

# FIRE

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## Role of Fire

In some areas, many aspen stands are all the same age, dating from a single great fire or a year of widespread fires (fig. 1). The 1879 fire in the Jackson Hole region of Wyoming (Loope and Gruell 1973) and the 1904 fires in Arizona's White Mountains (Kallander 1969) are examples. Choate (1966) found that almost all aspen stands in New Mexico were even-aged, many of them originating after fires dating since the mid-1800s.

Some authors (Fetherolf 1917, Langenheim 1962, Marr 1961, Reed 1971), considered aspen to be climax in some habitats. Others, notably Baker (1925), felt that all aspen forests are successional and fire-dependent in the Interior West, and, if not burned, that they would be replaced by conifers (see the VEGETATION ASSOCIATIONS chapter). Baker (1925) attributed the apparent aspen climax in some areas to the virtual absence of coniferous seed sources. However, he considered aspen to be a minor codominant species in some coniferous climaxes.

Charcoal from old fires is commonly found in the soil under aspen. Morgan (1969) cited charcoal on the sites he studied as evidence that aspen is successional. However, fire would also leave charcoal on sites where aspen is climax. The presence of coniferous charcoal would be much more meaningful. In some aspen stands, investigators have not found charcoal or other evidence of past fire (Reed 1971, Wirsing and Alexander 1975), unless the presence of aspen itself is taken as such evidence.

It is clear that many aspen stands, in the absence of fire, are replaced by grass, forbs, shrubs, or conifers (Beetle 1974, DeByle 1976, Krebill 1972, Schier 1975a).



Figure 1.—Pure even-aged aspen that probably originated from fire about 90 years ago. This excellent quality commercial aspen is on a good site in southwestern Colorado.

Also, almost all even-aged aspen stands in the West appear to be the result of severe fire, whether or not the aspen type is climax on the site. The development of uneven-aged aspen stands, on sites where fires have been light or absent for a long time, is discussed in the MORPHOLOGY chapter.

Even a mere scattering of aspen in a coniferous stand commonly will restock the area with a new aspen forest after a severe fire (Jones and Trujillo 1975a, Patton and Avant 1970, Pearson 1914, Stahelin 1943) (fig. 2). Perhaps many existing even-aged aspen forests developed after fire burned coniferous forests with a substantial aspen component (fig. 3). Descriptions of the development of aspen on some conifer burns state or imply that suckers formed scattered clumps during the first post-fire years and took over the burned site only after a period of about 5 to 20 years (Clements 1910, Ives 1941b, Loope and Gruell 1973, Stahelin 1943). This suggests that aspen had been very thinly scattered in those forests before they burned.

It is clear that fire is responsible for the abundance of aspen in the West and for the even-aged structure of so many stands.

## Fire Occurrence and Behavior

Aspen forest does not readily burn. Mutch (1970) pointed out that many vegetation types favored by fire have evolved characteristics which make them especially flammable. He considered aspen to be a low-flammability exception.

Fechner and Barrows (1976) proposed that existing aspen stands might be maintained and new stands



Figure 2.—Fire that kills the overstory in mixed aspen-conifer stands results in prolific aspen root suckering. Aspen often dominates sites such as this for perhaps a century after burning.

established as fuel breaks in critical areas. Their proposal was based on the infrequency, slow spread, low intensity, and ease of control of fires in aspen forests.

During a 14-year period on national forests in Colorado, an average of only 0.28% of the aspen acreage burned annually—a rate of less than 3% in a century (Ryan 1976). Aspen stands commonly will not burn at all. Crown fires running through coniferous forest drop to the ground when they come to an aspen stand and may even extinguish after burning into the aspen only a few yards. Fires sometimes bypass stands of aspen enclosed within coniferous forest. However, fuel conditions and flammability of aspen vary considerably among stands and times (Barrows et al. 1976).

Dated fire scars, historical records, and other evidence indicate that, before and during the mid-19th century, much larger acreages of aspen burned than have burned since. In the area of Jackson Hole, Wyo., the aspen stands date from fires between 1850 and 1890; significant fires burned in aspen forests there about every 6 years (Loope and Gruell 1973). In the Ephraim Canyon area of central Utah, Baker (1925) and Meinecke (1929) found very few aspens fire-scarred later than 1885. Earlier fire scars were common, indicating that fires burned in aspen there at intervals of 7 to 10 years. Extensive sampling of aspen in Colorado found few aspen fire scars dating later than about 1880 (Davidson et al. 1959).

Clearly, there has been a great reduction in the rate of fire rejuvenation of aspen in the West. This has resulted in a major and continuing change in the ages and structures of aspen stands. Green and Setzer (1974) showed that a heavy preponderance of western aspen acreage is dominated by pole and sawtimber-sized trees, which, for this species, means mature and overmature timber. Young stands are not common.

### Factors Influencing Fires in Aspen

During a sampled 14-year period on national forests in Colorado, most fires in aspen were found to be caused by people. Only 16% were started by lightning, compared to 57% of fires started by lightning in coniferous forests. October was the month with the most fires in aspen (Ryan 1976). In Colorado, not only are the weather and fuel often dry in October, it is also the month with the most hunting.

Houston (1973) briefly reviewed human factors that he believed were important in reducing burning late in the 19th century, in the Yellowstone National Park area. Although recently expanded use of the area has the potential to increase burning, current fire prevention campaigns and sophisticated suppression programs generally keep fire to a minimum.

When conditions are dry enough in aspen stands with a dense understory of conifers or shrubs, the abundance, chemistry, and vertical distribution of the fuel may favor a hot fire with rapid spread (fig. 4). In most aspen stands, however, the stocking of young conifers or shrubs is absent to moderate. In these stands, fuel largely consists of dead herbaceous material, fallen leaves,



Figure 3.—(A) A wildfire in June killed this mixed forest of aspen, lodgepole pine, and other conifers. (B) The scattered aspen trees in this forest produced enough aspen suckers by the end of that growing season to largely restock the site.

downed timber, and any shrubs or conifers that may be present. These fuels often are not abundant, and usually are not in a condition to burn. Under suitable conditions, fires in them may spread fairly rapidly but are not as intense as is common in coniferous forests.

Baker (1925) credited livestock use with major fuel reductions under aspen in the late 19th and early 20th centuries, when fire suppression was much less effective than it is today. Overgrazing by sheep was widespread, and by late summer there were little herbaceous fuels left beneath the aspen.

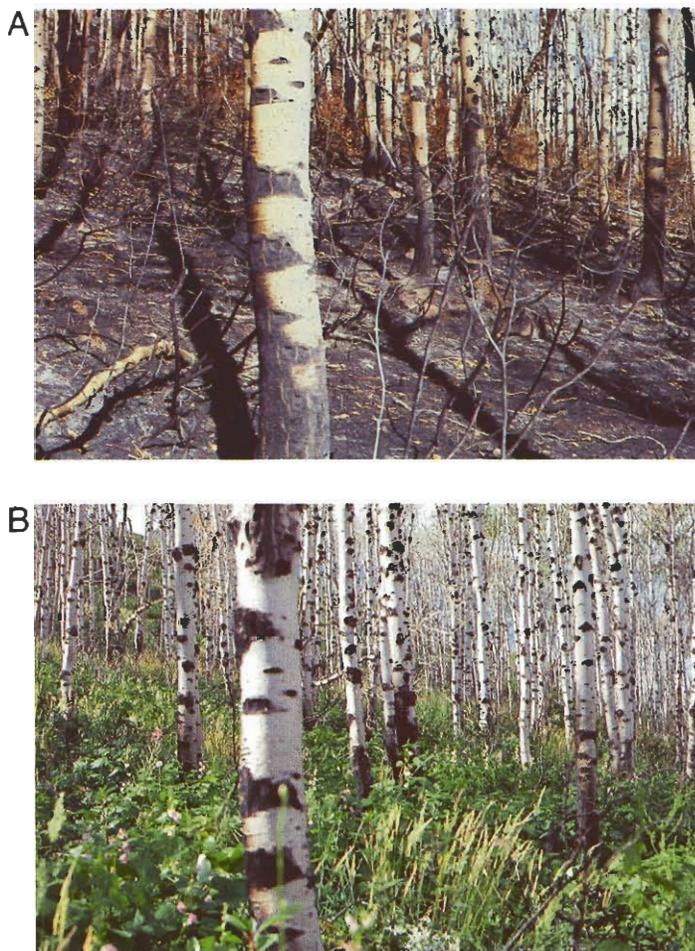
However, sheep grazing has become less common and less intense in aspen forests. Since about 1940, cattle have replaced sheep on many acres of western range. Where grassland is available, cattle do not use the nearby aspen stands as heavily as sheep once did. Heavy herbaceous stands are more common beneath aspen canopies. However, grazing still annually reduces the supply of fine fuels in most of the western aspen forest land (fig. 5). Without these fine herbaceous fuels, fire seldom burns through the aspen forest.

The combination of dry weather and cured fuels in the aspen forest does not occur every year. Most frequently, it occurs in the autumn, sometimes in late summer, and occasionally in spring. Late September and October can be wet, but often have periods of dry, sunny weather. By then, the herbaceous understory is frozen and dead, is still largely upright, and can burn readily. Also, the aspen canopy loses its leaves in late September and October. If conditions are dry, a continuous layer of loosely packed, fine fuels develops, making the aspen forest most flammable in this season. In most years, however, aspen leaf-fall and the first heavy, wet snowfall of autumn coincide in much of the aspen range, particularly in the north. The fall fire season ends when the winter snows come. These normally cover the ground from late October or November until April or May.

In much of the West, May and June are normally moist or wet. In Arizona and New Mexico, however, west of the Sangre de Cristo crest, May and June constitute the major fire season in coniferous forests. The weather is sunny, dry, and windy. However, in aspen stands without a coniferous understory, conditions then are much less favorable than is common in autumn. The previous year's dead forbs, grass, and fallen leaves form a low matted layer (fig. 6); and in the shade of June's new foliage, a fresh green herbaceous layer begins to develop that is essentially nonflammable. The May-June dry season is followed by the summer monsoon of July and August, with high humidities, frequent showers, and few fires.

Beneath aspen in the West, the litter layer from the previous autumn largely decays by mid-July. In the absence of a coniferous understory, there is little that will burn until the herbaceous undergrowth dies and dries in the late summer or autumn.

In the subalpine zone, coniferous understories are common beneath aspen; but the climate is not conducive to fires. Drying is slow. Snow may cover the ground in September or October, and may remain far into May or later. After the late snowmelt, green-up is very rapid.



**Figure 4.—(A)** An intense prescribed fire in September killed all the aspen in this pure stand with a shrub understory. Most trees were crown-killed as well as girdled. More than 50% of the fine fuels and 66% of the forest floor were consumed. Bare soil exposure increased from 3% to 35%. **(B)** One year later, this site had almost a complete cover of herbaceous plants. At the end of this first postburn growing season, there were about 1,250 pounds per acre (1,400 kg/ha) of grasses and forbs.

Even in Minnesota and Ontario, where a substantial layer of duff commonly is present for fuel (Alway and Kittredge 1933), conditions suitable for fire in aspen are infrequent (Buckman and Blankenship 1965, Horton and Hopkins 1965, Perala 1974b).

### Aspen Response to Fire

Although aspen forests do not burn readily, aspen trees are extremely sensitive to fire. Baker (1925) noted that very light fires kill aspen, because its bark is thin and green, with no protecting corky layers (fig. 7). He also stated that basal scars, which lead to destructive heart rot, are made on good-sized trees by the lightest of fires. Davidson et al. (1959) and Meinecke (1929) also pointed out the seriousness of fire scars as a cause of rot in aspen.

Despite the difficulty of getting fire to burn through aspen stands, the very sensitivity of the species,

especially that of young trees, apparently would make repeated prescribed fires a viable tool for eliminating aspen from a site. For example, Buckman and Blankenship (1965) found that reburning sucker stands in Minnesota markedly reduced the abundance and vigor of suckering. Two spring burns reduced sucker populations 68%, three burns 86%, and four burns 94% from the number found after only one spring burn. However, Perala (1974b) concluded that repeated dormant season burning was a poor tool for converting aspen to conifers, largely because fire was so undependable. He found that a spring burn killed only 42% of 21,000 2-year-old suckers per acre (52,000 per ha). A more effective burn in the autumn killed all the woody vegetation; but suckering was substantial 1 year later.

Bailey and Anderson (1979) tried to control aspen on sandy rangelands in Alberta, using a combination of fire and herbicides. Despite marginal success, they recommended burning as a desirable option if applied at about 4-year intervals. In a later article, Anderson and Bailey (1980) reported that 24 years of annual spring burning checked the invasion of aspen into grassland, reduced shrub and forest cover, but actually increased the numbers and cover of aspen suckers on the area.

A fire intense enough to kill the aspen overstory will stimulate abundant suckering (fig. 8); but some suckers will arise after any fire. For example, Maini and Horton (1966b) reported substantial suckering on burned plots whether or not the aspen canopy was removed. They suggested soil heating as the cause. However, the vigor of suckers growing under a live overstory is likely to be poor, as Barmore (1968) found in Yellowstone National Park after a light fire that killed existing suckers, the understory conifers, but few of the overstory aspen.

A severe fire removes the insulating duff, blackens the soil surface, and permits more solar radiation to effectively warm the mineral soil. A very severe fire also may kill roots in the surface 0.75-1 inch (2-3 cm) of soil (Horton and Hopkins 1965). Either or both of these effects may have contributed to the findings of Schier and Campbell (1978a), who reported an average suckering depth of 4 inches (10 cm) under a severe burn (more than 90% of the litter and duff consumed) as compared to



Figure 5.—Grazing by cattle or sheep reduces fine fuels in the aspen understory, which, in turn, reduces the flammability of the aspen forest.



Figure 6.—As illustrated in this vertical view, the matted forest floor in a typical aspen stand just after snowmelt in spring does not carry fire, especially after rapid greenup begins.



Figure 7.—A surface fire that burns around the base of aspen trees girdles and kills this thin-barked species.

2.5-3 inches (6-7 cm) under a moderate burn in Wyoming. Removal of all organic debris and exposure of bare mineral soil by fire also provides an ideal seedbed for the possibility of aspen seedling establishment.

Severe or repeated fires may have a detrimental effect on site quality. Stoeckeler (1948) attributed a 6- to 25-foot reduction in site index and reduced understory production to repeated burns in Lake States aspen. Horton and Hopkins (1965) and Perala (1974a), also reported poorer sucker growth on severely burned sites in Ontario and Minnesota, respectively. Severely burned sites in Wyoming produced the most suckers 2 years after the fire, as compared to 1 year after on the moderately to lightly burned sites (Bartos 1979, Bartos and Mueggler 1979). Most authors reported about equal numbers of suckers on both moderate and severe burns; but vigor and quality may be affected.

It appears that a moderate intensity fire that kills most or all the overstory will stimulate very adequate suckering and will have the least effect on subsequent sucker growth. From 12,100 to 60,700 suckers per acre (30,000 to 150,000 per ha) were produced after burning



**Figure 8.—A dense sucker stand 3 years after fire killed the pure aspen overstory.**

several sites in western Wyoming (Bartos 1979), certainly enough to adequately regenerate aspen on those sites (fig. 9). Also, after an initial decline during the first post-burn year, Bartos (1979) and Bartos and Mueggler (1979) measured an increase in herbage production for several years on these burned sites.

If fire occurs at infrequent intervals (e.g., 50 years) (Baker 1925) and is moderately intense enough to kill most or all of the aspen and competing conifers, most aspen sites in the West will retain viable stands of aspen. More frequent fires may adversely affect site



**Figure 9.—Fire on this relatively dry site in western Wyoming rejuvenated this derelict stand of aspen. There were about 12,000 suckers per acre and about 3,200 pounds per acre of understory production in this second postburn year.**

quality for aspen. Complete fire protection, however, will permit coniferous species to take over the majority of sites. In summary, fire is a natural feature in much of the aspen ecosystem of western North America. It is responsible for the abundance of aspen in the West and for the even-aged structure of most stands. Without human intervention, fire appears to be necessary for the continued well-being of aspen on most sites where aspen is seral.