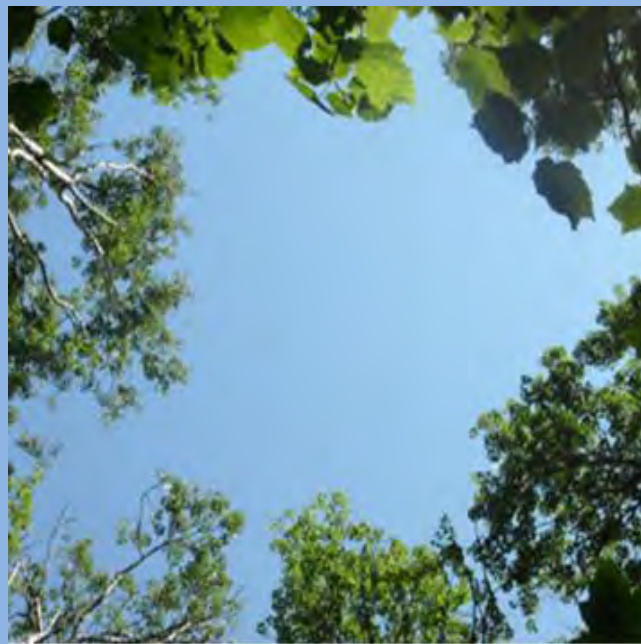


Sapling recruitment and mortality of residual stems (saplings and trees) after partial cuttings in the boreal mixedwood forest of eastern Canada

Arun Bose, Brian Harvey and Suzanne Brais



Why Partial cutting in the Canadian boreal?

Forest Ecosystem Management



Photo: Brian Harvey

Maintaining viable populations

Ecosystem representation

Maintaining ecological process

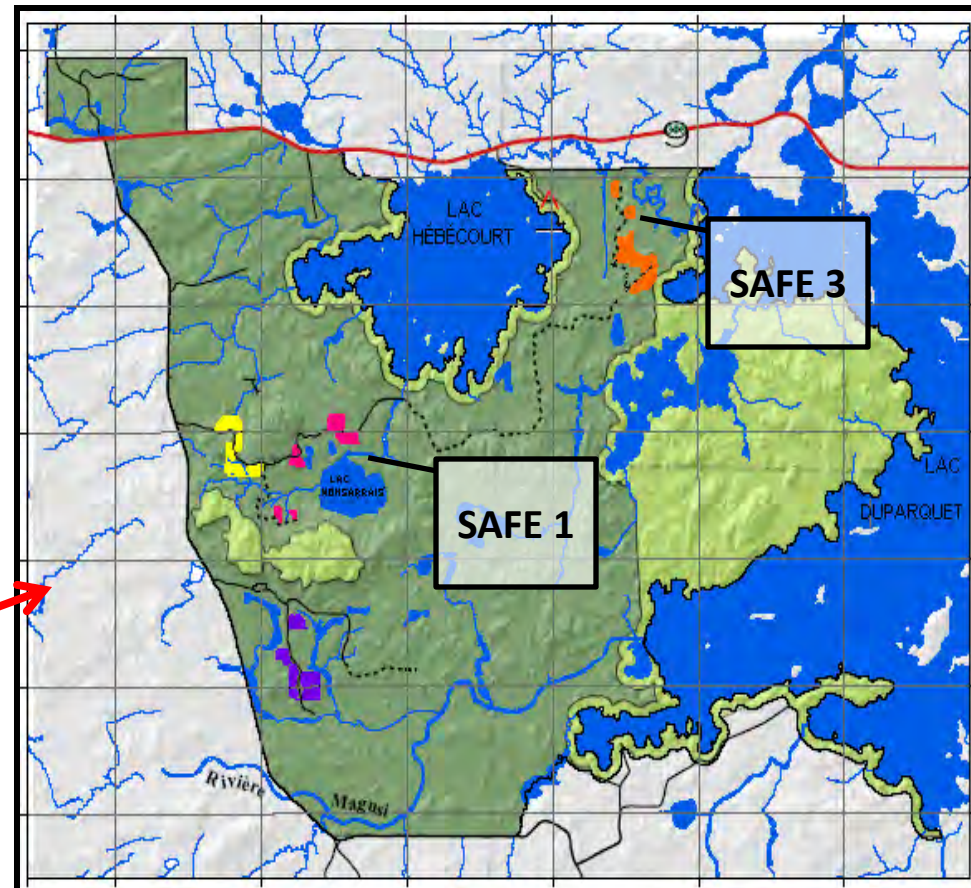
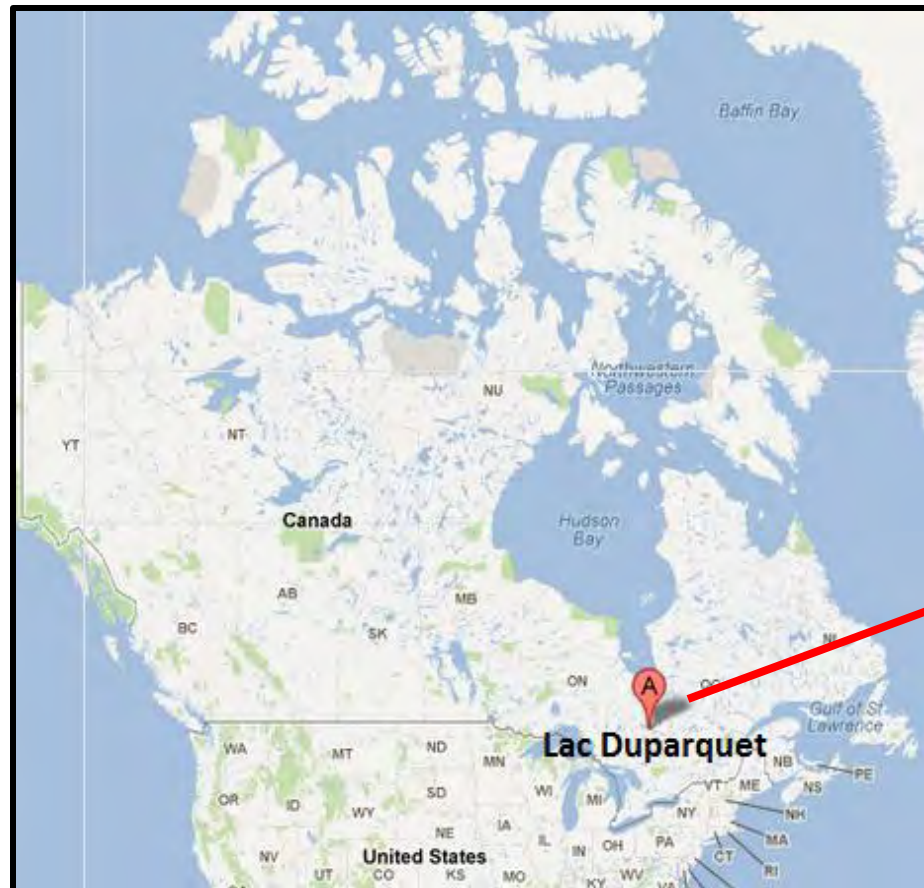
Protecting successional dynamics

Accommodating human use

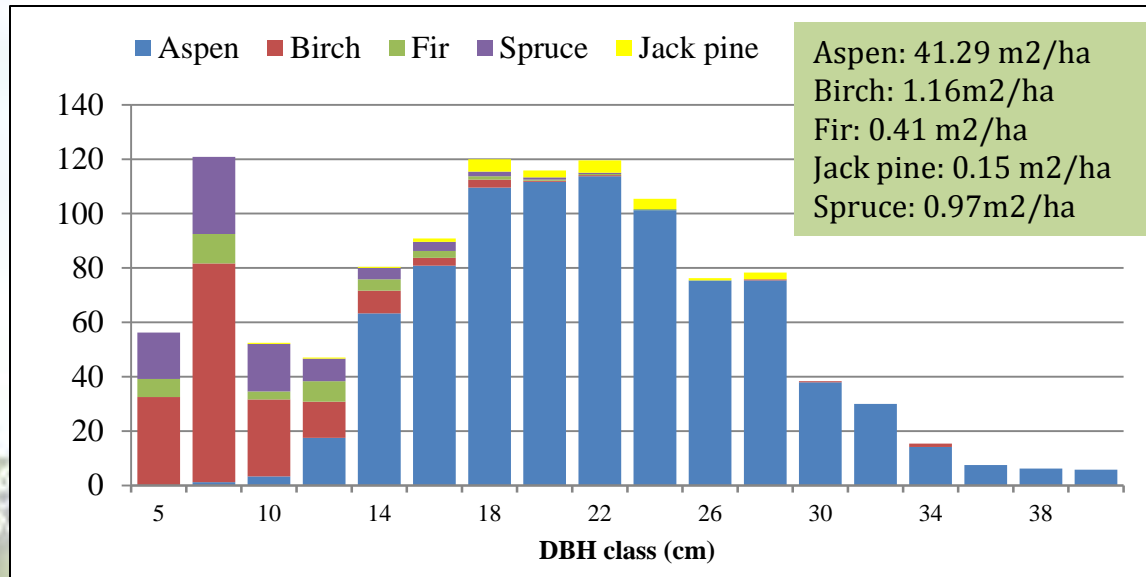
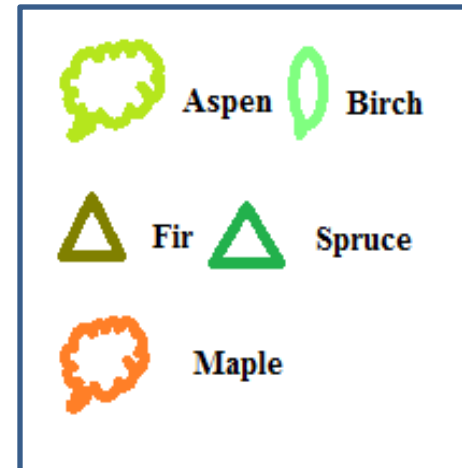
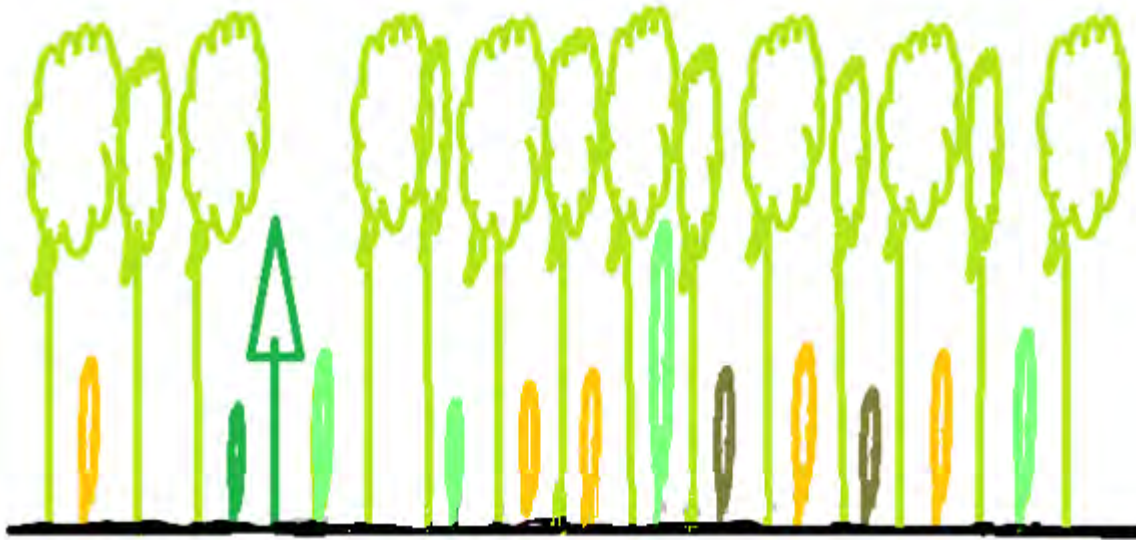
Current “alternatives” to even-aged (clear-cut) silviculture

- ✓ Variable retention (e.g., Lance and Phinney, 2001; Groot et al., 2005; Gustafsson et al., 2012)
- ✓ Shelterwood system (e.g., Wurtz and Zasada, 2001; Raymond et al., 2009)
- ✓ HARP (Harvest with Advanced Regeneration Protection) system (e.g., Thorpe et al., 2008, 2010; Riopel et al., 2010)
- ✓ Partial cutting aiming emulation of natural disturbances (e.g., Lieffers et al., 1996; Franklin et al., 1997; Bergeron and Harvey, 1997)

Study site: SAFE (sylviculture et aménagement forestiers écosystémique)

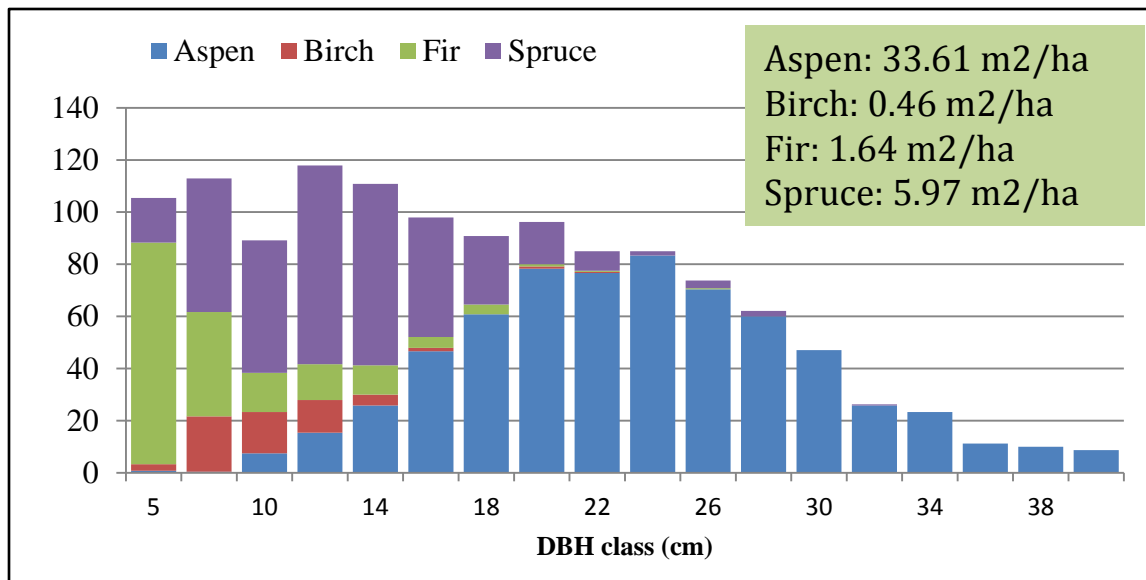
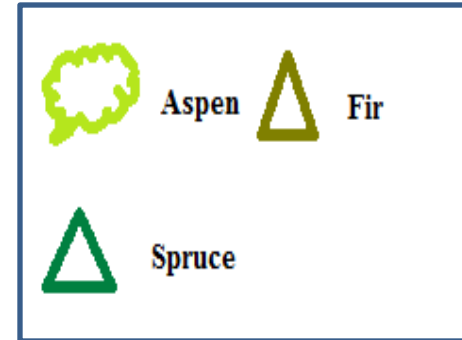
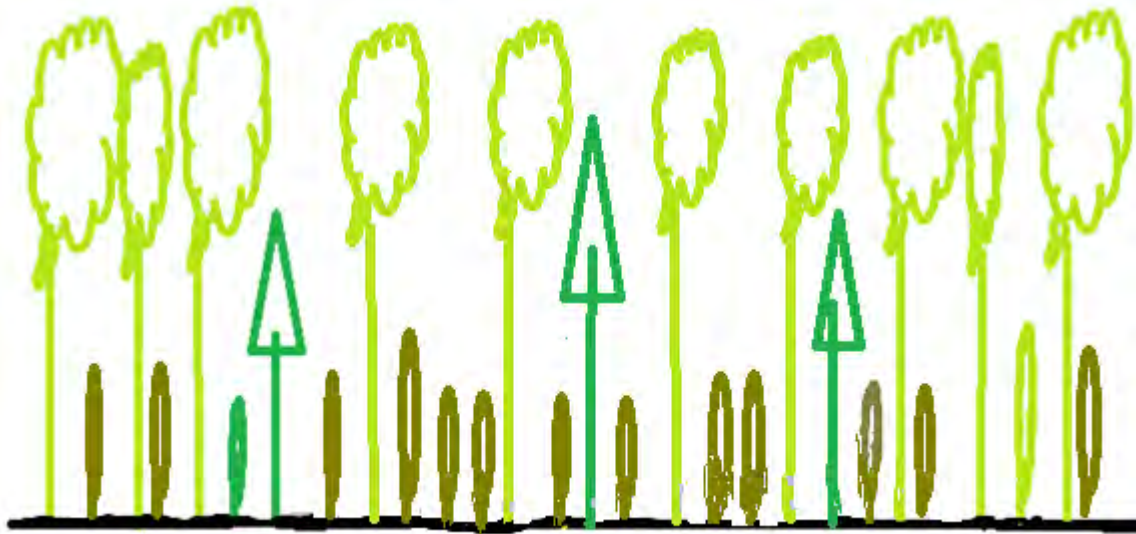


Study site: SAFE-1



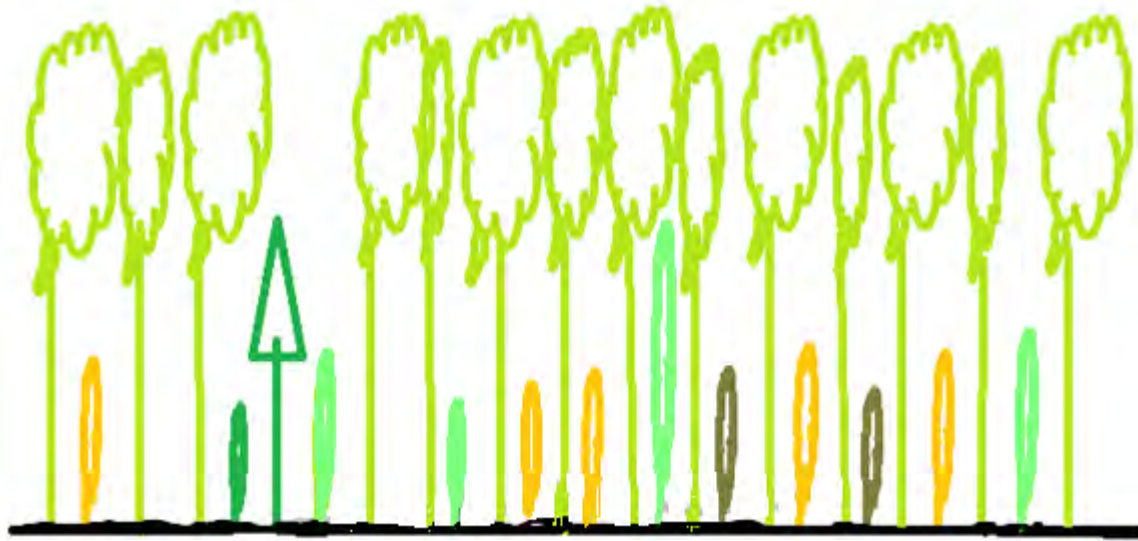
Stands originated
after 1923 fire

Study site: SAFE-3

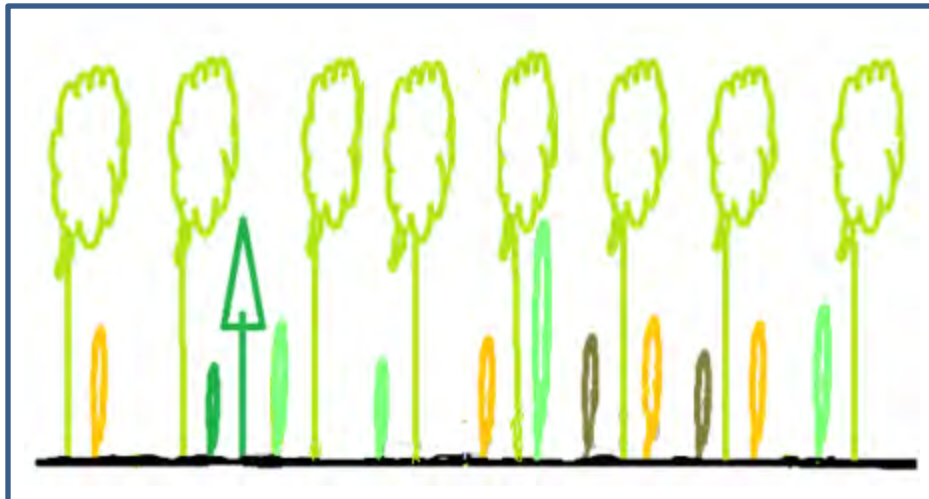


Stands originated after 1910 fire

Partial cutting treatments in SAFE-1

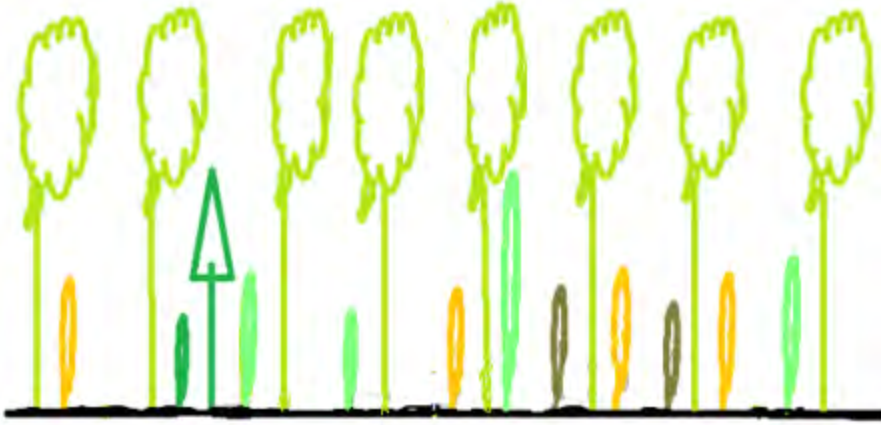


Partial cutting treatments in SAFE-1

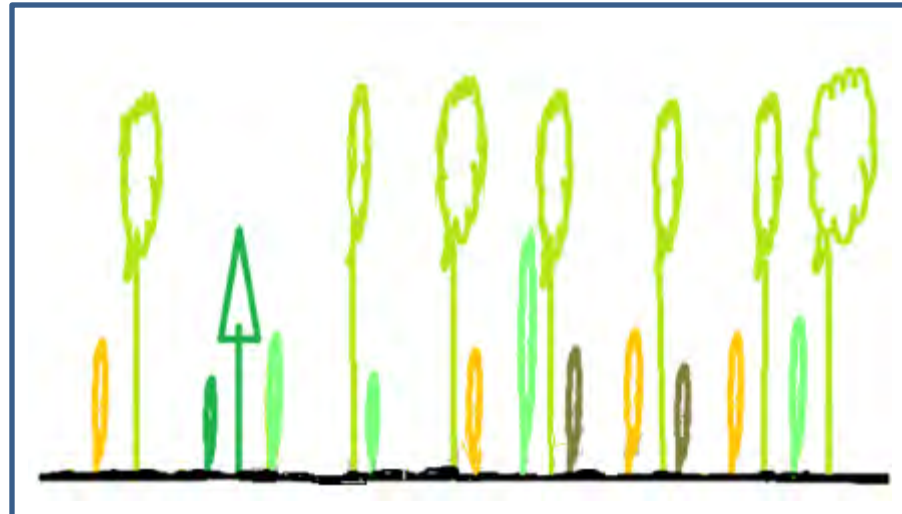


Low-light thinning; 1/3 basal area removal

Partial cutting treatments in SAFE-1



Low-light thinning; 1/3 basal area removal



High-heavy thinning; 2/3 basal area removal

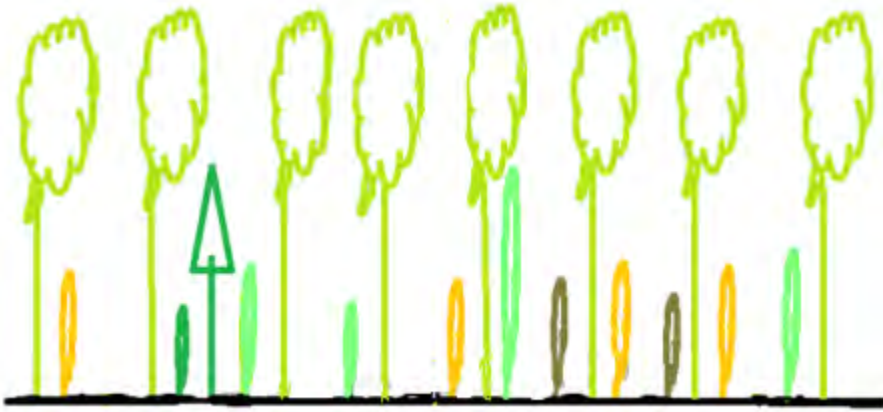
SAFE-1: Hypothesis

Mortality

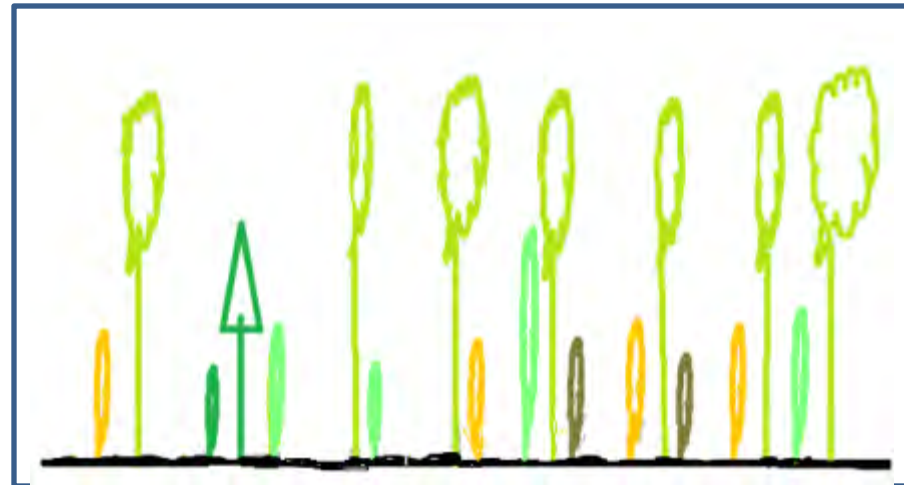
1. Initially after partial cuts, \uparrow mortality of residual aspen stems
2. Higher mortality after heavy crown thinning than light low thinning (higher logging damage, greater post-disturbance physiological shock to residuals)

Recruitment

1. Higher aspen recruitment after heavy crown thinning than light-low thinning
2. In partial cuts, aspen recruitment \downarrow with time & conifer recruitment \uparrow with time



Low-light thinning; 1/3 basal area removal

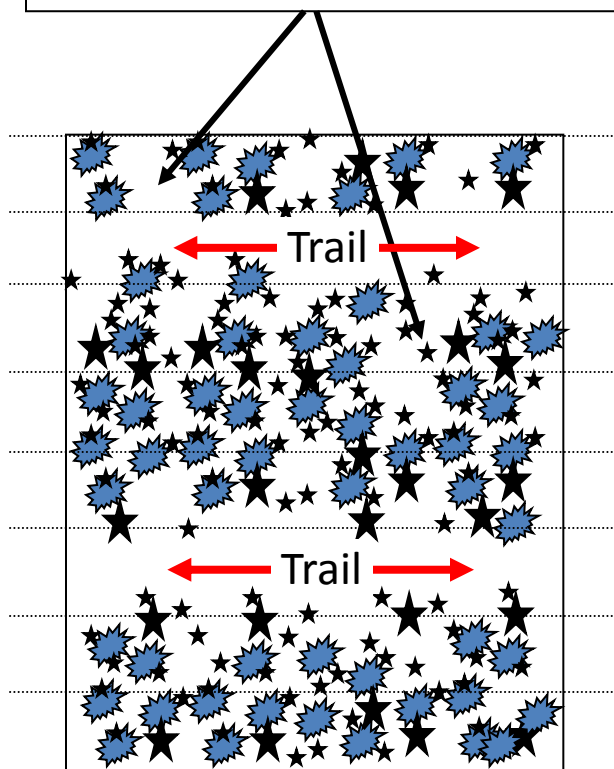


High-heavy thinning; 2/3 basal area removal

SAFE-3: partial cutting treatments

43% dispersed cut

1/4 of aspen stems removed from 5-7m band on each side of trail



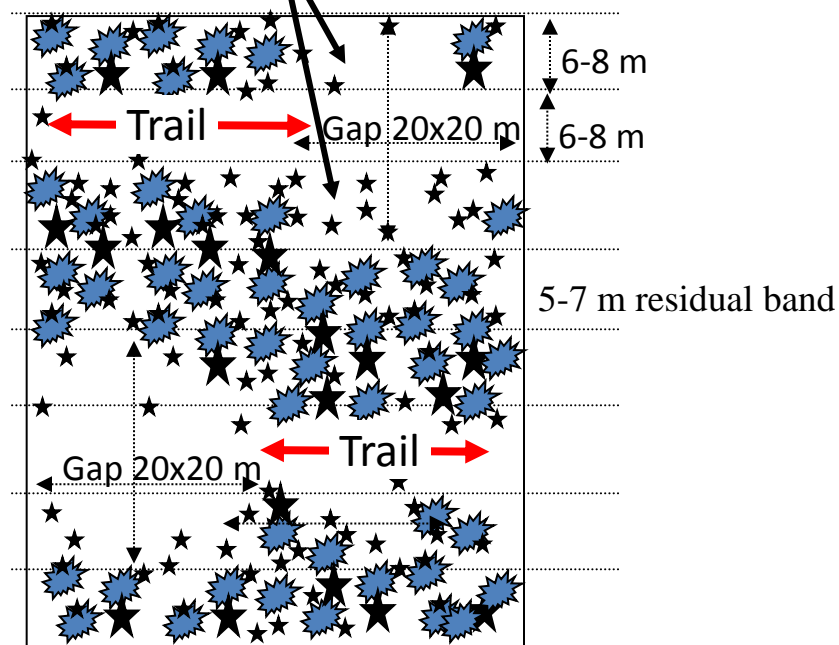
54% gap cut

All stems harvested on both sides of trail along 40% of trail length (Gaps approx. 20m X 20m)

Harvest removal

1/4
100%
1/4
0%
1/4
100%
1/4
0%

Band widths



Aspen

Merchantable conifer

Conifer regeneration

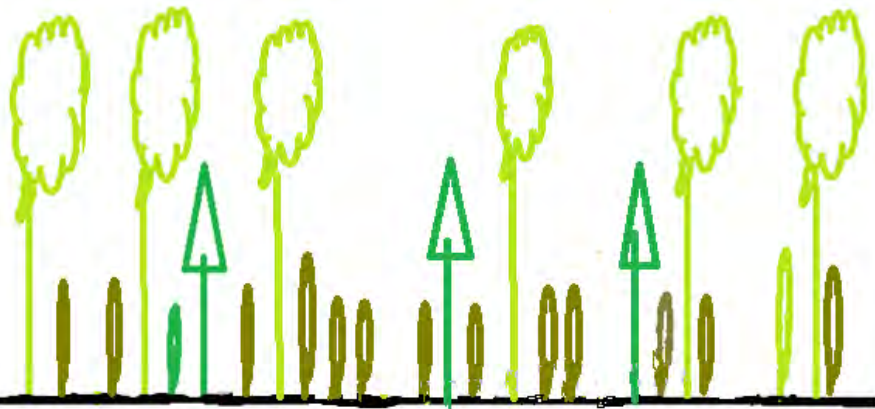
Partial cutting treatments in SAFE-3

Mortality

1. Initially after partial cuts, \uparrow mortality of residual aspen stems
2. Higher mortality following gap cut (higher logging damage, stability of residual stems)

SAFE-3: Recruitment

1. Proportion and density of aspen and fir regeneration reflect the degree of canopy opening following harvest treatments.

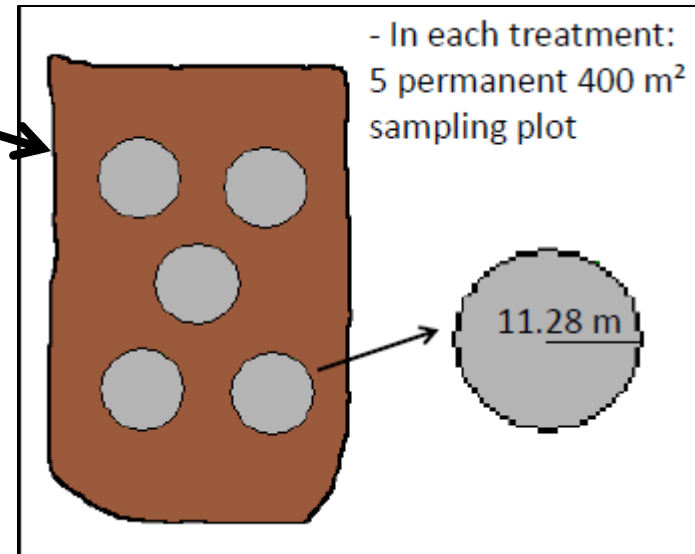
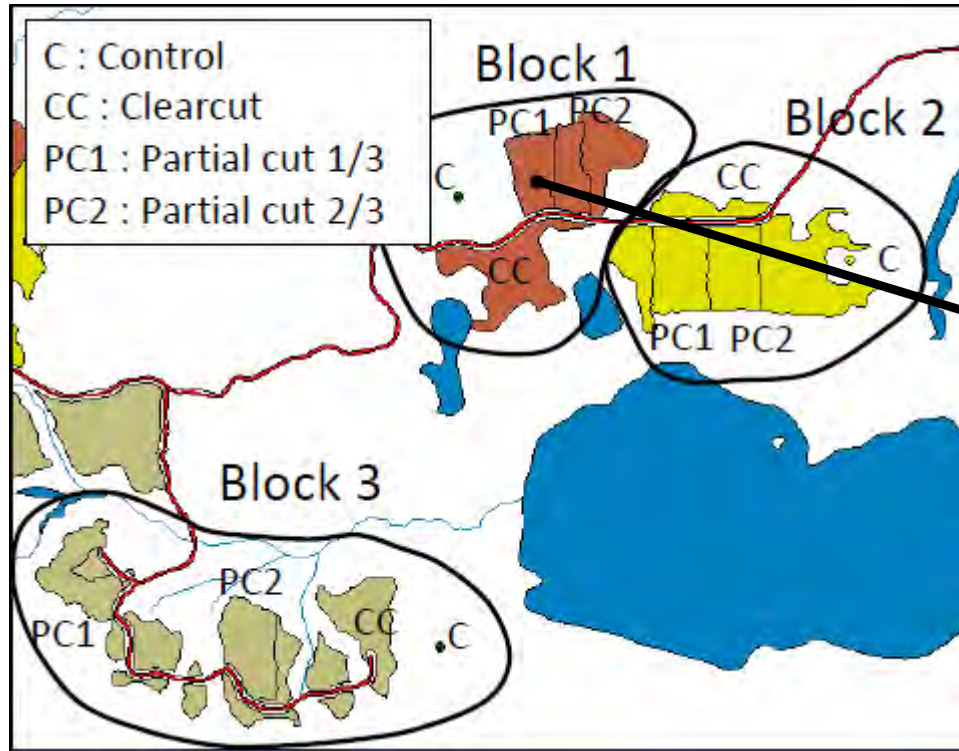


Dispersed thinning; 45% basal area removal



Gap (400 m²) thinning; 54% basal area removal

Experimental design



- Complete block design
- 3 replications of each treatment (1 to 3 ha/experimental unit)

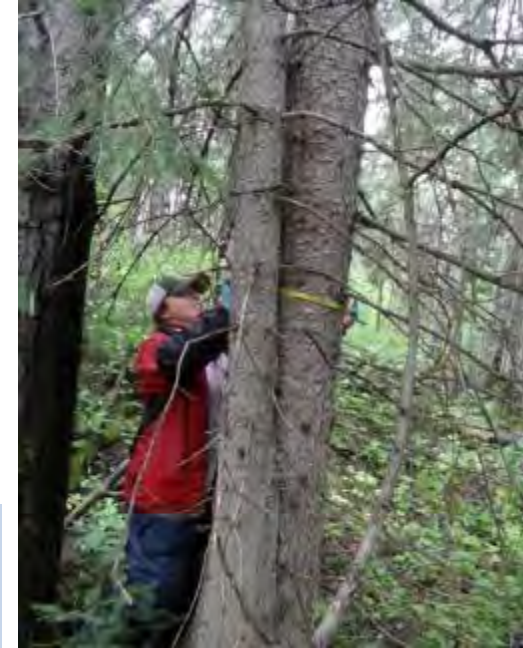
Data collection and statistical analysis

Experimental data

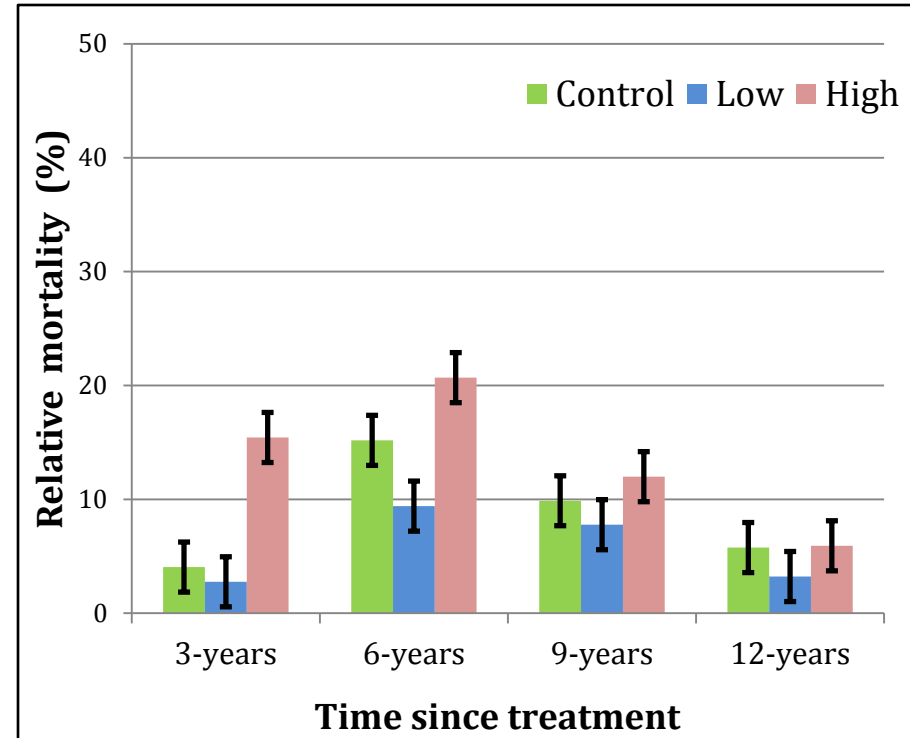
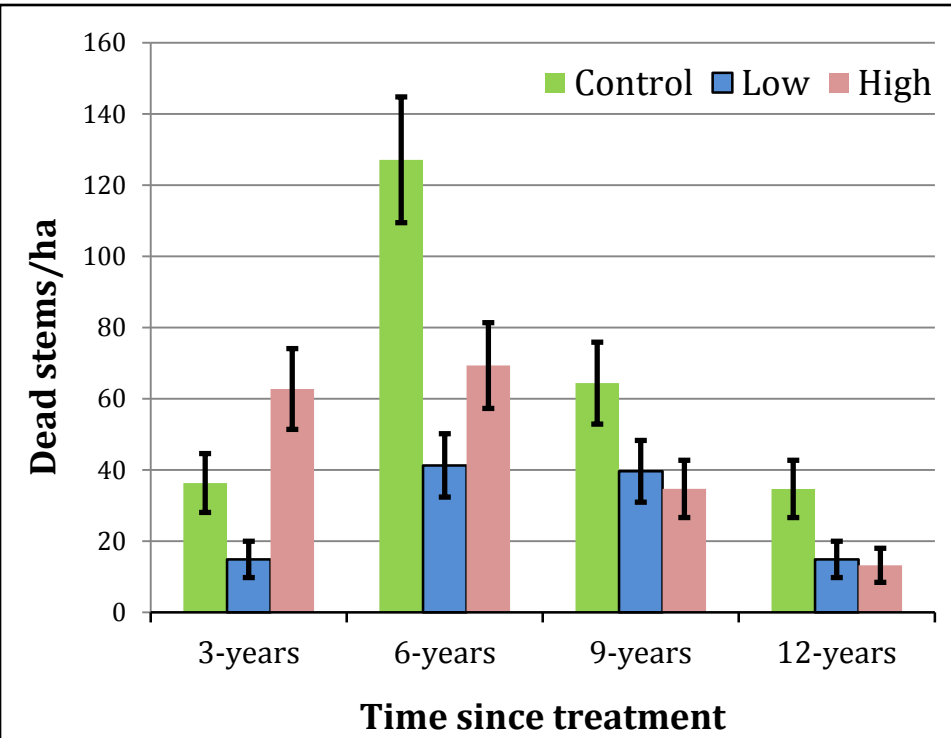
Stands	Year of treatment application	Re-measurement years
SAFE-1	1998	2001, 2004, 2007, 2010
SAFE-3	2000	2005, 2008, 2012

Statistical analysis

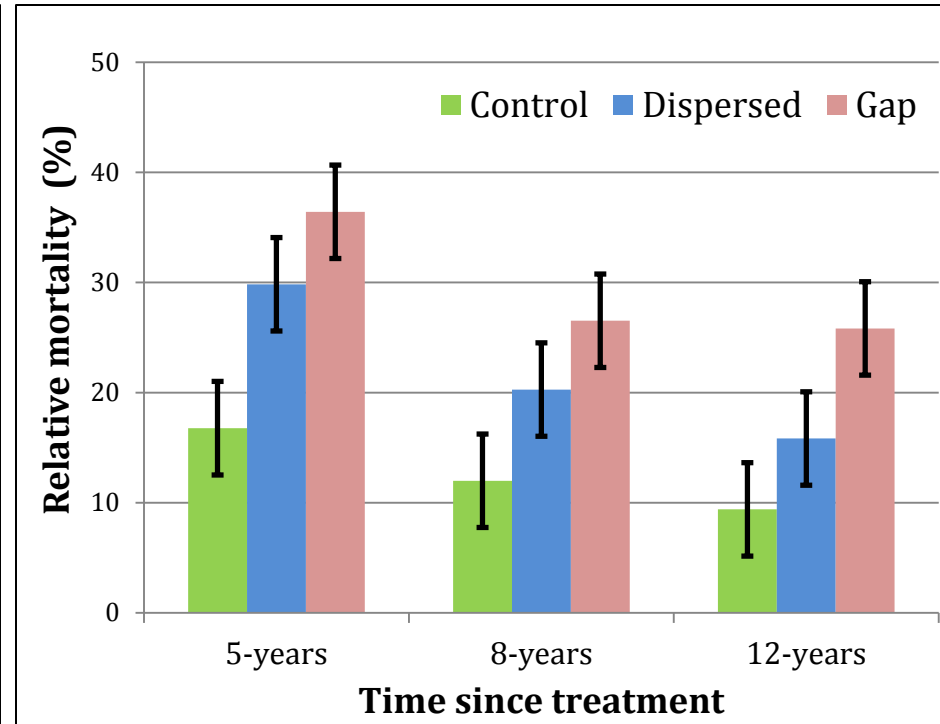
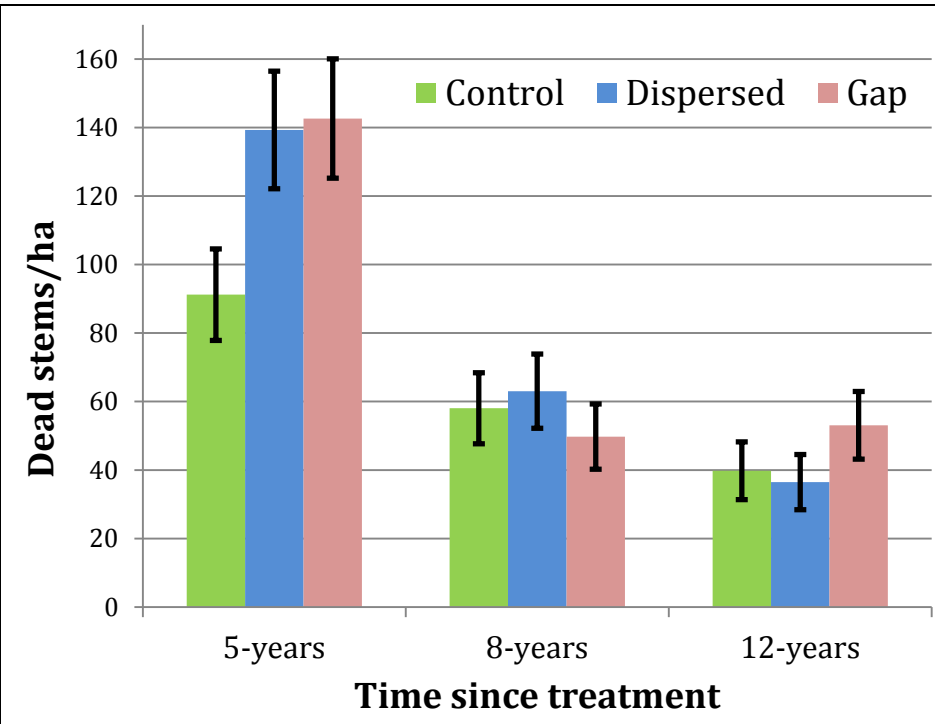
- Mixed models, with 'treatment' and 'year' as fixed effects and 'block (treatments are nested)' as random effect.
- Predicted mean with associated SE estimated using the R-function 'AICcmodavg'



SAFE-1: Effects of partial cutting on mortality of residual aspen stems (≥ 10 cm DBH)

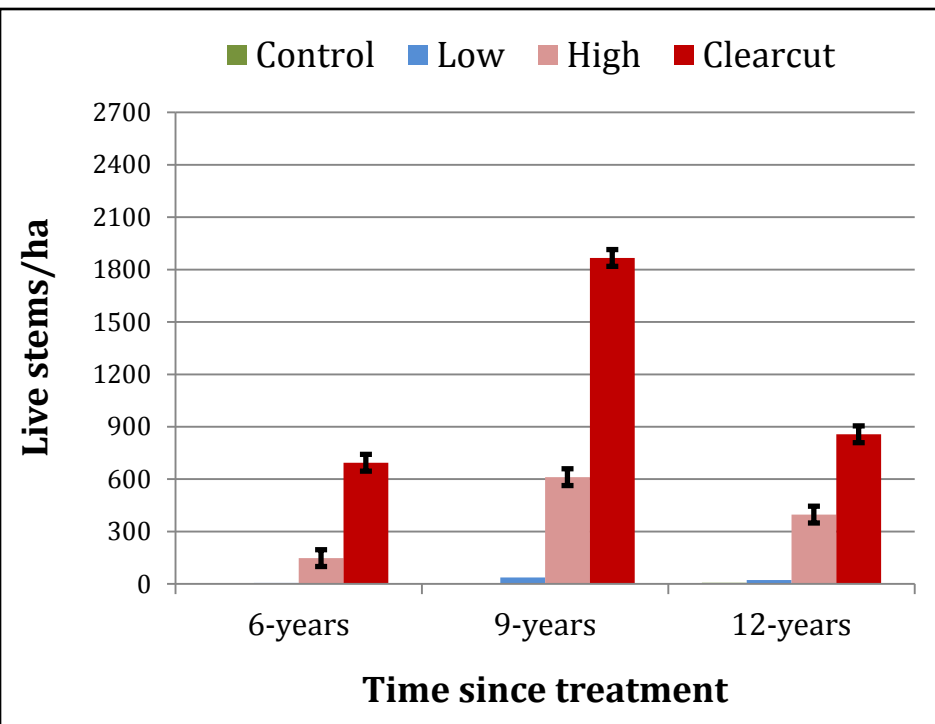


SAFE-3: Effects of partial cutting on mortality of residual aspen stems (≥ 10 cm DBH)

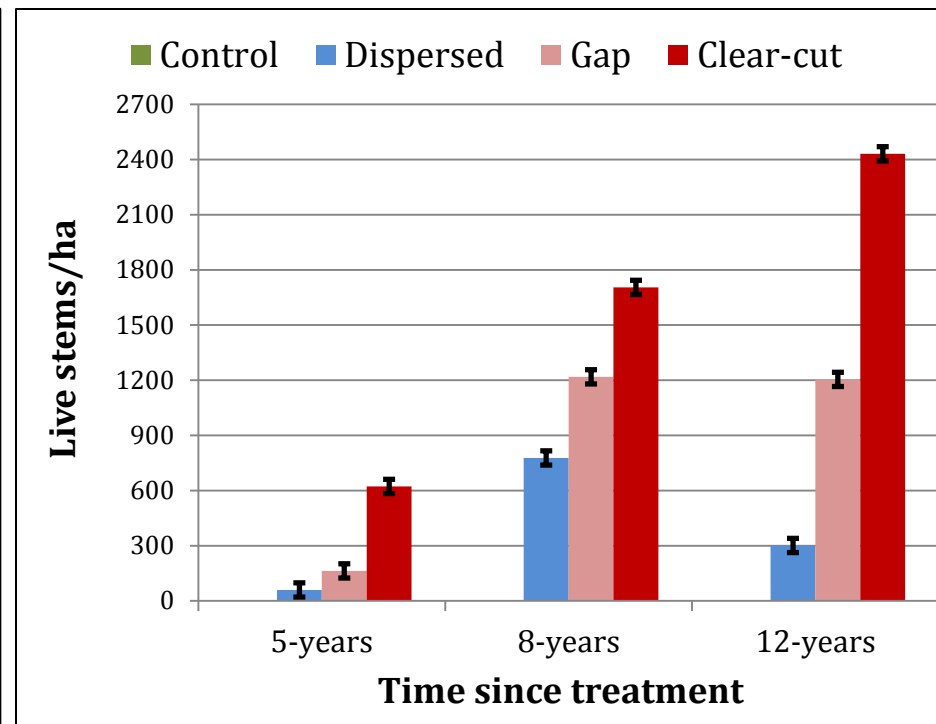


Effects of partial cutting on Trembling aspen sapling (20-99 mm at DBH) recruitment

SAFE-1

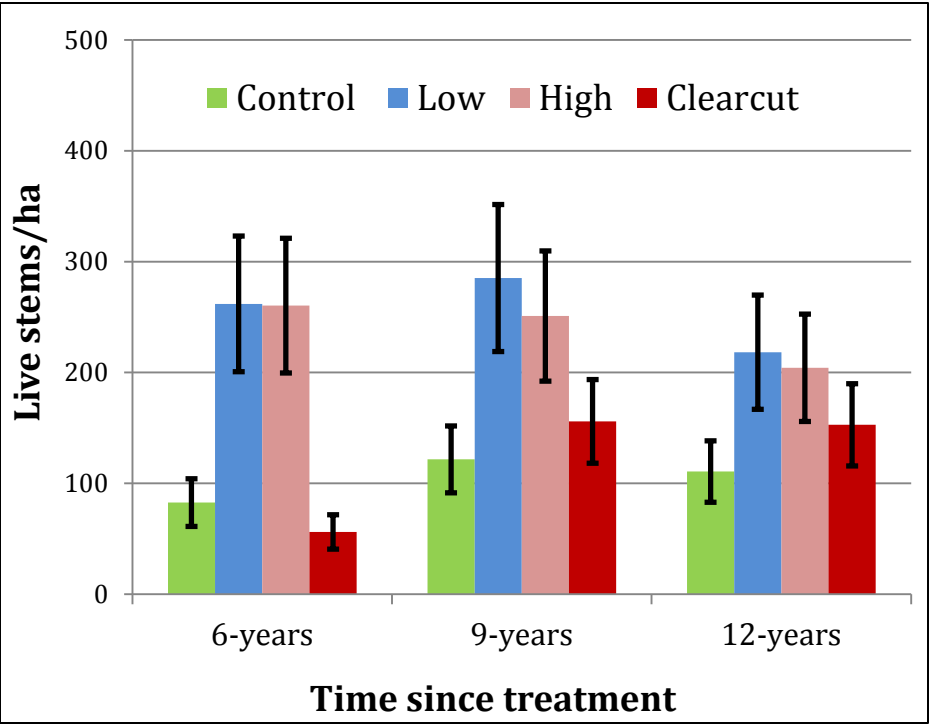


SAFE-3

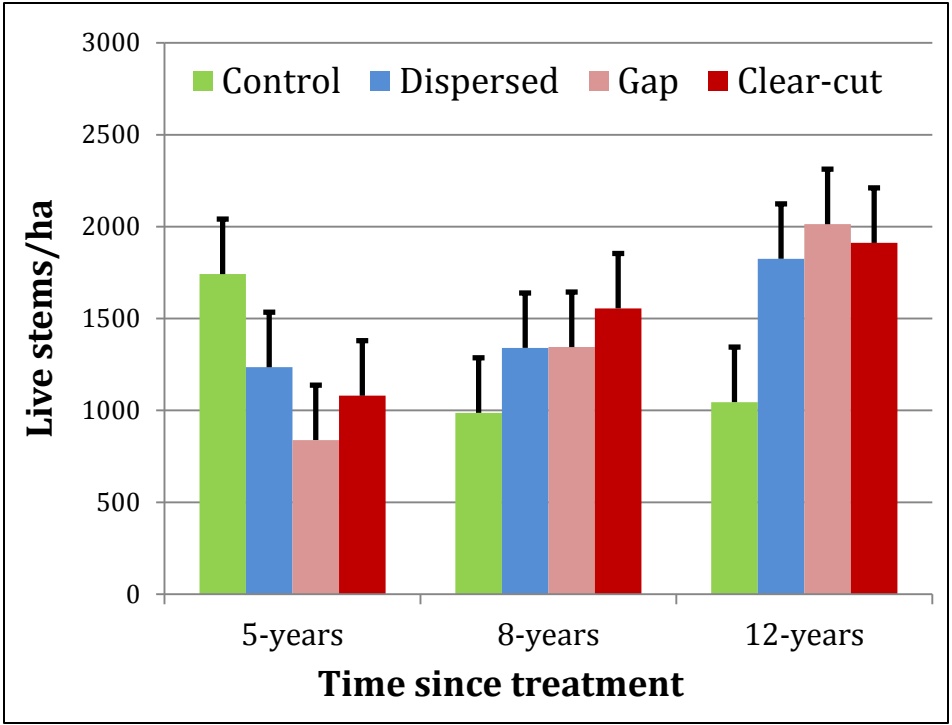


Effects of partial cutting on conifer sapling (20-99 mm at DBH) recruitment

SAFE-1 (Spruce and Balsam fir)

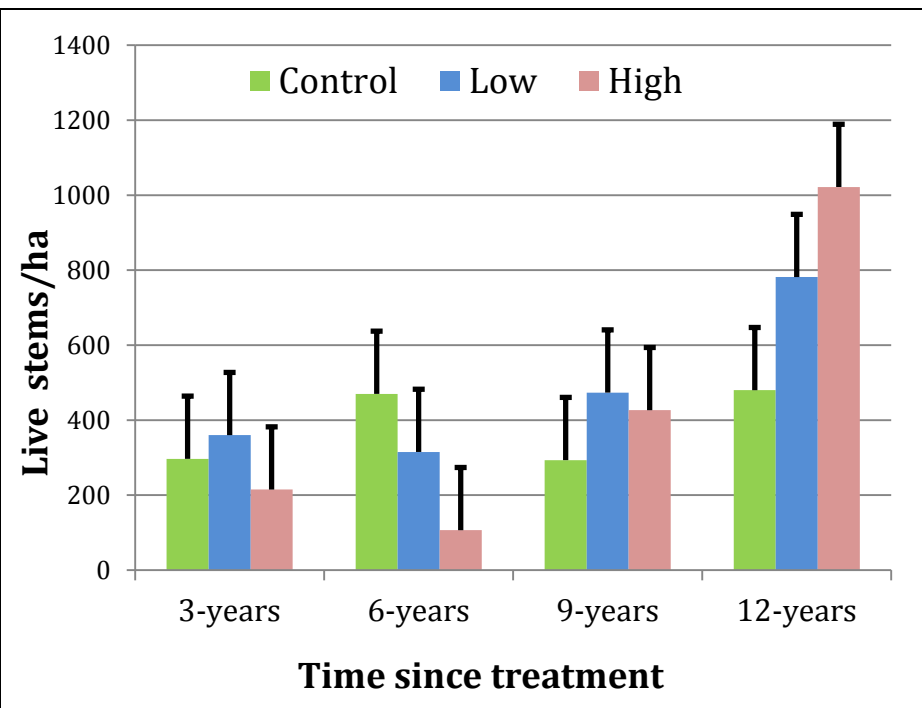


SAFE-3 (Balsam fir only)

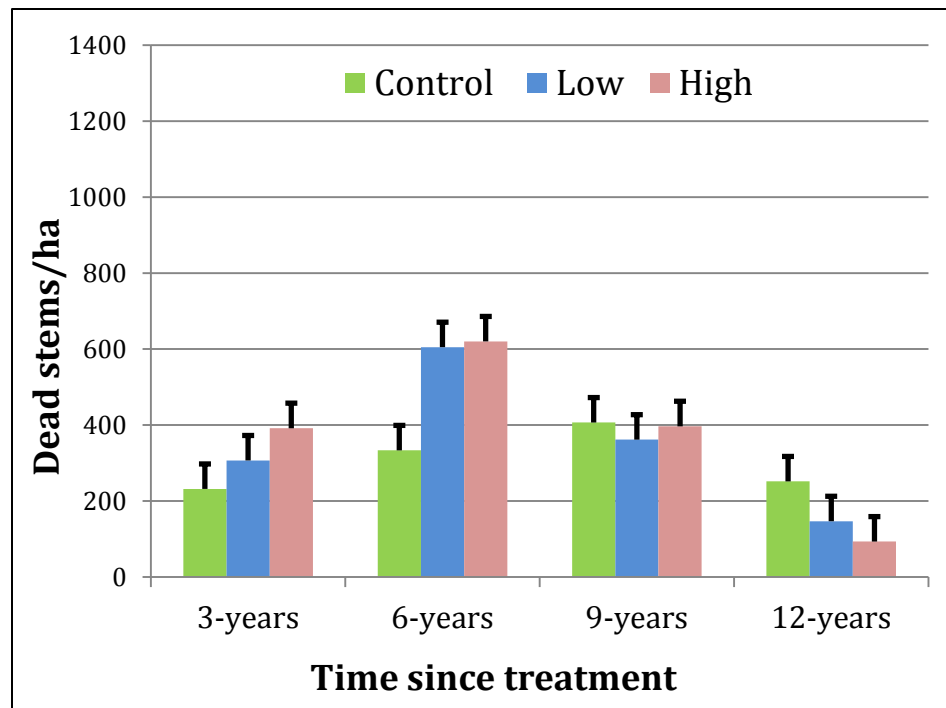


SAFE-1: Effects of partial cutting on Mountain maple sapling (20-49 mm at DBH) recruitment and mortality

Sapling recruitment



Sapling mortality



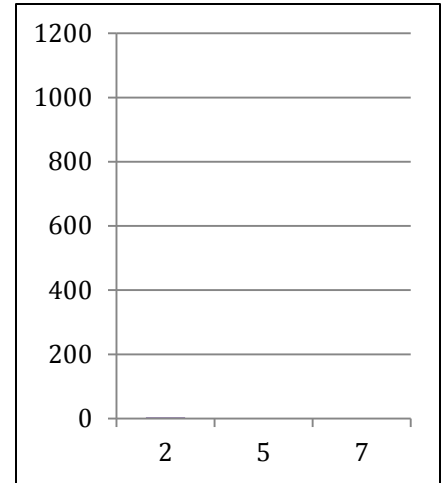
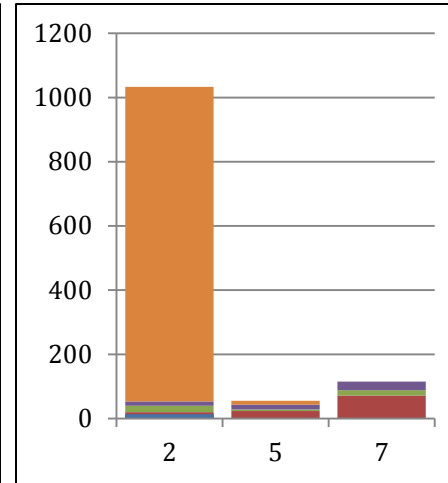
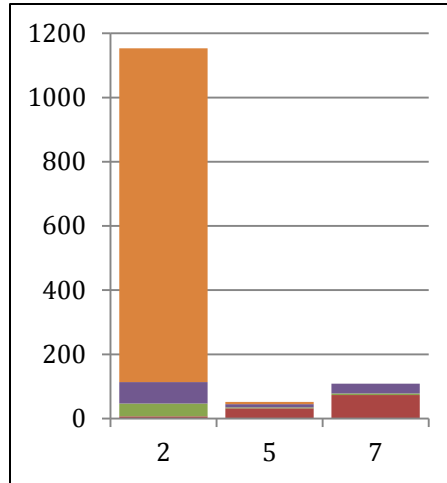
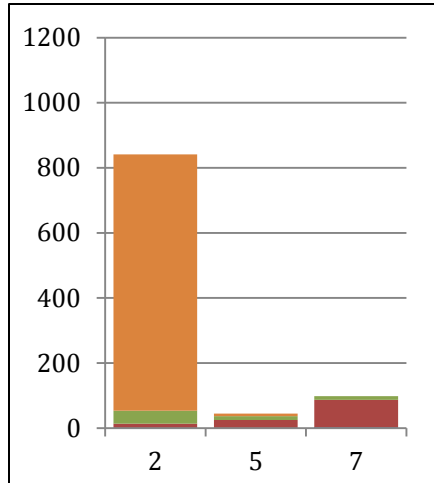
SAFE-1: Net sapling recruitment 12 years after treatments

Control, 1998

1/3 Low thinning, 1998

2/3 Crown thinning, 1998

Clear cut, 1998

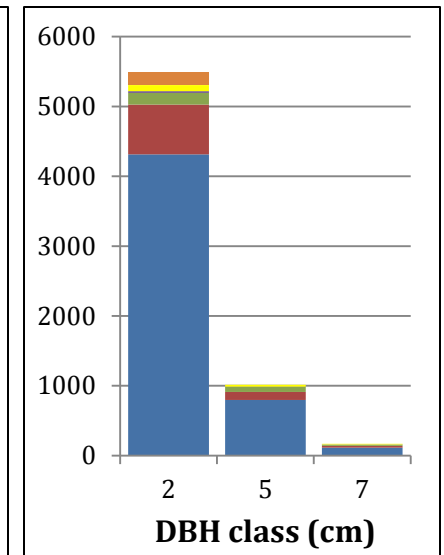
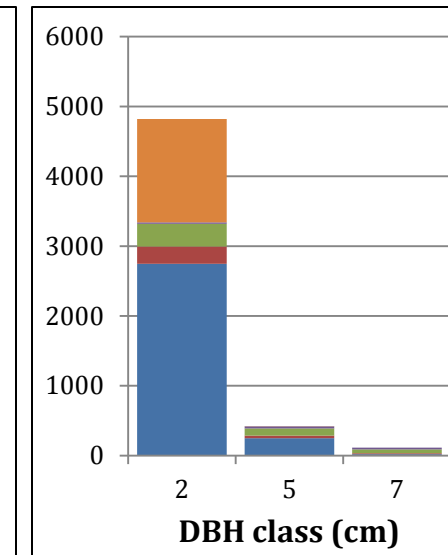
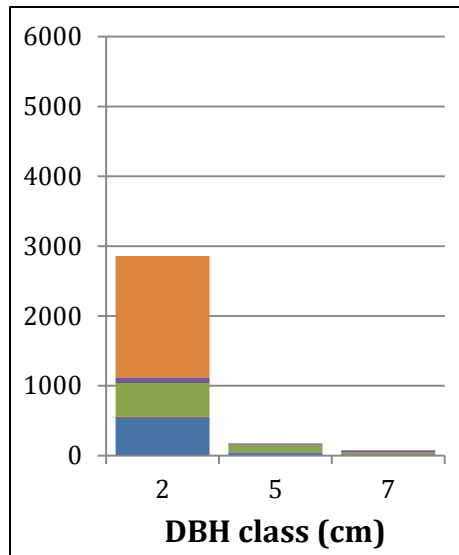
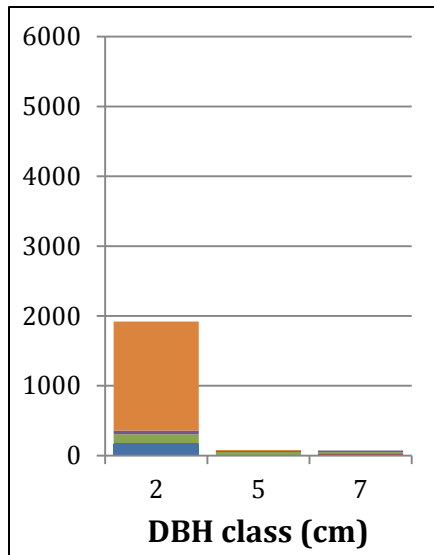


Control, 2010

1/3 Low thinning, 2010

2/3 Crown thinning, 2010

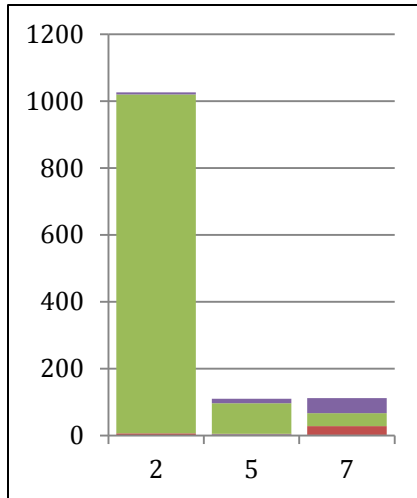
Clear cut, 2010



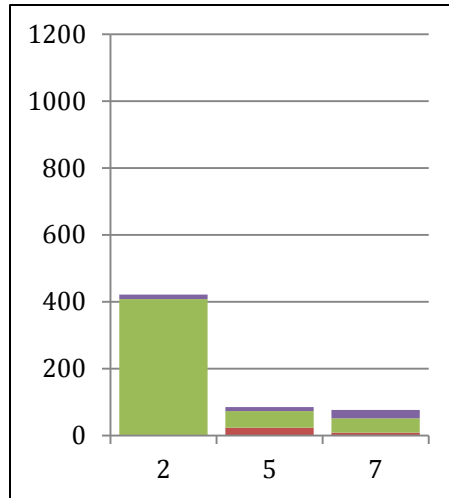
■ Maple
 ■ Jack pine
 ■ Spruce
 ■ Fir
 ■ Birch
 ■ Aspen

SAFE-3: Net sapling recruitment 12 years after treatments

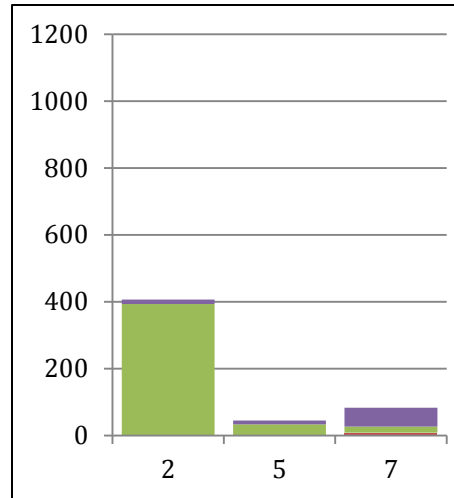
Control, 2000



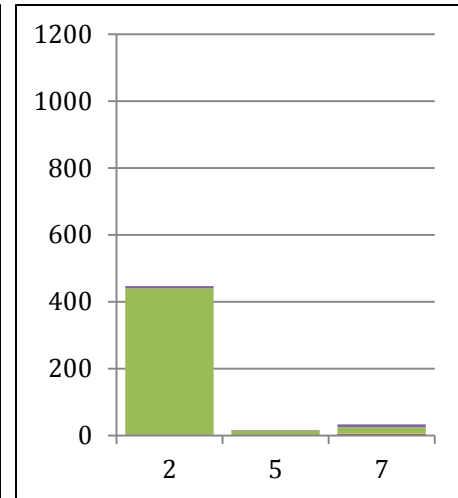
Dispersed cut, 2000



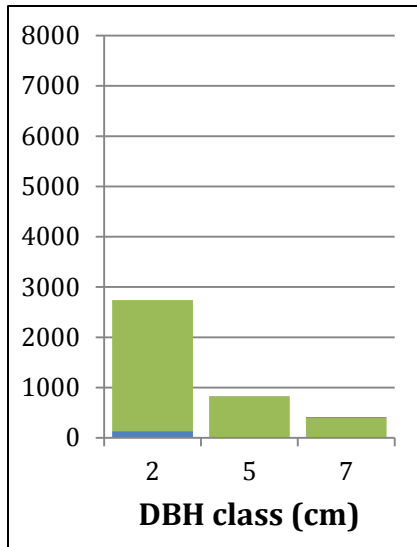
Gap cut, 2000



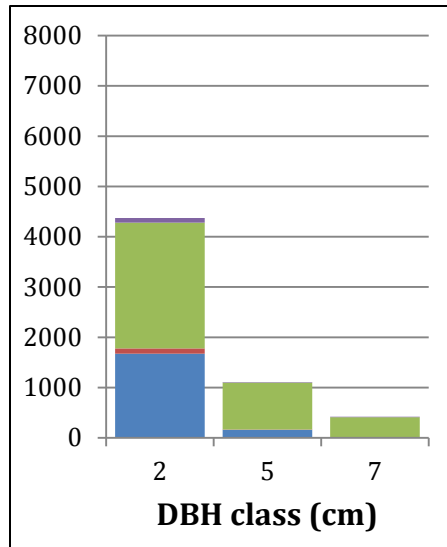
Clear cut, 2000



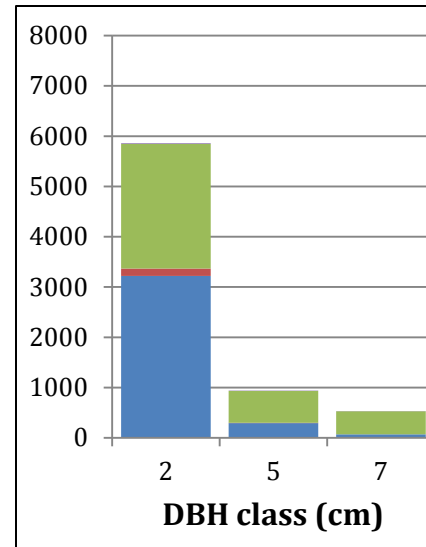
Control, 2012



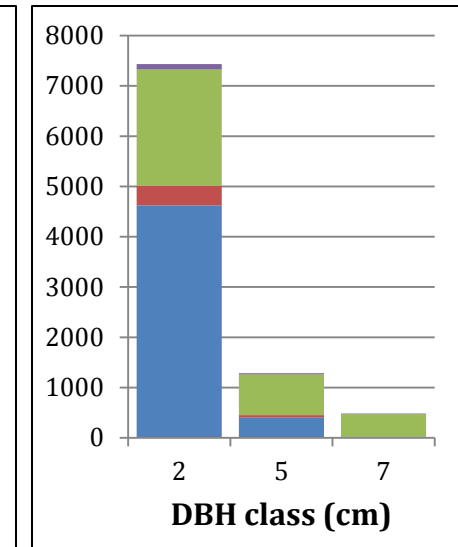
Dispersed cut, 2012



Gap cut, 2012



Clear cut, 2012



■ Aspen and Poplar ■ Birch ■ Fir ■ Spruce

Conclusions: SAFE-1

Mortality

- ✓ Initially, partial cutting increases residual aspen tree mortality (**H-1:√**).
- ✓ Significantly higher residual aspen mortality found after heavy crown thinning (**H-2:√**).
- ✓ Sapling mortality only appeared with mountain maple
- ✓ No significant mortality appeared in coniferous species

Recruitment

- ✓ Significantly higher aspen recruitment after heavy crown thinning than light low thinning and control (**H-1:√**).
- ✓ 8 years after partial cutting, aspen recruitment decreased significantly (**H-2:√**), but conifer recruitment did not increase (**H-2:√**).
- ✓ Despite initial recruitment of mountain maple proportional to BA removal, later it decreased with increasing basal area removal; almost no recruitment after clear cut.

Conclusions: SAFE-3

Mortality

- ✓ Initially, partial cutting increases residual aspen tree mortality (H-1:√).
- ✓ Significantly higher residual aspen mortality found after gap thinning (H-2:√).
- ✓ No significant mortality appeared in coniferous species

Recruitment

- ✓ Aspen recruitment proportional to canopy opening; (clear-cut > heavier Gapcut > moderate dispersed cut > Un-cut) (H-1:√).
- ✓ Initially, fir recruitment was higher in controls than partial cuts, but after 12 years, recruitment is significantly higher in harvested treatments than in controls (H-1:√).

Universal interpretation?

Partial cutting in transitioning even-aged forests may succeed in creating productive and more complex-structured stands if recruitment is adequate and mortality of residual stems is minimized. *Intensity and configuration of removal are key.*

Merci beaucoup!

Acknowledgements

NSERC-FQRNT-BMP Scholarship

Marc Mazerolle, Mario Major, Manuella Strukelj-Humphery, Jeanne Therrien, Suzie Rollin, Hannah Brais-Harvey, Elizabeth Turcotte, Alfred Coulombe

