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CLONE EXPANSION AND COMPETITION BETWEEN QUAKING AND BIGTOOTH ASPEN SUCKERS AFTER CLEARCUTTING

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The ability of quaking and bigtooth aspens (*Populus tremuloides* Michx., *P. grandidentata* Michx.) to vegetatively regenerate dense stands of root sprouts (suckers) is well documented (Brinkman and Roe 1975). Tens of thousands of suckers per hectare are commonly produced when stands are killed by fire or removed by clearcutting.

Suckers from a common parent are genetically identical and form a multi-stemmed clone that is distinct from other clones (Barnes 1966, Steneker 1973). Clones can expand, intergrow with other clones, and coalesce, depending on rate of root expansion, inherent suckering ability, and degree of stand disturbance (Barnes 1966). Clone sizes are usually small, ranging from a few trees covering 0.004 ha up to 1.5 ha (Steneker 1973). However, two clones of 10.1 and 43.3 ha have been verified in Utah, and other central and southern Rocky Mountain clones may be at least 81 ha in size (Kemperman and Barnes 1976).

There is much inherent variation among aspen clones in productivity, stem quality, disease resistance, and other characteristics of interest to the land manager (Steneker 1973). By taking advantage of the root suckering characteristics of aspens, it may be possible to extend the area of clones having desirable characteristics. But little is known about the effective range of clone extension where competition is keen in a closed forest environment.

Described here are the extension, early growth, and competition between quaking and bigtooth aspen clones after a mature, fully stocked aspen stand was clearcut.

STUDY AREA

The study area is located 47° 40′N, 93° 59′W on the Chippewa National Forest, Minnesota. The area supported a fully stocked forest of mature, even-aged (44 years) quaking and bigtooth aspen in about equal mixture, with lesser amounts of other uneven-aged hardwoods (table 1). Shrubs were sparse due to the dense shade cast by the hardwoods, but a well developed herb layer characterized by *Polygonatum biflorum, Uvularia grandiflora,* and *Maianthemum canadense* was present. The topography is rolling to hilly moraine. The soil is a well drained calcareous glacial till, classified as Warba very fine sandy loam, and a good site for aspen (site index = 24.5 m at age 50). The climate is continental, with mean maximum July temperature of 27° C and mean annual precipitation of 61 cm.

METHODS

In July 1974, 0.08-ha (16-m radius) plots were established on the contact boundaries of adjacent pairs of five quaking and five bigtooth aspen clones. There was a sharp separation of aspen species, with no intermixing. All trees greater than 5 cm d.b.h. were mapped by plane table, identified by number, and recorded by species and d.b.h. Twenty-five trees

Table 1.—*Parent stand summary*[1]

Species	Number per hectare	Basal area (m^2/ha)	Mean d.b.h. (cm)	Mean stand height (m)
Quaking aspen	313	10.4	20.6	22.1
Bigtooth aspen	378	15.5	22.8	23.5
Other hardwoods[2]	362	5.4	13.8	—
Total stand	1,053	31.3	19.5	—

[1]For all stems exceeding 5 cm d.b.h. Aspen data adjusted to reflect equal area of quaking and bigtooth clones (actual area mapped: 43 percent bigtooth aspen; 57 percent quaking aspen).

[2]*Betula papyrifera* Marsh., *Acer saccharum* Marsh., *A. rubrum* L., *Quercus rubra* L., and *Tilia americana* L.

of each species 10 to 35 cm in diameter were measured for total height and cored for total age.

The stand was clearcut during the winter of 1974-1975 to provide excellent conditions for aspen suckering. In May 1975, before leaf-flushing, the stumps of all quaking and bigtooth aspens on the clonal boundaries were re-identified and labeled (fig. 1). This provided accurate referencing for later sampling and mapping of regeneration.

In August 1975, the intrusion of quaking aspen suckers into the bigtooth aspen clones was mapped (fig. 1). The mapping was repeated for bigtooth suckers into quaking aspen clones. In May 1979, regeneration fronts were remapped to include only 4-year-old suckers that had dominant or codominant crown positions. Also in 1979, the d.b.h.'s, heights, and densities of dominant and codominant (within species) suckers were inventoried by point sampling using nonoverlapping triangles (Loetsch *et al.* 1973).

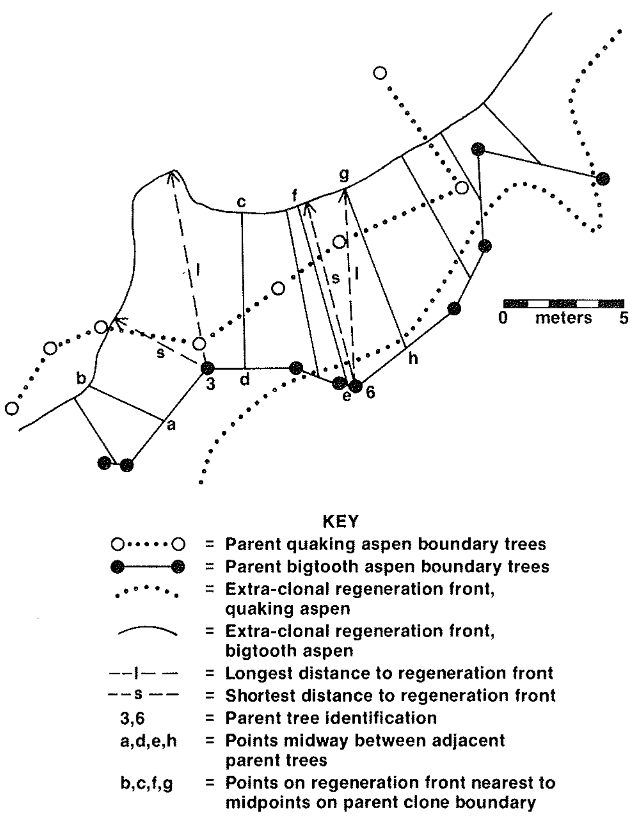

Figure 1.—*Map of quaking and bigtooth aspen clone boundary trees, regeneration fronts, and method to estimate regeneration reach by individual trees. For example, the putative area regenerated by bigtooth No. 3 is defined by a-b-c-d-3-a and for No. 6 is e-f-g-h-6-e. Regeneration reach is the mean of the long and short measurements from the parent tree to the regeneration front.*

Points were established at 3-m intervals on radii emanating every 45° from plot center. Thus there were 40 sample points (8 radii × 5 points per radius) in each of the five 0.08-ha plots.

The area added to each clone by extra-clonal suckering was determined from the maps by planimeter. Mean clone extension was then computed as:

$$\frac{\text{area added (m}^2\text{)}}{\text{length of parent contact boundary (m)}} = \text{clone extension (m)}$$

The clone extension attributed to each tree was also estimated from the 4-year data (fig. 1). These data were pooled for all clones within species and averaged by 5-tree, variable-interval, parent-d.b.h. classes.

The point sampling data were used to compute stem density, biomass (Perala 1973), and mean height [weighted by (d.b.h.)^2] of dominant and codominant suckers. These data were averaged within clone by species and outside of clone by 1-m distances from the nearest possible parent tree.

RESULTS

The two aspen species regenerated profusely both intra-clonally and extra-clonally. The extra-clonal extension of all suckers averaged 5.6 m for quaking aspen clones and 5.9 m for bigtooth aspen (table 2). Considering only dominants and codominants, quaking aspen clones extended an average of 5.1 m, compared with 3.3 m for bigtooth aspen.

The extra-clonal extension estimated for individual trees varied greatly (0.7 to 11.7 m for quaking, 0 to 9.5 m for bigtooth), but was largely accounted for by parent tree d.b.h. (fig. 2). Again, the species difference was pronounced, particularly in the smaller diameter classes, where bigtooth clone extension was much less than quaking aspen.

Quaking aspen produced suckers in greater numbers, total biomass, and mean weight than did bigtooth aspen (fig. 3). Moreover, quaking aspen extra-clonal sucker numbers and total biomass differed little from intra-clonal numbers and biomass up to 5 m away from the nearest possible parent before gradually declining. In contrast, bigtooth aspen suckers tended to decline continually in numbers and biomass as distance from nearest possible parent increased. The greatest contrast between the species is in mean sucker weight, which tended to increase with distance from nearest possible parent for quaking aspen and decrease with bigtooth. Despite these contrasts, mean height did not differ greatly between the species except at 7.5 m distance where quaking aspen was clearly taller.

Table 2.—*Quaking and bigtooth aspen parent trees and clone extension by suckering*

Clone	Parent boundary trees			Clone extension	
	Number	Mean d.b.h. (cm)	Boundary length (m)	All[1] (m)	D&C[2] (m)
			Quaking aspen		
1	16	17.4	71.4	([3])	3.40
2	9	22.1	35.9	7.09	6.39
3	9	24.1	19.6	([3])	6.46
4	29	21.0	97.8	4.10	4.10
5[4]	—	—	—	—	—
Mean	15.8	21.2	56.2	5.6	5.09
			Bigtooth aspen		
1	10	20.6	22.1	8.14	3.35
2	12	21.8	38.6	5.52	2.04
3	15	22.0	42.7	5.10	3.73
4	11	25.4	40.0	4.29	2.72
5	10	25.6	37.2	6.65	4.85
Mean	11.6	23.1	36.1	5.94	3.34

[1]All dominance classes, measured at age 1.

[2]Dominants and codominants only, measured at age 4.

[3]Not determined, suckering incomplete.

[4]This clone surrounded and regenerated completely across bigtooth clone 5. Therefore, maximum extension was unidentifiable.

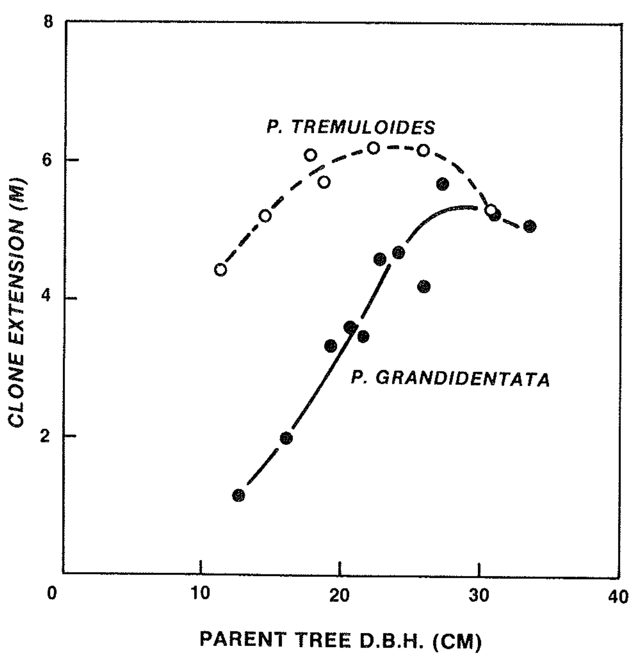

Figure 2.—*Clone extension of aspen in relation to species and d.b.h. of putative parent.*

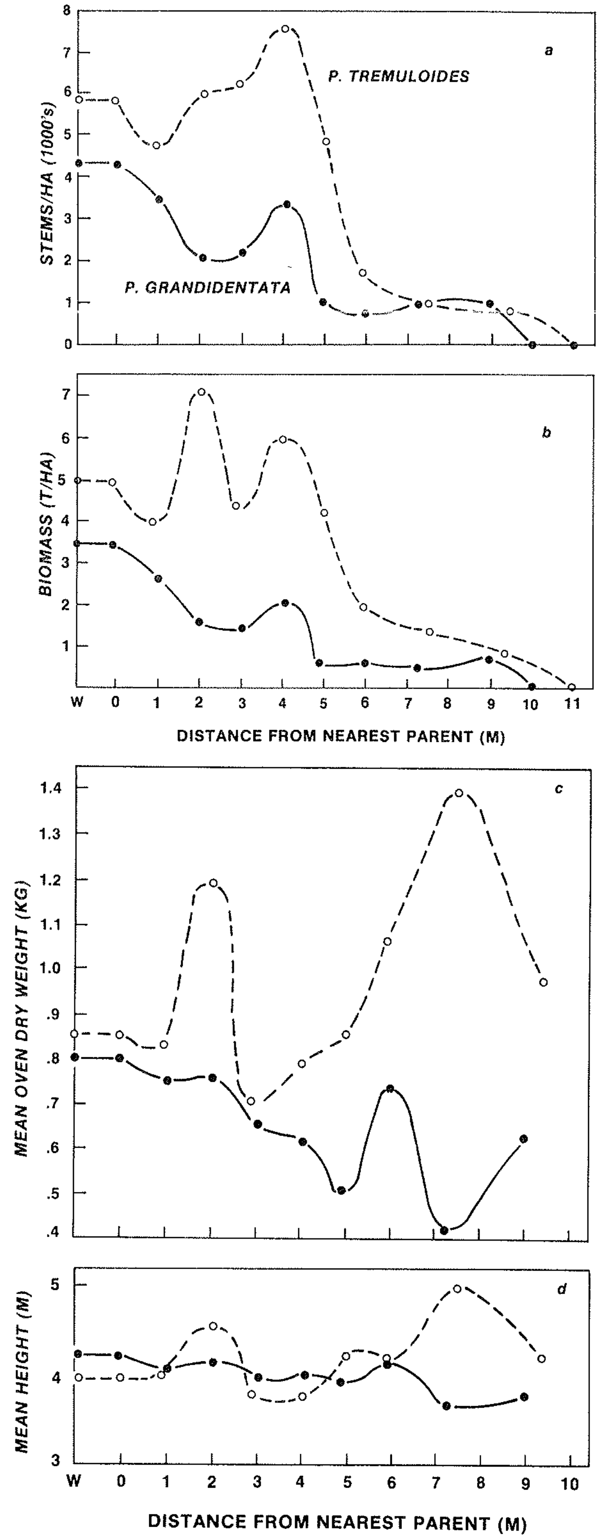

Figure 3.—*Characteristics of 4-year-old dominant and codominant (within species) trembling and largetooth aspen suckers in relation to distance from nearest putative parent; (a) stem density, (b) aerial ovendry biomass (except leaves, Perala 1973); (c) mean stem weight, and (d) mean stem height. W= within clone. Each data point is the mean of 10 to 17 observations, except for within clone with 69 (trembling aspen) and 36 (largetooth aspen) observations.*

DISCUSSION AND CONCLUSIONS

The extension of these competing aspen clones was much less than reports by Graham *et al.* (1963) and Beetle (1974) for aspen invading nonforested areas (up to 25 m), by Green (1961) for aspen invading deforested hardwoods (27 m), or what seems possible from excavated root systems (14.3 m reported by Day 1944 and 31.7 m reported by Buell and Buell 1959). Thus, the potential for enlarging favored aspen clones through silvicultural manipulation is modest.

Despite the ability of quaking aspen to regenerate greater sucker numbers and biomass than bigtooth aspen, the two species appear to coexist without great population changes in either. Rapid juvenile height growth to attain dominance is critical to both aspens' chances for survival. On that basis, neither species has demonstrated an early decided advantage.

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