

Chapter 24

Wildland Fire Management in the Guadalupe Mountains

TIM STUBBS has been with the National Park Service since 1969, in positions with fire management as a primary duty. He is currently the fire management officer at Carlsbad Caverns National Park and serves Guadalupe Mountains National Park as a prescribed fire planner. He has helped implement prescribed fire programs in several national parks and has assisted with interagency efforts to do the same.

“These four bodies are fire, air, water, earth.”—Aristotle, *Meteorologica*

This paper presents some of the available literature that supports the wise use of wildland fire and prescribed fire in the Guadalupe Mountains and in the adjacent upper Chihuahuan Desert biome. It is also a collection of personal observations and communications regarding wildland fire in the Guadalupe Mountains. It is hoped that the reader will come to understand why the fire management program at Carlsbad Caverns and Guadalupe Mountains national parks supports frequent, low intensity wildland fire in the parks' wilderness areas. Managers of both parks believe that all scientific research and other available evidence supports this management approach and mimics what nature would be doing were we not present.

Frequent fire?

For centuries prior to settlement, large unrestrained wildland fires burned every few years in the Guadalupe Mountains. Lightning ignitions are frequent, statistically more frequent than in most of the rest of North America (Komarek 1967, Schroeder et al. 1977). Tree ring analysis completed by the University of Arizona (Swetnam et al. 1994, Baisan et al. 1995) throughout the region and locally in the Bowl area of Guadalupe Mountains National Park suggests the median frequency of fire between 1700 and 1900 in southwestern “sky island” mountains to be less than 10 years. Fire scar analysis also showed these wildland fires to be low-intensity surface fires that rarely

damaged the overstory trees under which they burned. These studies and historic records in the Southwest (Bahre 1985) suggest that these fires were often very large, in the thousands of acres, and burned for weeks at a time in certain dry years, especially in the lower grasslands (Pyne 1982a).

Ponderosa and piñon pines in the west end of Carlsbad Caverns National Park and throughout the Lincoln National Forest portion of the Guadalupe Mountains show numerous fire scars (Ahlstrand 1981; author's personal observations). Texas madrone and even Torrey yuccas similarly display numerous fire scars throughout the lower elevations. Ahlstrand generalized that, between 1697 and 1922, the maximum interval between major fires in the higher Guadalupe appeared to be 30 years.

Studies done by Texas Tech University (Wright 1974, Bunting and Wright 1977) have suggested a similar high frequency, low intensity fire regime throughout the upper Chihuahuan biome of west Texas and southeast New Mexico. More recently other Texas Tech researchers have shown the beneficial effects of fire in the diversity of desert scrub communities adjacent to the Guadalupe (Monasmith et al. 1996).

Large fires?

It is well documented that the last very large natural, unsuppressed fire in the Guadalupe occurred no later than 1922 (Ahlstrand 1980). After this time a combination of heavy grazing and a full fire

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suppression policy limited ignitions to [fires that were] generally very small in size. In the Carlsbad Caverns area goats and sheep heavily grazed all available forage beginning in the 1920s and continuing until about 1942. Guadalupe Mountains National Park was subjected to varying amounts of grazing through this period and was known to have three times the calculated carrying capacity of cattle in the few years prior to its protection as a national park (personal communication with Kenneth McCollum, U.S.D.A. Forest Service fire management officer 1968–1992 and lifetime rancher and resident of Queen, New Mexico).

The next very large fire after 1922 did not occur until 1974. The Cottonwood Fire in the Upper Slaughter Canyon area was over 15,000 acres despite formidable U.S. Forest Service and National Park Service efforts to suppress it. The X-Bar fire in 1976 was 12,000 acres in upper Dark Canyon. It was widely agreed that the regime of periodic large fires in the Guadalupe had returned due to the cessation of grazing on National Park Service lands and the reduction of heavy grazing on U.S.D.A. Forest Service lands.

Between 1974 and the present there have been numerous lightning-ignited fires in the vicinity of both national parks that reached several thousand acres despite a continued full suppression policy. Many of these are listed and described in the fire management plans for the two parks (Stubbs 1995, Sullivan 1997), and fire report files in both parks. There similarly occurred many large wildfires and management-ignited prescribed fires on the adjacent Lincoln National Forest during this period even as light grazing continued.

In 1990 we witnessed two such large fires. The Big Fire covered over 33,000 acres of timber, desert shrub, and semi-desert grassland in about a week, and the Frijole Fire covered about 6,000 acres of timber in just four days, much of that as a crown fire. Both of these fires became as large as they did despite our best efforts to suppress them using all of the modern suppression tools available and despite spending in excess of \$1 mil-

lion for each effort. Some of us remember watching the lightning-ignited Frijole Fire in the heart of Guadalupe Mountains National Park and thinking that it very easily could burn all the way to White's City some 30 miles away. We have since similarly seen several lightning-ignited large fires in 1993 and 1994 that easily could have become many thousands of acres had we not suppressed them with a very heavy hand and at great expense.

The current El Niño–Southern Oscillation (ENSO) phase is leading into a similar La Niña situation that occurred during those years of high fuel loadings and dry, windy conditions. Looking at recent history, we can expect to see similarly large, intense fires again soon in the Guadalupe. This notion of very large fires in the Southwest during the La Niña phase has been supported by ongoing ENSO fire-occurrence research being conducted at several universities, namely the University of Arizona.

Can fire be beneficial?

With all the evidence of frequent large fires, one wonders how they must affect the ecosystem as a whole and the individual species within that ecosystem. So what do we know about the effects of fire on the parks?

The effects of fire on the ponderosa pine forests as found in the high country of Guadalupe Mountains National Park are very well documented and understood (Ahlstrand 1980, Wright 1977, Swetnam et al. 1994). High frequency and low intensity fire generally increases vegetation diversity and prevents fuel accumulation and subsequent overstory consumption. Frequent fires maintain healthier forests. Infrequent fires lead to less healthy forests beset with overstocking, surface fuel accumulations, disease, insects, and dwarf mistletoe. Lack of fire sets the stage for inevitable holocaust.

Similarly, in the lower country of Carlsbad Caverns, Kittams (1973) noted that the aggressively colonizing agave-type species, such as lechuguilla and sotol, were generally killed by frequent fire and were replaced by sprouting shrubs

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and grass/forb species. Bunting and Wright (1977) found that after two years fire had reduced total shrub cover by 43% and total grass cover by 72% while increasing forb and shrub sprouts by 650%.

Ahlstrand (1982) showed that biodiversity in the desert shrub–semi-desert grassland communities was greatly increased by burning. He went on to say:

The practices of suppressing fire and excluding livestock grazing, both in effect for more than 30 years on much of the study area, have permitted grasses, as well as woody and rosette shrubs, to accumulate in quantities sufficient to support fires over extensive areas. With periodic burning of perhaps every 10 to 15 years in this community, grasses can be expected to increase as scrub cover is reduced. In the absence of additional fires, coverage by shrubs can be expected to slowly increase again at the expense of grasses and forbs.

Ahlstrand completed a lengthy literature review in 1981 showing the beneficial effects of fire on 88 selected species of plants (Ahlstrand 1981).

The National Park Service continued Ahlstrand's studies with photo points (Walters 1988). In the early 1990s photo points and line intercept transects (Stubbs 1993, Mulligan 1996) have consistently shown a postburn increase of biodiversity and grass-forb density coupled with a marked decrease in agave-type cover and density. These studies continue.

The New Mexico Game and Fish Department, the Bureau of Land Management, and the U.S.D.A. Forest Service adjacent to the park have cooperated in several large (up to 26,000 acres) prescribed burns for the purpose of enhancing the deer herd and improving rangeland. Their subsequent monitoring of these areas consistently shows increased numbers and vigor of deer and

better rangeland as a result. We often see large deer herds concentrated in the post-burn "greenup" of both prescribed burns and wildfires. We also occasionally see that heavy deer browse causes damage to resprouting shrubs in isolated small burns, which draw large numbers of deer to the relatively small amount of browse forage made available by small fires.

The Fire Effects Information System (FEIS), an Internet-accessible, free-access database maintained by the U.S.D.A. Forest Service (Fischer et al. 1996), describes fire's effects on many of the plant and animal species found in the Guadalupe. The contributors of local species information were largely from researchers of the various universities of the west Texas and southern New Mexico area. Fire's effects on individual species are described as positive both for the individual species and for the ecosystem or niche in which it lives.

The Texas madrone, for instance, is known to occur in riparian and seep areas of the Guadalupe. These areas tend to become brushy and quite flammable if not subjected periodically to fire. Texas madrone is killed by high intensity fire and does not resprout (FEIS data). Most large trees show abundant fire scars (personal observation) which is evidence that they have survived past low intensity fires. The question is: could they survive a high intensity wildfire if highly flammable brush was allowed to grow unimpeded underneath them as has occurred in much of McKittrick Canyon?

The National Park Service has also begun extensive study on fire's effects on a threatened species, *Coryphantha leei*, found at Carlsbad Caverns National Park. This species was subjected to a low-intensity prescribed fire in 1993. Preliminary conclusions (Mulligan and Route 1996) are that *Coryphantha leei* is quite tolerant of low intensity fire, probably due to its normal habitat of flat, exposed, rocky shelves generally devoid of most other fuels. The 1993 burn showed mortality of about 10% not accounting for what could have been natural mortal-

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ity. My personal observations of the effects of high-intensity wildfire on this and other similar cactus species has approached 90% kill in some areas of the Big Fire of 1990! Could it be that by waiting for high-intensity wildfire and not allowing low-intensity prescribed or natural fire we are waiting for disaster to strike this rare species?

Similarly, Thomas (1997) has shown that fire can have various effects on succulent species in semi-desert grassland ranging from beneficial in low-intensity fires to extremely detrimental in high-intensity fires.

There are many other examples of management's need to compromise between the use of prescribed fire and the protection of individual species (LaRosa 1995). The key is that these compromises have been shown repeatedly in the management of wilderness ecosystems to best protect overall ecosystem health and integrity. An allowable take of individual specimens of rare species is necessary to protect the species and ecosystem as a whole.

So where are we going?

Both national parks, the Lincoln National Forest, and the Bureau of Land Management are engaged in continued discussions to develop an interagency fire management plan based not on jurisdictional concerns but on ecosystem management concerns. The draft of this plan defines the Guadalupe Mountains as a fire dependent ecosystem to be managed under a consistent fire management policy which strongly favors the ambitious reintegration of wildland fire, an approach suggested at this time by the best available science.

Wildland fire will only be fully suppressed if it becomes a threat to human safety or property. The "appropriate management response" will be applied to each ignition to ensure that resource management goals are being realized and that fire can continue to be an integral part of the management of the ecosystem.

Prescribed fire and manual fuel reduction will also be undertaken adjacent to developments, property, and sensitive resources to protect them from unwanted fire. Both national parks have identified large tracts of land for reintroduction of low-intensity wildland fire during the next few years through the use of management ignited prescribed fire.

Monitoring of the effects of fire on the flora, fauna, soils, air, and viewshed will continue. Funding has been requested for an exhaustive literature review on fire effects in the upper Chihuahuan Desert biome. University involvement in both literature review and data analysis will continue to be encouraged and subsidized to ensure that the suspected benefits of wildland fire continue to be realized.

The reintegration of wildland fire into the Guadalupe Mountains ecosystem will continue well into the 21st century. We will strive to restore the ecosystem, the processes, and the common and rare species, including that lately rare species: wildland fire.

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Chapter 25

Tree-ring Analysis of Ancient Douglas-fir at Guadalupe Mountains National Park

DAVID W. STAHL, Ph.D., has been a professor for the Department of Geography and director of the Tree-Ring Laboratory, University of Arkansas, Fayetteville, for the past 20 years. He is currently working on the development of long tree-ring chronologies sensitive to the El Niño–Southern Oscillation influence, including the ancient Douglas-fir stands on Guadalupe Peak, Texas.

Douglas-fir (*Pseudotsuga menziesii*) is the most important commercial timber species in the world (Van Pelt 2001). The natural range of the species extends across western North America from British Columbia to Oaxaca. The species is subdivided into two populations, the coast Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*), which reaches immense size in the Pacific Northwest, and Rocky Mountain Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) found on more arid sites in the inland Rockies (Lanner 1999), including the small outlying populations found in the Guadalupe and Chisos mountains of west Texas. The two types of Douglas-fir differ in terms of growth rate and size. Maximum growth rates and dimensions are achieved by coast Douglas-fir in the temperate rainforest of the Pacific coast, where the species has been reliably measured to over 300 feet in height and is second only to coast redwood as the tallest conifer in the world (Van Pelt 2001, Lanner 1999). In stark contrast, Rocky Mountain Douglas-fir on arid sites in the continental interior are often dwarfed because of moisture stress but attain remarkable ages and record an accurate and detailed history of precipitation in their annual growth rings. Some of the oldest and climate sensitive Douglas-fir have been found on petrified lava flows at El Malpais National Monument, New Mexico, where one tree over 1,274 years old was found (Grissino-Mayer et al. 1997). A tree-ring chronology over 2,129 years long was developed from Douglas-fir trees and relic wood littering the rocky fire-protected terrain at El Malpais (Grissino-Mayer 1996); this is

one of the most important tree-ring chronologies ever developed in North America.

Ancient Douglas-fir is also found in the Bowl and on other restricted microenvironments in Guadalupe Mountains National Park. Researchers from the University of Arkansas Tree-Ring Laboratory have investigated Douglas-fir on the slopes below Guadalupe Peak, and we have made 456-year-long, tree-ring chronologies of earlywood width (EW), latewood width (LW), and total ring width (TRW) from core samples extracted from mature and old-growth trees. The most exceptional Douglas-firs we have located in the park thus far are found on the edge of the dry, wind-swept escarpment just west of Guadalupe Peak at about 8,200 feet in elevation (Figure 1). But we have only examined a small fraction of the potential Douglas-fir habitat in the park and believe that many additional areas of old growth do indeed exist, some with trees likely in excess of 600 years old (e.g., on the rocky north-facing escarpments east of Guadalupe Peak and above Devil's Hall trail). Exceptionally old piñon pine (*Pinus edulis*) are also abundant in the park, and we have recently obtained core samples from chinkapin oak (*Quercus muehlenbergii*) that are over 300 years old along Devil's Hall trail.

The earlywood-width (EW) chronology (Figure 2) is based on measurements of 33 cores from 17 trees. These individual EW time series are very strongly correlated with each other, and the average correlation between these individual se-



Figure 1. An ancient Douglas-fir on the escarpment west of Guadalupe Peak, overlooking El Capitan (view SSE). These trees record an intricate history of climate in their annual growth rings.

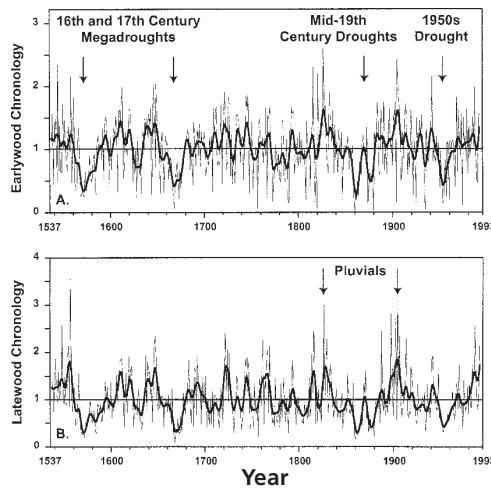


Figure 2. The earlywood (top) and latewood (bottom) width chronologies developed from drought-stressed Douglas-fir at Guadalupe Peak, Texas. These chronologies reflect winter-spring and spring-summer moisture conditions, respectively, and reveal several major decadal droughts and prolonged pluvials over the past 450 years.

ries and the master chronology (based on the remaining series) is $r = 0.82$ (calculated with the program COFECHA) (Holmes 1983). The latewood-width (LW) chronology (Figure 2) is based on 33 cores from 16 trees, and the average correlation between these individual series and the master LW chronology is somewhat lower at $r = 0.65$. But there is still a very high degree of cross correlation among the component specimens included in the LW chronology.

The EW and LW chronologies developed from Douglas-fir at Guadalupe Mountains National Park are not identical. The correlation between the two chronologies in Figure 2 is $r = 0.63$ ($P < 0.001$) for the full period from 1537 to 1993, so only approximately 40% of the interannual variability is shared between these two seasonal chronologies developed from the same Douglas-fir trees at Guadalupe Peak.

Correlation analyses with regional climate data indicate that the two chronologies are sensitive to different seasonal precipitation totals, with the EW chronology responding most strongly to winter-spring precipitation, and the LW

chronology responding most strongly to late-spring and early-summer precipitation. This differing climate response of EW and LW is very important because two different large-scale climate phenomena have been implicated in the interannual variability of cool and warm season precipitation over the American Southwest. The El Niño–Southern Oscillation (ENSO), the great air-sea interaction over the equatorial Pacific Ocean, modulates the interannual variability of winter precipitation totals and tree growth over the Southwest, including the Guadalupe Mountains (e.g., Ropelewski and Halpert 1987, Stahle et al. 1998). Summer precipitation over the Guadalupe and the greater Southwest is modulated by the North American Monsoon System (NAMS), which tends to develop over western Mexico in June and build into the Southwest by July and August. The EW chronology from Guadalupe Peak has already been used for the tree-ring reconstruction of ENSO indices (Stahle et al. 1998), and the LW chronology has been used in an analysis of warm season precipitation over Mexico and the extreme southwestern United States (Therrell et al. 2002).

The EW and LW chronologies for Guadalupe Peak have highlighted several decade-long moisture extremes. The severe and sustained drought of the 1950s is clearly recorded in both the EW and LW chronologies (Figure 2). The 1950s drought had serious impacts on the ecosystem dynamics of both grasslands and woodlands across the greater Southwest, as has been vividly documented at the Sevilleta Long-Term Ecological Research area, New Mexico (Swetnam and Betancourt 1998). However, the 1950s drought at Guadalupe Peak was exceeded in severity and duration by the prolonged megadroughts of the 19th, 17th, and 16th centuries (Stahle et al. 2000) (Figure 2). The spatial distribution of these extended droughts, and the notable wet periods of the early-19th and early-20th centuries (Figure 2), has been recently mapped by Fye and others (2003) using the continentwide tree-ring reconstructions of Cook and others (1999). The impact of these tree-ring re-

constructed droughts and pluvials on ecosystem dynamics in the 19th century have been described by West (1992) and Woodhouse and others (2002). These analyses highlight the larger ecological significance of the climate history embedded in the tree-ring chronologies now available for Guadalupe Mountains National Park, which can provide important insight into past and present trends in regional flora and fauna.

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Note: This paper is an updated (2003) version of the presentation given at the Guadalupe Mountains Symposium in 1998.

