Challenges and Opportunities for Sustainable Rangeland Pastoral Systems in the Edwards Plateau of Texas

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Challenges and opportunities for sustainable rangeland pastoral systems in the Edwards Plateau of Texas

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Abstract

This paper focuses on pastoral systems in an area of west-central Texas known as the Edwards Plateau. These rangelands have a combination of grass, forb and browse species and are used primarily for combinations of grazing by cattle, sheep, goats and wildlife. A major ecological challenge is woody plant encroachment. Stocking rate is the major factor affecting sustainability and historically this area was heavily grazed. Today the stocking rate is half or less of its historical peak. Species of livestock has shifted from predominantly small ruminant to cattle. About 70 % of pastoralists use some sort of rotational grazing system. On average ranches lose equity from livestock but appreciating land values make up for this loss. Rangelands are still a good investment for those that can afford them. Land ownership is changing and is creating land fragmentation problems and a need for targeted educational provision.

Keywords: economic, livestock, wildlife, grazing management

Introduction

This paper provides a brief description and history of an area in west-central Texas known as the Edwards Plateau. Our objective is to describe past and current conditions in order to provide recommendations for a sustainable future. As part of this effort, we will describe the principles of grazing management that are the basis for sustainable use of this resource area and the economic principles that influence management decisions of pastoralists. The focus will exceed the narrow definition of pastoral, i.e., devoted to or based on livestock production, and encompass the broader definition of this term, and encompasses all aspects pertaining to rural livelihoods in rangeland-based production systems. The reason for this broader definition is that in Texas sustainable pastoral systems require consideration of all potential products of the rangeland resource including forage production for livestock and wildlife, recreation, ecosystem services and existence values. To reflect the diversity of motivations of people responsible for managing Texas rangelands they will be referred to by a variety of synonyms, e.g. pastoralists, ranchers and landowners.

Texas consists of ten natural regions that are defined on the basis of the interaction of geology, soils, physiography and climate (Gould *et al*., 1960). The Edwards Plateau is an area of approximately 10 million hectares in west-central Texas that is bounded on the east and south by the Balcones Escarpment, an area know as the "Texas Hill Country." The Stockton Plateau forms the western border. The northern boundary is less distinct and blends with other natural areas known as the High Plains, Rolling Plains and Cross Timbers and Prairies. Soils are usually shallow with a wide range of surface textures. They are underlain by limestone or caliche on the Plateau proper and by granite in the Central Basin. Elevations range from slightly less than 300 m to more than 900 m. The surface is rough and well drained, being dissected by several river systems.

Annual rainfall ranges from about 350 mm in the west to more than 800 mm in the east increasing by about 1 mm for each km from west to east. On the average, there are more years with below-average than above-average rainfall. Droughts have occurred in the area frequently, but the most severe drought on record was from 1950 to 1957. Seasonal rainfall patterns are bimodal with May and September peaks. This pattern shifts to a late summer high on the western edge of the Stockton Plateau.

The original vegetation was grassland or open savannah-type plains with tree or brushy species found along rocky slopes and stream bottoms. Tallgrasses, such as cane bluestem (*Bothriochloa barbinodis* var. *boabinodis*), big bluestem (*Andropogon gerardii* Vitman), Indiangrass (*Sorghastrum nutans* [L.] Nash), little bluestem (*Schizachyrium scoparium* [Michx.] Nash), and switchgrass (*Panicum virgatum* L.) are still common along rocky outcrops and protected areas having a good soil moisture conteny. These tallgrasses have been replaced on shallow xeric sites by midgrasses and shortgrasses such as sideoats grama (*Bouteloua curtipendula* [Michx.] Torr.), buffalograss (*Buchloe dactyloides* [Nutt.] Engelm.), and Texas grama (*Bouteloua rigidiseta* [Steud.] A. S. Hitchc.). The western part of the area comprises the semi-arid Stockton Plateau, which is more arid and supports shortgrass to midgrass mixed vegetation. Common woody species are live oak (*Quercus virginiana* Mill.), sand shin oak (*Q. havardii* Rydb.), post oak (*Q. stellata* Wang.), mesquite (*Prosopis glandulosa* Torr.), and juniper (*Juniperus ashei* Bucholz. and *J. pinchotii* Sudw.). As a result of high grazing pressures and a reduction of fire, the density of woody vegetation has increased dramatically compared to its density prior to European settlement. Encroachment of juniper on shallow soils and slopes, and mesquite on deeper clay loam, is one of the major threats to sustainable use of this area.

The Edwards Plateau is about 98% rangeland with cultivation largely confined to deeper soils in valley bottoms. Rangelands have a combination of grass, forb (i.e., herbaceous dicot) and browse species and are used primarily for mixed livestock (combinations of cattle, sheep, and goats) and wildlife production. This area is the major wool- and mohair- producing region in the United States, providing about 98 % of the nation's mohair and 20 % of the lamb and wool production. Because of abundant grass the area was known as “Stockman’s Paradise” when it was first settled in ca. 1880. It also supports the largest deer population in North America. Exotic big-game ranching is becoming important, and axis, sika, and fallow deer and blackbuck antelope are increasing in number. Native white-tailed deer are abundant over much of the area and serve as a valuable source of income for ranchers.

Uses of Edwards Plateau rangelands have been in transition for about 40 years. Prior to the 1950s, livestock production was the primary use of this resource. During the 1960s, hunting for fees began in earnest and its importance has steadily increased to present, somewhat offsetting the loss of income from livestock. Revenues from hunting have an advantage compared to livestock revenues in that they are affected less by droughts. Other trends that occurred in this area starting around the decade of the 1960s were an increase in the number of deer and an explosion in brush. The deer population in Texas benefited from an increase in woody plants and eradication of the screwworm which was complete by 1966. Recently, large ranches are being subdivided and purchased primarily by people without agricultural experience.

Before discussing pastoral systems that are sustainable in west Texas, it is first necessary to define the goals of the system and examine the constraints to sustainability. Long-term sustainability has two dimensions: ecological and economic. The first dimension is self-evident and we use the definition of rangeland health, i.e., the degree of integrity of the soil and ecological processes that are most important in sustaining the capacity of rangelands to

satisfy values and produce commodities (National Research Council, 1994). It implies that the soil and its ability to capture and retain precipitation have not been unduly compromised. The second dimension, i.e. economic sustainability, is often ignored by ecologists but is equally important. As Ainesworth (1989) stated, "the only sustainable agriculture is profitable agriculture." However, for many landowners profit often takes many non-market forms such as the ability to provide a desired lifestyle or improve the resource, and this will be discussed in greater detail later.

A major ecological challenge not only of the Edwards Plateau but most of Texas, and arid lands worldwide, is woody plant (i.e., brush) encroachment (Archer, 1989). In Texas, this is primarily a result of overgrazing, which reduces competition from herbaceous species as well as a reduced fire frequency because of a reduction in fine fuels. The two most problematic species in this area are mesquite and redberry juniper. Left untreated both the canopy cover of mesquite (Ansley *et al.* 2001) and redberry juniper (Ueckert *et al.* 2001) increases by about 1% annually. Carrying capacity for domestic livestock significantly and rapidly declines when the canopy cover exceeds 20 % to 30 % for redberry juniper and mesquite respectively. Up to a point increased brush cover improves the habitat for white-tailed deer, the most economically important wildlife in this area, eventually it can reach densities that reduce their carrying capacity as well (Teer 1996). Current conditions have decreased the frequency of naturally-occurring fires below the level necessary to keep brush below an economic threshold thus requiring inputs, i.e., prescribed fire, herbicides or mechanical treatments, to keep the woody vegetation below an economic threshold so that these pastoral systems remain productive. This creates a problem because the cost of brush control often exceeds the economic return that results from reduced woody plant cover. Thus one of the most important principles of sustainable grazing management is management that facilitates low-cost alternatives for brush management.

Grazing management

There are three components of grazing that must be managed, namely stocking rate, species of livestock and distribution of livestock. A fourth component, namely, season of grazing which is important in more temperate climates, is less important in Texas because these ranges are grazed year-round. When domestic livestock are grazed, decisions relative to livestock species, timing of grazing and stocking rate are made, either consciously or unconsciously. Improving grazing distribution, however, normally requires the investment in capital improvements such as fencing or water development.

Stocking rate is the most important principle of grazing management and historically was high. Grazing in the Edwards Plateau began in earnest around 1880. Fencing was introduced with the invention of barbed wire in 1873 and by 1900 all of the ranches had been fenced. Based on census data since 1919, total livestock numbers in the Edwards Plateau peaked in 1940 and declined until 1970 when they stabilized until a drought that began in 1997 caused a further reduction in livestock numbers (Figure 1). However, other sources (Merrill, 1959; Smeins *et al*., 1979) suggest stocking rates around 1900 may have been as much as 3 times higher than the peak reported for 1940. What is clear regardless of the source, is that stocking rates routinely exceeded the sustainable carrying capacity throughout the history of grazing by domestic livestock and in the early years of the twentieth century stocking rates may have been extreme. The reduction in livestock numbers was caused by a reduction in the number of sheep and goats. Thus the proportion of forage demand shifted from 85 % from small ruminants down to 34 % by 2000.

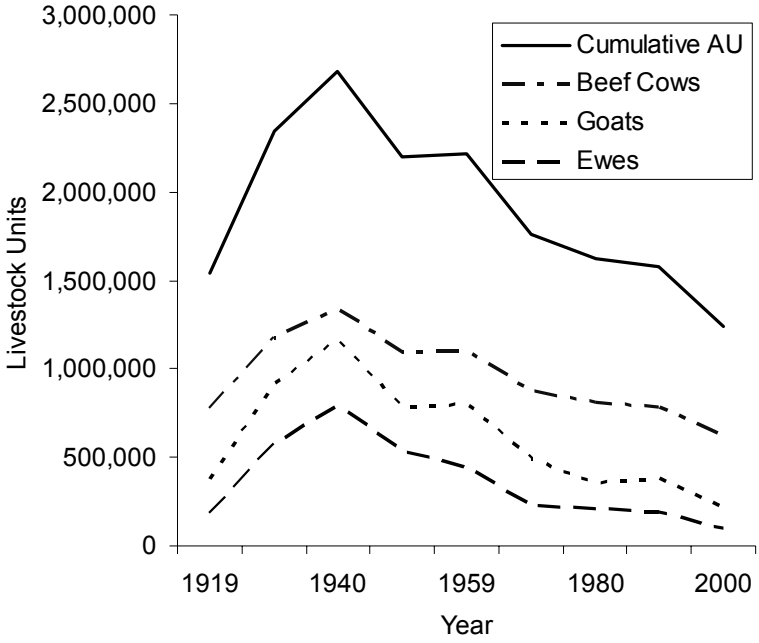

Figure 1 Changes in livestock units of grazing by breeding females of different livestock species commonly found in the Edwards Plateau, Texas. Data prior to 1970 are from U.S. Census Bureau and then from U.S. Department of Agriculture, National Agriculture Statistic Service.

Early overgrazing of this area was a result of early settlers with no experience of pastoral systems in semi-arid environments. The first pastoralists in this area had neither an appreciation for the certainty of drought nor an understanding of the importance of leaving residual forage to maintain plant vigour. Long-term overgrazing resulted in desertification of this region because of soil loss and a successional shift from tallgrasses and midgrasses to shallow-rooted shortgrasses. Another result of overgrazing was a reduction in fire frequency which in conjunction with reduced vigour of herbaceous plants allowed for encroachment of woody plants, particularly juniper. Because juniper can intercept and evaporate up to 47% of the precipitation that falls on it (Owens and Lyons, 2003), this further exacerbated the desertification cycle.

Much research has been conducted in the last 50 years that has shown the effect of stocking rate on livestock production and economic returns (Walker and Hodkinson 1999). These results clearly demonstrate that moderate to light grazing will result in greater economic returns and less risk than heavy grazing. Nonetheless there is still a strong tendency of ranchers in this area to overgraze. This is a result of several factors. One is the failure of pastoralists to anticipate and respond to the inevitability of drought. Another has been government programmes such as emergency feed programmes and price support for fibre production (i.e., wool and mohair) which encourages overgrazing because, when prices are favourable, fibre can be produced at stocking rates that are too high to produce meat profitably. Finally, 62% of Texas rangelands are leased usually at a fixed rate per unit area.

Such arrangements provide little or no incentive for lessees to adjust stocking rates for climatic variation or to preserve the long-term ecological condition and productivity of the resource. Flexible long-term grazing leases based on the number of animals grazed are necessary to provide lessees incentives to stock appropriately.

Paradoxically, juniper encroachment, which occurred as a result of high grazing pressures, may ultimately provide the impetus for pastoralists to graze more conservatively. Prescribed fire is the most cost-effective method for controlling juniper. Effective burning programmes depend upon adequate amounts of fine fuel, which can only be accumulated with moderate to light stocking rates. Thus, while ranchers may be reluctant to reduce stocking rates for the purpose of maintaining the vigour of the herbaceous vegetation, they may be willing to defer grazing to accumulate fuel to control juniper.

Species of livestock is the second most important component of grazing management. Unlike other parts of the U.S., the Edwards Plateau has a tradition of grazing cattle, sheep and goats together. However this was not always the case. During the early settlement of this area (ca. 1880), when there was still competition for unclaimed grazing lands, there was competition between sheep producers and cattle producers (McSwain, 1996). For instance, legislation passed in 1881 made it illegal to graze sheep on land belonging to another without the owner's permission, but cattle and horses were exempted from this law. As available land was bought, fenced and ownership established, conflicts eventually subsided. Around 1923 the proportion of sheep and goats began to increase as their purchasing power relative to cattle increased (Gabbard *et al*., 1930). In time as a result of the profitability of sheep in contrast to hard times in the cattle industry, cattle producers in the Edwards Plateau raised sheep and goats (McSwain, 1996).

This tradition continued until recent times when a combination of low fibre prices, loss of government support programmes, and greater management requirements of sheep and goats has resulted in a severe reduction in grazing by small ruminants (Figure 1). Matching livestock grazing preference with the botanical composition of available forage increases carrying capacity because grazing pressure is distributed more evenly across the available forage (Walker, 1994). Furthermore, grazing with cattle, sheep and goats will help keep less desirable forage from replacing preferred species. For instance Taylor and Fulendorf (2003) reported an increase of 16 large juniper trees (i.e. > 2 m tall) per hectare for each year following the cessation of goat grazing. At about the same time as sheep and goat numbers were declining demand for fee hunting was increasing and replacing the income that formerly had come from small ruminants. However, wildlife managers generally discourage pastoralists whose primary interest is deer production from grazing goats because they believe that deer and goats compete for forage resources. This is unfortunate because there is little data to support this claim while the ability of goats to help manage juniper encroachment is well documented.

The final component of grazing management is livestock distribution. Poor spatial distribution is the cause of many problems associated with grazing livestock (Holechek *et al.*, 1989). Cross-fencing in conjunction with grazing systems is used to manage the spatial and temporal distribution of livestock grazing pressure. Species of livestock will affect spatial distribution as well. There is good evidence that any increased livestock production as a result of rotational grazing is caused by improved distribution, which has the effect of increasing carrying capacity (Hart *et al*., 1993) rather than altered foraging behaviour (Gammon & Roberts, 1978) or increasing primary production (Heitschmidt *et al*., 1987). Carrying capacity

in large pastures with poor livestock distribution is lower than on similar areas with good distribution. Poor distribution may buffer the effect of changes in stocking rate on livestock performance compared to the classic response curve where animals are well distributed (Stafford Smith, 1996). Grazing systems in conjunction with proper stocking rates can help maintain or improve rangeland health.

Much of the research on grazing systems was conducted in the Edwards Plateau. The Merrill 3-herd, 4-pasture grazing system was developed by Dr. Leo Merrill, the long time superintendent of the Sonora Experiment Station (Merrill 1954). This system is still widely used in Texas. As indicated by the name it involves grouping livestock into 3 herds and rotating them through 4 pastures. In this system each pasture is grazed for 12 months, then rested for 4 months. The rest period comes at a different season in each succeeding 16-months grazing cycle. Thus over a 4-year period each pasture receives a 4-month rest during a different season. Adoption of this grazing system was enhanced because it is simple, and increases both individual animal performance and range condition. Interest and research on single herd multi-pasture grazing systems began in the 1970s. Some of these systems, such as high-intensity, low-frequency, which had one herd and eight or fewer paddocks, were useful for improving range condition at the cost of reduced animal performance. Others, such as short-duration grazing, in which one herd rotated rapidly through eight or more paddocks, were investigated for their potential to increase carrying capacity but did not meet these expectations. About 70 % of livestock producers use some sort of rotational grazing system (Hanselka *et al*. 1990). One of the greatest advantages of rotational grazing is that it provides management flexibility to implement other range improvement practices. As previously mentioned, encroachment of woody plants is one of the greatest threats to sustainable rangeland utilization in the Edwards Plateau. Management of woody plants, using prescribed fire, or mechanical removal, requires the ability to provide periods of rest for the accumulation of fine fuel in the case of fire and rest for the regrowth of herbaceous vegetation for both methods. This is only possible if some type of rotational grazing system is in place.

Financial management

Profit, defined as increasing equity, does not appear to be a primary motivation for most pastoral systems in Texas. On average, between 1991 and 2001, Texas ranches lost $33 US per cow annually if appreciating land value is excluded (McGrann, 2003). Ninety-one % of cow-calf operations have less than 100 cows and are part-time operations. Pastoral enterprises can operate with a long-term net loss because they are subsidized with non-ranch income. Ignoring incentives that result from appreciation in land values fails to provide a complete picture of the factors that motivate pastoralists. During the same time-period that ranches had negative returns from cow-calf production (1991 – 2001) real (i.e., deflated) Texas rural land prices in the Edwards Plateau more than doubled in value for a gain of $83 US /ha in real terms (Gilliland *et al*., 2004). This rapid appreciation was caused by recreation-based demand rather than agriculture production potential. Based on an average stocking rate of 7 ha per animal unit (AU) the annual appreciation of land values in the Edwards Plateau was 345$ US/AU or about ten times the average net loss per cow reported by McGrann (2003). Thus for many Texas pastoralists owning land is an insurance policy whose premiums are the cost of raising livestock. Insurance is a better description than investment for the motivation for owning land because the latter implies the willingness to sell is a financial decision, when in fact most pastoralists are motivated to sell land only in emergency financial situations when other assets are not available. Agriculture tax valuation, which is based on the production value as opposed to the market value of land, is another incentive for raising livestock even at

a financial loss. In 2001 the average agriculture valuation for rangeland in the Edwards Plateau was $38 US compared to a market value of $692 US. These values provide the basis for property taxes.

Although, cash flow is still an important consideration of most pastoralists, their primary motivations often are non-financial goals, such as preserving heritage, maintaining ownership of the land and/or improving the ecological condition of the resource. Ranching provides an opportunity to pursue these goals and simultaneously maintain a desired lifestyle and a large degree of security. Blank (2002) describes this phenomenon as living poor and dying rich.

While increasing equity may not be the primary motivating factor, cash flow or gross profit often is because it affects standard of living and the ability to achieve non-financial goals described previously. Standardized Performance Analysis (SPA) can help identify areas to manage cost and minimize equity use for pastoralists. While on average Texas ranches lost equity some were able to make a profit. More specifically one-half of the ranches had at an annual loss of $152 US per cow, while the other half had a net income of $84 US per cow (McGrann, 2003). Operations with a positive net income were characterized by weaning 8% more live weight per cow joined and more importantly having a 31 % lower production cost per cow. On average only those ranches with a cow herd size greater than 500 head were profitable. These large ranches accounted for less than 1% of the 133,000 cow-calf operations in Texas and only 14 % of the Texas beef cow inventory. Based on SPA results, all herds, regardless of size, can lower production cost by controlling grazing and feed cost, which account for 40% of total costs. This can be done by an appropriate stocking rate combined with a controlled breeding season that matches forage production with livestock nutrient requirements.

Nature tourism has been promoted as a way to increase economic activity in rural areas. While there are many potential outdoor recreational opportunities currently hunting fees have the greatest potential for increasing equity. Because of the growing importance of hunting fees for ranching enterprises, many operators make land and livestock management decisions based on the presumed effect on wildlife. However, such decisions do not appear to affect the economic reality. Based on a comprehensive investigation of ranches in the Edwards Plateau, hunting income accounts for 14 % of gross agricultural receipts. This agrees closely with respondent's estimate that 19 % of total ranch income came from hunting. Nonetheless the importance of hunting is increasing relative to livestock. Between 1993 and 2000 the average lease value of land for hunting increased by 30 % compared to a 10 %increase in livestock grazing fees. Currently, in the Edwards Plateau average lease rates are $10.11 US/ha for livestock grazing compared to $8.69 US/ha for lease hunting.

Although income from hunting provides less than 20 %of net ranch income, the effect of range management practices on wildlife and hunting is probably the deciding factor for many of the management decisions. As discussed above, land appreciation is the primary source of wealth accumulation for a ranching enterprise and this source of wealth is driven by recreational demands for land. Therefore range improvement practices, e.g., brush removal, are conducted only to the extent that they will improve wildlife habitat rather than to the degree that would be optimal for livestock production. Secondly, although for management decisions it is useful to analyze pastoral operations by their individual enterprises, ultimately ranching is an integrated economic activity that on the whole is profitable or not. Thus hunting income allows ranch enterprises to operate at a profit. Within this context livestock production is a commodity business, i.e., livestock producers are price-takers. As such, to

make this segment of a ranching operation profitable ranchers must manage production costs. In contrast, hunting enterprises, which are experientially-based, have a greater opportunity to add value to the hunting experience. As such, these experiences, i.e. hunting opportunities, are priced according to what the market will bear. This price has proven to be less cyclical than livestock prices and allows for ranch operators to capitalize on their existing infrastructures and/or willingness to provide additional amenities (e.g., meals, lodging and guide service). This allows ranchers to convert their time and labour to ranch equity according to their personal preference to trade services and ranch amenities for financial reward.

Land ownership is rapidly changing in the Edwards Plateau as urban dwellers see this region of the state as a good financial investment that allows them to enjoy recreational activities. Because of these financial and quality of life values, the numbers of land sales are increasing dramatically and tract size is decreasing Gilliland *et al.* (2003). From 1990 to 2003, we estimate that 6-8 % of the land in the Edwards Plateau has been purchased by people with no experience in land management or ecological processes.

The median size of the tracts purchased by these new landowners was 93 ha and has decreased by 5 ha annually. This change in ownership has potential positive and negative aspects. On the positive side these new landowners are well-educated, have good financial resources and are motivated to make improvements on their investment. On the negative side fragmentation of large ranches is considered the greatest single threat to wildlife habitat (Wilkins *et al*., 2003). Furthermore, most of the new owners lack the knowledge to manage these resources properly and many have unrealistic expectation of the production potential of these semi-arid lands. Thus without the knowledge and appreciation for the capacity of this area, there is a potential that new landowners may repeat the mistakes of the original European settlers in this region. This points to a great need for targeted educational provision that provide these new owners with the skills necessary to become responsible land stewards.

Because of this educational need, five years ago the Academy for Ranch Management (ARM) was established at the Texas Agricultural Experiment Station at Sonora, Texas, to provide training for new ranch owners including those that may be one or more generations removed from living on the ranch. Most of the ARM students own rangeland in the Edwards Plateau. Almost all of the students are genuinely interested in restoring their ranch to a better ecological condition and improve habitat for wildlife. Courses include training in prescribed fire, rangeland ecology, plant identification, rangeland restoration, animal nutrition, grazing management and improving wildlife habitat.

Conclusions

The greatest threats to sustainable pastoral systems in the Edwards Plateau natural resource region of Texas are encroachment of woody vegetation, rangeland degradation resulting from overgrazing, and the lack of cash flow required to control brush and maintain ranch infrastructure. Cash flow can be improved by managing the cost of livestock production, grazing cattle, sheep, and goats in combination, and hunting fees. Pastoralists that do not use all available options to increase cash flow can still accumulate wealth through land appreciation but the health of the rangeland will likely suffer if financial resources are not used to make necessary range improvements. Many large ranches have been divided into smaller holdings and purchased by people without an agricultural background. New landowners need to be educated about the effect overgrazing can have on the ecological health of their property and how properly structured leases can help prevent this problem.

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