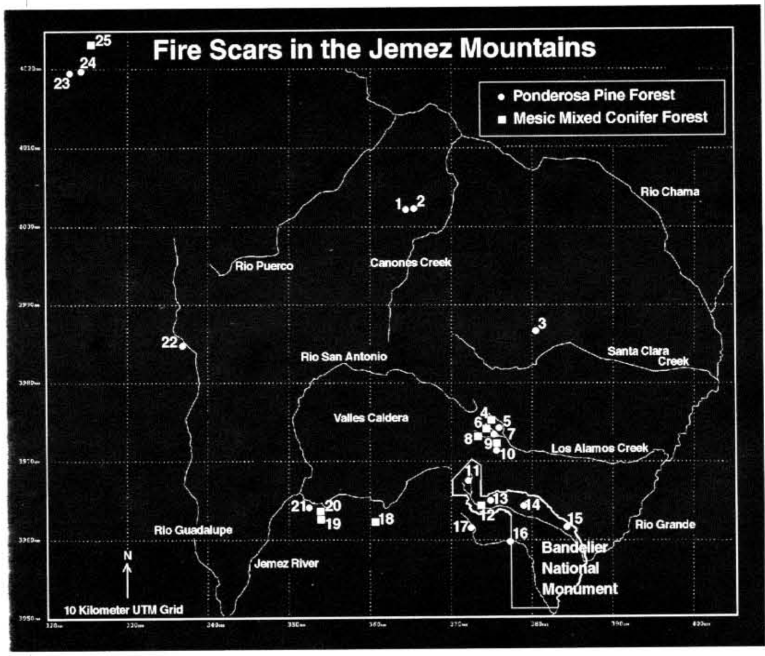

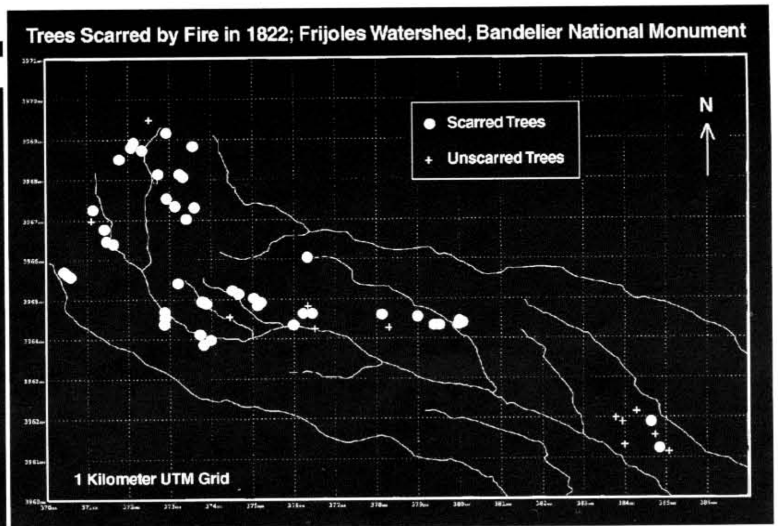

Figure 1 (left). Map of the location and general forest type of sites sampled for fire scars in the Jemez Mountains.

Figure 2 (above). Close-up of figure 1 sites 11-15 in Bandelier National Monument showing trees scarred by fire in the 1822 Frijoles watershed blaze.

Landscape-Scale Fire History Studies Support Fire Management Action at Bandelier

By Craig D. Allen, Ramzi Touchan, and Thomas W. Swetnam

Fire has long been recognized as a key process determining the ecological structure and function of many southwestern forests (Weaver 1951). Major changes in southwestern fire regimes over the past century (Swetnam 1990) are having correspondingly large ecological effects on southwestern forests, including those of Bandelier National Monument in the Jemez Mountains of northern New Mexico (Allen 1989). Ecologists and managers who seek to understand current landscapes require accurate information on the spatial and temporal variability in past fire regimes. This kind of information provides essential historical context that is needed to properly manage our modern park landscapes.

We are using dendrochronological (tree-ring) methods to reconstruct fire occurrence patterns over the last several hundred years across a variety of vegetation types, topographic situations, and geographic locations in the Jemez Mountains. The work is being accomplished through a cooperative effort between Bandelier National Monument, the National Biological Service, the Santa Fe National Forest, and the University of Arizona Laboratory of Tree-Ring Research (Touchan and Swetnam 1995). We have dated over 3,000 fire scars from 373 trees, snags, logs, and stumps at 25 sites located around an arc 50 km (31 mi) in diameter that circumscribes the Jemez Mountains (fig. 1). Elevations of sampled sites range between 2,000 and 3,000 m (6,562 and 9,843 ft, respectively). Each scar is dated to its precise year of formation, and in most cases even the season in which the fire occurred can be determined. We are using these data to develop fire histories at multiple spatial scales, building up from individual trees through clusters of trees to watersheds (fig. 2) and finally the entire mountain range.

Ponderosa pine *(Pinus ponderosa)* dominates most sample sites, although we also sampled mixed conifer forests that contained Douglas fir *(Pseudotsuga menziesii)*, white fir *(Abies concolor)*, and Engelmann spruce *(Picea engelmanni)*. We collected aspen *(Populus tremuloides)* cores from pure stands adjacent to some mixed conifer sites and crossdated them to determine postfire establishment dates. We also used dendroclimatic methods to reconstruct December-June precipitation back to 1653 A.D. using ring-width chronologies from nine sites in northern New Mexico.

The fire scar chronologies show that fire was frequent and widespread in the Jemez Mountains prior to the 1890s (fig. 3). For example, fire scar samples in Bandelier record 113 different fire years between 1480 and 1899 A.D. *Surface* fires burned in primarily grassy fuels from the lowest elevation mesa-top stands of ponderosa pine at 2,030 m (6,660 ft) to the summit of the Frijoles Creek watershed at over 3,000 m (fig. 2), with average intervals between widespread fires ranging from 5-15 years. In many years climate-synchronized fires burned throughout the Jemez Mountains (and even throughout the Southwest; see Swetnam 1990)–other years, smaller, patchier fires occurred. We believe that lightning caused the vast majority of these fires. Like elsewhere in the Southwest, the widespread surface fires ceased throughout the Jemez area in the late 1800s (fig. 3), apparently because intense grazing by large numbers of free-ranging livestock reduced the grassy fuels through which most fires spread (Swetnam 1990).

Major fire years tended to be dry in both ponderosa pine and mixed conifer forests in the Jemez Mountains. Adjacent ponderosa

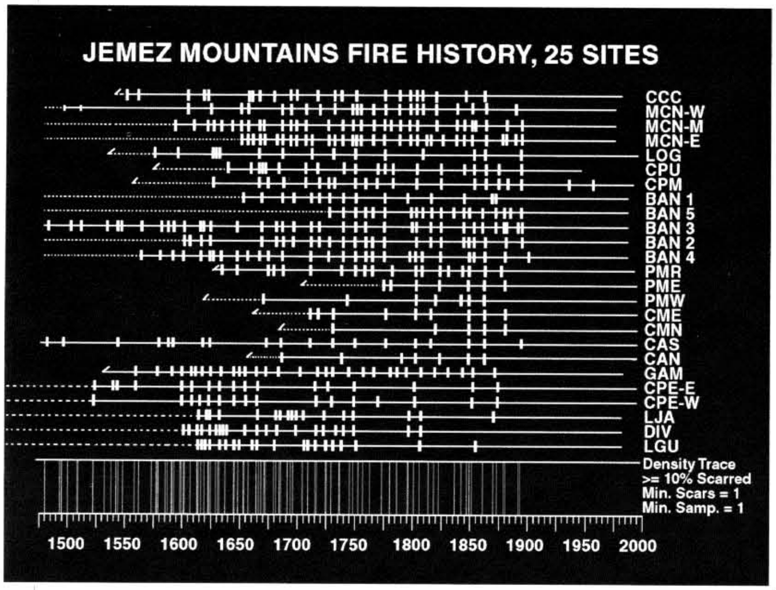

Figure 3. Composite fire history chart for major fires in the Jemez Mountains. Horizontal lines cover the life spans of trees within each site. Short vertical bars are composite fire dates recorded by scars on at least 25% of the trees within each site; thin vertical lines indicate fire dates on the time line. Note the synchrony of fire events between sites and the cessation of recorded fires in the late 1800s. Site code names and numbers (from fig. 1) shown on right margin.

pine and mixed conifer forests often, but not always, recorded synchronous fire events. However, major fire years in ponderosa pine forests typically occurred with a 2-year lag after significantly greater winter-spring precipitation; this is not observed in local mixed conifer sites. This suggests that the buildup of fine fuels (such as herbaceous vegetation following a wet year) was an important precursor to spreading fire in ponderosa pine forests, whereas fuel moisture, rather than fine fuel availability, was more important in determining fire occurrence in mesic mixed conifer sites. The lags in fuel-fire relations, and the influences of persistent atmospheric phenomena on fuel accumulation and fire occurrence in the Southwest (such as the El Niño-Southern Oscillation [Swetnam and Betancourt 1990]), suggest that long-range fire hazard forecasting models could be constructed.

The network of 25 fire scar sample sites reveals significant spatial variations in past fire regimes across the Jemez Mountains. Ponderosa pine forest sites exhibited a range of high frequency surface fire patterns, with reduced frequencies observed: 1) at low elevation sites, which have inherently lower potentials for producing fine fuels; 2) at places that are topographically isolated from the larger matrix of pine forests; and 3) during times that livestock grazing likely reduced the quantity and continuity of local surface fuels. Past fire regimes in mesic mixed conifer forests included a combination of surface fires and patchy crown fires at 15-30 year intervals. Historical lightning fire records from the park indicate that in most years middle elevation ponderosa pine forests have a greater propensity for sustaining fires than other vegetation types.

Other significant findings include: some of the first quantitative reconstructions of fire history from several southwestern forest types, including riparian mixed conifer, ponderosa pine/piñon-juniper ecotone, spruce-fir; surprisingly frequent fire occurrence from a number of moist or high elevation forest types; proof that essentially all paleofires occurred in spring or early summer, whereas much prescribed burning today occurs in fall for control reasons; indications of possible Native American enhancement of fire frequencies in a few, particular time periods and places; and demonstration of the long-term coexistence of two sensitive species with fire (the endemic Jemez Mountains salamander [*Plethodon neomexicanus,* listed as state-endangered and federal Category 2 Notice-of-Review] and the federally-threatened Mexican spotted owl [*Strix occidentalis lucida*]).

Fire suppression during this century has significantly affected area ecology in a variety of ways, most obviously by allowing the buildup of unnaturally high densities of trees and amounts of ground fuels that were formerly thinned by frequent surface fires. Thus, as across much of the west, fire suppression has promoted conditions today that threaten the health of forests in the Jemez Mountains, with increasingly large, intense, and uncontrollable crown fires. In 1977, one such fire, the La Mesa Fire, burned through the heart of the Bandelier ponderosa pine forests. Scientists have recently completed a dozen linked research projects investigating the ecological effects of the La Mesa Fire and have presented findings on diverse topics (ranging from fire effects on avifauna and nitrogen-cycling to cultural resources) at a well-attended symposium in 1994; the resultant manuscripts are nearly ready for publication.

Summary

Landscape-scale fire history research is providing critical information to initiate, guide, and support extensive use of prescribed fire by multiple agencies to restore this keystone process to forest lands in the Jemez Mountains. Fire history data have been essential to allow fire management programs to (carefully) proceed with burning plans in occupied habitat of such sensitive species as Mexican spotted owl and Jemez Mountains salamander. Overall, this fire history research provides much of the underpinning for the new Bandelier National Monument Fire Management Plan, and it is being used to support similar fire management efforts on surrounding Santa Fe National Forest and Native American lands.

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