

Gerald J. Gottfried
Peter F. Ffolliott
Pablo Garcia
Diego Valdez-Zamudio
Akram Al-Khouri

Assessment of Fire-Damaged Mesquite Trees 8 Years Following an Illegal Burn

Abstract: Effects of an illegal burn on the Santa Rita Experimental Range on mesquite (*Prosopis velutina*) survival in the semidesert grass-shrub ecosystem was initially assessed in terms of fire-damage classes 18 months after the fire and again 8 years after the burn. While many of the mesquite trees on the burned site were damaged by the fire, some of the trees appear to have recovered to preburn conditions. The effects of the burn on mesquite stocking characteristics and sprouting mortality were also determined from the latter assessment. Results obtained from the 8-year assessment add to the knowledge about the effects of fire on mesquite trees in semidesert grass-shrub ecosystems of the Southwestern United States.

Keywords: mesquite trees, fire-damaged, survival, postfire sprouting

Acknowledgments: The authors gratefully acknowledge the reviews of this paper by Malcolm J. Zwolinski, University of Arizona, Tucson, Carolyn H. Sieg, USDA Forest Service, Flagstaff, AZ, and Ronald J. Bemis, USDA Natural Resources Conservation Service, Douglas, AZ.

Introduction

An illegal fire burned approximately 80 acres of a mesquite-dominated semidesert grass-shrub rangeland in Sawmill Canyon on the Santa Rita Experimental Range in the early summer of 1994. The initial effects of this burn on the mesquite component of the burned ecosystem were assessed in the late fall of 1995, about 18 months after the fire (DeBano and others 1996). This paper reports on a followup assessment of the effects of the burn on mesquite trees 8 years after the fire. The current assessment was made to determine the extent to which fire-damaged mesquite trees have succumbed or recovered from the burn and whether stocking by mesquite has returned to preburn conditions in the absence of management practices to prevent their return. The information contributes to the earlier literature base (Alonso 1967; Cable 1965; Cox and others 1990; DeBano and others 1996; McLaughlin and Bowers 1982; Reynolds and Bohning 1956; White 1969; and others) on the effects of fire on mesquite in semidesert grass-shrub ecosystems of the Southwestern United States.

Fire Site

The fire burned on a rocky site about 1½ miles from the Florida Canyon Headquarters near the southern boundary of the Experimental Range. The site is 3,900 ft in elevation on largely southerly slopes ranging from 5 to 20 percent. Soil information is not available for the site. The prefire overstory was dominantly mesquite with ocotillo (*Fouquieria splendens*) scattered throughout. The prefire herbaceous cover based on similar sites at Santa Rita was dominated by Lehmann lovegrass (*Eragrostis lehmanniana*), a species that was introduced onto the Experimental Range in the 1930s (Cox and Roundy 1986), with black grama (*Bouteloua eriopoda*) and Arizona cottontop (*Digitaria californica*) intermixed. Cattle grazed the site in accordance with research plans prepared by the University of Arizona (Womack 2000). Fuel loadings before the fire are unknown.

Gerald J. Gottfried is Research Forester, Rocky Mountain Research Station, USDA Forest Service, Phoenix, AZ, phone: 602-225-5357. Peter F. Ffolliott and Pablo Garcia are Professors and Research Assistants, School of Renewable Natural Resources, University of Arizona, Tucson. Diego Valdez-Zamudio is Professor, Faculty of Agriculture, University of Sonora, Hermosillo, Sonora, Mexico. Akram Al-Khouri is Professor, Faculty of Agriculture, Damascus University, Damascus, Syria.

In: McClarlan, Mitchel P.; Ffolliott, Peter F.; Edminster, Carleton B., tech. coords. Santa Rita Experimental Range: 100 years (1903 to 2003) of accomplishments and contributions; conference proceedings; 2003 October 30–November 1; Tucson, AZ. Proc. RMRS-P-30. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Methods

Numbers of fire-damaged mesquite trees and mesquite with no visible fire damage were tallied on 40 $1/20$ -acre temporary plots spaced at 100-ft intervals along a series of randomly located transects traversing the burned area. The tallied mesquite trees were classified in terms of the following fire-damage classes:

- No visible damage
- Partial crown damage (initially classified as scorched crowns) with and without basal sprouting
- Complete crown kill (initially classified as either shoot killed or root killed) with and without basal sprouting

Diameter at root collar (d.r.c.) was measured on the single-stemmed trees that were tallied and equivalent diameter at root collar (e.d.r.c.) was calculated for multiple-stemmed trees (Chojnacky 1988). Equivalent diameter at root collar is the square root of the sum of squared d.r.c. values of the individual stems. These diameter measurements were later related to the occurrence of mesquite trees in the fire-damage classes.

Statistical comparisons of the assessment of fire-damaged mesquite trees 18 months after the fire with respect to the assessment made 8 years following the burn were limited because of the differences in the nature of the two sampling procedures. Temporary plots were established in both of the assessments, precluding remeasurements of the same tallied trees. Also, there was a larger number of $1/20$ -acre plots (60) in the initial postfire assessment. Although the same area of the burn was sampled in both assessments, the placement of transects was another factor. A Fisher's Exact Test and a chi-square tests were used to evaluate the proportion of stocked plots and the distribution of trees among damage classes. Statistical significance is indicated by an $\alpha = 0.05$. General trends and relative comparisons are reported in this paper. If the sample in each assessment is assumed to be representative of the burned area, these data should provide insights into changes over the past 8 years.

Results and Discussion

A total of 79 mesquite trees (equivalent to 39.5 trees per acre) were tallied on 18 (45 percent) of the 40 plots. The remaining plots were not stocked with mesquite. A total of 257 mesquite trees (equivalent to 85.7 trees per acre) were tallied on 37 (61.7 percent) of plots traversing the burned site 18 months after the fire (DeBano and others 1996). The apparent reduction in the stocking of mesquite trees is attributed largely to the intervening mortality of severely fire-damaged trees tallied 18 months after the burn. However, the proportion of stocked plots was not significantly reduced over the 8-year period.

The percent of mesquite trees in the respective fire-damage classes for the two assessments is shown in figure 1. The distribution among classes differed significantly between the two periods. While the number of trees tallied 8 years after the fire was smaller, the relative proportions of trees with no visible damage, partial crown damage (scorched crowns), and complete crown kill with basal sprouting (shoot killed) were largely similar in the two assessments. There was a decrease in the relative portions of trees that experienced complete

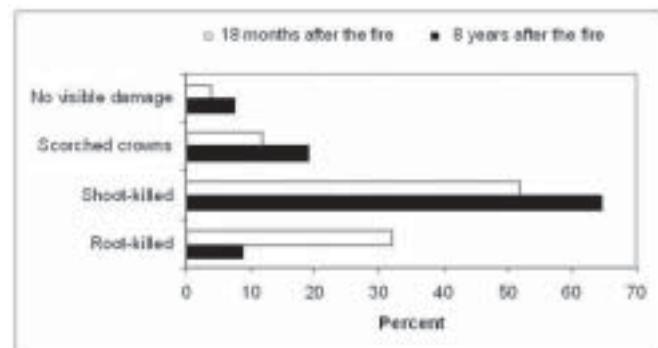


Figure 1—Percent of mesquite trees in fire-damage classes 18 months and 8 years following the Sawmill Canyon fire on the Santa Rita Experimental Range.

crown kill with no sprouting (root killed). This finding was partially due to incorrectly identifying mesquite trees in this fire-damage class in the initial assessment.

The sampled mesquite trees in 2003 ranged from 0.8 to 16.2 inches in diameter at d.r.c. or e.d.r.c. There were no relationships between the occurrence of mesquite trees in the fire-damage classes and their respective diameters (either d.r.c. or e.d.r.c.) or between the occurrence of these trees and the total number of trees that were tallied on the plots. This finding was similar to that reported in the initial assessment of the burn (DeBano and others 1996). Such relationships (or the lack of these relationships) are mostly fire specific (Cable 1965; McLaughlin and Bowers 1982; Reynolds and Bohning 1956; White 1969; Womack 2000) and probably affected by the interactions of fire intensity and fire-damaged tree size.

The postfire sprouting characteristics of mesquite 8 years after the burn were the same as those observed by Cable (1965), White (1969), and McLaughlin and Bowers (1982). Basal sprouts originating below the ground surface were the most commonly observed form of sprouting in the trees with partial crown damage (initially scorched crowns) in both postfire assessments. Basal sprouts were also observed in trees with complete crown kill, which were assumed to be shoot killed but not root killed 18 months after the fire.

Management Inferences

It was postulated that stocking by mesquite trees might return to preburn conditions in the absence of management practices to prevent their return in the 18-month assessment (DeBano and others 1996). However, this level of restocking had not occurred 8 years after the fire, and it is unlikely that it will be attained in the near future. It is concluded, therefore, that the Sawmill Canyon fire effectively converted a semidesert grass-shrub rangeland originally stocked (to an unknown level) with mesquite trees to a rangeland of relatively few mesquite trees. However, the effects of the reduction in tree density on the herbaceous cover are unknown. Fire has been reported to be effective in eliminating mesquite from semidesert grass-shrub rangelands in other studies (Cable 1965, 1967, 1972; Humphrey 1963, 1969; Martin 1975, 1983; Reynolds and Bohning 1956;

White 1969). These latter studies mostly involved applications of prescribed burning treatments rather than the occurrence of a wildfire as reported in this paper.

References

Alonso, R. C. 1967. Desert grassland mesquite and fire. Tucson: University of Arizona. 164 p. Dissertation.

Cable, D. R. 1965. Damage to mesquite, Lehmann, and black grama by a hot June fire. *Journal of Range Management*. 18: 326–329.

Cable, D. R. 1967. Fire effects on semidesert grasses and shrubs. *Journal of Range Management*. 20: 170–176.

Cable, D. R. 1972. Fire effects in Southwestern semidesert grass-shrub communities. *Tall Timbers Fire Ecology Conference*. 1972: 150–153.

Chojnacky, D. C. 1988. Juniper, pinyon, oak, and mesquite volume equations for Arizona. *Res. Pap. INT-391*. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 11 p.

Cox, J. R.; Roundy, G. B. 1986. Influence of climatic and edaphic factors on the distribution on *Eragrostis lehmanniana* in Arizona, U.S.A. *Journal of the Grassland Society of South Africa*. 3: 25–29.

Cox, J. R.; Ibarra-F., A; Martin-M, M. H. 1990. Fire effects on grasses in semiarid deserts. In: Krammes, J. S., tech. coord. *Effects of fire on Southwestern natural resources*. Gen. Tech. Rep. RM-191. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 43–49.

DeBano, L. F.; Gottfried, G. J.; Villanueva-Diaz, J.; Ffolliott, P. F.; Valdez-Zamudio, D. 1996. Initial assessment of fire-damaged mesquite trees following an illegal burn. In: Ffolliott, P. F.; DeBano, L. F.; Baker, M. B., Jr.; Gottfried, G. J.; Solis-Garza, G.; Edminster, C. B.; Neary, D. G.; Allen, L. S., tech. coords. *Effects of fire on Madrean Province ecosystems; a symposium proceedings*. Gen. Tech. Rep. RM-GTR-289. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 226–228.

Humphrey, R. R. 1963. The role of fire in the desert grassland areas of Arizona. *Tall Timbers Fire Ecology Conference*. 1963: 45–62.

Humphrey, R. R. 1969. The past role of fire in range management in the Southwest and some future possibilities. In: Wagle, R. F., ed. *Proceeding of a conference on fire ecology and control and use of fire in wildland management*: 52–56.

Martin, S. C. 1975. *Ecology and management of Southwestern semidesert grass-shrub ranges: The status of our knowledge*. Res. Pap. RM-156. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 39 p.

Martin, S. C. 1983. Response of semidesert grasses and shrubs to fall burning. *Journal of Range Management*. 36: 604–610.

McLaughlin, S. P.; Bowers, J. E. 1982. Effects of wildfire on a Sonoran desert plant community. *Ecology*. 63: 246–248.

Reynolds, H. G.; Bohning, J. W. 1956. Effects of burning on a desert grass-shrub range in southern Arizona. *Ecology*. 37: 769–777.

White, L. D. 1969. Effects of a wildfire on several desert grassland shrub species. *Journal of Range Management*. 22: 284–285.

Womack, J. D. 2000. Mortality and sprouting vigor of burned and cut velvet mesquite (*Prosopis velutina* Wooten): the role of basal diameter and number of stems. Tucson: University of Arizona. 61 p. Thesis.