RWFM-PU-412
June 2023

# PLANT RESPONSE TO SEASONAL FIRE IN THE EDWARDS PLATEAU, HIGH PLAINS, AND ROLLING PLAINS

Anita Hoskins[1], Deann Burson[2], and Morgan Treadwell[3]

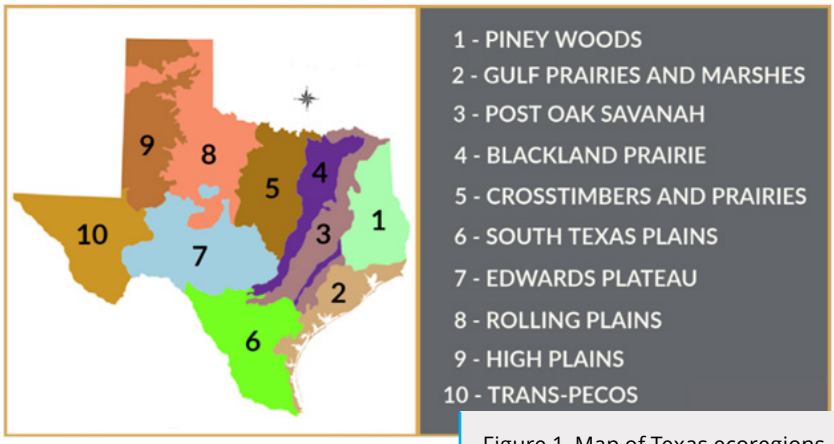


Figure 1. Map of Texas ecoregions.

A good craftsman must understand how to use available tools, but more importantly, when and why to use those tools. Range management is no different, with prescribed burning being one of the most versatile tools in the box. To effectively utilize and capture prescribed fire's versatility, it is just as important to know when to burn as it is to know why and how. How a plant community responds to fire varies greatly based on precipitation, soil type and moisture, presence of invasive species, grazing history, and countless other variables, as well as their interactions. In particular, the season and timing of a fire can influence specific successional plant community response. Plant phenology is marked by seasonal events, such as bud break, flowering, and dormancy, and the timing of a fire can shift a plant community toward or away from specific plant community goals. This is especially true in the Edwards Plateau, High Plains, and Rolling Plains regions of Texas (Fig. 1).

From vast grasslands to rolling hills to juniper thickets, these areas reach from the Panhandle into Central Texas and offer quality, productive rangeland to those willing to steward it. The diversity of plant communities throughout these regions also presents a variety of plant functional and structural groups. These groups, which can be categorized as warm-season grasses, cool-season grasses, forbs, and shrubs/brush, play diverse roles in this area's ecology throughout the year. As the plant community changes with each season, so do the outcomes that a prescribed fire can produce. Whether the goal is to optimize forage for livestock and wildlife, manage invasive species, reduce fuel load for wildfires, or all the above, a well-timed prescribed burn can shift a plant community in the desired direction.

Plant communities in the Edwards Plateau, High Plains, and Rolling Plains were once dominated by grasses. Historically, fires burned through these regions an average of once every 4 to 12 years, which maintained the grass- and forb-dominated grassland systems. Today, the removal of these fires has shifted the plant community composition in much of the region and caused many of these grasslands to be heavily encroached on by woody plant species, such as junipers, oaks, and mesquite. When integrating prescribed fire into a management plan, it is also important to consider the influences of the current plant community composition on the fire itself.

[1] Texas A&M University, Department of Rangeland, Wildlife, and Fisheries Management, M.Sc. Graduate Student

[2] Texas A&M University, Department of Rangeland, Wildlife, and Fisheries Management, Ph.D. Graduate Student

[3] Extension Range Specialist and Associate Professor, Department of Rangeland, Wildlife, and Fisheries Management, Texas A&M AgriLife Extension Service

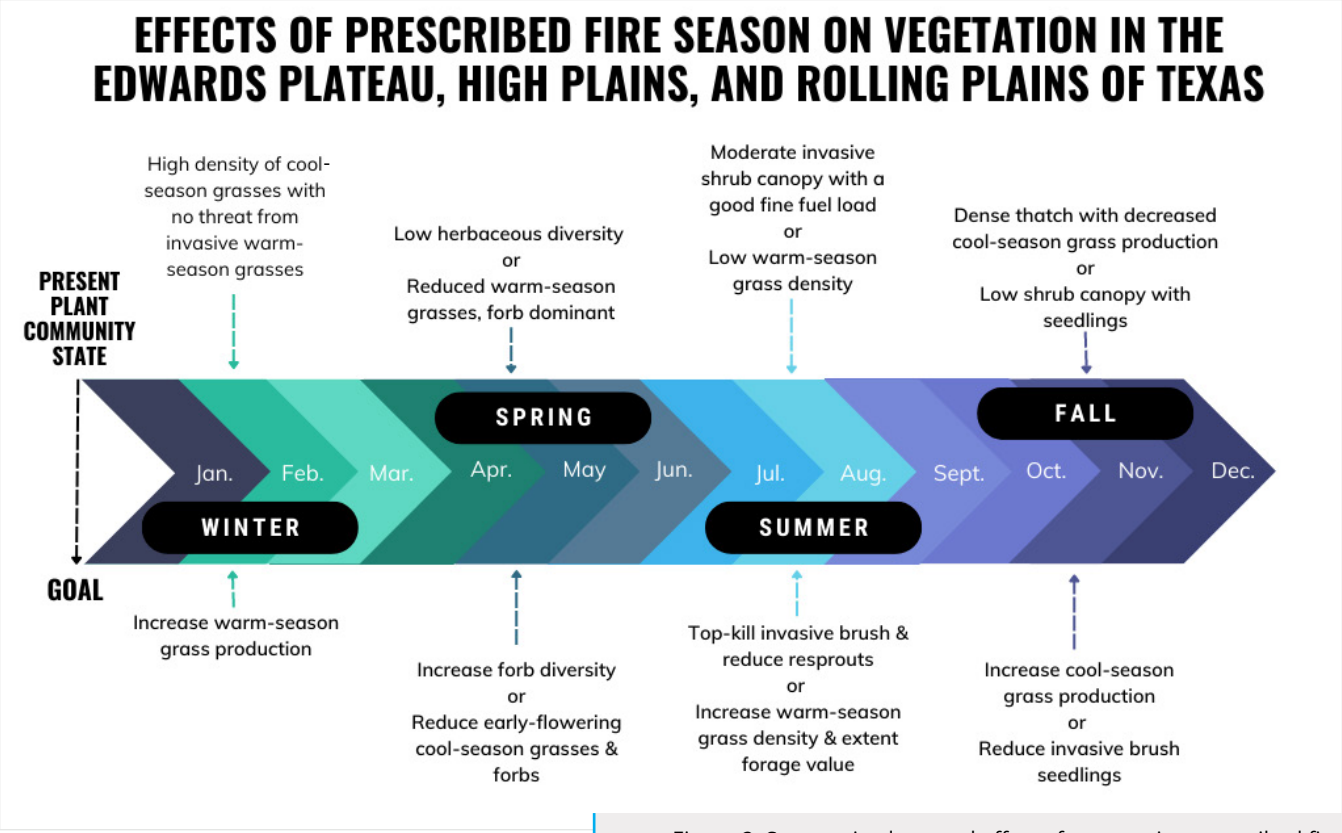


Figure 2. Summarized general effects from varying prescribed fire seasons in the Edwards Plateau, High Plains, and Rolling Plains of Texas.

The present-day state of the land will have just as much influence on a fire and its results as the time in which a fire is conducted. Managers should not only decide their fire's seasonality based on its phenological effects but also on the current state of their plant community (Fig. 2).

Some management situations in the Edwards Plateau, High Plains, and Rolling Plains may be out of the scope of prescribed fire. However, aspects that are within the scope have been organized in Figure 2. Management implications are based on the phenological effects of fire throughout different seasons, which can be used to influence or maintain plant community composition according to the season of burn.

This paper will assist landowners in comparing how fire changes plant communities relative to the season of the burn—specifically, how warm-season grasses, cool-season grasses, forbs, and shrubs/brush respond to burn season.

## SEASONAL FIRE BEHAVIOR

Fire behavior is determined by weather, fuel, and topography at the burn unit. Seasonal temperature, wind, and humidity interact with vegetation to create variable fire behavior throughout the year.

### Growing-season Burning

During the growing season, there is more live plant material present and higher fuel moisture content, which means growing season fires may depend on the amount of dormant thatch and litter material from the previous years to propagate, often resulting in a less-intense fire, with reduced flame length and rates of spread. At the same time, extreme air temperatures and low relative humidity in the summer can increase the energy of growing-season fires, making fire intensity highly variable during the summer months.

| Table 1. Index of common, warm-season grasses in the Edwards Plateau, Rolling Plains, and High Plains regions of Texas. | | | |
|---|---|---|---|
| **Common/Scientific Name** | **Livestock Forage Value[1]** | **Origin** | **Life Cycle** |
| Buffalograss *(Buchloe dactyloides)* | Good | Native | Perennial |
| Common curly-mesquite *(Hilaria belangeri)* | Good | Native | Perennial |
| Sideoats grama *(Bouteloua curtipendula)* | Good | Native | Perennial |
| Little bluestem *(Schizychyrium scoparium)* | Good | Native | Perennial |
| Switchgrass *(Panicum virgatum)* | Good | Native | Perennial |
| Indiangrass *(Sorghastrum nutans)* | Good | Native | Perennial |
| K.R. bluestem *(Bothriochloa ischaemum)* | Fair | Introduced | Perennial |

[1] (AgriLife Extension, 2023)

### Dormant-season Burning

Winter, or dormant-season, prescribed fire effects on plant communities often vary as much as favorable seasonal forecasts. While the temperatures may be lower, there may still be live plant material in the form of actively growing cool-season grasses. In other cases, herbaceous material may be entirely dormant. Further, dormant-season fires carry a large degree of variability due to unstable atmospheric conditions. Available burn days during the winter and early spring are frequently constrained by combinations of temperature, wind speed, and relative humidity. This reality makes planning critical for the execution of cool-season burns and should be considered in landowner decisions.

## WARM-SEASON GRASSES OF THE EDWARDS PLATEAU, ROLLING PLAINS, AND HIGH PLAINS

Warm-season grasses are those that reach maximum production in the summer months, attaining dormancy in the fall and winter, and comprise much of the forage base of the three regions. Table 1 provides a list of common warm-season grasses in the area, including their forage value for livestock, origin, and life cycle. The cyclic nature of their growth patterns is an important consideration when burning to influence their regrowth and persistence. Since warm-season perennial grasses are highly adapted to fire, there are many opportunities to burn throughout their life cycles. Plant origin is also an important consideration when planning a fire. King Ranch (K.R.) bluestem, an introduced warm-season perennial, quickly develops monocultures and threatens rangeland diversity. Unfortunately, many non-native species thrive in disturbance and are often enhanced by fire.

Growing-season fires, which occur in summer to late fall, prolong the availability of high-quality forage, increase warm-season grass productivity, and increase overall biomass and diversity in the long term. Areas subjected to repeated summer burns often show little difference in soil moisture and above-ground biomass than non-burned counterparts in years following a fire. Additionally, warm-season grasses show little decrease in production, with many fire-adapted native species, such as little bluestem, showing an increase in biomass following growing-season fire. Burning during active growth is key to effectively discouraging invasives like K.R. bluestem. Although native warm-season grasses are also actively growing under the same conditions, healthy populations of desirable natives, moderate temperatures, and intense growing-season fires with good movement may favor natives slightly more than the invasives to reduce K.R. bluestem stands.

Cool-season burning can encourage warm-season grass growth and increase grass density during a time when cool-season grasses are actively growing and temperatures are generally lower. Less-intense spring fires preserve warm-season grass bud zones while removing thatch from the cool-season grasses, shifting species composition to a greater proportion of warm-season grasses by opening the grass canopy. However, this treatment can produce a reduction in diversity among early-flowering grasses and forbs, including many spring wildflowers, and should be done with moderation where invasive warm-season grasses are present.

| Table 2. Index of common, cool-season grasses in the Edwards Plateau, Rolling Plains, and High Plains regions of Texas. | | | |
|---|---|---|---|
| Common/Scientific Name | Livestock Forage Value[1] | Origin | Life Cycle |
| Canada wildrye *(Elymus canadensis)* | Good | Native | Perennial |
| Virginia wildrye *(Elymus virginicus)* | Excellent | Native | Perennial |
| Texas bluegrass *(Poa arachnifera)* | Good | Native | Perennial |
| Japanese brome *(Bromus japonicus)* | Poor | Introduced | Annual |
| Texas wintergrass *(Nassella leucotricha)* | Fair | Native | Perennial |

[1] (AgriLife Extension, 2023)

# COOL-SEASON GRASSES OF THE EDWARDS PLATEAU, ROLLING PLAINS, AND HIGH PLAINS

Cool-season grasses play an important role in extending forage production as warm-season grasses reach dormancy. Table 2 shows some key cool-season species found in the region. Although cool-season grasses can be a valuable asset on rangelands, they may have the potential to overwhelm and restrict the growth of warm-season grasses in the following year. Texas wintergrass is a cool-season perennial, providing much of the year-round forage base in the area. While it is of good forage value in its early growth stages, it can also outcompete other cool-season and even warm-season grasses to shift balance into its favor as dormant plant material begins to choke out warm-season grasses. Another vigorous cool-season grass, Japanese brome, is a weedy, invasive annual keen to develop a monoculture. When it comes to cool-season grasses and burning, range managers need to be familiar with the changes in competitive relationships that occur with the seasonal timing of a burn.

## Timing of Burns to Encourage Cool-season Grasses

The best chance at giving cool-season perennial grasses the upper hand with burning is to burn during the summer or fall when they are dormant. Burning in the fall minimizes any potential damage to cool-season perennial plants. Summer burns create higher yields of cool-season grasses, like Texas wintergrass, long after the area has recovered from a fire. This can be attributed in part to reduced canopy cover after burning the standing fuel of warm-season grasses. The reduced competition allows cool-season grasses enhanced access to nutrient resources when active growth resumes.

## Timing of Burns to Reduce Cool-season Grasses

The best chance to kill, damage, or inhibit cool-season grasses with fire is to burn during the spring when they are actively growing and before seed set. During this time, green, growing plant material is easily harmed by heat, plants have fewer carbohydrate stores under the soil surface, and, ideally, there is enough dormant warm-season grass material left over to carry an intense fire. If burning to reduce invasive cool-season annuals, the key is to burn shortly after their seedling establishment. In the case of cheatgrass and Japanese brome, early spring burns are typically the most effective. March burns significantly reduce brome density in the following years, compared to fall and winter burns. March burns impact vulnerable seedlings, producing excellent individual mortality and preventing another seed crop from reaching the soil. However, like many rangeland annuals, the seeds of Japanese brome are often unaffected by fire, especially once they have reached the soil, and should be considered by managers to reduce invasive annuals. Ultimately, cool-season grasses lie in a delicate balance that must be considered on an individual species basis and burned according to their unique phenology.

Spring burns can severely harm Texas wintergrass. While this offers the greatest chance at giving balance back to warm-season grasses, it still has the potential to increase Texas wintergrass yields down the road. Burning when cool-season annuals are present can increase Texas wintergrass standing crop in the following years. Because wintergrass is perennial, it maintains a competitive edge over its cool-season annual counterparts and can re-establish more quickly following a disturbance. Additionally, some annual species require mulch and litter on the ground for their seeds to establish, which may have been removed by the fire. Thus, less intense spring fires that are not able to completely kill individual wintergrass have the chance of increasing this perennial down the line.

## FORBS OF THE EDWARDS PLATEAU, ROLLING PLAINS, AND HIGH PLAINS

Forbs play an important role in rangeland diversity and provide essential protein for livestock and wildlife. They are often the first plants to grow after disturbances, such as prescribed burning and overgrazing. Although forbs are prolific and can protect soil from erosion, under certain conditions, forbs may outcompete beneficial grass species. Managers may desire to increase, decrease, or promote the diversity of forb populations based on their specific goals.

The best time to burn for forb diversity is summer when dominant warm-season grasses are dense. Summer burns show increases in prairie forb species in the following years, especially early-flowering, cool-season species. By contrast, earlier burns during March can reduce cool-season forb diversity and numbers in the following years. Like grasses, forbs are typically most vulnerable to fire when they are actively growing and before the annuals have set seed. The key to forb management is understanding how to effectively manage their competition. It can be difficult to solve a forb problem only using fire, but encouraging the growth of competitors with a weed management plan using proper grazing, fire, and herbicides can be effective.

## SHRUBS OF THE EDWARDS PLATEAU, HIGH PLAINS, AND ROLLING PLAINS

Increasingly, prescribed burning is used to control woody plant invasion in the High Plains, Rolling Plains, and Edwards Plateau regions of Texas. Areas with dense canopies of redberry and Ashe juniper may be incapable of carrying any sort of fire except extreme canopy fires in drought situations. In these cases, prescribed burning may serve better as a follow-up regime to mechanical control. In other cases, mature brush species like honey mesquite and redberry juniper are vigorous resprouters and often have low mortality rates. For this reason, shrubs in the area can be addressed in two groups: resprouting brush and non-resprouting brush.

### Resprouting Brush

The most concerning resprouting brush species in the area are honey mesquite and redberry juniper. Although native to Texas, they are still considered invasive in select areas, as their opportunistic life histories keep them thriving throughout drought or overgrazing. As native species, they are highly adapted to fire as well, making managing them with fire a lifelong challenge. When working with resprouting brush species, the focus of prescribed burning is less on mature individual mortality and more on the prevention of seedling establishment and damaging mature plants in combination with other treatments.

Timing and seasonality are less of a concern when the goal is preventing seedling establishment. Table 3 shows the estimated mortality of honey mesquite and redberry juniper plants based on the height/age class and season of the prescribed burn. Although this table may be used as a guide, actual mortality rates will depend on several factors, including fuel loads and moisture, soil depth, and location of bud zones. Redberry juniper trees may have above-ground bud zones for a longer period, leaving them potentially susceptible to root killing from fire alone for 8 to 12 years. Prescribed fire is most effective for redberry juniper mortality under dry conditions, when bud zones are above soil level, and with fine fuel loads exceeding 2,000 pounds/acre.

**Table 3. Estimated mortality rates of honey mesquite and redberry juniper plants based on the height/age class and season of prescribed burn.[1]**

| Common/Scientific Name | Age/Height | Burn Season | Mortality Rate |
|---|---|---|---|
| Honey mesquite *(Prosopis glandulosa)* | 1.5 years | Any | High |
| | 1.5 to 2.5 years | Any | Moderate |
| | 10 months | Feb./Mar. | 35% |
| | 17 months | Sept./Oct. | 85% |
| | > 3.5 years | Any | Low |
| Redberry juniper *(Juniperus pinchotii)* | < 20 in. | Fall/Early Spring | Moderate-high |
| | > 3 feet | Fall/Early Spring | Low |

[1] (Ansley et al., 2015; Steutter & Britton, 1983)

When it comes to damaging mature resprouters, intense fires have often become the method of choice. High-energy fires, especially during periods of water stress, produce greater top-kill results and may even reduce resprouting capacity. However, high-energy fires have not been shown to completely overcome these species' persistence mechanisms, especially basal resprouting. Consequently, integrated brush management approaches using a combination of management techniques with sequential treatments, proper timing, and long-term perspectives are often necessary to induce desired mortality levels for resprouting brush species.

### Non-resprouting Brush

Burning for brush control may be more successful when working with non-sprouting species. Ashe juniper, while less common than its redberry counterpart, is still problematic in areas of the Rolling Plains and Edwards Plateau. Like redberry juniper, Ashe juniper seedlings are vulnerable to fire at almost any time. However, mature trees have a greater potential to be killed by fire as they do not have below-ground buds. Ashe juniper requires less intense burns for mortality. Managers can see almost complete control when burning Ashe juniper less than 4 feet tall. These burns are often conducted in spring or winter, as the lower temperatures favor the preservation of desirable woody species like oak or pecan. Year-round control, however, is possible with adequate fine fuel loads.

To prevent brush seedling establishment, it is best to maintain healthy communities of dense-standing, warm-season grasses and to avoid overgrazing or overutilization of rangelands. Thus, a fire that is timed to promote warm-season grass growth and density also has the potential to be a brush management fire. Dense herbaceous fuels also produce the energy needed to safely top-kill mature brush, as top-killing from canopy fires in dense brush lacking understory is less than ideal. It takes all aspects of fire seasonality, in addition to good grazing management, to produce a well-rounded fire regime with effective brush management results.

## CONCLUSION

It must be noted that the exact timing of a burn is often difficult to control. The season in which a burn can be implemented is at the discretion of many variables, including but not limited to weather conditions, drought, grazing history, fuel moisture and availability, soil moisture, brush canopy, and personnel. Each burn area has its unique balance of plant species and, thus, must be evaluated based on individual species phenology, as timing could vary based on soils, rainfall, and range condition. It is essential to have management goals in mind when planning to conduct a prescribed burn in a specific season, but it is equally important to be aware of the successional effects a plant community will undergo if burning needs to occur at a different time.

Though many variables can delay or prevent prescribed fire application, it is important to remember that prescribed burning is a process. Managers must keep in mind that it may take 1 to 3 years of succession to see burn effects. Fire frequency is also key when implementing the prescribed burning process, and managers can help promote herbaceous cover by replicating historic fire intervals in the Edwards Plateau, High Plains, and Rolling Plains.

## REFERENCES


AgriLife Extension. (2023). *Plants of Texas rangelands: Virtual herbarium*. Department of Rangeland, Wildlife, and Fisheries Management, Texas A&M University, College Station. https://rangeplants.tamu.edu/

Ansley, R. J., Kramp, B. A., & Jones, D. L. (2015). Honey mesquite *(Prosopis glandulosa)* seedling responses to seasonal timing of fire and fireline intensity. *Rangeland Ecology & Management 68*(2): 194–203.

Steuter, A. A., & Britton, C. M. (1983). Fire-induced mortality of redberry juniper *(Juniperus pinchotii Sudw.)* broadcast burns, grasslands in Texas, brush problem. *Rangeland Ecology & Management/Journal of Range Management Archives, 36*(3), 343–345.