Competitive effects and equivalence of woody and herbaceous vegetation in a young boreal mixed stand

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Background

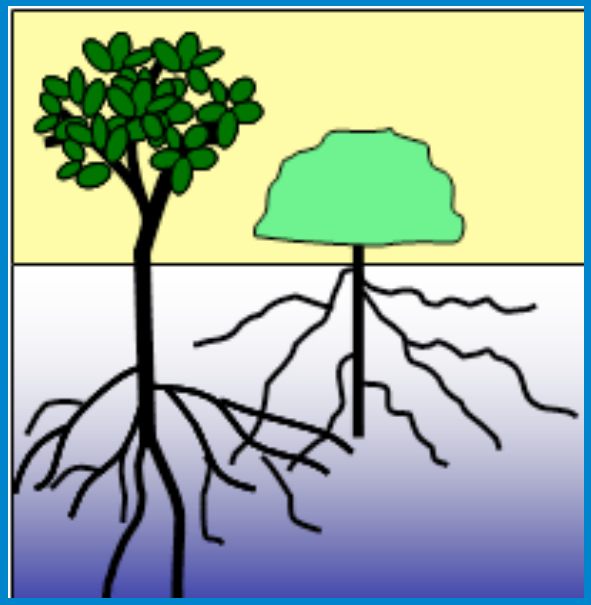
Competition – Aspen and Bluejoint (Calamagrostis canadensis)

(1) Light

(2) Water, nutrient

(3) Space

(4) Physical (vegetation press)



Background

- Facilitation effects of aspen

  (1) Reduce spring and summer frost

  (2) Reduce winter injury

  (3) Reduce bluejoint grass

Objectives

(1) Examine treatment effects on spruce growth

(2) Examine whether woody plants and bluejoint grass have the same competitive effects on spruce growth

(3) Examine whether competitive effects of woody plants and bluejoint grass on spruce growth change year to year

Experimental design

Study site

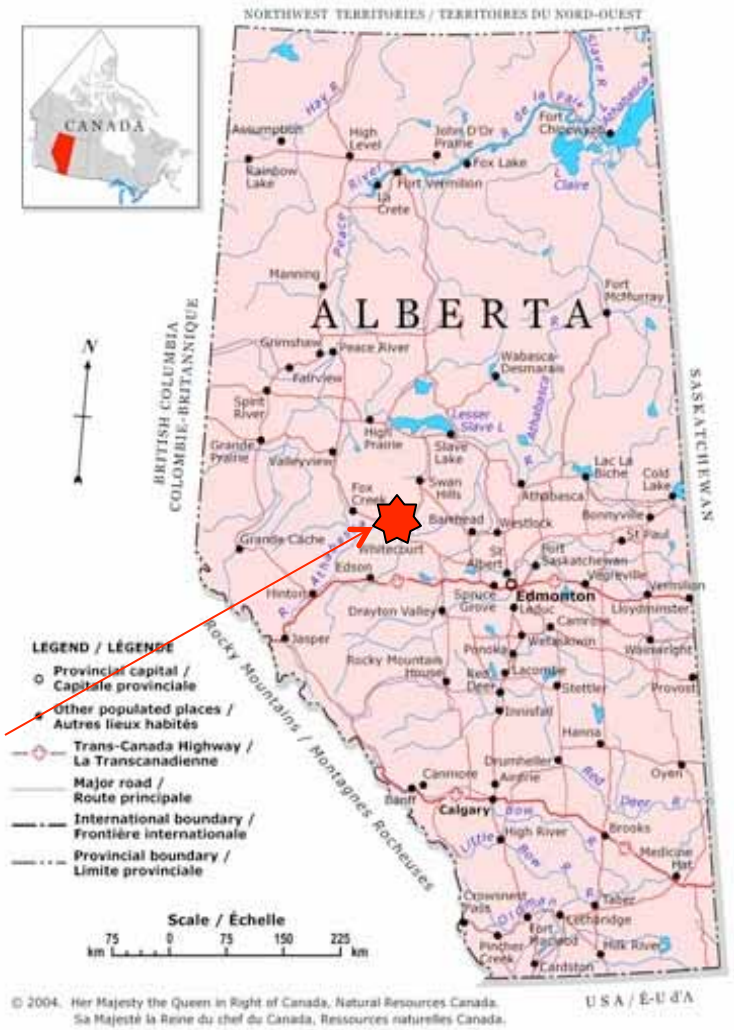
(1) Judy Creek long term mixedwood study, 30 km northeast of Whitecourt, Alberta

(2) Planted with 2+0 PSB 412 white spruce container stock in 2003

(3) Soil: luvisols, mesic and fine-texture

(4) Aspen cover: 2%-15%, 44,000 to 140,000 stem per hector

(5) Calamagrostis cover : 0.2% to 2%



Experimental Design

Treatments

- Complete vegetation control (broadcast and 2 m radius spot)
- Woody vegetation control (broadcast and 2 m radius spot)
- Herbaceous control (broadcast)
- Control (untreated)

Complete vegetation control treatment

Broadcast complete control (BCC)

2 years radial complete control (RCC2)

4 years radial complete control (RCC4)

Woody vegetation control treatment

Broadcast woody control (BWC)

Radial woody control (RWC)

Herbaceous vegetation Control

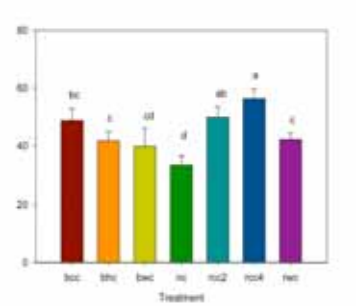
Broadcast herbaceous control
(BHC)

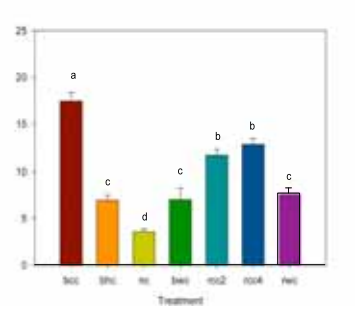
Control

No control (NC)

Results

The vegetation control treatments have significant effects on spruce height and diameter growth. At the end of the fifth growing season, treatment effects on both height and diameter increment were significant between treated and untreated ($p<0.0001$), radial and broadcast ($p<0.0001$), woody and complete control ($p<0.0001$).





Result

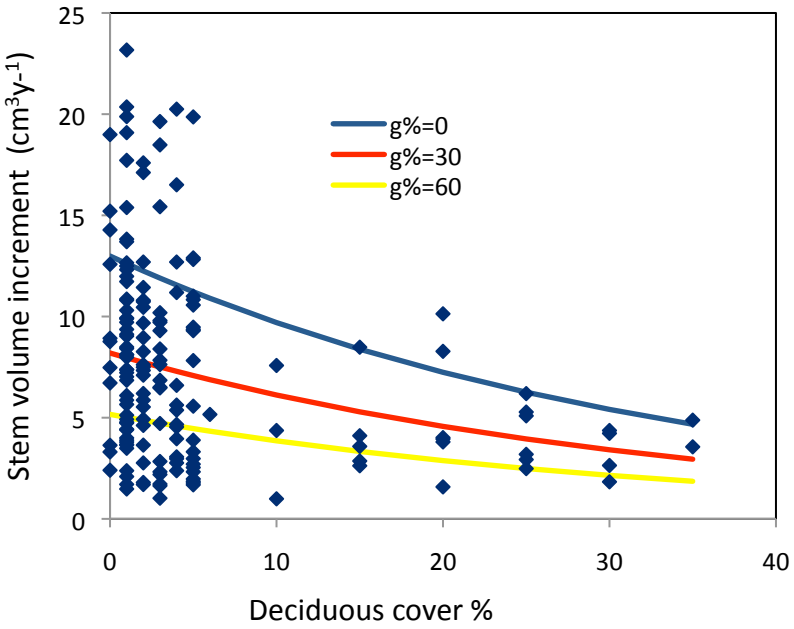


Figure 1. Relationship between stem volume increment of white spruce in 2004(vinc) and deciduous cover. Lines are shown for three levels (0, 30 and 60%) of grass cover (g%) for the equation: ln(vinc)=0.9808-0.0292*dec %-0.0154*grass%+1.0427*ln(ht2003); n=167R^2_{adj} =0.25,MSE=0.3706, height 2003 (ht2003) was set to 18cm for the lines shown.

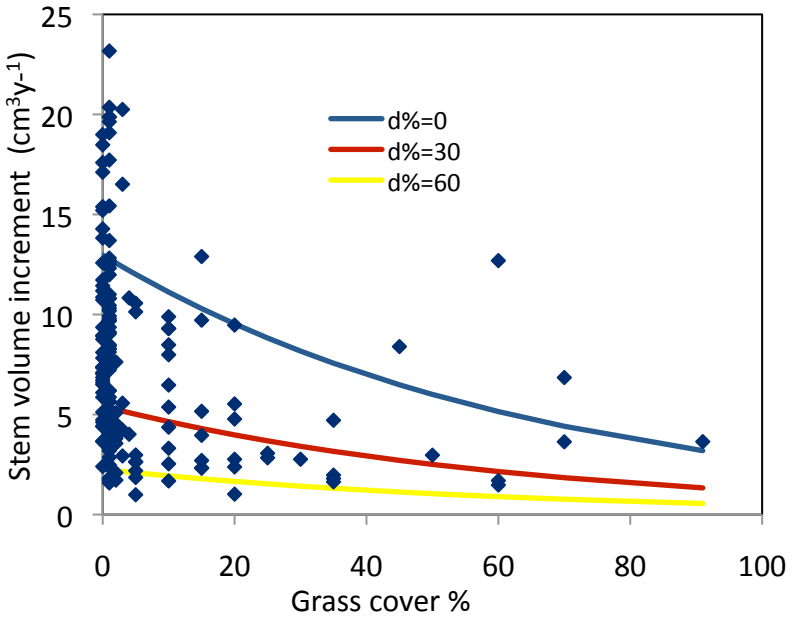


Figure 2. Relationship between stem volume increment of white spruce in 2004(vinc) and grass cover. Lines are shown for three levels (0, 30 and 60%) of deciuous cover (d%) for the equation: ln(vinc)=0.9808-0.0292*dec%-0.0154*grass% +1.0427*ln(ht2003); n=167R^2_{adj} =0.25,MSE=0.3706, height 2003 (ht2003) was set to 18cm for the lines shown.

Result

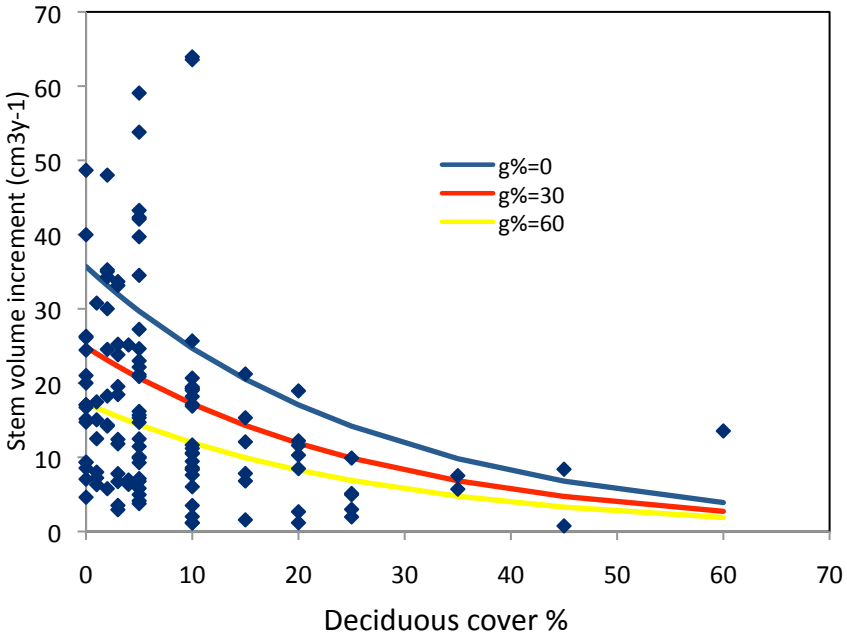


Figure 3. Relationship between stem volume increment of white spruce in 2005(vinc) and deciduous cover. Lines are shown for three levels (0, 30 and 60%) of grass cover (g%) for the equation: ln(vinc)=-2.3172-0.03690*dec%-0.0121*grass% +1.5976*ln(ht2004); n=125, R^2_{adj}=0.29,MSE=0.5655, height 2003 (ht2003) was set to 30cm for the lines shown.

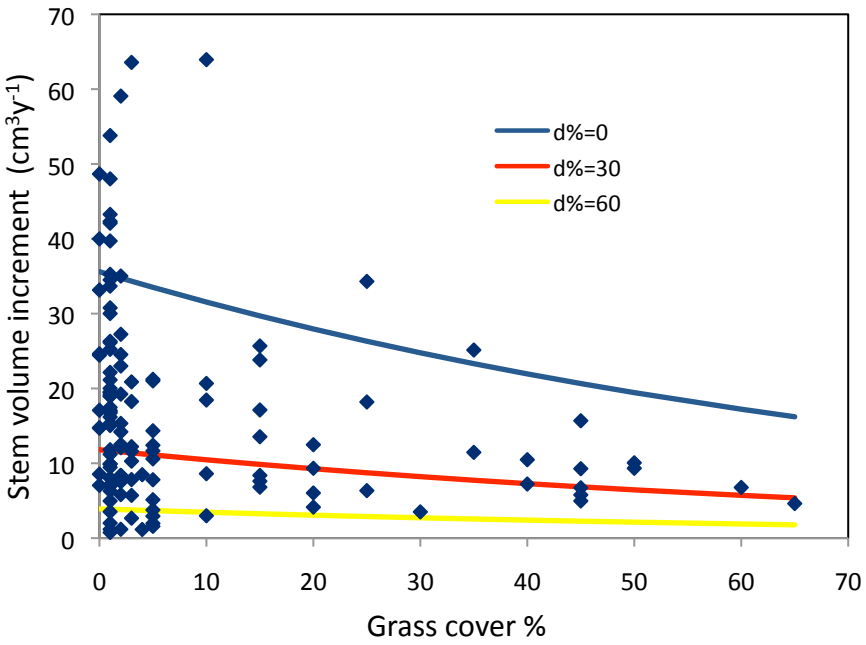


Figure 4. Relationship between stem volume increment of white spruce in 2005(vinc) and deciduous cover. Lines are shown for three levels (0, 30 and 60%) of grass cover (g%) for the equation: ln(vinc)=-2.3172-0.03690*dec%-0.0121*grass% +1.5976*ln(ht2004); n=125, R^2_{adj}=0.29,MSE=0.5655, height 2003 (ht2003) was set to 30 cm for the lines shown.

Result

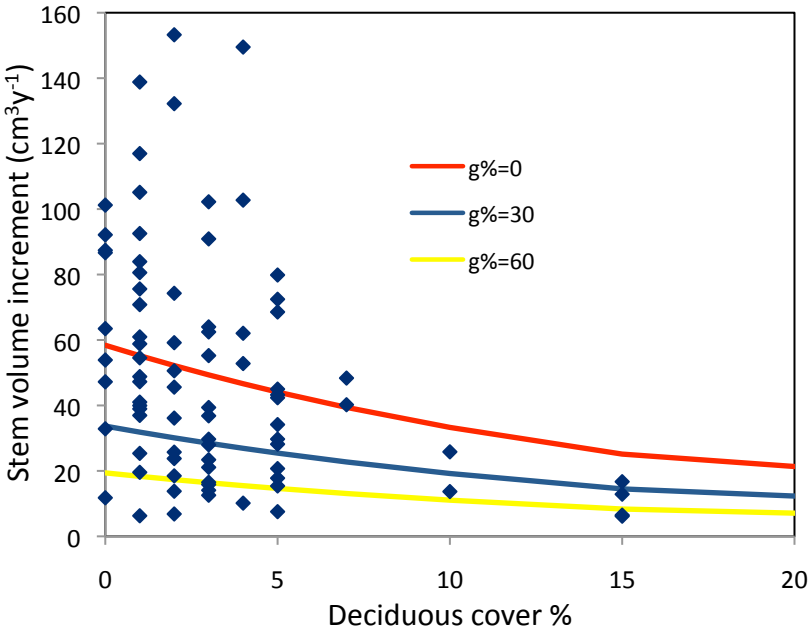


Figure 5. Relationship between stem volume increment of white spruce in 2006(vinc) and deciduous cover. Lines are shown for three levels (0, 30 and 60%) of grass cover (g%) for the equation: ln(vinc)=-3.7233-0.0562*dec%-0.0184*grass% +2.1124*ln(ht2005); n=83, R^2_{adj} =0.56,MSE=0.2940, height 2005(ht2005) was set to 40cm for the lines shown.

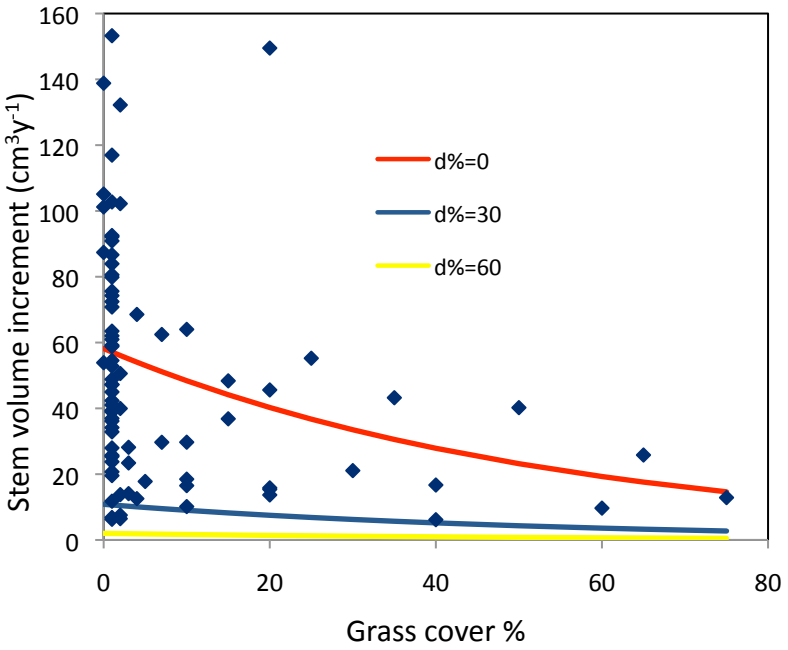


Figure 6. Relationship between stem volume increment of white spruce in 2006(vinc) and deciduous cover. Lines are shown for three levels (0, 30 and 60%) of grass cover (g%) for the equation: ln(vinc)=-3.7233-0.0562*dec%-0.0184*grass% +2.1124*ln(ht2005); n=83, R^2_{adj} =0.56,MSE=0.2940, height 2005(ht2005) was set to 40cm for the lines shown.

Result

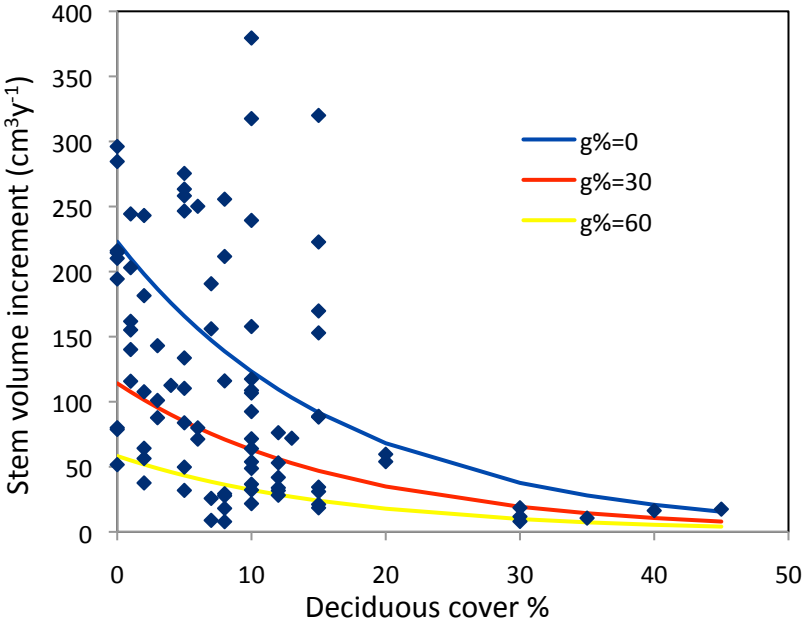


Figure 7. Relationship between stem volume increment of white spruce in 2007(vinc) and deciduous cover. Lines are shown for three levels (0, 30 and 60%) of grass cover (g%) for the equation: ln(vinc)=-3.7955-0.0593*dec %-0.0224*grass%+2.2482*ln(ht2006); n=89 R^2_{adj} =0.68 MSE=0.3151, height 2006 (ht2006) was set to 60cm for the lines shown.

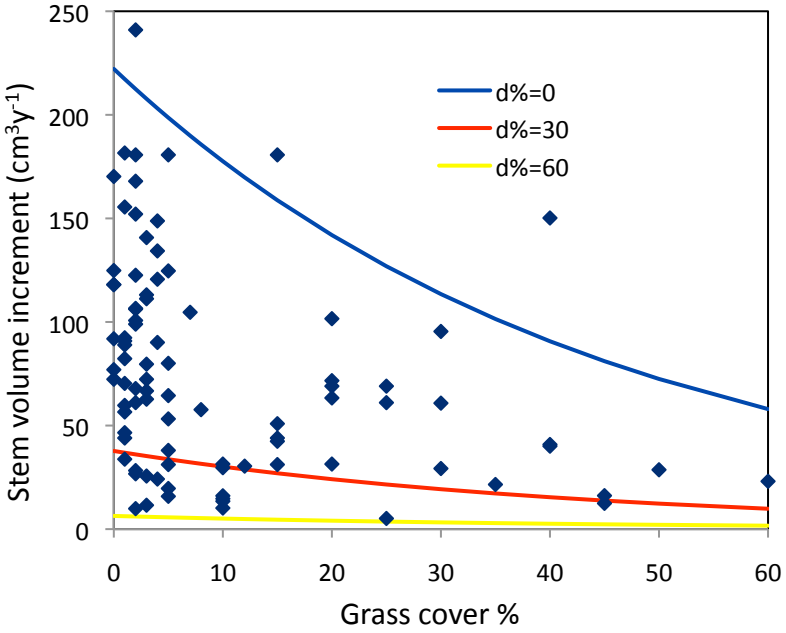


Figure 8. Relationship between stem volume increment of white spruce in 2007(vinc) and grass cover. Lines are shown for three levels (0, 30 and 60%) of deciuous cover (d%) for the equation: ln(vinc)=-3.7955-0.0593*dec%-0.0224*grass% +2.2482*ln(ht2006); n=89 R^2_{adj} =0.68 MSE=0.3151, height 2006 (ht2006) was set to 60cm for the lines shown.

Result

Woody and herbaceous vegetation differ in their competitive effects, woody vegetation showed stronger competitive effects on spruce growth than herbaceous vegetation in 2005, 2006 and 2007, but equivalent with herbaceous vegetation in 2004

Year	Obs #	Adj R^2	MSE	a	b1	b2	c
2004	167	0.25	0.3706	-0.9808	-0.0292	-0.0154	1.0427
2005	125	0.29	0.5655	-2.3172	-0.0368	-0.0121	1.5976
2006	83	0.56	0.2940	-3.7233	-0.0562	-0.0184	2.1124
2007	89	0.68	0.3151	-3.7955	-0.0593	-0.0224	2.2482

Table 1. Parameter values and statistical information for models between white spruce volume increment and woody and herbaceous cover from 2004 to 2007. The relationship is ln(vinc)=a+b1*dec%+b2*grass%+c*lnht. Vinc is spruce volume increment, dec% is woody vegetation coverage, grass% is grass coverage, ht is the initial height of spruce (at the beginning of the year).

Result

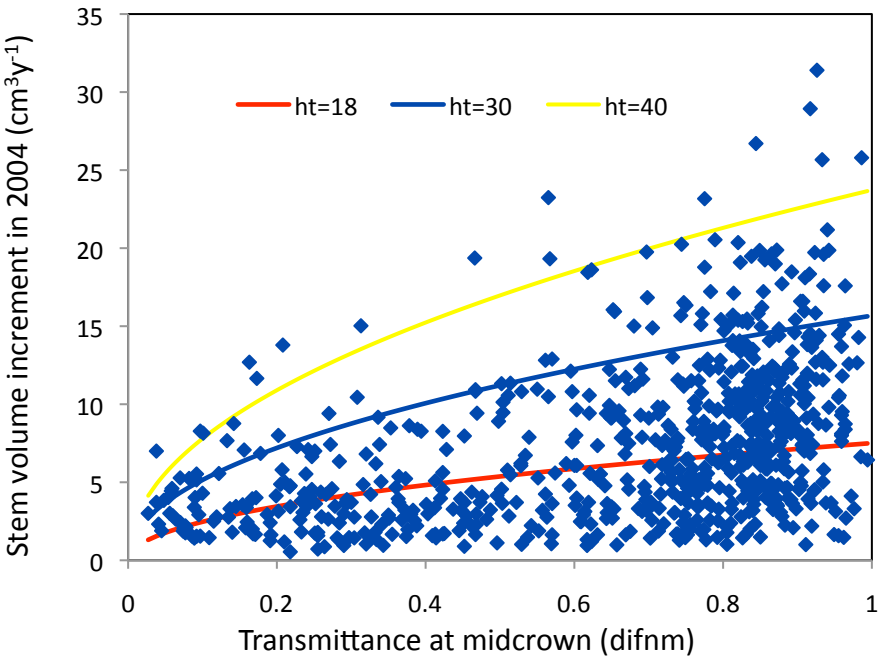


Figure 9. Relationship between stem volume increment of white spruce in 2004(vinc) and transmittance at spruce middle crown level(difnm). Lines are shown for three levels of initial spruce height (ht=18, 30 and 40) for the equation: ln(vinc)=-2.1481+0.4835*difnm+1.4407*lnht ; n=719 R^2_{adj} =0.30 MSE=0.3869

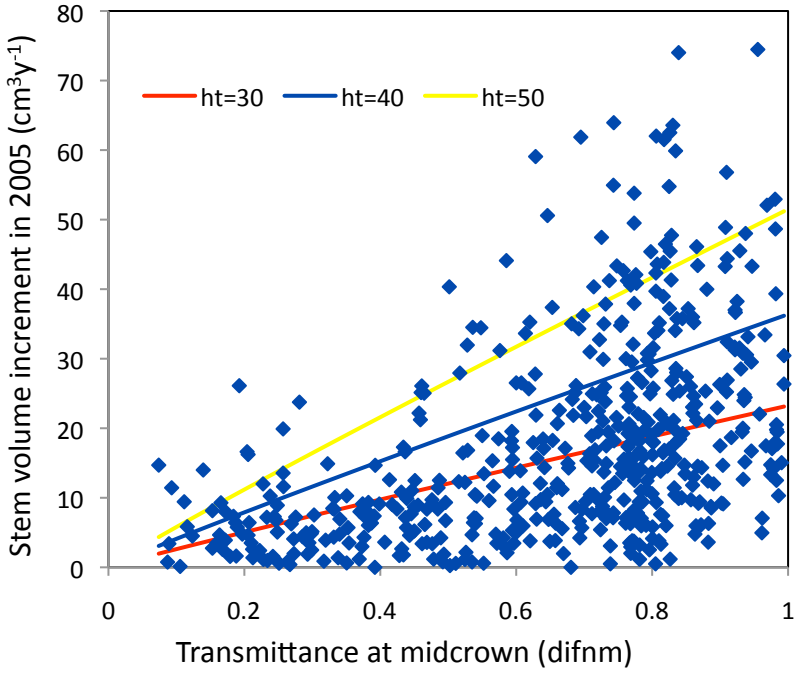


Figure 10. Relationship between stem volume increment of white spruce in 2005(vinc) and transmittance at spruce middle crown level(difnm). Lines are shown for three levels of initial spruce height (ht=30, 40 and 50) for the equation: ln(vinc)=-2.1483+0.9489*difnm+1.5567*lnht ; n=521,R^2_{adj} =0.34,MSE=0.3869

Result

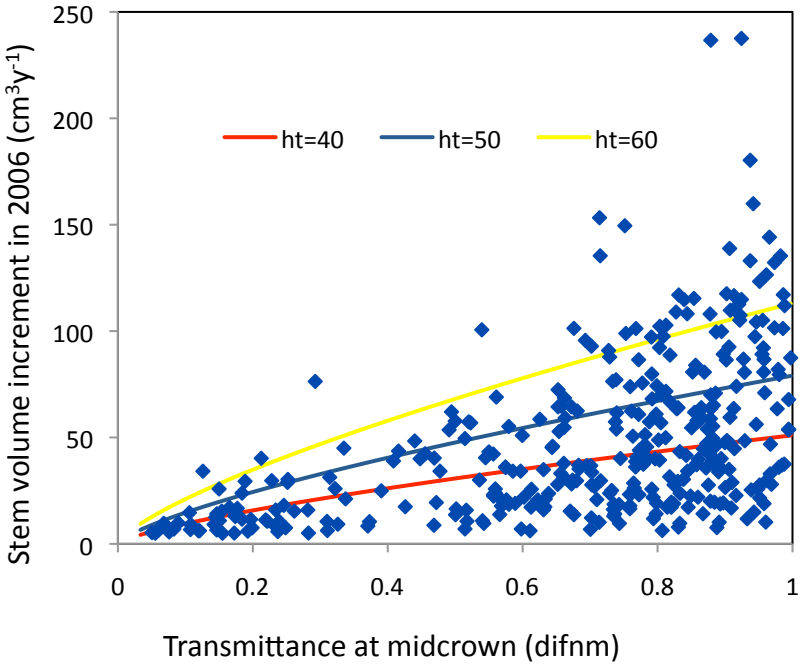


Figure 11. Relationship between stem volume increment of white spruce in 2006(vinc) and transmittance at spruce middle crown level(difnm). Lines are shown for three levels of initial spruce height (40, 50 and 60) for the equation: ln(vinc)=-3.3096+0.7314*difnm+1.9632*lnht ; n=360,R^2_{adj} =0.58,MSE=0.3118

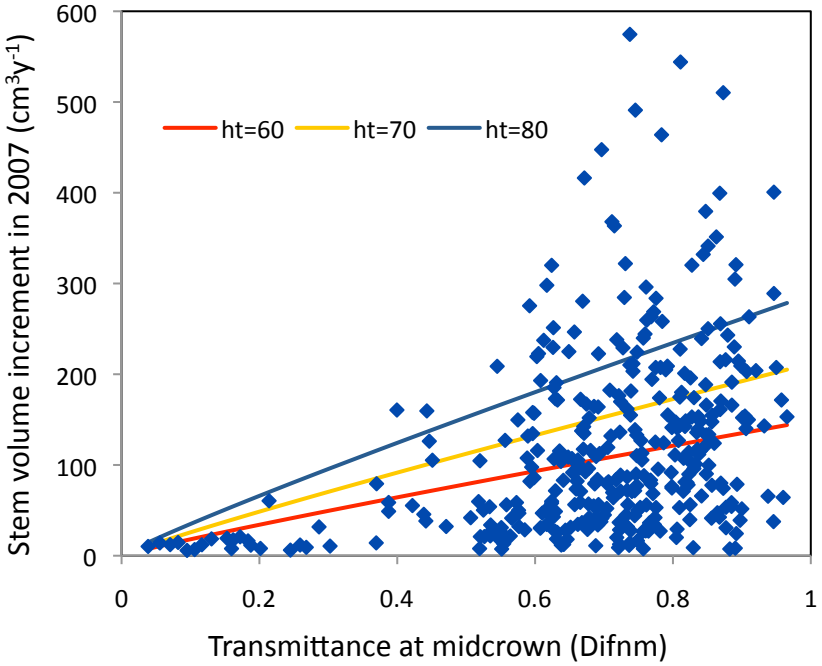


Figure 12. Relationship between stem volume increment of white spruce in 2007(vinc) and transmittance at spruce middle crown level(difnm). Lines are shown for three levels of initial spruce height (60, 70 and 80) for the equation: ln(vinc)=-4.3851+0.9149*difnm+2.2927*lnht ; n=352R^2_{adj} =0.50,MSE=0.5056

Result

The relationships between spruce growth and competition are not the same every year. The competitive relationships of 2004 is different from 2007.

Year	Obs#	Adj R^2	MSE	a	b	c
2004	719	0.30	0.3869	-2.1481	0.4835	1.4407
2005	521	0.34	0.6830	-2.1483	0.9489	1.5567
2006	360	0.58	0.3118	-3.3096	0.7314	1.9632
2007	352	0.50	0.5056	-4.3851	0.9149	2.2927

Table 2. Parameter values and statistical information for models between white spruce volume increment and spruce middle crown light availability (DIFN) from 2004 to 2007. The relationship is ln(vinc)=a +b1*difnm+c*lnht. Vinc is spruce volume increment, difnm is light availability at spruce middle crown level, ht is the initial height of spruce (at the beginning of the year).

Conclusion

- Control of only woody or herbaceous vegetation results in little improvement in spruce growth, control of both components in the young plantation provided significant improvement in spruce growth. 2-m radius complete control can be an effective option in promoting spruce growth in the early stages.
- Aspen is generally more competitive than grass (for any given level of cover), but when the grass cover is high its effects can be substantial.
- Competitive relationship vary annually, growth of competing aspen, changes in resource availability and climate variability may cause this variation.

Acknowledgement

- Blue Ridge Lumber, Western Fraser Timber, Canadian Forest Service, NSERC, MWMA, AFPA, WESBOGY

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