Aspen Regeneration and Soils

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For the past ten to twelve years the Montrose, Colorado, field and soil survey offices, Soil Conservation Service, have been conducting soil surveys and vegetative correlation on about five million acres in western Colorado. The areas covered are lands managed by the Forest Service, Bureau of Land Management, the State of Colorado, and private interests. During these surveys an ecological theory between aspen and their affinity for specific soils has been developed.

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Editor's Note:
Readers may also wish to read the article "Aspen Regeneration" by S. Hawk Greenway which appeared in the February 1990 issue of *Rangelands*.

The reasons why some aspen stands will resprout after a disturbance and some will not has eluded ecologists and foresters for a long time. Professionals have examined many theories, but nothing substantial has been established. A common concept is that aspen is a seral or pioneer species that eventually gives way to a spruce-fir forest. This isn't necessarily the only case. In some cases, aspen stands are very stable or permanent and can remain free of coniferous trees for hundreds of years (DeByle and Winokur 1985). We believe that one factor which affects the persistence of aspen stands is the soil. Understanding the soil characteristics gives an insight into some of the controlling factors for successful aspen regeneration.

Fig. 1. *Good aspen soil. (Argic Pachic Cryoborolls, clayey-skeletal, montmorillonitic)*

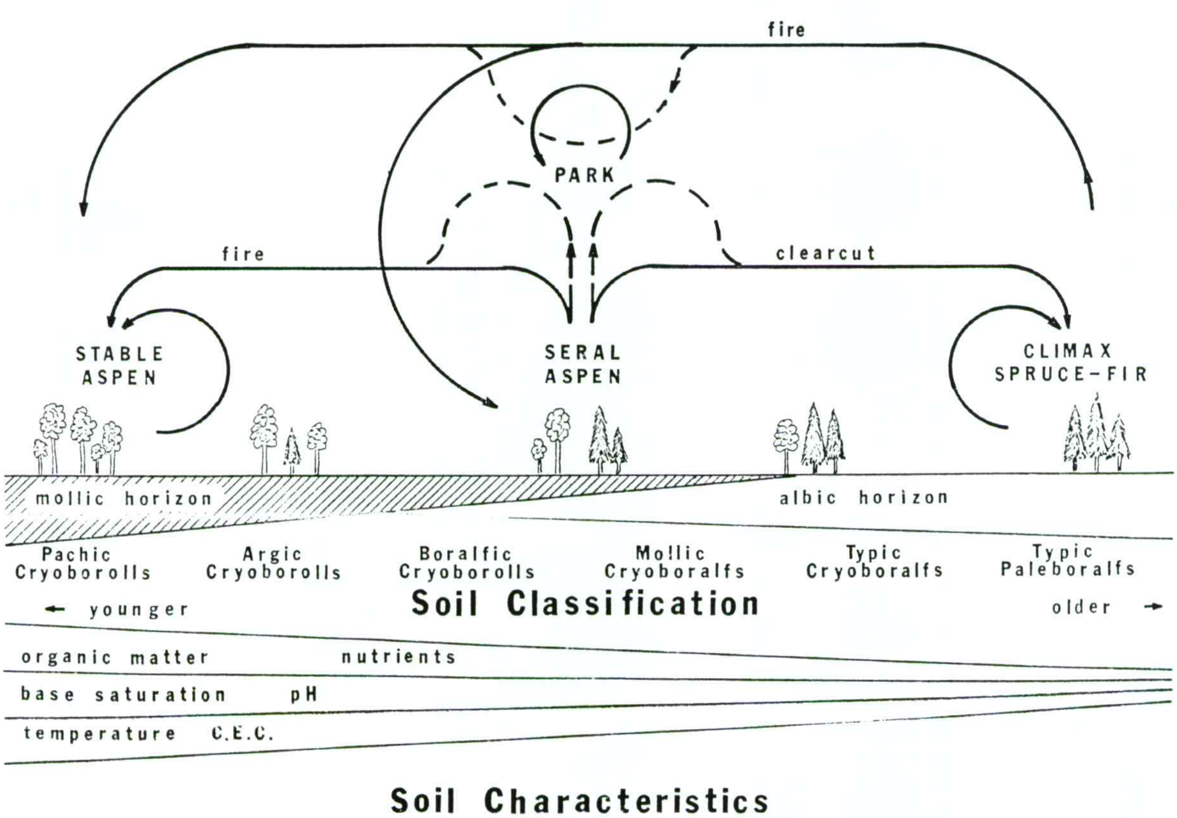

Fig. 2. *Soil influence on forest cover types.*

Soils

Aspen in stable or permanent stands is found only on one soil order—mollisols—and a few soil subgroups of which Argic Pachic Cryoborolls and Pachic Cryoborolls are dominant. These soils have a very dark, organically enriched mineral soil layer.

When aspen are actively encroaching on an open park, they are usually moving onto a soil with a thin mollic surface layer. As the trees get larger, the leaf fall becomes greater and the mollic horizon thickens. As long as the aspen stay healthy and maintain a heavy leaf fall, the soil's mollic horizon will continue to thicken (Buol et al. 1973). (Figure 1-Photo 3).

Without disturbance, the trees will begin to deteriorate. With reduced leaf fall, the organically enriched and thickened mollic horizon begins to lose organic matter and thickness. This allows increased water percolation through the soil, which will produce an albic (leached) horizon (Birkeland 1974). As the leaching process continues, the albic horizon thickens, and the mollic surface horizon becomes thinner. This albic horizon is low in nutrients, organic matter, and water holding capacity (Brady 1974). With continued leaching the soil loses some of its base saturation and becomes more acidic (Tisdale and Nelson 1975).

When the spruce and fir move onto these soils, the rate of change increases. The mollic horizon is replaced by an albic horizon and the soil pH drops to 6.0 or lower.

In Figure 2, the normal soil aging process goes from left to right. The mollic horizon will thin, the albic horizon will thicken, and an argillic horizon will form. As these changes occur the soil classification also changes (Buol et al. 1973). There will also be a loss of base saturation, pH, nutrients, CEC, temperature, and organic matter from the soil (Tisdale and Nelson 1975).

When natural or man-made disturbances occur, this aging process can be accelerated, halted, or reversed (Birkeland 1974). This will depend upon the type of disturbance and when or where it occurs.

Glossary

Albic horizon. A soil layer formed by the leaching processes of water.
Argic. A soil layer with an increase in clay content.
Cryoborolls. A mollisol with very cold soil temperatures.
Leaching. The water movement of material within the soil from one place to another.
Mollic horizon. A very dark, organically enriched mineral soil layer.
Mollisol. A soil order with a mollic horizon.
Pachic. An overthickened mollic horizon.
Permeability. The quality that enables the soil to transmit water or air.

Clearcutting a stable aspen site, tends to maintain a stable aspen site (Figure 3 (Sharpe et al. 1976)). Thousands of new shoots will produce the necessary heavy leaf fall to maintain the organic matter, pH, nutrients, and temperature within the soil (DeByle and Winokur 1985). As many as 150,000+ resprouts have been recorded on these soils. Three to four feet of terminal growth per year is common. As these trees get older, the stand will thin, but the heavy leaf fall will be sustained because of the larger trees.

Clearcutting a seral aspen stand, which is on a soil that has aged too far towards a spruce-fir site, will

more than likely hasten the spruce-fir intrusion (Figures 4 & 5). Aspen would have a hard time competing with spruce-fir, because of the lowered pH and low nutrient availability (Epstein 1972). Aspen has been observed to resprout and attain a height of two to three feet, then begin to die. Low soil nutrients and low pH are believed to be the main causes for this mortality. There is a possibility that this cycle will go from seral aspen to open park to spruce-fir.

Burning a seral aspen site may cause the stand to revert to stable aspen. This could happen with or without going through an open park stage. Burning increases the soil pH and adds organic carbon and available nutrients to the soil (Martin and Dell 1978). This allows the aspen to better compete with other vegetation (Russell 1973). The young aspen in turn increase the soil organic matter and thicken the mollic horizon (Stoeckler 1961).

Fig. 3. *Reproduction after clearcut on stable aspen site (>85,000 stems per acre) Argic Pachic Cryoborolls, clayey-skeletal, montmorillonitic*

The presence of spruce-fir is not necessary for an aspen stand to be in a seral stage. The soil is a major factor in determining seral or stable aspen sites. There are many seral aspen stands that have no spruce-fir encroachment.

Use and Management

It is now possible to make some management decisions concerning aspen forests. Rejuvenating old permanent aspen stands can be accomplished by either clearcutting or by a prescribed burn. There are some obstacles in returning a seral aspen stand to a stable aspen stand. If the soil has aged to a stage which favors a spruce-fir, simply clearcutting may not promote a fully stocked aspen stand, or the sprouts may eventually die. A prescribed fire may be required to encourage the return of an aspen forest. However, burning after a clearcut in a seral aspen stand may not produce a stable aspen stand. The reduced amount of biomass left to burn may be insufficient to increase the soil pH or nutrient level enough to sustain aspen sprouts (Martin and Dell 1978).

We have been able to relate the significance of base saturation, pH, and cation exchange capacity of the soils to the regeneration of aspen. However, we do not know the different soil characteristics threshold values. For example, at what pH will aspen not resprout at all, or if they do will they remain alive to restock the forest?

As this study progresses, the significance or lack of significance of other soil properties will be explained. In the meantime, this information can be used to make some important management decisions regarding aspen forests.

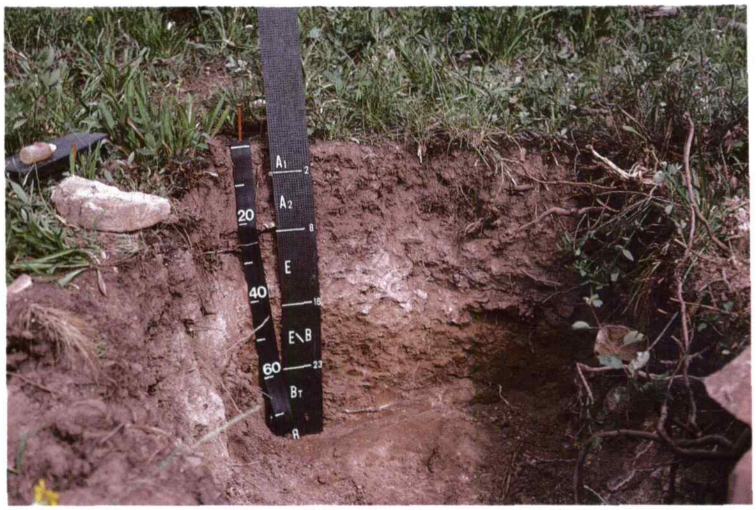

Fig. 4. *Poor aspen soil. Typic Cryoboralfs, clayey-skeletal, montmorillonitic*

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Fig. 5. *Regeneration after clearcut on seral aspen site (<100 stems per acre) Typic Cryoboralfs, clayey-skeletal, montmorillonitic*