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Type Variability And Succession In Rocky Mountain Aspen[1]

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Abstract.--Most of the 6 million acres of aspen lands in the West occur in the Central Rocky Mountains. The ability of western aspen to occupy a wide variety of sites, the great genetic diversity among clones, and the role of aspen as both a dominant successional and stable species severely complicate management. Such ecological and genetic diversity results in considerable variability in both resource production and potential response to management. Progress in classifying the ecological variability of aspen lands is slow; useful partitioning of genetic diversity is nil.

INTRODUCTION

Quaking aspen (*Populus tremuloides* Michx.) occupies a unique position as a dominant forest tree. It is the most widely distributed tree in North America; the aspen type is recognized for its multiple values of wood, livestock forage, wildlife habitat, and esthetics; yet in the West it has received very little management or research attention. Lack of interest in the past probably stems from the weak demand for aspen wood products, which is certain to change with time. Demands for all of the multiple products obtainable from our aspen lands will undoubtedly increase. Already our resource managers are facing the problems created by the broad range of environmental conditions where the type occurs and by the genetic diversity of aspen itself, both of which severely complicate development of reliable management practices.

DISTRIBUTION

Aspen extends across the North American continent from Labrador to Alaska, and as far south as Mexico (Little 1971). It occupies approximately 6 million acres (2.5 million ha) of the western United States. The most extensive stands in the West are found in the Central Rocky Mountains. Colorado and Utah alone contain over 4 million acres (Jones and Markstrom 1973). Although widely distributed elsewhere in the West, in these areas aspen is usually confined to small, isolated stands or rather narrow, transitional zones between conifer forests and grasslands.

Aspen grows under a wide variety of environmental conditions. However, its range in the Rocky Mountains appears to be related to cool, relatively dry summers and winters with abundant snow. Summer temperatures above 90° F (32° C) are rare, while winter temperatures below 0° F (-18° C) are common. Annual precipitation ranges from about 16 inches (40 cm) to over 40 inches (100 cm), mostly in the form of a deep winter snowpack which, upon melting, recharges the soil with moisture sufficient to meet most of the water requirements of aspen during its period of active growth.

Aspen grows at elevations ranging from less than 3,000 feet (923 m) in northerly latitudes to over 10,000 feet (3,077 m) in the more southerly latitudes. In Colorado and Utah, aspen commonly occurs in an elevational belt between about 6,500 feet (2,000 m) and 10,500 feet (3,230 m). Aspen is found on a wide variety of soils ranging from rocky talus slopes to deep, heavy clays. The better stands, however, are usually found on deep, loamy soils.

GENETIC VARIABILITY

Aspen in the Central Rocky Mountains is recognized as a probable climatic race distinct

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from that extending across Canada and into the Lake States. The Rocky Mountain aspen is designated by the varietal name *Populus tremuloides* var. *aurea*. Great and unclassified variability exists within variety *aurea*, which confuses attempts to develop precise management guides.

Anyone familiar with aspen soon becomes aware of the striking variability in growth form and in coloration of different clones. The almost exclusive vegetative mode of reproduction gives rise to genetically idential trees within a clone (Barnes 1966), which emphasizes the visual impact of phenotypic differences between clones.

Clones of eastern aspen vary markedly in stem form, branching habit, height and diameter growth, leaf morphology, leaf flushing, fall colors, leaf drop, and susceptibility to disease (Barnes 1969; Wall 1971). Similar phenotypic variability apparently exists in western aspen. Barnes (1975) sampled over 1,200 clones from Colorado to British Columbia, and by multivariate analysis of only leaf, bud, and twig characteristics demonstrated variation among 24 basic populations. He found a gradient in leaf characteristics from southern Utah to northern Idaho and Montana. Tew (1970) observed that the nutrient content of aspen foliage differed appreciably among clones of western aspen. For example, clonal differences in protein content ranged from 11.8 to 16.2 percent, suggesting considerable clonal variability in the value of aspen suckers for wildlife browse. It is very likely that growth rates, longevity, and other important but obscure physiological processes also differ markedly among clones. Such clonal variability might well affect the potential of different clones for producing wood products as well as the clone's response to harvesting and other management practices.

Unfortunately, progress in partitioning genetically similar strains within the Rocky Mountain variety of quaking aspen has been minimal.

SERAL VS. STABLE ASPEN

Aspen has generally been regarded as a fire-induced successional species able to dominate a site until replaced by less fire-enduring but more shade-tolerant and environmentally adapted conifers. The extensive stands of aspen throughout the Rocky Mountains are usually attributed to repeated wildfires. This is no doubt true for many of our aspen lands, as evidenced by aspen's relatively rapid replacement (within a single aspen generation) by conifers upon curtailment of fire. In areas of optimum aspen development in western Colorado and central Utah, however, conifer invasion can be so slow that well over 1,000 years of fire-free conditions may be required for aspen stands to progress to a conifer climax.

The uneven-age distribution of aspen trees in some stands suggests that under certain conditions aspen can be self-perpetuating without requiring a major rejuvenating disturbance such as fire or cutting. From a management standpoint, these relatively stable stands of aspen can be considered *de facto* climax. We expect them to remain dominated by aspen in the foreseeable future.

The successional status of aspen on a given area and the ability to recognize seral versus stable stands have considerable management significance. Obviously, we should be wary of planting conifers on stable aspen sites. Also, we must be alert to the need for removing conifers from seral aspen sites if we wish to maintain aspen dominance.

Even though we are reasonably certain that both stable and seral site conditions exist, progress in developing criteria that define environmental conditions indicative of seral and stable aspen communities has been minimal. Harper (personal communication) suggests that the rate of conifer succession might be predicted from knowledge of understory species. For example, on the Wasatch Plateau in Utah, Oregon grape and myrtle pachistima are indicative of areas subject to rapid invasion by conifers, but mountain snowberry and red elderberry indicate a relatively stable aspen community. Harper found that although seral aspen stands appear to be associated with sandstone soils on the Wasatch Plateau, they are associated with basaltic soils on the Aquarius Plateau and with granitic soils in the LaSal Mountains.

As yet, the most valid general indicator of a seral aspen situation appears to be the presence of conifers, which suggests active replacement of the aspen overstory by a more shade-tolerant tree. Mere presence of conifers, however, is not the infallible indicator of a seral condition that one might suppose. Occasional conifers can be found in a basically stable aspen community because of a highly unusual and temporary combination of circumstances favoring conifer establishment. In such cases, a stable aspen community might contain a few scattered, uneven-aged conifers but lack subsequent conifer reproduction. Presence of a multiaged conifer understory is generally reliable evidence of a seral aspen site.

In addition to replacement by conifers, aspen can also be replaced by shrublands or grasslands. Such replacement usually occurs on sites not suited for the establishment and growth of conifers and where aspen fails to regenerate. Regeneration can fail when apical dominance prevents suckering during gradual deterioration of the clones (Schier 1975). Where suckering does occur in a decadent clone, continued heavy browsing of sprouts by deer, elk, or livestock can prevent successful regeneration and cause conversion to shrublands or grasslands.

TYPE VARIABILITY

The ability of aspen to thrive under a wide range of environmental conditions contributes not only to the confusion in identifying stable and successional stands, but also is reflected in substantial variability in the ability of aspen-dominated sites to produce wildlife habitat, livestock forage, wood, and other needed resources. For example, aspen with a predominant understory of grasses is markedly different wildlife habitat than aspen with an understory dominated by shrubs. Livestock forage production in one range condition class in aspen can vary from 600 to 2,000 pounds of air-dry herbage per acre (672 to 2,242 kilo/ha) because of differences in site potential (Houston 1954). Wood production, measured as annual bole increment, can range from 42 to 194 cubic feet per acre (2.9 to 13.6 m^3/ha) because of site and genetic variability (Jones and Trujillo 1975). Theoretically, we should be able to identify meaningful environmental differences among sites and relate these to quantity and quality of resource production.

Attempts to classify aspen sites, as with most other forest and range types, have relied heavily upon using the vegetation as an integrator of the many factors constituting "environment." Such approaches categorize on the basis of species composition in stable, relatively undisturbed plant communities. Such classification efforts for aspen sites have been few and geographically narrow. The difficulty in developing a site potential classification for aspen is compounded by aspen's questionable status as a stable or seral tree on a given site.

Reed (1971) concluded that a single, stable aspen/snowberry type exists in the Wind River Mountains of Wyoming along with seral aspen communities that are succeeded by Douglas-fir, lodgepole pine, and limber pine at the higher elevations. Severson and Thilenius (1976) found both relatively stable and obviously seral aspen stands in the Black Hills and Bear Lodge Mountains of South Dakota and Wyoming which they classified into nine "aspen groups" according to similarity of vegetation and site. Judging from understory composition, Bunin (1975) determined that four stable aspen associations occupy the west slope of the Park Range in Colorado: (1) aspen/Gambel oak - serviceberry - meadow rue, (2) aspen/sticky laurel, (3) aspen/meadow rue - aster, and (4) aspen/bracken fern - cow parsnip. She also recognized a seral type that is rapidly succeeded by subalpine fir. And, Pfister (1972), while developing a subalpine forest classification for Utah, found apparently stable aspen communities at lower elevations, but concluded that aspen on upper elevation sites is usually a dominant seral species that will eventually progress to spruce-fir climax.

Such studies as these have helped us to understand the ecological variability of aspen communities throughout the Rocky Mountain area. But this understanding is far from complete. We have hardly begun to provide land managers with the guidelines necessary to reliably relate aspen site variability to the potential of these sites to produce important resources, and to determine how these various sites will respond to management. Development of such guidelines must be in two steps. First, we must develop a realistic classification which partitions the spectrum of variability in site capabilities; then we must quantitatively relate resource production and management to these classification units. Once these steps are taken we will be able to offer precise management prescriptions for specific aspen sites.

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