Sustainable Management Strategies for Mesquite Rangeland: The Waggoner Kite Project

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The Waggoner Ranch

The 500,000 acre Waggoner Ranch spans 6 counties south of the Red River midway between Dallas and Amarillo. The landscape is gently rolling plains, covered with grass, a liberal presence of mesquite and a fair share of nodding oil jacks. With an average annual rainfall of 26 inches and a good mixture of warm- and cool-season midgrasses, it is one of the best cow-calf range areas in the nation. The ranch is currently stocked at 28–30 acres per cow compared to the recommended NRCS stocking rate of 18–20 acres per cow. Range condition is fair to good and grass is abundant even in times of drought. Most of the land is rangeland but a significant area is planted to wheat in fall to graze home-grown stockers prior to shipping them off to feedlots for finishing. The large size of the operation gives them some economy of scale, and when judged by the Standardized Performance Analysis (SPA) (National Cattleman's Association 1992), they come out as one of the least-cost cow-calf operations in the nation (McGrann et al. 1993).

The Waggoner ranching enterprise was founded by Dan Waggoner in 1837 near Sulphur Springs, Texas. In 1868, his son, Tom, earned enough money in the Texas cattle drives to Kansas, to purchase 56,000 acres of farmland near Electra, Texas. As the free range era came to an end in the late 1880's, Tom sold this land and purchased the current ranch land along the Beaver Creek, south of Vernon. Shortly after, oil was discovered in the region and the Waggoner organization became significant in both the oil and ranching economies of Texas.

The Problem

The biggest problem today on the ranch and many ranches in the Rolling Plains of Texas and beyond, is mesquite brush. There is so much brush that on much of the ranch, many cattle cannot be gathered without using a helicopter. Not only does thick mesquite increase the cost of working cattle but it also reduces total grass production and density of the most desirable grass species. However, mesquite is not all bad. At low or moderate densities it improves wildlife habitat and provides the right conditions for some cool-season grasses to prosper, providing green grass in winter that reduces winter feeding costs substantially.

Mesquite poses the most serious problem where it grows as multi-stemmed thickets (Fig. 1a). Prior to man's attempts to kill it with chemical or mechanical treatment, mesquite existed mostly as a few-stemmed plant that posed much less of a problem (Fig. 1b). The Waggoner ranch has treated

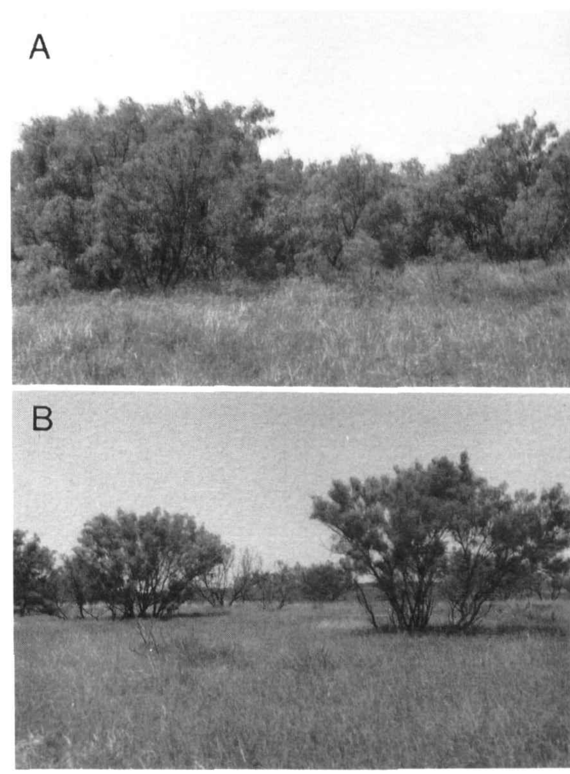

Fig. 1a. *Mesquite growing as a multi-stemmed thicket providing low diversity and poor visibility.*
Fig. 1b. *Mesquite growing as few-stemmed trees providing high diversity and moderate visibility.*

many thousands of acres since the 1950s, but the brush has grown back as multi-stemmed thickets everywhere except where the brush was removed by root-plowing and follow-up grubbing of individual plants. Most of the treatments to reduce mesquite have been terminated due to high costs.

Cause and Possible Solutions

The grass prairies of North America evolved under periodic defoliation by grazing and fire. It is believed that fire was a major factor in preventing woody plants from dominating on grasslands prior to fencing of the land. Grazing by migrating bison herds was intense but infrequent. Areas that were ungrazed became rank and unpalatable, supporting wildfires and fires started by Indians to aid their hunting activities. With fencing and cattle ranching, continuous and often heavy grazing pressure reduced the grass fuel load needed to carry wildfires and the ability of grasses to compete with brush.

Research in north Texas indicates that prescribed fire could potentially control mesquite more cheaply than any other treatment (Table 1). The challenge was to develop a

Table 1. Approximate costs of treating mesquite in north Texas.

Treatment	Cost per treatment**	Treatment interval
Chemical spray*	$ 15 – 25/acre	Retreat every 10–12 yrs.
Spray + chain (as above)	$ 25 – 40/acre	Chain after 2 yrs. then as above
Roller Chopping	$ 25 – 65/acre	Retreat every 6–8 yrs.
Root Plowing + reseed	$ 80 – 90/acre	Grub every 12 yrs.
Fire***	$ 2.5 – 5/acre	Burn every 5 to 7 yrs.
Grub	$ 10 – 75/acre	Retreat every 10–15 yrs.

* Reclaim + Remedy
** All costs are estimates and will vary with the size of the equipment, density, and size of the brush, fuel costs, and number of acres to be treated and regrowth rate.
*** With a rotational grazing system the cost of burning is $ 2.5/acre. With continuous grazing an additional cost of deferment (pre- and post-burn) is included at $ 2.50/acre.

management system that allowed us to incorporate fire on a regular enough basis and still produce beef profitably. Most fire research has shown that fire does not root-kill many mesquite (Wright and Bailey 1982), but if used frequently enough in an appropriate grazing system, mesquite could be sufficiently checked to reduce competition with grasses and interference while working livestock.

The key to using prescribed fire is to manage livestock grazing to accumulate sufficient grass fuel to conduct regular burns. Most rangelands managed under continuous grazing will not support frequently-planned controlled burns because fuel is insufficient or too patchy to have the desired effect. Rotational grazing, on the other hand, has been shown in Africa (Trollope 1984) to have the potential to manage for sufficient fine fuel and allow for recovery after burning before it is grazed again. Fire has also been used in the midgrass and tallgrass prairie of the USA to control brush and improve livestock nutrition and wildlife habitat (Wright and Bailey 1982).

The Research Project

In September of 1994, we as scientists with Texas A&M, in co-operation with the Waggoner Ranch began conducting a five-year research project applying controlled burning by using rotational grazing. The objectives are to develop a profitable management strategy to reduce mesquite using fire, decrease chemical and mechanical inputs for mesquite control, improve grass composition and productivity, cope with drought, and enhance wildlife habitat.

To be of greater value to ranchers, the experiment is being conducted under commercial ranch conditions at the ranch scale. The study includes 4 treatments with 2 replications per treatment covering an area of about 34,000 acres. Replicate sizes range from 3,000 to 5,000 acres so results will apply to ranches of this size as well as to larger ranches. A similar mixture of soils is present between treatments. All treatments were stocked with Hereford cows having the same age composition at levels consistent with NRCS moderate stocking rates. These were calculated according to the acreage of each of the 4 major range sites in each pasture and the range condition in each.

Three different rotational grazing systems are being compared with continuous grazing. These 3 different systems represent different levels of management intensity and are being compared to provide the points for and against each, since different ranchers are likely to be comfortable with different intensities of management (Fig. 2). The treatments include:

1. Continuously grazed pastures at a moderate stocking rate (control with no burn).
2. A 4-pasture, 3-herd (Merrill) system where each pasture is rested 4 months at a time and the pasture being rested during January through April will be burned in February.
3. A 4-pasture, 1-herd system where all pastures will receive about 45 days rest during the rapid growth and 90 days at other times. One fourth of the system or 1 pas-

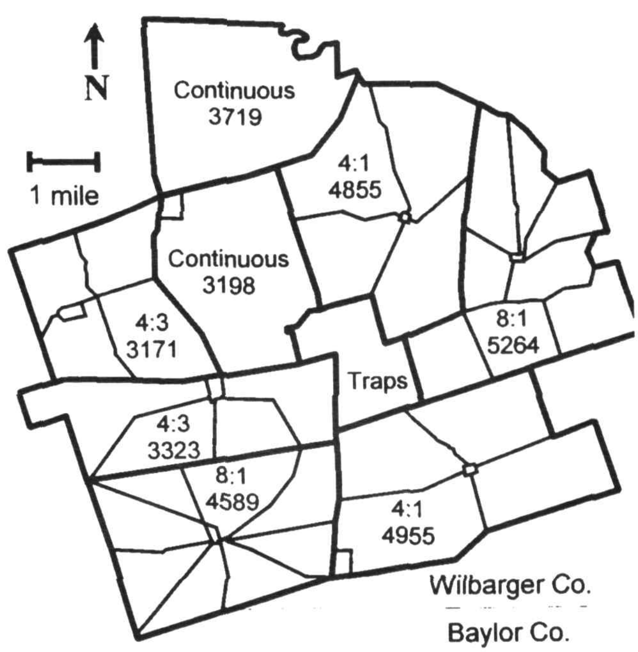

Fig. 2. *The treatment plan on the Kite Project showing the position and size (acres) of individual treatment replicates. The respective treatments are: continuous grazing; a Merrill 4-pasture, 3-herd system; a 4-pasture, 1-herd system; and an 8-pasture, 1-herd system.*

ture will be rested to provide sufficient fuel for burning in February and March.

4. An 8-pasture, 1-herd system where all pastures will receive about 45 days rest during rapid grass growth and 90 days at other times. One fourth of the system or 2 pastures will be rested to provide sufficient fuel for burning in February and March.

Fire is used in years when there is sufficient fuel to carry the fire and produce the desired effect on mesquite. The whole area is grazed during the year, but at least 1,500 lb/ac of fuel is left in the areas to be burned that year. Prescribed burning is conducted in late winter to minimize negative effects on the soil and vegetation, increase the safety factor, and achieve the desired effect on mesquite (after Wright and Bailey 1982). In terms of frequency, the goal of the prescribed burning is to burn every 4–6 years.

Fire can have very different effects on mesquite depending on how it is applied. If a very intense fire is applied using high fuel levels, high air temperature, and low humidity under moderately windy conditions, the entire aboveground portion of the tree is killed. This is followed by regrowth of virtually all plants, which eventually creates a regrowth thicket. An alternative is to burn using less fuel and when weather conditions will result in a less intense fire. This topkills small mesquite plants, but only kills growing points on the lower canopy of taller trees, creating a "savanna" effect (Ansley et al. 1996). Compared to a complete topkill, a savanna fire burns only 30% to 70% of the lower positioned, secondary branches while leaving the very top branches alive (Fig. 3).

Such low intensity fires result in mesquite trees that (1) have less foliage and potentially compete less with grasses for water, (2) maintain apical dominance and do not resprout, and (3) improve visibility for livestock management because the lower branches are removed and there is no regrowth. Both high and low intensity fires are being applied in each treatment to evaluate the relative merits of each.

Questions To Be Answered

The questions we are asking in this project include which treatment(s) provide;

1. Enough fuel for fire to reduce mesquite (either by topkilling or creating a savanna effect)?
2. The highest gross profit per acre while maintaining the natural resources on which production depends?
3. The best management for wildfire habitat?
4. The best grass composition, density, and cover?
5. The minimum economic and environmental impact due to drought?
6. The most stable cash flow and minimum capital expenditures?

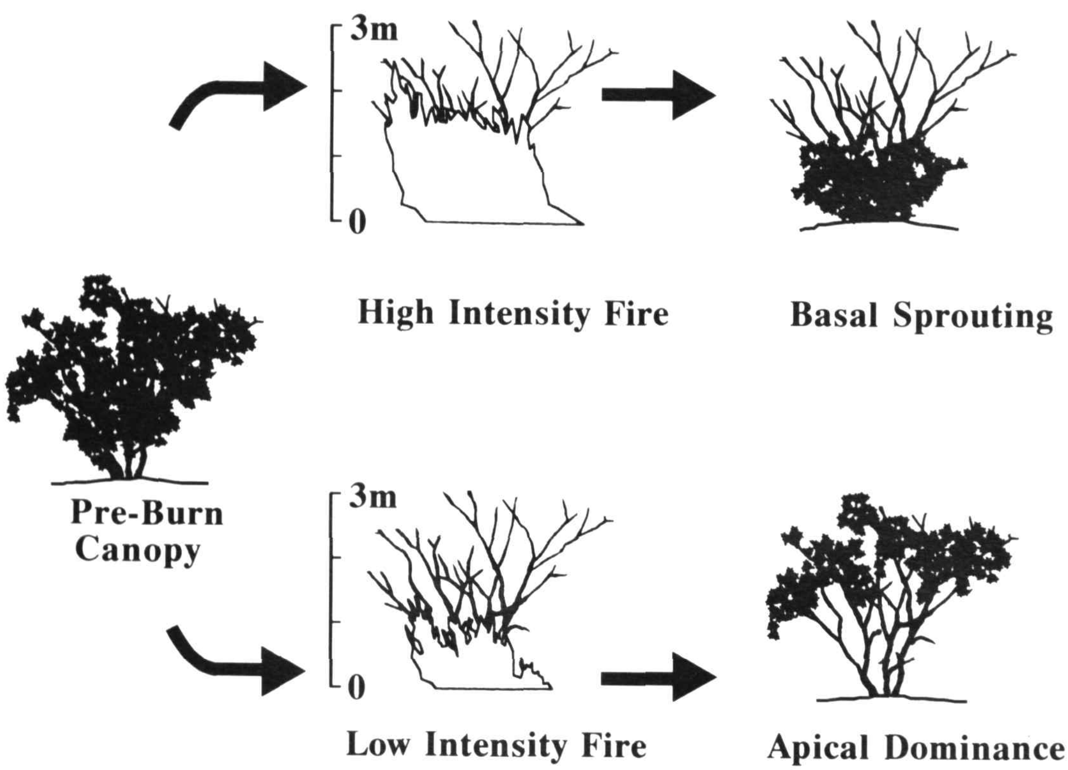

Fig. 3. *The consequences of burning with high intensity fire to achieve a topkill or a low intensity fire to achieve a savanna effect.*

Measurements

Environmental measurements taken in each treatment include rainfall, soil moisture, soil organic matter, infiltration rate, litter cover, bare ground, sign of soil erosion, forage decomposition rate, forage production, and changes in plant species composition. Aerial photography and ground transects are used to quantify mesquite densities and canopy cover and the effects of fire on mesquite. Wildlife population estimates for white-tailed deer and bobwhite quail are also taken to assist in evaluating treatment effects on wildlife habitat (Fig. 4).

Fig. 4. *Wildlife habitat must meet specific food, cover, water, and space requirements. Many wildlife species require a mosaic of woody and grassland vegetation.*

Body condition scores are estimated and fecal samples collected for each herd monthly. These are used to monitor the nutritional status of each herd and determine the level of supplementary feeding necessary in winter and spring to maintain the cows in the desired condition. Target body condition scores are 6 at the beginning of calving in January and 5 when the bulls are put in with the cows in April. Supplementary feeding levels are calculated using the "NUTBAL" feeding decision aid system (Stuth and Lyons 1995). It uses expected cow performance, cow condition, stage of lactation, vegetation conditions, and current weather to calculate the required level of feeding.

The grazing impact is assessed monthly using "THE GRAZING MANAGER" grazing decision aid system (Kothmann and Hinnant 1994). It gives an early warning of 3–6 months in advance if there is likely to be a shortage of grazing so that management can plan ahead and minimize the effects of drought.

In addition to environmental and animal performance measures, a full economic analysis of each treatment will be conducted using Standardized Performance Analysis (SPA) (National Cattleman's Association 1992). Cow-calf performance is assessed in terms of beef produced and profit per acre. One of the most important results will come from the unburned controls. In this treatment, the cost of *not* controlling mesquite or *not* implementing other treatments will be taken into account when calculating profit. In this way the cost of *not* maintaining the natural resources on which production depends will be taken into account to calculate *true profit*.

Making Results Useable at Other Locations

What ranchers often want to know from research information is, what would happen if I did different things on my ranch with different soils, slopes, vegetation, cattle and rainfall? In order to answer such questions on a ranch-specific basis, we are developing and testing a computer model named SPUR (Simulation of Production and Utilization of Rangeland). It is a grazingland ecosystem model that has the potential for long-term trend forecasting.

Before the model can be called a useful tool, it has to be tested against the measurements we make in this project and other relevant research. Once calibrated for a particular location, SPUR can be run to predict the outcome of different management and different weather sequences, to assess best management strategies, and combinations of management practices. The output from SPUR can be selected to include rainfall runoff, soil loss, grass production, soil organic matter, forage harvested by livestock and wildlife, animal weight and gain, and estimates of net return.

What We Have Learned After 2 Years

We have completed 2 years of grazing and 1 year of burning to date. Highly unusual weather was experienced in these 2 years. Rainfall in spring and summer 1995 was well above normal while winter 1995 and spring and early summer 1996 were the driest this century. This resulted in very low forage quality during winter 1995, and spring and early summer 1996. We increased stocking rate from 28 acres to 18 acres per cow recommended by NRCS in this area in fall of 1995 to take advantage of the abundant grass growth. Even though the fall and winter of 1995 were dry we burned according to plan because soil moisture was still high from the heavy summer rains.

Only half of the planned burns were completed in February–March 1996 because of the drought. Supplementary feeding was also much higher than normal. Lack of winter and spring rain prevented grazing the burned pastures until late summer. These drought conditions also resulted in the need for early weaning and destocking by 35% in October 1996, back to original stocking levels.

Below are listed some of the points we have learned in the process thus far:

- Do not increase stock numbers when beginning a rotational grazing system even if you are lightly stocked.
- We still have a way to go before we can predict carrying capacity reasonably accurately. Be conservative when starting.
- A Merrill (4-pasture, 3-herd) system must have all pastures very similar in carrying capacity to operate well.

- When beginning a rotational grazing system, start with a 4-pasture, 1-herd arrangement before progressing to more pastures per herd. Cows must tame down if at all wild and both cows and management must be trained and get experience.
- There is a very strong advantage to having a centralized water point or having complete control over water access.
- Make sure that fences are constructed so that cows move through gates at right-angles. If fences are angled, the cows will move down the wrong side of the fence and not through the gate.
- Until cows know the area, they need to be moved to a water point in the pasture they are moved to or they will not stay in the new pasture.
- Bad weather will restrict moving cows by feed wagon. Cows need to be tamed and trained to moving as soon as possible so that they can be moved in more than 1 way.
- Cows must be in Body Condition Score 6 when calving begins or feed costs will be high.
- Begin supplementary feeding early after frost when diet protein drops to 7 or 8% depending on cow Body Condition Score. You can not play "catch up" later.
- Fecal sampling and use of the NUTBAL feeding decision aid worked well to assess supplementary feed levels to maintain target weight loss through winter to achieve a Body Condition Score of 5 at bulling in April. However, there is no substitute for an experienced eye and timely judgment in the field, even though laboratory results are returned in a week to 10 days.
- THE GRAZING MANAGER decision aid system proved very valuable in making early decisions in a drought situation and keeping in touch with pasture use every month. Experience needs to be developed for effective field assessment of pasture use rating. When this system (TGM) is used, separate assessments of forage and diet quality must be made to supplement information on forage amount.
- A double fire line prepared well before the main fire, along the 2 leeward sides of the pasture, allows burning of large pastures to be completed very easily and safely in the relatively small windows of time that conditions for burning are close to optimal (as recommended by Wright and Bailey 1982).
- Burning may be desirable for animal performance in normal or wet springs but it is a liability in a dry spring. We were largely unable to use the burned pastures from April until we got effective rain in August.
- Burning to give a topkill of mesquite or achieve a "savanna" effect, improves vision and ease of moving cows considerably.
- All management functions are considerably easier with little or no brush.

Conclusions

It is our intent that this facility and method of conducting research will improve the applicability of the information we generate. Results will be published in *Rangelands* as they become available in the future. We will be glad to show the experiment to any interested party.

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