Control of Aspen Regrowth by Grazing with Cattle

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Abstract

Aspen *(Populus tremuloides)* forest occupies potentially useful grazing land in the aspen parkland of western Canada, and is expanding. The replacement of forest with grassland involves the removal of trees and the control of suckers which invariably emerge following overstory removal. The control of aspen suckers by heavy browsing with cattle may be a useful technique especially in the presence of logs and stumps.

In order to evaluate the effectiveness of browsing by cattle, aspen forest was burned and seeded to forages, after which the regrowth was heavily grazed by cattle either after emergence of suckers (early) or just prior to leaf fall (late). Grazing treatments were conducted over two growing seasons.

A single heavy late grazing practically eliminated aspen regeneration, and two quite different plant communities resulted from the two grazing regimes. After the first year, the plant biomass in early-grazed plots consisted of 29% aspen and 28% grass (mainly sown species), while late-grazed plots had only 2.5% aspen and 18% grass, with a higher proportion of shrubs, especially snowberry. Trends established after the first year were still evident after the second year. The results indicated that heavy browsing by cattle in August may be an effective technique for control of aspen suckers following initial top kill.

The aspen parkland of Western Canada covers an area of about 14.5 million ha, and in its native state, consists of groves of aspen *(Populus tremuloides)* alternating with fescue grasslands, predominantly rough fescue *(Festuca hallii)* (Looman and Best 1979). Aspen also occurs extensively in the warmer climes of the Boreal Forest (Rowe 1972). Since the forage yield within the forest groves may be less than 10% of adjacent grasslands (Bailey and Wroe 1974), the removal of trees and their replacement with productive forage species should increase the carrying capacity for beef cattle, especially since the aspen groves usually occupy the more moist, and hence, potentially more productive sites in depressions and around sloughs.

The removal of the aspen tree overstory by mechanical means, herbicides, or fire, almost invariabily stimulates vigorous suckering from shallow lateral roots (Schier 1976). Hence, in addition to the initial removal of trees, the replacement of aspen forest with grassland involves the elimination or suppression of suckering aspen and understory shrubs and the establishment of productive forage species.

Substantial suppression of aspen suckering has been associated with heavy browsing by elk (Gruell and Loope 1974), and by sheep and to a lesser extent by cattle (Smith et al. 1972). Hence, heavy grazing by sheep or cattle may be an effective low cost control measure, especially where logs and stumps inhibit mechanical operations. Canada Agriculture recommends that control operations be conducted in spring to coincide with the time of lowest root carbohydrate levels (Friesen et al. 1965), but cattle on open range appear to browse aspen more readily as the season advances (Smith et al. 1972).

Timing may be critical to the effectiveness of the use of cattle as a regrowth control measure. Hence, we investigated the timing of heavy grazing by cattle to control aspen suckers which emerged after the overstory was burned and forage seeds were broadcast into the burned forest. Complete defoliation by cattle following emergence of suckers, when root carbohydrates would be minimal (Schier and Zasada 1973), was compared with defoliation just prior to leaf fall, when carbohydrate levels would be relatively high, but when little time remains for shoot development or carbohydrate replenishment before the dormant season.

Methods

Experimental Site

The experiment was conducted on the University of Alberta Ranch at Kinsella, in the aspen parkland of Alberta. Average annual precipitation recorded at the University's Meteorological Station is 432 mm of which 75% or 323 mm falls in the growing season from April to September inclusive. Growing season precipitation in 1979 and 1980 was 259 mm and 503 mm respectively. The normal frost-free period is 100-120 days from late May to early September (Wonders 1969). Average maximum and minimum

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temperatures (1962-1980 inclusive) range from −14.0° and −21.0°C in January respectively to 21.9° and 12.5°C in July. Generally, the glacial moraine topography is strongly undulating with numerous lakes and sloughs. The experiment was located on the slopes surrounding 2 adjacent sloughs, the soils of which were described by Scheffler (1976) as Dark Gray, Black and Dark Brown Chernozems and Humic Gleysols following nomenclature of Canada Soil Survey Committee (1978). Generally, the soils of the area are classified as unsorted glacial loams, having an average 7-10 cm of black or brown topsoil (Wyatt et al. 1944).

Experimental Design

Mature aspen forest was burned in May 1972, and the 7-year-old regrowth burned again on May 15, 1979. Prior to burning in 1979, trees were about 3-4 m high, with an average trunk diameter at breast height of 2.0 ± 0.3 cm. Aspen density was estimated at 23,100 ± 8,300 ha^{-1}. Practically all top growth within the experimental area was killed by the 1979 fire.

Three days after the 1979 fire, the burned forest was sown to a mixture of seed of 2.8 kg ha^{-1} of 'Drylander' alfalfa *(Medicago sativa)* inoculated with rhizobium, and 7.0 kg ha^{-1} each of 'Magna' bromegrass *(Bromus inermis)* 'Key' orchard grass *(Dactylis glome rata)* and 'Boreal' creeping red fescue *(Festuca rubra)*. The seed was broadcast and forage seedlings were established successfully. The effects of subsequent grazing treatments on initial seedling survival and growth have been reported elsewhere (FitzGerald and Bailey 1981).

The area was subdivided into 6 paddocks of an average 0.5 ha each, to provide 3 completely randomised replications of each of 2 grazing treatments. Each paddock consisted of approximately 70% regenerating aspen forest and 30% native grassland. Three of the paddocks were heavily grazed with cattle from July 5 to 17 1979 (12 days), soon after emergence of suckers of regenerating forest species. The remaining 3 paddocks were heavily grazed from August 22 to September 1 1979 (10 days); i.e. just prior to the breakdown of leaf chlorophyll in late summer, and approximately coinciding with the expected time of maximum root carbohydrate concentration. The plots were subjected to the grazing treatments again in 1980 when early grazing took place from May 31 to June 13 (13 days) and late grazing from August 15 to 23 (8 days).

The objective of the grazing treatments was to completely remove all accessible and edible plant material. Grazing was considered to be a substitute for mechanical removal. Hence, it was conducted over a short time interval to prevent any grazing of subsequent regrowth. In 1979, complete removal of edible vegetation within about 10 days required 8 animals ha^{-1} for early grazing, and 25 animals ha^{-1} for late grazing, when there was more material to be removed. In 1980 the early treatment was grazed with 8 animals ha^{-1}, and the late treatment with 27 animals ha^{-1}. Grazing achieved complete or near complete defoliation of all species except snowberry *(Symphoricarpos occidentalis)* in both treatments.

Measurements

Fixed quadrats (1 m^2) were established at random within the aspen community, 10 per paddock, 30 per grazing treatment. Density of individual woody species was determined from counts of all species within these fixed quadrats. In order to facilitate counting, density estimates were conducted during grazing periods when some foliage had been removed. Thus, density in the early grazed treatment was determined in May/June in 1979 and 1980, while in the late-grazed treatment it was determined in August in those years. In 1981 it was determined in July in both treatments. This difference in the timing of density counts in 1979 and 1980 prevented a comparison being made between grazing treatments, but allowed an analysis of density changes over time.

Estimates of the yield of the components of the regenerating forest were made in both May and August in 1980, and in July 1981. Unlike the density counts, sampling took place in both treatments on each sampling occasion. Quadrats (1 m × 0.5 m) were placed at predetermined distances (about 2 m) and directions from the above-mentioned fixed quadrats. All material within these 0.5 m^2 quadrats (10 per paddock, 30 per treatment) was clipped, sorted into species, dried in a forced draught oven at *ca.* 100°C for 24 hours, and weighed. Estimates (paddock means) were subjected to analyses of variance. Effects of grazing season treatments on species yield were analysed separately for each year because seasonal sampling time varied.

Results

The yield of aspen was profoundly influenced by the timing of grazing (Table 1). It was much lower in late-grazed paddocks than in early grazed paddocks. On the other hand, the yield of rose (*Rosa* spp.) was lower in early grazed paddocks in August 1980, although by July 1981 the difference was no longer significant.

Table 1. Yield (kg ha^{-1}) of the components of regenerating aspen forest under early or late grazing, in May 1980, August 1980, and July 1981.

Date		Grazing season	Aspen	Rose	Snow-berry	Grass[1]	Other
			Species/category				
May	1980	Early	615 *	210	417	381 *	366
		Late	70	466	631	175	360
	SE[2]		278	276	501	100	181
August	1980	Early	953 **	224 **	524	1117	402
		Late	56	605	1364	791	1009
	SE		230	167	1073	273	757
July	1981	Early	1640 *	435	792	1191	715
		Late	136	865	1394	1031	698
	SE		805	785	770	209	123

[1]Includes sown grasses, alfalfa and volunteer grasses.
[2]SE = Standard error
*Difference between early and late grazing significant ($P<0.05$).
**Difference between early and late grazing significant ($P<0.01$).

"Grass" consisted mainly of sown grasses, but included a small proportion of alfalfa and volunteer grass species especially Kentucky bluegrass *(Poa pratensis)*. Grass contribution was greater in early grazed than late-grazed paddocks in early 1980, but not thereafter.

The high mortality of aspen plants under late grazing was confirmed by the plant density counts (Table 2). Aspen plant density declined dramatically from 1979 to 1980 in late-grazed paddocks, though not in early grazed paddocks. Increases in densities of rose, raspberry (*Rubus strigosus*) and snowberry were apparent by 1981,

Table 2. Density (plants M^{-2}) of the major woody plants in regenerating aspen forest grazed early or late, and measured at grazing in 1979 and 1980, and in July 1981.

Species	Grazing season	1979	1980	1981	SE[1]
		Year			
Aspen	Early	18.3[2]	20.3	12.9	5.6
	Late	12.6a	1.3b	0.9b	1.2
Rose	Early	9.4b	14.6ab	23.4a	5.3
	Late	18.0ab	14.4b	26.0a	3.3
Raspberry	Early	13.1	11.2	19.0	5.0
	Late	17.7ab	14.9b	26.1a	3.6
Snowberry	Early	21.6b	28.2ab	36.1a	5.3
	Late	31.2b	23.1b	46.9a	5.7

[1]SE = Standard error
[2]Means within rows followed by the same letter, or without following letters are not significantly different ($P<0.05$).

particularly under late grazing.

Discussion

Two quite different plant communities developed under the 2 grazing treatments. With early grazing, the major species within the old forest were grasses and aspen suckers, the latter appearing in clumps, mostly at the base of old burnt trees. Snowberry was also a significant component. With late grazing, the major species were snowberry, rose and grasses, with little or no aspen. This dramatic effect of late grazing on aspen regeneration was established after only 1 period of heavy grazing (Tables 1 and 2).

Hence a substantial degree of control over plant succession in a regenerating aspen forest was demonstrated. It was possible, by changing the season of defoliation, to radically and consistently alter the type of plant community which developed after burning.

The suppression of growth of rose by early grazing (Table 1) is consistent with previous studies on time of clipping of range shrubs. Willard and McKell (1978) found the same relative effects of June 1 and September 1 clippings on little rabbitbush *(Chrysothamnus visidiflorus)* and a palatable species of snowberry, *(Symphoricarpos vaccinioides)* in Utah. Wright (1970) observed a similar depression in regrowth of 2 species of *Artemisia* from clipping in June or July relative to August or September. Clearly the timing of defoliation is critical for plant succession in a regenerating forest, and effects different species in different ways.

The reason for the suppression of aspen suckering by late grazing is not clear. Since root carbohydrates are lowest in spring (Schier and Zasada 1973), a decline in the vigour of regrowth would seem to be most likely from defoliation in spring. This is the experience with many partially defoliated shrubs (Wright 1970, Trlica et al. 1977, Willard and McKell 1978). It did not occur in this experiment. It seems unlikely that late-grazed aspen plants suffered carbohydrate exhaustion after 1 defoliation, when plants grazed early (when carbohydrate levels would have been low) resuckered vigorously.

Suckers released by spring logging and emerging in mid-summer may not be thoroughly "hardened off" by fall and, consequently, may be winter-killed (Zehngraff 1946). Again alfalfa is rendered susceptible to winter-killing if cut in the fall (McKenzie and McLean 1980). If aspen suckers were released by the defoliation in August before conditions became too cold for growth, then probably they were killed by cold. Temperatures which were low enough to kill very young shoots might also prevent the formation of new primordia. In this way, existing viable primordia may have been eliminated, leaving no primordia to produce suckers the following spring.

The existing defoliated stems also perished after late grazing, though not after early grazing (Table 2). Late August defoliation may have prevented the development of dormancy characteristics in these stems. Abscisic acid (ABA) is synthesised in chloroplasts in the leaves (Zeevaart 1977) in response to shortening day length (Wareing and Saunders 1971) and transported out of the leaves to the stem and apex (Phillips et al. 1980), where it has been associated with the development of bud scales and other characteristics of winter dormancy in woody plants. Total removal of leaves of aspen in August would remove the source of ABA, perhaps preventing the normal development of dormancy. Plants left in a non-dormant state would freeze in the winter. Obviously, there is room for further investigation into the effect of late-season defoliation.

The study indicates 2 conflicting needs under range conditions. Aspen control requires late season defoliation, while the initial establishment of grasses is enhanced by early defoliation (Table 1). A third factor requiring consideration is the presence of snowberry and its tendency to expand in the absence of aspen (Tables 1 and 2). A development program may involve some combination of early and late grazing conjunction with a strategy, as yet undefined, for control of snowberry.

Cattle grazed aspen quite readily in August in the presence of ample alternative forages, but early in the season they tended to avoid it until the herbaceous species had been consumed. If cattle are to be used for early season defoliation, some method of concentrating them on regenerating shrubs, such as temporary electric fencing, may be necessary. Alternatively, other methods of achieving complete rapid defoliation of aspen suckers may be more practical and equally effective if timed correctly.

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