Réponse des tiges résiduelles à la coupe partielle de peuplements de peuplier faux-tremble (*Populus tremuloides* Michx) en forêt boréale mixte

Arun Bose, Suzanne Brais et Brian D. Harvey

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Jardin botanique de Montréal

Why partial cutting?

- **Partial cutting has been suggested as a silvicultural tool to implement "ecosystem based forest management"**

- **Partial cutting or any type of retention harvesting could mimic biological legacies of natural disturbances**

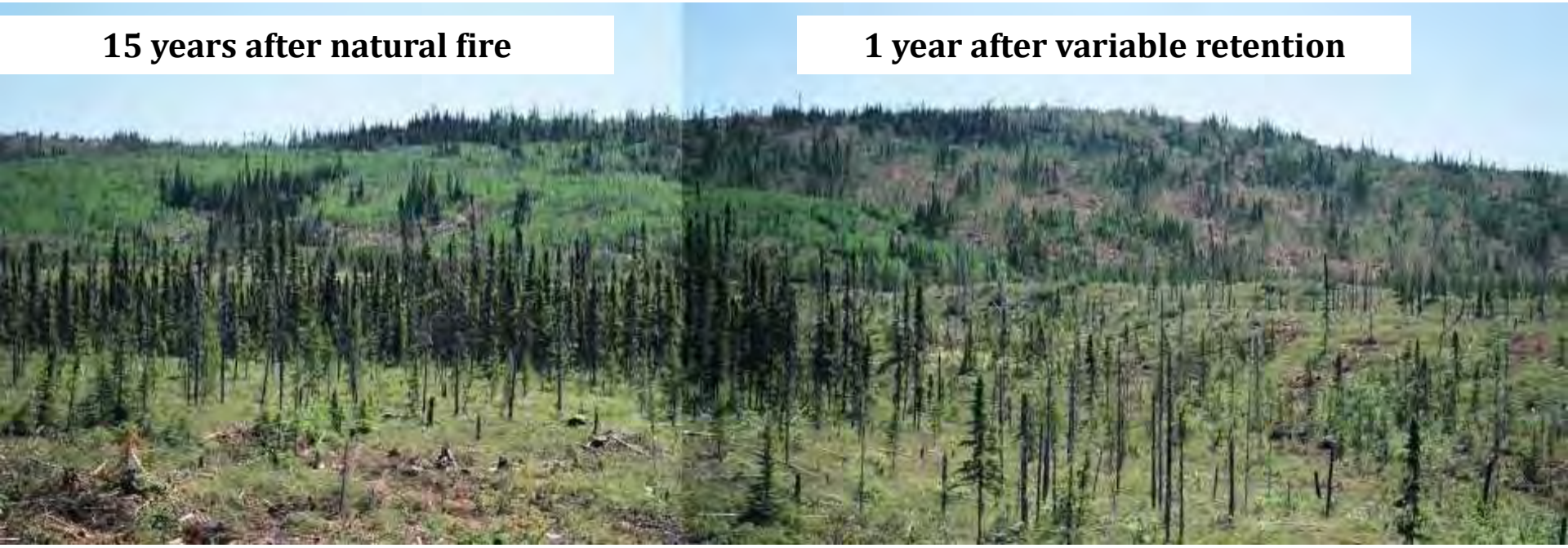

Image: J-P Jette, MRNF

Is partial cutting a viable practice?

Production perspective

- ✓Growth or residual trees (Thorpe et al. 2007)
- ✓Mortality of residual trees (Coates 1997)
- ✓Recruitment of desired species (Messier et al. 1999)

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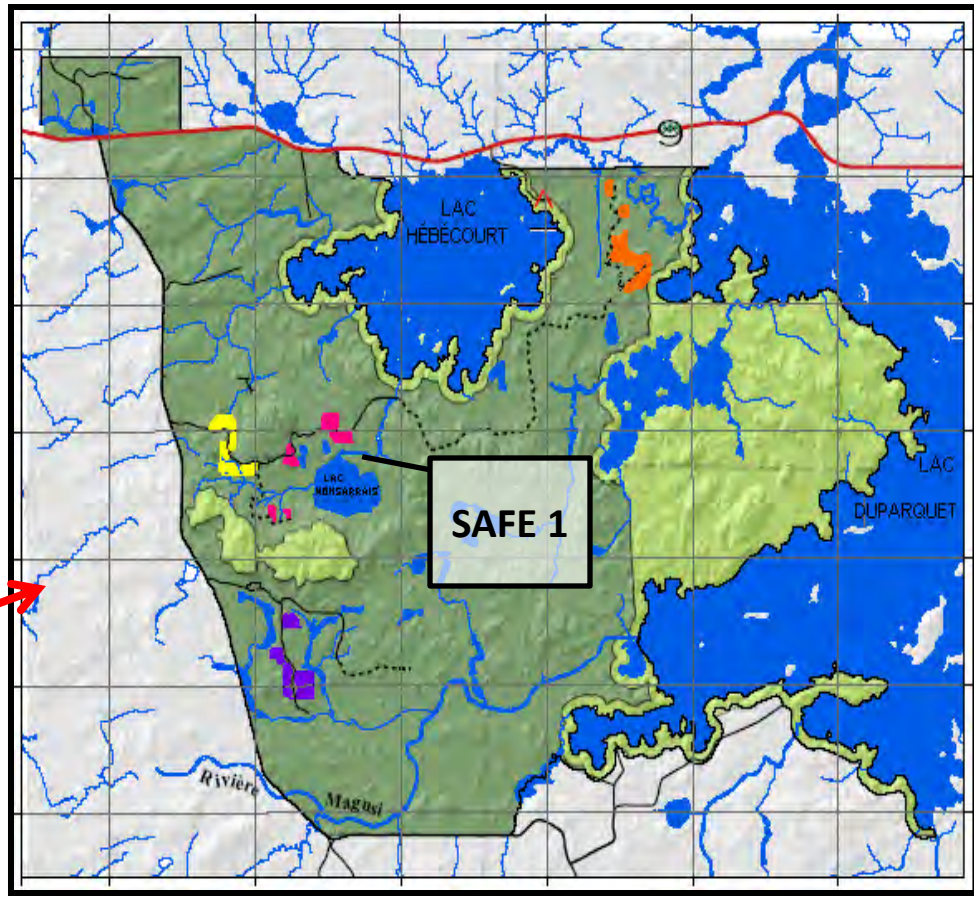
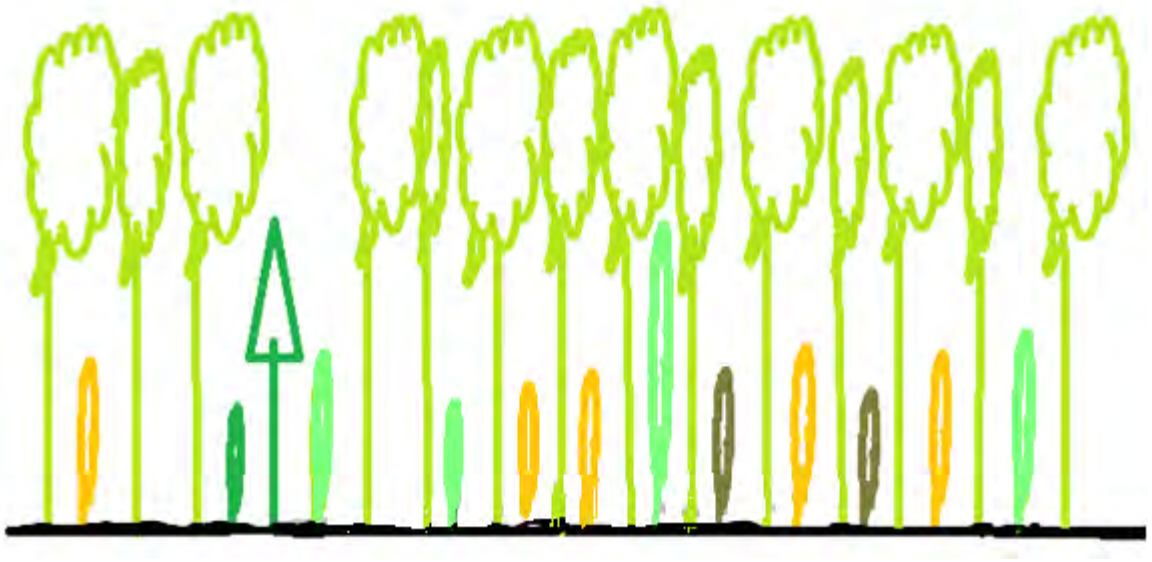
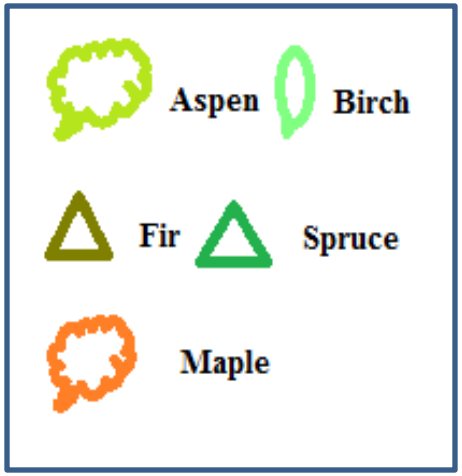
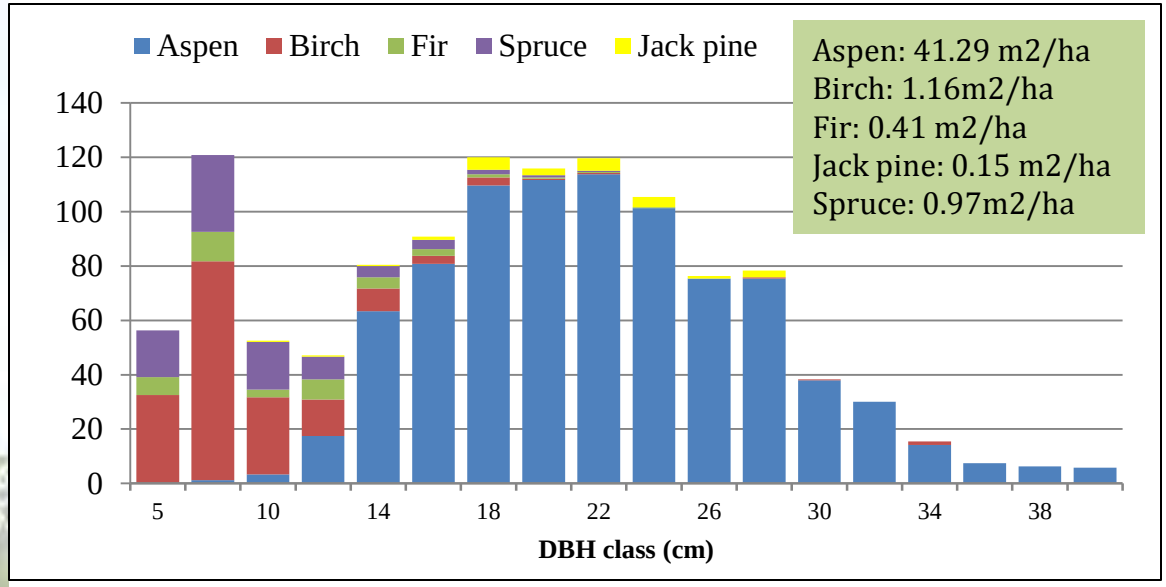
Study site: SAFE (sylviculture et aménagement forestiers écosystémique)



Study site: SAFE-1

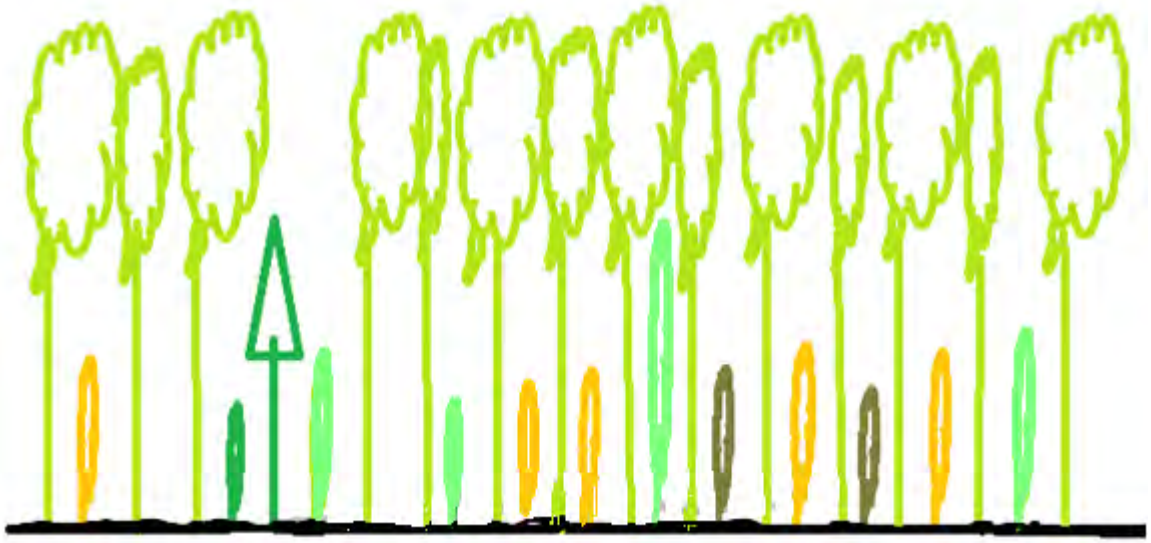


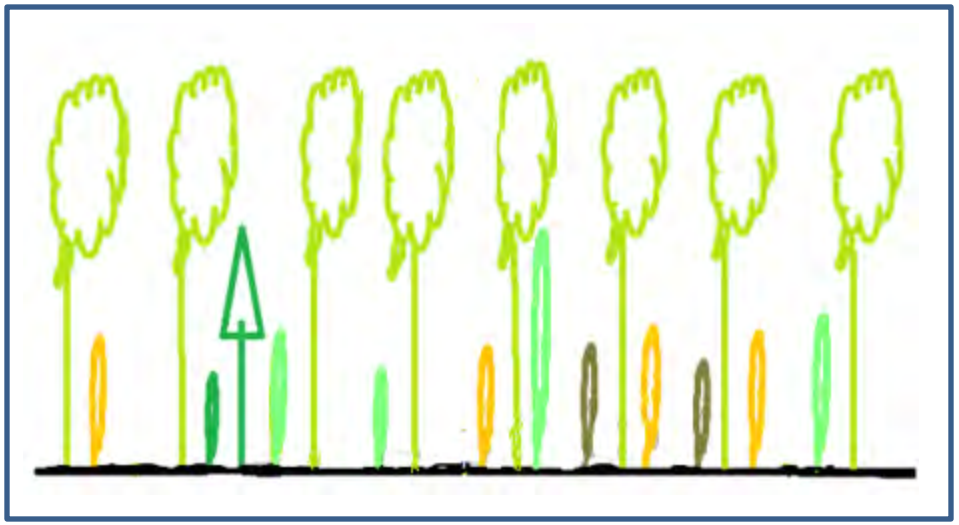




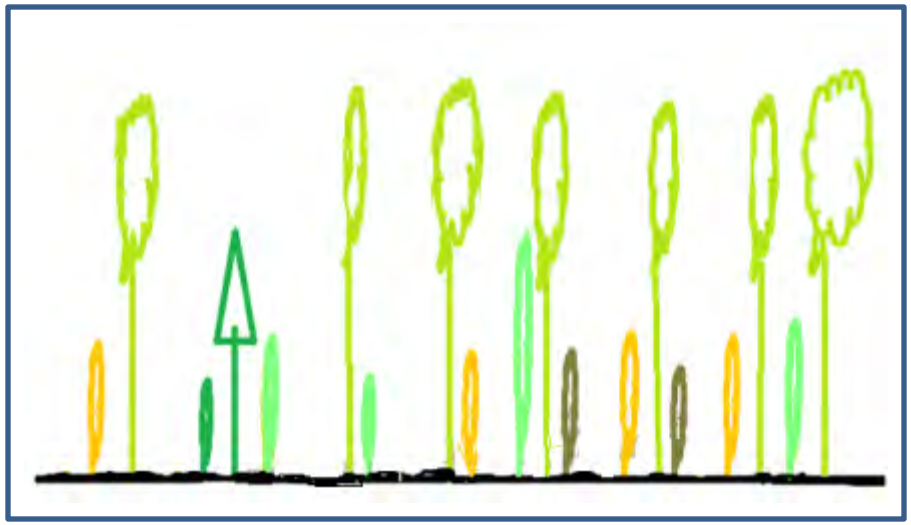
Stands originated after 1923 fire

Partial cutting treatments



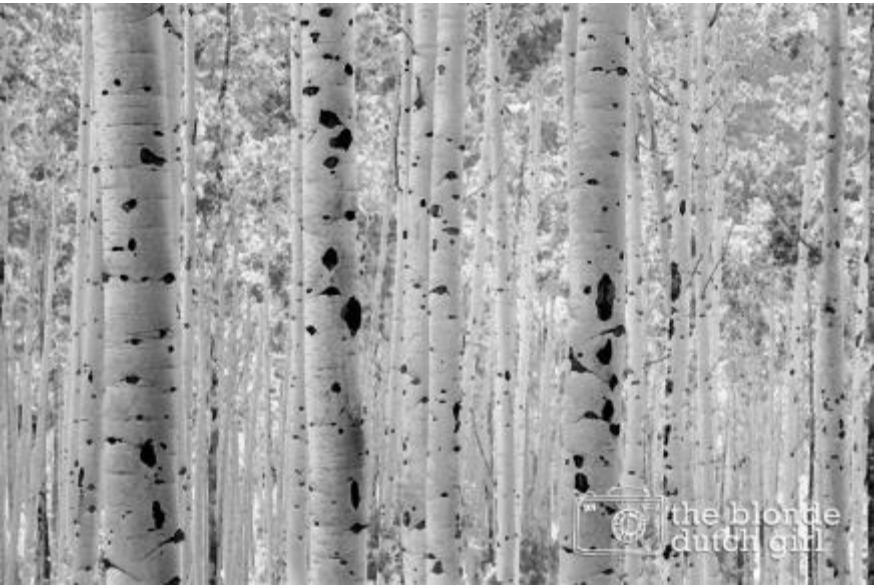


Low-light thinning; 1/3 basal area removal



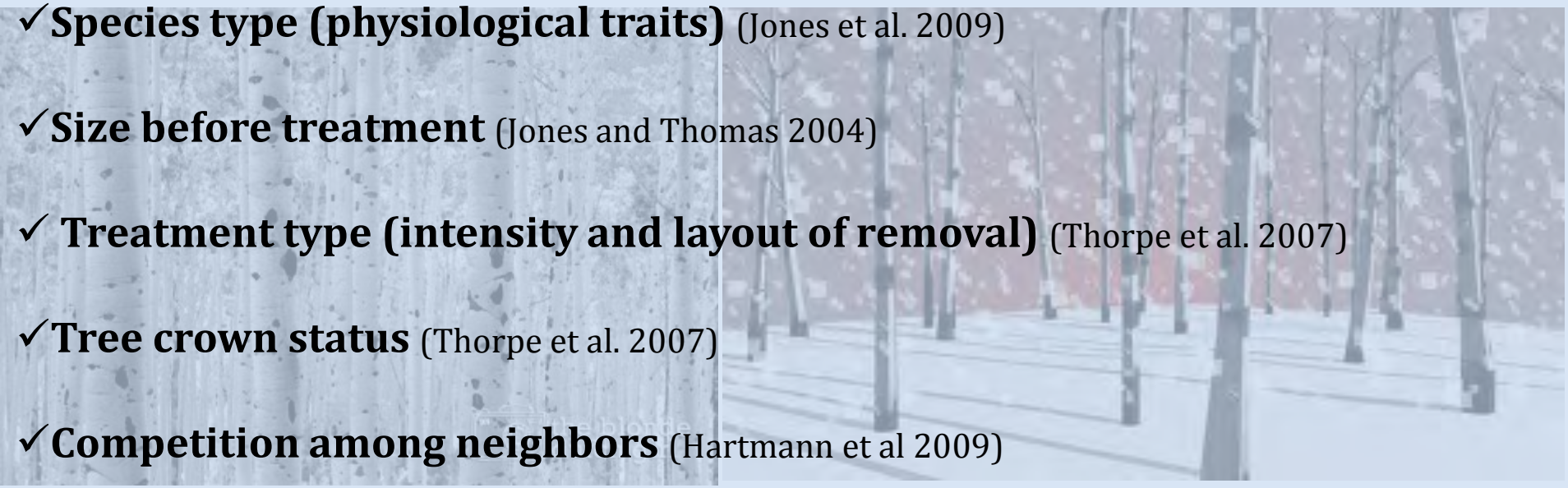
High-heavy thinning; 2/3 basal area removal

Partial cutting treatments



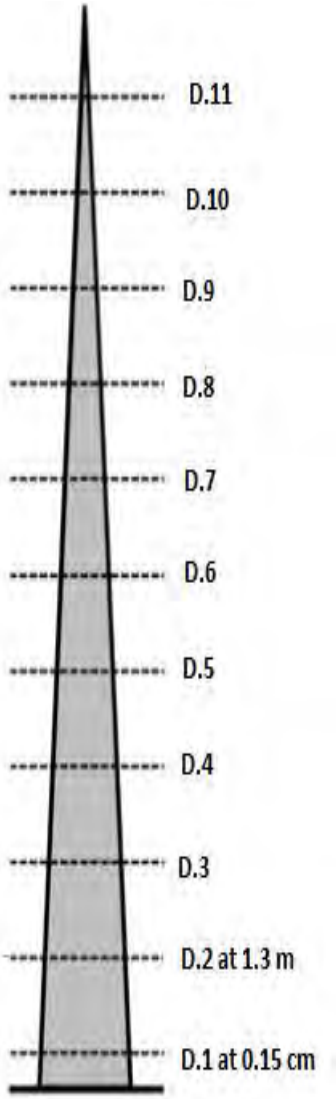
Potential factors affect growth responses

- ✓ **Tree age** (Thorpe et al. 2007)
- ✓**Species type (physiological traits)** (Jones et al. 2009)
- ✓**Size before treatment** (Jones and Thomas 2004)
- ✓ **Treatment type (intensity and layout of removal)** (Thorpe et al. 2007)
- ✓**Tree crown status** (Thorpe et al. 2007)
- ✓**Competition among neighbors** (Hartmann et al 2009)
- ✓**Time effect** (Thorpe et al. 2007; Jones et al. 2009)



Data collection

- 1 Site, SAFE-1
- Sample trees: 54
- 27 each from dominant and codominant crown status
- Three treatments; high-heavy thinning, low-light thinning, and control
- Neighborhood mapping for each sample tree 12 years after treatment application



Hypothesis

✓ **Tree age** (Thorpe et al. 2007) **Not Applicable**

✓**Species type (physiological traits)** (Jones et al. 2009) **Not Applicable**

✓**Size before treatment** (Jones and Thomas 2004):

H1-Positive effect

✓ **Treatment type (intensity and layout of removal)** (Thorpe et al. 2007)

H2-Positive effect

✓**Tree crown status** (Thorpe et al. 2007)

H3: Dominant>Co-dominant

✓**Competition among neighbors** (Hartmann et al 2009)

H4-Negative effect

✓**Time effect** (Thorpe et al. 2007; Jones et al. 2009)

H5-Linear effect

❑ **Initial (2-5 years) growth lag** (Thorpe et al. 2007; Jones et al. 2009)

Yes

Data Processing and Labs

Data Processing and Labs

- Tree ring Width measurement by WinDendro (Regent Instrument)
- Measurement varification by COFECHA
- Volume measurement by WinStem (Regent Instrument)

Data Analysis

- Neighborhood Competition Indices (NCI)

$$NCI = \frac{\sum_{j=1}^{N} (DBH_j)^{\alpha} / (dist_{ij})^{\beta}}{1000}$$

- Neighbor size index, α = 0, 1, and 2
- Neighbor distance index, β = 0, 0.5, 1, and 2
- Neighborhood radius limit, R = 6, 8, and 10 m

Canham et al. 2006; Coates et al. 2009; Hartmann et al. 2009

Results:
The best NCI model

R (m)	α	β	K	AICc	ΔAICc	AICc weight (w_i)	LogLik
6	1	0	5	139.42	0.00	0.30	-64.08
8	1	0	5	140.63	1.21	0.17	-64.69
10	1	0	5	141.05	1.63	0.13	-64.90
10	1	0.5	5	141.10	1.68	0.13	-64.92
8	1	0.5	5	141.25	1.84	0.12	-65.00
6	1	0.5	5	142.15	2.73	0.08	-65.45
10	1	1	5	144.66	5.25	0.02	-66.71
8	1	1	5	145.72	6.31	0.01	-67.24
6	1	1	5	147.34	7.92	0.01	-68.04

OUI

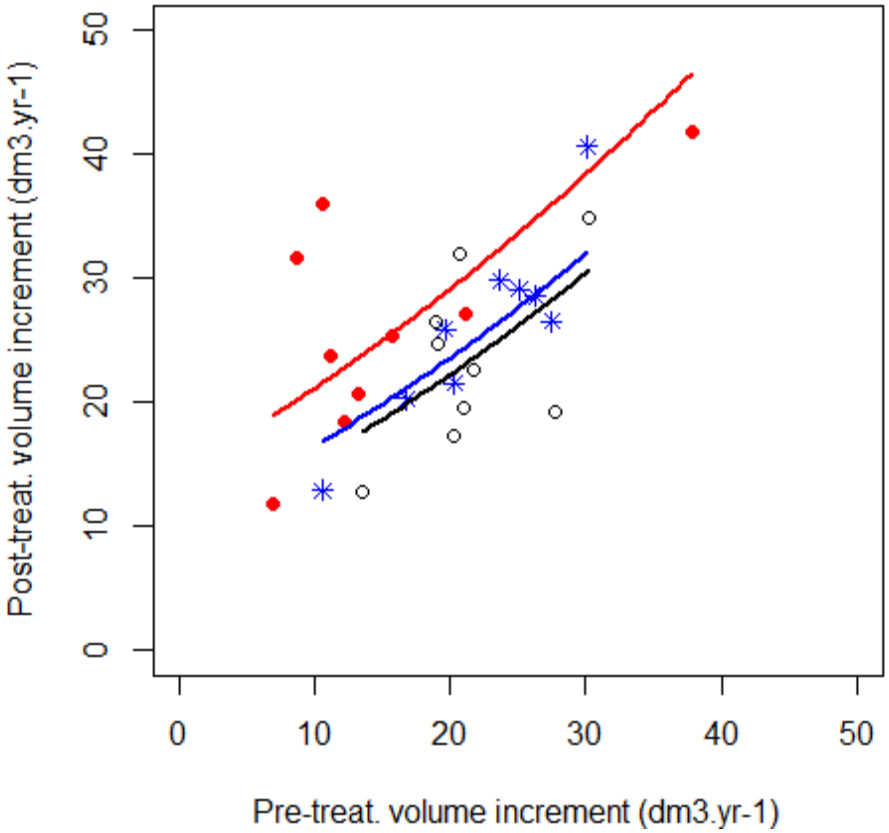
Results:
The effect of treatment, crown status, NCI and pre-treatment tree size

Model	K	AICc	ΔAICc	w_i
AAVI ~ TREAT+SS+PT	8	-43.73	0.00	0.60
AAVI ~ TREAT+SS+PT+NCI	9	-42.88	0.85	0.40
AAVI ~ TREAT+PT	7	-35.55	8.18	0.00
AAVI ~ TREAT+PT+TREAT:PT	9	-30.13	13.60	0.00
AAVI ~ PT	5	-29.58	14.15	0.00
AAVI ~ TREAT+SS+PT+NCI+TREAT:SS+TREAT:NCI+TREAT:PT	15	-28.44	15.30	0.00

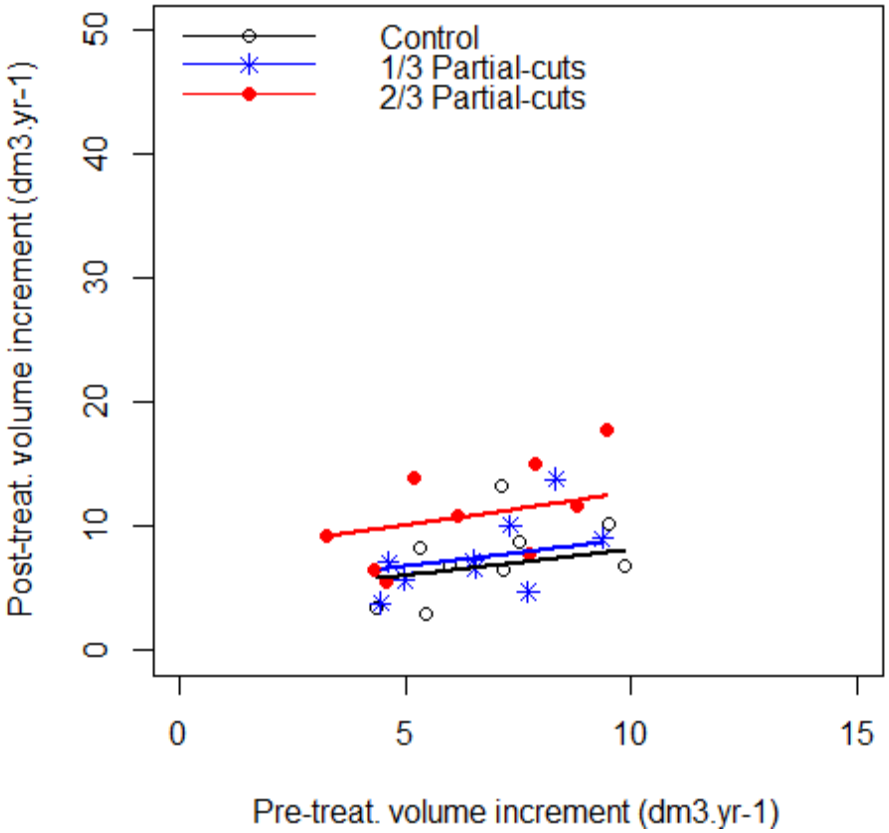
Parameter	Estimate (β)	Lower 95% CI	Upper 95% CI
TREAT1 (1/3 partial-cut vs controls)	0.1003	-0.2489	0.4494
TREAT2 (2.3 partial-cut vs controls)	**0.6308**	**0.2232**	**1.0383**
NCI (neighborhood competition index)	-1.7547	-4.1039	0.5945
PT (pre-treatment size)	**0.0798**	**0.0536**	**0.1061**
SS2 (Co-dominant vs dominant)	**-1.0131**	**-1.4487**	**-0.5776**

Results:
The effect of treatment, crown status, NCI and pre-treatment tree size

Dominant

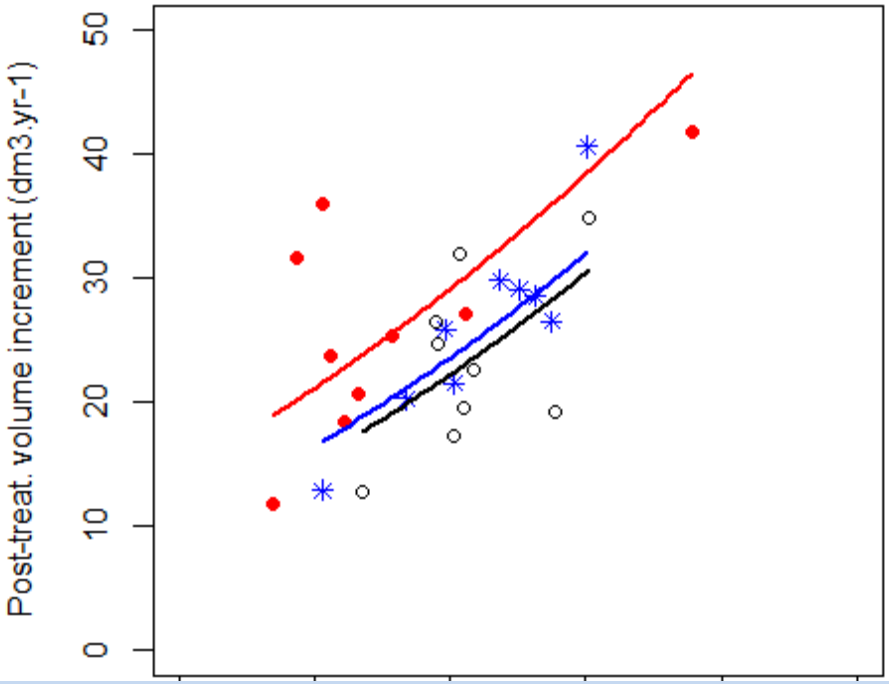


Co-dominant

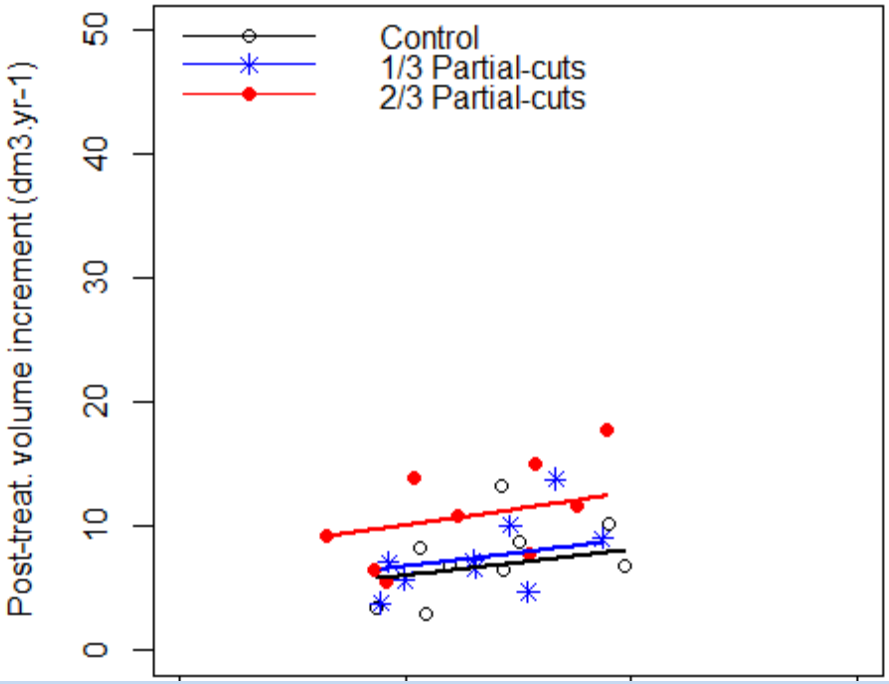


Results:
The effect of treatment, crown status, NCI and pre-treatment tree size

Dominant



Co-dominant



Annual increase in volume of dominant trees was higher by 16.2 dm^3yr^{-1} than that of co-dominants and was proportional to pre-treatment volume growth

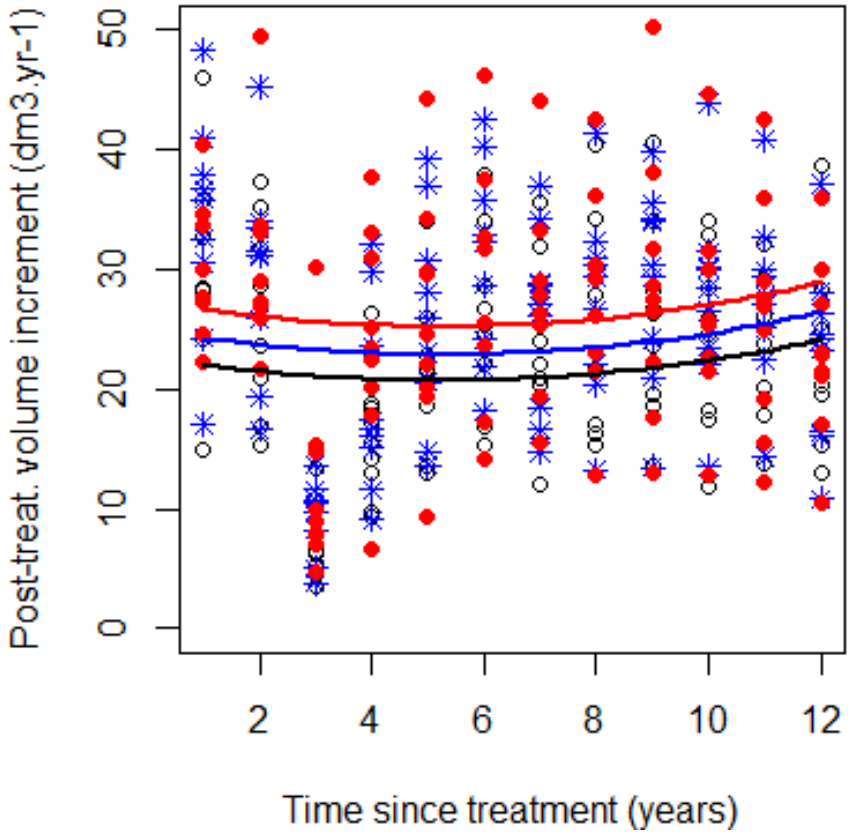
Results:
The effect of Time, treatment and crown status

Model	K	AICc	ΔAICc	w_i
AVI~TREAT+SS+TIME+TIME^2	9	-187.36	0.00	0.98
AVI ~TREAT+SS+TIME	8	-183.83	3.53	0.01
AVI~TREAT+SS+TIME+TIME2+TREAT:SS +TREAT:TIME+TREAT:TIME^2	15	-181.32	6.04	0.01
AVI ~TREAT+SS+TREAT:SS	9	-179.63	7.73	0.00
AVI ~TREAT+SS	7	-178.80	8.55	0.00

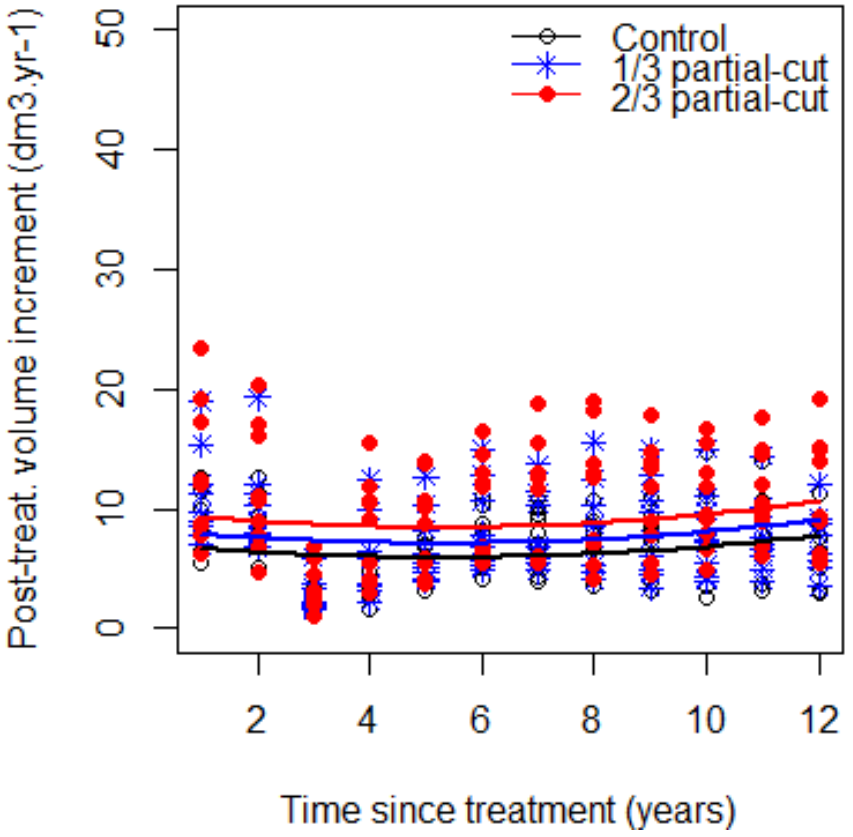
Parameter	Estimate (β)	Lower 95% CI	Upper 95% CI
Time	**0.0198**	**0.0053**	**0.0242**
Time^2	**0.008**	**0.0033**	**0.0127**
TREAT1 (1/3 partial-cut vs controls)	0.2309	-0.1616	0.6234
TREAT2 (2/3 partial-cut vs controls)	**0.4696**	**0.0771**	**0.862**
SS (Co-dominant vs dominant)	**-2.1187**	**-2.4391**	**-1.7982**

Results: Analysis-2,
The effect of Time, treatment and crown status

Dominant

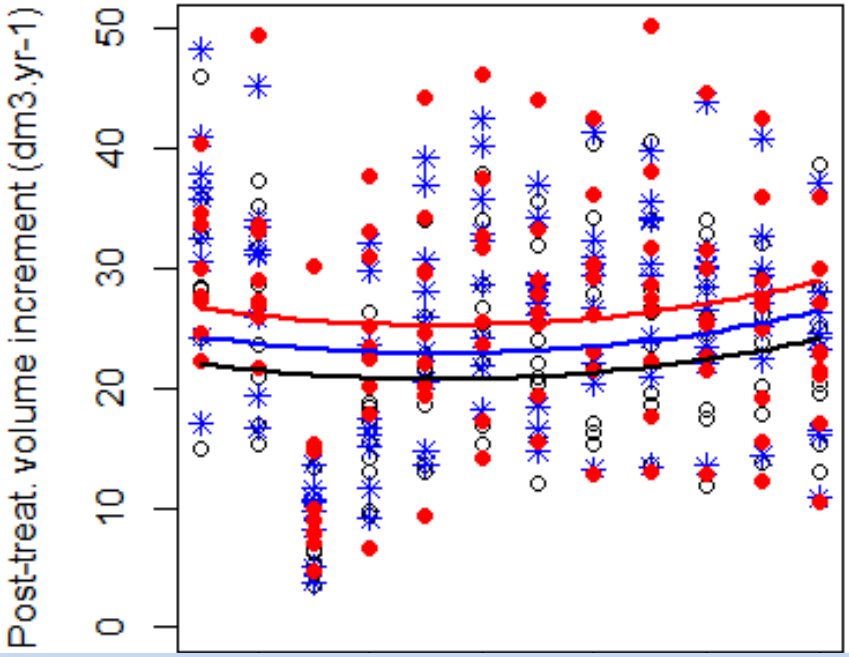


Co-dominant

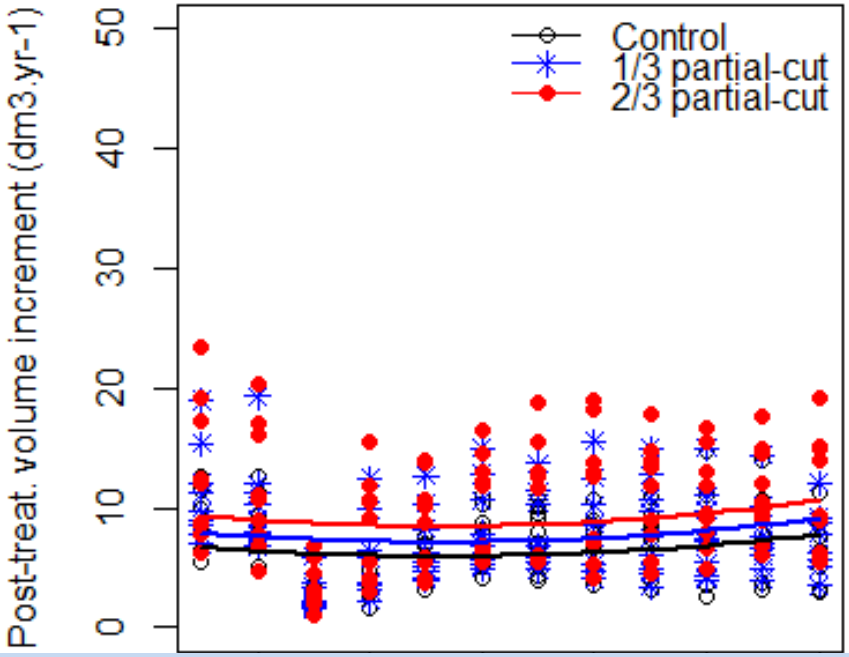


Results: Analysis-2,
The effect of Time, treatment and crown status

Dominant



Co-dominant



Annual increase in volume in the 2/3 partial cut was 25.6 % higher than controls over 12 years

Conclusions

✓**Size before treatment** (Jones and Thomas 2004):

H1-Positive effect √

✓ **Treatment type (intensity and layout of removal)** (Thorpe et al. 2007)

H2-Positive effect √

✓**Tree crown status** (Thorpe et al. 2007)

H3: Dominant>Co-dominant √

✓**Competition among neighbors** (Hartmann et al 2009)

H4-Negative effect X

✓**Time effect** (Thorpe et al. 2007; Jones et al. 2009)

H5-Linear effect √

❑ **Initial (2-5 years) growth lag** (Thorpe et al. 2007; Jones et al. 2009)

Yes X

Merci beaucoup!

Acknowledgements

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