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ECOLOGICAL SUCCESSION IN ASPEN AND ITS CONSEQUENCES ON MULTIPLE USE VALUES

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ABSTRACT

Aspen can be categorized as (1) seral--successional to conifer, (2) stable--regenerates to aspen, or (3) decadent--successional to brush, forbs, or grasses. Succession to conifers reduces understory production, plant and wildlife diversity, water yields, and aesthetic values while it increases timber values. Stable aspen stands, except possibly for timber values, maintain these multiple use values if grazing is not excessive. In decadent aspen stands all of the multiple use values except water are reduced. Management expectations and returns for multiple use values would depend on the successional status of the aspen.

Aspen is the most widespread tree species on the North American continent (Fowells 1965). This feature of aspen has contributed to conflicting hypotheses about its role in plant communities. Generally, aspen is considered seral to conifers over much of its range (Baker 1918; Shirley 1941). However, aspen has also been noted for its stability in Canada (Bird 1930; Moss 1932; Lynch 1955) and the Western United States (Fetherolf 1917; Sampson 1916; Langenheim 1962). Deteriorating aspen stands have been described and compared to healthy stands in Utah (Schier 1975; Schier and Campbell 1980). Upon deterioration, an aspen stand can succeed either to conifers or to shrubs, forbs, and grasses.

Some of the incongruity about aspen succession may be due to the different successional rates made possible by various combinations of soil, site, and tree species. Lack of a conifer seed source, and the time and conditions conifers take for establishment, also mask successional rates. Gleason (1927) suggested five factors that affect successional trends: (1) reaction of vegetation to its habitat, (2) physiographic processes, (3) climatic changes, (4) immigration of new species, and (5) species evolution. Generally, the reaction of vegetation to its habitat is the factor focused on in most plant succession studies.

ASPEN SUCCESSION OVERVIEW

Harper[1] found that aspen was succeeding to conifers in 75 to 100 years on sandstone soils in central Utah. Aspen was more stable on limestone and alluvial soils, succeeding to conifers in 140 or more years. In the successional path to conifers, the grasses disappeared first, followed by forbs and then the shrubs as the conifers became established in the aspen. Understory species and yields were related inversely to the basal area coverage of the conifers. The dry matter yield of the understory dropped over one-half when conifers increased to about 20 ft^2 of basal area per acre (Harper 1973).

Kleinman (1973) examined six burned aspen-conifer sites in central Utah for the change in species related to conifer establishment. He found that density, frequency, and forage production of the understory species were influenced by grazing pressure, community age, and conifer basal area. Maximum densities of the understory species and forage production occurred about 20 years after fire. Wildlife use was influenced positively by forage production and negatively by conifer basal area and domestic livestock utilization. Warner and Harper (1972) found that the site that had the best site quality index for aspen also produced the most forage in the understory.

Many studies present evidence that water yield is increased by removing forest cover (Anderson and others 1976). Kittridge (1953) in the Sierra Nevada of California showed lower water yields under conifer stands than in open areas. From 13 to 27 percent of the seasonal snowfall was intercepted by the conifer canopy. Dunford and Niederhof (1944) studied the influence of the conifers, aspen, and open grassland types in Colorado on water yield. They found aspen and open grasslands to yield more water than conifers. Interception by the conifers was the factor that caused most of the difference. Jaynes (1978), in a

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[1]Differential successional rates in aspen forests of central Utah, by K. T. Harper, 1973, unpublished report in files at Forestry Sciences Laboratory, Logan, Utah.

watershed hydrology model in Utah, predicted 4.6 inches net loss in water yields when aspen converts to conifers, and 3.4 inches net loss when grass-forb converts to aspen. His model suggested that conifer invasion of aspen reduced streamflow as the result of differing snowmelt and plant activity patterns.

IMPACT OF SUCCESSION ON MULTIPLE USE VALUES SOME GENERAL HYPOTHESES

I have hypothesized successional curves for the multiple use values of water, timber, forage, wildlife, and recreation. These curves result from a review of literature, from discussion and work with colleagues (see Bartos 1973; DeByle 1976; Mueggler 1976), and from my personal observations. The curves are scaled from 1 to 10 for the multiple use values and begin in year zero after some major disturbance to the tree overstory. Two curves are presented, one for succession after burning, and one for succession after cutting or spraying.

To present plant succession in western aspen, I have divided the aspen forest into three broad categories; (1) decadent, (2) stable, and (3) seral aspen. Decadent aspen is characterized by low levels of aspen stocking, high stem mortality, little sucker regeneration, and with no replacement by conifers. Ultimately it will succeed to brush, forbs, or grasses. Stable aspen is characterized by high levels of aspen stocking, no unusual mortality, no or few conifers, and shows evidence of regeneration through more than one generation of aspen stems (that is, †125 years). Seral aspen is characterized by high levels of aspen stocking after a disturbance, with conifers significantly increasing aspen mortality and reducing aspen regeneration in one generation of aspen stems (that is, within 50-120 years aspen will begin to turn over to conifers).

After burning, water yields would be the highest at the beginning of succession because little vegetation exists in all three aspen situations (fig. 1). As aspen mature and transpire more water, there would be a decrease in water yields. In decadent aspen stands, with the demise of aspen, water yields should slightly increase late in stand succession. In stable aspen stands, as the aspen trees mature, water yields would decline and then stabilize. As conifers come in and occupy seral aspen stands, water yields would decline, primarily through losses from interception. When a mature conifer stand occupies the site, water yields would stabilize at a lower level. Cut or sprayed aspen stands would have lower water yields than burned stands because of water use by the understory vegetation that remained after treatment. Later in succession, after the aspen begin to mature, the successional patterns of burning, cutting, or spraying should mimic each other.

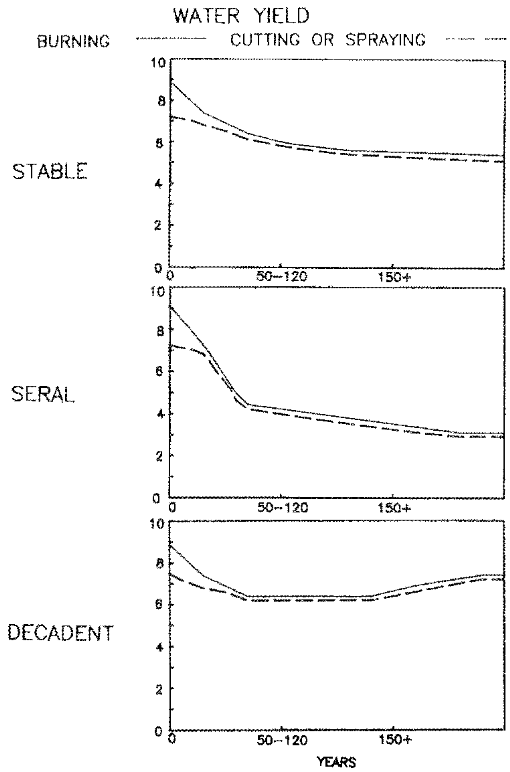

Figure 1.

In terms of volume, timber should increase as succession advances in decadent, stable, or seral aspen stands (fig. 2). Volume would be low in the decadent stand and would decline with the demise of the aspen trees. The decadent stands generally have a ratty appearance caused by branchy, crooked stems (Schier and Campbell 1980). They also found site index, tree height, basal area, number of stems, and bole length to be lower in decadent aspen stands when compared with healthy, stable aspen stands. Tree volume in stable aspen stands would increase until stand maturity; then, as the aspen trees become overmature and the stand deteriorates, waves of reproduction would come in. At this time, timber volume would decrease slightly and stabilize as an even-aged group or all-aged aspen stand develops. With the addition of conifer in the seral stand, tree volumes would increase until the aspen begin to disappear, then level off or decline as succession proceeds. Disease in the aspen would reduce the value of the aspen for timber products as succession continues to conifers. Cutting the aspen when it matures would minimize the disease loss.

Timber responses after burning, cutting, or spraying are assumed to be nearly similar. This assumption ignores the strong delaying effect that understory vegetation can have on tree reproduction and subsequently on timber volumes. Burning, by removing the understory vegetation, may prepare a better seedbed for trees to reproduce. In certain situations, for instance with thick stands of brush, removal of the understory vegetation should be considered after spraying or cutting aspen stands.

After burning, forage production would increase rapidly as the herbaceous vegetation, shrubs, and aspen suckers regenerate and grow (fig. 3). As the aspen mature, and suckering declines, forage production would decline slightly and level off in both the decadent and stable aspen stands. In seral aspen stands, forage production would continue to decline as the conifers mature and take over the stand. Also, the number of plant species would decrease and change to more shade tolerant plants as conifers occupy the sites. Cutting or spraying would not affect forage production to the degree that burning would, and thus production would be higher in early succession. As succession proceeds, and aspen matures, there would be little difference in treatments on forage production.

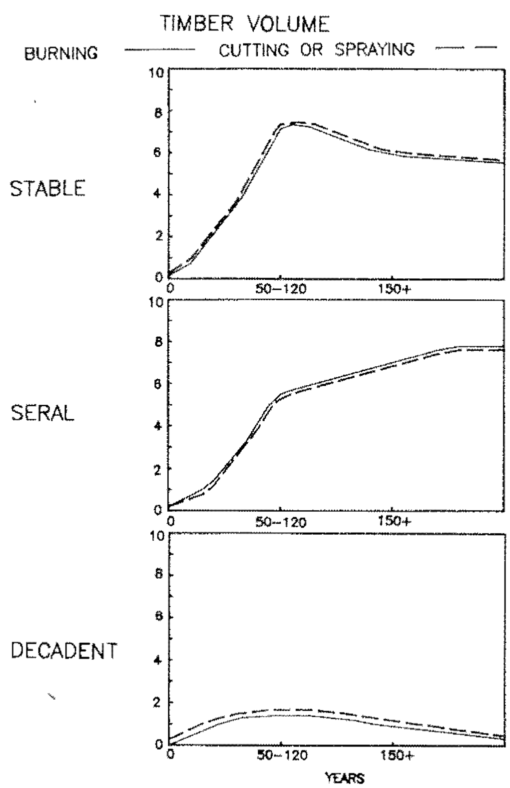

Figure 2.

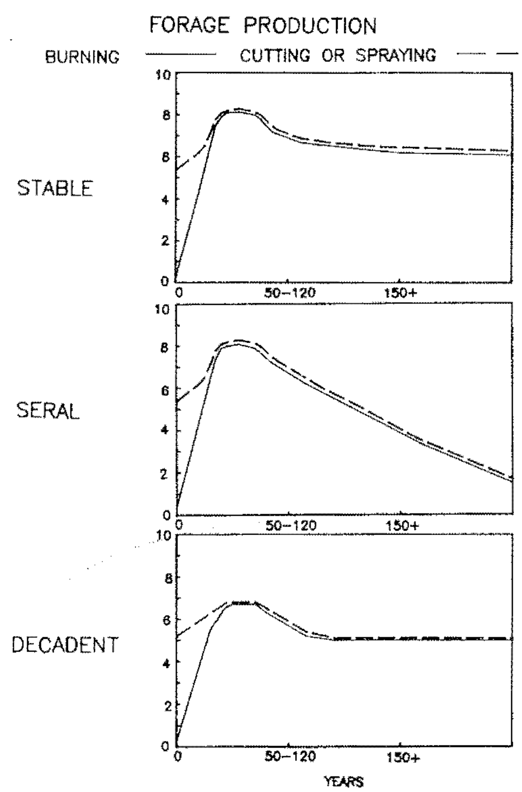

Figure 3.

Wildlife habitat and diversity or number of animal species would increase early in succession (fig. 4). Cutting or spraying an aspen stand would not reduce habitat or diversity as much as burning in the early years after treatment. With the demise of aspen, wildlife habitat and diversity would tend to decrease in decadent aspen stands. Wildlife values should stabilize at a high level in stable aspen stands as the aspen mature and later become overmature and break up. In seral stands, a good mix of aspen and conifer should give optimum habitat and diversity for wildlife. As the aspen die out of the seral stand, both wildlife habitat and diversity would decrease.

Recreation values would generally be low in decadent aspen stands because of the ratty appearance and high incidence of disease (fig. 5). The recreational value in stable aspen stands would increase as succession proceeds and stabilize at a high level because of the diverse wildlife, forage, and scenic qualities of these stands. In seral stands, an aesthetically pleasing mix of aspen and conifers should give maximum recreational values for many years. As the aspen die out and conifers occupy the site, recreational values would decline. Cutting or spraying would have less impact on recreational values than would burning only in the early years after treatment.

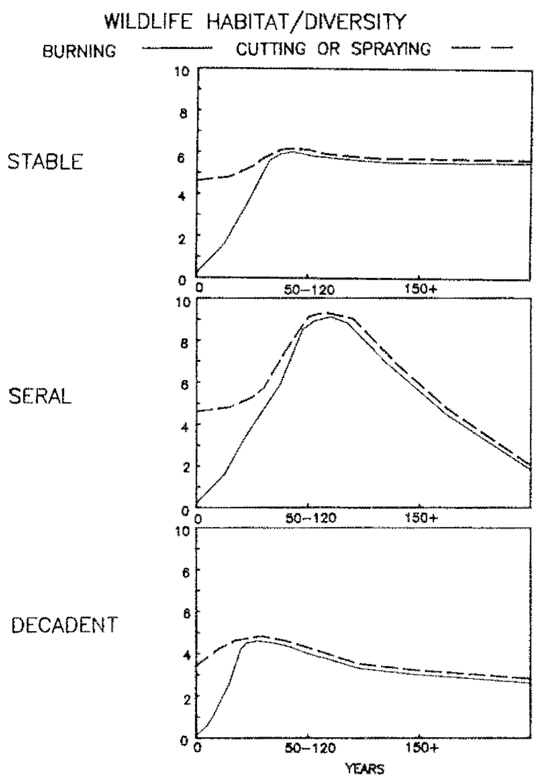

Figure 4.

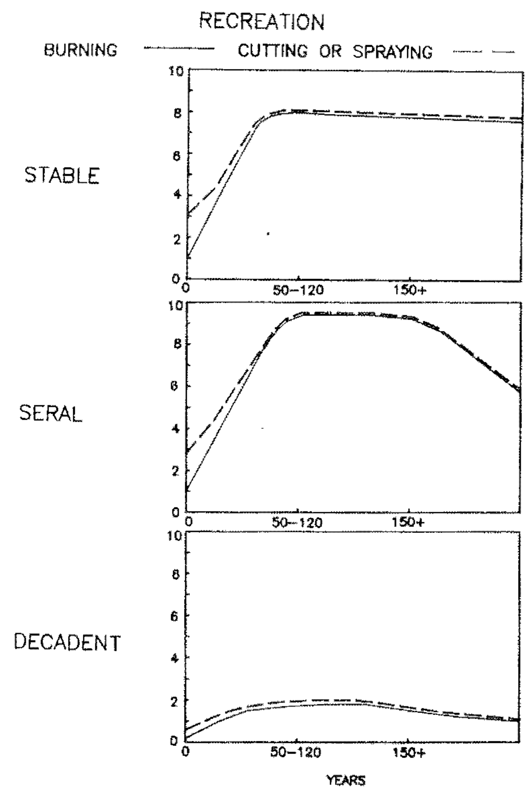

Figure 5.

Some conclusions about the effects of aspen succession on management decisions would be:

1. Management expectations for water, timber, forage, wildlife, and recreation values would be dependent on the successional status of aspen--that is, whether the aspen is decadent, stable, or seral.

2. Decadent aspen stands, in terms of management returns, have low expectations; conversely, seral aspen stands have high expectations for management returns.

3. Water, forage, wildlife, and recreational values diminish rapidly as succession proceeds to conifers.

4. On marginal sites for timber production, control of conifers in seral aspen stands would increase or maintain water, forage, wildlife, and recreational values.

5. On sites where aspen timber and other resource values are marginal or secondary, and where conifer timber growth and value are very high, succession would be more rapid by converting seral aspen stands to conifers.

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