BROWSE AND HERBAGE YIELD FOLLOWING CLEARING IN THE ALBERTA MONTANE ASPEN ECOREGION

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ABSTRACT: Small openings were cleared by bulldozing in montane aspen *Populus tremuloides* forest in southwestern Alberta in 1976. Production of browse, forbs and grasses was measured at the end of the growing season 2 and 7 years later. In the 2nd year production of woody twigs was significantly higher than on uncut controls (87.0 kg/ha compared to 56.0 kg/ha). In the 7th year twig production on cut blocks still exceeded that on the control blocks (53.9 kg/ha compared to 35.5 kg/ha). Leaf production was also significantly higher on the treated blocks during both years. Forb production and species composition was not significantly affected by cutting. Production of grasses increased significantly on the treated blocks in 1978 but was similar to production on the control blocks in 1983. Forage production and percentage increases following treatment were low compared to those reported from studies in aspen forests in the western United States and much lower than values reported following treatment in the boreal mixedwood forests. Decisions to use patch clearcutting to increase ungulate forage in montane aspen stands should be based on site characteristics.

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The aspen-dominated cover type is widespread in western North America (Jones 1985, Samoil 1988). It provides important habitat for ungulates such as moose (*Alces alces*), North American elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*) and white-tailed deer (*Odocoileus virginianus*) (Mueggler 1985). It also provides suitable range for cattle (*Bos taurus*). Productivity of browse and other forages in relation to manipulation of the vegetation has been studied in aspen forests by several workers (Smith *et al.* 1972, Usher 1981, Mueggler 1985).

The influence of an aspen-forest overstory on the productivity and species composition of understory is quite variable (Mueggler 1985). Warner (1971) and Severson and Kranz (1976) reported understory production to be unrelated to overstory density. However, Woods *et al.* (1982) reported that dense aspen crown cover suppressed understory productivity. Most workers have found that forage productivity in openings substantially exceeded that occurring under the crown cover of aspen stands (Smith *et al.* 1972, Bartos and Mueggler 1982, Crouch 1983). However, Ellison and Houston (1958) found that on their Utah study area, productivity was greater in aspen stands than in openings.

The present study tested the null hypothesis that there was no difference in browse, forbs or grass productivity between cleared openings and control blocks of untreated aspen forest after 2 and again after 7 growing seasons.

STUDY AREA

Streeter Basin is a 5.98-km^2 experimental watershed at 114°03'West and 50°07'North and 100 km southwest of Calgary Alberta. The Basin is in the Porcupine Hills, an outlying portion of the eastern foothills of the Rocky Mountains. Elevations on the Basin range from 1,325 m to 1,660 m. The Porcupine Hills were formed on uplifted tertiary sediments and consist of a narrow ridge trending north and south from which extend branch ridges that are separated by steeply sloped valleys. The Basin consists of two subbasins, the East and West Branch, approximately equal in area. The site of the present study was in the aspen stands of the West

Basin. The treated and control blocks were on both northeasterly and northwesterly-facing middle and upper slopes.

The regional climate is "arid with a cold season" (Walter and Lieth 1967) and is characterized by foehn winds called chinooks. In winter chinooks bring sharp rises in temperature with more than 15% of winter days having a maximum exceeding 5°C (R. Olson, unpubl. rep. to Alta. Fish and Wildlife Div., Edmonton, 1984). Above-freezing temperatures cause melting and redistribution of snow and subsequent frost damage to woody plant twigs that flush prematurely.

Vegetation is a transition between grassland and forest and has been assigned by Rowe (1972) to the Douglas Fir-Aspen District of the Montane Forest Region. The study area was 40% grass or herbland, 20% shrubland and 40% aspen forest (Canadian Wildlife Service unpublished data). Aspen stands in the area treated averaged 2,757 stems per ha larger than 4.06 cm DBH and 1,030 larger than 9.1 cm while total basal area averaged 19 m^2/ha (Canadian Wildlife Service unpublished data). Most trees were in the smaller size classes with stems larger in diameter than 9.1 cm averaging only 13.4 cm.

Streeter Basin was grazed by cattle and also supported heavy use by wild ungulates, principally moose and mule deer with lesser numbers of elk and white-tailed deer.

MATERIALS AND METHODS

Treatment

During July and August of 1976, 118 openings, varying between 60 and 180 m long and 1 to 3 tree-heights wide (*ca* 20-40 m), were cleared (Swanson 1986). Trees were sheared off and piled by bulldozer. Piles were burned that year between October and December. Total area of openings created was 30.4 ha.

The 118 openings were numbered, and 10 were chosen from a table of random numbers to serve as replicate treatment blocks. Once the treated block replicates were selected, 10 control replicates were also established, one adjacent to each treated block. Control replicates were chosen so as to be as similar as possible to their adjacent treatment blocks in slope, aspect, forest crown cover, tree diameter and height, and understory vegetation.

Forage Yield Surveys

In late summer of 1978 and 1983 production of forage, including shrub twigs and leaves, grasses and forbs was determined in the study blocks using the double-sampling system proposed by Wilm *et al.* (1944). Twenty 0.25 m^2 plots were located in each of the 10 treated and 10 control area replicates by the method described by McCaffery and Creed (1969). Plots were located along a transect with distances between plots selected by reference to a table of random numbers. The start of the transect was at the point where the investigators entered the block. The bearing of the first leg of the transect was the one of the 8 cardinal compass directions that headed toward the nearest opposite edge of the block. When that edge was reached, the next leg of the transect was established by turning an angle of 135° right or left as required to head back toward the centre of the block. Additional transect legs were established until the goal of 20 plots was achieved.

Green weights of above-ground parts of graminoids and forbs were estimated by species. Woody plant leaf weight and weight of twig growth of the current year were also estimated for each species within the height range of 0.15 to 2.50 metres. Raspberry (*Rubus strigosus*) canes were treated as woody plant stems.

In each block, 2 plots were selected systematically and, following estimation of green weight, all vegetation was clipped and seperated by species. Leaves of woody plant species were seperated from twigs. The separated samples were then placed in labelled paper bags and air-dried previous to ovendrying in a forced-draft oven for 24 hours at 70° C. Average ratios of estimated green weight to actual oven-dry weight were the calculated as described by Blair (1958) and used to reduce green weights estimated on all plots to an oven-dry basis.

RESULTS

Production of browse, both woody twigs and leaves, on the cleared blocks was significantly ($p = 0.05$) greater than that on the control blocks in both 1978 and 1983 (Table 1). In 1983 twig production dropped but was still 52% higher on the treated blocks 7 years after treatment. Leaf production in the shrub layer exceeded twig production during both years (Table 1). Leaves are an important summer food for moose and mule deer in the study area while fallen leaves have been reported to be an important moose and elk winter food source in Alberta when not buried by snow (Renecker 1987).

Trembling aspen was the species that responded most strongly to overstory removal (Table 1). Rose (*Rosa* spp.)was the second most important species. It declined slightly in production in the 7th year as did saskatoon (*Amelanchier alnifolia*) and spirea (*Spirea*

Table 1. Mean browse yield on treated and control blocks, Streeter Basin Experimental Watershed, Alberta (kg/ha).

	1978				1983			
	Control		Treated		Control		Treated	
Species	Leaves	Twigs	Leaves	Twigs	Leaves	Twigs	Leaves	Twigs
Trembling Aspen (*Populus tremuloides*)	6.8	6.2	131.6	56.7	16.4	7.4	158.7	45.0
Balsam Poplar (*Populus balsamifera*)	25.0	12.0	3.9	3.8	1.8	0.4	10.1	2.0
Willows (*Salix* spp.)	5.6	3.4	2.4	1.3	2.5	1.3	2.1	0.9
Saskatoon (*Amelanchier alnifolia*)	6.9	4.7	3.6	3.0	1.5	2.5	0.7	0.8
Water Birch (*Betula occidentalis*)	0	0	0.6	0.2	1.7	1.3	0	0
Rose (*Rosa acicularis*)	28.6	15.7	29.5	12.1	33.8	15.4	17.1	8.0
Spiraea (*Spiraea lucida*)	31.8	12.4	22.3	9.3	8.9	4.1	7.0	2.5
Gooseberry (*Ribes oxyacanthoides*)	0.2	0.4	0.2	0.2	0	0	0	0
Raspberry (*Rubus strigosus*)	0.3	0.2	0	0	2.5	2.5	4.0	4.9
Honeysuckle (*Lonicera* spp.)	1.4	0.8	1.2	0.4	0	0	0	0
Snowberry (*Symphoricarpos* spp.)	7.2	0.7	2.3	0.3	4.7	1.2	1.8	0.6
Totals[1]	114.0	56.0	198.0	87.0	73.5	35.5	202.0	53.9

[1]Differences in total yield of leaves and twigs between treated and control blocks were significant in both years (one-way ANOVAs, F values significant at ($p \leq 0.05$).

lucida). Willows (*Salix* spp.), a major regional browse-producing group, were not benefitted by the treatment. After 7 years the production of willows averaged only 0.9 km/ha on the treated areas compared to 1.3 km/ha on the control blocks. This lack of response was unexpected and disappointing.

In 1978 the total production of graminoids was significantly higher by 108 kg/ha on the treated blocks due to increases in *Poa*, *Elymus* and *Bromus* species (Table 2) but by 1983 production was not significantly different from the controls. Total production of forbs on treated and control blocks was not signifi-

Table 2. Mean herbage yield on treated and control blocks, Streeter Basin Experimental Watershed, Alberta (kg/ha).

	1978		1983	
Species[1]	Control	Treated	Control	Treated
Grasses & Sedges				
Agropyron spp.	20	6	1	8
Bromus sp.	0	31	1	11
Calamagrostis sp.	245	224	154	109
Elymus innovatus	6	36	16	14
Phleum pratense	1	0.3	7	21
Poa spp.	4	70	1	14
Carex spp.	4	1	7	2
Total Sedges & Grasses	280	388*	187	179
Forbs				
Smilacina stellata	25	6	15	8
Clematis verticellaris	10	0	T[2]	T
Delphinium spp.	4	7	34	43
Thalictrum venulosum	32	21	24	34
Vicia americana	16	46	21	55
Geranium viscosissimum	36	22	11	8
Viola rugulosa	13	3	10	8
Ėpilobium angustifolium	339	475	812	758
Heracleum lanatum	0	11	13	39
Lomatium dissectum	4	13	3	T
Lappula sp.	0	0	0	17
Monarda fistulosa	T	0	5	14
Galium boreale	9	13	8	10
Arnica sp.	4	12	3	3
Aster conspicuus	292	239	194	254
Aster spp.	27	38	4	41
Taraxacum officinale	8	13	81	10
Other[3]	90	88	81	146
Total Forbs	909	1,007	1,254	1,449
Total Herbage	1,189	1,395	1.441	1,628

[1]Species contributing >1% of the total in any treatment.
[2]"T" = trace, <1%.
[3]41 other species.
*Significantly different from control (one-way ANOVAs $p \leq 0.05$).

cantly different in either study year (Table 2). Mean production of individual species showed substantial differences that were not statistically significant due to high within treatment variation. In both 1978 and 1983 *Epilobium angustifolium* and *Aster conspicuus* provided a large portion of the total forb production. Total herbage (forbs plus grasses) production was slightly larger on the treated blocks in both years but not significantly so (Table 2).

DISCUSSION

In 1978, the second growing season following clearing, woody browse production increased 55% on the treated blocks in this study. Similarly, Smith *et al.* (1972) reported an increase of 59% by the second year in Utah. Bartos and Mueggler (1982), show a 3.8-fold increase after two years, also in Utah, while Crouch (1983) reported a 2.5% -fold increase on cut areas from his study area in Colorado.

In sharp contrast to those montane aspen forests, creation of clearings in boreal mixedwood forests in northeastern Alberta resulted in extremely vigorous sprouting by aspen root systems with a second growing season production of woody browse exceeding the controls by 17.2 fold (calculated from data reported in Usher 1981). The second survey in the present study, conducted following the 7th growing season after clearing, found woody browse production on the treated blocks to be 52% higher than on the controls. Crouch (1983) reported 3.4-fold increase in browse on treated blocks in Colorado over that on controls in the 5th year following treatment. In the boreal mixedwood Usher (1981) found a 1.6-fold increase of production on treated compared to control areas 5 years after cutting. Some of the aspen suckers had already grown beyond the reach of moose.

The vastly greater initial increase in production in the boreal mixedwood probably resulted from a cooler and wetter summer climate than at Streeter Basin, the existence of a well-developed aspen root system and also the fact that production on the controls was quite low, probably because of the intermixture of coniferous trees (Usher 1981). Conifers have been shown to compete more severely with understory production than do overstory aspen (Mueggler 1985, Severson and Kranz 1976).

In contrast to the increase in woody browse and leaf production in the 2nd year after treatment in the present study, forb production did not increase significantly. Other montane aspen studies reported increases ranging from 10% (Crouch 1982) to 90% (Smith *et al.* 1972). Five years after cutting, Crouch's (1982) treated blocks were producing 63% more forb biomass than were the controls. At 7 years the treated blocks in the present study were producing only 16% more than the controls.

Graminoid production at Streeter Basin was 39% higher on the cleared blocks at 2 years after treatment. Bartos and Mueggler (1982) reported a 67% increase in the 2nd year after treatment, and Smith et al. (1972) reported an 80% increase on their Utah study area. However, Crouch (1983) found that graminoid production was 14% *less* on treated blocks at 2 years and 19% less after 5 years. In the present study graminoid production had also dropped to 4% less on treated areas compared to control blocks by 7 years.

The comparatively small increase in browse and herbage production resulting from the removal of the aspen overstory in the present study may reflect a moisture limitation characteristic of the sites. In the Porcupine Hills, Montane Region forest growth gives way to fescue grassland on the drier sites (Strong and Leggat 1981). Although northerly in aspect and therefore less exposed to evapotranspiration, the upper slope location of the study site was probably drier than valley bottoms and lower slopes in the region. Thus greater increases on forage production than those observed in the present study may be expected in those locations.

In Streeter Basin and elsewhere in the Porcupine Hills, aspen forest is invading grassland as the result of effective wildfire control (Frederickson 1975). The lack of difference in species composition and productivity of the forb and grass components of the vegetation of the cleared and control areas indicate that the aspen stands had developed on herbland fairly recently. Forest understory species had not yet become dominant. Removal of the aspen overstory in such stands does not result in large increases of browse and herbage but does maintain the early successional stage. Declines in forage production usually associated with dense forest (Woods *et al* 1982) may thus be prevented.

The highly-variable results in terms of browse, forb and graminoid productivity shown by the studies cited above suggest that caution is advisable in advocating patch clearcutting as a means of increasing forage biomass. The short-term response can be expected to be large in the boreal mixedwood region of northern Alberta studied by Usher (1981) but less so in the montane aspen forests. However, the increases reported by Bartos and Mueggler (1982) and Crouch (1983) are at a level that could be useful in providing some additional forage for ungulates, especially if the cost of overstory removal were carried by timber harvest or other land uses. Managers should pay careful attention to site characteristics of proposed treatment areas and look at forage production in existing clearings before committing resources to extensive range improvement through clearing.

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