Landscapes

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CHAPTER 35

ANTHROPOGENIC LANDSCAPES

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NATIVE peoples of the Southwest impacted their environments in myriad ways, to varying degrees, and at varied scales. It remains somewhat controversial whether or not southwestern societies could impact their environments at such a scale as to describe the entire region as an anthropogenic landscape. As has been argued for other parts of the world, a primary mechanism that could have accomplished this is the use of broadcast burning of vegetation, either by igniting fires across all parts of the landscape or through such prodigious use that anthropogenic fires spread to all corners of the Southwest (Dobyns 1981; Pyne 1982). This scenario grossly oversimplifies the relationship that southwestern biotic communities have had with fire. In fact, natural ignitions—primarily the abundant and ubiquitous lightning that accompanies the onset of the summer monsoon season—are sufficient to generate the fires that are so historically important in some Southwestern ecosystems (Allen 2002). Equally important to acknowledge, however, is that while fire is a keystone process in some ecosystems, it is an infrequent visitor to others.

Describing past fire regimes in the Southwest as entirely natural, however, overlooks the evidence from early twentieth-century ethnography that Native Americans used fire in sophisticated ways to manipulate their environments at varying scales. Prior to the introduction of European crops, livestock, and agricultural technologies and the imposition of political and military restrictions on traditional land use practices, Native southwesterners may have used fire in ways that were no longer extant at the time of ethnographic observation. Rather than asking whether fire is "natural" or "cultural" in the Southwest—it is both—we may be better served by asking how, when, and where people used fire (or otherwise impacted existing fire patterns) and at what scale these activities may have shaped their surroundings. To best accomplish this, archaeologists must consider the purpose of any fire-use by southwestern people, as well as the ecological and social contexts of its use. In this chapter, I will briefly summarize the state of knowledge on historical patterns of landscape fire in different biotic communities in the

Southwest, followed by a review of different purposes for fire use as recorded from ethnography and inferred from archaeological and paleoecological studies. Finally, I revisit the scale at which these activities may have impacted Southwest landscapes to illustrate how archaeologists might utilize the inherent ambiguity of anthropogenic burning to explore long-term fire-climate-society couplings.

What We Know: Historic Fire Regimes in Southwestern Biomes

Not all fire is ecologically equivalent. Landscape fires can occur in fuels on the surface of the ground (surface fires) or through the vegetation canopy (crown fires); they can occur frequently (every few years) or rarely (every few centuries); they can be widespread (single fires covering > 10,000 hectares) or patchy (< 100 hectares); they can occur in any part of the annual cycle in which fuel is in sufficient abundance but fuel moisture is sufficiently low to carry it. The patterns by which landscape fires tend to occur are called *fire regimes*. The size, intensity, frequency, context, and seasonality in which fires typically occur have different ecological impacts and are the fire regime to which the individual species and plant and animal communities will be adapted. Southwestern fire regimes vary substantially by biome. Although there is a tendency to assume that indigenous anthropogenic burning was exclusively a frequent surface fire regime (Stewart 2002), it is not at all clear that such a fire regime would be biophysically possible in all Southwest biotic communities.

The distribution of biomes in the Southwest is significantly influenced by topographic variability and elevation (Brown 1994; Figure 35.1). In addition to different assemblages of plants, these biotic communities differ in their vegetative productivity. With the exception of the cool, moist alpine forests of the highest elevations, other biomes are fuel limited, meaning that landscape fire activity is primarily restricted by fuel abundance and continuity. Natural ignitions from lightning are abundant and widespread, although they occur more frequently in the higher elevations. At the lowest elevations, the Sonoran and Chihuahuan deserts are characterized by vegetation that is both very fire-sensitive (succulents and cacti) and at such low density in their distribution as to make fire spread very difficult. Over long timescales, it is likely that fire was virtually absent from the deserts because of severe limitations on fuel abundance and continuity. This is changing in modern times with the introduction of exotic grasses that provide a continuous, flammable fuel bed that is threatening the desert biomes. However, with the exception of riparian corridors (Davis et al. 2001), fire was probably exceedingly rare and small in scale in the deserts of the Southwest (Fish 1996).

The high-desert grasslands of the Sonoran uplands, Chihuahuan desert margins, and the Plains and Great Basin grasslands in the northern Southwest were also fuel limited and probably experienced natural ignition rates that were lower than the forests and

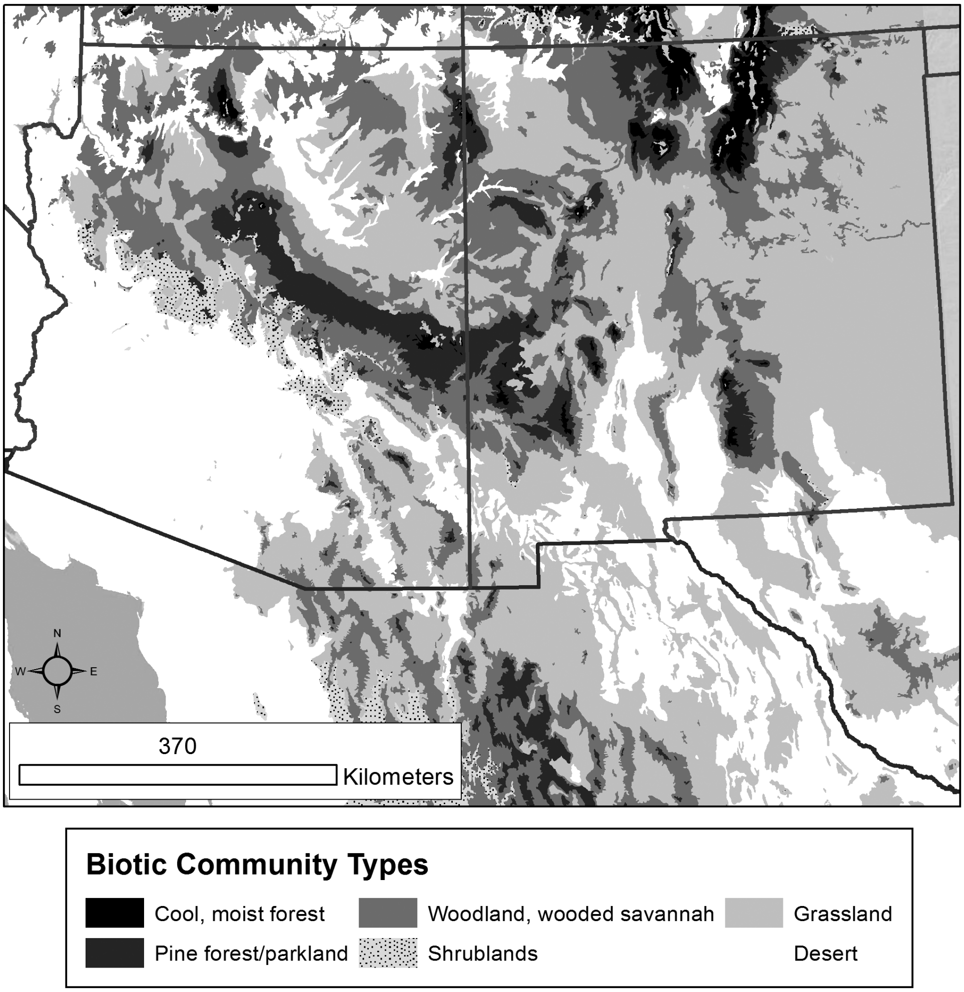

FIGURE 35.1. Distribution of biotic community types in the Southwest United States and Northwest Mexico.

Aggregated and adapted from data in Brown (1994).

woodlands that sit above them in elevation. However, when grassland productivity is high due to elevated precipitation, abundant continuous grass cover can lead to fires that can burn over entire basins (> 100,000 hectares) over the course of several weeks (Bahre 1985). Such fire patterns are probably particularly prevalent after prolonged wet winters and El Niño events in particular. The frequency with which such conditions occurred in the past is not entirely clear, although the relative dearth of woody vegetation in this biome prior to the twentieth century provides circumstantial evidence that fires burned within a particular grassland patch roughly once per decade (MacPherson 1995). Tree-ring records from canyon bottomlands adjacent to grassland-covered basins seem to corroborate this frequency (Kaib 1998).

Middle-elevation woodlands often have different associations of piñon and juniper species. Overstory and understory composition in these woodlands vary tremendously depending on topography, bedrock geology, and soil conditions from open juniper savannahs to dense piñon-juniper woodlands with very sparse understory components (Romme et al. 2009). Piñon and juniper trees rarely record fire scars, and many studies suggest that these species are very fire sensitive (Floyd et al. 2003:264). With high canopy density, these woodlands are capable of carrying very hot crown fires when live fuel moistures are low (during severe droughts). Stand-age studies suggest that some old growth, dense woodlands have lacked fire for centuries (e.g., Floyd et al. 2004). However, some piñon-juniper woodlands have yielded fire scar chronologies that are the result of surface fire regimes (Poulos 2007), and the potential fire regimes of these woodlands are highly dependent upon the nature of canopy density and understory vegetation type (continuous grasses or discontinuous woody shrubs) (Romme et al. 2009). Some documented human activities, such as pruning of lower dead branches, would alter the vulnerability of the canopy species to surface fires in these settings by removing "ladder fuels" that could carry fire from surface fuels into the canopy (Anschuetz 2013:418–419). Ultimately, there is a great deal yet to be learned about the historic fire regimes of southwestern woodlands.

The dry middle-elevation pine forests are primarily dominated by a single overstory species (ponderosa pine or related species) and, prior to the twentieth century, were characterized by a very open stand structure that promoted a grassy understory plant community (Covington 2003). These biotic communities have the best-known historical fire regimes because the overstory species regularly record fire scars that can be dated to the portion of the growing season in which a surface fire occurred (Dieterich and Swetnam 1984). These forests are dry enough to be limited by surface fuel availability; therefore surface fires in these contexts have a very strong relationship to antecedent wet conditions that promote understory plant growth (Crimmins and Comrie 2004; Swetnam and Baisan 2003). At these middle elevations, the combinations of regularly occurring fuel conditions sufficient for spreading surface fires and abundant lightning during the early summer (Allen 2002) mean that conditions for a frequent, summer-dominated, surface fire regime were present through much of the Late Holocene (Roos and Swetnam 2012). At higher elevations, the cooler, more mesic conditions also mean that these forests are more productive, with greater biomass and additional canopy species (e.g., Douglas fir, white pine). Fires occur less frequently in mixed conifer forests, although when they do occur, they tend to have a mix of surface and small crown fires, depending on local conditions (Margolis et al. 2011; Bigio et al. 2016).

At even higher elevations, cool and moist climates favor the growth of dense spruce and fir forests. Fires in these forests are not limited by the abundance or continuity of fuels, but by fuel moisture content. The abundant, dense canopy fuels of these forests are only dry enough to burn during extreme drought conditions, but at these times they primarily burn as crown fires, the size of which is limited primarily by topographic conditions (Margolis and Swetnam 2013).

Scales of Fire Use

Our knowledge of indigenous fire use in the Southwest is severely limited by the historical timing of most ethnographic work and the difficulty of inferring fire use in the archaeological and paleoecological records (Bowman et al. 2011). Most ethnographic descriptions of land use practices of different Native American southwestern groups date to the late nineteenth and early twentieth centuries—long after the impacts of introduced crops, livestock, and farming practices had altered subsistence economies and very recently after the governmental restrictions on traditional land-use practices with the establishment of reservations in the 1870s. Fire ecology did not exist as a concept until the mid-twentieth century, so there were very few anthropologists working in this key period of time who were even aware that fire use may have been an important subject of investigation. Therefore, the shreds of information in the ethnographic record almost certainly under-represent traditional fire use practices.

Fire Use in Hunting

The use of fire as a tool in hunting drives is one use of fire that persists into the ethnographic present for many Native groups across the Southwest (Buskirk 1986; Gifford 1940; Stewart 2002; Williams 2002). Although the contexts of fire use in these attributions is often ambiguous, these probably refer primarily to driving lagomorphs in areas with continuous fuels (i.e., grasslands), although ungulates may have been driven by fire in higher elevation ecosystems (Buskirk 1986:127, 131). Out of necessity, such fires would have been relatively small in scale (ca. 10–15 hectares or less), although the actual size of these historic fire drives is not documented. The spatial scale of these fires and the infrequent nature of communal hunts with which they are associated would mean that this form of fire use is unlikely to have "landscape-scale" impacts through burning. The mosaic of previously burned areas (if fire drives occurred annually) could have had an impact on the ability of grassland fires to spread as extensively as they would have otherwise, creating a landscape of many more small fires but perhaps less fire overall.

Another probable use of fire related to hunting is burning to promote new growth to attract ungulates to a predictable location. This activity is not directly documented in Southwest ethnography, but it could have been an effective strategy for increasing encounter rates of ungulates during the fall hunting season, when securing sufficient animal protein for the winter and spring may have been important. Such burning would probably have been most effective in the middle-elevation forests and woodlands near the start of the summer monsoon, when the rains would have limited fire spread and provided the soil moisture for vegetation regrowth that is key to this strategy. This form of hunting fire use is also unlikely to have had landscape-scale impacts. The effectiveness of this strategy for increasing encounter rates would have been undermined if the burn patches were too large or widespread. One could also imagine a scenario where burned patches defined ungulate hunting grounds as a form of usufruct, identifying a particular hunting patch as being "used" in the way that it communicates ownership among Aboriginals in Western Australia (Bird et al. 2005).

Although the scale of individual burn patches may not have been large, the location of these burn patches may have been at a rather large scale, relative to the daily use zone for the settled agriculturalists of the later prehispanic period. Long-distance (> 20 kilometers) logistical hunting forays could have involved this fire use strategy and created a mosaic of anthropogenic burn patches onto existing fire regime patterns at great distances from the locations that have the greatest archaeological visibility. From this perspective, such fire use may have the potential to create anthropogenic landscapes at a large scale, but the frequency, seasonality, and ecological contexts of these fires would have made them very difficult to distinguish from historical fire regimes, except in some woodland settings that would otherwise have had infrequent crown fires.

Fire Use in Wild Plant Management

Another ethnographically documented use of fire is in the manipulation of wild plant resources, although this has primarily been documented for Athapaskan (Buskirk 1986) and Piman (Dobyns 1981) groups. A number of economic food plants, plants for crafting materials, and medicinal plants thrive in post-fire settings (Foxx 1996). Wild annuals, including those in the sunflower family and cheno-ams, were important wild food resources for both their abundant seeds in the late summer and as leafy greens in the spring (Fish and Adams, Chapter 41 in this volume). The economic importance of such plants was enough to promote broadcast seeding near settlements or preferred collecting areas in the early twentieth century. It is easy to imagine that burning wild seed-collecting areas may have been used in the past to promote such plants, although such burning practices are not universally documented in the Southwest ethnographic record.

Fire use to manipulate wild plant communities has also been inferred archaeologically (Fish and Adams, Chapter 41 in this volume). On the basis of low maize recovery rates and high recovery rates of wild annuals and perennials, Sullivan has argued that Pueblo II period residents of the Grand Canyon area used fire to manipulate succession for economic purposes (Sullivan 1996). He has described these as "fire reliant" economies (Sullivan and Forste 2014) that use fire to remove competition for seed-producing annuals, especially cheno-ams, and hypothetically to enhance the yield of piñon crops (Sullivan 1992). There is tentative paleoecological evidence to support this hypothesis (Roos et al. 2010; Sullivan and Ruter 2006).

Also from the Grand Canyon area, Bohrer (1983) has suggested that burning of select shrub fields could have promoted the long, straight shoots necessary for making the famous Middle Holocene stick figurines that have been recovered from alcoves within the Inner Canyon. Given the importance of basketry technology, such burning to promote raw materials may have been important over a wide range of southwestern environments where suitable species were found (predominantly at middle to lower elevations). The scale of these fires would probably not have been very large—at least they would not have needed to be larger than a particular patch of vegetation—although there is not good evidence to determine the sizes of these fires. Fire spread in shrubby contexts would have depended on weather conditions (wind speed, relative humidity, and ambient temperature) and on the continuity and abundance of fuels.

Fire Use in Agriculture

When establishing a new agricultural field, existing vegetation would need to be removed to reduce competition for water, nutrients, and sunlight. Fire may have been a preferred mechanism for establishing new fields or cleaning out old ones. Burning vegetation in situ would have had the added benefit of recycling key nutrients, such as nitrogen, phosphorus, and potassium, from live vegetation to mineral and plant-available forms in the ash produced by such fires—the so-called *ash bed effect*. In grassland and shrubland contexts, fire would have been a straightforward mechanism for preparing fields and recycling nutrients, although the seasonal timing may have been important to limit fire spread beyond the desired field setting. For example, burning in early spring when ambient temperatures are relatively cool (especially at night) and fuel moisture levels were relatively high would have facilitated greater control over fire behavior.

In forests and woodlands, it is not clear to what extent the overstory would have needed to be removed to establish new agricultural fields. Kohler (2004) has suggested that individual trees could have been top-killed with fire to recycle nutrients at their base for cultivating domesticates. In this case, the dead limbs and trunk of the tree would have been a standing resource for fuelwood as well. This may have been a necessary strategy to establish agricultural plots within dense, old growth stands where light may have been restricted at the surface, but would not have been necessary where sparse trees were separated by broad patches of understory vegetation. In pine forests/parklands, individual tree burning would not have been particularly viable, since mature ponderosa pines self-prune their lower branches and develop thick insulating bark at their base. Indeed, ponderosa parklands offered enough light at the ground surface for dense, continuous grassy understories, so burning may have been entirely unnecessary to establish sufficient access to sunlight for a new field. Among Western Apaches, standing trees were left intact when fields were established by burning in the woodland and pine forest zones (Buskirk 1986:61).

Sullivan (1982) has suggested that fire may have been used in pine forest contexts primarily to recycle nutrients from live and dead surface fuels as part of a non-swidden fire-farming rotation that he calls "burn plot agriculture." In some pine forests, particularly those at elevations over 2,000 meters in elevation, the blackened surface created by low-temperature combustion of surface fuels would have decreased the albedo and potentially lengthened the growing season by altering the microclimate of the burn plot fields. The nutrient benefits of the ash bed effect are very short lived, however, probably necessitating a burn plot rotation of every three to five years.

In all cases, the locations of burning would have been tethered to the agricultural landscape associated with a particular community, including any outlying fields, but this would have restricted the anthropogenic burning impacts to particular places on the landscape and would not have been spread at large scales. Elevated charcoal concentrations with "natural" pine forest pollen assemblages with traces of domesticate pollen in alluvial sediments seem to corroborate a "burn plot" agricultural strategy by Ancestral Pueblo farmers in the eastern Mogollon Rim region (Roos 2008; Roos et al. 2010), whereas elevated charcoal abundance from lake and wetland cores in southwest Colorado similarly corroborate a role for agricultural burning of some kind by Ancestral Pueblo farmers (Herring et al. 2014; Petersen 1988).

Fire Use in Warfare

Fire may have had myriad uses associated with the practice of raiding and warfare in the Southwest. Burned rooms within abandoned villages are an ambiguous but often cited indicator of ancient warfare (LeBlanc 1999). Although village conflagrations started by a wildland fire are alternative explanations for some burning patterns, particularly those in woodland settings that may have experienced crown fire regimes, the fuel loads surrounding large, long-occupied villages were probably far too low to permit fires to spread to architectural fuels within the village (Liebmann et al. 2016).

In an interdisciplinary study combining ethnohistorical and dendrochronological analyses, Kaib (1998) produced an influential study that suggests that wildfire activity at a very large scale was influenced by periods of warfare between Apaches and Spaniards, Mexicans, and Americans. Two keys to his analysis were the coincidence of periods of shortened fire return intervals in fire-scar records within pine forests with periods of warfare and raiding recorded in archival documents during the eighteenth and nineteenth centuries. Further supporting his inference that the elevated fire activity was due to warfare-related activities, Kaib notes that roughly 75% of all Spanish references to Apache fire use come in the context of warfare. Among the probable wartime uses of fire were burning to create smokescreens to evade pursuit, to destroy forage needed for horses, or to destroy agricultural crops, all of which may have been allowed to spread to larger areas if sufficient fuel was available.

Fire Use in Religious Practice

Although most interest in fire use by ancient southwesterners has been implicitly or explicitly functionalist, among the most detailed and provocative categories of fire use described in early Southwest ethnographies relates to the use of fire in religious practice. These are by no means common, but they do illustrate a dimension of fire use that may have impacted southwestern landscapes at a very large scale. For example, Zuni pilgrimages were accompanied by *Shulawitsi*, the Little Fire God, who reportedly set fire to everything he touched (Stevenson 1904:158). The persistence of this practice associated with Zuni pilgrimages in the early twentieth century may even have implications for the difficult to explain persistence of fire activity on the ponderosa pine–covered *kipukas* within the El Malpais basalt flows that are otherwise cut off from fire spread (Grissino-Mayer 1995). Zuni pilgrimages cross these basalt flows and may have added anthropogenic ignitions to these *kipukas* well into the twentieth century (Zedeño et al. 2001).

At Acoma, Leslie White (1932:94–96) documents a Kachina ceremony that he calls "Curatca lights the fires," in which young male kachina impersonators depart the pueblo at midnight and travel as far as 20 kilometers from Acoma to light fires in the cardinal directions and continue lighting fires on their travels back to the pueblo. According to White, the leaders of the Corn Clan would convene each summer to decide if the ceremony would be performed. This ritual was to be performed every five to ten years in early July across a variety of biomes, including grasslands, woodlands, and pine parklands and, over time, could have impacts across more than 100,000 hectares.

The legend that relays the origins of this particular ritual tradition indicates that Acoma people were aware of the regenerative power of fire in southwestern landscapes. When asked by the leader of the Corn Clan why he is lighting fires, Curatca simply replies "to heat the earth and make it more fertile" (White 1943:314). The frequency, seasonality, and biological contexts in which the young Acoma men were burning—every five to ten years, near the onset of the monsoon, in grasslands, woodlands, and pine forests—indicates a very sophisticated knowledge and mimicry of natural fire regimes. Although the potential impacts of such anthropogenic burning would have been at very large scales and at great distances from permanent settlements and agricultural landscapes, the Acoma practice highlights another key ambiguity in southwestern fire regimes. It probably meant little to Acoma people whether those environments burned from lightning ignitions or from kachina impersonators, so long as the landscape burned where and when it was necessary, and it was always Curatca who lit the fires.

Summary: Scale and Ambiguity

There is an essential tension between the scale at which anthropogenic burning impacted southwestern landscapes and the degree to which it can be easily parsed from the natural fire regime. At small scales, and at particular places (e.g., tethered to long-term settlements and agricultural landscapes), the impacts of burning for agriculture and wild plant management may have had the greatest cumulative impact and may have been easiest to segregate from natural variability in lightning-driven fire regimes (Roos 2008; Roos et al. 2010; Swetnam et al. 2016). Hunting, religious, and wartime fire use could have extended the reach of anthropogenic burning to landscape scales, but the frequency and seasonal timing may have made such fires very difficult to distinguish from the fire regimes onto which they were mapped.

Archaeological and paleoecological evidence for anthropogenic burning also retain ambiguities as to the types of fire use that generated them. Paleofire proxies are a palimpsest of different fire patterns that include natural ignitions and a variety of human uses. Separating the sacred from the utilitarian forms of burning may also be a fools' errand (Fowles 2013). Among the Western Apache, who used fire as a tool for myriad functional purposes (Buskirk 1986) and for whom there is paleoecological evidence for centuries of fire use in their homelands of Eastern Arizona (Roos 2008; Roos et al. 2010), the landscapes created by such burning are imbued with cultural meaning (Basso 1996), creating an interplay between the functional/economic and the cultural/moral domains (Roos 2015) that perpetuates the ambiguity of fire landscapes. As the Curatca legend from Acoma reminds us, even non-anthropogenic fires were part of the cultural world in which native southwesterners lived.

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