Regeneration of woody species following burning and grazing in Aspen Parkland

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Abstract

The effect of short duration, heavy grazing by cattle was evaluated 3 and 6 years after burning and seeding of an aspen (*Populus tremuloides* Michx.) grove. Replicated paddocks of June grazed (early), August grazed (late), and ungrazed treatments were established. Regardless of treatment, density of all woody species was lower 6 years after burning than after 3 years. Early or late season grazing reduced the density of aspen and wild raspberry (*Rubus strigosus* Michx.). Late season grazing promoted a greater density of unpalatable western snowberry (*Symphoricarpos occidentalis* Hook.). Grazing reduced the height of aspen, preventing the development of a forest canopy. Herbage production averaged 1,700 kg ha-1, not differing between years 3 and 6: but the proportion of smooth brome (*Bromus inermis* Leyss.) increased while orchard grass (*Dactylis glomerata* L.) declined. Burning of aspen forest in Central Alberta followed by forage seeding and short duration, heavy grazing is an effective, economical range improvement tool.

Key Words: aspen forest, prescribed fire, short duration grazing, seeding

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The invasion of productive grasslands of the Aspen Parkland region of North America by aspen poplar is a problem for ranchers because it reduces the availability of useful herbage for cattle. Annual herbage yield under aspen and associated shrub species can be reduced to as little as 10% of the yield of adjacent grassland (Bailey and Wroe 1974). Removal of the aspen canopy and re-establishment of a grass sward is complicated by the ability of aspen and associated brush species to sprout vigorously. Competition from suckers of aspen and western snowberry reduces growth of herbage (Bailey and Gupta 1973). In the past, control of resprouts has been attempted with varying success by mechanical means or selective herbicides (Bailey 1972, Bowes 1975, Bowes 1976). More recently, cattle browsing has been investigated as a means of controlling brush regrowth. In a burned and seeded aspen forest in the Central Parkland region of Alberta, heavy grazing in August just prior to leaf fall, provided better control than the June grazing treatment (FitzGerald and Bailey 1984). This contrasted with conventional theory (Friesen et al. 1965) which suggests that defoliation just after leaf emergence, when carbohydrate reserves are lowest, would be the most effective in controlling sucker regrowth. Defoliation in early fall apparently (a) stimulated shoot primordia to grow too late in the season to permit development of winter hardiness, and (b) prevented shoots which had emerged earlier in the growing season from going into dormancy, leaving

them susceptible to winter kill.

Overgrazing is generally considered to be detrimental to range stability and productivity over the longer term, but short duration heavy grazing may have a place in forage establishment and control of woody species. Range managers are justifiably wary of such practices. Hence, if cattle were to control woody species, it is important to observe the longer term effects of repeated heavy grazing. FitzGerald and Bailey (1984) reported results for the first 3 years of grazing following a 1979 burn. This paper reports the longer term effect of season of grazing on control of shrub regrowth and forage response following prescribed burning and seeding of forages in the Aspen Parkland region of central Alberta.

Materials and Methods

Experimental Site

The study was conducted at the University of Alberta Ranch, Kinsella, Alberta, 53° N Lat, 111° W Long. The vegetation consists primarily of aspen groves interspersed with native grasslands dominated by rough fescue (*Festuca hallii* [Vasey] Piper) and western porcupine grass (*Stipa curtiseta* [A.S. Hitchs.] Barkworth). The soils of the area, in general, consist of unsorted glacial loams having an average of 7-10 cm of black or brown topsoil (Wyatt 1944). Average annual precipitation recorded at the University of Alberta Ranch is 432 mm, of which 323 mm falls as rain during the growing season.

Experimental Design

This paper reports successional developments from 1981 to 1985 following a 1979 burn. Grazing treatments which originally began in 1979, were continued through 1984, using the same guidelines as in the original study. The study area consisted of a large aspen grove containing several clones. It was burned in 1979. Following burning, the grove was broadcast seeded to a mixture of 'Drylander' alfalfa (*Medicago sativa* L.), 'Magna' smooth brome grass, 'Kay' orchard grass, and 'Boreal' creeping red fescue (*Festuca rubra* L.). Six paddocks, approximately 0.5 hectare each, were located within the grove. Three paddocks were randomly chosen to be grazed early in the growing season (soon after emergence of suckers of regenerating forest species). The other 3 paddocks were allocated to late season grazing (just prior to leaf fall). In the original study, early grazing took place in early/mid June; late grazing occurred in mid August. The actual length of time cows were in a paddock depended on forage availability. The objective of the grazing treatments was to remove all accessible edible material. In general, 5 AUM/ha were required to achieve the desired defoliation. More detail of the initial procedures is provided by FitzGerald and Bailey (1984).

In addition to the grazed paddocks, 3 control areas were established in 1984 in regenerating forest adjacent to the grazed paddocks. The controls were in the same series of aspen clones as the grazing treatments. The controls had been fenced and had not been grazed since the study was established in 1979.

Measurements

Herbage yield and woody plant density and height were estimated in the same manner as the original study. In 1984 and 1985, 10 quadrats (1 × 1 m) were located at random within each of the grazed paddocks and ungrazed control paddocks. In 1984 the density was recorded for the major woody species: aspen, western snowberry, wild rose (*Rosa woodsii* Lindl., *R. acicularis* Lindl.), wild raspberry, and other shrubs. In 1985, sampling was repeated with height of the major woody species also being recorded. The tallest individuals of aspen, western snowberry, and rose were measured (cm). If a quadrat did not contain an individual of any particular species, the individual nearest to the quadrat centre outside the quadrat was located and measured. The density of raspberry was too low for reliable estimates of height.

Herbage production was measured in 1985. Ten, 1 × 1-m quadrats were randomly located in each grazed paddock and ungrazed control. All green herbaceous material was hand-clipped and field sorted to alfalfa, smooth brome, orchard grass, and other herbs. The sorted material was oven dried for 24 hours at 60° C and weighed.

Analysis

Analysis of sample data followed 2 objectives. The first objective was to compare the shrub densities, heights, and herbage yields of 1984/85 with those reported by FitzGerald and Bailey (1984) for 1981. The second objective was to compare densities, heights, and herbage yields of grazed and ungrazed plots in 1984/85. Analysis of variance was used in all comparisons. Means of significant effects were compared using a Student-Neuman-Keuls (SNK) multiple range test.

Results

There were no significant differences between 1984 and 1985 so the data were aggregated. Density of all woody plants declined between 1981 and 1984/85 (Table 1). The effect of grazing treatment over this period was revealed by the year × grazing interaction. The decline from 1981 to 1984/85 in aspen density in early grazed treatments from 12.9 to 0.8 stems m^{-2} was significant, while the change in the late grazed treatment from 0.9 to 0.2 stems m^{-2} was not. Year × treatment interactions were not significant for other woody species.

Table 1. Comparison of shrub densities (stems m^{-2}) for early and late grazing treatments between 1981 and 1984/5 showing probabilities for significance of main effects in parenthesis.

	Aspen	Western snowberry	Wild rose	Wild raspberry	Total shrubs[1]
Year	(0.02)	(0.04)	(0.03)	(0.06)	(0.02)
1981	6.9a	41.5a	24.7a	22.5a	95.6a
1984/5	0.5b	9.3b	7.8b	0.8a	18.4b
SE	0.7	4.4	2.1	4.0	0.7

[1]Total shrubs includes aspen, snowberry, rose, raspberry, and other shrubs.
[2]Means within columns followed by the same letter are not significantly different at $P<0.05$ using the SNK multiple range test.

In 1984/85 density of aspen and raspberry was lower in both grazing treatments than in the absence of grazing (Table 2). By contrast, density of western snowberry was greater under late grazing than under early grazing or without grazing. The density of wild rose was greater under early grazing. By 1984/85, density of total shrubs was the same whether grazed early, late, or not at all. In 1985, the heights of aspen and rose were significantly reduced under grazing compared with no grazing (Table 3).

Table 2. Comparison of shrub densities (stems m^{-2}) among grazing treatments for 1984/85 showing probabilities for significance of main effects in parenthesis.

	Aspen	Western snowberry	Wild rose	Wild raspberry	Total shrubs[1]
Treatment	(0.00)	(0.00)	(0.18)	(0.00)	(0.11)
Early	0.8b[2]	6.2b	8.4a	1.3b	17.1a
Late	0.2c	12.4a	7.3a	0.3c	20.8a
Control	3.1a	9.0b	6.2a	3.3a	20.2a
SE	0.2	1.1	0.8	0.3	1.3

[1]Total shrubs includes aspen, snowberry, rose, raspberry, and other shrubs.
[2]Means within columns followed by the same letter are not significantly different at $P<0.05$ using the SNK multiple range test.

Table 3. Heights (cm) of selected shrub species under early, late, or no grazing (control) in 1985.

	Aspen	Western snowberry	Wild rose
Treatment	(0.004)	(0.09)	(0.005)
Early	77a[1]	31a	32a
Late	75a	33a	28a
Control	284b	61a	67b
SE	22	8	2

[1]Means within columns followed by the same letter are not significantly different at $P<0.05$ using the SNK multiple range test.

Total herbage production in the 2 grazing treatments did not change significantly from 1981 to 1985 (Table 4). However, yield of the species that made up total production did change. Orchard grass yields decreased while smooth brome grass increased. There was a trend for alfalfa production to increase over time. In 1985 there was 422 kg ha^{-1} of herbage in ungrazed controls, significantly less than in either early or late grazed paddocks. This consisted entirely of native species, mainly native legumes (*Lathyrus venosus* Muhl., *L. ochroleucus* Hook., *Vicia americana* Muhl.) and fireweed (*Epilobium angustifolium* L.).

Table 4. Yield (kg ha^{-1}) of herbaceous species in 1981 and 1985. Probabilities for significance of main effects are shown in parenthesis.

	Smooth brome	Orchard grass	Alfalfa	Other herbs	Total herbs
Year	(0.02)	(0.03)	(0.20)	(0.47)	(0.11)
1981	368b[1]	507a	51a	610a	1537a
1985	717a	323b	160a	668a	1868a
SE	32	23	41	46	84

[1]Means within columns followed by the same letter are not significantly different at $P<0.05$ using the SNK multiple range test.

Discussion and Conclusions

In this study, aspen suckers which emerged after the mature trees were killed by burning were subjected to severe annual defoliation for a total of 6 years. Suckers defoliated by grazing in August, late in the growing season, were nearly eliminated after only 1 defoliation (FitzGerald and Bailey 1984) whereas suckers defoliated earlier in the season continued to regenerate and took 7 years to decline to 7% of original stem densities. This time frame for control of aspen suckers by grazing in June corresponded to that reported by Berry and Stiell (1978) and Perala (1979), who removed tops annually during the dormant season. Schier (1976) indicated that repeated removal of tops and consequent initiation and growth of new suckers leads to a gradual depletion of nonstructural carbohydrates in the roots. Exhaustion of carbohydrates by annually repeated destruction of growing points appears to take from 6 to 8 years, too long to have practical application. Clearly, for immediate control of aspen suckers, top removal or defoliation must be timed similarly to the late grazing treatment in this study. However, aspen suckers are suitable forage for cattle provided they are maintained within reach. In this study, the grazing treatment selected to control aspen did not matter because after 6 years of annual defoliation following burning, aspen sprouts had been controlled. The problem shrub was western snowberry. This shrub is mostly unpalatable to cattle, although it became more acceptable towards the end of the grazing season (FitzGerald et al. 1986). Grazing late in the growing season resulted in a significantly greater density of western snowberry compared with grazing early in the growing season or without grazing.

Sown species did not establish in the absence of grazing (control) from 1979 to 1985. The removal of competition by early season grazing enhanced the rapid establishment of sown forage species while late season grazing did not (FitzGerald and Bailey 1983). Nevertheless, after 6 years the sown species were producing similar amounts of forage in both early and late grazing treatments. The slow establishment of sown forages and the rapid decline of aspen suckers in the late season grazing treatment apparently gave the least palatable shrub, western snowberry, a competitive advantage.

Over 6 years, orchard grass production declined and smooth brome grass production increased. Smoliak et al. (1982) reported that orchard grass was susceptible to close grazing, whereas smooth brome grass was relatively tolerant of such grazing. They explained that smooth brome has a rhizomatous habit, is better adapted to extreme defoliations, and is more protected from the aspen parkland climate than orchard grass.

Walker et al. (1986) argued that conditions of southern African rangelands are driven by events rather than by constant strategy manipulation of grazing (such as one kind of grazing system). These are referred to as event driven ecosystems. The 2 studies of mixed grass swards cited both seem to be driven by rainfall events. In contrast in our 6 years of study of burned aspen forest, the mixed shrub-herb sward seemed to be controlled by grazing events that occurred a few months after spring burning. In 1979, early season, short duration heavy grazing soon after burning severely reduced competition from woody suckers for newly germinated forage seedlings. It resulted in a more rapid establishment of forages than either late season, short duration heavy grazing or no grazing (FitzGerald and Bailey 1983). In contrast late season, short duration heavy grazing nearly eradicated regenerating aspen suckers (FitzGerald and Bailey 1984). From 1980 to 1984 it did not seem critical to the sward at what season this grazing regime was imposed. Provided heavy grazing occurred, the sward remained relatively constant; without heavy grazing the sward reverted to forest. Under both grazing regimes there was a gradual decline in density of woody species as well as a decline in orchardgrass and an increase in smooth brome. It would appear that timing of grazing affected the rate of succession, but the presence or absence of heavy grazing affected the final composition of a stable community. Without periodic heavy grazing, taller growing aspen quickly overtops other shrubs and herbs, and the site returns to a forest.

If short duration grazing is to be used to manage cattle in a burned aspen forest for optimum forage and liveweight production, then certain priorities must be established. If the first priority is to rapidly establish seeded forages in order to recover range improvement costs quickly, then one should apply early season, short duration heavy grazing about 6 weeks after the spring burn. In contrast if the first priority is to nearly eradicate regenerating aspen suckers, then late season, short duration heavy grazing should be applied the year of the burn. In subsequent years there seems to be opportunity for more flexibility; grazing events could be applied at various times and so long as the grasses remain vigorous and woody species are not allowed to seriously overtop them, a productive sward can be maintained. When woody species overtop the grasses, a cool spring burn is needed to again favour grasses over woody species. If an excessive density of western snowberry develops then other means such as herbicides, mowing or browsers are required.

The study demonstrates that cattle are an effective range improvement tool capable of controlling woody plants and promoting herbaceous forages in the Alberta aspen parkland. Additional research into control of western snowberry should be a priority, since it seems to be the only shrub species of this area which was not satisfactorily controlled by grazing with cattle.

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