# Contents

# Figures

# Tables

# 6

# Rebound of Fire Regimes in the Dry Forests and Woodlands of the Southwest U.S.A., AD 1200–1900

Christopher I. Roos, Thomas W. Swetnam, *and* Matthew J. Liebmann

Fire is a keystone ecological process in the woodlands and forests of the Southwest U.S.A. (Allen et al. 2002). Prior to twentieth-century fire suppression, these environments experienced characteristic fire regimes—regular patterns of fire frequency, fire size, seasonality, and environmental impacts (Wright and Bailey 1982). The historical ecology of these fire regimes provides the basis for many contemporary forest management decisions, including determining what role fire should play in these forests and woodlands today. The key concept in this approach is the historical (or natural) range of variation (HRV) of fire regimes and forest structure (Swetnam et al. 1999). The HRV concept leaves important questions unanswered, such as: How much of these historical fire regimes is representative of long-term Holocene dynamics in the absence of human interference? How much of the HRV for fire regimes across the Southwest is an emergent property of the rebound of fire regimes after the collapse of human populations and the reorganization of political and economic systems initiated in the wake of European colonization? How much of the HRV is influenced by anthropogenic burning practices that are new to the Protohistoric and Historic periods?

The "rebound of nature" has mostly been used to describe environmental properties that are the result of a sudden release of prior land-use pressures (Denevan 2016). The rebound concept also applies to ecological processes, such as fire (see also Klimaszewski-Patterson this volume). Fire regimes are vulnerable to human impacts, although different ecosystems are more vulnerable than others (McWethy et al. 2013). The character of any natural rebound will vary based on the character of the prior land use and the character of the natural fire regime. In dry mixed conifer and ponderosa pine forests, which occur at middle elevations across the Southwest (Figure 6.1), fires happened frequently (once or twice per decade) almost entirely as low-severity surface fires (Allen et al. 2002; Fulé et al. 1997). It has long been thought that ancient human impacts in these forests would have been minimal and spatially discrete (Allen 2002). It was expected that frequent anthropogenic burning would be overprinted on frequent lightning fires and the two regimes would be indistinguishable. However, these forests were home to long-term agricultural occupations in parts of the Southwest, so the potential for human impacts on fire regimes associated with more intensive land use is high, whether by adding ignitions, removing fuels, or both.

Piñon-juniper woodlands and savannas are the driest forest/woodland ecological zone in the Southwest U.S.A. (Brown 1994). Here, the historical fire regimes are less well known and might include long fire-free intervals punctuated by crown fires in old growth stands (Floyd et al. 2003). As woodlands grade to savannas, surface fires may have been more common in

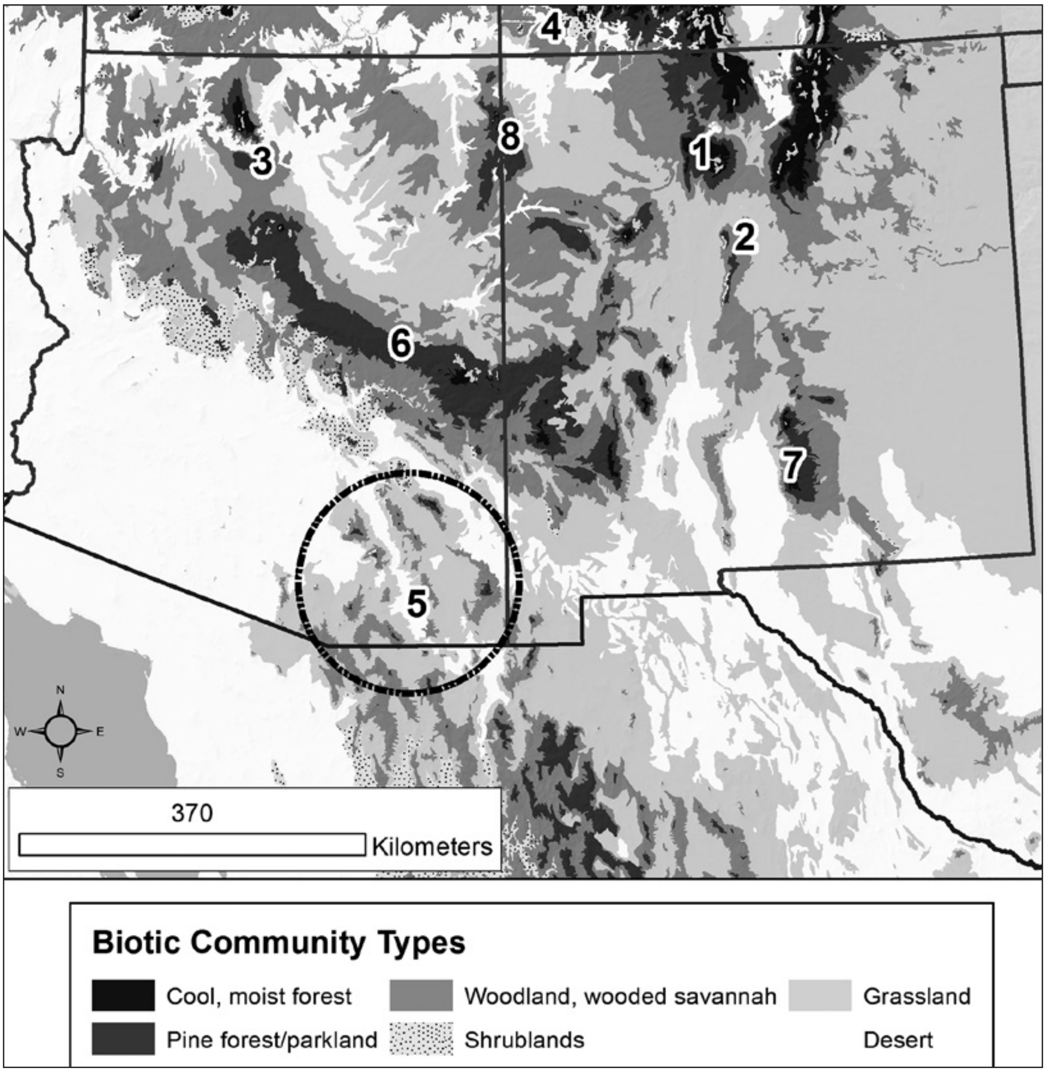


FIGURE 6.1. Regional biota of the Southwest U.S.A./Northwest Mexico. Numbered locations are the landscapes described in the text: 1) the Jemez Mountains; 2) the Sandia, Manzano, and Manzanita Mountains; 3) the Upper Basin of the eastern Grand Canyon region; 4) the Mesa Verde area; 5) the general territory used by Chiricahua Apaches; 6) the Forestdale Valley in the Mogollon Rim region; 7) the Sacramento Mountains; 8) the Chuska and Lukachukai Mountains.

the grassy fuels (Margolis 2014; Romme et al. 2009). Woodlands were among the most intensively utilized upland environment by ancient Southwestern farmers (Euler et al. 1979); however, so the potential for human impacts in these settings is high (Roos 2017).

Despite fundamental ambiguities in many paleofire records (Roos et al. 2014; Roos et al. 2019), evidence is beginning to accumulate that Indigenous communities of the Southwest used fire as a landscape management tool in agriculture, to improve wild plant collecting areas, or in hunting (Roos 2017). If the period after European contact is characterized by population upheavals, as well as economic, political, and land-use changes, it is not unreasonable to

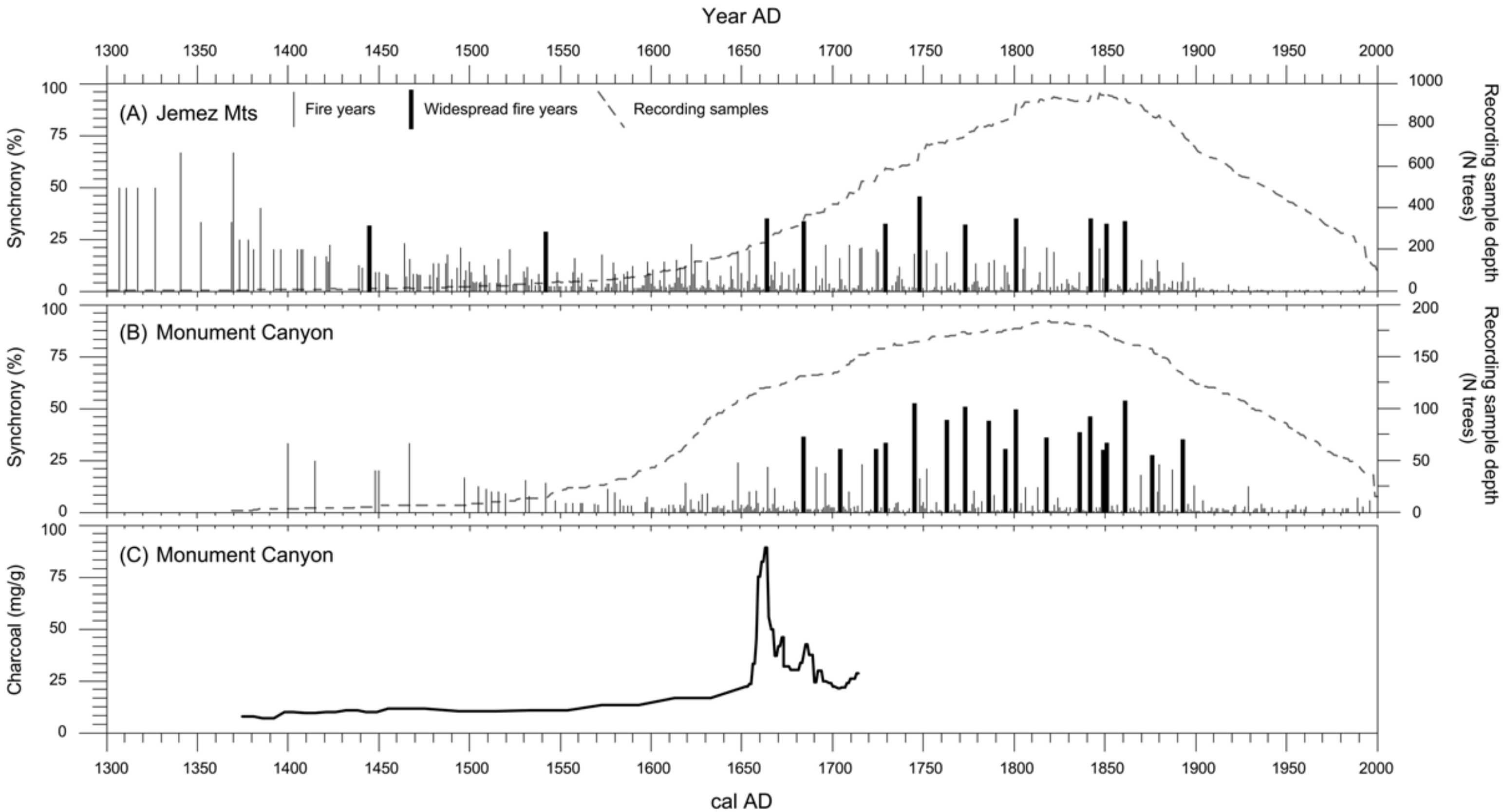


FIGURE 6.2. Time series plots of fire synchrony (the percentage of recording tree samples that record a fire that year) for the entire Jemez Mountains set (A; N = 1,377 trees) and the Monument Canyon Research Natural Area (B; N = 198 trees). Thin bars indicate synchrony for all fire years. Thick bars indicate fire years with at least 25% of all trees scarred when a minimum of 10 trees are in the record. (C) is charcoal abundance from alluvial sediments just below the Monument Canyon Research Natural Area.

expect that either natural fire regimes would rebound or novel fire-vegetation associations may have emerged at that time. In some cases, this may have involved the accumulation and spatial reorganization of fuels in the absence of wood collecting. In others it might involve the removal of extra ignitions. In yet other cases, the cessation or reduction of land use by one group may have granted room for new land uses by other groups. The character of these "rebound" processes is variable and complex across the region.

The record of fire regime rebound is complicated further by heterogeneity of human population and land-use histories that cannot be projected uniformly across the region. We discuss some of this complexity, including classic environmental rebound after European contact, precontact rebound that accompanied earlier population upheavals, the "rebound" of anthropogenic fire regimes, and even de facto fire suppression driven by economic and cultural processes initiated in the Protohistoric period.

We take an explicitly fuzzy approach in our use of "Protohistoric" and do not restrict our discussion to the sixteenth and seventeenth centuries. The social, demographic, cultural, political, and economic processes that changed before and after European contact had consequences that took centuries to play out, many of which remain unresolved today. We focus specifically on the impacts of population collapse and relocation, changing political landscapes, and the impacts of introduced domesticated animals to Indigenous populations. Regions discussed in the text are highlighted in Figure 6.1.

## Rebound of Spreading Surface Fires in Northern New Mexico

A classic example of environmental rebound of fire regimes comes from the Jemez Mountains of northern New Mexico (Figure 6.1, location 1). Here, long and well-replicated tree-ring dated fire-scar records document precontact and protohistoric fire regimes influenced by Pueblo farmers living in ponderosa pine forests (Liebmann et al. 2016; Swetnam et al. 2016). During the period of initial contact with Spanish explorers in the sixteenth and early seventeenth centuries, 5,000–8,000 Ancestral Pueblo (Jemez) farmers lived in 18 villages and towns, mostly within the dry ponderosa pine forests on the mesa tops of the southwestern flanks of the Jemez Mountains (Liebmann et al. 2016). Prior to the Pueblo Revolt in 1680, fires were small, patchy, frequent, and low severity (Figure 6.2). Fire scars are created when a tree is damaged but not killed by a fire. If temperatures on part of the bole of the tree are hot enough to kill the cambium (the tissue that grows the tree), the tree will lose its bark there and it will try to regrow across the wound from the margins. This allows for the dating of the fire scar using traditional dendrochronological methods. The relative size of the area burned each year is inferred from the percentage of all previously scarred trees that record a fire in a given year. This is referred to as fire-scar synchrony. Despite a fading record of declining tree-ring samples, nearly annual fires are recorded by relatively few trees (i.e., they have low synchrony) across scales from the stand-level to the entire mountain range supporting this inference of frequent small fires. The patchiness of these fires likely promoted pyrodiversity and patch heterogeneity, breaking up fuels and ultimately decoupling fire occurrence from climate patterns (Swetnam et al. 2016). In addition to adding many small fires to the landscape, Jemez communities would have required large quantities of wood for construction and domestic fuel. Wood harvesting would have reduced coarse fuel loads, perhaps contributing to lower fire intensities.

In the seventeenth century, after the establishment of Spanish missions, as much as 85% of the Jemez population living among the ponderosa pine forest was lost. Following the Spanish reconquest of the 1690s, colonial policies concentrated the surviving Jemez people in the valley into a single pueblo located among the piñon-juniper woodlands at lower elevations (known today as Walatowa; Liebmann 2012; Liebmann et al. 2016). Coincident with this precipitous decline in Jemez population, its relocation, and a change in land use was a reorganization of wildland fuels. Without Jemez

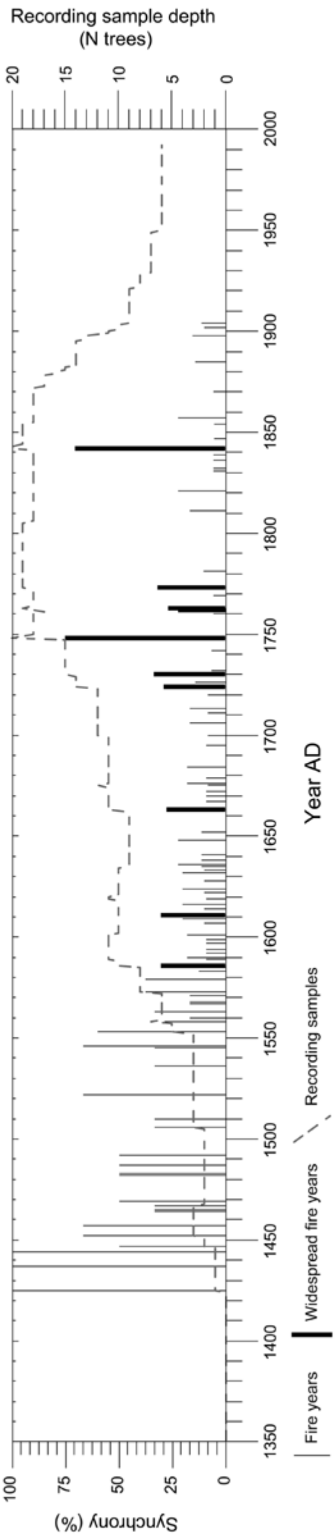


FIGURE 6.3. Time series plots of fire synchrony (the percentage of recording tree samples that record a fire that year) for the entire Sandia and Manzanita Mountains (N = 31 trees). Thin bars indicate synchrony for all fire years. Thick bars indicate fire years with at least 25% of all trees scarred when a minimum of 10 trees are in the record.

farmers living among the ponderosa pines, harvesting wood, and burning a patchwork of the forest annually, those patches began to accumulate fuels and to generate horizontal continuity of fuels across the landscape. Lightning is abundant in the Jemez Mountains (Allen 2002) and once fuel continuity was no longer a limiting factor, spreading fires emerged in which large areas burned synchronously when climate conditions were right. After large-scale depopulation of the ponderosa pine forests, fire events had higher synchrony (i.e., larger burn patches) and had strong relationships with interannual climate patterns in which wet prior years produced abundant and continuous fuel that was burned in subsequent dry years (Swetnam et al. 2016). This overall story is mirrored in the charcoal record, wherein prior to the late seventeenth century charcoal abundances are relatively low. As can be seen in the tree-ring record, this is not from an absence of fire but from small patchy fires that have low rates of biomass consumption and therefore produce less charcoal. In the late seventeenth century, however, charcoal concentrations increase dramatically as fuels reorganize and fires burn more widely and consume more biomass (Figure 6.2).

Similar processes occurred during the sixteenth and seventeenth centuries elsewhere in the northern Rio Grande region. In the Sandia, Manzano, and Manzanita Mountains to the east of Albuquerque (Figure 6.1, location 2), limited records suggest that prior to 1680, fires were frequent, small, and had little clear relationship to interannual climate patterns (Baisan and Swetnam 1997). Here too, after 1680 widespread fires became more common (Figure 6.3). The processes are probably the same for the two regions. Southern Tiwa communities, who would have used the Sandias, Manzanos, and Manzanitas, probably suffered severe population losses when many of the Southern Tiwa pueblos were depopulated during the seventeenth century (Schroeder 1979). One feature of these tree-ring records that is not present in the Jemez records is a decline in fire frequency after 1785. In at least one locality, fires cease entirely and fire is only represented at other sites in the mid-1800s, accompanying political upheaval (Baisan and Swetnam 1997). The reduction (and absence) of fire after 1785 suggests that something was interrupting or consuming fuels before they could burn. We will return to this issue below, but across the Southwest, this cessation of fire is associated with intensive grazing and pastoralism (Savage and Swetnam 1990).

In both the Jemez and Sandia cases, the historical fire regimes (ca. AD 1680–1900) can be interpreted as a product of fuels and fire reorganizing in the wake of massive population collapses. As such, the historic fire regimes in these mountain ranges are emergent properties of changes in ignitions and fuels that accompany social processes in the Protohistoric period, thereby making them classic examples of rebound of fire regimes.

### Depopulation and Earlier Rebound of Fire Regimes in Northern Arizona and Southwest Colorado

The tree-ring evidence from the northern Rio Grande provides strong evidence that fire regimes reorganize or rebound in the wake of major population changes. Some of the most significant population translocations in the ancient Southwest occurred in the precontact past. At the end of the Pueblo II period (AD 1150), there was a substantial population contraction from the peak distribution of Ancestral Pueblo communities (Euler et al. 1979). In the next century, at the end of the Pueblo III period (ca. AD 1250–1300), an even greater population relocation happened as communities in the Four Corners region were depopulated (Glowacki 2015). Many of these populations lived in piñon-juniper woodlands, where historical fire information is scarce. In old-growth woodlands, fire seems to be rare and stand-replacing in the more productive stands with shrub understories (Floyd et al. 2004; Floyd et al. 2008). However, in woodland savannas, fire was likely much more common (Margolis 2014; Romme et al. 2009). Nevertheless, there is some paleoecological evidence that Ancestral Pueblo residents of the Mesa Verde and Grand Canyon areas used fire in these woodland landscapes. What happened to these fire regimes after permanent communities left in the precontact past?

A variety of evidence from the eastern Grand Canyon area (Figure 6.1, location 3) attests that Ancestral Pueblo people used fire to manage wild resources between AD 875–1200 (Sullivan and Mink 2018). In particular, paleobotanical assemblages from domestic storage, cooking, and food processing contexts are all dominated by wild, disturbance-loving annuals and woodland products (e.g., piñon nuts; Sullivan et al. 2015; Sullivan 1987, 1992; Sullivan et al. 2001). Fire use has been implicated as a management strategy by which local residents could have enhanced the productivity of wild seed patches, which are largely composed of $C_4$ plants, such as goosefoot and amaranth (Sullivan and Forste 2014). This seems to be corroborated by paleoecological (Roos et al. 2010) and modern ecological evidence (Sullivan and Mink 2018). In an alluvial stratigraphic locality in the Upper Basin on the South Rim, the "ruderal horticulture" period is characterized by relatively low charcoal concentrations but stable carbon isotope ratios suggesting abundant growth of $C_4$ plants coincident with pollen assemblages that are dominated by ruderal taxa (Roos et al. 2010; Sullivan and Ruter 2006). This area was no longer used for perennial settlement after ca. AD 1200. After depopulation, carbon isotopes and pollen taxa indicate an increase in woodland taxa whereas charcoal records indicate that fire continued to play a role in the historical ecology of these woodlands after Ancestral Pueblo people left. However, the eastern Grand Canyon area continued to be used after 1200 by Hopi (Sullivan 1992, 1995; Sullivan et al. 2001) and Navajo people (Banschbach 2010; Sullivan et al. 2007). It is unclear if some of these post-1200 fires were tied to new forms of land use by Hopi and Navajo visitors or if the environmental rebound included some non-anthropogenic role for fire in these woodlands (cf. Floyd et al. 2008).

At Mesa Verde (Figure 6.1, location 4), two records suggest enhanced fire activity during the population peak between AD 1000–1300. At

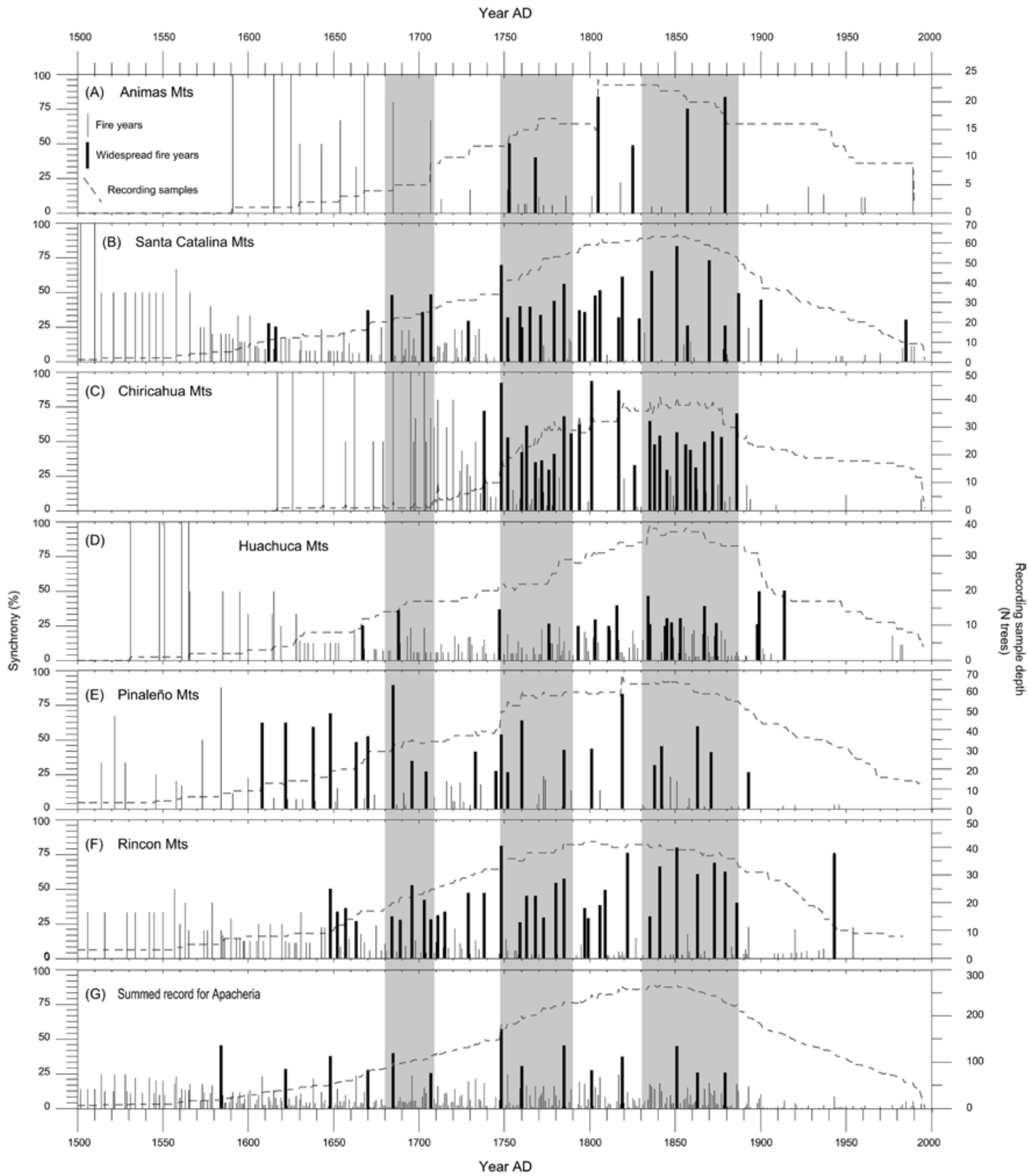


FIGURE 6.4. Time series plots of fire synchrony (the percentage of recording tree samples that record a fire that year) for southeastern Arizona and southwestern New Mexico. Thin bars indicate synchrony for all fire years. Thick bars indicate fire years with at least 25% of all trees scarred when a minimum of 10 trees are in the record. Gray areas are the three wartime periods identified by Kaib (1998).

Beef Pasture in the La Plata Mountains (above the West Mancos River), there is a spike in charcoal deposition at all size classes indicative of a dramatic increase in fire activity around AD 1000 (Petersen 1988). Closer to the core of the Mesa Verde area, charcoal abundance from Prater Canyon closely tracks archaeological population reconstructions with peak charcoal concentrations coinciding with peak population in the thirteenth century (Herring et al. 2014). In both cases, it appears that as populations grew, more fire was introduced to woodland (Prater Canyon) and forest (Beef Pasture) settings. Charcoal declines in both records after Ancestral Pueblo people leave the area but charcoal deposition never ceased, suggesting that fires continued to be part of these woodlands and forests. This is an interesting compliment to the stand-age reconstructions of long-interval stand-replacing fires, especially for Mesa Verde (Floyd et al. 2003). Either the recent fire-free state of these old growth stands on Mesa Verde is a historical anomaly or the presence of non-stand replacing fire is underappreciated for the historical ecology of these woodlands (e.g., Margolis 2014). Nevertheless, the paleoecological evidence suggests that fuels, trees, and fire reorganized after the depopulation of the Four Corners perhaps providing evidence of precontact environmental rebound of fire regimes.

In both cases of anthropogenic burning in woodland settings, there is paleoecological evidence of reorganization but persistence of fire in southwest Colorado and northern Arizona. The processes may be grossly analogous to the better understood northern Rio Grande records, wherein anthropogenic burning ceased because of population collapse or migration followed by a reorganization of fuels and the generation of a different fire regime. If we consider these woodland records to be environmental rebound, it leaves open the question of the role of subsequent human use of these environments. Is this the rebound of non-anthropogenic fire regimes? Or is it something different representing a different form of human-fire relationship than the intensive one that preceded it? In southeastern Arizona, abundant tree-ring records provide a window onto what the "rebound" of anthropogenic fire regimes might look like.

### Rebound of Anthropogenic Fire Regimes in Apachería

Apaches entered eastern, central, and southern Arizona by the late AD 1500s. Ethnographic evidence from Western Apaches indicates sophisticated and varied uses of fire in horticulture, wild plant management, and hunting (Buskirk 1986). In a remarkable study, Kaib (1998) assembled historical and tree-ring evidence to evaluate whether or not anthropogenic burning by Chiricahua Apache in southeastern Arizona and southwestern New Mexico could be identified during periods of enhanced conflict with Euroamericans (Figure 6.1, location 5). In the forested environments of sky island mountain ranges throughout Chiricahua traditional territory, fires became more frequent (Kaib 1998) and more synchronous within each mountain range during the three wartime periods identified by Kaib (Wartime Period 1: AD 1680–1710; Wartime Period 2: AD 1748–1790; Wartime Period 3: AD 1831–1886; Figure 6.4).

The increase in synchrony during wartime periods is remarkable because this is the opposite of anthropogenic burning regimes by Pueblo people in the northern Rio Grande. In fact, most subsistence uses of anthropogenic burning are more effective when the burning is small and patchy (Lewis and Ferguson 1999; Scherjon et al. 2015; Trauernicht et al. 2015). So why would Chiricahua fires be larger during wartime periods? Kaib identifies this paradox and points out that Chiricahua Apaches had great respect for fire for most uses and would only use fire in broad landscape burning when they were trying to escape pursuit or when trying to burn out encampments or resources from enemies (Kaib 1998). Notably, although fires within a particular mountain range increase in synchrony during wartime periods, fire years are not widely synchronous across mountain ranges (Figure 6.4G). Widely synchronous fires often have strong fire-climate relationships (Swetnam and Baisan 2003; Swetnam and Betancourt 1998), as the few regionally

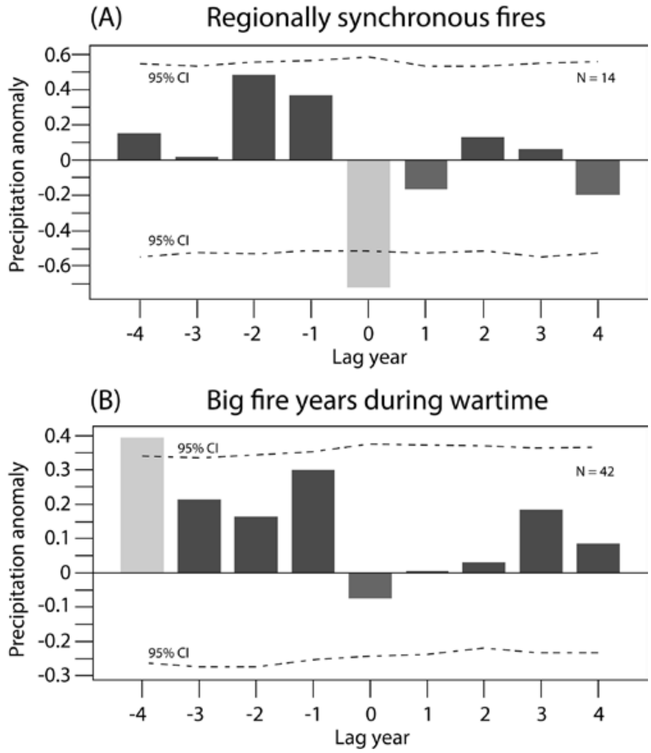


FIGURE 6.5. Superposed Epoch Analysis (A) of widespread (≥25%, ≥10 trees) fire years across Apacheria (time series in Figure 6.4G) using the Arizona Climate Zone 7 reconstruction (Arizona climate zone 7; Ni et al 2002). Superposed Epoch Analysis (B) of widespread (≥25%, ≥10 trees) fire years during wartime in each mountain range (Figure 6.4A-F), excluding regional fire years from Figure 6.4G. Superposed Epoch Analysis is an event-based analysis that looks at the patterns of climate in the years before (and after) each fire event to determine statistically significant relationships between the occurrence of fire events and fire-year climate and climate of the preceding years (>95% confidence interval).

synchronous fires in Apacheria do (Figure 6.5A). This is the classic pattern across western North America of a significantly dry fire-year preceded by at least two wet years (Swetnam and Baisan 2003; Swetnam et al. 2016). By contrast, when those regional fires are excluded, the big fire years (i.e., high synchrony within each mountain range) during wartime periods have a very different climate relationship. Multi-year wet conditions that grew abundant fuel remained important but a dry fire year was no longer a significant predictor of synchronous fires within mountain ranges, suggesting that altered ignitions were sufficient to burn large areas once fuel was available (Figure 6.5B).

In the Mogollon Rim region (Figure 6.1, location 6), Ancestral Pueblo people ceased to occupy the area year-round by AD 1400. This area was *Tierra Despoblada* according to the Coronado Expedition in 1540 but was clearly occupied by Western Apaches by the end of the sixteenth century (Herr 2013). In the Forestdale Valley, charcoal, phosphorus, and pollen document changing fire regimes over the past millennium (Figure 6.6). Prior to AD 1400, Ancestral Pueblo burning for agricultural purposes (Sullivan 1982) increased charcoal and phosphorus deposition without appreciably changing the ponderosa pine forest pollen signature (Roos 2008). When the valley was *despoblada*, charcoal and phosphorus declined while the pollen assemblage was unchanged. By the late sixteenth century when Western Apaches lived in the valley, pollen records indicate an increase in ruderal taxa and an increase in phosphorus, suggesting frequent fires but low biomass consumption promoting economically important wild plants (Roos 2015). These fires were almost certainly small and patchy in contrast to the widespread fires of the Chiricahua area.

In the Sacramento Mountains of southern New Mexico (Figure 6.1, location 7), occupation by Mescalero Apache did not coincide with changes in fire frequency or fire spread, but did coincide with changes in fire seasonality (Kaye and Swetnam 1999). In this case and in the Mogollon Rim region, where conflict with European-Americans may have been less common than southeastern Arizona, fire use was probably driven by subsistence concerns and involved changes in the fire mosaic and seasonality. In fact, this pattern of fire use in ponderosa pine forests may have been part of creating "transported landscapes" for Apaches moving into the Southwest from along the Colorado Rockies (Roos 2015). The enhanced conflict with Chiricahua Apaches may have stimulated a very different anthropogenic fire regime, one that superficially replicated the post-1700 fire regime in northern New Mexico but with different drivers and different climate associations.

### De facto Fire Suppression

Livestock grazing is implicated in de facto fire suppression in the late nineteenth century prior to active fire suppression later in the twentieth century (Swetnam et al. 1999). However, sheep, cattle, and horses were introduced in the sixteenth and seventeenth centuries and were readily taken up by Indigenous communities (Jones this volume, 2015, 2018). Horses were fundamental to Apache raiding (often for more horses and cattle; Basso 1998). At least some Pueblo people retained domesticated animal husbandry even in the context of the post-Pueblo Revolt revitalization movement (Liebmann 2012). Pastoralism became a key component of Navajo identity (Kluckhohn and Leighton 1956). Although some of the late nineteenth-century grazing impacts are tied to the sheer magnitude of post-railroad sheep and cattle grazing (Jones 2015), there is evidence that Indigenous pastoralism and small-scale Hispanic pastoralism may have contributed to local de facto fire suppression as much as a century earlier (Baisan and Swetnam 1997; Guiterman et al. 2019; Margolis and Balmat 2009).

As mentioned above, this appears to have been the case for upland forests overlooking Albuquerque, wherein fire disappears or is substantially reduced in tree-ring records after AD 1785 (Baisan and Swetnam 1997). The areas where early de facto fire suppression is best documented, are the Chuska and Lukachukai Mountains on the Navajo reservation (Figure 6.1, location 8; Guiterman et al. 2019; Savage and Swetnam 1990). This pattern has been repeated in more recent studies with some added complexity. Although grazing reduces fire activity on the broader landscape, high-traffic areas and travel corridors retain frequent surface fires into the early twentieth century (Whitehair et al. 2018). Although these nineteenth-century fire regime changes are not in the Protohistoric period sensu stricto, they are a product of processes unleashed during the Protohistoric and cannot be disentangled from them.

### Conclusion

There is no single rebound event or process for fire regimes in the wake of protohistoric demographic, economic, and political changes. In some cases, reductions in human populations altered ignition patterns and reorganized the abundance and spatial relationships of landscape fuels, ushering in a period of widespread, extensive surface fires (see also Klimaszewski-Patterson this volume). In other cases, changes in the demographic and political landscape created open niches for relatively new immigrants to the Southwest, both human (Athapaskan) and nonhuman (sheep and cattle). Intensively occupied woodlands that were depopulated prior to the Protohistoric period show evidence for rebound or reorganization centuries before Spanish colonization (see also Alsgaard and

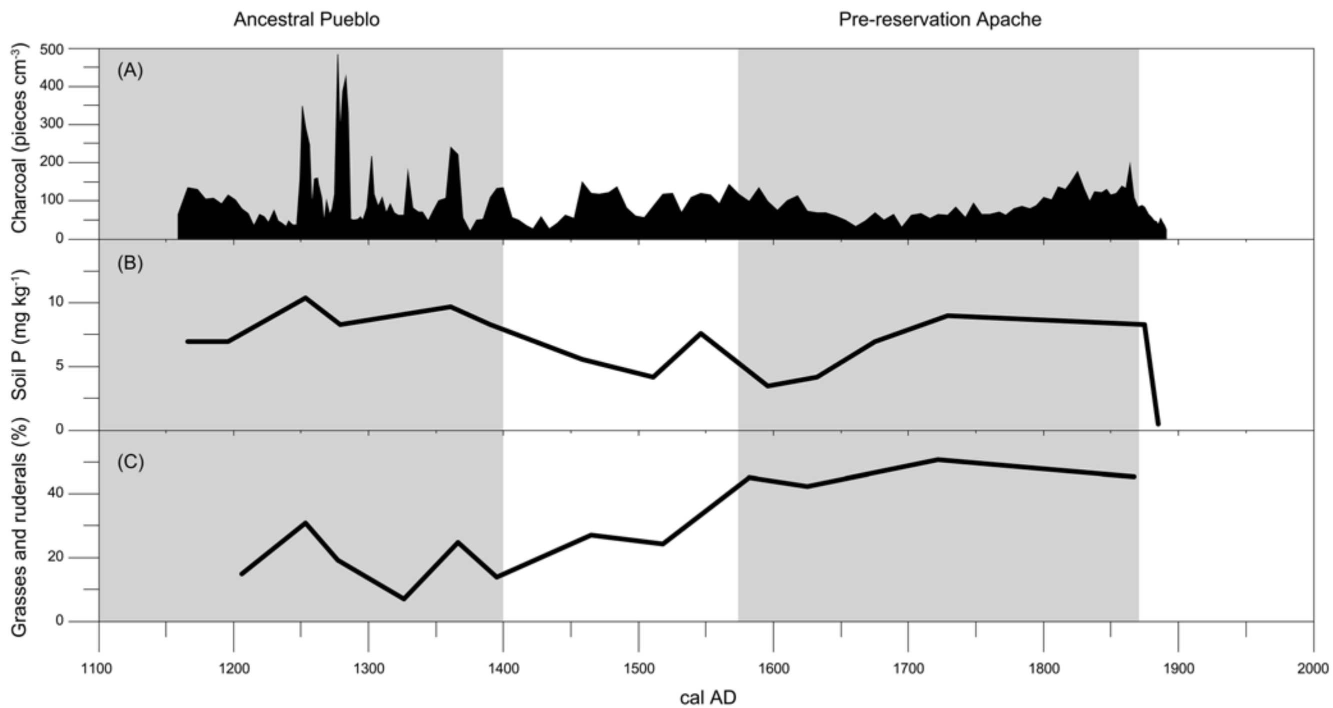


FIGURE 6.6. Time series plots of charcoal (A), phosphorus (B), and grass, compositae, and cheno-am pollen from Forestdale locality 10 (C; from Roos 2008). Gray areas indicate different cultural periods and highlight different fire regimes.

Jones this volume). Although these areas also indicate complexity with continued human use, even as those uses changed. Another source for this complexity is the spatially and temporally variable nature of human impacts on Southwest fire regimes.

Given this complexity and the long time spans over which these processes play out, with what confidence can we describe any particular process as fire-regime rebound? Given historical contingency, any particular landscape history may be too messy to describe as rebound in a simple sense. However, in each of the cases we describe, reorganization might be a more appropriate description. Regional syntheses of fire-scar records clearly indicate that spreading surface fires characterized dry forest fire regimes from at least AD 1700 across scales (Falk et al. 2011). Given spatial heterogeneity in the distribution of human populations and land use, it is unlikely that there is a characteristic human impact or environmental rebound to Southwestern fire regimes. It almost certainly varied from place to place. The best candidate for environmental rebound would be the fire regimes documented for the northern Rio Grande after AD 1680, which align with the regional fire patterns and regional fire-climate relationships. However, the Apache and Navajo examples indicate that fire-regime rebound was not uniform across the Southwest U.S.A.

# Contributors

Cinthia Abbona,
CONICET/UTN-Instituto de Evolución,
Ecología Histórica y Ambiente,
Av. Gral. J. J. Urquiza 314, CP5600,
San Rafael, Mendoza, Argentina.
Email: cabbona@mendoza-conicet.gob.ar

Asia Alsgaard,
Department of Archaeology,
History, Cultural Studies and Religion,
Østeinsgate 3, Postboks 7805, 5020 Bergen, Norway.
Email: aalsgaard49@gmail.com

Jacob L. Fisher,
California State University Sacramento,
Department of Anthropology,
MS6106, 6000 J Street, Sacramento, CA 95819, U.S.A.
Email: jlfisher@csus.edu

Adolfo Gil,
CONICET/UTN-Instituto de Evolución,
Ecología Histórica y Ambiente,
Av. Gral. J. J. Urquiza 314, CP5600,
San Rafael, Mendoza, Argentina.
Email: agil@mendoza-conicet.gob.ar

Christina M. Giovas,
Department of Archaeology,
Simon Fraser University,
8888 University Dr., Burnaby, BC V5A 1S6, Canada.
Email: cgiovas@sfu.ca

Jeff A. Johnson,
Wolf Creek Operating Foundation,
1026 Soldier Creek Road, Wolf, WY 82844, U.S.A.
Email: jeff.johnson@wcof-wy.org

Emily Lena Jones,
Department of Anthropology,
MSC01-1040, 1 University of New Mexico,
Albuquerque, NM 87131, U.S.A.
Email: elj@unm.edu

Anna Klimaszewski-Patterson,
California State University Sacramento,
Department of Geography,
MS6003, 6000 J Street, Sacramento, CA 95819, U.S.A.
Email: anna.kp@csus.edu

Matthew J. Liebmann,
Department of Anthropology, Harvard University,
21 Divinity Avenue, Cambridge, MA 02138, U.S.A.
Email: liebmann@fas.harvard.edu

Lisa Nagaoka,
Department of Geography and the Environment,
University of North Texas,
1155 Union Circle #305279
Denton, Texas 76203-5017, U.S.A.
Email: lnagaoka@unt.edu

Gustavo Neme,
CONICET/UTN-Instituto de Evolución,
Ecología Histórica y Ambiente,
Av. Gral. J. J. Urquiza 314, CP5600,
San Rafael, Mendoza, Argentina.
Email: gneme@mendoza-conicet.gob.ar

Clara Otaola,
CONICET/UTN-Instituto de Evolución,
Ecología Histórica y Ambiente,
Av. Gral. J. J. Urquiza 314, CP5600,
San Rafael, Mendoza, Argentina.
Email: claraotaola@conicet.gov.ar

Torben Rick,
Curator of North American Archaeology,
Department of Anthropology,
National Museum of Natural History,
Smithsonian Institution, P.O. Box 37012,
MRC 112, Washington, DC 20013-7012, U.S.A.
Email: RickT@si.edu

Christopher I. Roos,
Department of Anthropology,
Southern Methodist University,
P.O. Box 750336, Dallas, TX 75275-0336, U.S.A.
Email: croos@mail.smu.edu

Thomas W. Swetnam,
Laboratory of Tree-Ring Research,
University of Arizona,
1215 E. Lowell Street, Tucson, AZ 85721-0045, U.S.A.
Email: tswetnam@ltrr.arizona.edu

Elic M. Weitzel,
Department of Anthropology,
University of Connecticut,
354 Mansfield Road, Storrs, CT 06269-1176, U.S.A.
Email: elic.weitzel@uconn.edu

Steve Wolverton,
Department of Geography and the Environment,
University of North Texas,
1155 Union Circle #305279
Denton, TX 76203-5017, U.S.A.
Email: Steven.Wolverton@unt.edu