a bobwhite in the bag costs $207. On a per-pound basis, that's $34 per ounce, or $552 per pound!

Green Ketchup

"*Take change by the hand before it takes you by the throat*." - Sir Winston Churchill

"Paradigm" is a two-dollar word for "rut". As in, I'm stuck in one and its steering my future. A paradigm shift happens when times, and attitudes, change suddenly.

Paradigm shifts that I've observed over the last 25 years include the replacement of the row binder with the round hay baler, the preference for ATVs over jeeps, and quality reflected by the phrase "made in Japan." Sometimes there's little fanfare over a paradigm shift, but others are accompanied with much gnashing of teeth.

Take green ketchup for example. My daughter recently brought home a jar and insisted I try it with my french fries that evening at supper. Who dreamed this stuff up? Obviously nobody who has ever worked wheat-pasture cattle through a squeeze chute. Every time I dipped a tater into that green concoction, I had flashbacks of working at the salebarn. How unpalatable. But when I learned to close my eyes, I was okay; it tasted the same as my beloved, traditional red variety.

There's a paradigm shift that's sweeping the ranching industry over much of Texas, and like green ketchup, it's not always palatable.

One change is the realization that there's often more profit in a quail or a deer than in a calf (or calves). This can be a bitter pill to swallow to those who prefer the branding iron to the beeper collar and a quarter horse over the Japanese variety (i.e., ATVs).

Another paradigm shift that is evolving is the increasing occurrence of absentee landowners. Odd thing, but these folks don't always think along "traditional" lines. Some don't want cattle, or if they do, they seek a much lighter stocking rate, usually just enough to maintain the proper amount of grass for quail. At some time, this paradigm shift will likely limit opportunities for those seeking grazing leases.

This paradigm shift won't mean the end of cattle grazing. O contrare! But it does portend a change about who'll be calling the shots on such ranches, especially relative to stocking rate and brush control decisions. And those changes may be accompanied by considerable heartburn.

Pass the ketchup please . . . and the Rolaids.

Feeding Quail

There are several ways to feed quail. I'll start with the least intensive methods and proceed to the most intensive. Be forewarned that feeding quail doesn't necessarily increase survival or increase productivity of quail; research results are mixed. A recent study at the Packsaddle Wildlife Management Area in western Oklahoma concluded that feeding did increase quail survival at least during the colder winters.

The efficacy of supplemental feeding is often debated among quail circles. Some argue it concentrates birds and predisposes them to higher levels of predation, parasitism or disease. The Oklahoma study found no difference in predation rates between areas with and without feeders. Another recent study in Florida reported lower predation on areas that had supplemental feed. The researchers reasoned that quail on the supplemented site

were able to fulfill their daily energy food requirements more quickly, and thus were less exposed to predators.

At the low end of the scale, if you're feeding sorghum, sudan, or wheat hay (that contain any grains to speak of) to your cattle, be sure and select a feeding location on the leeward side of woody cover. Quail likely won't travel far from protective cover no matter how hungry they are.

The next alternative is to "salt" the roads. Generally milo, wheat, or "floor sweepings" containing either of these, are the feeds of choice for feeding quail. Quail can ingest corn, but it will be more attractive to other critters ranging from raccoons to feral hogs. Feeding the roads can be simplified by using a "trip hopper" or similar automatic feeder. Some managers affix a "spin feeder" to their grill guard or rear bumper and just feed selective areas along the road (remember the cover requirements). To be most effective feeding should be done at least twice a week during inclement weather. Salting the roads is likely the most expensive way of providing feed if you count your labor and fuel costs.

Various feeders are perhaps the most common means of providing winter feed. Feeders come in all shapes and price ranges, and the variety of home-made versions suffice as metal versions of Darwin's finches. Prices can range up to $200 per feeder.

In my opinion the "Currie Quail Feeder" is a tough design to beat. Take a metal drum (any size, but I prefer the 16 or 30-gallon sizes), drill about a half dozen holes in it about an inch from the bottom. Insert a steel punch and push downward on the hole to create a lip that serves as a rain deflector. Hole size should be 9/32 inch for milo and 7/32 inch for wheat. Set the barrel on a concrete block or old wheel rim to where the "feeding ports" are about quail's eye height. Sink two t-posts on opposite sides of the barrel and tie some No. 9 wire around it to secure it from feral hogs to mischievous bulls. Works like a charm.

One of the most innovative ways to feed quail is what I call the "patty melt quail feeder." It is the epitome of complementarity between cows and quail and was the brainchild of Dr. Ed Huston of the TAMU Center here at San Angelo. About 1992 Ed came to me with the idea of producing a cottonseed range cube that contained 400 pounds of whole milo per ton of cake. Most of the milo passes through the cow undigested and is deposited more or less randomly across the pasture as biotic quail feeders. We did some pilot testing that winter and found that quail learn very quickly to dissect the cow patties, er feeders.

There's no guarantee that winter feeding will increase quail survival, but given the current body condition of the quail, the apparent dearth of available natural foods, and what could be another sixty days of cold weather, it's a gamble either way.

Just Add Water

Habitat management for wildlife in semi-arid rangelands of the southwestern U.S. is a pretty simple recipe: just add water. When you think of water, wildlife, and habitat management, images of various water storage facilities, i.e., "guzzlers" usually come to mind. But another approach involves water harvesting of another sort, using small dams to slow runoff from rain squalls and allow it to percolate into the soil.

I was schooled on this philosophy by Sherman Hammond on his 33,000-acre ranch located southwest of Ft. Stockton. Now Mr. Hammond is downright stingy when it comes to water. His philosophy is that you should keep all the rain that falls on your property, and take all that your upstream neighbor sends to you. In an area that garners only 12 inches of rain annually, his miser-like water management enhances not only his livestock production, but wildlife as well.

I first met Mr. Hammond in 1996 and since then we've become "Blues Brothers." We share an admiration for the "blue" (scaled) quail that inhabits much of the Chihuahuan desert.

Scaled quail populations, once abundant in areas west of about the 100th meridian, took a regional, and unexplained, nosedive in about 1989. And the population remained uncharacteristically low over most of its range in the Trans-Pecos for the next decade. But not everywhere. A trip to the Hammond Ranch in 1996 confirmed that the ranch still had lots of blue quail, more than anywhere else to our knowledge in west Texas during this time period.

So, what's Mr. Hammond's secret? He attributes the quail surplus to his water management. For years, Hammond has constructed spreader dams along the ranch's roads. The spreader dams divert water that runs down the road's hard surface and stores it in shallow pits. Lots of west Texas ranches sport spreader dams on the roads, but still don't have the quail they had ten years ago. Why should Hammond's place be different?

Hammond doesn't just have a few spreader dams . . . he has hundreds, if not thousands! Each of the shallow pits supports vegetation that makes a stark contrast to neighboring sites only a few yards away. During our research, we found that the moist-soil sites produced about 25 times more vegetation than the adjacent uplands.

Hammond ran out of ranch roads years ago, so he began constructing small dams along any type of small drainage across the entire ranch.

We have since coined the phrase "quail oases" for the mini-wetlands. And they appear to be just that . . . green islands in an otherwise stark desert. During our research, we found that the moist-soil sites produced about 25 times more vegetation than the adjacent uplands. Walking through some of the oases begs the question "what did you reseed theses areas with anyway?" Nothing. The white tridens and vine mesquite grasses, and assorted forbs, were there; they just needed a drink.

Over the years Hammond and his bulldozer operator have perfected the art of building quail oases. In some areas of the ranch, they've engineered the catchments to where when one fills to a depth of about eight inches, the water goes around a spillway and into the next. During winter months, several of the larger pits held enough water to support several species of ducks. Mule deer frequent such areas for the better availability of forbs and the standing grass provides winter forage for Hammond's cows. Hammond feeds protein supplement for his cows, but no hay.

But back to quail. Are the oases the reason why Hammond's ranch yields a harvest of blue quail when many other areas fail? Maybe. The sites appear to offer patches of nesting habitat and probably attract insects that are a mainstay of a quail chick's diet. Hammond's livestock grazing is lighter than most ranches in the area, so the lower stocking may have affected quail habitat positively.

During 1999 and 2000, we trapped female blue quail from various parts of the ranch (some with quail oases, others without) in an attempt to determine if the quail oases were the factor for higher quail numbers. The quail were fitted with radio "collars" that allowed us to monitor the hen's whereabouts, survival, and nesting status.

Over the two summers, we radio-marked 196 hens. We learned very quickly that the most common nest site for blue quail in this region is tobosagrass (*Hilaria mutica*). And the Hammond Ranch has lots of it, in areas with and without the quail oases. Over 90 percent of the nests located were situated in tobosagrass. None of the nests were located in, or immediately adjacent to, any of the quail oases. Nesting success was unusually high and averaged 74 percent. This high nest success is about three times what might be considered "normal" for blue quail across its distribution.

For More Information

The TeamQuail website (http://teamquail.tamu.edu) serves as a good portal to online information about quail management. Several symposia proceedings are available online, most notably for west Texas the 1999 symposium "Preserving Texas' Quail Heritage into the 21st Century." A new textbook "*Texas Quails: Ecology and Management*" is in press with Texas A&M University Press and should be available by late 2004. I continue to write about quail happenings in my columns in Livestock Weekly, Farmer-Stockman Magazine, and Quail Unlimited Magazine; subscription information for these periodicals is available at their respective websites. The Texas Quail Index (http://teamquail.tamu.edu) provides hands-on mechanisms for landowners to gauge their progress towards their quail goals.

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HABITAT REQUIREMENTS OF PRONGHORN ANTELOPE

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Abstract: Two of the most important characteristics of quality antelope habitat concern visibility and mobility. Because the pronghorn's primary means of self-defense are vision and speed, anything that interferes with these abilities will, in the long-term, decrease their chances of survival. Another very important habitat characteristic that impacts pronghorn health and productivity is the freedom to make seasonal, long-distance movements to locate improved forage conditions and thermal cover. Anything that interferes with the pronghorn's ability to roam the range (fences, highways, dense brush, etc.) will impact herd health and survival. An important aspect concerning the vegetation component of antelope habitat is fawning cover. Nothing is more critical to fawn survival than adequate hiding cover. There are 2 factors that dictate whether fawns will have adequate hiding cover. The first factor, precipitation, is beyond the manager's control. The second factor is controlled directly by the manager and concerns stocking rates and pasture deferment. Pronghorn in the Trans Pecos (and elsewhere) prefer forbs, although woody plants are critical when forbs are not available (seasonally and during drought). To a lesser extent, grasses are important seasonally. Small herds of pronghorn do exist in arid regions with little or no free water, but good water distribution can improve herd health and productivity.

Introduction

In the 1920's pronghorn numbers in the Trans Pecos were at an all-time low of 692 animals following decades of commercial harvest and unregulated sporthunting. After restocking efforts in the 1940's and 1950's, pronghorn numbers in the Trans Pecos climbed to more than 12,000 in 1961. Over the past 4 decades, the Trans-Pecos pronghorn population has fluctuated widely from a low of less than 5,000 animals to a high of 17,000 animals. These oscillations occur in close association with long-term weather patterns, and the population has often exhibited increases or decreases of 50% from one year to the next. Dramatic fluctuations in wildlife numbers are normal and necessary phenomena in arid regions such as the Trans Pecos where weather and forage conditions fluctuate dramatically. Similar to livestock grazing in West Texas, serious habitat degradation would occur if numbers of large herbivores (deer, elk, pronghorn) remained high during extended drought conditions.

The drought that began in 1993 has been one of the worst since the area was settled in the 1880's. As expected, pronghorn numbers decreased substantially. Those who understand the resiliency of the country and the ability of the pronghorn to recover are not overly disturbed by this relatively "short-term" weather-related decline in pronghorn numbers. What's more disturbing is the long-term declining trend in grassland health and acreage, and the associated trend in wildlife species that rely on healthy grassland and savanna habitats. West Texas species such as the Aplomado falcon, Montezuma quail, lesser prairie chicken, eastern meadowlark, and the pronghorn antelope all have gradually declined (not just during the recent drought) as a result of grassland degradation and human activities. If we are concerned about the pronghorn and other grassland species, we need to understand the changes occurring in grassland habitats and what we can do to reverse those trends or at least minimize their impacts.

Food Habits

Several food habit studies were conducted in West Texas to gain information about annual and seasonal pronghorn diets (Buechner 1950, Hailey 1979, Roebuck et al. 1982). The research indicated similar results for annual diets, ranging from 65-70% forbs, 25-30% browse, and 5-8% grass. During a 3-year study (Hailey 1979), heaviest use of forbs occurred during the fall (77% of the diet), although forb use in winter was considerable (56%). Browse received heaviest use in summer (60%), but was also important in the spring (45%). Grasses were used more in the spring (20%) than any other season, with moderate use in winter (8%).

The majority of annual rainfall in the Trans Pecos is received during summer and fall (although annual precipitation fluctuates dramatically among years). During the good rainfall years, forb availability increases considerably during late summer and fall, and there is a corresponding increase in forb use by antelope. Forbs are highly preferred by pronghorns, and they tend to consume them seasonally in proportion to their availability with heaviest use in the fall. Forbs are very palatable and are an excellent source of nutrients for pronghorns. Some of the more important forbs are euphorbia spp., silvery bladderpod, paper daisy, perennial broomweed, plains blackfoot, plains zinnia, shaggy purslane, spreading sida,

common horehound, scarlet gaura, spreading dyschoriste, leatherweed croton, old man's beard, dwarf calliandra, nightshade, and several composites.

Browse species are second in importance in antelope diets and tend to be used most in spring and summer. However, woody plants can become especially important to pronghorn survival during dry seasons when forbs are not available. Browse species preferred by pronghorn are skeletonleaf goldeneye, Gregg dalea, feather dalea, Apache plume, James bundleflower, walkingstick cholla, prickly pear, littleleaf and skunkbush sumac, tarbush, ephedra, and juniper. A few browse species, such as tarbush, can be detrimental to antelope when taken in large quantities. Tarbush toxicity, combined with malnutrition, can be a problem on drought-stricken or over-grazed ranges when the herd is not allowed to make long-distance movements to better forage.

Grasses are generally considered the least important forage category in antelope diets, as grasses only compose 6-7% of their annual diet. Although grasses represent a limited proportion of the annual diet, grasses can be extremely important to pronghorns on a seasonal basis. Fiber increases in grasses as they mature while digestibility and nutrient content decline. Pronghorns have difficulty digesting mature grasses. Tender grass shoots, on the other hand, are highly palatable, nutritious, and contain low amounts of indigestible components such as lignin and cutin. Perhaps just as important as the nutrients they contain, the timing of grass shoot emergence can be critical to pronghorn survival during some years. In most years, cool-season grasses will begin sprouting in February and March, prior to foliage growth on most woody plants and long before the normal forb growth (promoted by summer rainfall). The heaviest use of grasses by antelope is during March through May, with grasses representing up to 30% of the diet during this time. Following a severe, dry winter, these succulent green shoots can provide a boost in nutrition that can save many antelope from starvation until woody plants grow new shoots or early rains promote forb growth. Although grasses are primarily used in spring, there is some use of sprouting cool-season grasses during late fall and early winter.

The 3 greatest influences on pronghorn nutrition include precipitation, numbers of grazing and/or browsing animals (livestock and wildlife), and restrictions on long-distance movements. As previously mentioned, the production of annual and perennial forbs preferred by antelope is directly tied to rainfall. Under good forage conditions, there is very little diet overlap between cattle and pronghorns. Yoakum and O'Gara (1990) found less than 30% overlap in 9 out of 10 food habit studies. Under drought conditions, declining quantity and quality of grasses force cattle to consume increasing amounts of woody plants and perennial forbs (if available), resulting in an increasing diet overlap with pronghorns. If livestock numbers are not substantially reduced during persisting drought conditions, there can be a detrimental impact on pronghorn nutrition (and fawning cover). After the past decade, it is difficult to imagine enough antelope on the range to negatively impact the forage supply. However, when a pronghorn herd is contained in a net-wire fence pasture, several years of good rainfall can allow them to increase above the long-term carrying capacity of the range. A subsequent drought can result in a die-off when the herd is unable to move beyond the fence in search of improved forage conditions. The pronghorn is a resilient species that can thrive in harsh country, but not when they are prevented from making long-distance movements when necessary.

Water Availability

Pronghorn water requirements and water consumption will vary seasonally and from day-to-day depending on precipitation, temperature, humidity, and availability of green, succulent vegetation. Daily water consumption rates for adults can range from almost no intake of free water in April and May to more than a gallon per day in August. However, a close relationship exists between pronghorn distribution and the location of available water. The vast majority of antelope (95%) in the Red Desert (Wyoming) were found within 4 miles of a water source (Sundstrom 1968). On the other hand, a few small herds (Sonoran pronghorn) exist in arid regions with little or no available water.

The majority of antelope range in Texas is adequately watered because of widespread watering systems for livestock. Therefore, water availability on antelope range is often taken for granted. However, situations regarding water do arise in ranching operations that can impact the pronghorn herd. For example, when livestock are removed from pastures for marketing or pasture management reasons, watering sites should be maintained so that the antelope have access to water on a daily basis.

Antelope prefer to drink from ground-level water sources such as stock tanks or windmill overflows, but they will use most water facilities designed for livestock. The trough height (~18") and water level should be sufficient to allow weaned fawns access to water. Extremely cold weather can freeze water troughs and prevent antelope from using them. Under normal conditions, a ranching operation will break the ice in the troughs on a daily basis to keep water available for livestock. But if the livestock have been removed from a pasture, these frozen water sites may be neglected. Extended periods of extreme

cold weather can severely stress a pronghorn herd, especially if they are deprived of drinking water.

Habitat Visibility

Can pronghorns survive in habitats where visibility is poor? Yes (at least for awhile)-- we have all seen antelope meandering though some brushy vegetation. A more appropriate question is "Will a pronghorn herd remain healthy and productive over the long-term in habitat with poor visibility?" The answer is no.

Reduced visibility in pronghorn habitat results in subtle problems--it doesn't cause immediate mortality of the herd, and it won't necessarily cause the herd to abandon the site (although there is ample documentation of pronghorn herds abandoning habitat with poor visibility). Habitats with poor visibility simply reduce, over the long-term, survival rates of fawns and even adults. Just as important, antelope instinctively avoid areas with poor visibility (unless they are somewhat desperate to fulfill a survival requirement). Encroaching brush effectively reduces their available acres of foraging habitat. Open grasslands and grassland-savannas are critical not only because of good visibility-there are several interacting factors that improve antelope survival (predator detection, predator avoidance, visual/social cues among herd members, herbaceous hiding cover, superior foraging habitat, freedom to make long-distance movements).

Does 100% of the antelope habitat need to have high visibility? No. Pronghorn require good browse diversity during winter and during drought. This can easily be provided with less than 5% cover of succulent and woody species, as long as there is a good diversity of browse (lightly scattered yucca, cholla, ephedra, catclaw, mesquite, juniper, oak, prickly pear, littleleaf sumac, lotebush, even tarbush). In addition, woody plants located along draws and among low rolling hills provide thermal protection for antelope during winter and summer. However, the majority of pronghorn habitat must have high visibility for long-term health and productivity of the herd.

Over the long-term, the best and most economical tool for maintaining a healthy grassland savanna while preventing brush encroachment is prescribed fire. Periodic fire is a natural process that maintained the health of arid grasslands for centuries (Thornber 1910, Griffith 1910, Humphrey 1958), but rest from grazing is necessary before and after the fire. Herbicides are effective in situations where dense stands of mesquite, catclaw, creosote, or tarbush have developed. But chemicals are expensive ($22-38/acre), they reduce forb abundance, and don't provide the same benefits as fire (Richardson 2001). Mechanical treatments such as chaining, roller chopping or aeration can be effective in temporarily damaging woody species and providing grasses an opportunity to recover. Grass restoration tends to be less effective if the treatment is followed by several years of drought. Mechanical treatments are expensive ($45-70/acre). Most are temporary and will have to be repeated in the near future unless the manager implements a burning program after grasses have established.

Mobility for Escape

Pronghorns have tremendous speed and endurance. Habitats that allow them to use their natural abilities for self-defense without interference are critical to long-term success of the herd. Historically, gray wolves were the primary predator of antelope herds in Texas. With considerable endurance and persistence, they hunted in packs and provided a real threat to adult antelope. As the gray wolf was gradually extirpated in the early and mid-1900's, coyotes (kept in check by wolf predation) were allowed to expand in numbers and distribution. They are now the primary predator of antelope, followed distantly by bobcats, eagles, and mountain lions. Unable to assume the long-distance-pursuit role of the wolf, coyotes have resorted to a strategy of preying on fawns, usually before they are 2 months old. Coyotes are no match for healthy, adult pronghorns on open range. However, in marginal habitat coyotes can have an impact on adult pronghorn. When antelope have to negotiate brush thickets or a series of barbed-wire fences, the chances begin to improve for a couple of pursuing coyotes. When fleeing pronghorn are turned by net-wire fencing (or hung up or injured as they attempt to run through), this provides the pursuing predators with an even greater advantage. It doesn't take long for a coyote to understand that net-wire fences, steep slopes, and dense brush are effective barriers for fleeing antelope and that these barriers can be used to their advantage. Several accounts have been documented of coyotes using fence corners to hem up a fleeing antelope.

Mobility for Herd Movements

In the northern extremes of their range (Wyoming, Montana), pronghorns sometimes migrate up to 100 miles to avoid deep winter snows. The Texas antelope herds are not migratory; however, they do move on a limited basis in response to seasonal availability of forage. Although they can move greater distances, a movement of only 5 or 10 miles may be critical during dry periods when forb production is limited and woody browse plants on an adjacent range become necessary for survival.

The free movement of an antelope herd during all seasons is a key factor in maintaining a healthy and productive herd. Moving to a new vegetation type is the only means available to pronghorns for dealing with seasonal and weather-related changes in forage conditions. The most common barrier that restricts free movement of pronghorns is fencing. Because antelope tend to negotiate fences by diving under or going between wires, a net-wire fence or a sheep-proof, barbed-wire fence can be a serious barrier to pronghorn movements. Where such conditions exist, the ranch manager should take steps to provide access through these fences. This can be done by: 1) folding up the bottom of a net-wire fence in 100 to 200-yard stretches every half mile, leaving a 16-18" gap between the fence and the ground, 2) replacing net-wire water gaps with barbed-wire, once again leaving at least 16" of space between the bottom wire and the ground, and 3) replacing 100 to 200-yard sections of sheep-proof fencing with 4-strand barbed wire (a smooth wire on the bottom will reduce hair loss and injury). These steps will improve conditions for pronghorn movements and forage selection, while still maintaining a cattle-proof fence.

Ranch managers interested in benefitting pronghorns should consider their yearly movement patterns and eliminate any restrictions on their long-distance movements. Managers sharing the same antelope herd on an annual basis can benefit the herd by cooperating to provide freedom of movement for the animals, which could prove beneficial to all those involved. For example, the seasonal movement of antelope from one ranch to another can improve nutrition and survival and ultimately increase herd production and numbers. Although it may be just one of the reasons, some managers install and maintain net-wire fencing to protect their antelope from harvest by neighbors-this strategy sometimes "protects" them to death.

Little can be done about the highways, railroad tracks, and right-of-way fences that often hinder antelope movements. However, dense brush that serves as a barrier to herd movements can be managed to improve free movement of pronghorn herds. Broad-scale brush treatments are extremely expensive. However, a dense strip of brush that effectively separates 2 quality pronghorn habitats often can be removed at a much lower cost (than a broad scale treatment) and provide a movement corridor that greatly improves the herd's chances of survival.

Fawning Cover

The primary factor influencing the long-term success or failure of an antelope herd is fawn survival. Nothing is more critical to fawn survival than adequate hiding cover (even more important than predator numbers). Predation losses are substantially reduced when sufficient fawning cover is available. There are 2 factors that dictate whether fawns will have adequate hiding cover. The first factor, precipitation, is beyond the manager's control (although maintaining herbaceous ground cover greatly improves rainfall effectiveness). The second factor influencing fawning cover is controlled directly by the manager and concerns stocking rates and pasture deferment.

In average rainfall years and with timely supplementation, the local stocking rate recommended by the Natural Resources Conservation Service provides adequate animal performance and generally does not damage forage plants. However, precipitation during most years is below average (Nelle 2002) and recommended stocking rates result in a high percentage of forage utilization. When considering critical needs of pronghorns such as hiding cover for fawns, a stocking rate 2/3's to 3/4's of the traditional rate may be more appropriate. A deferred rotation grazing system (allows antelope to select among rested pastures and allows regrowth of desirable plants, if it rains) is usually preferable to continuous grazing of all pastures. Grazing deferment also allows the manager to provide additional rest to pastures containing traditional fawning grounds. Under extended drought conditions, reducing the stocking rate is the best means of allowing antelope to survive nutritionally and reproductively.

Predation

Predator control is not technically a habitat requirement (more of a population management tool). However, the overall impact of predation is directly related to habitat quality. Predation generally has a minor impact on pronghorn populations under good to excellent habitat conditions. Consequently, the greatest "benefit" from predator control is realized on marginal or poor pronghorn ranges (drought-stricken, over-grazed, and/or lots of fences). Predators and pronghorns have coexisted for thousands of years, and predators were not a population problem for pronghorns until grassland quality in West Texas began to decline (Richardson 2003). Quality habitat quickly becomes marginal habitat when grasslands are subjected to extended drought and/or overgrazing (impacts nutrition and fawning cover), when brush encroachment interferes with visibility and mobility, and when net-wire fences and other barriers interrupt long-distance herd movements. Pronghorns have a difficult time thriving under marginal habitat conditions, especially when drought is added to the habitat equation. Predators can have a substantial impact

on antelope numbers under these conditions.

As was described in earlier sections of this paper, predation is only one of many factors that influence pronghorn populations. Several studies across the United States have shown that predator management is not always the answer for improving pronghorn numbers. However, predation has proven to be more significant on marginal pronghorn ranges and in areas where predator numbers are high in relation to antelope numbers. Both of these situations exist for many of the pronghorn herds in the Trans Pecos because of frequent droughts, some overgrazing, and high coyote populations across much of the region. Therefore, predation may be a greater limiting factor among many Trans-Pecos herds than for pronghorn herds in other states. However, if a healthy, productive pronghorn herd is a priority, investments should be directed at long-term habitat improvements rather than solely at annual predator control.

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LIVESTOCK HABITAT

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Abstract: Livestock species, like wildlife, have specific requirements that they must obtained from their environment. Therefore, livestock need to be placed in the correct habitat to optimize performance. Livestock managers control where livestock are placed and can therefore evaluate a habitat before introducing livestock. As with wildlife, some livestock habitat requirements can be provided or improved with management practices. However, if it is not feasible to change a specific area within a ranch to match a given animal species, that area could be managed for its best use with potentially less effort and cost. When livestock species share the habitat with other livestock species and/or native or exotic wildlife species, neither the livestock or wildlife enterprise can be maximized. However, it may be possible to optimize the total ranching enterprise.

Introduction

When we hear the word habitat, we usually think of wildlife. Webster defines habitat as "the region where a plant or animal naturally grows or lives." We know that the essentials of habitat are food, water, and cover or shelter. So, habitat is a place where we would naturally expect to find certain plants or animals because it provides the essentials of life for those plants or animals. If a particular place does not provide these essentials for a wildlife species, the species leave. However, with livestock, humans have total control, e.g., livestock can be put in a specific place and kept there with fences. Unfortunately, livestock are sometimes expected to conform to environments where they would not naturally live. The better suited a livestock species is to its environment, the better animal performance will be.

Habitat Evaluation and Management

Habitat evaluation involves determining the capability of an area to provide the essential habitat requirements. An understanding of the four habitat requirements- food, water, space, and cover or shelter- is an essential prerequisite for habitat evaluation. Each livestock species has its own specific requirements in terms of an ideal habitat. The closer an area matches habitat requirements of a species, the less habitat manipulation is required.

If an area lacks or only partially provides habitat requirements, it is sometimes possible to use management practices to improve habitat deficiencies. It is usually best to select practices that provide the most limiting requirement. Remember that it is impossible to manage habitat for one species without affecting other species in some way. Management practices that improve habitat for one species may be detrimental to other species.

Livestock Habitat Requirements

Although livestock species need all four of the habitat requirements, the two most important requirements are food and water. Cattle, sheep, and goats all eat grasses, forbs, and browse. However, the proportions of these foods that they prefer and are best suited to eat differs significantly. Water requirements differ mostly in the quantity required.

Water

Estimates of daily water requirements for cattle range from about 7 to 16 gallons or more per day. Sheep and goats need from 1 to 4 gallons per day. Livestock prefer clean to muddy water.

Livestock need free-choice access to water. When their water intake is restricted, milk production drops, feed intake is lowered, and gain in offspring decreases.

Several factors influence the amount of water that grazing animals require. More water is needed as there are increases in live weight, lactation, physical activity, air temperature, salt intake and dry matter intake. Less water is required when the forage has a high water content and for animal breeds that use water more efficiently.

When animals are forced to travel great distances between forage and water, they use more energy. Young suckling animals are most susceptible to lack of water availability because they are affected by reduced milk production of the mother, and they are less likely to travel all the way to water with their mothers on hot days.

Water availability is a major cause of poor grazing distribution (Table 1). Water is the central point of grazing activities. Near water, plants are often used heavily and forage production drops.

Location and number of watering points are the main factors in determining movement, distribution and concentration of grazing animals. The influence of

watering location is affected by vegetation type, topography, season, kind, class, and age of the grazing animals.

Table 1. An example of the effect of distance to water on pasture use.

Distance from Water, miles	% Use
0-0.5	50
0.5-1	38
1-1.5	26
1.5-2	17
2-2.5	12

Research with cows fitted with Global Positioning System (GPS) collars has demonstrated that grazing distribution is affected by both topography and distance to water. These collars were used to determine locations of cows within pastures on a 24-hour basis. When cows were only given access to water close to a preferred grazing site (Figure 1a), they grazed mostly within 6/10 mile of the watering point. There was little use of the south end of the pasture, which included rougher terrain. However, when given access only to water close to the rougher terrain in this pasture (Figure 1b), cattle grazed more evenly across the pasture.

Food/Forage

Given a choice, average annual cattle diets consist of more than 80 percent grass, about 12 percent forbs, and 7 percent browse (Figure 2). Sheep free choice diets consist of less grass but more forbs and browse than cattle. Goat diets tend to be about equal with regard to the amount of grass and browse with only about 11 percent forbs.

These diet preferences are strongly influenced by the anatomy of the mouth parts and the digestive system. For example, cattle have a wide mouth with a stiff upper lip and piston-like tongue. Cattle use their tongues to wrap around forage and draw it into their mouths. This type of forage prehension puts them at a distinct advantage when eating grass, but at a distinct disadvantage if they are forced to try to eat small browse leaves, especially those associated with thorns. Cattle also have a large compartmentalized rumen that is able to store plant material like grasses and allow the amount of time needed to undergo fermentation by rumen microbes to release energy bound in grass cell walls.

In comparison, sheep and goats have narrower mouths with flexible upper lips and tongues that allow them to select individual leaves from browse plants, avoiding the woody stems that cattle might have to harvest to get at the leaves. Sheep and goats also have relatively large rumens which allow them to eat a significant amount of grass. Goats tend to be very flexible in their diets, shifting between browse and grass depending on their availability. On the other hand, cattle are much less flexible in their diets and harvest browse inefficiently. For example, a study in South Texas reported that beef steer forage intake declined rapidly as browse increased in the diet due to decreasing grass availability (Figure 3)

Grazing and browsing animals exhibit definite preferences for certain groups of plants as well as plant parts. In general, all livestock species prefer in order of highest to lowest preference: 1) young, green leaves, 2) mature, green leaves, 3) green stems, 4) dry leaves, and 5) dry stems. Therefore, quantity of available preferred plants or plant parts is as important as forage quality. Livestock may search for preferred plants and plant parts that are in scarce supply rather than eat less preferred forage that is in greater supply.

Animal Size

One of the greatest mis-uses of terms is the use of the term animal unit and cow as interchangeable. A cow may or may not be an animal unit. The most important part of the definition of an animal unit is the amount of forage that animal unit is expected to eat. In the most widely used definition, an animal unit expected to eat 26 pounds of forage on a dry matter basis per day. Therefore, any animal or group of animals that is expected to eat this amount of forage per day is equivalent to an animal unit.

The reason this distinction is important is that many, modern livestock species are bigger than those the animal unit was based on when it was defined. For example, the animal unit definition uses a 1000-lb cow as the single

animal eating the 26-lb unit of forage. Many modern cows average 1150 pounds or more at a body condition score 5. Angora and Spanish goats were typically used as equivalents to the animal unit when it was originally defined. Modern goats are typically Boer or Boer-crosses that are larger than the Angora or Spanish goats. Many of these modern cattle and goats are also more productive, weaning bigger offspring.

Larger, more productive animals need to eat more forage. Therefore, to leave the same amount of residual grass standing crop to protect the soil and plant vigor, these larger, more productive animals need more acres to graze.

If forage is limited, bigger, more productive animals may not suit the resource. In this situation, it may be better to use smaller animals that have a lower maintenance requirement.

Sharing the Habitat

Range livestock usually share the habitat with other animals. When this occurs, it is important to understand the potential for competition among the species present. One example of potential competition would be a ranch stocked with livestock, native wildlife, and exotic wildlife. Many ungulate exotics are ruminants and are classified as intermediate feeders. Intermediate feeders are very flexible in their diets with the ability to shift between browse and grass as availability of these forages changes. Cattle and white-tailed deer, on the other hand, are not very flexible in their diets. Therefore, exotics that are intermediate feeders are potentially competitive with these two major species and their presence must be considered.

Animal Behavior

Animals decide where to graze based on their perceptions of an area, their knowledge of plants consumed in the past and their memory of potential choices. Cattle studies suggest that livestock quickly explore a new pasture and develop map-like representations of the locations of different areas within that pasture.

It appears that this information is stored in the animal's long-term memory. Based on their long-term memory, animals may return to areas previously grazed to search for forage. Their expectations of an area based on long-term memory change more slowly than changes in forage quality and quantity. In other words, animals may revisit areas where forage has been exhausted, but where they have found forage in the past, until they learn that forage is no longer available.

Grazing animals appear to use their short-term memory to recall which areas they have recently visited. They will use this memory in the near future to avoid or return to these areas. For periods of up to 8 hours, cattle can vividly remember areas where they have recently foraged.

Observations and research have documented that an animals' previous experience strongly influences which plants they eat and which areas they graze. If they are introduced to a range that is sharply different from the one they are accustomed to, they will spend more time grazing, but eat less than animals familiar with the range. Therefore, introducing animals from one type of vegetation and/or topography to a very different type of range can reduce animal performance until animals learn the new environment which can take up to a year.

Topography

The second most important cause of poor grazing distribution is topography. Cattle seldom use areas with greater than 10 percent slope (slope is the percentage of vertical drop over a surface distance of 100 feet). On the other hand, sheep make good use of areas with up to 45 percent slope.

Topography is more important in the hilly or mountainous parts of the state. The effect of topography varies with the kind of grazing animal. For example, cattle prefer easily accessible areas that are flat, gently rolling, valley bottoms, low areas between drainages, level benches, or mesas.

The fact that cattle, horses and bison will graze on slopes during some seasons of the year suggests that they may be more unwilling than unable to graze steeper slopes. Cattle will cross steeper slopes if they have easy access to the slope and contours that cross the slopes.

Sheep and goats, which are smaller, more agile and more surefooted, can make more use of steeper and rougher topography. Yearling cattle are also more agile than mature cows and will travel further and use more rugged areas.

However, because even smaller, more agile livestock have their limitations, rugged terrain can still limit use. For example, sheep have been reported to use slopes up to 45 percent fairly evenly, but reduce use by as much as 75 percent on steeper areas.

The studies with cows fitted with GPS collars mentioned above have demonstrated that cattle prefer some range sites over others because of the terrain. On a ranch with predominantly two range sites, cattle strongly preferred the Rumple-Comfort soil over the Comfort-Rock soil (Table 2). This preference appears to be related to the presence of loose and imbedded rock in the Comfort-

Rock soil. In this study, use of areas by cows declined steadily as rock cover increased and almost no use occurred with more than 30 percent rock cover (Figure 4).

Table 2. Comparison of cattle soil type use in the Eastern Edwards Plateau.

Herd	Rumple-Comfort versus Comfort Rock GPS Fixes/ac Ratio
Spring-calving	2.6
Fall-calving	2.9

In other situations, cattle avoid range sites because of brush. In a South Texas GPS study, cows used a Gray Sandy Loam range site that had been aerated to suppress brush four times more heavily than the portion of the same site that was not aerated.

Habitat Management Tools and Recommendations

Water
To improve grazing distribution, water sources can be developed in a number of ways, including drilling wells and building drinking troughs, earthen reservoirs, or pipelines to transport water to new locations.

An effective way to draw animals to desired areas without additional fencing is to control and change their access to watering points. When taking this approach, however, use fencing that does not exclude wildlife.

To make the most efficient use of water sources, use temporary water when available and permanent water in dry periods. As a last resort or temporary measure, water can be hauled to poorly used locations.

In general, do not require cattle to travel more than 1/4 to ½ mile from forage to water (½ to 1 mile between watering points) in steep, rough terrain; or more than 1 mile (2 miles between watering points) on level or gently rolling ground. Spacing for sheep and horses can be wider. Generally, plan for no more than 50 cattle and 300 sheep, or 50 to 75 animal units, per watering facility.

Fencing
Fencing is a direct way to alter grazing distribution. Fences can separate areas that need different grazing management: riparian areas, irrigated pastures, or areas subject to seasonal use. Fences can also be used to subdivide large pastures into more a manageable size.

When establishing fencing, make the best use of existing or projected watering points. Permanent water facilities should serve more than one pasture. Make sure that each fenced area has enough watering points. Consider range site and potential production where possible.

However, it is usually impractical to fence individual plant communities because of their small size and random distribution across the landscape. If multiple livestock species are to be grazed, use the appropriate fencing materials for the species.

Supplemental Feeding
Because livestock tend to go from water to grazing to salt, it is not necessary to place salt at watering points. Salt consumption tends to stimulate the appetite of grazing animals. To encourage grazing in areas where livestock need to be drawn, place salt where it is easy to access within those areas.

Purposely locate salt, minerals and other supplements over pastures not less than 580 yards (1/3 mile) from water on pastures of 640 acres or more. On smaller pastures, place them no less than about 350 yards (2/10 mile) from water. Because bed grounds are already being used, locate salt and other supplements away from them. Move salt and supplements frequently.

Reports vary concerning whether salt is an effective tool for altering grazing distribution. It does not appear to overcome the influence of water, favored forages, favorable terrain, protective cover or shade. In addition, salt is less useful where naturally salty vegetation or salt licks are present.

Move creep feeders away from watering and concentration areas as soon as calves learn to eat.

Protein and energy supplements or salt-meal mixes are more likely to be effective in influencing grazing patterns than salt alone. Place pelleted or cubed supplements on the ground or in movable bunks to encourage cattle to move from feed grounds to poorly used areas.

Grazing behavior and distribution are also affected by the

feeding interval for supplements. In a Texas study, cows fed a protein supplement daily or three times a week came readily to feed when called; however, cows fed once a week did not come to feed quickly when called. Less than daily feeding of equivalent amounts of protein supplement appears to reduce the time spent at feeding areas and to encourage a wider grazing distribution.

Kind of Livestock
Match the livestock species to the vegetation. Place cattle in a habitat where grass is readily available. Consider using goats in areas with a high proportion of browse plants.

Some classes of livestock fit the terrain better than others. For example, yearling cattle are more agile and tend to travel farther than cows with calves, and therefore, make better use of rugged terrain.

Animals may have difficulty adjusting to new foraging environments even if the new location has abundant forage. Previous grazing experience affects the kinds of plants, plant parts and grazing sites the animals select. New locations with toxic plants are potentially dangerous.

Naive animals tend to spend more time grazing but they eat less, walk greater distances, suffer more weight loss and are more likely to eat toxic plants. Although animals can make the transition to new locations, it usually takes about a year to adjust. This transition can be eased if the food and terrain in the new location are similar to what the animals already know.

Shade
Shade influences grazing distribution on hot summer days. Livestock have been observed to travel considerable distances to reach shade on hot days.

Cattle and sheep routinely seek shade around midday on summer days when temperatures exceed 85°F. Brahman-based cattle are less likely to seek shade during hot midday and rest more in open areas. Cattle with dark hair coats tend to seek shade earlier and for longer periods.

Cattle are more likely to stay around water if shade is available. In comparison, sheep are less likely to rest and idle near water.

Providing shade has been shown to increase summer-long weight gain in yearling steers. On desert or prairie ranges that have few trees or tall shrubs, artificial shade may help attract animals to under-grazed areas. However, results have been inconsistent with using artificial shade and cover to improve distribution.

Improving Palatability
Some treatments can improve palatability of forages and/or increase the length of the green period. These treatments act by removing unpalatable species or old growth or stimulating palatable growth. The theory is that improving palatability could attract grazing animals into previously unused or underused areas.

For example, nitrogen fertilization is known to lengthen the green period. Nitrogen can also improve the palatability of some species. However, the economics of fertilizing native grasses only to improve grazing distribution is questionable. Justification for this practice must be based on the potential to increase forage production and ultimately to increase profit.

Prescribed burning can be used to improve palatability. Burning is used mostly to remove old growth, which makes new growth more accessible. However, be careful to avoid too much grazing pressure by removing less than 50 percent of the new growth. Probably the best approach is flash grazing – grazing for a very short period in the spring after a burn and then allowing the burned areas 3 to 6 months or longer to recover to a point where normal grazing is feasible without damaging the plants.

Herbicides have been suggested as a means to improve palatability. Many weed species are more palatable to grazing animals after herbicide treatment. However, several weed species can be toxic. A management recommendation for these toxic weeds is to avoid grazing after herbicide treatment. Like the use of fertilizers, the use of herbicides to improve grazing distribution is seldom economically feasible.

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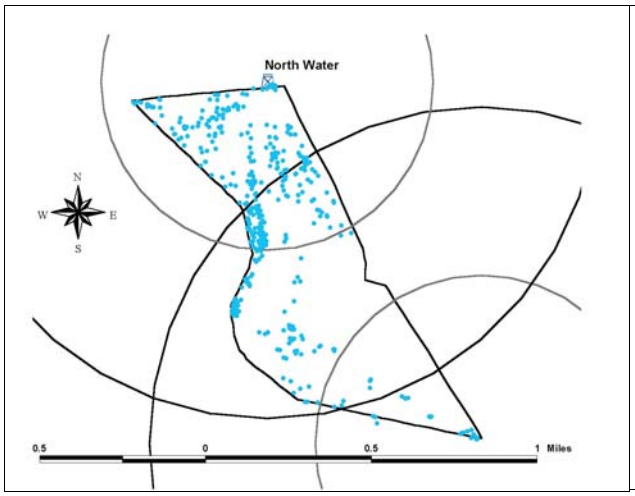


Figure 1a. Cow GPS locations (dots) when only access to the north water source was allowed, with most GPS locations in the north end of the pasture where the preferred Rumple- Comfort soil exists.

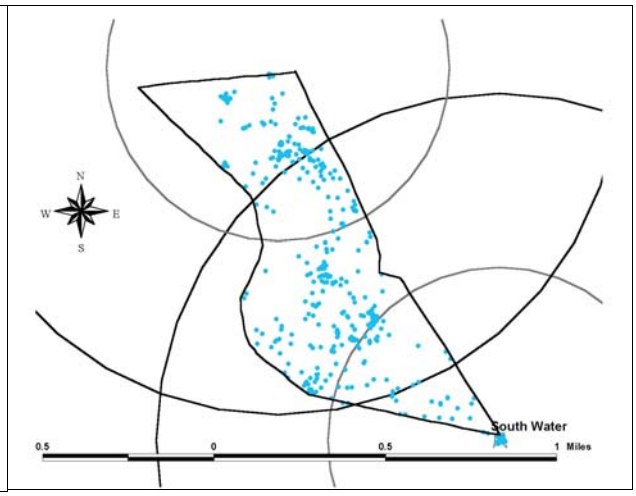
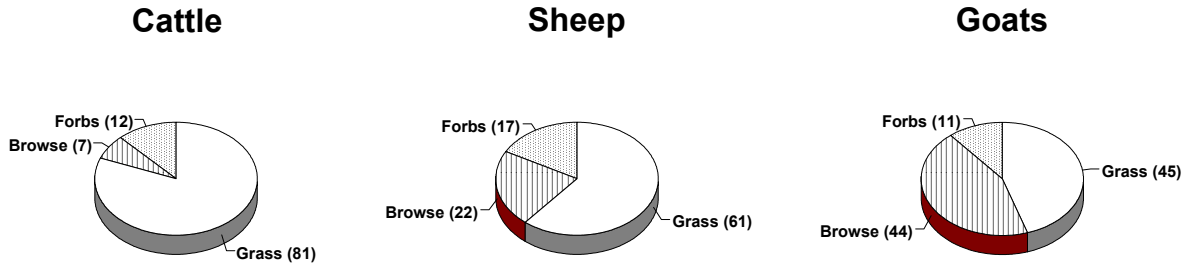


Figure 1b. Cow GPS locations when only access to the south water source was allowed. Cattle distribution was improved by using water to attract cattle into the less preferred Comfort-Rock soil.

Figure 2. Comparison of average annual diets of cattle, sheep, and goats.



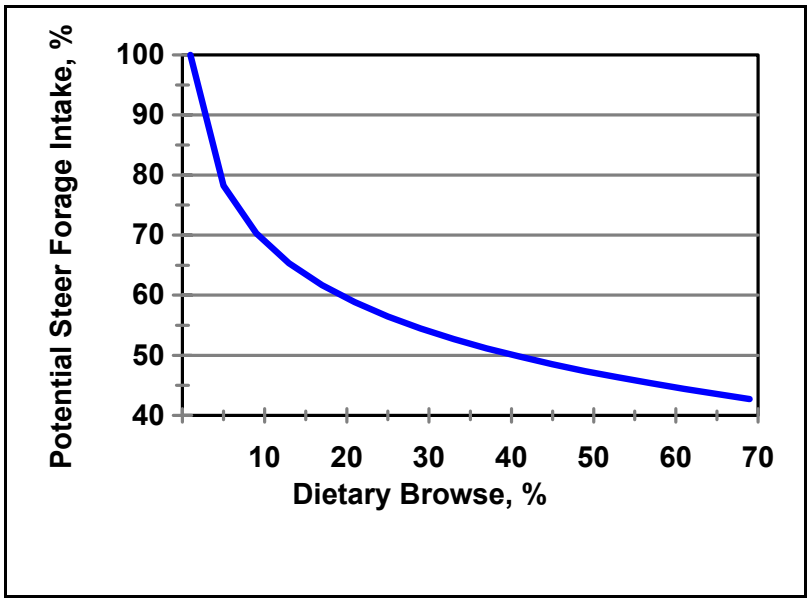


Figure 3. Decreasing forage intake with increasing dietary browse illustrates the inability of steers to harvest browse efficiently.

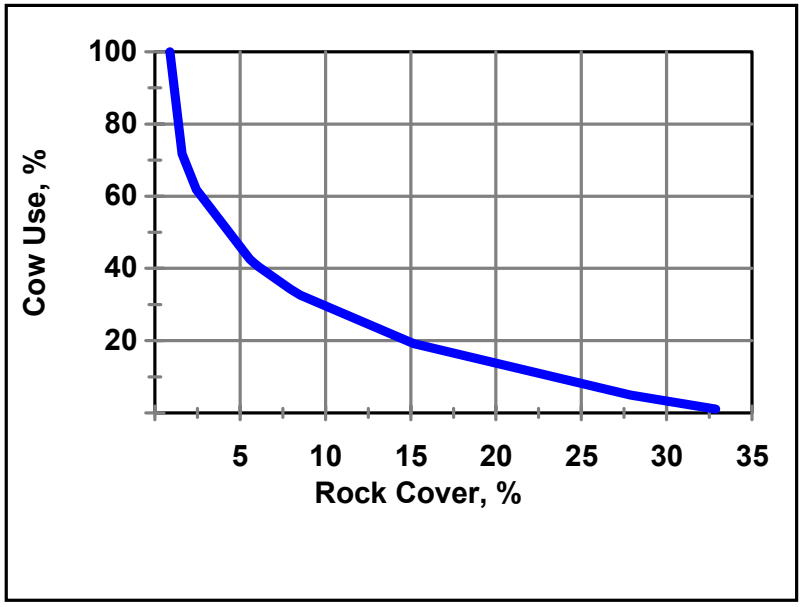


Figure 4. Cows avoided areas with more than 30 percent rock cover on Low Stony Hill sites in the Eastern Edwards Plateau.

TOOLS AVAILABLE FOR BRUSH SCULPTING

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Abstract: Brush sculpting is the planned, selective removal of brush for the benefit of wildlife. As a concept from which to base land management decisions it requires an understanding of the needs of specific wildlife populations in order to avoid undesirable effects. Successful brush sculpting relies heavily on extensive planning and conscientious application using an understanding of rangeland health principles, and incorporating wise range management decisions.

Introduction

The concept of brush sculpting has gained prominence in ranching circles in recent years mostly as a result of the increased awareness of the effects on wildlife of clearing brush. Strictly defined, brush sculpting is the planned, selective removal of brush for the benefit of wildlife (Rollins 1997).

Brush removal has been a needed and practiced activity since brush encroachment began reaching intolerable proportions on Texas rangelands decades ago. Livestock production has traditionally been the driving force behind these efforts, but lately the habitat needs of wildlife as supplied by some level of brush on the landscape has garnered attention due to the income potential and the aesthetic value of the wildlife that more or less brushy rangelands provide.

Brush Sculpting refers to: a) the planning process; and to b) on-the-ground implementation. It involves art mixed with science in order to achieve the desired goal-rangeland that is productive and aesthetically pleasing, the latter being especially important when considering resale value.

Planning

"*I saw the angel in the marble and carved until I set him free*". Michelangelo Buonarroti

Like the accomplished and revered Michelangelo, we as brush sculptors must carefully carve, if you will, on plant communities until the desired result is in view. That minds-eye view will be based on your goals and objectives as well as principles of rangeland health. You might say, "you remove everything that doesn't look like the kind of habitat which will best meet the needs of _____" (you fill in the blank). But, use caution. You can always remove more later, if needed. It takes a considerable amount of time to grow brush. In fact it may never return as it once was. Of course , that situation is only regrettable if there exists a minimum threshold of brush density and composition to satisfy the needs of certain species. Such is often the case. So, study the situation well before laying the axe to the root.

After having decided on the overall objectives for your brush sculpting project, questions will come to mind such as:

1. How can I portray my minds-eye view tangibly?
2. What tools or techniques should be used for the brush sculpting?
3. How can I convey my plan accurately to those involved in its execution?

The remainder of this paper will address these questions in some detail.

Blueprints

What blueprints are to building construction, maps are to brush sculpting. Along with a familiarity with wildlife presence and movements on your land, there is no substitute for a good, up-to-date, high resolution aerial photograph and topographic map (showing changes in elevation) when planning a brush sculpting project. Photographs and maps are available online at the Texas Natural Resources Information System website, http://www.tnris.state.tx.us., and through private entities also. Aerial photographs are also available through your local Natural Resources Conservation Service office.

Digital aerial photographs offer the advantage of making it easy to mark clearings and transfer your plan to a Global Position System (GPS) receiving unit. The GPS unit can then be taken to the field to find the proposed clearing outlines so that they can be marked (e.g. with surveyors' flagging tape) for treatment.

An alternative method would be to decide on-the-ground what areas will be cleared, and use a GPS unit while afoot, in a vehicle, or horseback to record the outlines of

the areas. The information could then be downloaded onto the digital maps for scrutiny and changes if desired. Once the clearing plan is finalized the pattern(s) could be sent back to the GPS unit for use in marking the patterns or as a navigation tool onboard the equipment being used for the sculpting.

Tools

The basic categories of tools which might be used for brush sculpting are:

1. Mechanical
2. Chemical
3. Grazing Management
4. Prescribed Fire

This paper will deal with mechanical means of brush sculpting, the most selective and yet one of the most expensive, generally, of the brush management tools in our arsenal. Examples of the types of equipment typically used are: track mounted excavator-type grubbers; aerators and roller choppers; root-plows; hydraulic tree shears; chaining; dozing; and grubbers.

Currently one of the most commonly used pieces of equipment in west Texas is a track-mounted excavator equipped with a modified grubber (Figure 1). It allows a high degree of selectivity and is fairly fast-moving in all

Figure 1. Modified grubber on track excavator.

but the densest of brush stands.

Aerators and roller choppers (Figure 2), though not effective in killing brush, are useful for lowering the height of the brush, thereby making the landscape more accessible for hunting, wildlife viewing, and livestock handling. The use of the equipment also stimulates forb growth and browse regrowth. Frequent re-use (every 3-5 years in many cases) of aerators or roller-choppers, or some other follow-up method of brush management, will

Figure 2. Aerator

be necessary to maintain clearings.

Root-plowing (Figure 3) is generally the most expensive of the conventional methods of brush removal. It causes the most soil disturbance and is best suited for relatively deep soils. The method cannot be as selective as some of the others, but is one of the most effective means to kill brush.

Skid-steer tractor mounted shears (Figure 4) are gaining

Figure 3. Rootplow

in popularity for brush sculpting. They appear to be especially suited (though not exclusively) to Ashe juniper removal in and around live oak stands. At least two factors contribute to the machines usefulness in these situations– the Ashe juniper can be killed with top removal, and skid-steer tractors are small and highly maneuverable.

Chaining– which is accomplished by dragging an anchor chain stretched between two dozers across brush, uprooting some plants, knocking down others– has been used for many years for broad-scale brush management. Though relatively fast and inexpensive, it lacks much of the selectivity that is usually desired. Therefore, it is rarely used for brush sculpting. Recent developments

Figure 4. Tree shear on skid-steer tractor.

which include the addition of disks and dikers on tow-behind chain implements have made "chaining" a somewhat more maneuverable undertaking, and may prove to be more useful for selective brush treatment.

Dozing, using the front blade on a bulldozer to scrape the surface of the ground and push undesirable plants into piles for burning (usually), is sometimes used as a means of selectively removing brush. The method is effective from a removal standpoint, but the life of the treatment, like using the aerator, is rather short-lived due to the fact that many times only the top portion of the plant is removed. Re-sprouting is to be expected, therefore follow-up treatment will be necessary sooner than is the case with methods which remove more of the root system.

Grubbers can be mounted on track-type or rubber-tire tractors. Though operator visibility is somewhat restricted as compared to track excavators virtually the same level of selectivity is afforded by them. With the capability to remove enough of the root system of brush plants to kill them, grubber cleared land has a relatively long life. The "divots" left by the grubbing are the scourge of anyone driving or riding a horse over the treated area, but they provide excellent rainwater catchments which greatly increase water infiltration on the rangeland and reduce overland flow of rainwater.

Implementation and Communication

The step least often contemplated, but which holds the most potential to sabotage your efforts at transferring your ideas to the landscape, is that of communicating the clearing plan to the personnel who will be operating the clearing equipment. Your success in actually putting your plan on the ground depends totally on your ability to accurately convey the information.

Before saying "sic 'em" be careful to impart the general guidelines for your brush sculpting scheme. Make sure, for example, that it is well understood which plants, if any, should be left if encountered in an area that was otherwise slated for complete clearing (e.g. hackberry, lotebush, chittam, skunkbush, etc.). Be certain to impart the notion that erring on the side of caution– not clearing anything questionable– is entirely acceptable and preferable. Though returning to the area to remove more brush later is more expensive than going ahead and removing it on the first pass, your ultimate satisfaction in achieving the sought-after result is worth taking that chance of that being necessary.

GPS technology provides the best means for transferring the plan to the operator. A GPS receiver which contains the clearing pattern(s) within its memory can provide the equipment operator with ready access to a graphic display of your plan and the proximity of the machine in relation to particular portions of the pattern at all times. The GPS unit can then be used to navigate to, and clear, the outlines of the intended clearings. With that accomplished the clearing can be completed easily.

Next in effectiveness would be an aerial photograph which is plainly marked with the clearing design. An equipment operator with the photograph in hand can do a reasonably good job of installing the design if the scale of the photograph allows discernment of the fine details.

Monitoring

"*The best laid schemes o' mice an' men / Gang aft a-gley*." (translation- The best-laid plans of mice and men often go awry) - from "To a Mouse" by Robert Burns

The chance of satisfactorily completing a brush sculpting project is directly related to the successful transfer of the plan to the equipment operator, and to frequent scrutiny by the "sculptor" as the work progresses. The more often the work is monitored, the more likely the finished product will be acceptable. Plan to spend adequate time on the ground, providing the clearing crew with input regarding the work done so far.

Conclusion

We as individuals are temporary stewards of the land resource and the life that inhabits it. Leaving the land in better condition than that in which we find it is a laudable goal. Brush Sculpting offers an effective means of accomplishing that end while enhancing the welfare of wildlife, livestock, and/or other ranching enterprises.

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WATER CONSERVATION: A TOOL FOR IMPROVING ARID AND SEMI-ARID RANGELANDS FOR MULTIPLE USES

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Abstract: Many rangelands in western Texas can not provide the essentials necessary for optimal production of the array of multiple uses desired by landowners or the ecological services required by society because they are hydrologically dysfunctional. A good vegetative cover of perennial grass is nature's most efficient mechanism for conserving the essential resources - water, soil, nutrients, and organic material. Drought, long-term excessive grazing, excessive densities of low-value woody plants and forbs (weeds), and desert termites can reduce permanent vegetative cover below minimum thresholds and render rangelands dysfunctional relative to the water and mineral cycles and energy capture. Minor degradation of rangelands that still retain control of these essential resources can be reversed by proper grazing management and in some cases by controlling excessive densities of woody plants, cacti, and forbs. Special water conservation treatments, such as contour ripping, wing ripping, furrowing, pitting, and diking, along with reseeding are effective for restoration of arid and semi-arid rangelands that have deteriorated beyond a critical threshold in the downward desertification spiral. When properly installed and spaced, these mechanical soil disturbances function on the principles of "runoff farming" or water harvesting. This paper describes these technologies and discusses their utility for restoration of degraded rangelands. Contour ripping of a degraded clay loam range site near San Angelo, Texas resulted in infiltration of water from a 2-in. convection thunderstorm to a depth of 54 in. compared to only about 5 in. on adjacent, untreated rangeland. Over a period of 4 to 5 years, total herbage production on ripped, unseeded rangeland landscapes was 1700 lb/acre compared to only 490 lb/acre on adjacent, untreated rangeland. Ripping increased the carrying capacity of the range site from about 8 animal unit years (AUY)/section to about 29 AUY/section.

Ecologically sound rangeland and wildlife habitat management requires that ranchers and resource managers understand how arid and semi-arid landscapes function (Fig. 1; Ludwig et al. 1997) and that they work with, rather than against, the natural ecological processes of energy flow, the hydrological cycle, and mineral cycles (Whisenant 1999). Rainfall is the "trigger" factor necessary for plant production in arid or semiarid regions where rainfall is erratic and unpredictable, but it must be effectively transferred deep into the soil ("reserve") in quantities which exceed the minimum threshold necessary to generate "pulses" of plant growth (Fig. 1) (Ludwig et al. 1997). Healthy rangelands are efficient in conserving water, soil, nutrients, and organic material because the surface soil has good structure (aggregation), sufficient vegetative cover of perennial grass plants and mulch exist to resist runoff, and rainfall infiltration rates are high ("transfer", Fig. 1) . Good soil structure facilitates rapid infiltration of rainfall while vegetative cover protects the surface soil aggregates from the energy of raindrop impact and provides resistance to runoff. Rangelands become dysfunctional, relative to the hydrologic cycle, mineral cycles, and energy capture, because of droughts, excessive grazing, persistent infestations of low-value or noxious plants, and desert termites. The strategic plan of every rancher should be to minimize "outflow" of water from his rangeland (Fig. 1), i.e., to retain most of the rainfall very near where it falls, and to capture as much runoff from adjacent properties as possible. Proper grazing management is the basic tool for restoration of rangelands that still retain control of water, soil, nutrients, and organic materials. However, proper grazing management alone or integrated with control of undesirable weeds and woody plants may not result in acceptable restoration within a time frame acceptable to meet the objectives of land owners or resource managers where the rangeland has lost control over water, soil, nutrients, and organic materials. Ecologically and economically sound practices that can facilitate and expedite the restoration of dysfunctional rangelands that have slipped into the downward desertification spiral include ripping, wing ripping, furrowing, pitting, diking, and re-seeding.

HYDROLOGICALLY FUNCTIONAL RANGELANDS

Healthy rangelands have high rainfall infiltration rates (part of the "transfer" element in Fig. 1) because the soil surface has good structure - meaning that the soil particles are held together in water-stable clusters

(aggregates) by roots, fungal hyphae, byproducts of organic matter decay and microbial synthesis, and resistant humus components (Boyle et al. 1989). These water-stable aggregates do not readily disperse during rainfall events; thus the silt and clay particles are not released to plug up the soil macropores as they move into the soil with water. Soil porosity (pore space) increases as the degree of aggregation increases, and rainfall infiltration increases as soil porosity increases. Healthy rangelands support sufficient vegetative cover, primarily perennial grass plants or colonies, mulch, and desirable shrubs or trees, to protect the soil surface aggregates from being dispersed by the energy of raindrop impact and to provide resistance to surface runoff (another part of the "transfer element in Fig. 1). Vegetative cover also ameliorates the extremes of soil temperature, reduces evaporation of soil water, and provides a micro-environment favorable for decomposition of organic matter, which in turn contributes to the formation of water-stable soil aggregates (Thurow 1991).

HYDROLOGICALLY DYSFUNCTIONAL RANGELANDS

The direct and indirect effects of drought, excessive grazing, excessive densities or cover of noxious or low-value plants, and/or excessive population densities of desert termites can render rangelands dysfunctional relative to conserving water, soil, nutrients and organic materials and yielding the products and services needed by society (Thurow 1991). These effects seriously diminish the annual production of herbage and deposition of litter, the depth and branching of plant root systems, soil aggregation, and rainfall infiltration rates while increasing the losses of water, soil, nutrients, and organic materials from the landscape as surface runoff.

As vegetative cover and the mulch layer decline, the kinetic energy of raindrops hitting bare soil causes the dispersion of soil aggregates. This releases silt and clay particles which move downward with water into the large soil pore spaces. The clay and silt particles plug the pore spaces (i.e., "soil puddling"), thus reducing the capacity of the soil to absorb and store water. The surface soil develops a characteristic "platy" structure which seals over very quickly during rainfall events. The result is drought-like conditions, even in years of "normal" rainfall. Over time, the vegetative composition changes as the palatable, productive deep-rooted grasses die out and are replaced by smaller, less palatable, shallow-rooted annual and weak perennial plants (Archer and Smeins 1991, Briske 1991). These plants are less efficient in capturing the energy of sunlight, retrieving nutrients from deep in the soil, resisting runoff, and transferring rainfall into the soil profile ("reserve" in Fig. 1). The result is less microorganism activity, less soil aggregate formation, a harsher environment for seed germination and seedling establishment, more soil exposed to raindrop impact, fewer and shallower roots to exploit soil water and nutrients, decreased rainfall infiltration, and accelerated surface runoff and erosion. Annual forbs (weeds), woody plants, and succulents (e.g., cactus) are better adapted to harsh environments and often invade and/or increase in abundance in degraded rangelands. These plants then compete with the remaining desirable plants for space, sunlight, and the diminished supply of soil water and nutrients. Annual forbs are not as efficient as perennial grasses for conserving water, soil, nutrients, and organic materials because they are not as heavily lignified - their aboveground structures are either rapidly decomposed by bacteria and fungi or are moved across the landscape by wind and surface runoff.

On degraded rangeland, a large proportion of rainfall is lost as "outflow" (runoff) because the "transfer" function (i.e., infiltration and resistance to runoff) is impaired or inefficient (Fig. 1) (i.e., there is insufficient surface roughness, perennial grass cover, mulch, etc. to resist runoff and capture water, soil, nutrients, and organic materials). The water content of the "reserve" (soil profile) rarely or never reaches the minimum threshold necessary to generate a "pulse" of plant growth. Consequently, "feedback"to the "transfer" mechanism becomes negative (i.e., the density, height, and weight of perennial grasses decrease) and there is very little "ploughback"(i.e., return of seeds, nutrients, and organic matter to the soil and replenishment of energy reserves of perennial grasses) to maintain or improve the "reserve" (Fig. 1). These dysfunctions must be corrected early in the degradation process to avoid the long-term consequences of desertification.

MANAGEMENT TO ENHANCE WATER CONSERVATION

Ranchers and resource managers must understand how arid and semi-arid rangeland landscapes function (Fig. 1) and learn to work with, rather than against, the natural ecological processes - energy flow, the hydrological cycle, and mineral cycles - to manage vegetation and soils in order to achieve and maintain high infiltration rates and minimize losses of water, soil, nutrients, and organic materials in surface runoff (Ludwig et al. 1997, Whisenant 1999). Proper grazing management is the basic tool for achieving efficiency in water and nutrient conservation and utilization on rangelands. Control of excessive densities of low-value or noxious weeds or woody plants can increase the amount of water entering mineral soil and the availability of soil water for desirable plants. Mechanical water-conservation treatments, such as ripping, wing ripping, furrowing, pitting, or diking may be necessary to reverse the downward spiral toward

desertification on severely deteriorated rangelands. Re-seeding may be necessary to re-introduce plants that have the genetic potential to efficiently utilize the increased supply of soil water and nutrients that becomes available following application of these mechanical water-conservation treatments.

Grazing Management

The topic of grazing management in relation to the re-introduction of fire into rangeland ecosystems will be covered in the next paper in this proceedings by Dr. Charles A. Taylor. However, since grazing management seems to be one of the more difficult technologies for many ranchers to master, we will briefly discuss the subject relative to its role in water conservation. The importance of proper grazing management can not be over emphasized.

Excessive grazing affects plants directly by altering their physiology and morphology and indirectly by altering microclimate, soil properties, and the competitive interactions among plants (Archer and Smeins 1991). Without sufficient leaf surface area, plants cannot efficiently capture energy from sunlight via photosynthesis, root growth is reduced, energy reserves are depleted, plant vigor and seed production decline, and eventually plant mortality occurs. Over time, the more palatable plants die out and composition of the vegetation changes; vegetative cover, plant production and rainfall infiltration decline (Figure 2); and surface runoff increases.

Proper grazing management involves balancing the number of animals with the forage supply, selecting the appropriate kinds and classes of animals to be grazed, controlling the timing of grazing, and distributing grazing evenly across the landscape (Briske and Heitschmidt 1991). Proper grazing management controls the timing and amount of vegetation consumed by livestock and wildlife, and thus:

- facilitates greater plant growth pulses following rainfall events
- provides positive feedback (increased density, width, and height of perennial grasses and more mulch) to increase the efficiency of transfer of rainfall, nutrients, and organic materials into the reserve, and
- re-charges the soil with organic matter, seeds, and minerals and recharges the energy reserves of desirable forage plants (ploughback to the reserve) (Fig. 1).

Achieving the proper level of utilization of forage plants and maintaining an acceptable minimum amount of residual plant material is the most important management decision, regardless of whether rangeland is grazed continuously or in a complex grazing system. The minimum amount of residual needed to sustain productivity of shortgrass rangelands is 300 to 500 lb/acre. For mid-grass rangeland the minimum residual is 750 to 1,000 lb/acre, while 1,200 to 1,500 lb/acre is required for tall grass rangeland (White and McGinty 1992).

"Take half and leave half" is the guiding principle for determining stocking rates. Under most management systems, roughly 50% of the forage produced during the year should remain ungrazed. About 25% of the current year's forage growth will be lost to trampling, insects and other animals, or rendered ungrazable due to contamination by livestock dung or urine. The remaining 25% of plant growth can be utilized by livestock and wildlife (White and McGinty 1992). Rangeland vegetation and precipitation records should be continually monitored, and livestock and wildlife numbers should be adjusted annually or even seasonally to achieve proper use.

Proper grazing management is the natural, ecological, and least-cost method for maintaining healthy rangelands and for restoration of mildly-to- moderately degraded rangelands. However, severely deteriorated rangelands, especially in arid and semiarid regions, often recover slowly or not at all after initiation of proper grazing management or the total removal of livestock because of: the lack of vegetative cover; poor soil aggregation; low infiltration rates; the resultant harsh environment for plant establishment and growth; and/or the density and cover of noxious or low-value plants has become excessive (i.e., a critical threshold has been crossed in the downward desertification spiral). The potential for range recovery is poor on many southwestern rangelands, even with the exclusion of livestock for 20 to 30 years (Dregne 1978). The rate of recovery following implementation of proper grazing management may be too slow to meet the management objectives of ranchers or resource managers on range sites which have deteriorated below a critical threshold in the desertification spiral. Mechanical water conservation treatments, re-seeding, and/or management of persistent infestations of low-value or noxious vegetation may be useful to expedite restoration of these sites.

Management of Undesirable or Low-Value Vegetation

Excessive grazing, drought, climatic changes, a reduction in the "natural" frequency and intensity of fire, and perhaps the increasing concentration of atmospheric carbon dioxide predispose many rangelands to invasion by annual forbs, woody plants, and succulents. Although many of these plants may provide one or more of the habitat requirements for wildlife and other rangeland

uses, their density and cover often become excessive and thus they must be "managed" or controlled. These plants intercept or transpire large quantities of water that might otherwise be used by plants that have greater values for food and cover for livestock and wildlife and that are more effective in sustaining the essential ecological functions (the hydrological and mineral cycles and energy flow). The efficiency of water use on rangelands can be increased by controlling excessive densities of undesirable plants (Ueckert 1979, Thurow and Hester 2001).

Herbicidal, mechanical, prescribed burning, and biological control methods, or appropriately timed and sequenced combinations of these methods, when integrated with proper grazing management, can provide effective, cost efficient, and ecologically practical solutions to noxious plant problems (Hamilton et al. *in press*). Rangelands should be monitored annually for noxious plants, and control programs should be initiated before these plants mature, thicken, utilize excessive amounts of water, and cause deterioration of desirable vegetative cover (McGinty and Ueckert 2001). Our Brush Sculptors Symposium Proceedings is a helpful brush management guide for landowners whose primary or important secondary interest is wildlife and enterprise diversification (Rollins, Ueckert and Brown 1997). The Brush Busters' individual plant treatments (McGinty and Ueckert 2001) and several mechanical treatments (Hamilton et al. *in press*) provide tools that allow ranchers to selectively take out unwanted plants without damaging desirable plants.

Management of excessive densities and cover of undesirable or low-value plants:

- increases the transfer of rainfall into the reserve
- increases availability of soil water to desirable plant species
- allows greater growth pulses of desirable plants following rainfall events, and
- provides positive feedback to improve the transfer function and ploughback to improve the reserve (see Fig. 1) **IF** proper grazing management is integrated with the brush and weed control technology.

Recently, we observed luxuriant growth of healthy bunch grasses beneath dead redberry juniper trees that had been grubbed a few years earlier on a range site in Crockett County, Texas. With the exception of annual forbs, the surrounding surface soil was mostly bare ground and obviously "capped" (puddled) and not efficiently absorbing rainfall. Woody debris left by chaining or grubbing should be left in place rather than raked and burned because it is very effective in resisting surface runoff and in capturing soil, nutrients and organic materials carried by runoff and wind. Raking of brush often removes much of the vegetative cover and mulch that may be present and leaves a smooth soil surface - eliminating the desirable surface roughness and depressions which help resist runoff and retain rainfall. The soil beneath woody debris-hummocks becomes enriched with nitrogen and carbon, its infiltration rate increases, and populations of soil invertebrates increase. Soon, desirable perennial plants establish and flourish within the protection of the debris, producing an abundance of seeds that can spread across the landscape (Ludwig et al. 1997, Whisenant 1999).

Mechanical Water Conservation Treatments and Seeding

Mechanical land treatments such as ripping, wing ripping, furrowing, diking, and pitting can expedite natural recovery of moderately-to-severely degraded and desertified rangelands (Valentine 1971, Whisenant 1999) by increasing resistance to surface runoff, shattering compacted soil layers, and thereby increasing rainfall infiltration and retention. These treatments function as temporary substitutes for vegetative cover and perennial plants and mulch within the "transfer" mechanism (Fig. 1). To have a lasting effect, mechanical treatments must modify the soil surface sufficiently so that rainfall is detained and stored in the soil (Branson et al. 1966). Mechanical treatments that effectively increase deep infiltration or percolation of precipitation in saline soils can leach soluble salts below the root zone and thus increase the availability of water to plants (Branson et al. 1966). The objective of using these mechanical treatments is to facilitate the establishment of dense patches or bands of deep-rooted, perennial bunch grasses that will persist and continue to conserve water and nutrients naturally, long after the soil disturbances have disappeared.

Mechanical soil disturbances, if properly installed and spaced, function on the principles of "runoff" farming, a method developed over 4,000 years ago that involved collecting runoff water from higher elevations with characteristically low infiltration rates for application to small fields in valleys (i.e., "water harvesting") (Evenari et al. 1961). The limited natural rainfall in arid and semi-arid regions can be more effectively used for forage production by using mechanical soil disturbances to collect runoff water from hydrologically dysfunctional rangeland and concentrating the water in bands or "patches" across the landscape. These forage production zones will be in contour "bands" where ripping, wing ripping, furrowing, and diking are installed on the contour and in equally spaced "patches" where pitting is used.

"Patchiness" or a banded vegetation pattern is essential for achieving acceptable levels of productivity in arid and

semi-arid landscapes because if rainfall is spread uniformly over the entire surface, there would rarely be enough water in the reserve to meet the minimum requirements for generating a significant pulse of plant growth. However, when water is redistributed and concentrated into patches or bands, then there is sufficient water for a significant pulse of growth within these areas (Noy-Meir 1981). In a study in southern Arizona that received only 5.1 in. of rainfall during the growing season, the yield of blue panic grass was increased 16 fold by harvesting water from wax-coated runoff areas two times the area producing grass, compared to the yield on areas not receiving runoff (Schreiber and Frasier 1978). Adjusting grass yields for the size of the bare runoff areas, the average yield increase was still 5 times greater than that which was produced without utilizing runoff areas. Surface soils on western Texas rangelands that are devoid of vegetative cover, have a platy structure, and that puddle quickly during rainfall events function similarly to the wax-coated runoff areas in the Arizona study. These barren soils represent a major problem, but ranchers, rangeland resource managers, and wildlife habitat managers can utilize the principles of runoff farming or water harvesting in conjunction with mechanical soil disturbances to restore the productivity of degraded rangelands.

Ideally, mechanical soil disturbances should be installed before rangeland degradation has proceeded to the point of complete mortality of desirable, perennial bunch grasses so that these plants can respond immediately to the benefits of water harvesting and so that seeding would not be necessary. If desirable perennial bunch grasses are no longer present on a site, then re-seeding will be necessary to re-introduce germplasm that has the genetic potential to efficiently utilize the resources (water, soil, nutrients, and organic materials) that will be concentrated along the mechanical disturbances by water harvesting.

The success of mechanical soil treatments and re-seeding requires an integrated management approach. The full potential of mechanical soil treatments and re-seeding will only be realized if treated areas are initially protected from grazing to allow the establishment of desirable vegetative cover and continually afforded proper grazing management thereafter. Management of persistent stands of weeds may also be necessary. Annual and perennial forbs are usually the first plants to establish along patches or bands of soil enriched by water harvesting. These plants are extremely efficient at utilizing the available soil water and nutrients, they are highly competitive with bunch grasses, and thus may have to be managed or controlled to facilitate the establishment of the desired end result - perennial bunch grasses.

Ripping

Ripping (also referred to as subsoiling or deep chiseling) involves pulling one to three heavy shanks (Fig. 3) equipped with broad lifting tips 16 to 24 in. deep through the soil on the contour (Valentine 1971). Space between rips is variable, and usually depends upon the equipment available, slope of the land, and amount of vegetative cover present. Ripping fractures impervious soil layers (which increases porosity and the rate of infiltration), causes uplifting of the soil (which resists surface runoff) if the clay content of the soil is sufficiently high, leaves a furrow in the center of the uplift (which will retain water), and the soil disturbance provides a seedbed for new plant establishment. Rips installed with narrow shanks and cutting tips have little lasting effect (Branson et al. 1966). We have found that ripping with 1.5-in.-wide shanks and 2.63-in.-wide cutting tips in silty soils with very low clay content creates only a narrow "slit" with very little uplifting. In this situation, wings or furrow openers must be attached to the ripper shanks (refer to "wing ripping" below). The potential for water harvesting diminishes as the horizontal and vertical distances between rips decrease, but the probability that runoff will breach the uplifted soil along rips increases as the horizontal and vertical distances between rips increase.

Forage production was 1405 lb/acre 10 years after ripper furrows were installed in a desert grassland in southern Arizona, compared to 563 lb/acre on adjacent, unripped areas (Brown and Everson 1952). These rips were installed with construction-type rippers pulled by a crawler tractor. The ripper shanks were broad and the flat cutting tips were 3 to 4 in. wide. The rips were 18 to 24 in. deep and installed in pairs on 30-ft horizontal spacings. The treatment produced a furrow as deep, and ridges as high as an average lister furrow. Forage production on these ripped areas was 1.6 times greater than that on adjacent untreated rangeland after 24 years (Branson et al. 1966).

In South Texas, subsoiling increased the production of coastal bermudagrass and buffelgrass by 2026 and 1167 lb/acre, respectively, compared to untreated areas; and chiseling increased the production of coastal bermudagrass, kleingrass, and buffelgrass by 1412, 3539, and 1275 lb/acre, respectively, compared to untreated areas (Hanselka et al. 1993). Vibratilling to a depth of 18 in. with rippers spaced 39 in. apart near Post, Texas increased total herbage production to 1700 lb/acre compared to 1125 lb/acre on untreated rangeland (Bedunah and Sosebee 1986).

We initiated a study on rangeland ripping in late April 1995 on a very poor condition, clay loam range site

northwest of San Angelo, near Carlsbad, Texas (Ueckert et al. 2001). The soil was a Tulia loam with 3 to 5% slope. Long-term average annual rainfall at the study site is about 20 in. The site appeared abused and over-grazed (>90% bare ground) even though it had not been grazed by livestock during 1969-1985 and was grazed lightly with long periods of rest from 1985 until 1995. Visible evidence of a soil crust (slick surface with a platy structure) and excessive runoff led to the hypothesis that poor rainfall infiltration and the soil crust, which provided a very poor seedbed for grass seed germination and establishment, were the factors limiting herbage production and natural recovery of the site. A preliminary, small-plot experiment on ripping was installed in late April 1995. Rips were installed about 15 in. deep on the contour on 22-ft horizontal spacings with a single-shank ripper mounted on the 3-point hitch of a 55-horsepower farm tractor. At the end of the first growing season, the yield of grasses and forbs was 1760 lb/acre immediately up-slope from the rips, compared to only 380 lb/acre on untreated areas.

These promising results prompted us to install a larger experiment on an adjacent area in the spring of 1996. A small, steel "baffle" plate was attached to the ripper shank in the 1996 experiment to create a more distinct furrow, about 2 in. deep, into which seeds could be planted and to deflect most of the soil from the furrow to the down-slope side of the furrow. Seeding treatments in the 1996 experiment included: seeding of Haskell sideoats grama, Lometa Indiangrass, little bluestem, or WW-Spar oldworld bluestem in the furrow; transplanting fourwing saltbush seedlings in the furrows; and controls (no seed or transplants). Grass seeds and saltbush seedlings were planted by hand into the shallow furrows, covered by scarifying with a hand-pushed garden tiller, then the seedbed was firmed by rolling the wheels of an all-terrain vehicle down the furrow.

The total standing crop of grasses and forbs immediately upslope from the 1995 rips increased gradually through 2000, reaching about 5800 lb/acre by August 2000 (Figure 4). Dense stands of cane bluestem, a highly productive, warm-season bunch grass, established naturally on the rips installed in 1995 and the production of buffalograss and three-awns increased substantially. The major change observed on the 1996 experiment was a substantial increase in abundance of Texas wintergrass and increased production of buffalograss and threeawns. Seeding was initially of limited success in the 1996 experiments because of drought and below-normal growing season rainfall during 1996 through 2001. Limited establishment of 'Haskell' sideoats grama and 'WW-Spar oldworld bluestem was achieved, but the average densities of these species were only 39 and 28 plants per 100 ft of rip, respectively in mid August 2000. Survival of fourwing saltbush transplants in the rips averaged 25% and these plants averaged 20 in. in height and 14 in. in diameter after 5 growing seasons. By August 2000, the bands of forbs and perennial grasses visibly enhanced by ripping were 9.3 ft wide on the 1995 rips and 7.8 ft wide on the 1996 rips. Profiles of native plant yields in August 2000 across 1995 and 1996 rips that were not seeded are shown in Figures 5 and 6, respectively. Standing herbage along rips was 10 to 20 fold greater than on untreated rangeland.

The rangeland receiving these mechanical soil treatments in1995 or1996 was substantially improved within 4 to 5 years in spite of the on-going drought. Averaged over the two experimental areas, clipping data collected in August 2000 showed that ripped landscapes that were not seeded yielded 1700 lb/acre of herbage, compared to 490 lb/acre on unripped areas. Assuming proper use, i.e., grazing only 25% of the standing herbage, rangeland that had been ripped on 22- ft horizontal spacings had a carrying capacity of almost 29 animal unit years (AUY) of grazing/section compared to only about 8 AUY/section for unripped rangeland (Table 1). This response in herbage production during a period of severe drought was possible because of "water harvesting", i.e., utilizing the degraded rangeland between rips as a watershed to provide runoff to the band of soil along the rips. Water harvesting results in the enrichment of a zone of soil along the rips with water, nutrients, and organic material. In a year with 20 in. of rainfall, the puddled (capped) soil in the interspaces between rips may only absorb 5 to 10 in. of water, whereas the disturbed soil along rips may absorb 25 to 40 in. of water.

Table 1. Effect of ripping in 1995 and 1996 on total herbage production, grazeable herbage, and carrying capacity of a clay loam range site near Carlsbad, Texas. (From data collected in mid August 2000).

Range Site Characteristics	Untreated	Ripped
Total herbage yield (lb/acre)	490	1700
Grazeable herbage (25% of total lb/acre for proper use)	122	425
Animal unit days of grazing/acre	4.7	16.4
Animal unit years of grazing/section	8.2	28.7

Above-normal cool-season precipitation during the fall-winter of 2000 - 2001 at our Carlsbad, TX study site produced luxuriant growth of cool-season annual forbs which apparently utilized all of the deep soil moisture as evidenced by the lack of a pulse of growth of the warm-season perennial grasses. There was no effective precipitation on the Carlsbad study site during the growing season of 2001, and consequently, a high percentage of the perennial grasses appeared to have died. This apparent mortality of perennial grasses was extremely disappointing, but the presence of perennial grasses along the rips for a few years had improved the structure of the surface soil and some of the dead grass plants and mulch remained to resist runoff and to protect the surface soil from the energy of raindrop impact. The moist winter of 2001-2002 produced another abundant crop of annual and perennial weed, mostly annual broomweed and ragweeds. Knowing that these forbs, which are highly efficient at utilizing soil water, would interfere with recovery of warm-season perennial grasses, we treated some of the rips with herbicide for weed control to evaluate the integrated use of mechanical soil treatments + weed control for establishing dense bands of bunch grasses on the contour across the landscape. Broadcast sprays of Grazon P+D (a mixture of 2,4-D and picloram) were applied at 1 quart/acre to 12-ft-wide bands along the rips in early April 2002. Half of the rips were not sprayed. Native forbs grew prolifically along the 1995 and 1996 mechanical soil disturbances following summer and autumn rains in 2002 (Fig.7) whereas perennial grasses made a remarkable recovery along sprayed rips (Fig. 8). These observations suggest that herbicide treatments integrated with mechanical soil disturbances may greatly expedite the establishment of dense bands of perennial, warm-season bunch grasses and tall grasses - the type of vegetation most effective for conserving water, soil, nutrients, and organic material and the type of vegetation of greatest interest to cattle ranchers. We recognize that ranchers interested in wildlife production may be very pleased to have dense bands of annual broomweeds, ragweeds, croton, etc. across their landscapes to provide food and cover for wildlife. A compromise management scheme that we suggest for ranchers interested in enterprise diversification that would simultaneously achieve restoration of hydrologically dysfunctional rangelands, produce more forage for cattle, and improve wildlife habitat is to treat a portion of the rips with herbicide and leave a portion untreated.

Rainfall from 1.5- to 2.0-in. spring and summer convection thunderstorms at the Carlsbad study site often penetrates to a depth of 48 to 54 in. along the rips, compared to only 4 to 5 in. on adjacent, unripped rangeland. However, this difference is not as great following gentle, soaking winter rainfall events. A series of 12 gentle rains during Sept. 14 - Nov. 15, 2002 (total of 8.65 in.) infiltrated more than 60 in. deep along rips installed in 1996, compared to only about 16 in. on untreated rangeland (Fig. 9). The data shown in Fig. 9 demonstrate that bands of bunchgrasses (e.g., Haskell sideoats grama and WW-Spar oldworld bluestem) along rips are more effective for enhancing rainfall infiltration than bands of shortgrasses (e.g., buffalograss and threeawns).

Ripping with the 55-horsepower farm tractor is relatively inexpensive. About 6.7 acres/hr can be ripped using the single-shank ripper on 20-ft horizontal spacings in 3rd gear; about 9.9 acres/hr can be ripped with 30-ft horizontal spacings. Assuming a labor cost of $10/hr and a cost of $ll.67/hr for the tractor, the costs for ripping on 20- and 30-ft spacings are $3.28 and $2.18/acre, respectively. Costs are higher for ripping in extremely dry and compacted soils because lower gears must be used. The best time to install ripping or other mechanical soil treatments, to minimize draft requirement and creation of large clods, is during late winter or early spring following gentle winter rains, when the soil is moist 1.5 to 2 ft deep. Ripping when soils are dry might be more effective for shattering sub-surface hardpans, but hardpans are rarely a problem on rangeland except where vehicular traffic has occurred on wet soils. Rippers that can be mounted on the 3-point hitch of rubber-tired tractors can be purchased with one to several ripper shanks. Our single-shank ripper (Fig. 3) (Bison SVH-1, Bison Equipment Co., Waco, TX) cost less than $400.

Wing Ripping

Wing ripping is accomplished by attaching shop-made wings or a furrow opener to the leading edge of the shank of ripping implements (Branson et al. 1966). The wings or furrow openers remove soil from the trench created by the ripper shank and flattened tip, resulting in a larger furrow for greater water retention capacity and larger ridges of soil adjacent to the furrow for increased resistance to surface runoff. We have learned that ripping alone will not create sufficient uplifting, soil ridges, or furrows on soils with a low clay content. Wing ripping was accomplished by attaching 18.5-in.-wide wings made in the shop from 1/4-in. steel plate (Fig. 10) or a furrow opener (Fig. 11) onto the leading edge of the the ripper shank. Brackets are welded onto the back side of the wings or furrow opener to facilitate attaching these to the ripper shank with bolts. The brackets and bolts also facilitate the vertical positioning of wings or furrow openers at the proper height to effectively create a clean furrow and shove the soil aside to create effective soil ridges adjacent to the furrow. Properly positioned furrow openers created a furrow with a depth of about 5 in. below the undisturbed soil surface, 24 in. wide at the top, and soil ridges about 5 to 6 in. in height above the undisturbed soil surface. The overall depth from the top of soil ridges to the furrow bottom was about 10 in. Furrows made when the shop-built wings are attached to the ripper shank were slightly narrower and shallower. Wing ripping should also be done following gentle winter rainfall when soils are moist to considerable depth to minimize the draft requirement and large clods in the soil ridges adjacent to furrows.

We attach a 1-row grass seeder to the ripper frame to facilitate seeding while ripping or wing ripping (Fig. 12). The seeder (Truax Company, Minneapolis, Minnesota), which has separate seed boxes for slick and chaffy seeds and is powered by a hydraulic motor, was fitted with a flexible seed tube that can be moved right or left by the tractor operator to strategically deposit grass seeds either into the disturbed soil on the up-slope side of the soil ridge along rips or furrows or directly into the furrow. Log chains, pulled in a loop behind the seed tube, cover the seeds with soil. Estimates of the costs and efficiency for wing ripping alone and wing ripping + seeding with a 55-hp rubber-tired tractor, from field trials conducted under extremely dry soil conditions in summer 2002 in degraded grass planting at Carlsbad, TX are shown in Table 2.

Table 2. Estimated costs for wing ripping or wing ripping + seeding with a 55-horsepower rubber-tired tractor in 2nd gear on 15-, 20-, and 30-ft spacings in dry compacted soil, with B. Dahl old world bluestem, Haskell sideoats grama, Lometa Indiangrass, and blue panicum, each at 25% of the normal full seeding rate ($2.38/acre seed cost for 15-ft spacing).

Space between furrows (ft)	Efficiency (acres/hour)	Cost for wing-ripping only ($/acre)	Cost for wing-ripping + seeding ($/acre)
15[1]	4	$5.50	$7.90
20[2]	5.3	$4.20	$5.90
30[2]	8	$2.80	$3.90

[1]Estimated from work done in three fields, 15 to 20 acres in size, at the Carlsbad Research Area in late July - early August 2002.

[2] Calculated from the actual field data, assuming that efficiency for 20-ft and 30-ft spacings would be 1.33X and 2.0X that for 15-ft spacing, respectively. Costs for 20-ft and 30-ft spacing were calculated by dividing the cost for 15-ft spacing by 1.33 and 2.0, respectively. Values have been rounded off.

In a 20-acre trial in Upton County in 2002, the efficiency of wing ripping with an 85-horsepower crawler tractor (Caterpillar D3C XL) equipped with a single-shank, construction-type ripper was about 6.7 acres/hr. Estimated contract costs for wing ripping on various spacings with similar-sized crawler tractors are shown in Table 3.

Table 3. Estimated contract costs for wing ripping alone or with seeding on 15-, 20-, and 30-ft spacings with 85-horsepower crawler tractors equipped with single-shank, industrial rippers with wings. Cost values assume a contract cost of $50/hr for the dozer and operator. Seed costs are based on 2002 prices for seeding B. Dahl oldworld bluestem, Haskell sideoats grama, Lometa Indiangrass, and blue panicum, each at 25% of the normal full seeding rate ($2.38/acre

for 15-ft spacing).

Horizontal distance between wing rips (ft)	Efficiency (acres/hr)	Cost for wing ripping only ($/acre)	Cost for wing ripping + seeding ($/acre)
15	3.35	$15.00	$17.38
20	4.5	$11.25	$13.03
30	6.7	$7.50	$8.69

Contour furrowing

Contour furrowing involves pulling disk plows or other tillage implements, such as lister bottoms, to create depressions or grooves in the soil surface 4 to 8 in. deep, 6 to 30 in. wide, and 2 to 10 ft apart (Valentine 1971). These soil depressions increase on-site water retention and the ridges of soil adjacent to the furrow provide resistance to surface runoff. Furrowing implements can be designed with rippers in front of the disks or furrow openers (see discussion of wing ripping above) as well as dikers that dam up the furrows at selected intervals. Diking of the furrows makes furrowing on an exact contour less critical (Branson et al. 1966). Seeders can also be attached that deposit seed on or into the disturbed soil during the furrowing process to establish plant species that can make beneficial use of the water retained in the furrows.

Broadbase furrows are built with a road grader by pushing soil from a 6- to 8-ft-wide area downslope to form low dikes 1.5 to 2 ft in height. Road grader blades can also be tilted at a steep angle, using only the tip of the blade, for constructing contour furrows only about 2 ft wide and creating dikes about 1 to 1.5 ft in height. Another method for constructing contour furrows is to attach wings or a furrow opener to the leading edge of the scarifier implement on a road grader. Sherman Hammond, an innovative rancher in southwestern Pecos County, TX is currently using these two latter methods very successfully.

Contour furrowing with the Arcadia Model B contour furrowing machine increased perennial grass production by over 500 lb/acre while broadbase furrowing increased perennial grass by almost 1500 lb/acre (Branson et al. 1966). Listing of rangeland near Spur, Texas increased perennial grass production 2.1 to 4.1 times compared to that produced on untreated rangeland (Dickenson et al. 1940).

Pitting

The most effective rangeland pitting has been done with disk plows equipped with eccentric or deeply notched disks or disk plows with eccentric furrow wheels that alternately raise and lower the disks. The pitting implements create thousands of small basins or pits across the landscape, which function similarly to contour furrows (Valentine 1971). Perennial grass production has been increased by about 200 lb/acre by eccentric disk pitting (Branson et al. 1966). Seeders can also be attached to pitting implements.

Pits installed with implements that utilize spike teeth tend to fill in with soil within about a year. It is questionable whether spike-tooth or rotary pitters are of value as a land-treatment practice (Branson et al. 1966).

Another implement that is being utilized for simultaneously scarifying the soil surface and top removal of woody vegetation is the Lawson aerator. This implement utilizes sharpened steel blades about 12 in. X 12 in. welded onto large steel drums to create thousands of small divots per acre in the soil surface. The drums are usually pulled at an angle and often two drums are pulled in tandem for maximum effect relative to seedbed preparation and top removal of woody species. Broadcast seeders can be attached to Lawson aerators for planting adapted grasses, and excellent grass stands have been established this way in many situations. However, the soil roughness created by Lawson aerators is usually short lived, thus it may be effective for resisting runoff and retaining rainfall for only a few months to 1 yr. Furthermore, pricklypear will most often be spread if present where aerators are used and few, if any, of the sprouting woody plants will be killed. Top removal of mesquite and other basal-sprouting woody species with this method results in a multiple-stemmed growth form of plants that may have formerly had only a single stem. This growth form modification of woody plants provides escape and thermal cover for quail and other upland game animals for a few years. However, the canopy cover of mesquite and other basal sprouting woody plants may exceed that on untreated areas within a few years after use of aerators. The proliferation of new, basal growth of palatable woody plants can increase the diet quality and browse availability for deer following use of aerators.

Lawson aerators should be expected to provide greater

benefits in humid and sub-humid areas than in arid and semi-arid areas. Pulses of plant growth may not occur where Lawson aerators are used over entire pastures or wide strips in arid and semi-arid areas because this type of mechanical disturbance is not conducive to the development of patches or bands of vegetation, i.e., the uniform soil disturbance spreads the limited supply of rainfall more or less uniformly over the entire surface area, thus resulting in insufficient soil water in the reserve to meet the minimum requirements for significant pulses of plant growth activity.

Disk Diking

Disk diking is accomplished by pulling opposing gangs of disks arranged to create a berm or dike of soil with a shallow furrow on both sides of the berm. To our knowledge, we are the first to evaluate disk diking for restoration of degraded rangeland. Our experimental disk diker utilizes 4 sets of disk bedders attached to a tool bar on the 3-point-hitch of a 55-hp tractor (Fig. 13). This implement produces a dike of soil about 10 to 12 in. in height and about 30 in. broad at the base. The furrows are only 2 to 3 in. deep. A 1-row grass planter attached to disk diker with a flexible seed tube allows the tractor operator to position the seed delivery tube to distribute the grass seeds into the furrow on the up-slope side of the dike where rainfall will be retained by water harvesting. Looped log chains are dragged in the furrows, behind the seed delivery tube, to cover the seed with soil. Horizontal spacing between dikes is generally 15 to 30 ft.

A possible disadvantage of disk diking, compared to ripping and wing ripping, may be that there is no deep fracturing of the soil immediately up slope from the dike to allow rapid infiltration of runoff. Advantages of disk diking, compared to ripping, wing ripping, and furrowing are that:

- the disks will roll over unseen, underground obstacles (e.g., tree stumps, large roots, and large rocks) that could damage ripper shanks or furrow openers
- the draft is less (i.e., requires less horsepower to pull)
- the ridge of soil (dike or berm) is of greater height and width and thus should provide greater resistance to runoff and have a longer effective treatment life.

Seeding

Seeding of rangeland is an expensive and high-risk venture in arid and semiarid regions due to the erratic and unpredictable nature of rainfall. Seeding should be preceded by seedbed preparation. Root plowing and roller chopping are normally used for seedbed preparation on rangelands infested with woody plants. Root plowing alone can cost about $100/acre, while a native grass seed mixture may cost $30 to $50/acre, and roller chopping to cover the seeds and compact the seedbed may cost an additional $20 to $25/acre. Due to the high costs and risk and the low potential for recovery of costs, we have seen little root plowing and re-seeding in arid and semiarid regions in several decades. A major reason for the lack of success with root plowing and re-seeding in arid and semi-arid areas is that this type of mechanical disturbance is not conducive to the development of vegetative "patchiness" or bands, i.e., the uniform soil disturbance spreads the limited supply of rainfall more or less uniformly over the surface resulting in insufficient soil water in the reserve to meet the minimum requirements for significant pulses of plant growth activity.

Seeding only within 1-ft-wide bands of soil disturbed by ripping, wing ripping, furrowing, or diking reduces the risks and the costs substantially and increases the probability for successful plant establishment compared to broadcast seeding. The amount of seed that would be necessary to broadcast or drill seed 1 acre will seed about 8.3 miles of rips, furrows, or dikes. If rips or furrows are spaced 15 to 30 ft apart, the amount of seed necessary to drill or broadcast seed one acre will extend over 15 to 30 acres of treated rangeland. Because of this, seed costs are generally less than $2/acre, averaged over the entire treated pasture. Strategically placing the seed in the furrow or in the edge of the ridge of soil up-slope from the rip, furrow, or dike reduces the risk of a seeding failure because this is the region where water will be concentrated by water harvesting. This seed placement strategy and leaving 15 to 30 ft between rips or furrows for water harvesting increases the probability that the seedbed will stay sufficiently moist for a sufficient duration to facilitate seed germination, seedling emergence, and seedling establishment. Seeding only on the upslope side of rips or furrows has its own inherent risks for two reasons. First, a good seedbed has not been prepared and often is not present. In some cases the surface soil may be too compacted for the drag chain to cover the seeds with soil, or the presence of dense stands of weeds may prevent seed coverage by the chain. Secondly, following effective rainfall events, the seeded band may be rapidly colonized by annual weeds or low-value grasses which may out compete seedlings of the seeded species. Seeding in the furrow carries with it the risk that the first high-intensity rainfall event may cause excessive sloughing of soil from the furrow slopes into the furrow bottom and cover the grass seeds too deeply. Grass seeds should generally be planted only about 1/8 to 1/4 in. deep and the seedbed should be firmed up or

packed so that there is intimate contact between the grass seed and the soil particles. We are currently conducting research to identify the safest site for seed placement when ripping, wing ripping, and disk diking.

The plant species and varieties to be used for seeding along mechanical soil disturbances should be carefully selected from among those known to be adapted to the climate and soils of the treated area. Local Texas Cooperative Extension or USDA Natural Resources Conservation Service personnel are good sources of information on adapted species for use in rangeland re-seeding projects.

CONCLUSION

Ranchers interesting in improving the value of their land for livestock production, for wildlife, or for other enterprises should first develop a clear understanding of how arid and semi-arid landscapes function and learn how to work with, rather than against the essential ecological processes. Water is the critical limiting factor for successful ranching in western Texas. Maintaining good vegetative cover, a mulch layer, and soil aggregation is critical for the efficient utilization of rainfall on rangelands. Proper grazing management budgets about half of the annual plant production to be left to maintain healthy hydrological and mineral cycles and an acceptable level of energy capture via photosynthesis. Control of excessive densities of noxious or low-value plants can decrease wasteful interception and transpiration of water while increasing availability of water for beneficial plants. Mechanical water conservation treatments offer effective technology for effectively reducing surface runoff and increasing infiltration of rainfall into the soil reserve, thus increasing the potential for plant production. Seeding in conjunction with mechanical water conservation treatments can result in the establishment of plant species which have greater genetic potential than the resident plant species for effectively utilizing the available soil water. Persistent stands of annual or perennial forbs may have to be controlled along mechanical soil disturbances to facilitate establishment of perennial bunch grasses - nature's effective mechanism for conserving water, soil, nutrients, and organic materials. The long-term effectiveness of these mechanical water conservation treatments hinges upon the use of proper grazing management and periodic pasture rest to facilitate the establishment and maintenance of dense patches or bands of perennial vegetative cover. By utilizing the principles of water harvesting, these treatments offer ranchers the opportunity to substantially increase the yield of desirable plants, the carrying capacity of their land for wildlife and livestock, and to engage in a wider array of economic enterprises.

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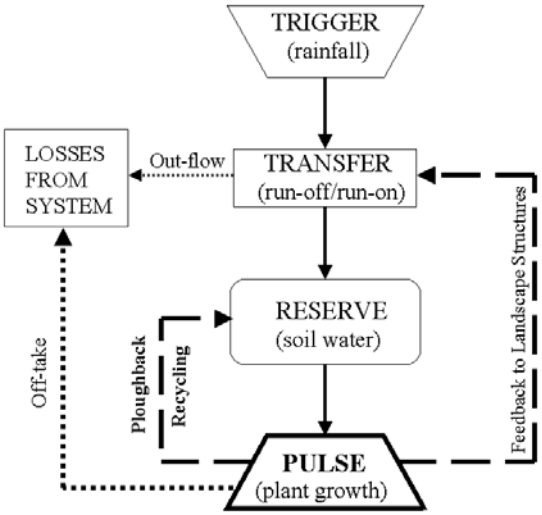

Figure 1. The trigger-transfer-reserve-pulse framework for arid and semi-arid rangeland landscapes (from Ludwig et al. 1997).

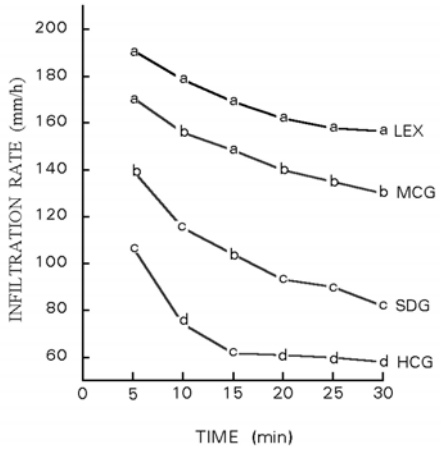

Figure 2. Mean infiltration rates for four grazing treatments six years after they were initiated on the Edwards Plateau, Texas. LEX = livestock exclosure; MCG = continuously grazed at moderate intensity; SDG = short duration rotation (14-pasture, 1-herd; 4 days on, 50 days rest) stocked at 1.75 times the moderate intensity; HCG = continuously grazed, stocked at 1.75 times the moderate intensity. Means within a time period with different letters are significantly different at $P \leq 0.05$. [from (2)]. Reprinted from *Grazing Management: An Ecological Perspective* with permission from R.K. Heitschmidt and J.W. Stuth.

Figure 3. A single-shank ripper (Bison SVH-1, Bison Equipment Co., Waco, TX) used by the authors for restoration of degraded rangelands and pastures.

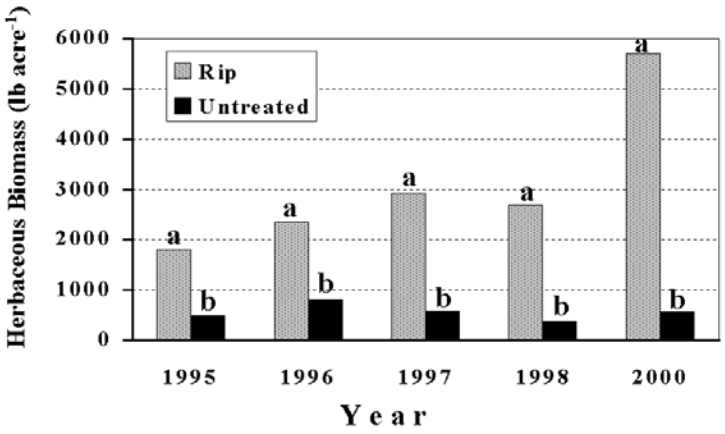

Figure 4. Herbage production during 1995 - 2000 within a 3.3-ft-wide band immediately up slope from rips installed on a clay loam range site near Carlsbad, Texas in April 1995 and on adjacent untreated areas. Means within a year with different lower case letters are significantly different at the 5% probability level.

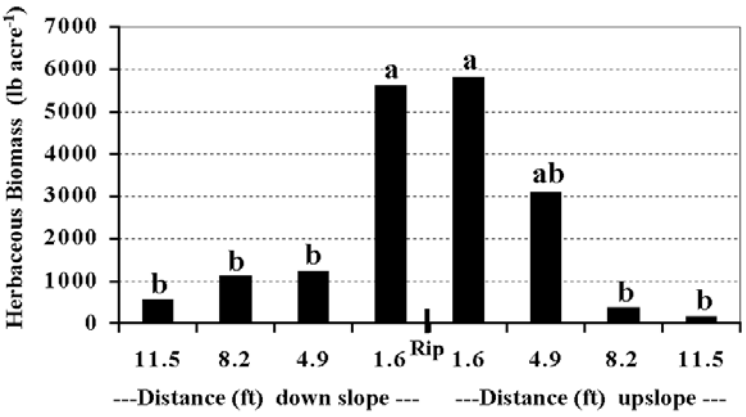

Figure 5. Profile of herbage production in mid August 2000 across rips installed in 1995 on a clay loam range site near Carlsbad, Texas. Values with different lower case letters are significantly different at the 5% probability level.

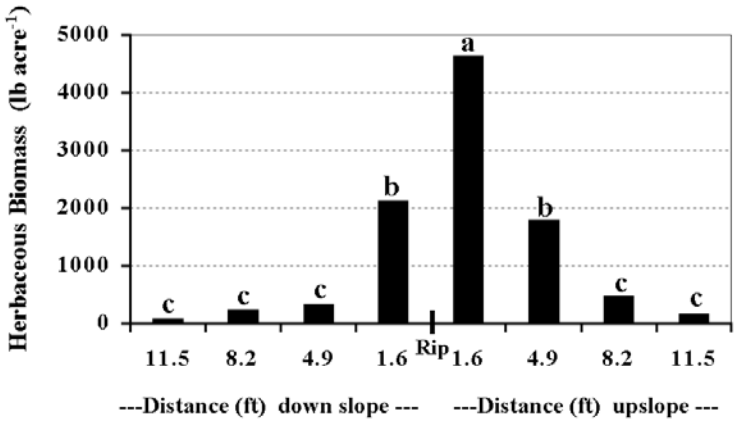

Figure 6. Profile of herbage production in mid August 2000 across rips installed in 1996 on a clay loam range site near Carlsbad, Texas. Values with different lower case letters are significantly different at the 5% probability level.

Figure 7. Annual broomweed, ragweed, and other forbs dominated mechanical soil disturbances installed in 1996 following improved growing conditions in the 2002 growing season at the Carlsbad, TX research area. No herbicide was applied to this rip. Photo taken in November 2002.

Figure 8. Excellent recovery of Haskell sideoats grama, WW-Spar oldworld bluestem, and Lometa Indiangrass occurred along rips installed in 1996 at the Carlsbad research area following rainfall during the 2002 growing season and application of broadcast sprays of 2,4-D + picloram (Grazon P+D at 1 qt/acre) in early April 2002. All grasses had appeared dead on this site at the end of the 2001 growing season.

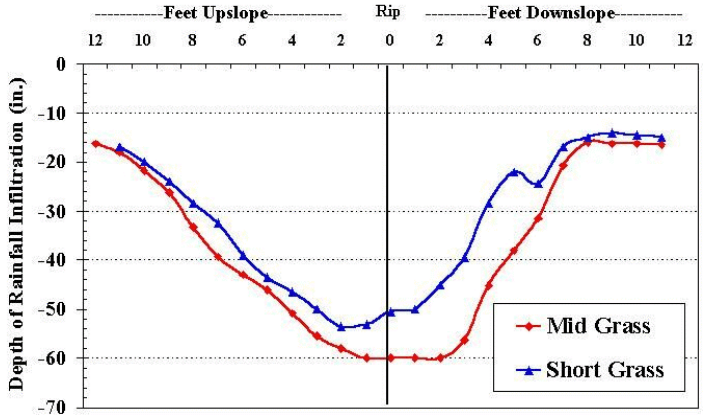

Figure 9. Water from 8.65 in. of rain (12 rainfall events) during September 14 - November 15, 2002 infiltrated >60 in. deep along rips installed about 22 ft apart in 1996 at the Carlsbad research area, but only about 16 in. deep on untreated rangeland and mid-way between the rips. Rainfall infiltrated deeper where bands of bunch grasses (sideoats grama and old world bluestem) had been seeded and colonized the rips than where shortgrasses (buffalograss and threeawns) colonized the rips. These data were collected along rips where weeds had been controlled with broadcast sprays of 2,4-D + picloram (Grazon P+D at 1 qt/acre) in April 2002.

Figure 10. Shop-made wings, made from 1/4-inch-thick steel plate, attached to the leading edge of a ripper shank for wing ripping.

Figure 11. A furrow opener attached to the leading edge of a ripper shank for wing ripping.

Figure 12. A single-row grass seeder (Truax Company, Minneapolis, MN) attached to a single-shank ripper for seeding adapted grasses, forbs, or shrubs while ripping or wing ripping. The flexible seed-delivery tube, controlled by ropes from the tractor, facilitates placing the seeds either in the furrow bottom or in the disturbed soil on the up-slope side of the furrow of rips or wing rips. Looped log chains that are dragged behind the seed delivery tube cover the seeds with soil.

Figure 13. The experimental disk diker utilizes 4 sets of disk bedders to create contour dikes or berms of soil about 10 - 12 in. high to resist runoff and retain rainfall until infiltration can occur. Ropes attached to the flexible seed-delivery tube on the Truax planter allow the operator to position the tube so that seeds fall into the shallow furrow on the up-slope side of the dike where water will be concentrated by water harvesting. Looped log chains are dragged in the furrow behind the seed delivery tube to cover the seeds with soil.

GRAZING MANAGEMENT AND PRESCRIBED FIRE INCREASE RANGELAND PRODUCTIVITY

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Abstract: The application of an effective fire program on rangelands is not a simple task. Overgrazing by livestock since the early development of the livestock industry has altered the vegetative complex on most rangelands with an increase in woody plants. Because of its relatively low cost, prescribed fire, both cool and warm season are sustainable practices if proper grazing management is part of the management scheme. Grazing management and prescribed fire have often been treated as separate issues by rangeland managers; however, development and application of an effective prescribed burning program requires an understanding of the relationship between fire and grazing. Ranchers need fuel (grass) to burn and they also need income from livestock, which requires forage (grass, a major part of forage). In the short-term fire reduces carrying capacity for livestock but in the long-term fire increases grass production resulting in increased carrying capacity. Therefore, some monitoring technique is needed that will allow the manager to budget grass for both fuel and forage. The Grazing Manager (TGM) is a software program that projects both forage production (expressed as animal unit days) and, animal demand (expressed as animal unit days) for each forage year. TGM has been successfully used on the Texas A&M University Research Station at Sonora as a tool to integrate prescribed fire and grazing management.

Introduction

Texas rangelands provide food, fiber, water, wildlife, and other economic and social benefits to mankind. Sustainable production of these products requires cost-effective methods of managing and monitoring the rangeland resource. Since European settlement, rangeland vegetation has been altered, and in some instances, this has had a negative effect on rangeland products as well as the sustainability of the range resource. For example, overgrazing by livestock since the early development of the livestock industry has been a major factor in causing this change (Archer 1989, 1994). Yearlong, overgrazing reduces the grass component (fine fuel load) and can eventually fireproof the landscape. With a significant reduction in fire frequency and intensity, noxious brush species start to dominate the rangeland. For example, ashe juniper (Juniperus ashei) and redberry juniper (J. pinchotii) infestation of Texas rangelands is an important dilemma because of its impact on forage and livestock production, water yield and quality, wildlife habitats, and rapidly increasing costs of conventional control methods (Thurow & Hester, 1997; Ueckert, 1997).

Other important factors that interact with overgrazing include drought, soil modification, and nutrient cycling. Drought is difficult to define, especially in arid and semi-arid regions of the world. Basically, drought refers to a decrease in precipitation, which results in decreased production. Long-term precipitation patterns are naturally erratic on most western rangelands. Therefore, range managers must consider climatic variability and develop a flexible management strategy to cope with normal fluctuations resulting in below average precipitation.

Soil modification can occur when critical amounts of vegetative cover have been removed from the landscape. This condition can actually increase the frequency and intensity of drought. For example, water runoff is the portion of precipitation that leaves the site via overland flow. Runoff is mostly determined by the rate at which water can enter the soil (infiltration rate). Infiltration rate is primarily determined by the size and amount of pores in the soil. Organic matter is vital to formation of stable soil aggregates, which provides for optimal pore space. Organic matter is reduced with overgrazing and/or drought, which can reduce water-holding capacity of the soil.

A reduction in soil organic matter also affects nutrient cycling. Over the long term, excessive levels of grazing and/or drought can potentially reduce nitrogen fixation; increase ammonia volatilization, leaching and erosional losses; and cause a net loss of nutrients (Archer & Smeins, 1991).

On arid or semi-arid rangelands, grazed forage is the primary source of nutrients for livestock enterprises and, for these regions, estimating forage production is difficult due to the variability in precipitation. This problem creates one of the most difficult and important management decisions (i.e., adjusting livestock numbers

to match forage demand with a fluctuating forage supply). Also, livestock demand on forage (degree of use) prior to and during drought determines the severity of drought's effect on both livestock and forage production.

As the economics of ranching becomes tighter, one of the hardest decisions to make is how to manage the forage resource so the higher successional, more productive grasses, forbs and browse can be maintained in the vegetative complex. Another important consideration is budgeting the forage resource for either livestock consumption, or fuel for prescribed fire while maintaining adequate soil cover to ensure a healthy soil.

Rangeland Monitoring

The purpose of most monitoring programs is to improve land stewardship by providing a tool to objectively measure the effects of current management. This means that monitoring must provide information that is useful in making management decisions. Management goals and objectives often depend upon the individual owner or manager (i.e., individual management practices that benefit one objective can be detrimental to another). However, regardless of the type of goals and objectives sought by management, some type of monitoring program has to be implemented to measure success or failure.

There are numerous techniques available to monitor rangeland. A review of these techniques is beyond the scope of this discussion; however, Smith (1984), NRC (1994) provide reviews on this subject. Later in this discussion, I'll be presenting a specific monitoring technique that provides land managers with timely information that can be used to maintain a proper balance between forage production and animal demand.

Adoption of a grazing strategy that provides a cushion of "reserve forage" allows ranchers some flexibility in the speed and extent to which they must respond to drought as well as provides for the periodic use of prescribed fire to manage noxious brush encroachment (Taylor & Kothmann, 1993). It is the responsibility of the individual rancher or land manager to be aware of how much forage is available and to anticipate current and future animal (livestock and wildlife) demand. Monitoring the extent of use on key vegetation species is a useful indication of grazing pressure. By careful monitoring and control of grazing, the rancher can quickly identify and respond to the beginning of a forage deficit. A user-friendly computer decision aid (The Grazing Manager) has been developed to help ranchers estimate seasonal adjustments of livestock stocking rates and test "what if" scenarios regarding forage production (Kothmann and Hinnant, 1994).

Fire

It is well documented that prior to European settlement both prescribed and wild fires were disturbances that played key roles in shaping the different plant communities across the United States (Baker, 1992, Foster, 1917). Historically fires occurred during all months of the year (Higgins 1986; Komarek 1968), but summer fires were probably more frequent due to dry conditions combined with increased lightning frequency during the summer (Komarek, 1968; Taylor, 2001).

Fire is a natural disturbance and the fire regime (i.e., frequency, intensity, and size of burns) often is an integral part of ecosystem function (Leitner et al., 1991). As the livestock industry developed across the continent, fire suppression was a major activity of the early European settlers (Scifres & Hamilton, 1993). For example, in 1848 a state law was passed in Texas that made it illegal to fire the prairies between July 1 and February 15. In 1884 another Texas law was passed that made setting fire to any grass a felony. It wasn't until 1999 that a law was passed in Texas that unambiguously stated that a landowner had the right to conduct a prescribed burn on his or her own property.

The increased frequency and intensity of grazing also reduced the grass cover (i.e., fuel load), which helped fire proof a big part of the western rangelands. With the suppression of fire, woody species were able to invade rangelands (Baker, 1992; McPherson, 1997). Intense grazing pressure, which produced gaps in the herbaceous cover, concomitant with increased seed dispersal by herbivores also may have contributed to increased establishment of woody plants (Brown & Archer, 1989).

Ecological theory provides a basis for examining hypotheses about the role of fire in rangeland ecosystems. The intermediate disturbance hypothesis suggests that intermediate disturbance frequencies control competitive dominant species allowing inferior competitors to be maintained in the landscape (Connell, 1978). Only colonizing species are able to establish when disturbance is very frequent whereas, when disturbance is very rare, succession leads to colonizing species being supplanted by competitive dominant species. If historic rangelands were subjected to periodic wildfires then the historically dominant species should be well adapted to this disturbance regime but not competitively dominant in the absence of the disturbance.

Susceptibility to fire and competitive ability are mainly governed by growth form/life form characteristics (Scifres, 1980). Perennial grasses were historically

dominant on many arid and semi arid rangelands (Cory, 1949). The buds of perennial grasses are located at or below the ground making them resistant to fire. Invading woody species are potentially more susceptible to fire because their buds are elevated. However, many shrub and tree species can re-sprout from the roots or underground crowns if fires are not intense enough to kill these tissues. Woody plants, once established, are better competitors than grasses because their root systems generally are deeper allowing access to ground water supplies during times of drought. Therefore, the historically dominant grasses generally are better adapted to the disturbance regime than are the invading woody species; however, grasses are less able to compete for required resources once woody plants have become established.

Woody plants also affect nutrient cycling. In general, levels of organic carbon and total nitrogen are greater in soils beneath woody plants than in the grass dominated interspaces (McPherson, 1997). Carbon and nitrogen accumulation under woody canopy cover probably results from increased litter and root biomass.

The reintroduction of fire as a management tool should reestablish the disturbance regime of pre-settlement times allowing an optimal balance between the herbaceous and woody plant species. Moreover, diversity should be highest for areas where a fire regime has been reestablished because both inferior and competitive dominant species could be maintained in the landscape (Fuhlendorf & Engle, 2001; Copeland et al., 2002). With the advent of hierarchical analysis of ecosystems and landscapes it is becoming possible to consider the long-term implications of prescribed burning and other management regimes on structure and functioning of rangeland ecosystems (Baker, 1992).

As we enter the 21st Century, prescribed fire faces an uncertain future. Historic use of prescribed fire by ranchers has never been widespread; however, with the rapid increase in population and increased "urbanization" of rangeland and air quality concerns, the implementation of fire will be even more difficult in the future. Nevertheless, these problems should not lessen our enthusiasm for prescribed fire. In fact, now is the time to become bold and innovative in the use of prescribed fire, but also be prudent.

Because of its relatively low cost, prescribed fire, both cool and warm season fire (multi-seasonal) is viewed as an extremely viable tool (Engle & Bidwell, 2001; Ansley & Taylor, 2000). However, a combination of prescribed fire, coupled with proper grazing management (i.e., proper budgeting of grass to either forage or fuel) should offer the best-case scenario for managing noxious woody plants.

Grazing Management and Prescribed Fire

Grazing management and prescribed fire have often been treated as separate issues by rangeland managers. However, development and application of an effective prescribed burning program requires an understanding of the relationship between fire and grazing. For example, vegetation serves a dual role as forage for grazing animals and as fuel for prescribed burns. The manager must balance the amount of forage that is used by grazing animals and the amount that is used for fuel. The range manager should manage the stocking rate and grazing schedule to allocate enough forage to livestock to provide ranch income and also allocate enough to fuel for effective burning. Land managers can use The Grazing Manager (Kothmann & Hinnant, 1994) to determine the most effective stocking rate and grazing schedule to reduce the cost of burning and increase the probability that burning can be implemented as required to manage the range resource.

Where do you start?

Planning and implementing a successful prescribed burning program to meet long-term goals and objectives requires basic knowledge in the areas of forage and animal production, grazing management, plant ecology, and prescribed fire. Before beginning a burning program, a manager should obtain training in these concepts and techniques. Also, it would be wise to initiate an inventory and monitoring system to measure current conditions and determine if goals and objectives are being met.

Inventory

The first step in planning a prescribed burning program is for the manager to inventory the current condition of both herbaceous and woody vegetation. The current status of the vegetation and the stocking rate will determine the potential for using prescribed fire and what may need to be changed prior to burning as well as the cost of implementing an initial burn. Also, the current status of the vegetation will determine the kind of plan that should be developed. To make this decision a decision aid would be helpful. Listed in Table 1 is an example of a decision aid that helps determine the status of a problem. This decision aid was developed for Texas rangelands that have the potential to be dominated by juniper. With this aid, pastures can be placed into 4 different categories and then an evaluation can be determined, based on goals and objectives of the manager.

For example, a target pasture that has been heavily stocked, is in poor range condition, and has dense mature juniper would fit into category 4. Under these conditions there is almost no potential for initiating a cool-season, prescribed burning program until the mature juniper has been mechanically controlled (i.e., chaining, grubbing, roller chopped, etc.) and grazing management is improved. Cost of implementing a burning program under these conditions would be high for winter burning and moderate for summer burning.

Initially the potential for prescribed burning is low for category 3; however, improved grazing management may provide adequate fuel before juniper becomes dense enough to seriously reduce forage production. Initiating a management program before the juniper reaches maturity and begins producing seeds is important. Years of heavy stocking reduces range condition, soil condition, and plant vigor. The pasture may not produce enough fuel to support an effective fire even if it is rested for a year prior to burning. In these cases, stocking rates should be reduced and pastures provided deferment to increase plant vigor and seed production of desirable species prior to burning. Burning prior to correcting grazing management problems will not yield good results. Pastures will need to be monitored to determine when vegetation fuel loads are sufficient for carrying an effective fire. It's obvious that different management plans will have to be initiated for each category. An initial inventory will be required and then the rangeland will have to be monitored until sufficient kinds and amounts of fine fuel are grown to provide for effective burning.

Pastures that fit into category 2 have a higher range condition than category 3 and 4; however, twenty-five percent of the juniper is mature. For winter burning, a pre-fire mechanical treatment might be required to kill the mature juniper, which will increase the cost significantly. A reclamation type burn could be initiated with a hot summer fire; however, risks would be greater and this would require a longer post-burn deferment to allow for vegetation recovery. Marginal fuel loads would make it difficult for either summer or winter burns.

Category 1 is the best-case scenario because good to excellent range condition is providing the best kinds of fine fuel (i.e., midgrasses) for hot fires. Also, juniper density is light with immature plants. Winter or summer fires would be very effective and pre- and post-burn deferment periods would probably be shorter than other categories.

How do you graze and burn?

A rancher acquaintance commented a while back that one can burn too much. He emphasized how difficult it was to make a living from ranching, especially with today's operating costs, and that burning too much would jeopardize income to the ranch enterprise. It was a very honest comment and irrefutably, the ranching industry has fallen on hard times. It's also apparent that burning grass costs money and, in the short-term, may reduce ranch income.

Prescribed fire is a double-edged sword. Ranchers need fuel (grass) to burn and they also need income from livestock, which requires forage (grass, a major part of forage). In the short-term fire reduces carrying capacity for livestock but in the long-term fire increases grass production resulting in increased carrying capacity. Therefore, the answer to the rancher's comment is, "budget your grass for both fuel and forage".

How do you budget grass for fuel and forage and how much will it cost?

Approximately 10 years ago it was decided to develop an intensive burning plan for the Texas A&M University Research Station at Sonora. The objectives are to compare the effectiveness of warm-season burning and cool-season burning and also the costs associated with not burning (controls). The burning project began with the goal of burning 25% of each grazing system each year, except for the controls. Treatments that represented warm season burning, cool season burning and control (no burning) were assigned to 36 pastures. All pastures were assigned to grazing management units (GMUs). Each GMU is represented by four equal size pastures, which represent one 4-pasture grazing system. Each GMU (grazing system) is assigned its own set of sheep and goats. Initially cattle were removed from grazing to reduce harvest of the fuel load. Once a more favorable balance is achieved through burning and browsing, cattle will be gradually integrated back into the grazing animal mixture. Each treatment is replicated with three GMUs.

In terms of livestock production, the experimental unit is each GMU, which has 3 replicates (3 complete 4-pasture grazing systems per treatment). Management of the grazing systems follow the recommendations of Taylor et al. (1993). Livestock production, including kg of deer harvested, is measured for each year.

Because of the variation within and between pastures due to past grazing and brush control treatments, and differences in soils and topography, three years of base line data were collected. The Grazing Manager was used to determine average carrying capacity for each pasture and GMU (Fig. 1). Also TGM was used to determine seasonality of forage production, monthly forage use

ratings for each pasture and GMU and provide information for timely stock adjustments in response to forage supply (Kothmann & Hinnant, 1994). Vegetation data is being measured from aerial infrared photographs, permanent line transects for woody plant composition, and quadrats measured along permanent transect lines for herbaceous composition. Individual pastures will be used as experimental units for vegetation analysis.

By using the decision aid (table 1) pastures can be placed into 4 different categories and then an evaluation is determined, based on goals and objectives, which pasture to burn first in each GMU. From a personal perspective, pastures that have the greatest and quickest potential to respond to a fire and are cheaply implemented should receive first priority. For example, if 4 pastures are evaluated and two fall into category 1, one in category 2, and one in category 4, I would plan on burning the pastures in categories 1 first. This is not to say that the other pastures would be ignored; in fact, proper grazing management would be required for the other pastures to improve in range condition, which would be part of the process of getting it in condition to eventually burn.

Furthermore, I cannot over-state the value of The Grazing Manager (TGM) software as a tool in determining proper stocking rates and also as a monitoring device to determine the increase or decrease in carrying capacity. TGM projects forage production (expressed as animal unit days) and projects animal demand (also expressed as animal unit days), for each forage year (Figure 2). When animal demand is equal to forage production in the TGM program, use on the vegetation is moderate. When forage production values are greater than animal demand, it indicates a surplus of forage. For example, TGM is predicting that approximately 3,500 animal unit days (AUDs) are available for grazing through March for one GMU (Figure 2). Animal demand is approximately 1700 AUDs; therefore, TGM is predicting that we could have increased our stocking rate for the past forage year by 1800 AUDs and still be moderately stocked. However, we could also consider a change in stocking rate at the end of September rather than waiting until the end of the forage year. Approximately 75% of total forage is produced by the end of September for most years for the southwestern region of Texas. Based on this knowledge and the use of the information from TGM, livestock numbers could be increased as early as September. So, it's the manager's decision, does he increase stocking rate to harvest the additional forage or does he burn?

Look at what happens to animal demand if we burn one of the four pastures (Figure 3). TGM is showing us that we can burn one pasture and still have forage for grazing without reducing stocking rate for the total GMU. This data is from an actual forage year on the Texas A&M University Research Station at Sonora. By monitoring forage growth and animal demand adjustments can be made in animal numbers to balance forage supply with animal demand. TGM assumes a 25% harvest efficiency of the forage by domestic livestock. TGM is an effective tool to allow one to budget grass to either fuel or forage and quantify changes in range productivity.

Sustainable management of most rangelands requires repeated applications of prescribed fire as well as proper grazing management. Prescribed fire has the potential to be an effective low cost control method but it requires greater levels of expertise and management than other control methods. Long-term application of prescribed fire also requires more attention to proper grazing management. Grazing management required for an effective prescribed burning program will also be effective for improving range condition; however, an active monitoring program will have to be initiated to quantify responses of forage growth so that adjustments in management can be done in a timely manner to meet rancher goals and objectives.

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Table 1. A decision aid to help determine the status of a juniper problem for Texas rangelands.

Categories	1	2	3	4
Stocking Rate	Light	Moderate	Heavy	Extreme
Range Condition	Good/Excellent	Good/Fair	Fair/Poor	Poor
Juniper Age	Immature	Immature/Mature 75:25	Immature/Mature 50:50	Immature/Mature 25:75
Juniper Density	Low	Moderate	Heavy	Extreme
1-Hour Fine Fuel Load	Adequate	Marginal	Low	Inadequate
Success of Winter Burn	High	Moderate	Low May Require Mechanical Treatment Preburn	Very Low Requires Mechanical Treatment Preburn
Cost of Winter Burn	Low	Moderate	High	High
Success of Summer Burn	High	High	Moderate	Low
Cost of Summer Burn	Low	Low	Moderate	Moderate

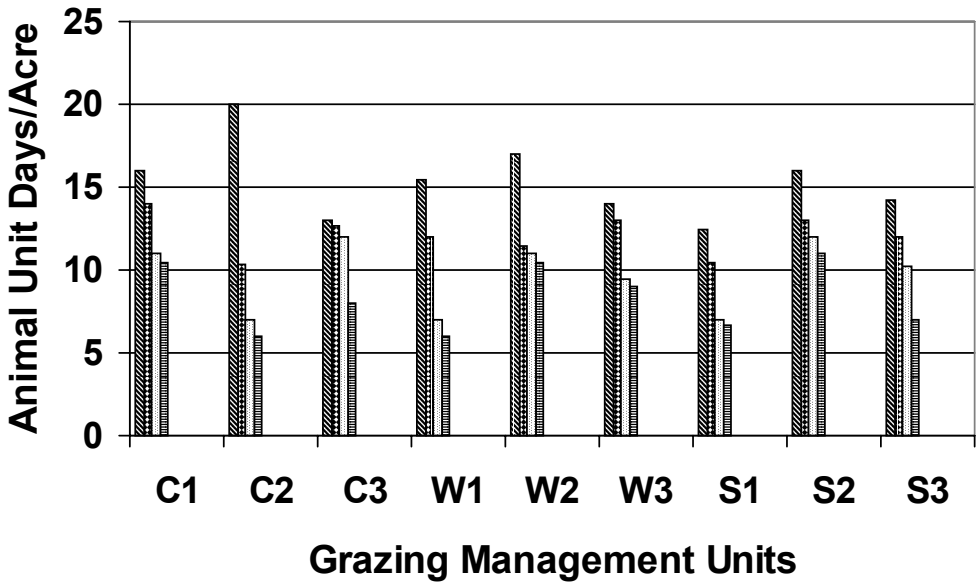

Figure 1. Average carrying capacity of pastures on the Texas A&M University Research Station prior to burning treatments. Determined from 3 years data by using The Grazing Manager Software. C=control pastures (no burn), W=winter burn pastures, and S=summer burn pastures. Four pastures represent one grazing management unit.

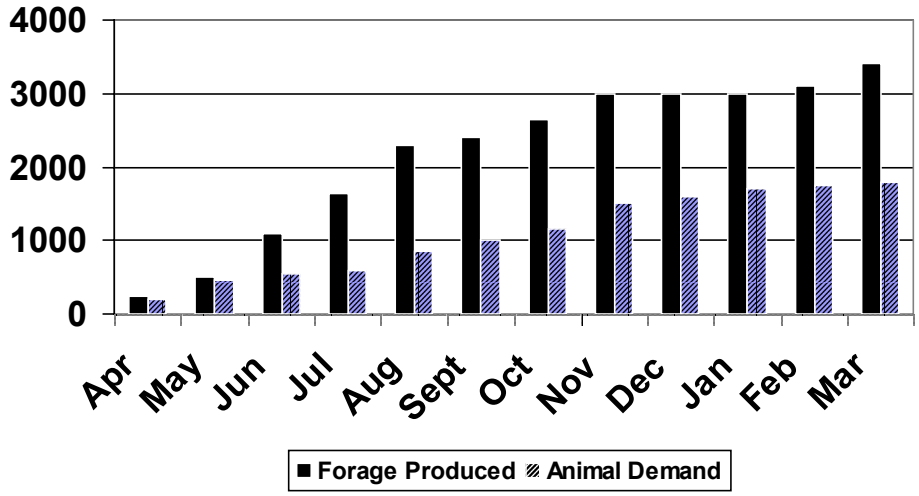

Figure 2. Cumulative forage produced and animal demand (expressed in animal unit days) for an actual forage year on the Texas A&M University Research Station at Sonora. Data represents an actual grazing management unit (GMU), which has four separate pastures.

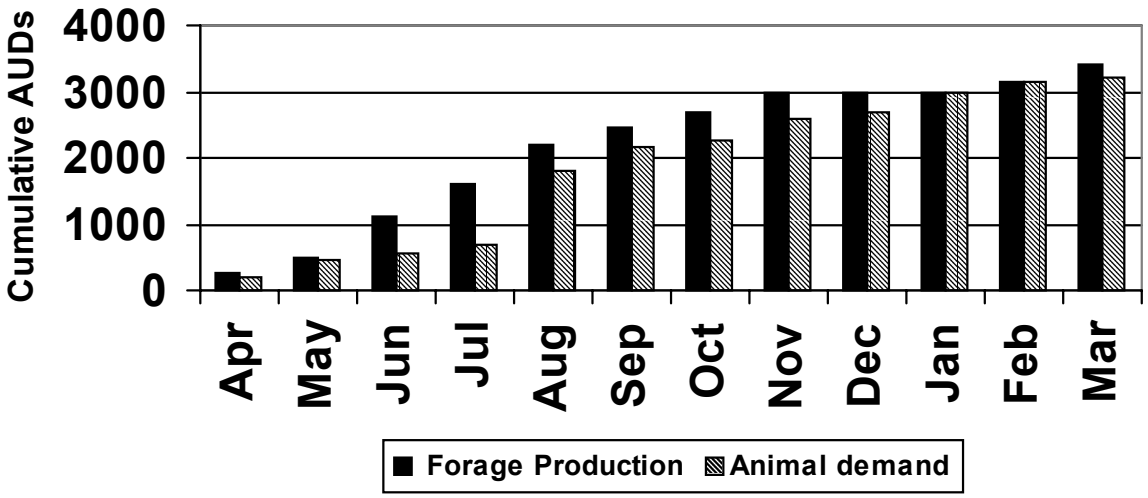

Figure 3. Cumulative forage produced and animal demand (expressed in animal unit days) for an actual forage year on the Texas A&M University Research Station at Sonora. Data represents an actual grazing management unit (GMU) in which one of the four pastures is burned.

STRATEGIC PLANNING: SELECTING THE "RIGHT" ENTERPRISE MIX

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Abstract: Some landowners seek to capitalize on under-used resources by diversifying their operations. One question must remain at the forefront: "*why am I doing this*?" Strategic Planning is a process that tells us: where we are, defines where we want to go, and tells us how we're going to get there. It is a tool for both enterprise selection, and evaluation. It is easy to talk about. Its concepts are not especially hard to grasp. But... *It is hard to do.* It takes discipline to sit down with paper, pen, and calculator.

-Why do ranchers ranch ? -

To get rich? To make a modest profit? To break-even? Even if true, these would rarely top a list of reasons people give for owning or operating a ranch. Most will admit, the reason they ranch is because they like it: they enjoy the lifestyle, or they are keeping a family heritage, and/or they want the opportunity to pass something on to their kids. There are certainly other reasons too, like land appreciation or speculation. Regardless of what motivates a person to ranch, at some level, income or even profit eventually surface as considerations. Why ? Because it costs money to own and operate a ranch. To pay the bills some ranchers use the land, its resources, and equity. Others may infuse off-ranch income or wealth, but this group probably still expects ranch resources to generate at least some of the needed cash-flow.

Therefore, an enterprise, or more typically a combination of enterprises, are necessary to accomplish this. Potential enterprises run the gamut from traditional livestock (cow-calf, stockers, seedstock, sheep, goats, etc.); to traditional wildlife (hunting - deer, quail, etc.); to various forms of "nature tourism" (birdwatching, rock hounding, trail riding, etc.). With so many "opportunities", the question quickly becomes, "**what should I do?"**. Other equally elusive questions quickly follow: "What do I want to do?" "What am I capable of doing?" "What must I do to survive?" "What is the risk of doing this.....or not doing this?"

STRATEGIC Planning, is a tool or systematic process that can help managers address these kinds of questions, evaluate what they've done, and hopefully keep sight of that most important goal of all: "I ranch because _____". In the business world, strategic planning is standard protocol. It can be equally useful in natural resource management. Its framework involves goal-setting on three distinct levels:

1) *Strategic goals* - i.e. Why do I ranch? Why do I have this enterprise or that enterprise ? In what condition do I want to leave my ranch estate ? etc.

2) *Tactical goals* - usually include performance benchmarks for specific enterprises. For example, percent kid crop is likely an important target for a meat goat enterprise; for a branded beef enterprise, the percentage of carcasses produced that meet a grid's specifications would be important; or buck:doe ratios and Boone and Crockett antler scores might be targets for a deer enterprise.

3) *Operational goals* - are things ranchers spend a lot of time on. They are just as important as the first two - but not more important. These are the daily or seasonal activities that keep things running and help realize tactical goals. For example, we trap predators to help get that kid or quail crop; we buy certain bulls, or keep breeding records to make sure we produce the kind of calves that fit a given market; we conduct a deer survey or age deer to make sure we have enough of the right kind of bucks (or does), then spend some time marketing that.

In short, Strategic Planning tells us: where we are, defines where we want to go, and tells us how we are going to get there. On all levels, goals should be "*SMART*"*:*

S = specific in spelling out what is to be accomplished, or why
M = measurable so that progress, or the lack of it, can be seen
A = attainable
R = related to other goals, but without undue conflict
T = trackable over time

Strategic planning can be used for both enterprise **selection**, and **evaluation**. It is simple to talk about. It's concepts are not especially hard to grasp. But... **It is hard to do.** It takes discipline to sit down with paper, pen, and calculator. First, write down and prioritize strategic goals. Second, determine what level of performance (often

defined by income) is required to get there. Third, inventory ranch resources under the categories of natural, financial, and human. Fourth, begin to examine potential enterprises that might fit those resources. When projecting income from each, be conservative - especially in the "start-up" years. Finally, have methods to evaluate, adjust and re-plan.

Sometimes diversification is easy. Enterprises naturally compliment each other with little or no competition. For example, deer hunting and cattle are typically presented as "non competitive" with regard to natural resources (range forage) since little dietary overlap occurs when their numbers are within carrying capacity. Things like water developments for livestock are even synergistic to a deer enterprise. Ultimately though, resources specific to individual situations dictate whether or not these are truly compatible enterprises on any given ranch. In the above example, requirements for other resources like labor and finance were ignored. Will labor be available for hunters? How much cash will be required for things like hunting lodges, advertising, electricity to a primitive camp, etc.?

Probably the most practical way to manage these and other unforseen conflicts (especially with multiple enterprises) is to keep a production calendar for each enterprise. Each month, write down what the main activities are going to be. Will the month of April have birdwatchers sharing a camp house with turkey hunters ? A production calendar is also a good place to record both income and expenses each month. This can be used to evaluate cash flow **by enterprise**, and to perform yearly economic analysis regarding the performance of **each enterprise**.

Often, one of the biggest failings of "diversification" is that enterprise analysis is not properly or objectively done. There must be a commitment to accounting procedures that are pre-designed and then correctly implemented (the production calendar can help here too). For example, labor is a big expense on a lot of ranches, but how do you fairly charge labor across 2 or more enterprises? Probably the simplest method is to divide salary(s) by the amount of time spent on major activities. If a ranch hand spends most of his time on cattle, then his salary is regularly charged against that enterprise. If he spends significant time elsewhere, for example, preparing for and then guiding trail riders for 7 days, then his salary for that time is charged to the trail riding enterprise. If he spends a month laying a new water pipeline, and there is a mule deer enterprise, 15 day's of labor is charged to the mule deer enterprise. In addition, the cost of machinery and materials for that pipeline should be fairly charged across all of the enterprises that benefit. Fixed costs like taxes or land payments should also be allocated likewise.

In summary, diversification is necessary to pay all (or perhaps just some) of the bills on a lot of ranches today. This allows ranch ownership and/or other strategic goals to be realized. The challenge is to select those enterprises that work, vs. enterprises that just make work, and/or end up costing money. As lamented below, "*the 'devil' is usually in the details*".

TEMPTATION AND DECEIT

by: Darin Brookman
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Now, at first there was only grass and cows. He went a horseback ever' day.
He got along on what they made, with time left over to loaf and play.

But then one fateful summer's morn, his life would soon be changed forever.
The devil showed up at his house disguised as an aged farrier.

He slyly looked the cowboy up and down, from his hat to his fancy boots.
Said,"It's a shame to have so many horses, all runnin' around barefoot."

"I'm compelled to show ya this little trick known only to me and God."
Then he fired his forge, hammered out some shoes, and soon the cowboy's mounts were shod.

The cowboy, he was amazed and impressed. Ole Satan played him for the fool.
And when he drove off, he'd sold that cowboy his forge and horse shoein' tools.

He was told to trim 'em ever' six weeks. But found that kind of hard to do.
'Cause ever' time he went to catch a horse he had to re-set all four shoes.

So a few months later, when the Devil happened back by the cowboy's place.
He found him running 'tween the forge 'n anvil - sweat a-pourin' off his face.

The Devil said, "I see that you've more time than what it takes to tend yer cows.
If you'll allow, I'll show ya one more trick - I'll teach you how to make a plow."

The naive cowboy he watched mystified, as a plowshare Ole Scratch did beat.
Then when finished, with a beguiling glance said, "Now go sow yourself some wheat."

The cowboy, he got 'er all plowed and sowed after many long and hard days.
Then thought, that really weren't so steep a price, to have my cows some winter graze.

But then that spring, the wheat all headed out. Turned to a golden amber brown.
And the Devil, he showed up again, as the implement dealer from town.

With an evil smile said, "yer new wheat crop is sure lookin' extra fine.
This time drove off, after sellin' our boy an old and wore out combine.

After a lengthy, troublesome harvest, he completed the job at hand.
Then noticed his calves all looked plumb naked. Because he'd had no time to brand.

As he prepared to plow his stubble, he realized he may have been a sap.
Then the tempter paid him one more visit. Wearin' a seed comp'ny cap.

Looked the combine and the cowboy over thru his two little beady eyes.
Said, "by yer looks I can see yer an old hand that's tryin' to diversify."

"But if you really want to get on top. Have ever'thing goin' yer way.
You ought to consider plantin' yerself a few little patches of hay."

He then expounded on the virtues of havin' plenty of winter feed.
And proceeded to sell his victim a ton of weedy alfalfa seed.

So the poor fool plowed and sowed. Worked the soil. Behind got further and further.
The implement dealer showed up again. Sold him a baler and swather.

"Oh how could I ever 'a stooped to this. He woefully contemplated.
His good horses'd all grown fat 'n lazy. His corrals delapidated.

He had little time for anything else. Cept to patch his old machinery.
He had to haul hay and plow, grease and weld. The end was nowhere he could see.

His stomach became quite ulcerated. He begin havin' nervous fits.
But when he finally considered stoppin'. He was in way too deep to quit.

So he just roamed around in a stupor. Grease caked under his fingernails.
Went to bed each fitful and sleepless night, amid a putrid diesel smell.

From afar, Scratch watched in satisfaction. This wretched soul he'd tricked to farm.
Then paid the cowboy one final visit. Out there behind the old horse barn.

The swather lay in pieces. The combine's sickle was wrapped around it's reel.
From the baer's throat stuck a bois d'arc post. The tractor's tire run off its wheel.

The cowboy's laying in a pool of oil. Tryin' to fix a hydraulic leak.
Lucifer noted his evil mission was now very near complete.

The Devil grabbed his hand and helped him up. Slapped the cowboy's grimy back.
The cowboy grabbed a bottle from his poke. Took him a handful of Zantac.

Beezlebub said, "My friend yer almost there. Fame and fortune for you await.
Yer outfit needs one minor adjustment to permanently seal yer fate.

The poor cowboy could only stare at him. Now just a blank and mindless soul.
As Lucifer eagerly poised himself for the final and fatal blow.

Satan then planted in the cowboy's head. An idea so vile and rotten.
Said, "All you need to get over that bump - Is some irrigated cotton !"

COMMERCIAL HUNTING OPERATIONS FROM A TO Z

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Abstract: I have often said that the hunting business is like no other business. However, there are some basic business principles that apply to this type of enterprise, though few people who get into this business actually apply these fundamental conceptual parameters. Developing and maintaining a successful hunting enterprise can be broken down into three components. A sound business concept is a safeguard against heading the wrong direction out of the starting blocks, which is a sure way of short-circuiting your venture before it has a strong chance to make it. Adequate financing is necessary if a sound business concept is going to have the necessary strength to last through various stages of implementation and growth. Implementation is the mechanical and often laborious process that is necessary to put one's thoughts into action in the appropriate manner to ensure production and yield. Failure to adequately satisfy all three of these business components would likely have a negative impact on the business venture.

Introduction

The hunting business can often be a peculiar and challenging way to make a living. Unlike most other service or consumer type of businesses, each person who pays money to attend an outfitted hunt has a slightly to greatly different vision of what they paid for. Catering to these individuals and varying expectations requires an "on your toes" approach to ensure optimal satisfaction for each client. To complicate things even more, there are variables that the operator has little or no control over. Elements such as weather conditions, finicky game movement, hunter capabilities, hunter attitudes, chemistry between hunters and between hunters and staff, and even bad luck, can all have a strong influence on the outcome of the hunt and the perception of the client.

Despite the notion that the hunting business is indeed a peculiar and sometimes strange business, there are basic business principles that apply. Due to the nature of the hunting business being perceived as a recreational event, this industry does have a tendency to attract entrepreneurs who typically disregard the fact that there are indeed certain business principles that apply, and many of these operators conduct themselves in a less than professional and business-like fashion.

I identify three important and necessary components that apply to developing a successful hunting enterprise, and each one of these would likely apply to most businesses, regardless of the industry involved. As a matter of fact, I suspect that the inability to adequately satisfy any of these three business components would have some adverse impact on the venture. These three components are "concept," "financing," and "implementation," and the remainder of this paper will address how each of these relates to the hunting business.

Business Concept

The conceptual plan of a hunting business allows the operator/owner an opportunity to construct their business operation in an objective, organized, and efficient manner. This pre-initiation stage is an excellent opportunity to organize your thoughts and "get your ducks in a row". Here are some considerations regarding this conceptual stage of the process.

Research- Learning from other people's mistakes is a great way to avoid repeating the same. Though many operators may be reluctant to share proprietary information, there is indeed information that can be accumulated by asking questions, reading, surfing the net, and simply paying attention to related industry activities.

Know Your Product- This may not be quite as easy as it seems. Having an intimate and detailed understanding of what services and amenities you are providing, not to mention harvest allowances, restrictions, etc., are all important in not only promoting your wares, but delivering them as well.

Written Business Plan- A written and detailed business plan will provide you with a practical resource tool during your implementation stage. This may also be necessary if you seek financial assistance through a lending institution. In addition to operational procedures, this plan should also include projected budgets and cash flow estimates so that you, and perhaps your financier, can plan accordingly.

Be Realistic- There is a tendency for many entrepreneurs to be a bit unrealistic or over-zealous when it comes to their anticipated progress. Set your goals on the conservative side so that your enthusiasm is not squelched should business performance be somewhat

slow, especially on the front end. You should not only be realistic with yourself, but with others as well, so that your honesty and integrity is perceived well by them.

Financing

Let's face it, goodwill and good intent will only get you so far in the business world. The hunting business does require operational expenses, and quite often, requires sizeable investments in terms of capital costs for equipment and facilities. If you are leasing your land to operate your hunts, you can spend large sums of money quickly, and those lease fees are there every year, regardless of your performance. Adequate financing, not only to get you started, but to carry you through the tough times, is absolutely necessary if you are going to be successful. There are various financing options to consider.

Self Funding- Those individuals who are already in a positive cash position may simply choose to rely on their own capabilities. However, there are individuals who may indeed possess the financial means of operating, but are a bit reluctant to drain their capital reserves, and consequently they may likely secure financial assistance elsewhere.

Lending Institution- This option is generally in the form of a banking institution. Loans to small business ventures are relatively common in this arena. The disadvantage perceived by some would be the banking demands of collateral requirements, business plans and similar performance projections, and of course the interest costs associated with the loan pay back.

Investor/Partner- This option has been around since the beginning of proprietorship. It generally involves an individual who has the technical skills and knowledge of a particular trade or field but lacks capital and/or the business savvy necessary to initiate and carry out the process. There are probably not quite as many venture capitalists out there today as there were a few years ago, but in the hunting business the likely investor/partner is often a friend or relative. The downside to this financial option is that you will likely have someone "meddlin'" and engaged in your business activities. Many partnerships are destined for problems simply because of the inability for multiple individuals to mutually work or operate together.

Implementation

Implementation of one's business ideas and plans is truly the "nuts and bolts" aspect of creating a successful business. There are various aspects that apply to implementing a business plan, and for the sake of this paper, I have broken this stage of a start-up hunting business into multiple categories in "marketing," "prehunt," "hunt," and "post hunt."

Marketing- Marketing one's wares and services is an absolutely critical part of a start-up business. There are indeed some fundamental marketing principles that apply to the hunting business such as market segmentation and target marketing. Fortunately, in a sense, there are a number of established marketing outlets or mediums that allow a hunting operator to reach various market audiences. Magazines, internet, trade or exhibit shows, direct mail, television shows, and booking agents are all advertising options that can yield possible results in booking hunts. Advertising costs can quickly add up, so do your research to make sure that excessive costs are minimized.

Prehunt- The prehunt stage of preparing for your hunting clients is a critical time which gives you an opportunity to sort out details and prepare your people and your resources in a fashion that will ultimately have major influence on the outcome of your hunting services.

1. Facilities- Facilities are an integral part of conducting a package hunting program, especially as it relates to housing. Nice, well-appointed lodges are a plus but are not always an option, and basic ranch cabins are typically the norm. Regardless of the style of facility you use, it should always be clean and well maintained. Motel options can occasionally be a workable alternative if no housing exists on the premises but should be considered a last resort, as these hunts can be more difficult to market, and do not generally offer the kind of well-rounded experience most hunting clients seek.

2. Equipment - Various kinds of equipment are generally a necessary component of a hunting operation. Capital investments on these items can often be sizeable and financial budgeting should allow for this. Some common equipment items include hunting blinds, feeders, vehicles, ATV's, dog kennels and supplies, office equipment, and even personal field equipment such as binoculars, spotting scopes, and cameras.

3. Familiarity with hunting area- It is imperative that guides become familiar with the area they are guiding and the animals they are hunting. This will build the client's confidence in the guide and will likely minimize embarrassing possibilities of perception from client that the guide is ill-prepared.

4. Camp staff training - This is often lacking with many hunting operations but is an important consideration in maximizing performance from your support staff. Training through printed materials and through active

means should include operational procedures, company staff policies, and first aid concerns. Having a staff that is adequately prepared will reflect well on your operation and will enhance the service you provide.

5. Client preparation - A well prepared client will help ensure that there are no unexpected surprises and can minimize the risk of glitches and last minute inconveniences. This should be accomplished orally and by written materials that spell out dates, prices, inclusions, exclusions, what they need to bring, normal weather conditions, and various other pertinent matters. Some of this information should definitely be covered in a contractual form.

Hunt - This phase of the program is the culmination of all your efforts leading up to your client's arrival and is naturally a major stage of the process. Once again, the "Hunt" stage of the business has several components that should be taken into consideration.

1. Transportation - Package hunting programs often cater to clients who are traveling great distances to reach your destinations. Simple logistics such as getting these clients from the nearest airport to your facility can be a bit more challenging than it seems. If you choose to provide these services, you should plan for possible flight delays/cancellations, baggage problems, and the possibility of clients arriving at various times of the day. Should clients be driving to your facility, detailed maps are a must, and it is well advised that you provide specific instructions on arrival time. Otherwise you may likely have clients arriving much earlier than you anticipated.

2. Orientation - Shortly after all hunters arrive at your camp, prior to when they begin hunting, a hunters' orientation is a good way to get the hunt started in the right direction. This will not only allow you to immediately show your clients that the hunt will have order and structure, but it also allows you to go over camp rules, safety policies, and your game plan for the next few days.

3. Guides - A package hunting program relies heavily on guides. It goes without saying that hunting skill levels are important for a hunting guide to provide quality field service, but equally important, a well-rounded hunting guide should possess good people skills as well. Dependability, positive attitude, and enthusiasm are also traits to look for when selecting your guides. Those guides who are willing and capable of working effectively as team players will help ensure healthy chemistry among your guiding staff.

4. Cooks/Groceries - Finding good camp cooks is often more difficult than finding good guides. This is an important feature of any hunting camp, and if the hunting happens to be a bit on the slow side, good tasty food and a hospitable host in the kitchen will help soften the impact. Gourmet food is not necessary in satisfying most hunters' tastes, but it is absolutely critical that there is plenty to eat. If you try to cut many corners when it comes to meals, it will be evident and not perceived well from your clients.

5. Game care - This aspect of providing a well-rounded hunting service is often lacking in many camps these days. This can be a major consideration and can add up to be a great deal of work. Proper meat care is a must, and the ability to properly care for capes and skins for taxidermy purposes is critical as well. Additionally, this aspect of your service package should also take into consideration documentation requirements to ensure compliance with state and federal laws.

6. Procedural format - As mentioned earlier, it is important for the mechanics of the hunt to flow well and have organization. Though you do not want the camp to appear as though it is being run as a boot camp, it will be apparent and appreciated by your clients if your staff is working together under a routine format. There should be daily routines, such as meal schedules and skinning shed duties that are consistent and automatic. Many other small details and activities that make up to the hunt's process should be well thought out and anticipated.

7. Promotional photography - This is yet another area that is lacking with many hunting operations. Quality, tasteful harvest photos are valuable visual aids in promoting a hunting operation. A good 35MM camera is a wise investment and will pay dividends. There are indeed strategic techniques in obtaining high quality harvest photos and one should become familiar with some of these basic photography skills.

Post Hunt - As they say, "it's not over until it's over." Post hunt details will allow the operator to close out the hunt in good order and provide a complete service package, which may make the difference in retaining your client's business in the future.

1. Clean-up - This dreaded aspect of wrapping up a hunt is not very glamorous but it is essential. If your property happens to be leased property, leaving the camp area in clean and well-maintained condition may go a long way in appeasing your landlord.

2. Shipment of meat/trophies - Once again, this is a "thankless" duty, but is often required. I discourage you from offering to ship meat because of meat storage complications, documentation requirements, and the possibility of lost/delayed shipments which can lead to

meat spoilage. We either require that our hunters take their meat back with them or donate it with proper donation documentation.

Regardless of how much you discourage it, you will likely have to ship capes/antlers to a client's home or taxidermist from time to time. Proper crating and boxing of capes and antlers is a must in avoiding potential damage to these items. This all takes time and effort, and it is important that clients understand that they will be charged accordingly so that they don't perceive these cost as hidden costs.

3. Follow-up - It is good business to contact your hunters shortly after their hunt as a follow-up gesture. This will show a sense of concern on your part and will allow you to not only get some feedback on how they felt their hunt went, but will also allow you to get a feel for whether they may be interested in re-booking. The ability to retain their business through re-booking is often enhanced if you can receive a commitment shortly after their hunt.

Conclusion

The hunting business if full of unique challenges and weird nuances that are inherent to this profession. There are, however, many fundamental business principles that apply to the hunting business. Using a serious, professional approach in developing and running a hunting operation is a big step in the right direction. Pay attention to what other successful hunting operators are doing, learning from their mistakes and successes, and rely on time-tested practices to minimize your risk of mistakes and miscalculations. You must also be cognizant that the hunting business is very much a customer service oriented business. Creating an objective, detailed customer service package will be appreciated by your customers and will enhance client retention.

NON-CONSUMPTIVE WILDLIFE RELATED RECREATION PLANNING FOR TEXAS RANCHES

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Your ranch can generate non-consumptive wildlife related incomes far beyond the usual wildlife watching fees. With careful planning, you can create a program valuable enough to bring in a significant amount of money, even during hard times and drought. The first step is to assess your goals and needs, so you can develop a plan that will make money and positively affect your ranching environment. Once you've thought through the impacts of allowing access to others, you'll have some important decisions to make.

If you plan to sell access to your ranch, you will want to make sure that it is still a ranch after you have done so. What does your ranch mean to you? Why are you motivated to operate it? When you can pin down your answer to these questions you'll be better prepared to develop an access plan, preserve the ranch, and add value to the recreational experience.

People will pay money for access to private properties in Texas, and their access fees can help support your land management costs and supplement production incomes. Non-consumptive wildlife recreation goes way beyond birding and wildlife watching. The possibilities may surprise you.

Non-consumptive recreational income can be substantial enough to reduce the economic pressure to maximize production. When times are hard, ranch conditions suffer; maintenance costs are deferred, brush increases, and improvements wear out. Typical access fees don't bring in enough money to cover the shortfall, especially if the visitors are few enough not to take over your ranching environment.

I believe we can create more valuable programs so that they will generate more income without involving too many visitors. It's up to you to decide how much recreational development is appropriate on your land, and how much to limit access. If your recreational development plan is attractive enough to the right clients, they will pay enough money to make it worth your while.

In times of drought, recreational business can save the day. If you have enough supplemental income, you can reduce production in time to save grass and keep your ranch in an attractive state. Your clients will prefer a healthy range, and the fees they pay will help you reduce grazing pressure. More conservative stocking will also support wildlife, and lessen the chance of dietary competition with cattle during a drought. In this way, recreational business becomes an important range management tool.

You ranch for a variety of satisfying reasons, and people will pay to share your experience. Think about our motivations to operate a ranch. We enjoy learning about the land and caring for it. We want to preserve the wealth of knowledge and information accrued in our ranches. We love our land, both for its real and economic value, and for the intangible wealth this lifestyle affords. We care to sustain the ranch, even when we're not making as much money as we could by investing in something else. We know that agricultural operations perform the ecological management to protect the environment. We do these things through love, interest, challenge, cultural participation, and other non-economic reasons. Generally speaking, we don't make much money at it. Right now, Texas agriculture is self-funding, but it's at risk of becoming unsustainable unless we find a way to bring in additional income.

People who live and work on ranches share a lot of these experiences and challenges with the landowners. That's why when I speak of ranchers and ranches, I mean the whole culture: the cowboys, managers, and owners as a group. When we make plans to sell access to our properties, we should also consider the impacts on others who work there. If we overdo it, the traffic on the ranch can really change the environment.

This is a lot like the old "production versus range health" controversies. If we overuse the ranges, we reduce their health; if we overdo tourism, we may undo the ranch. That's why a careful plan is so important. Instead of allowing a lot of tourists on your land, you can choose a small but high-paying clientele-people who, like you, value the ranch for what it is and want to preserve and appreciate it. You'll attract people who don't have the resources or know-how to run their own ranches, but who have an interest for ranching and want to learn.

Texas is unique, and Texas ranching is the complex integrated environmental management of private property. Access to these properties is unique, and knowledge of all that is going on here is rare. When you look at it that way, we have something to sell that is very valuable.

You can create an experience much more valuable than conventional day-access wildlife watching. When you do, people will be willing to pay unconventionally high fees. Instead of merely granting access to tourists, you can target responsible clients and spend time teaching them about the ranch, so that they will feel more like partners. Show them what it's really all about. Teach them to understand the ranch and wildlife management systems, and the good stewardship practices you already have in place. This will be very different from just granting them access to the ranch's amenities.

For example, what if your client is interested in mule deer? Typical access fees only buy him some time on your land and a chance to sight the deer. Instead, you can teach your client when to look for mule deer, where to look, and why they are found in certain locations. This more complete experience will be much more valuable to him.

The management of the ranch is complex and interesting, as is the management of the mule deer herd. The ranch management plan harmonizes with the wildlife management plan, and both plans support the deer habitat. Mule deer predators are interesting, too, and so is your predator management plan. Once your client learns about all this, he'll want to come back and find out how the herd is doing. In fact, he may love it as much as you do. Soon, when he's able to guide himself through the process, he'll start bringing other guests.

Ranchers are busy. You don't have time to lead every recreational guest through the “ins and outs” of ranch management. Instead, invest your time in a core group of carefully selected clients. Use the management tools and maps described in earlier presentations to educate these key clients; once they know their way around the land and the management processes, they'll enjoy hosting other customers and bring in repeat business.

The more people learn about ranch management, the longer we can preserve this way of life. Too often, the knowledge and management plans for a particular ranch are lost when the rancher dies or moves on. Put your plans in writing, get people interested, and keep your ranch alive.

Here are some things to consider while planning a non-consumptive recreational program for your ranch:

How much money will you need to maintain your operation? Assess your cash flow needs, then formulate goals for your recreational income plan.

Develop good maps of your ranch. Different maps can be configured for different purposes. Recreational maps can depict wildlife zones, routes to drive and hike, Indian camps, historical points such as homestead ruins, and other amenities. Management maps can depict watering locations, range sites, soil types, range trend monitoring sites, water distribution systems, buildings, and corrals. Government and private services are available to assist you with this effort. Get to know your county agent and the resources of the Extension Service.

Write a description of your grass production cycle, from first frost through the growing season and back again to the season of dormancy. Write up your range utilization plans following the same cycle, and include the livestock and wildlife production cycles. Be able to describe how all the cycles relate to each other.

Write a description of your management activities that follow the animal and range production cycles. For example, describe activities that accomplish your fall roundup, marketing, winter management, calving, spring works, summer grazing management, and back again to the fall season.

Write up your wildlife management plans, including habitat conservation and enhancement, water provision, census methods, and harvest data. Include the inventory of types of wildlife, viewing locations, observation routes, and best times of day for each opportunity.

Establish rules of conduct and access procedures for your clients, and explain the reasons as necessary. For example, you may want to restrict vehicles to certain roads, hikers to specified routes, and times of travel to reduce disturbances to wildlife and livestock.

Plan additional activities, such as GPS navigation to specified sites, recording of sightings, shooting opportunities, and special vistas. Observation of various management activities such as branding, a deer census, and habitat improvement projects may be of a special interest to clients.

Develop guest lodgings if you want clients to be able to stay at the ranch. Clients may wish to build a lodge, and there are ways to contract for leasehold improvements. Some improvements such as pole sheds can be inexpensive, and can make the visitors' experience more comfortable. Also, assess hotel and other lodging opportunities in your region, and provide prospective clients with a list.

The Texas Department of Agriculture is working on plans to advertise the advantages of visits to rural towns. Access to the environments around these towns will greatly increase the attraction. The towns and the local ranches can be mutually supportive.

Local airports and ranch airstrips are very important. The remoteness of your ranch is a great attraction for urban visitors, but the distance and travel time to it are not. Accessibility by air adds immense value to remote areas. Research potential clients' home airports for charter services they may not have discovered. Air taxi services are not always as expensive as presumed to be. Charters make it possible for clients to come for short visits outside their usual vacation schedules.

Consult with an attorney and your insurer to create access contracts, hold-harmless agreements, and adequate insurance.

Here are a few other suggestions for planning:

1. Your hunters may like to visit the ranch outside the usual hunting seasons. They are a great source of off-season revenue, and are already familiar with the ranch. They have a vested interest in the health of the wildlife populations, and may enjoy showing them to friends.

2. Range improvements such as chiseling can be partly financed with arrowhead hunting opportunities. Establish rules for cataloging and photographing the finds, but require that they be left in the field. This policy is non-consumptive, will preserve the artifacts, and will also help you to gain further information about your resources.

3. Orienteering is a sport that is gaining in popularity, and GPS units are inexpensive and fun to use. Navigating to a viewing site can be as much fun for clients as being there, and good maps can make this easy.

4. It can be fun for clients to find food sources, water, and other factors relevant to wildlife locations by GPS.

5. Share copies of your management plans and certain maps with key clients. Use the maps to chart project and management plans. They will increase the client's knowledge of your ranch very quickly, and enable him to host others. Help him "name it and claim it," and he'll feel like he owns it. With the right client, you're not giving up privacy-you're gaining a paying partner.

6. If you don't want to guide groups, consider using your plans and information to train someone else to do so and share in the fees.

7. Seek resources to find potential clients. Hunting clubs, hunting guides, chambers of commerce, Texas Parks and Wildlife Department, gun shops, birding clubs, hotels, resorts, and other sources can provide prospects. Form an alliance with existing recreational groups so that your ranch will be one of their destinations.

8. Corporations may want to use your ranch for entertaining or meeting with their own clients and employees. Business entertainment adds value to their business relationships. This enhances the value of the plan you offer.

Interview your prospective clients very carefully, and develop a good sense of the type of guest you wish to host. Those who have an interest in learning about ranching and resource management will be good partners. Spend time making them feel welcome and informed, and equip them to help develop your recreational business. Prioritize those who can create their own "value added" experience by hosting their own guests. These values can be either economic, as in business entertainments, or relational, as in family trips. Select prospects who will respect and follow the rules you mutually establish, and let them bring others with whom they want to share "their ranch." Give them a sense of belonging, and they will love it as much as you do.

There are many Texans out there who will be very happy to learn that the real Texas is still alive, and that it is possible to share in it.

ROCKER b RANCH: A CASE STUDY

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The Rocker b Ranch, perhaps, may not be as well known as other large Texas ranches; however, it has a rich history that has left a mark on the lives of many people, especially those who have been patients of Texas Scottish Rite Hospital for Children in Dallas, Texas. The Rocker b Ranch straddles the Irion-Reagan county line and sprawls across 173,000 acres of gently rolling mesquite and cactus prairie with both the Middle Concho River and Centrailia Draw crossing its north side.

Originally part of the Bexar District, the Rocker b Ranch, formerly known as the Bar-S Ranch, was assembled by the Sawyer Cattle Company during the 39-year period 1871 to 1910.

The Sawyer Cattle Company owned the ranch until 1954, when it was sold to U.S. Senator and Dallas businessman, William A. Blakley. Senator Blakley changed the name of the ranch to the Rocker b and operated it until May 1964, when he deeded it as a gift to Texas Scottish Rite Hospital for Children. The Hospital has owned and operated the Rocker b as a working ranch ever since.

There have been many changes in management practices over the 132 years the ranch has been in existence. These changes have affected the history of the ranch's surface operations, which, in turn, has affected the ranch's current management practices. However, one common thread has remained throughout the history of the ranch, which has enabled it to survive; it has always been blessed with abundant natural resources, both above and below the ground.

During the second half of the 1800's, cattle grazed open range over the region which includes the current-day Rocker b Ranch. There was essentially no brush, and the Concho River and draws feeding into it held standing spring water. Huge herds of pronghorn antelope roamed the entire region. Cattle were gathered once a year and the yearlings were driven either on the Chisholm Trail to Kansas or the Goodnight-Loving Trail to New Mexico and Colorado. Then, in the late 1800's, came barbed-wire fences. The first fence establishing the Bar-S Ranch's boundaries was constructed in 1884.

During the late 1800's and early 1900's, cattle grazed openly on the ranch and were confined only by the perimeter fences. Few other management changes were implemented during this period. The ranch was relatively free of brush, with only small amounts being found around the draws and river. Water was still furnished by springs and standing pools in the river country and, except for deer, wildlife was abundant. Cattle were gathered once a year, and those to be sold were driven to the Barnhart rail some 10 to 12 miles away. The cattle were then shipped by rail to Fort Worth and sold.

In the 20's, 30's and 40's, the Bar-S Ranch ran a cattle herd averaging between 3,000 and 4,000 cows. Sheep were introduced to the ranch as a new enterprise in the 40's. The ranch was cross-fenced in the late 40's into 20 pastures and water wells were beginning to be drilled. Large herds of pronghorn antelope continued to roam the prairie of the Bar-S. There was sparse brush on the ranch and the draws and the river still held standing spring water.

In the mid-1950's, a severe drought hit the ranch and the cattle and sheep were sold off. During the 1950's the ranch constructed numerous cross-fences and drilled several water wells. During this period of time more brush invaded the ranch and many of the spring-fed watering holes were lost. When the screw-worms were eradicated from the ranch in the late 50's and early 60's, white-tailed deer appeared on the ranch for the first time.

In the 1960's, range conditions improved and the cow herd was built back to around 2,500 cows and the sheep herd grew to approximately 10,000 ewes. Livestock was being trucked to market in San Angelo and the last herd of sheep was sold in 1969. Dense mesquite thickets began to cover the draws and the Concho River country, and wildlife began to be a problem. An overpopulation of deer and pronghorn competed with the livestock for grazing. In 1965 the ranch hosted its first hunt to reduce the pronghorn population.

In 1977, the ranch held its first white-tailed deer hunt after a Texas Parks and Wildlife Department census indicated the Rocker b had approximately 2,900 bucks, 6,100 does and 5,900 fawns. The ranch also had approximately 1,300 pronghorn, according to the count. Amazingly, the ranch was also running 3,000 cows at this time. It was during the late 1970's the ranch realized it had a new cash enterprise - hunting.

In the 1980's, the deer and pronghorn populations remained strong, and the cowboys considered the annual hunts "unavoidable nuisances" that were simply required to supplement the ranch's livestock income. All hunts were non-guided pasture hunts with no lodging or meals being furnished. Rocker b hunting was beginning to be talked about and interest continued to grow.

Drought conditions hit the ranch again in the late 1980's and continued through the 90's. Cattle numbers were reduced and wildlife populations declined. Hunts were only held a couple of times in the 90's; however, the demand for Rocker b hunts was greater than ever.

In the late 90's and early 2000's, drought conditions persisted. The cattle herd was reduced to a small base herd and the wildlife numbers also continued to decline. At this point, the Hospital's board determined it was time to take a hard look at what could be done to make the surface operations financially viable by utilizing all available resources.

The Hospital's approach was to determine goals for the ranch and develop a strategic formal written plan outlining how to meet those goals. The surface operations were evaluated and all available enterprises were identified. The enterprises were as follows:

- Livestock
- Wildlife
- Eco-tourism
- Other surface resources, such as groundwater

Each enterprise was evaluated independently with help from key resource personnel at the Extension Service, Texas Parks and Wildlife Department and various Farm Service Agencies.

New management practices for each enterprise were identified and implemented. Some of the new management practices are as follows:

Livestock

- Use existing cross-fences for rotational grazing to improve range conditions for both livestock and wildlife.
- Move the cattle herd toward one with more English influence.
- Test bulls for breeding soundness and use Expected Progeny Differences (EPD) to establish genetic makeup of cattle herd.
- Precondition the calves and market them directly off the ranch.
- Run stocker calves on winter and early-spring forage, if it is available.
- Establish a comprehensive herd health program and maintain strict records.
- Obtain carcass performance data on calves through the Texas A & M Ranch-to-Rail program or other sources.
- Attend workshops, seminars and other livestock related educational opportunities.

Wildlife

- Apply for and maintain Managed Land Permits to extend the white-tailed deer hunting season.
- Split the Ranch into different game management units to utilize the higher density areas for guided hunts and lower density areas for semi-guided and pasture leases.
- Develop various classes of lodging facilities for overnight guests, both hunting and non-hunting.
- Construct "free movement" corridors across the ranch to help increase foraging opportunities for the pronghorn.
- Increase marketing efforts for quail hunts.
- Develop new hunts such as predator hunts.
- Train ranch employees and guides in first-aid, CPR and hunter safety.

Eco-tourism

1) Market the Ranch as a vacation or retreat destination.

Other Surface Resources

1) Secure a professional underground water study to determine reserves and future potential.

Lessons learned from new management practices

1) Non-guided pasture hunts: Although these hunts require less work, there is a high risk of losing some good animals because the hunters are difficult to monitor.

2) Job-specific employees: All new employees understand that they will be involved with the management of livestock, hunting, eco-tourism and all other surface enterprises.

Where the Rocker b Ranch is headed in the future

- All ranch employees will work and participate in each of the enterprises.
- The ranch will continue to strive to utilize and optimize all of its natural resources, while being good stewards of the land.

STASNEY'S COOK RANCH: A CASE STUDY

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Abstract: Stasney's Cook Ranch is operated on the principle of good stewardship of our land and resources. Our goal is to maintain a viable, sustainable and profitable business that will enhance our community, generate tourism income for our county, and create jobs. The ranch's nature tourism business developed as a result of evaluating the resources available and recognizing a family interest in the property, including the wildlife habitat and animals dwelling there. We also recognized that we possessed a significant historical resource. With the personnel already involved with the ranch we were able to successfully add nature tourism to the existing mix of enterprises which included viable hunting and ranching operations. The ranch has progressed in recent years from: having no hunting business; to season hunting; then to the addition of year round nature retreats for individuals, couples, and groups of up to 40; and finally to hosting special events.