University of Nebraska–Lincoln EXTENSION

EC160

Management After Wildfire in Central and Western Nebraska

Jerry D. Volesky, Extension Range and Forage Specialist
Patrick E. Reece, Extension Rangeland Ecologist
Jon S. Wilson, District and Extension Forester

More than 90 percent of the grassland and forested savannah burned each year by wildfires in Nebraska is in the semi-arid region of the state, west of U.S. Highway 281. From 1987 to 2000, the total area burned by wildfires annually in this region ranged from about 4,550 acres in 1993 to 235,420 acres in 2000 *(Table I)*. High winds, low population densities, and limited natural or man-made fire breaks often set the stage for potentially large, fast moving, and destructive wildfires in this region. While lightning storms are seasonal, accidental ignition, careless management or disposal of burning debris, or arson can result in wildfires any time when adequate fuel and favorable climatic conditions occur. Lightning induced fires have been a natural part of these ecosystems for thousands of years; however, loss of herbage and damage to infrastructure from any wildfire may negatively impact commercial enterprises. Additionally, herbage is needed to provide cover and food resources for wildlife and protection against soil erosion in critical areas of the landscape.

Given the dependence of livestock and recreational enterprises on plant cover, management changes often

Table I. Number, extent, and time of occurrence of wildfires in central and western Nebraska counties from 1987 through 2000.[1,2]

			Percent of wildfire occurrence by time of year			
Year	*Number of wildfires*	*Acres burned*	*October 1 to March 31*	*April 1 to May 15*	*May 16 to June 30*	*July 1 to Sept. 30*
			%			
1987	832	25,506	29	18	10	43
1988	1,195	48,841	39	16	15	30
1989	1,452	189,307	41	25	14	20
1990	1,019	31,716	44	9	11	36
1991	984	34,212	44	12	4	40
1992	551	16,480	40	31	12	17
1993	306	4,551	45	23	11	21
1994	887	38,565	34	17	17	32
1995	831	95,650	37	5	5	53
1996	817	50,397	41	24	9	26
1997	1,304	35,966	52	12	11	25
1998	1,824	100,120	38	17	10	35
1999	889	177,488	59	8	7	26
2000	1,127	235,425	33	13	15	39
Average	1,001	77,445	41	16	11	32

[1]Central and western counties are all those from U.S. Highway 281 to the west.
[2]Data compiled from Nebraska Forest Service records.

are needed after fire to optimize the return of rangeland resources to pre-fire condition with minimal financial loss during the recovery process. Post-fire management plans often differ according to natural resource characteristics and management objectives of the enterprise.

Wildfire vs. Prescribed Fire

Prescribed fires are carefully planned and conducted to meet specific natural resource management objectives. These objectives may include increasing the nutritive value, palatability, availability, or yield of forage; suppressing unwanted species like eastern redcedar; or reducing excessive accumulations of plant material that may be a wildfire hazard or detrimental for wildlife and/or plant communities. Prescribed fires are most often conducted when desirable plants are breaking dormancy and soil moisture is adequate for sufficient plant growth after the fire. Except for applications to suppress undesirable plant species or remove excessive residual herbage from several years of plant growth on Conservation Reserve Program (CRP) grassland, most prescribed burning is conducted in eastern Nebraska.

Fire Effects on Rangeland Ecosystems

A review of research on post-burn vegetation response in native rangeland suggests a wide variety of responses are possible (Engle 2001). This can likely be attributed to the large number of interacting factors and variables associated with any given fire. Vegetation response to fire can differ measurably because of differences in season of occurrence, soil moisture, fire intensity (as affected by fuel load, wind speed, temperature, and relative humidity), range condition and plant vigor before the burn, and precipitation and weather conditions after the fire. Fire can affect a wide array of vegetation characteristics including nutritive value and production of herbage, species composition, plant density and size, root development, and seed survival and germination.

Soil characteristics that may be affected include temperature, moisture, pH, nutrients, and erosion. A number of factors affect the potential for runoff and soil erosion after a wildfire. Soil moisture content before precipitation and soil texture greatly affect infiltration, the rate at which surface water moves into the soil *(Table II)*. When soils are wet, infiltration cannot exceed permeability, the rate at which water moves through the soil profile. Availability of soil moisture is the primary variable limiting plant growth in semi-arid environments. Measurable amounts of runoff result in measurable reductions in plant growth. As length and degree of slope increase, the flow rates of surface water increase exponentially. Consequently, protective plant material becomes increasingly important for restoring burned areas to prefire hydrologic condition as soil texture becomes finer and topographic relief increases. Standing herbage and litter are especially critical for reducing the physical impact of raindrops on soil surface particles and impeding the flow of surface water during periods when heavy precipitation occurs. About 70 percent of the annual precipitation in central and western Nebraska occurs from April through August. Much of the precipitation from late June through August occurs during heavy thunderstorms. Prudent postfire grazing management decisions must be based on the hydrologic conditions within the burned area and the probability of heavy precipitation events.

Table II. Permeability of clay, loam, and sand surface soils when wet (at field capacity) or dry (below the wilting point) and the amount of water available to plants at field capacity.

	Permeability		
Soil series	*Wet*	*Dry*	*Plant-available water*
	- - inches/hour - -		inches/3 ft of soil
Orella clay	0.05	0.20	1.8
McCook loam	0.80	2.50	6.0
Valent sand	5.00	10.00	1.5

Date of Wildfire

Dormant Season

Season or date of burning is an important factor when predicting the effects of fire on rangeland. About 41 percent of the wildfires west of U.S. Highway 281 in Nebraska occur from October to March when vegetation is dormant *(Table I)*. After a killing frost, the remaining live tissue in perennial grasses and forbs is at the soil surface or below ground. Consequently, fire has a direct physiological effect on these plants only when crowns are burned or exposed to excessive heat. New growth will be initiated from buds that are at or below the soil surface during the next growing season. However, many species store energy reserves in the lower portions of stems and in crowns. If fire damages plant crowns, it is likely that these plants will have reduced vigor and production during the next growing season.

Little bluestem, a bunchgrass that tends to accumulate dead stems and leaves, is particularly susceptible to damage from fire. This effect will be greater when it is very dry and there is abundant old growth within the bunch (Pfeiffer and Steuter 1994). Negative impacts on little bluestem may be reduced when strong winds move fire rapidly over the landscape. When post-fire conditions are favorable, the major warm-season, rhizomatous grasses (prairie sandreed, sand bluestem, big bluestem, and switchgrass) are generally not affected by a dormant season wildfire. Buffalograss is typically set back after fire but recovers in a few years. The response of blue grama and sideoats grama has been variable.

Figure 1. Early spring growth following a dormant-season wildfire on Sandhills rangeland. Note evidence of wind erosion on distant hills.

Most sedges and cool-season grasses are not as greatly affected by a dormant-season wildfire. Under favorable post-fire conditions, productivity of western wheatgrass, prairie junegrass and sedges may increase. Similar to little bluestem, needleandthread and green needlegrass may be damaged by fire if fuel loads are high within the bunches. There often are marked increases in annual and perennial forbs for one to two years after a dormant-season fire; many of these are considered to be weedy species.

Loss of litter and standing residual plant material well in advance of the next growing season greatly increases the risk of wind erosion, particularly on sandy soils *(Figure 1)*. Litter, which is dead and decaying plant material on the soil surface, and the standing residual herbage help protect the soil from wind and water erosion, increase water infiltration, reduce soil moisture evaporation, and stabilize soil surface temperatures.

Research has found that on sandy and sands range sites in the Sandhills, total herbage production the year after a late-summer or dormant-season fire was similar in burned and unburned areas (Volesky and Connot 2000). In these studies, however, precipitation was near or above average during the growing season after the burn. Production on choppy sands sites will likely be less on burned than unburned areas the year after fire, particularly if erosion has occurred (Bragg 1978).

Growing Season

When plants are green, perennial grass response to fire depends on the position of growing points within individual tillers. Grass tillers are composed of a shoot, crown, and roots. Bunchgrasses form dense populations of many tillers whereas sod-forming grasses are usually composed of widely dispersed tillers. Leaves within each tiller originate from the growing point, which is initially near the soil surface. Elevation of the growing point is associated with stem development. Vegetative tillers may remain stemless with the growing point near the soil surface the entire growing season. Growing points that are elevated in elongated tillers can be consumed or damaged by fire, ending growth in those tillers. New tillers may be produced by buds in the crown, on rhizomes, or on stolons if soil moisture and air temperatures are favorable; however, this growth comes at the expense of the plant's energy reserves.

Wildfires at any time of year will affect habitat of many species of wildlife. Fires during the growing season also have the potential to severely impact nesting and brooding activity of ground-nesting birds *(Table III)*. Visual obstruction from standing herbage is critical for the successful completion of these activities for most species.

Table III. Potential detrimental effects of wildfire timing on nesting and brooding activity of ground-nesting birds.

Consideration	*Oct-Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*
Destruction of active nests							
Disruption of current year brooding activity							
Risk of inadequate cover for spring nesting next year before plant growth[1]							

[1]The beginning and end of moderate risk in not providing adequate nesting cover is dependent on the season of growth of dominant grass species.

Low **Moderate** **High**

Table IV. Seasonal likelihood of wildfires affecting post-fire herbage production through interaction with environmental variables and plant growth and development.

Consideration	*Oct-Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*
Seasonal wind distribution[1]	Moderate / High	High	High	High	Low	Low	Low
Seasonal precipitation distribution[2]	Low	Moderate	Moderate / High	High	High	High	Moderate
Potential of severe defoliation to reduce vigor of cool-season species[3]	Low	Moderate / High	High	High / Moderate	Low	Low	Low / High
Potential of severe defoliation to reduce vigor of warm-season species	Low	Low	Low / Moderate	Moderate / High	High	Moderate	Moderate

[1]Probability of days with an average wind speed greater than 15 mph.
[2]Much of the precipitation during June, July, and August occurs during thunderstorms and may exceed infiltration rates. If wildfires occur in the fall, winter, or spring, plant growth during April, May, and/or June will diminish the risk of reduced infiltration and accelerated soil erosion on slopes.
[3]Severe defoliation of fall green-up in cool-season grasses will reduce energy reserves needed for winter survival and spring green-up.

Low	**Moderate**	**High**

Wildfires during April and May are usually most damaging to cool-season species *(Table IV)*. In contrast, wildfires in late May and June may damage cool- and warm-season species because many are actively growing during this period. In order for wildfires to occur in late spring and early summer, it is likely that dry conditions exist, further compounding the problem. Continued dry conditions after the fire will hinder plant growth and increase the risk of soil erosion during the thunderstorm season.

An average of 32 percent of all wildfires in central and western Nebraska occur during July, August, or September *(Table I)*. Conditions for wildfire are usually favorable because of herbage accumulations in ungrazed summer and dormant-season pastures and potentially rapid drying of herbage under summer air temperatures. Lightning typically starts the majority of fires at this time of year.

The response of different plant species to wildfires in July to September varies *(Table IV)*. Cool-season species are mature and may be in summer dormancy, reducing the potential of fire damage to plants; however, sedges and cool-season grasses may produce additional herbage in late August, September and early October. When these plants have little or no green herbage before a fall green-up, stored energy reserves are used for initial growth. If the green-up is interrupted by fire, frost, or grazing, reductions in stored energy may delay spring green-up and reduce herbage production during the next growing season. Additionally, cool-season species often initiate biennial tillers in late August and September, which over-winter and resume active growth the following spring if not damaged by fire.

Warm-season species grow rapidly during June and early July and reach maturity in late August or September. The risk of damage to warm-season species is greatest in July and diminishes as plants mature. Because minimal growth occurs in warm-season grasses after August, the greatest concern is exposure of bare soil surface to wind and rain for up to eight months until the next growing season.

Post-Wildfire Evaluation

Mapping

Maps of burned areas can be useful for future reference. This is especially true of pastures that were partially burned. Information about the fire (date, weather conditions) and specific observations (severity of the burn, amount of remaining residual herbage or litter, if any) also should be recorded. Areas highly prone to erosion should be identified and control measures considered. Range management specialists with the Natural Resources Conservation Service (NRCS) can provide assistance with post-fire evaluation and mapping.

Monitoring

In conjunction with maps and site information, grazing and precipitation records before and after the fire are valuable for monitoring recovery and assessing effectiveness of management practices. Vegetation in properly managed pastures often recovers more rapidly than vegetation that has been repeatedly exposed to excessive defoliation. Differences in recovery among burned areas may be caused by differences in fire intensity, site variables, composition of plant species, and grazing management or other defoliation processes such as hail, frost, or grasshoppers. Initially, it will be necessary to monitor degree of use in burned areas frequently to avoid overgrazing.

Fences

Accumulation of herbage in ungrazed areas or on meadows can result in fire burning through wood posts or complete combustion of the posts. In the absence of heavy fuel loads, the structural integrity of most wood posts is not reduced by rapidly moving wildfires. Research has shown that fire does not affect the breaking strength, zinc coating, or ductility of most types of barbed wire, regardless of the age of the wire (Engle and Weir 2000). After a fire, wire often exhibits a staining or discoloration of the galvanized surface. This discoloration comes from the iron-zinc layers within the coating and does not indicate coating failure or rusting of underlying steel. Plastic posts or insulators, commonly used with electric fence, are easily damaged during a fire. Similarly, fire may reduce the structural integrity and lifespan of fiberglass posts, warranting their replacement.

Grazing Management

Grazing Strategies

The primary resource management objective after a wildfire is the replacement of protective plant material and litter needed to restore burned areas to pre-fire hydrological condition and to reduce the risk of erosion. The rate at which residual or carryover herbage from preceding years accumulates depends on environmental variables, grazing management decisions, and other defoliation processes. Levels of residual herbage generally are similar among burned and unburned areas at the end of the first full growing season after a fire with relatively high annual precipitation or subirrigation and within two to three years on upland sites in western Nebraska.

Excluding livestock until October the year after a wildfire allows plants to attain full growth and enhances the recovery of vigor. The potential effect of wildfire on plant vigor is closely related to the date of the fire *(Table IV)* and suitability of soil moisture and air temperatures for plant growth after the fire. Depending on the percentage of the ranch affected by wildfire, full growing season deferment the year after fire may not be feasible. If pastures are to be grazed during the first growing season after a wildfire, wait until mid-June or later.

Stocking Rates

Stocking rates should be no more than 25 percent to 50 percent of normal on burned upland range sites during the first year after a summer or dormant season fire. Although plant growth may look adequate or even abundant in pastures that had burned, reduced stocking rates will allow more of the plant material to eventually become residual cover and litter. Stocking rates during the second year after a wildfire could be 70 percent to 90 percent of normal. If burned and unburned areas are not separated with temporary electric fence, stocking rates should be based on proper use of burned areas without regard for under-utilization of the unburned areas. Livestock should be excluded from areas highly prone to erosion until enough herbage has been produced to ensure site stability after grazing.

In all situations, further reductions in stocking rate would be needed to accommodate drought or delayed recovery of key forage-producing species.

Partially Burned Pastures

If burned and unburned areas are not separated, livestock will preferentially graze herbage in burned areas within pastures regardless of stocking rates or stocking densities. Forage produced after a fire is not mixed with residual herbage from preceding years. Consequently, nutrient density is higher in herbage on burned than on unburned sites.

Temporary fencing should be used to isolate unburned areas for grazing if carrying capacity for unburned portions with water will justify the cost. Temporary fenced lanes across burned land to provide access to water can result in measurable damage to upland range sites. If temporary water lanes are used, they should be located in areas with low erosion potential. When possible, avoid establishing water lanes through burned areas during the first year after a fire.

In locations with relatively high annual precipitation or subirrigation, it may be feasible to use prescribed burning to remove residual herbage from initially unburned portions of a pasture. This is particularly true if unburned areas have undesirable plants that can be controlled by fire and fuel loadings are adequate for burning objectives.

Emergency Forage Options

Depending on the percentage of a ranch's pasture affected by wildfire or if dry conditions limit plant growth, alternative feed resources and/or relocation or sale of livestock should be considered. A number of emergency forage options could be used to accommodate deferring or resting pastures and reducing stocking rates. Cereal crops such as triticale, winter wheat, rye, or oats can be used for grazing or haying. Summer annual forages, such as sudangrass, forage sorghum, or millets could be planted. These forage options are the same as those that could be used in a drought situation. Wet meadows can provide excellent spring and early-summer grazing. Meadows that are dominated by cool-season species can have adequate new growth to begin grazing by early May. Forage production on meadows during May and June can support about two to three animal

Figure 2. Fire-damaged windbreak with new tree planting. Note dead trees left to provide short-term protection.

unit months (AUM) per acre under proper grazing management; however, hay production from the grazed meadow will be correspondingly reduced. Fertilization may be an economically efficient way to increase forage resources or hay production on meadows or seeded pastureland.

If hay has to be purchased, test its quality to formulate cost-effective rations that meet but do not exceed the nutritional needs of specific classes of livestock. In some situations, livestock management practices such as heavy culling and/or early weaning could be considered to reduce feed and forage needs.

Trees and Windbreaks

Wildfire can cause considerable damage to trees and shrubs in windbreaks and other tree plantings. Often, the initial reaction by landowners is to remove fire-damaged trees and replant as soon as possible. However, some tree and shrub species may survive or be able to sprout after fire. Most broadleaf tree species and some shrubs, such as chokecherry, resprout from buds near or below the soil surface after fire occurs. Well-established root systems of fire damaged plants allow sprouts to grow more rapidly and survive environmental stresses better than newly planted seedlings. In contrast, evergreen trees, like cedar and pine, will not resprout. If the foliage on evergreen trees turns reddish-brown and dry after a fire, the trees are most likely dead.

Another advantage of delaying tree removal is that dead trees are better than no trees. The stems and branches of dead trees will function similarly to a slated wood snowfence, providing some summer and winter wind protection *(Figure 2)*. The result is often improved establishment success of newly planted trees and shrubs.

Finally, before any trees are removed, contact a consulting forester to appraise the value of the destroyed trees.

There are several options for replacing damaged plants, such as planting bare root or containerized trees and shrubs, or transplanting larger trees and shrubs with a tree spade. If only a portion of a windbreak is damaged, new trees can be planted between burned trees. In situations where extensive damage occurs, part of the windbreak may need to be removed to facilitate renovation. There also may be an opportunity to redesign the windbreak or to change its location and/or species composition to make it more effective for the landowner's objectives.

The key to re-establishing fire-damaged windbreaks is proper evaluation and planning. Landowners need to initiate the planning process early to ensure availability of tree and shrub species best suited for their soils, to properly prepare planting sites, and to obtain cost-share assistance. Landowners who would like assistance with renovating fire-damaged windbreaks or planning a new tree planting should contact their District Forester or local University of Nebraska Extension office, Natural Resource District, or Natural Resources Conservation Service office.

Landowners also should consider establishing a firebreak around their windbreaks to minimize or reduce the risk of fire damage. Management practices to reduce the amount of fine fuels (grasses) would include grazing or haying around the windbreak perimeter and/or mowing or tillage between tree rows inside the windbreak.

References

Bragg, T.B. 1978. Effects of burning, cattle grazing, and topography on vegetation of the choppy sands range site in the Nebraska Sandhills prairie. pp 248-253. In: Proc. First International Rangeland Congress. Society for Range Management, Denver, Colo.

Engle, D.M. and J.R. Weir. 2000. Grassland fire effects on corroded barbed wire. Journal of Range Management. 53:611-613.

Engle, D.M. 2001. Viewpoint: The response of central North American prairies to seasonal fire. Journal of Range Management. 54:2-10.

Pfeiffer, K.E. and A.A. Steuter. 1994. Preliminary response of Sandhills prairie to fire and bison grazing. Journal of Range Management. 47:395-397.

Volesky, J.D. and S.B. Connot. 2000. Vegetation response to late growing-season wildfire on Nebraska Sandhills rangeland. Journal of Range Management. 53:421-426.