

OTHER PHYSICAL FACTORS

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Light

Aspen has been recognized for many years as being very intolerant of shade (Baker 1918a, Clements 1910, Weigle and Frothingham 1911, Zon and Graves 1911). In dense stands, vigorous aspen trees are confined to the dominant and codominant crown classes. Regardless of size, when they are overtopped by larger trees, aspen trees deteriorate and eventually die. Many well-stocked, even-aged aspen stands have virtually no aspen regeneration beneath them, even in the form of small ephemeral suckers (Beetle 1974, Jones 1974b). In contrast, healthy coniferous seedlings may be plentiful under the densest aspen canopies. Paucity of suckers in an aspen stand, however, is only partly a result of reduced light; it also is partly a matter of apical dominance and of low temperatures in the shaded soils. (See the VEGETATIVE REGENERATION chapter for a fuller discussion of suckering physiology.)

Light Intensity

Often, well-stocked even-aged stands have many ephemeral suckers. These arise, reach heights of a few inches, die, and are replaced (Baker 1918a), often without being noticed. Some suckers may arise annually; but sufficient light is needed for successful development of viable saplings. Strain (1964) found maximum photosynthetic rates in two California clones at about 10,000 foot-candles—equivalent to a bright sunny day near sea level. At 6,000 foot-candles, photosynthesis was 80-95%; at 2,000 foot-candles it was still about 50% of maximum. Development of independent roots on suckers was found to be greater with increasing light intensity from 25% to 100% of full sunlight (Sandberg 1951, Sandberg and Schneider 1953). Under more open canopies, suckers persist longer and grow larger. Under old aspen stands in advanced stages of deterioration, canopies have as much gaps as crowns, and many suckers reach large sapling size. (See the stand structure discussion in the MORPHOLOGY chapter for more details.)

The number of suckers that regenerate after partial cutting of an aspen stand varies with degree of overstory removal. In Maine, Weigle and Frothingham (1911) followed the development of suckers that came in after timber cuttings that reduced the canopy to different densities. Light cutting produced a few suckers; these soon died. Moderate cutting produced abundant suckers; these subsequently dwindled and died, too.

Only when almost the entire canopy was removed and the suckers were given nearly full light was a uniform and vigorous sucker stand produced. Suckers under residual canopy trees do not do well, even where stands are heavily cut. Baker (1925) counted suckers in different light regimes in Utah. At 50% of full sunlight, there were only about 6% as many suckers per acre as on a clearcut, and they were much smaller.

After a fire or clearcut, most of the suckers which start in full sunlight are subsequently overtopped by more vigorous neighbors (Jones 1975, Jones and Trujillo 1975a, Pollard 1971). These overtopped and suppressed suckers progressively decline and finally die.

Photoperiods

Light can have other effects on aspen besides providing the primary energy source for photosynthesis. Using seedlings from two sources grown under uniform temperatures and near-optimum moisture, Vaartaja (1960) found that photoperiod differences were accompanied by differences in growth, with seedlings from the two sources differing greatly in response. Bate and Calvin (1971) induced dormancy in Ontario seedlings with 4 to 6 weeks of 8-hour light period. In the forest, however, dormancy would be induced in the autumn by lower temperatures before the period of daylight shortened to 8 hours.

Sunscald

Mature aspen trunks are likely to sunscald if they are exposed abruptly to a large increase in sunlight. Stems on the north side of clearcuts, those remaining after heavy thinning (Hubbard 1972), and those exposed by construction of campsites and roads (Hinds 1976) are likely candidates. Strain (1964) suggested that susceptibility to sunscald may vary with the amount of loose waxy periderm cells ("bloom") on the surface of the bark. The reflectivity of aspen bark differs with the amount, and probably the color, of that bloom. The amount and color of bloom differs among genotypes. On most clones, the amount also varies somewhat with the time of year. Covington (1975) felt that production of bloom was a function of temperature, and pointed out that it was greater on the south sides of trunks than on the north. He reported that it was increased by increased exposure to sunlight.

Wind

Aspen Blowdown

Occasionally, wind can have somewhat the same impact as a severe forest fire. For example, in 1958, an exceptional storm blew down 1,300 acres (500 ha) of mixed spruce, fir, and aspen forest on the Kaibab Plateau, in northern Arizona. After usable timber had been salvaged and the debris disposed of, aspen suckers came up over much of the area (Russo 1964).

Ordinarily, however, aspen is relatively windfirm. Trees with root rot or heartrot usually are the ones blown down (Baker 1925). Most blowdown of aspen in the West is windthrow—the trees tip over instead of breaking off above the ground. At least in Colorado, most trees that blow down have butts and roots rotted by *Ganoderma applanatum* (*Fomes applanatus*) (Davidson et al. 1959, Landis and Evans 1974).

Resistance to blowdown is largely a matter of mutual protection. An old, heavily stocked, mixed conifer stand in Arizona, with scattered large old aspen, was cut very heavily in summer (fig. 1) (Gottfried and Jones 1975). The aspen were left. Most of the large aspen blew down during a series of storms in October. On adjacent unlogged areas, few aspen blew down despite decay, wind, and saturated soils.

Other Effects of Wind

Wind has other effects on aspen besides blowing trees down. Basham (1958) suggested that trees swaying in storms may break small aspen roots, thereby providing entrances for root diseases. Fralish (1972) wrote: "Exposure to wind is nearly as important in influencing aspen growth as soil water-holding capacity and water table depth. Isolated stands and stands located on ridge



Figure 1.—A heavily cut mixed conifer forest. The aspen were not cut. Most large aspen which were isolated by logging soon blew down. Apache National Forest, Arizona (Gottfried and Jones 1975).

tops have lower site indices because of higher internal wind velocities. In general, protected stands, whether in valleys, between ridges, or surrounded by forest, have higher site indices than unprotected stands, other factors being equal.¹

Beetle (1974) wrote that, in Wyoming, aspen height growth was strongly inhibited where the trees were exposed to wind. "On sheltered sites [aspen] trees grow much taller than on similar, neighboring unsheltered sites. The formation of doghair stands suggests that climatic suppression causes hormonal stimulation similar to that caused by browsing of the terminal shoot."

Despite the observations by Fralish (1972) and Beetle (1974), which seem reasonable, there are no known data concerning wind effects on the growth or behavior of standing aspen. Where an aspen stand is isolated on an open, windswept area, there may be reasons other than wind for the openness of the area and the small size of the aspen.

In the foothills of southern Alberta, aspen often is damaged by warm dry Chinook (fohn) winds in winter. When the trees break dormancy the next spring, the leaves cluster at the tips of the branches; all the buds on older parts of the trees are dead.¹

Branches sometimes are broken by wind. These may scar the trunks and provide infection points for pathogens (Hinds and Krebill 1975).

Air Movement Within Stands

Wind conditions inside a stand are much different than those outside. Marston (1956) reported total air movement in a stunted Utah stand of aspen was only 21% as much as in an adjacent meadow. High velocities were reduced the most. In October, after leaf fall, air movement increased, but still was markedly less in the aspen stand than in the meadow. In two Wyoming stands, Turlo (1963) reported that summer windspeeds averaged only 7% and 16% of those in adjacent openings. Rauner (1958) reported on winds above and within a well-stocked, 55-foot (17-m) tall, two-storied stand of aspen and birch in Russia. When the wind was 5.5 mph (8.8 km per hour) at twice the canopy height, it was 2.2 mph (3.5 km per hour) at the canopy top, and zero at 26 feet (8 m) and 5 feet (1.5 m) above the ground. When 21.5 mph (34.6 km per hour) at twice canopy height, it was 11.2 mph (18 km per hour) at the top of the canopy, 2.7 mph (4.3 km per hour) at 26 feet (8 m), and 1.3 mph (2.1 km per hour) at 5 feet (1.5 m).

Snow Damage

Snowstorms are infrequent when aspen are in full leaf. Extensive damage may result if the snow is wet and clings to aspen crowns. Limbs often break. Whole trees of sapling to pole size may be broken off, bent to the

¹Personal communication from A. K. Hellum, University of Alberta.

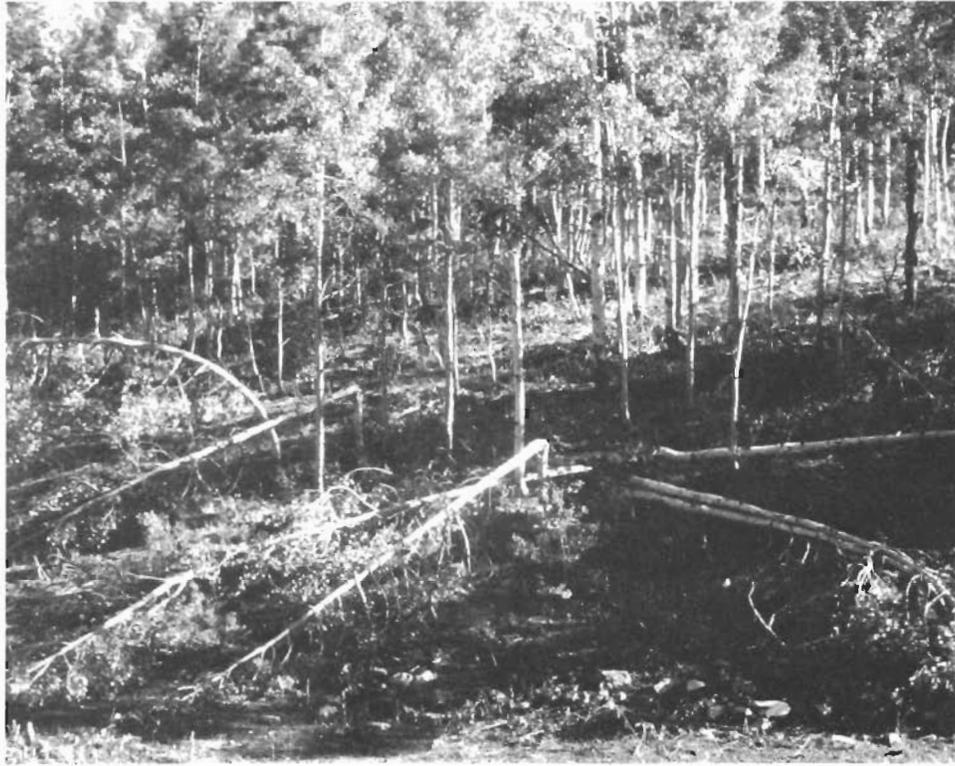


Figure 2.—Approximately 1 foot (30 cm) of wet snow on September 17-18, 1978 damaged aspen stands throughout northern Utah and southeastern Idaho. This photo was taken 2 weeks later, on the Caribou national Forest, near Preston, Idaho.



Figure 3.—Several years after the September 1978 snowstorm, damage to many aspen stands still was very evident, as illustrated in this 1981 photo.

ground, and sometimes partially uprooted. Such bending is permanent in the larger trees. Snowstorms in early September, before formation of a leaf abscission layer, most frequently cause such damage. Late spring storms are likely causes, too. A storm in the Wasatch Mountains of northern Utah and southern Idaho in September 1978 illustrated this impact (fig. 2). Several inches of wet snow weighed down, broke, and bent over aspen throughout these mountains. Some stands were devastated; the damage was still very evident 3 years later (fig. 3). In contrast, during dormancy large aspen are relatively immune from such damage. For example, freezing rain in winter in Manitoba deposited a heavy layer of ice on tree branches. About 12 inches (30 cm) of snow fell just after that. Many conifers were bent and broken; but aspen, bare of leaves at the time, suffered only minor damage (Cayford and Haig 1961).

Snow damage to seedling-size aspen is more common and more insidious than damage to large trees in the West. Usually any aspen trees shorter than 4 to 8 feet



Figure 4.—Aspen on mountain slopes in the West are commonly pistol butted because of flattening by snow creep during their youth.



Figure 5.—Burial of aspen suckers under deep snowpacks, even on relatively level terrain, sometimes can be disastrous when the pack settles. These suckers were sampled from a clearcut on the Wasatch National Forest, in northern Utah.

(1 m to 2 m) become entirely buried as deep snowpacks develop during a typical winter on mountain slopes. As the snowpacks creep downhill, they frequently bend these small stems to the ground, producing the characteristic pistol butt on aspen growing on mountain slopes (fig. 4). Even on level terrain, settling of the snowpack, particularly if ice lenses have formed in it, breaks branches and sometimes stems (fig. 5).

Hail and Lightning

Riley (1953) described an aspen stand in Saskatchewan in which the crowns had been heavily damaged by a severe hail storm. Some trees were killed. Survivors suffered many bark bruises on the upwind side, marked by black callus overgrowths, which led to increased insect and fungal attacks. Severe hail damage to aspen also has been reported from the Great Lakes region (Basham 1953, Thomas 1956). However, hail damage in the western mountains appears to be rare; such storms are very unusual there.

Meinecke (1929) reported that in Utah, lightning scars were "negligible" on live aspen. Hinds and Krebill (1975) stated that aspen struck by lightning usually were killed. They felt that lightning should be suspected when groups of aspen die suddenly, especially if one of the group has a lightning scar.