Foothills Growth and Yield Association

Interim Technical Note

Effects of trembling aspen on lodgepole pine growth

August 2008

Background

Trembling aspen (*Populus tremuloides*) is considered to be a potentially serious competitor in regenerating lodgepole pine stands and is common in such stands in western Alberta. Aspen has more rapid height growth than lodgepole pine on most sites, and when present in sufficient density it casts sufficient shade to seriously impact on the growth of shade intolerant lodgepole pine. When present at low densities, aspen may contribute to the productivity of pine forests through its influences on nutrient cycling and other factors. As a result, an understanding of the influence of aspen abundance on pine growth is needed to serve as a basis for the management of this species within lodgepole pine stands. In addition, development of growth and yield models for mixtures of aspen and lodgepole pine requires data on the development of mixed stands of these two species.

The objective of this study is to develop models for estimating effects of amount of aspen on growth of lodgepole pine. Specific questions to be addressed include:

- How serious are the effects of aspen and what are threshold densities?
- Are effects similar in the Upper foothills and lower foothills?
- What variables (and competition indexes) are useful for modeling competitive effects?

Methods

During 2006 and 2007 a total of 18 installations were established in 6 FMA's. As shown in Table 1, a total of 6 installations were located in each of the three selected age classes (10-20, 20-30, and 30-40 years old). For comparison between the lower and upper foothills ecological subregions, 9 installations (3 in each age class) were located in each subregion.

Within each installation 6 sample plots (9.77 m radius) were established across gradient from lowest to highest aspen density. Within each sample plot 12 "SUBJECT" pine were selected as the focal trees and all trees measured and their location mapped. These data are being used to calculate various measures of aspen competition. Three installations in each age class were selected for destructive sample to determine diameter growth of the pine. In these 9 installations, pine subject trees (and a sample of aspen) were cut and cookies measured to determine diameter increment pine in 3 plots.

Table 1. EMLP2 installations overview information.

Age Class	Installation	FMA	Location	Date Measured	Natural Subregion	Ecological Description	Destructive Plots
10-20	2-008-0462	HWP	Emerson Rd km 80	15-Jan-06	LF	E 4 C	2, 4, 6
10-20	2-009-0048	HWP	Swansons South Rd km 72.5	1-Jan-06	UF	E 5 C	2, 4, 6
10-20	2-008-0443	HWP	Emerson Rd km 83	15-May-06	LF	E 5 C	
10-20	68130046	WCG	Calahoo Rd km 31	5-Jun-06 / 18-Jan-06	UF	C 5 C	2, 3, 6
10-20	S19904	CFG	4123 km RHS		UF	F 5 D	
10-20	ER 129-418	MWW	Eagle Tower Rd km 7.6	30-Jan-07	LF	C 4 C	
20-30	2-007-0596	HWP	Emerson Rd km 86	23-Jan-06	LF	D 6 B	
20-30	120	SDA	Sundance Rd km 60.1	15-Feb-06	UF	E 5 C	2, 4, 6
20-30	121	SDA	Sundance Rd km 60.3	10-Feb-06	UF	E 5 C	2, 4, 6
20-30	2-009-0060	HWP	Emerson Rd km 73	25-May-06	UF	C 3 C	
20-30	65070015	WCG	3.0 km W on Weyco Main from Bald Mtn Rd Junction	10-Jan-07	LF	C 5 C	
20-30	3-003-025A	HWP	3-3-102 Rd, 1.0 km past Erith bridge, RHS	Jan-07	LF	C 4 C	2, 4, 6
30-40	55	SDA	Sundance Rd km 61	5-Feb-06	UF	D 5 B	2, 4, 6
30-40	65070016	WCG	3.0 km W on Weyco Main from Bald Mtn Rd Junction	15-Jan-07	LF	C 4 C	
30-40	3-003-0011	HWP	Sundance Rd km 21.5, RHS 0.2 km	15-Nov-06	UF	C 4 C	
30-40	OG3-8-604	MWW	Goose km 57 (approx) 1 km SW of bridge	Feb, Mar-07	LF	F 6 D	2, 4, 6
30-40	1970	SLS	Hwy 68, S of Jumpingpound Demo Forest	Feb-07	LF	E 5 C	2, 4, 6
30-40	4-006-0682	HWP	Prest Creek Rd km	17-Jan-07	UF	D 6 B	

Results

Initial analysis of plot level results indicates that stems/ha is the best competition index for explaining variation in height growth, while Stand Density Index[1] (SDI) and basal area/ha work best for estimating pine diameter growth (Table 2). Crown length was found to be a useful variable for explaining variation in growth and is used in combination with basal area or other competition measures.

Table 2. Comparison of R^2 values for various competition Indexes (9.77 m radius plot level).
MODEL I=a * CLb*e (d*BAaw+f*BApl+g*BAs)
CLb=crown length of pine, BAaw=aspen basal area, BApl=lodgepole pine basal area, BAs=spruce basal area.

Dependent variable	**CI**	**LF**	**UF**
Height increment	TPH	0.360	0.372
	BAHA	0.309	0.330
	HR*BAHA	0.325	0.360
	SDI	0.323	0.326
	HR*SDI	0.335	0.326
	SAMPLE SIZE	626	626
Diameter increment	TPH	0.333	0.164
	BAHA	0.752	0.471
	HR*BAHA	0.675	0.455
	SDI	0.759	0.430
	HR*SDI	0.678	0.430
	SAMPLE SIZE	138	175

Highlighted cells indicate the best competition indexes for explaining variation in pine growth.

Table 3. Models for lodgepole pine diameter and height increment for Lower Foothills (LF) and Upper Foothills (UF). Model: I=a * CLb*e (d*BAaw+f*BApl+g*BAs)

		Diameter increment		**Height increment**	
Parameter	**Indep variable**	**LF**	**UF**	**LF**	**UF**
a		0.097	0.1152	0.2493	0.2592
b	CL	0.488	0.5375	0.4119	0.3154
d	BA-Aw	-0.04319	-0.00718	-0.00244	-0.00516
f	BA-Pl	-0.05838	-0.0709	-0.00701	-0.00026
g	BA-Spruce	-0.04864	-0.399	-0.1381	-0.0305
n		138	175	626	626
R^2adj		0.752	0.471	0.309	0.33

Highlighted cells indicate where parameter values are non-significant

Results shown in table 3 and figure 1 indicate that aspen is having a significant negative influence on pine diameter in both the UF and LF, but aspen is more competitive (value of parameter d is bigger) in the LF than in the UF. Competing pine are also significantly reducing diameter growth and the effect is stronger in the UF than in the LF and pine is having more competitive effect per unit basal area than aspen.

[1] SDI is a measure of the degree to which a stand is occupied by trees, taking into account both their number and size

Spruce basal area is negatively correlated with pine growth. This may be reflecting spruce effects on soil temperature, however other factors may also be involved.

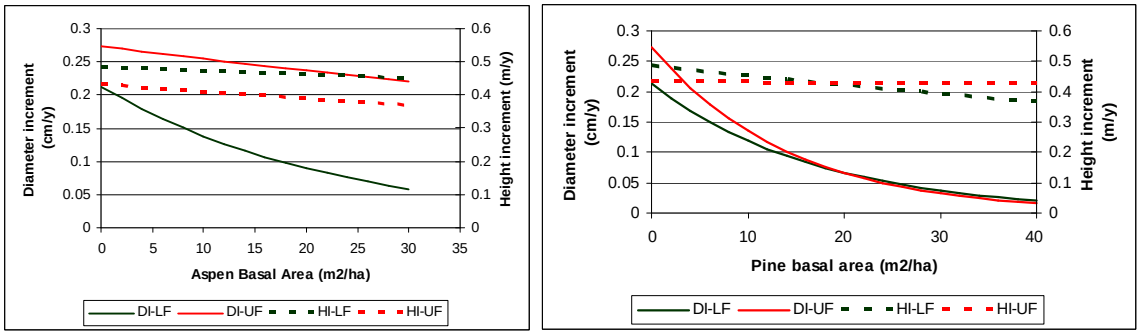

Figure 1. Illustration of aspen and pine effects on diameter and height increment. Lines shown are based on models described in table 2.

Discussion

Preliminary results suggest that competitive effects of aspen and pine on pine growth can be estimated using basal area or other simple competition measurements. The addition of crown length to the models substantial improves their ability to estimate growth rates.

Aspen competition appears to be having stronger effects on pine diameter growth in the lower foothills than the upper foothills. Results also suggest that intraspecific competition from other pine in the plot has a stronger effect on diameter growth than does aspen competition.

Analysis of data from this study is underway and will include separation of the effects of competitors that are taller and shorter than the subject tree, comparison of distance dependant and distance-independent competition indexes, and plot size effects.

If you have comments or questions regarding this note, or would like more information, please contact: Phil Comeau, Dept. of Renewable Resources, Univ. of Alberta; email: phil.comeau@ualberta.ca; phone: 780-492-1879.

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