

Role of Summer Prescribed Fire to Manage Shrub-invaded Grasslands

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Abstract: Prior to development of the livestock industry, both anthropogenic and natural disturbances (such as prescribed and wild fire) played key roles in shaping the different plant communities across Texas. Historically, fires occurred during all seasons of the year, but summer fires were probably more frequent due to dry conditions combined with increased lightning frequency during the summer. When fire was frequent, the upland or western divide region of the Edwards Plateau was typical of a savanna ecosystem. The purpose of this study was to determine the effects of summer and winter burning and no burning (controls) on vegetation. Woody and succulent vegetation species were highly vulnerable to both summer and winter fire. Herbaceous response was species dependent; however, overall grass production was greater under a summer burning regime compared to control and winter burn treatments. Summer burning is recognized and recommended for reclamation of rangeland vegetation under appropriate conditions and levels of supervision, experience, and training. Once reclaimed with one or two summer fires, management can shift to lower risk, cool-season burns for maintenance.

Introduction

When European explorers and settlers first came to the Edwards Plateau, they found a different landscape than what is present today—especially for the uplands and “divide” regions of the Edwards Plateau (Cory 1948; Smeins and others 1997). The landscape appeared open with stubby thickets of liveoak (*Quercus virginiana* Mill.) and shinoak (*Quercus* spp.) and an occasional larger liveoak. On the valleys, slopes, and shallow soils, the dominant grasses were little bluestem (*Schizachyrium scoparium* (Michx.) Nash), sideoats grama (*Bouteloua curtipendula* [Michx.] Torr.), Indian grass (*Sorghastrum nutans* L. Nash), cane bluestem (*Bothriochloa barbinodis* var. *barbinodis* Lag. Herter), Texas cupgrass (*Eriochloa sericea* [Scheele] Munro), common curlymesquite (*Hilaria belangeri* [Steud.] Nash), Texas wintergrass (*Stipa leucotricha* Trin. & Rupr.), and others. Warm season perennial forbs were also abundant with a diverse mixture of desirable woody shrubs. Kidneywood (*Eysenhardtia texana* Scheele), littleleaf leadtree (*Leucaena retusa* Benth. in Gray), Carolina buckthorn (*Phamus Caroliniana* Walt.), Texas mulberry (*Morus microphylla* Buchl.), white honeysuckle (*Lonicerna albiflora* T.&G.), Plum (*Prunus* spp.), bumelia (*Bumelia lanuginosa* [Michx.] Pers.), sumacs (*Rhus* spp.), etc., are just a few of the more desirable woody shrubs that were abundant.

With the development of the livestock industry, Edwards Plateau rangelands were fire-proofed due to excessive numbers of livestock and yearlong grazing that grazed out the tall and mid grasses. The more productive grasses were replaced with short grasses, which were more resistant to grazing and provided much less fuel for fires. Reduced fuel loads were also followed by fire suppression activities by early settlers. 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 grass a felony. It was not 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 natural and man-made fires kept woody plants in check and allowed the higher successional grasses to dominate the landscape. 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). With the reduced fire frequency, redberry juniper (*Juniper pinchotii*), Ashe juniper (*J. Ashei*), and prickly pear (*Opuntia* spp.) began to increase across the landscape.

The Insidious Invasion of Juniper

A common principle in vegetative ecology is given a certain set of circumstances (such as weather, soil, herbivory, fire, etc.), some plant species will be more competitive and dominate the landscape at the expense of other species. Natural competition is the concept that individuals of a species, which survive and reproduce better than other species, will have their genes proportionally represented in future populations to a greater extent because they leave more offspring. Nowhere can this be better demonstrated than with the increase of juniper species across the “divide” region of the Edwards Plateau.

At the time of European settlement, juniper species were not perceived as a problem and for various reasons. Firewood

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and building materials were important commodities to early settlers. For example, Ashe juniper was an important source of lumber for construction of houses, railroad ties, fences, pens, etc. for the early settlers (Smeins and others 1997). It still has commercial and ecological value today (Garriga and others 1997; Rollins and Armstrong 1997).

The increase in juniper density is slow at first and can go unnoticed for many years until it becomes a serious problem. In the early 1900s, juniper represented a small part of the plant composition on many areas of the Edwards Plateau. With the reduction in fire frequency and intensity, the process of juniper encroachment was initiated on many areas that had previously been grasslands. However, some areas, especially on the southeastern Edwards Plateau, are not as conducive to repeated fires because of the highly variable topography and fine fuel discontinuity (Smeins and others 1997). Therefore, it is probable that juniper was present in some local areas and occurred in association with rocky outcrops, canyon-lands, or along streams and rivers where fire frequency was low. A thorough review of the history of juniper in the Edwards Plateau is presented by Smeins and others (1997) and Ueckert (1997).

My concern is the encroachment of juniper on areas in the Edwards Plateau that were historically grasslands or savannas. Also, it is not the author's intent to suggest that all areas of juniper be removed from the Edwards Plateau. In fact, some juniper, even some deliberately located dense stands, may be desirable. However, for the sake of biodiversity, wildlife habitat, domestic livestock production, water availability, and management of volatile fuels, juniper has to be managed and fire should be a major part of an active integrated juniper management program.

Methods

Study Site

The data presented herein were collected from a replicated study from the Texas Agricultural Experiment Station located 45 km south of Sonora, Texas (31°N; 100°W). The landscape of the Sonora Station is rolling stony hill topography typical of the Edwards Plateau. Soils on the site are Tarrant stony clays and Tarrant silty clays of the Lithic Haplustolls family. The growing season associated with the Sonora Station is 240 days. Most of the precipitation results from intense, convective storms of short duration. The average precipitation (1919 to 2003) recorded at the station is 57.4 cm per year.

In 1993, six study sites of approximately 2.5 ha each were established from two adjacent pastures to measure the effects of seasonal fire on native perennial vegetation. Summer and winter burning treatments were established along with an unburned control with two replications per treatment. Each treatment was blocked within each of the two pastures. Sites were selected to represent similar woody plant cover and herbaceous composition. Dominant herbaceous plants included common curlymesquite, threeawn, sideoats grama, and Texas wintergrass. Dominant woody plants were live oak, ashe juniper, and redberry juniper.

Vegetation in all six sites was sampled for species composition and woody canopy cover in July, 1994. Data were collected from transect lines that are permanently marked. Various vegetation measurements were sampled that included percent composition based on frequency and line intercept. Standing crop of grasses was measured by hand clipping vegetation from 50 quadrats per replicate. Analysis of variance was conducted on standing crop data with the general linear model univariate analysis option of SPSS (SPSS 2001). Significance levels for the tests were set at $\alpha = 0.05$.

Two replicates were burned in August, 1994 (growing season treatment), two burned in February, 1995 (dormant season treatment) and two were left as unburned controls. The winter burn treatments were burned for a second time in February, 2000, and summer burned treatments in August, 2000. The emphasis of this study is to measure the long-term effects of repeated seasonal fire on the perennial vegetation community. These sites will continue to be periodically burned for at least 20 years or longer. Only the major species are discussed in this report. Livestock have not grazed these pastures since 1993, but white-tailed deer have access to the treatments.

Results and Discussion

In 1994, prior to implementation of the burn treatments, standing crop of grass was measured on all six treatment sites. Standing crop was not different among treatments and averaged 42 g/m² per treatment (fig. 1). The first burn had little impact among burn and control treatments. It was not until after the second burn that treatment differences were first measured. The reason for the increased grass production after two summer burns is due to the reduced liveoak canopy cover, and elimination of juniper growing under the oak canopies, and reduction in prickly pear (*Opuntia* sp.).

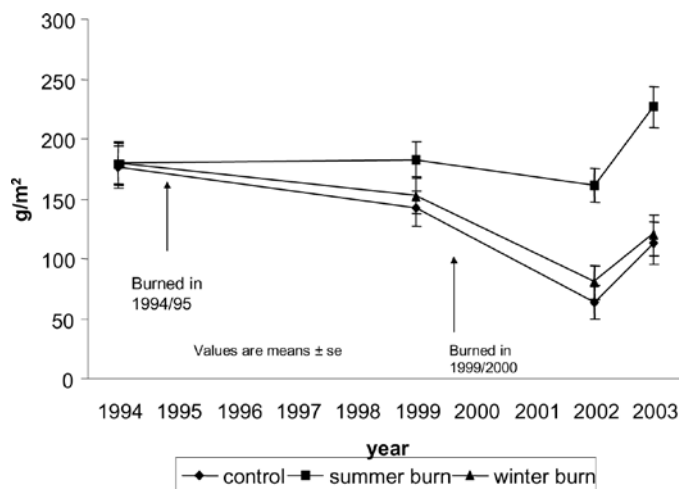


Figure 1. Standing crop of grass (g/m²) from control, winter, and summer burned pastures. Winter burned replicates were burned in February of 1995 and 2000 and the summer burned replicates were burned in August of 1994 and 2000.

Liveoak is an evergreen that is usually classified as moderately preferred by livestock and wildlife. Liveoak increases in the absence of fire and low browsing pressure, but does not generally have the potential to dominate a landscape like juniper. Liveoak tends to cluster in mottes on soils derived from Buda limestone, which is typical for pastures in the current research project.

Liveoak trees make good perch sites for robins (*Turdus migratorius*) and cedar wax wings (*Bombycilla cedrorum*). These two bird species, along with other animals that consume juniper berries, disperse the seeds over large areas, especially under the canopy of liveoak trees.

For example, after two burns, 100 percent of the oak mottes in the unburned control pastures had juniper compared to 67 and 8 percent for the winter and summer burned treatments, respectively. Juniper density was similar for all treatments prior to the implementation of the burning treatments (approximately 74 plants per ha in 1993). After two prescribed burns, average number of juniper plants per motte was larger for the control pastures compared to the summer and winter burn pastures—46, 4, and .1 plants, respectively.

Summer fire was more effective than winter fire at managing juniper in liveoak mottes and was also more damaging to the liveoak. Liveoak canopies were reduced 60 percent in the summer burned treatments and 20 percent in the winter burns treatment.

Juniper density was measured in June, 2001, and averaged 1,013, 100, and 25 plants per ha for the control, winter burned, and summer burned treatments, respectively. Recall, that both burn treatments had received two prescribed fires prior to the 2001 sampling period. Although juniper density was light at the beginning of the study, the trees were large and had the potential to produce large seed crops. Also, no livestock grazing/browsing has occurred since 1993. The rapid recruitment of juniper in the control treatments is a good example how quickly juniper density can increase in an area without any type of management (such as fire and/or use of goats).

Most ranchers in the Edwards Plateau attempt to manage prickly pear because of its competitive nature with herbaceous forages (Mayeux and Johnson 1989; Ueckert and others 1988). Prescribed burns conducted in the winter period reduced prickly pear density to about half of the control treatments (642 and 370 plants/ha, respectively), whereas summer fire reduced prickly pear to less than 4 percent of the controls (25 plants/ha).

Grass response

Common curly mesquite grass is an abundant warm-season perennial grass that has increased with the advent of excessive livestock grazing in the Edwards Plateau (Merrill and Young 1959). Under better management, or complete rest from grazing, common curly mesquite is replaced by higher successional grasses (Smeins and Merrill 1988).

In this study, frequency of common curly mesquite decreased from 60 percent in 1994 to 32 percent in 2003. Because the response of common curly mesquite was similar across all treatments, including the non-burned control

treatments, it appears that fire had little influence and indicates that this grass may be neutral to fire.

Sideoats grama, a climax warm season perennial grass, has two different growth forms for this region (rhizomatous type and bunch type). The rhizomatous type (underground stems) dominates the pastures in this study. These underground rhizomes are a major source of new tillers for the plants and would appear to be resistant to fire.

Averaged across all treatments, frequency of sideoats grama was the same in 2003 as in 1994 (19 vs. 20 percent, respectively). Frequency of sideoats grama was not affected by the fire effect ($P = 0.717$).

Texas wintergrass, a desirable cool season grass, responded differently than sideoats grama. Averaged across all treatments, frequency of Texas wintergrass increased from 1994 to 2003 (36 and 44 percent, respectively). Frequency of Texas wintergrass increased for all treatments over the course of the study and was not affected by either summer or winter fire.

Threeawn species (*Aristida* spp.) include both annual and perennial threeawns. Most threeawns are not considered as good forage, although Wright's threeawn provides early grazing prior to the green-up of the more productive grasses. Averaged across all treatments, threeawn frequency decreased from 1994 to 2003 (33 and 10 percent, respectively). For the summer burning treatments, threeawn frequency decreased from 30 to .3 percent ($P = 0.064$) from 1994 to 2003, respectively. Threeawn tends to accumulate dead leaves and stems, which may play a part in its response to hot fire.

Management Implications

These data illustrate the importance of a long-term, sustainable management program for juniper. Without fires, or when their severity is reduced because of low fuel, juniper can quickly invade and start to dominate a range site in a few years. Warm-season fires are more effective in killing juniper than cool-season fires. After two prescribed burns, it is the author's opinion that the summer burn treatments in this study would not have to be burned again for up to 30 years, possibly longer, to maintain their grassland dominance. The winter burn treatments, given their current juniper status, would need to be burned within 15 years to maintain their grassland dominance. Recruitment of new seedlings is occurring at an accelerated rate in the control treatments. Within a few years, juniper will start to dominate the control areas and significantly reduce the carrying capacity for both livestock and wildlife.

Because of this, landowners are facing a dilemma with predictable consequences. One option, to do nothing, has major negative ecological consequences. Without intervention with proper management, the ecological system is locked indefinitely into an unnatural juniper dominated woodland.

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