Prescribed Fire to Restore Shrublands to Grasslands

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Abstract: Prescribed burning to restore grasslands is more complicated than just setting a fire or, worse, letting a fire burn. We will examine how fire may be used to restore a more desirable landscape. First, any area that might be considered for prescribed fire should be thoroughly evaluated. Soils are paramount as they will indicate what we can expect from a given site. Then, we should study the plant community which originally existed on the site. Comparing the original plant community to the current plant community will help us construct a viable set of objectives. Second, we will determine how prescribed fire might be used in this restoration process. Should it be the first and only tool used or must it be preceded by some other tool, such as a mechanical or herbicidal treatment? Finally, we will consider a planning chart to organize the re-treatment scenario.

Introduction

Historically, periodic fire was the primary force in holding shrub populations at low densities on native grasslands west of the Mississippi River. Questions arise as to the timing and frequency of these fire events. Unfortunately, we will never know the exact nature of these events, as no recorders such as fire scarred trees are available to help us estimate what happened to grasslands in the past.

Frequency of fire occurrence in grasslands has usually been estimated in the range of once every 2 to 25 years. There is no normal or average fire return interval because the sequence of wet years and dry years impacts fuel loads and atmospheric condition conducive to fire spread. It would be a good guess to assume that widespread natural fires would dominate in dry years that followed one or more very wet year(s) (Wright and Bailey 1982). We believe that precipitation regimes and dry lightning storms produced the fire environments that shaped the western grasslands.

We would like to dispel the myth that summer fires are the most natural. If we take the human factor out of the equation, then the natural ignition source is lightning. Lightning can occur any month of the year throughout the western grasslands; thus, the condition of the fuel becomes paramount. Fuel moisture is the major predictor of when natural fires occurred. Except in drought years, this would narrow the most likely period from late winter to early spring just before green-up of grasses. Air temperature is the third most important factor in determining the natural fire period. During late winter and early spring, there are frequent warm days, and in summer, warm days are abundant. Lastly, humidity is a prominent factor. Relative humidity is commonly high in summer for most western grasslands. More importantly, absolute humidity is extremely high in summer compared to late winter and early spring. Absolute humidity is the factor that regulates dormant fine fuel moisture. In summary, we can say that a natural fire can occur in any month if the fine fuel is dry and lightning occurs.

Another myth that should be dispelled is that because summer fires were most common, they are the most natural and the most beneficial. We are aware of no data to support this myth in grasslands or shrublands. The opposite is supported by the literature (Wright and Bailey 1982). The more correct scenario would be to follow well-established rules of defoliation. After all, fire represents a severe defoliation with removal of herbaceous phytomass to near the soil surface. The accepted opinion is that in most western grasslands, herbaceous removal is least damaging in the winter dormant period and most damaging during the period of seed-set or mid summer (Holechek and others 2004). Sosebee and others (2004) emphasize this fact by stating “The most important deferment or rest period for grasses is post-reproduction to dormancy. For perennial, warm-season grasses in the southern Great Plains, this occurs from late summer to early autumn.” This clearly illustrates that fire in this period would be damaging to the forage resource.

Using fire in plant communities that have not experienced their historic fire regime is equivalent to applying a natural tool to an unnatural situation. We have mismanaged our plant communities so that the fuel matrix has been radically changed. We currently operate on the two extremes. Either we have reduced the fuel to such an extent that a fire will not spread, or fuel has accumulated to such high loads that the resulting fire is catastrophic. By resource mismanagement we have eliminated any possibility of a natural fire. Thus, our object in fire management is to apply prescribed fire to meet well-thought-out objectives relating to healthy, balanced, and productive grassland communities. Restoring fire as an ecological force in native plant communities is a priority of all land managers. Determining how and when to burn to achieve the most natural effect requires planning based on sound ecological and historical evidence. Natural landscapes and their features—geologic, edaphic, and biotic—are the manifestations of factors that structure the world around us. An important corollary of this principle is that natural landscapes also are *indicators* of these factors, both historically

In: Sosebee, R.E.; Wester, D.B.; Britton, C.M.; McArthur, E.D.; Kitchen, S.G., comp. 2007. Proceedings: Shrubland dynamics—fire and water; 2004 August 10-12; Lubbock, TX. Proceedings RMRS-P-47. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 173 p.

and currently. For example, geological processes in the distant past produce the parent material from which soil is formed by edaphic processes. These processes form the abiotic arena in which biotic factors operate to assemble the communities characterizing every landscape.

This perspective provided the conceptual cornerstone of Frederick Clements' pioneering vision of the climax community: *the* climax community was considered to be *the* ultimate expression of *the* stable equilibrium between vegetation and its environment. Hans Jenny and Jack Major later formulated these ideas into "factors of soil development" and "factors of vegetation development," respectively, frameworks that have guided the thinking of several generations of ecologists.

With European settlement of the U.S., the pristine environment, supposedly the climax, was altered in far-reaching ways. It was only natural to view these changes as *reversible* consequences of disturbance. After nearly a century of land management experience, most observers are reconciled with the conclusion that many of these changes may not be reversible. This realization motivated the development of *multiple stable equilibria*, whose trajectories depend on the nature of the disturbance and the accidents of subsequent vegetational development.

Most interpretations of vegetation change have variously implicated land use changes (usually in the context of domestic herbivory), climate (both short-term weather fluctuations and long-term climatic trends), and fire history. Climate change is a *global* issue that may be beyond our control. Land use patterns are a *local* issue best decided in the private sector by responsible land owners. Fire history is a *regional* issue that lies within the domain of state and federal agencies charged with land management. In this paper, we focus on the importance of fire history in understanding today's landscapes.

Recreating fire history is difficult even with the best information. In the forest, decisions based on trees with cat-faced scars that document past fire are rife with errors. In grassland or pygmy forest, this task becomes virtually impossible. However, good descriptions of previous landscapes can be reasonably approximated with an understanding of the total resource complex.

Old photographs offer good approximations of previous landscapes. Numerous examples throughout the western U.S. have been published, and many more can be found in private collections through diligent searching. These photographs must be evaluated with care to understand the complete natural resource base. For example, figure 1 illustrates a view on the historic Three Block Ranch in south-central New Mexico. The top photograph was taken in 1905 from the western peak of the Twin Mountains looking west. Erwin Smith took this photograph with George Patullo in the foreground. The ridge in the background has a sparse stand of juniper with possibly a few small pinon trees. The bottom photograph shows the identical location as photographed in 1990. Vegetation on the ridge has changed dramatically with juniper density and size increasing over the interval between photographs. The question is which photograph illustrates the *appropriate* ecological state of this ridge? Contemporary wisdom will say the 1905 photograph. After all, this rangeland had been stocked with cattle for less than 25 years and, although altered, the period of time had been short enough that the negative impacts were not yet fully manifest. Fire was eliminated from this plant community, and thus, no pyric control on woody plants has operated for at least 85 years. This resulting landscape is not in balance with historic ecological forces that included recurrent fire. Our challenge is to restore these natural forces.

Figure 1. These photographs were taken from the same location looking westward from atop the Twin Mountains along the Cienega del Macho at the headquarters of the Three Block Ranch.

We suggest additional information be found to support the evidence seen in the photographs. The first and easiest place to seek excellent information is a soil survey. In this case, the Soil Survey of Lincoln County Area New Mexico. This ridge is mapped as a 14 Deama-Rock outcrop association, very steep (fig. 2).

The following description is provided:

This map unit is on hills and breaks. Slope is 15 to 50 percent. Areas are irregular in shape and are 1,000 to 5,000 acres in size. The native vegetation is mostly short and mid grasses. Elevation is 4,500 to 6,000 feet. The average annual precipitation is 12 to 16 inches, the average annual air temperature is 45 to 56 degrees F, and the average frost-free period is 150 to 190 days,

This unit is 60 percent Deama very cobbly loam, 15 to 50 percent slopes, and 20 percent Rock outcrop of

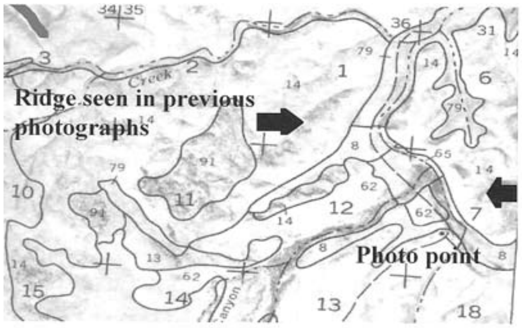

Figure 2. Section from Lincoln County Soil Survey showing the ridge illustrated in Figure 1 and the approximate location where the previous photographs were taken.

limestone. The Deama soil is on hills, and the Rock outcrop is on breaks.

Included in this unit are areas of other soils that may or may not be present in all mapped units. These areas are Harvey, Dioxice, and Pena soils on hillsides and Pastura soils on summits. Included areas make up about 20 percent of the total acreage.

The Deama soil is very shallow to shallow and is well drained. It formed in material derived dominantly from limestone. Typically, the Deama soil is brown, very cobbly loam about 7 inches deep over limestone.

Permeability of the Deama soil is moderate. Effective rooting depth is 7 to 20 inches. Available water capacity is very low. Runoff is rapid, and the hazard of water erosion is high. The hazard of soil blowing is slight.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on this unit is mainly sideoats grama, New Mexico feathergrass, plains lovegrass, and little bluestem. This unit can support scattered oneseed juniper. As the plant community deteriorates, the desirable forage plants decrease and there is an increase in threeawn, curlyleaf muhly, and catclaw acacia, which normally occur in small amounts in the potential plant community. Grazing management should be designed to increase the productivity and reproduction of plains lovegrass, sideoats grama, and little bluestem. This unit is poorly suited to rangeland improvement practices such as fences, pipelines for providing stock water, water impoundments facilities, and mechanical brush management because of the shallow and very shallow depth to bedrock and steepness of slope.

The average annual production of air-dry vegetation on this unit ranges from 1,100 pounds per acre in favorable years to 300 pounds in unfavorable years.

This range site description provides abundant information. First, it describes the soils on the range site and several important characteristics of the soils. If we do not understand soils, we do not understand the very basic unit of ecological planning. Second, it gives us a brief description of the common vegetation we should expect on the site and the most common increasers that occur as the plant community moves away from the climax. Vegetation description is the second basic unit of ecological planning. The herbaceous production also gives us a good indication of potential yield for this range site. This information clearly agrees with what we see in the 1905 photograph as it describes the site with "scattered oneseed juniper," not the dense juniper stand shown in the 1990 photograph.

Now that we have an initial impression of what this site should look like, we can expand and refine our view. Many sources of additional information are easily available. Surveyors' notes can be a especially useful. Diaries of early explorers and settlers may yield helpful information. Descriptive ecological research also can be valuable if one is careful to read and understand the sampling methodologies. Many times, the methodologies are not suitable to yield data that are useful. Old aerial photographs are especially useful as they illustrate changes in tree and shrub densities over time. Vast amounts of information are available to reconstruct our vision of past rangeland plant communities.

Reconstruction of past communities from historical sources (for example, old photos) and an understanding of current potential (for example, from soil survey descriptions) involve a number of interpretational issues that must be considered. For example, *suppose* that in the earlier photograph in figure 1, there was evidence of human habitation (an old ranch house, mining structure, or church). In this case, the absence of woody vegetation might then be only *apparent* if, in fact, woody vegetation was an important, harvested source of fuel. In this case, the presence of woody vegetation in the latter photograph in figure 1 might then be attributed to re-growth of woody plants that were, in fact, part of the historical community recorded in the earlier photograph and not woody plant invasion into a historical grassland because of the absence of fire.

Assuming that the *apparent* absence of woody vegetation in the earlier photograph in figure 1 is also a *real* absence, some investigators have attributed increases in woody shrubs throughout the Southwest to changes in climate. This interpretation may have merit, but it also is controversial, and resolution awaits additional research.

Once we understand the soils, plants, and ecology of an area, it is time to organize the planning chart for our fire treatment scenario. Our main objective is to ensure we have enough fine fuel (grass and forbs) to carry the fire and also accomplish our management goals. Redberry juniper at canopy covers of even less than 10 percent can greatly decrease fine fuel levels (Racher 2000). When juniper canopy cover reaches 30 percent, fine fuel is not continuous and a broadcast burn becomes extremely difficult and fire is not the first treatment. Therefore, we must resort to some

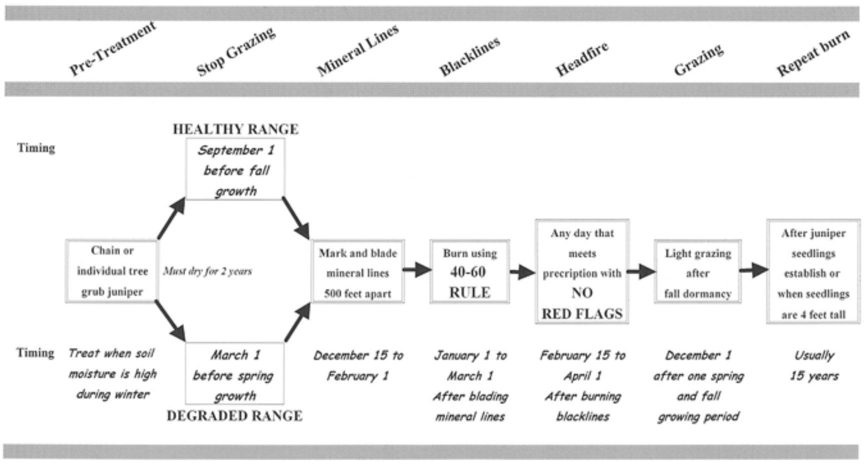

Figure 3. Planning Chart for a prescribed burn on lightly infested juniper rangeland in the Rolling Plains of Texas. Complex burn implies a volatile fuel involved in the fuel matrix.

mechanical treatment to reduce juniper canopy cover and increase fine fuel. On other rangeland communities herbicides may be effective in increasing fine fuel so fire can be returned to its natural role. The planning chart illustrated in figure 3 shows an initial mechanical treatment step. Next, we would have to allow the pasture to rest until sufficient herbaceous growth occurs to accumulate fine fuel. All these items must be flexible, as precipitation will exert a continuous and changing influence.

Weather conditions prior to the burn are very important. Excessive rainfall in the weeks before a prescribed burn can be either beneficial or disastrous. On the beneficial side, it is always desirable to have good soil moisture available so desirable plants can have an uninterrupted growth period after the fire. On the negative side, prolonged high moisture conditions will result in high juniper leaf moisture contents (Mitchell and Britton 1998). Leaf moisture concentrations above 70 percent reduce the ignition potential for the juniper canopy, and when the moisture concentration reaches 80 percent, canopy torching is nearly eliminated. Also, on clayey soils, precipitation can cause long intervals when road and firelines are impassible.

The reburn phase of the planning chart would also need to be flexible. If several above average precipitation years followed the burn, large numbers of juniper seed may germinate and establish. Fire should be applied sooner before either a high density of small plants reduces fine fuel load or the sprouting collar of redberry is buried and the plant becomes resistant to fire induced mortality.

Detailed planning and constructing a meaningful planning chart will help eliminate the wide variety of oversights that cause failure in prescribed burning. Attention to the interactions between environmental and plant responses will help increase the benefits of the prescribed burn.

The absence of fire in ecosystems that have historically burned must be an integral component in our understanding changes in plant communities. Considerable research has yielded a thorough understanding of fire's role in natural plant communities (FEIS 2005). With our understanding of how we might reintroduce fire into natural plant community dynamics, we can begin proactive management to achieve desirable goals. Since fire has been absent from our rangeland plant communities for a great number of years, it may not magically take us to the point we envision. It is reasonable to believe that fire will take us closer to our vision, but it is contrary to ecological principles for it to immediately return us to the original condition. Patience must be the guiding factor in our quest to pursue more natural plant communities through the process of goals, objectives, and strategies.

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