Native Burning in Western North America: Implications for Hardwood Forest Management

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Abstract

It is now widely acknowledged that frequent low-intensity fires once structured many western forests. What is not generally recognized, however, is that most of those fires were purposefully set by native people, not started by lightning. Data from the Rocky Mountains attest to the widespread use of fire by native people, as does the ecology of aspen, the only common deciduous hardwood in the West. Fire history studies all show that aspen once burned at frequent intervals, yet aspen will readily burn only when the trees are leafless and the understory dry — conditions which occur only early in the spring before leaf-out and understory regrowth, or late in the fall after leaf-drop and the understory has been killed by frost. During both these periods, though, there are few lightning strikes and virtually no lightning-started fires in the Rocky Mountains. Thus if aspen burned frequently in the past, as all evidence indicates it once did, then those fires must have been started by native people, who used fire to modify plant communities for human benefit. Similarly, eastern deciduous forests will readily burn only when leafless, but during that time there are few lightning strikes — one of many indications that aboriginal burning was also common in the eastern U.S.

Introduction

It is now generally acknowledged that frequent low-intensity fires were once common and historically structured many western forests (Barrett and Arno 1982, Kay 1995, Kloor 2000). In addition, it is widely assumed that most, if not all, of those earlier fires were started by lightning (Kloor 2000, Loope and Gruell 1973:434, Romme and Despain 1989). Data from Arizona, New Mexico, Idaho, Yellowstone, and the southern Canadian Rockies, though, all attest to the widespread use of fire by native people, as does the ecology of aspen (*Populus tremuloides*), the only common deciduous hardwood in the West.

Aboriginal Burning in the West

Selway-Bitterroot Wilderness Area

Brown and Bradshaw (1994) and Brown and others (1994, 1995), for instance, compared the U.S. Forest Service's Prescribed Natural Fire Program with pre-European settlement fires in the Selway-Bitterroot Wilderness Area along the Montana-Idaho border. Based on stand-age analyses and fire history maps, Brown and others (1994, 1995) determined how frequently various forest types burned in the past and then compared those data with how frequently the same vegetation types burned from 1979-1990 when lightning-caused fires were allowed to run their course. Brown and others (1994, 1995) reported that, on average, the area burned during pre-European times was nearly twice as great as the area burned by lightning fires alone today. Moreover, low-elevation montane areas that once had the highest fire frequency, now seldom burn. Since the overall climate has not changed, it is unlikely that lightning-caused fires burn less area today then they did in the past. Instead, it is likely that there are fewer fires today because native people no longer use fire to manage the land, as they once did.

Southern Canadian Rockies

A similar situation exists along the east slope of the southern Canadian Rockies. In the past, fires were exceedingly frequent, while today lightning-caused fires seldom occur (Barrett 1996, Heathcott 1999, Kay and others 1999, Kay and White 1995, White 1985). In some vegetation types, fire-return intervals are now 100 times greater than they were in the past. Lower montane valleys that once burned every 5 years or less now do not burn at all. Based on this and other evidence, Parks Canada has concluded that native burning, not lightning-caused fires, was critical in maintaining what heretofore was believed to be the “natural” vegetation mosaic of the southern Canadian Rockies (White and others 1998). That is to say, there simply are not enough lightning-caused fires to account for historical burn and vegetation patterns (Heathcott 1999).

Yellowstone National Park

Prior to park establishment, Yellowstone's northern grasslands had a fire-return interval of once every 25 years (Houston 1973). Yellowstone has had a “let burn” policy for nearly 30 years now, yet during that period, lightning-caused fires have burned practically none of the northern range. In 1988, fire did burn approximately one-third of the area, but according to agency definitions that was “unnatural” because the fire was started by a man, not lightning. Moreover, the fire that burned the largest portion of the northern range started outside the park and was driven by unusually strong winds more than 70 km before it reached the northern range. Besides, the 1988 fires are thought to be a 100-300 year event (Schullery 1989a, 1989b), so similar fires could not have caused the original 25 year fire frequency.

Despite a series of recent droughts, why has Yellowstone's northern range remained virtually unburnt? Park biologists contend that this is because “lightning has chosen not to strike very often on the northern range” (Despain and others 1986:109). That assertion, though, is not supported by data from the Bureau of Land Management's Automatic Lightning Strike Detection System which shows that, on average, lightning strikes the northern range 4 times per km^2/yr (Kay 1990:136-137). So lightning strikes, but why doesn't the

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Figure 1—An example of the ponderosa pine communities that were common throughout the West at European contact. These early forests were so open and park-like that it was possible to go nearly everywhere with horse-drawn carriages. These pine forests also supported a lush understory of grasses and forbs, while today, forest ingrowth has created a forest health crisis and understory forage production has fallen to virtually nothing (Uresk and Severson 1989, 1998). Photo taken on the south rim of Arizona's Grand Canyon by R. Arnold (No. 166) in 1905 — courtesy U.S. Geological Survey Photographic Archives, Denver, CO.

range burn? The answer is that when most lightning strikes occur, the herbaceous vegetation is too green to carry a fire (Kay 1995). Thus, it is likely that the park's original 25 year fire frequency was entirely the product of aboriginal burning.

Arizona and New Mexico

At European contact, ponderosa pine (*Pinus ponderosa*) forests in Arizona, New Mexico, and throughout the Rocky Mountains were open and park-like (see Figure 1), but have since developed into impregnable thickets due to the ingrowth of smaller trees, which, in turn, has created the current forest health crisis (Covington and Moore 1994, Fule and others 1997). The open nature of the original forests, as well as the more recent proliferation of smaller trees, is generally attributed to modern fire suppression and the lack of lightning fires. That is to say, it is commonly believed that lightning historically was the primary ignition source, not native people (Seklecki and others 1996, Swetnam and Baison 1996a). This interpretation, though, is not supported by lightning frequency data or time of fire-scar analyses.

In the southwest, over 95% of lightning strikes occur after July 1st (see Figure 2a), while, historically, 85% or more of ponderosa pines were scarred by fire during April, May, and June (see Figure 2b). Now, despite the relatively low incidence of lightning, lightning fires early in the year do burn a disproportional area due to generally dry conditions at that time of year (Baison and Swetnam 1990:1562, Barrows 1978, Swetnam and Betancourt 1990), but lightning fires alone still cannot account for the magnitude of early-season fire scarring seen during pre-European times (Barrows 1978). In many mountain ranges today, there simply are not enough lightning fires to have caused the high fire frequency observed prior to European settlement (Baison and Swetnam 1997:3). Thus, it is logical to assume that a large proportion of the "natural" fire regime in pine forests and

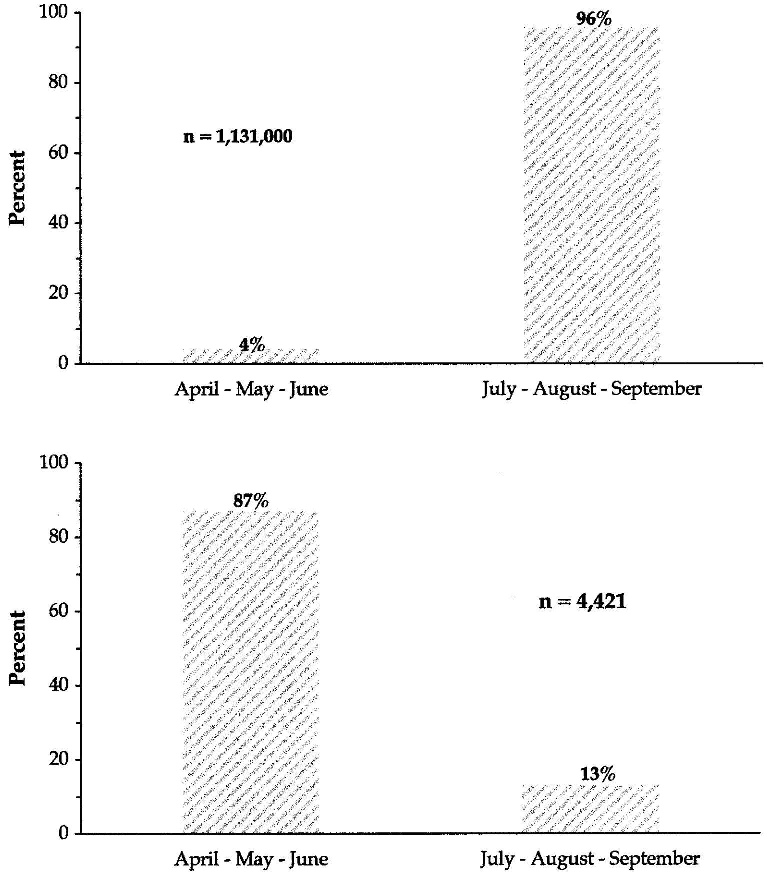

Figure 2—(a) Frequency distribution of cloud to ground lightning strikes in Arizona and eastern new Mexico during 1989 and 1990. From Watson and others (1994:1720). (b) Frequency distribution of fire-scar data for the southern Rockies. Clearly most trees were scarred by fire when there were few lightning strikes. Timing of fire scars determine by microscopic analysis of when individual growth rings were damaged by fire. From Brown and Sieg (1996), Fule and Covington (1999), Fule and others (1997), Morino (1996), Swetnam and Baison (1996b).

other regions of the southwest was actually due to aboriginal burning (Bonnicksen 2000).

Aspen Ecology

Repeat photographs and fire history studies indicate that Rocky Mountain aspen communities burned frequently in the past, yet experience has proven that aspen is extremely difficult to burn (Brown and Simmerman 1986). Terms such as “asbestos type” and “firebreak” are often used to describe aspen (DeByle 1987:75). Even raging crown fires in coniferous forests seldom burn adjacent aspen communities (Fechner and Barrows 1976). DeByle and others (1987:75) noted that “wild fires that had burned thousands of acres of shrubland or conifer types during extreme burning conditions usually penetrated less than 100 feet into pure aspen stands.” Lightning-fire ignition rates for aspen are also the lowest of any western forest type, and overall ignition rates are less than half that for all other cover types, including grasslands (Fechner and Barrows 1976). At current rates of burning, “it would require about 12,000 years to burn the entire aspen type in the West” (DeByle and others 1987:73). Something is clearly different today than it was in the past.

Research has shown that these communities will readily burn only when aspen is leafless and the understory plants are dry, conditions that occur only during early spring and late in the fall (Brown and Simmerman 1986). Prior to May 15th and after October 1st, though, there are few lightning strikes and virtually no lightning fires in the northern or southern Rocky Mountains (Kay 1997a, 1997b; Nash and Johnson 1993) — see Figures 3 and 4. So if aspen burned at frequent intervals in the past, as fire-frequency data and historical photographs indicate it did, then the only logical conclusion is that those fires had to have been set by Native Americans (Kay 1997a, 1997b).

Why did Native People Burn?

Thus, it is increasingly clear that Native Americans had a major impact on ecosystems by repeatedly firing the vegetation (Bonnicksen 2000). They did this to modify plant and animal communities for human benefit and to increase productivity (Pyne 1995). In California, for instance, native peoples had 70 reasons for burning (Lewis 1973), and even in northern Canada, where the vegetation is less diverse, Native Americans still set fires for at least 17 different reasons (Lewis and Ferguson 1988). Native peoples commonly set fires to enhance forage production and to attract prey; to herd wildlife during hunts; to rid the forests of underbrush and to facilitate travel; to enhance plant production such as berry producing shrubs, mast species, and root crops; to destroy poisonous snakes and other vermin; to clear the land prior to farming; to kill trees for firewood; to rid the land of places an enemy could hide; and as an instrument of war, among many others. Although

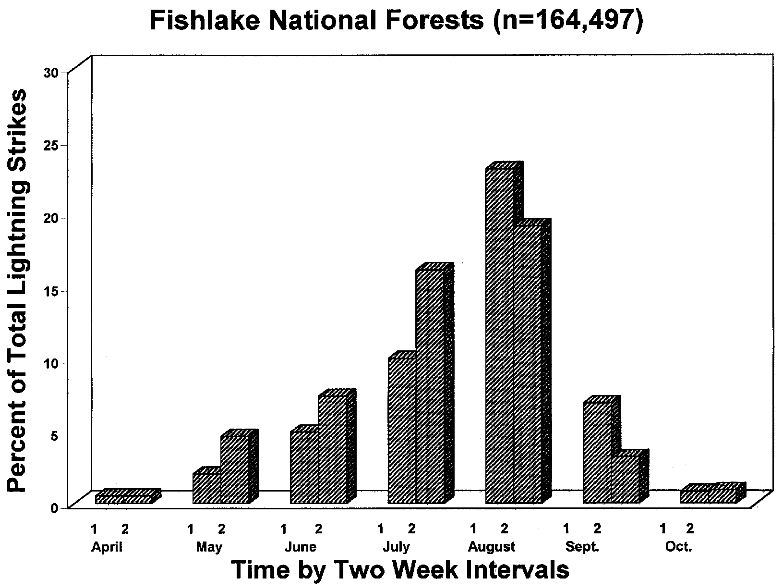

Figure 3—Frequency distribution of lightning strikes on the Fishlake National Forest in southcentral Utah. When aspen is normally dry enough to burn during early spring and late in the fall, there are few lightning strikes. This is true throughout western North America (Kay 1997a, 1997b; Kay and others 1999). Lightning data (1985-1994) from the Bureau of Land Management's Automatic Lightning Strike Detection System, Boise, ID as provided by the Fishlake National Forest, Richfield, UT.

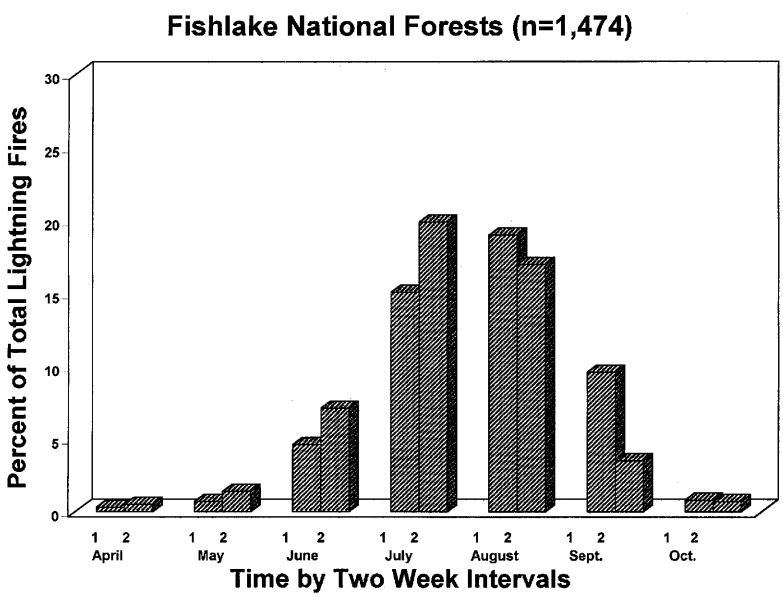

Figure 4—Frequency distribution of lightning-caused fires on the Fishlake National Forest in southcentral Utah. When aspen is normally dry enough to burn during early spring and late in the fall, there are few lightning strikes (Figure 3), and few lightning-started fires. Although, there are virtually no lightning fires capable of burning aspen, historical photographs and fire-history data indicate that aspen burn frequently in the past (Bartos and Campbell 1998). This suggests that the earlier fires had to have been set by native people. Forest fire data (1960-1996) from the Fishlake National Forest, Richfield, UT.

aboriginal burning has been widely reported in the anthropological literature (e.g., Boyd 1986; Gottesfeld 1994; Lewis 1985; Pyne 1993, 1995; Turner 1991), those findings have largely been ignored by ecologists and modern land mangers (Bonnicksen 2000, Kay 1995).

Determining how fires started, though, is critical because "fires set by hunter-gatherers differ from [lightning] fires in terms of seasonality, frequency, intensity, and ignition patterns" (Lewis 1985:75). The majority of aboriginal fires were set in the spring, between snowmelt and vegetation greenup, or late in the fall when burning conditions were not severe (Pyne 1995). Unlike lightning fires, which tend to be infrequent and of high intensity, native burning produced a high frequency of low-intensity fires. Aboriginal burning and lightning fires created different vegetation mosaics, and in many instances, entirely different plant communities (Blackburn and Anderson 1993, Bonnicksen 2000). Moreover, aboriginal burning reduced or eliminated the number of high intensity, lightning-generated fires (Pyne 1993, 1995; Reid 1987). Once aboriginal fires opened up the vegetation, then subsequent lightning fires behaved like those set by Native Americans (Pyne 1993, 1995).

Aboriginal Burning in the East

There are several lines of evidence which indicate that aboriginal burning was also common in eastern deciduous forests (Bonnicksen 2000, Hamel and Buckner 1998). These include the lack of lightning fire, the original structure of the forests, and species composition changes that have occurred since European settlement, among others.

Lightning Fires

Although lightning is common in most eastern forests, lightning-started fires are rare (Barden and Woods 1974, 1976; Bratton and Meier 1998; Harmon 1982; McCarthy 1923). This occurs because when lightning strikes are most frequent during July and August, eastern deciduous forests are too green to burn. Like western aspen communities, eastern deciduous forests will readily burn only when the trees are leafless and the understories dry — conditions that generally occur only early in the spring or late in the fall, and during both those periods there are few lightning strikes and even fewer lightning-caused fires. Fire history studies, however, have shown that prior to European settlement, fires were common in the eastern U.S. — many more than can be accounted for by lightning alone (Bonnicksen 2000:259-269, Bratton and Meier 1998). Therefore, the only logical conclusion is that burning by native people was once widespread in many eastern forests, similar to conditions in the West.

Forest Structure

At European contact, many eastern forests were open and park-like, with little undergrowth (Bonnicksen 2000, Day 1953, Olsen 1996). Like ponderosa pine forests in the West, most eastern forests were once composed of large, widely-spaced trees "so free of underbrush that one could drive a horse and carriage through the woods" (Botkin 1990:51). Like western forests, though, most eastern deciduous forests are now choked with dense underbrush and smaller regenerating trees. The only way to create open park-like stands in either western or eastern forests is for those areas to have been subjected to a high frequency of low-intensity surface fires. In eastern deciduous forests this would have required fires either early in the year before the trees leafed-out or in late autumn after leaf-fall. During both those periods, though, lightning-caused fires seldom occur. Thus, the only way for eastern forests to have displayed the open-stand characteristics that were common at European settlement is if those communities had regularly been burned by native people as part of aboriginal land management activities.

Species Composition Changes

An even more compelling piece of evidence is the species composition changes that have occurred in eastern forests since European colonization (Bonnicksen 2000). For the last 3,000-4,000 years, or longer, much of the eastern United States was dominated by oak (*Quercus* spp.), American chestnut (*Castanea dentata*) and pines (*Pinus* spp.), all fire-tolerant, early successional species (Bonnicksen 2000; Bratton and Meier 1998; Clark and Royall 1995; Cowell 1995, 1998; Delcourt and Delcourt 1997, 1998, 2000; Delcourt and others 1986, 1998; Hamel and Buckner 1998; Meyers and Peroni 1983; Olson 1996). Since European contact, however, oaks and pines have been replaced by late-successional, fire-sensitive species, such as maples (*Acer* spp.) (Abrams 1998, Bonnicksen 2000, Botkin 1990:51-71). That is to say, the species composition of many eastern forests had been maintained for thousands of years by frequent fires — fires, as we have seen, which could only have been set by native people. It is equally clear that aboriginal burning created the many eastern prairies and "barrens" reported by early Europeans (Barden 1997, Belue 1996, Bonnicksen 2000, Campbell and others 1991). Canebrakes (*Arundinaria gigantea*) too likely owed their existence to native burning and other aboriginal land management practices (Platt and Brantley 1997).

In the absence of aboriginal burning, massive vegetation changes have also occurred throughout the West (Bonnicksen 2000). Millions of acres of aspen have been lost to invading, fire-sensitive conifers (Bartos and Campbell 1998, Kay 1997a). Similarly, vast acreages of ponderosa pine and Douglas fir (*Pseudotsuga menziesii*) forests are being replaced by more fire-sensitive, and more shade tolerant conifers. In many areas of the West, native grasslands have declined precipitously as fire-sensitive, woody species have increased (e.g., Miller and Rose 1995). Oak dominated communities in California and Oregon have also been severely reduced by invading conifers, until today, oak woodlands are one of the most endangered habitat types in the West. All because native people no longer employ fire to manage the land (Bonnicksen 2000).

Aboriginal Populations

In addition, aboriginal populations were much larger than commonly believed (Hamel and Buckner 1998). Until recently, it was thought that only about two million natives inhabited North America prior to the arrival of Columbus (Stannard 1989, 1992). Dobyns (1983), however, postulated that native people, who were attempting to escape Spanish exploitation in Cuba, fled to Florida in ocean-going canoes and brought European-introduced smallpox with them to the mainland during the early 1500s. This and other diseases, to which aboriginal inhabitants had no immunological resistance, then ravaged native people, reducing aboriginal populations by >90% before the Pilgrims set-foot at Plymouth Rock. Subsequently, Ramenofsky (1987), Smith (1987), and Campbell (1990) tested Dobyns' hypothesis using the archaeological record and concluded that a major collapse of native populations occurred ca. 1550-1600 throughout North America — 100 to 200 years prior to direct contact of Europeans with native people in many areas; i.e., European diseases were transmitted from native group to native group across all of North America — termed pandemics.

Based on this and other evidence, it is now believed that in 1492 there may have been as many as 100 million native people in North America with perhaps an even larger number in South America (Stannard 1992). Although Dobyns' hypothesis is still debated (Snow 1995), in general, estimates of pre-European native populations have steadily been revised upward. Needless to say, prior to European influence there were more than enough native people to have structured vegetation communities throughout North America (Bonnicksen 2000). This is especially true in the eastern United States where agriculture supported high densities of native people (DeVivo 1991, Hamel and Buckner 1998, Smith 1987).

There was no “wilderness.” There were no unnamed streams, there were no unnamed mountains. The idea that North America was a “wilderness” untouched by the hand of man before 1492 is a myth, a myth created, in part, to justify appropriation of aboriginal lands and the genocide that befell native peoples (Cronon 1995, Denevan 1992, Gomez-Pompa and Kaus 1992, Simms 1992). Moreover, there is no evidence that native people ever purposefully limited their populations to avoid environmental impacts or that, if they tried, they were successful (Blurton-Jones 1986, 1987; Cohen 1977, 1989; Smith and Winterhalder 1992).

Conclusions

Prior to European discovery of the New World, aboriginal use of fire was widespread in both western and eastern forests. In fact, the Americas, as first seen by Europeans, had largely been crafted by native people, not created by nature (Bonnicksen 2000, Kay 1998). Thus, the only way to preserve original vegetation conditions in parks and other natural areas is for modern land managers to reinstitute historical burning regimes. A hands-off or “natural-regulation” approach by today’s land managers will not duplicate the ecological conditions under which eastern deciduous forests developed. Instead, letting-nature-take-its-course creates highly unnatural conditions that have never before existed in eastern or western forests (Bonnicksen 2000, Hamel and Buckner 1998). Unless the importance of aboriginal burning is recognized, and modern management practices changed accordingly, our ecosystems will continue to lose the biological diversity and ecological integrity they once had even in parks and other protected areas (Kay 1998).

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