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# STAND CHARACTERISTICS OF ROCKY MOUNTAIN ASPEN

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## ABSTRACT

A study is in progress at the Rocky Mountain Forest and Range Experiment Station, using data from 140 aspen stands in Colorado and southern Wyoming to describe overstory stand conditions and to characterize growth rates of aspen in the central Rocky Mountains. Differences in physiographic location, clonal characteristics, age structure, productivity, and incidence of damage and disease are being used to develop a classification scheme for making management decisions and writing silvicultural prescriptions.

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The National Forests in Colorado contain an estimated 2.3 million acres of aspen (Populus tremuloides Michx.), of which 1.8 million acres are currently classified as commercial forest land. Until now, little has been known about the overstory stand characteristics of aspen throughout the Rocky Mountain region. Previous studies have either been local in nature (Morgan 1969; Severson and Thilenius 1976), or have been concerned with other factors that gave no quantitative description of the overstory (Pfister 1972; Reed 1971; Wirsing and Alexander 1975; Hoffman and Alexander 1980).

This study, based on overstory stand and growth characteristics and begun in 1979, is expected to result in a regional classification scheme for aspen in the Rocky Mountains.

Two restrictions were placed on the study: (1) existing regional inventory techniques would be used, where possible, to insure that results could be easily applied, and (2) only pure aspen, not mixed stands, would be sampled.

# METHODS

Aspen stands were sampled at 140 sites, on 11 National Forests, in Colorado and southern Wyoming. Sample sites were selected to proportionally represent the typical range of stand conditions found in any given area and to include the full range of age and site classes found in the central Rockies. Existing inventory records and a preliminary reconnaissance of each forest were used to assess stand conditions and choose representative stands to sample. Both variable and fixed radius plots, similar to standard inventory plots, were randomly located within a single clone at each sample site. In stands of larger average diameter, a basal area factor was used, which resulted in 8-10 trees being sampled in each plot and usually 3 plots sampled per site. Trees 5 inches and larger were included in the sample. In smaller diameter stands, all stems were sampled using fixed radius plots, which provided 8-10 sample trees per plot. The height and diameter of each tree within the plot were measured, and ages were obtained on a representative sample of each diameter class. Radial growth for the past 10 years was also measured.

Each sample tree was examined for defects and damage. These included fork, crook, sweep, dead leader, environmental damage such as frost rack, lightning scar, and fire scar, and disease such as Cenangium or sooty bark canker and *Phellinus tremulae* trunk rot. Damage caused by animals was also recorded for each stem; these included elk gnawing, damage by rodents, and human damage.

At the center of each variable radius plot, a 1/100-acre, fixed radius plot was taken to sample stems up to 5 inches diameter at breast height (d.b.h.). Disease, damage, and poor form were also noted for these stems.

A number of clonal and overall stand characteristics were also recorded at each sample location. These included bark color--white, green, yellow, or sooty bark. Bark textures were also noted--smooth, bumpy, a characteristic swelling termed "eye knot," which adds some defect to a stem, or occasional furrowed bark. Three categories of branching characteristics of the clone were coded--live branches in the upper 1/3, the upper 1/2, or throughout the stem. Stand spacing was categorized as either uniform or clumped. Pruning was another clonal characteristic noted. Some clones prune themselves, while other clones retain many of the dead branches. Single-story, two-story, or occasionally, multistory stand structure was also coded. All of the above variables were very useful in determining clonal boundaries when sampling.

Physiographic variables such as elevation, slope, aspect, vertical and horizontal distance to the ridge-top, slope position and inclination, latitude, longitude, and yearly precipitation determined from an isohyetal map were recorded for each sample location.

The following 14 categories of aspen-associated vegetation[1] were used to identify the understory vegetation at each sample site: Aspen-Spruce-Fir, Aspen-Ponderosa Pine, Aspen-Lodgepole Pine, Aspen-Low Shrubs, Aspen-Tall Shrubs, Aspen-Shrubs-Grass, Aspen-Shrubs-Forbs, Aspen-Talus-Rockland, Aspen-Riparian, Aspen-Tall Forbs, Aspen-Thurber Fescue, Aspen-Elk Sedge, Aspen-Grass-Forbs, and Aspen-Grass.

## PRELIMINARY RESULTS AND DISCUSSION

The analysis of data from this study has not yet been completed and not all variables measured have been thoroughly examined. However, a number of apparent differences and relationships have been observed.

### Physiographic Differences

Stands sampled ranged from 6,900 ft to 11,000 ft in elevation, with an average of 9,300 ft. However, 96 percent of the stands sampled occurred between 8,000 and 10,800 ft.

Aspen grows on all aspects and a variety of physiographic positions in the central Rockies. Differences in growth and productivity were evident among the various locations. For example, stands on wet hillsides had larger cubic volumes than those on dry hillsides; and average site indexes (Jones 1967) of stands on dry hillsides were less than stands located in bottoms or draws, rolling terrain, or wet hillsides.

There was a marked difference between aspen stands growing on the west and east slopes of the Continental Divide. Basically, western slope stands are much more extensive, larger, more productive, and in generally better condition. About half of the eastern slope stands were in bottoms or draws, while few of the western slope stands were in these physiographic positions. Nearly one-third of the western slope stands were in rolling terrain or dry flats; none of the eastern slope stands were in those places.

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[1] Stand characteristics to meet major uses of aspen. An unpublished report by USDA Forest Service, Rocky Mountain Region, 1977.

Western slope stands had higher site indices, cubic volumes, and received more precipitation. Average diameters of western slope stands were also slightly larger, but no differences were found in average stand age, stocking, basal areas, or mean annual increments. Eastern slope stands contained more dead basal area, which could indicate somewhat poorer vigor. However, these eastern slope stands also had more suckers, indicating that they were regenerating. The lack of intensive livestock grazing on many areas of the eastern slope may be responsible for the larger number of suckers.

Differences in bark color were also noticed between eastern and western slope stands. Yellow-barked stands were much more common on the eastern slope, while green-barked stands were more common on the western slope.

There was also a marked difference in the types of understory vegetatation on either side of the Continental Divide. Grass understories predominated on the eastern slope, while grass-forb understories were most common on the western slope. Tall-shrub associations were the second most common understories on the western slope, and low-shrub associations were second in occurrence on the east slope. No tall forb associations were sampled on the eastern slope. Generally, xeric to mesic understory vegetation was common on the eastern slope while mesic to hydric or near hydric vegetation was common on the western slope. This is probably a result of the differences in precipitation between the slopes.

## Quantitative Growth Variables

Average age of the stands sampled was about 80 years. The average age of mature sawlog stands (greater than 8 inches d.b.h.) was 96 years, with a range from 40 to 190 years. Stands as young as 9 years were sampled, but stands younger than 50 years are difficult to find.

Single-aged stands, in which all the stems were within 20 years of the mean age, made up most of the stands sampled. Two-aged stands, containing two distinct age classes at least 20 years apart, were second in frequency. Broad-aged stands, containing three or more age classes, made up a small portion (4 percent) of the sample. Uneven-aged stands result from some disturbance to the stand that has partially destroyed the original overstory and allowed the establishment of younger understories.

Single-aged stands had higher site indexes than two-aged stands. As could be expected, broad-aged stands had more suckers per acre in the understory than either single or two-aged stands.

Stands also had different structures. Multistoried stands had higher percentages of dead basal area than single storied stands, and they contained more suckers per acre, again indicating an ability to self-regenerate.

The distribution of stems within the stands was also related to growth characteristics. Uniformly distributed stands had a higher percentage of dead basal area than did clumpy stands. However, clumpy stands were more heavily stocked. The average site indexes of clumpy stands was somewhat higher than uniform stands, and uniform stands were older than clumpy stands, which may be related to the fact that they had a higher percentage of dead basal area.

The productivity or mean annual increment of the stands sampled varied considerably. Only 10 percent of the stands produced more than 90 $ft^3$/acre/year, and half of the stands produced less than 48 $ft^3$/acre/year. Mean annual increment was related to the basal area, site index, and stocking of a stand.

## Relationship of Clonal Features to Growth

Several growth characteristics were related to clonal features. Bark color of a clone is related to growth rate and productivity. Green-barked stands had higher average site indexes and mean annual increments than yellow-barked stands. Both yellow- and green-barked stands had more stems per acre than white-barked stands, and green-barked stands were younger than white-barked stands. Yellow-barked stands contained more dead basal area and greater numbers of suckers in the understory than did green- or white-barked stands. White-barked stands had larger average stand diameter than yellow-barked stands. Finally, green-barked stands received more precipitation than either yellow- or white-barked stands.

This indicates that yellow-barked stands are an indicator of somewhat poorer productivity and stand conditions, which could prove to be a reliable, easy means of classifying relative stand conditions.

Bark texture was related to a couple of variables. Stands with bumpy bark had larger average volumes than smooth-barked stands or "eye knot" stands. Stands with furrowed bark at the base of the stems had larger average stand diameter than smooth-barked stands and were also older.

Branching characteristics were related in a number of ways to stand growth. Stands with live branches along the full length of the stem were younger, more heavily stocked, were shorter, and contained less basal area than stands with live branches on only the upper one-half or one-third of the stem. Classifying stands according to these three branching classes also resulted in differences in radial growth, cubic volumes, and average stand diameter. Basically, the relative age of a stand can be determined by the proportion of the stems that contain live branches.

Whether or not a stand is self-pruning (stems do not retain dead branches) is related to its growth characteristics. Self-pruning stands had slightly greater cubic volumes, had more dead basal area, more suckers, larger average stand diameters, and were taller and older than those that retained dead branches.

## Relationship of Vegetation Associations to Growth

The vegetation associations developed by the Rocky Mountain Region aspen task force also proved useful as an indicator of relative growth. Differences in radial growth between tall shrub and low shrub types were most evident. Aspen-tall forb stands had greater cubic volumes than aspen-low shrub, aspen-grass-forb, and aspen grass stands. Site indexes and average stand diameters were higher in aspen-tall forb stands than in aspen-low shrub or aspen-grass associations.

Aspen-shrub and forb associations received more precipitation than aspen-elk sedge, aspen-grass, aspen-low shrubs, or aspen-grass-forb associations. Because aspen-tall forb associations did not receive more precipitation than other associations, ground water could be contributing to the lush, wet conditions found in these stands. Trees in the stands classified as aspen-tall forb type were taller than those in either aspen-low shrub or aspen-grass stands and had greater mean annual increments than trees in aspen-low shrub stands.

Differences in overstory growth characteristics exist among several kinds of understory vegetation. Although the data taken were not quantitative, the Rocky Mountain Region aspen vegetation associations could be useful in a classification of aspen stands.

## Stem Damage

A number of factors were responsible for damage to overstory aspen stems (fig. 1). The most frequent damage was spike knot (resulting from past mortality of stem leaders); second frequent was rot. Stem wound, fork, and large-animal damage also occurred in more than half of the stands.

The main concern is the amount of damage. While spike knot occurred in most of the stands, it damaged few of the stems. Rot is not as serious as it might seem either, damaging only about one-fifth of the stems in stands where it occurred. However, rot probably has the most effect on aspen wood utilization, because a larger portion of a stem will be culled if rot is present than if other damaging agents are present.

Some agents did not occur very often but damaged considerable numbers of stems when they did occur. Fire scar occurred in only a few of the stands, but damaged about one-fourth of the stems in those stands. Small-animal damage, which occurred in a few more stands, also damaged about one-fourth of the stems, but seldom seriously affected stem vigor or product value.

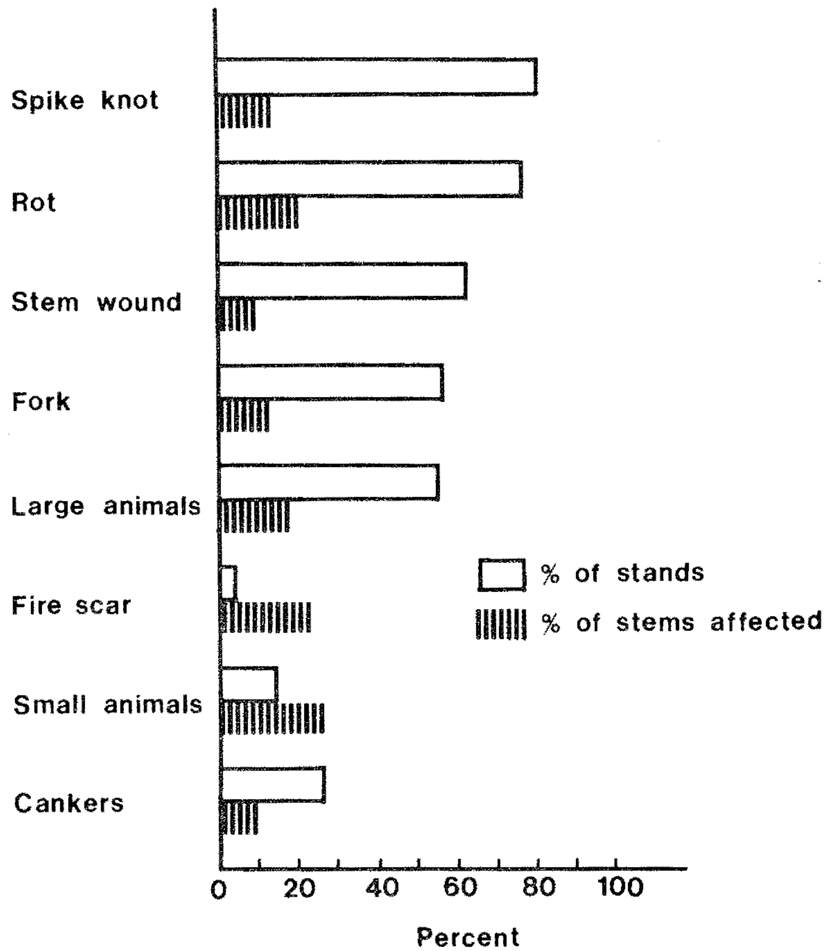


Figure 1.--Comparison of the percent of stands sampled that contained several damaging agents, and the average percent of stems damaged by those agents.

Cankers occurred in about one-fourth of the stands sampled, but usually damaged only a few of the stems in those stands. A slight increase in the incidence of infection occurred in denser stands, which logically would be expected.

Suppression occurred in about one-fourth of the stands and affected about one-fourth of the stems. It was most often present in young, dense stands and no doubt is a mechanism responsible for self-thinning in aspen. The average number of stems per acre damaged by suppression was higher than all other causes, again because suppression occurred in young, dense stands.

Fire scar and human damage occurred in open, less dense stands. In the case of fire scar, fire may have thinned the stand. In contrast, human damage is concentrated primarily around recreation areas, and these are typically placed in large diameter, open-appearing aspen stands.

Gnawing of bark by large animals damaged a considerable number of stems in some stands and can be quite serious. It is unclear why animals repeatedly damage some stands and avoid others nearby. The only relationship between large-animal damage and any of the stand characteristics measured is that heavily damaged stands had few suckers under them. Natural regeneration problems could be expected in these stands as they continue to decline under the impacts of bark gnawing of large stems and browsing of suckers.

## SUMMARY

It should be possible to use the overstory characteristics discussed to develop a stand classification scheme that would adequately separate Rocky Mountain aspen stands and give the manager some silvicultural alternatives to consider in arriving at management decisions for a particular aspen stand.

For instance, if managers were interested in identifying good, healthy, fast-growing stands to manage for fiber and that would not be in immediate need of cultural treatment, they might first eliminate from consideration yellow-barked stands, two- or multistoried stands, stands with grass or low shrub understories located on dry hillsides, and stands with more than 20 percent of their stems damaged by any single agent. They would be left with stands that are healthy, good-growing, and not in need of immediate treatment.

Any number of decision models can be developed for other uses of aspen stands. This will be the next step in utilizing the large data base made available by this study

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