BIOMASS PRODUCTIVITY IN TWO-YEAR-OLD ASPEN CUTOVERS NEAR CALLING LAKE AND SLAVE LAKE, ALBERTA

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Biomass productivity was estimated for 2-year-old aspen from cutovers in three ages of parent stands logged by two methods. The age of the previous stand affected aspen and total biomass productivity, but logging method did not. Site difference, however, is suspected to be the cause of this variation.

On a évalué la productivité de la biomasse pour des trembles de deux ans obtenus de coupes à blanc dans trois catégories d'âge de peuplements de trembles abattus selon deux méthodes. L'âge du peuplement précédent influence la productivité des trembles et de la biomasse globale, mais non la méthode d'abattage. On soupçonne toutefois que la différence d'emplacement soit la cause de cette variation.

INTRODUCTION

Aspen (Populus tremuloides Michx.) wood can be used for waferboard, oriented strandboard (OSB), lumber, pulpwood, disposable chopsticks, animal feed and as an energy source (Morley 1986). Interest in aspen biomass has been growing in the past 20 years. In Alberta biomass studies focused on young stands (Bella and De Franceschi 1980), on above-ground components (Johnstone and Peterson 1980), and prediction equations for regional above-ground biomass components (Singh 1982). In the east-central area of Alberta, aspen biomass research was initiated in 1981 to establish standing biomass and nutrient content of aspen ecosystems (Peterson et al. 1985). Presently a study is involved with nutrient cycling within the cutover (1984) aspen stands in the Calling Lake and Slave Lake area of Alberta but productivity soon after clearcut was not initially included. The nutrient and productivity data obtained will be used for calibrating the FORCYTE-11 (Kimmins and Scoullar 1984) model for aspen.

The objectives of this study are 1) to determine the biomass productivity of aspen suckers, other tree species, grasses, herbs and shrubs in 2-year-old cutover aspen stands in the Calling Lake and Slave Lake areas, 2) to test the effects of previous stand age and harvesting methods on biomass productivity.

MATERIALS AND METHODS

Twelve aspen blocks, 0.4 ha (64m x 64m) in size were harvested in August 1984. Four blocks were cut in a young age (10-15 years) class, four from a medium age (30-35 years) class, and four from an old age (55-60 years old) class.

Cut blocks within the young and medium aged stands were located 75 km south-west of Slave Lake, Alberta and those within the old stand were located 40 km north of Calling Lake, Alberta (Figure 1). The plots were of fire origin, hence the random location of various age groups. Within each age class, two blocks were harvested by removing stems only (conventional harvesting);

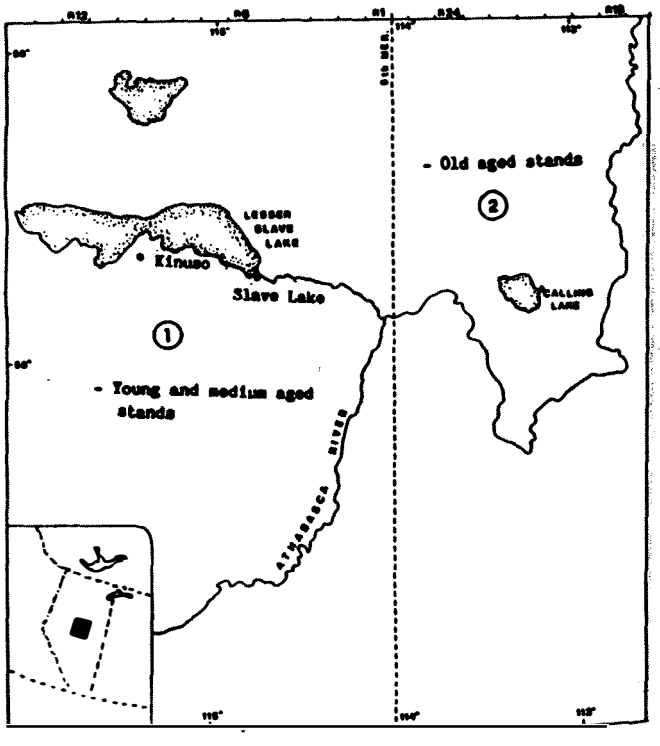

Figure 1. Approximate locations of study areas in Alberta.

on the other two blocks, stems and branches were removed (total harvesting).

Fieldwork

In the period August 11 to 22 1986, four circular $6m^2$ (r=1.38m) plots were established within each block to sample biomass of aspen suckers, other tree species, grasses, herbs, and shrubs. In each of the four plots, all suckers were harvested and the height (stem length) of the four tallest aspen suckers was measured to the nearest cm. The fresh weight of aspen suckers and other tree species (if present), was recorded to the nearest 2g.

A circular subplot of $1m^2$ (r=0.56m) was located within the plot. In this subplot all lesser vegetation was sheared and separated into 3 components: grasses, herbs, and shrubs, and weighed separately.

One of the four plots was chosen for sampling for dry weight determination. In this plot, all aspen suckers (stems and foliage), other tree species (if present), grasses, herbs, and shrubs were placed in labelled paper bags which were then placed in a large heavy-duty polythylene bag for transportation to the laboratory.

Laboratory Work

Oven-drying of all samples was done at the Northern Forestry Centre, Edmonton. The samples were dried at 70°C until constant weight. Dry weight was determined to the nearest 2g. The dry weight-to-fresh weight ratio was calculated for each component from each sample plot. This ratio was used to determine dry weight of biomass components for each plot in the block.

RESULTS AND DISCUSSIONS

Dry weight to fresh weight ratios

For aspen, the mean dry weight to fresh weight ratio of aspen was 0.472 and varied from 0.404 to 0.588. The mean ratio for grasses, shrubs, and herbs was 0.427, 0.338 and 0.329 respectively. Other tree species occurred sporadically in the plots. The mean ratios were alder (Alnus crispa (Ait.)) 0.410, willow (Salix spp.) 0.517, balsam poplar (Populus balsamifera L.) 0.456, birch (Betula papyrifera Marsh.) 0.417 and spruce (Picea spp.) 0.529 (Table 1).

Table 1. Dry weight/fresh weight ratios of aspen, other tree species, and lesser vegetation on the 2-year-old cutover aspen stands.

COMPONENT	N	MEAN	STANDARD DEVIATION	MIN. VALUE	MAX. VALUE
Aspen	12	0.472	0.051	0.404	0.588
Grasses	11	0.427	0.047	0.350	0.506
Herbs	11	0.329	0.058	0.250	0.455
Shrubs	12	0.338	0.057	0.240	0.440
Alder	1	0.410	0.000	0.410	0.410
Willow	1	0.517	0.000	0.517	0.517
B. Poplar	1	0.456	0.000	0.456	0.456
Birch	2	0.471	0.051	0.435	0.507
Spruce	1	0.529	0.000	0.529	0.529

Dominant height

Based on the four tallest trees in each plot, aspen suckers developed from old aged stands were the tallest (170 cm), while suckers derived from the young and medium aged stands were similar in height (135 and 138 cm respectively) (Table 2). The difference due to age was significant ($p \leq 0.01$), but no difference emerged from harvesting method. Bella and De Franceschi (1980) found that the dominant height averaged 170 cm for two-year-old fully stocked aspen regeneration sites (n=48) in Alberta and Saskatchewan.

Table 2. Dominant heights of 2-year-old aspen suckers on cutovers of three ages of aspen stands. (cm)

Logging Method		AGE OF PREVIOUS STAND		
		YOUNG	MEDIUM	OLD
TOTAL (stems and branches)	mean	145	137	167
	st.d	22	18	20
	min.	111	108	125
	max.	169	167	185
	n	8	8	8
CONVENTIONAL (stems only)	mean	126	139	173
	st.d	23	19	47
	min.	102	100	111
	max.	175	162	259
	n	8	8	8
mean		135	138	170

Aspen dry weight biomass

Aspen biomass differed significantly ($p \leq 0.01$) among sucker stands developing from different ages of previous stands but did not differ significantly with harvesting method. Young stands produced the highest aspen sucker biomass (2258 kg/ha), followed by old stands (1888 kg/ha). Medium aged stands were the poorest (911 kg/ha) (Table 3). Bella and De Franceschi (1980) reported that the dry weight biomass of fully stocked 2-year-old aspen stands ranged from 6,648 to 7,460 kg/ha corresponding to densities of 160,000 to 280,000 stems per ha. The aspen biomass in the present study ranged from 312 to 4,730 kg/ha (see Table 3). A northern Minnesota two-year-old aspen sucker stand after whole tree harvesting contained 3,900 kg/ha of total biomass

(Silkworth and Grigal 1982).

Table 3. Total Dry weight biomass of 2-year-old aspen suckers from cutovers. (kg/ha)

Logging Method		AGE CLASS OF PREVIOUS STAND		
		YOUNG	MEDIUM	OLD
TOTAL (stems and branches)	mean	2437.3	916.0	2150.4
	st.d	1263.2	355.6	715.5
	min.	1153.3	318.3	1320.0
	max.	4730.0	1445.0	3220.0
	n	8	8	8
CONVENTIONAL (stems only)	mean	2079.7	905.8	1626.6
	st.d	1027.6	336.2	610.4
	min.	961.6	311.6	641.6
	max.	4265.0	1336.6	2471.6
	n	8	8	8
mean		2258.5	910.9	1888.5

Other tree species

This group includes alder, willow, birch, balsam poplar, white and black spruce. These species occur sporadically at low levels and therefore were combined in the analysis (Table 4). Neither original stand age nor harvesting method had a significant effect on biomass of other tree species. Alder occurred in old age stands but not in young stands; willow, birch, white and black spruce on the other hand, were found in the young stands. Balsam poplar, was found in all age groups. The occurrence of some tree species in one age class and not the others suggests that there are site differences that affect biomass regardless of age of the previous stand.

Grasses

Plots located in medium aged stands that were harvested by removing stems and branches, had the highest amount of grass biomass while young aged stands that were harvested by removing stems and branches had the lowest amount (Table 5). Age ($p < 0.01$) and age x harvesting method ($p \leq 0.05$)

Table 4. Biomass statistics of other tree species -alder, willow, birch, balsam poplar and spruce from the 2-year-old cutover aspen stands. (kg/ha)

Logging method		AGE CLASS OF PREVIOUS STAND		
		YOUNG	MEDIUM	OLD
TOTAL (stems and branches)	mean	692.9	1.5	37.2
	st.d	43.5	4.1	62.7
	min.	0.0	0.0	0.0
	max.	4620.0	11.6	185.0
	n	8	8	8

Table 4 cont'd.

CONVENTIONAL (stems only)	mean	29.5	64.1	52.9
	st.d	43.5	101.2	77.8
	min.	0.0	0.0	0.0
	max.	123.3	276.6	233.3
	n	8	8	8
mean		356.2	32.8	45.1

were significant. The significance of the interaction term implies that grass depends on local conditions as well as age. Overall, old stands had more grass biomass. The great plot range and grass biomass seemed to be affected by local conditions. At low sucker density, grasses were abundant. Occurance of grasses and other lesser vegetation depends on the forest type and site condition.

Table 5. Dry weight biomass of grasses from the 2-year-old cutover aspen stands. (kg/ha)

Logging method		AGE CLASS OF PREVIOUS STAND		
		YOUNG	MEDIUM	OLD
TOTAL (stems and branches)	mean	55.0	672.5	468.7
	st.d	70.5	300.8	356.9
	min.	0.0	0.0	80.0
	max.	220.0	920.0	1150.0
	n	8	8	8
COVENTIONAL (stems only)	mean	231.2	352.5	575.0
	st.d	135.2	219.5	372.0
	min.	10.0	30.0	150.0
	max.	370.0	700.0	1340.0
	n	8	8	8
mean		143.1	512.5	521.8

Shrubs and herbs

The common herbs and shrubs were: prickly rose (Rosa acicularis Lindl.), bunchberry (Cornus canadensis L.), fireweed (Epilobium augustifolium L.), northern bedstraw (Galium borealis L.), Sarsaparilla (Aralia nudicaulis L.), low bush cranberry (Viburnum edule(Michx.) Raf.), dwarf raspberry (Rubus pubescens Raf.), wild lily-of-the-valley (Maianthemum canadense Desf.), yellow peavine (Lathyrus achroleucus Hook.), violet (Viola spp.), Canada honeysuckle (Lonicera involucrata (Richards). Banks), wild red raspberry (Rubus idaeus L.), one-sided wintergreen (Pyrola secunda L.), bishop's cap (Mitella nuda L.), twinflower (Linnaea borealis L.), star-flower (Trientalis borealis Raf.), and aster (Aster spp.). The small quantities of shrubs and herbs were combined into one category (Table 6). Cutovers resulting from medium aged stands had the highest amount (934 kg/ha), and cutovers from young stands had the least (601 kg/ha). Age was, statistically, not significant ($p \leq 0.05$).

Table 6. Dry weight biomass of shrubs and herbs from the 2-year-old cutovers. (kg/ha)

Logging methods		AGE CLASS OF PREVIOUS STAND		
		YOUNG	MEDIUM	OLD
TOTAL (stems and branches)	mean	655.0	758.7	695.0
	st.d	305.2	416.3	329.2
	min.	190.0	180.0	200.0
	max.	1110.0	1620.0	1320.0
	n	8	8	8
CONVENTIONAL (stems only)	mean	546.2	1105.0	908.7
	st.d	328.3	476.5	368.2
	min.	110.0	530.0	380.0
	max.	950.0	1860.0	1600.0
	n	8	8	8
mean		600.6	931.8	801.8

Total above ground biomass

Age of previous stand is a significant ($p < 0.05$) factor in total dry weight of above-ground biomass. The young and old aged stands had higher amount of total above ground biomass than the medium aged stands (Table 7). Harvesting method however, is not a significant factor in terms of biomass productivity. Aspen biomass was higher in young and old stands than in medium aged stands. The young stands were higher in biomass of other tree species but lower in grass biomass while the medium and old stands had similar amounts of other species, herbs and shrubs, and grasses (Table 8). In the overall breakdown of total biomass components, 56% was aspen, 5% other tree species, 26% herbs and shrubs, and 14% grasses (Figure 2).

Table 7. Dry weight biomass from the 2-year-old cutovers. (kg/ha)

Logging methods		AGE CLASS OF PREVIOUS STAND		
		YOUNG	MEDIUM	OLD
TOTAL (stems and branches)	mean	3840.2	2348.7	3352.4
	st.d	1687.8	201.5	1127.8
	min.	1960.0	2020.0	2110.0
	max.	6903.3	2580.0	5280.0
	n	8	8	8
CONVENTIONAL (stems only)	mean	2876.8	2427.5	3163.3
	st.d	919.7	566.7	1050.6
	min.	2070.0	1736.6	1868.3
	max.	4815.0	3240.0	4963.3
	n	8	8	8
mean		3358.5	2388.1	3257.4

Site differences

Site difference must be considered as the reason for variation in biomass productivity, The young and medium aged stands are located near Slave Lake whereas the old stands are found near Calling Lake, a distance of 300 km apart. The two sites are quite different in terms of soil and precipitation. Soils at Slave Lake are clay whereas the Calling Lake soils are coarser textured, i.e. sandy loam and loam. The Slave Lake site has higher precipitation and is about 100m higher in elevation than the Calling Lake site.

Table 8. Total biomass by component (combined harvesting methods) on the cutovers. (kg/ha)

COMPONENT	AGE CLASS OF PREVIOUS STAND			
	YOUNG	MEDIUM	OLD	mean
Aspen	2258.5	910.9	1888.5	1685.9
Other spp.	356.2	32.8	45.1	144.7
Herbs and shrubs	600.6	931.8	801.8	778.1
Grasses	143.1	512.5	521.8	392.5
Total	3358.5	2388.1	3257.4	3001.2

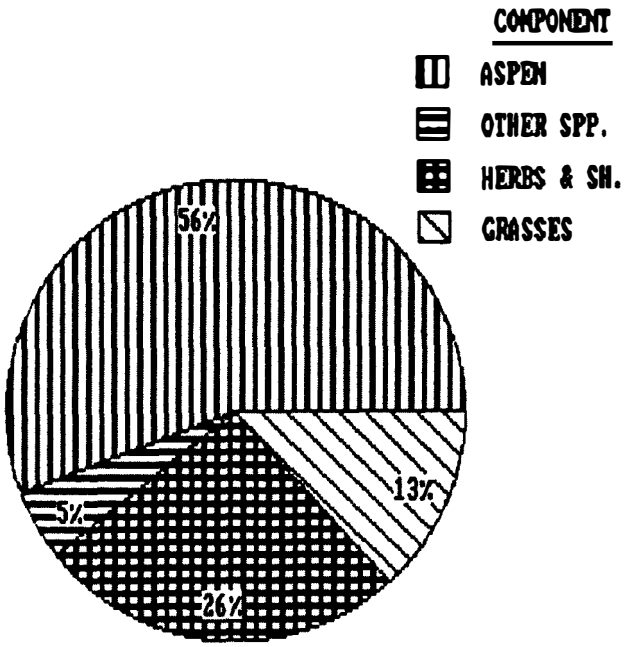

Figure 2. Total biomass by component (combined age and harvesting methods)

CONCLUSION AND RECOMMENDATIONS

Age of previous stand affects the biomass of aspen suckers as well as total biomass. Biomass however, does not appear to be related to harvesting method. It is suspected though, that site quality is the main factor in determining biomass productivity of cutover aspen stands.

It is recommended that the stands be sampled again in 5 years' time. This further work is necessary to determine the rate of increase in aspen biomass and to see if the undergrowth will change significantly as the stand develops. The factor of age of parent stand may become more pronounced as the stand matures.

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