



# Carbon stock growth in ten year-old afforested open woodlands of the boreal forest

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## Context

Terrestrial C absorptions presently mitigate approximately one-third of total human GHG annual emissions (IPCC 2007). Relatively modest efforts could increase this mitigation by another 15% (Nabuurs et al. 2007). Black spruce-lichen open woodlands (OWs) are naturally open stands within Canada's closed-crown boreal forest, and might support the growth of planted trees for C sequestration (Hébert et al. 2006, Girard 2004). Only in the province of Québec, there are approx. 1.6 M ha of OWs, or 7% of the closed-crown boreal forest. It has been recently established that the simulated afforestation of OWs corresponds to a net sequestration of 77 t C ha<sup>-1</sup> after 70 years of growth (Gaboury et al. 2009).

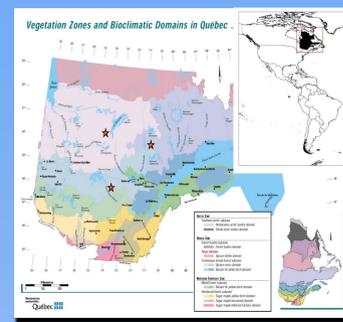
## Objective and hypothesis

To validate the sequestration potential and measure the net C balance of 10 year-old afforested OWs. The hypothesis is that the boreal OWs have a positive C balance ten years after afforestation, compared to the baseline scenario (intact OWs).

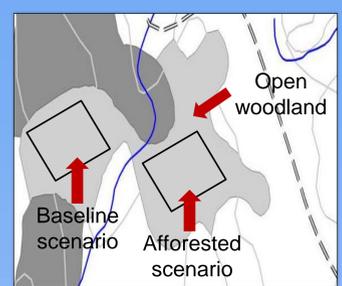
## Methodology

An experimental design was established in 1999-2000 in which plantations in scarified OWs (afforestation scenario) were compared to undisturbed OWs (baseline scenario). The experimental design includes seven experimental blocks (repetitions) among three study sites in the central part of Québec's closed-crown boreal forest. Total C was estimated for the five recommended C pools (IPCC 2003) – aboveground vegetation, roots, humus, mineral soil, and dead biomass. C stocks were estimated with allometric relations of dendrometric measures and dry biomass of samples in each pool.

## Study sites



## Experimental design



## Baseline scenario



## Afforested scenario



## Results

- Only the aboveground and root pools are significantly different between the baseline and afforested scenarios (Fig. 1).
- The predominant C stocks in the mineral soils level off the relatively small differences in the other pools, 10 years after afforestation (Fig. 1).

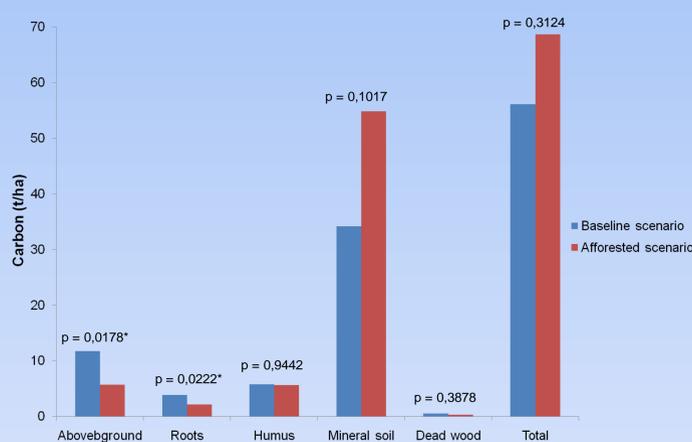


Figure 1. Carbon stocks in the five pools of both baseline and afforestation scenarios, 10 years after afforestation.

- The tree stems and roots contribute to 37,9% and 23,9%, respectively, of the total C stock in all trees of both scenarios (Fig. 2).
- There is no significant difference between the baseline and afforested scenarios in any individual class of tree dominance (Fig. 2). However, the combination of a higher number of trees (not shown) results in the significantly higher C stocks in the aboveground biomass pool of the baseline scenario, compared to the afforested scenario (see Fig. 1).

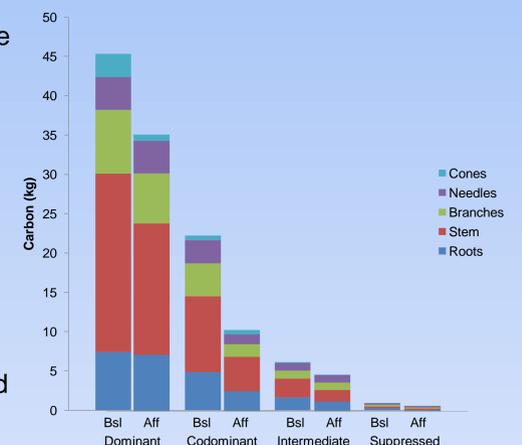


Figure 2. Distribution of biomass compartments in trees according to four classes of dominance. (Bsl = baseline scenario, Aff = afforested scenario)

- The proportion of each compartments to the total C stocks shows that the mineral soil was a major pool in both baseline and afforested scenarios (Fig. 3).
- Black spruce regeneration (planted + natural seedlings) does not contribute much to the total C stocks ten years after afforestation. However, planted jack pine (results not shown) more than doubled the contribution of black spruce, after ten years of growth.

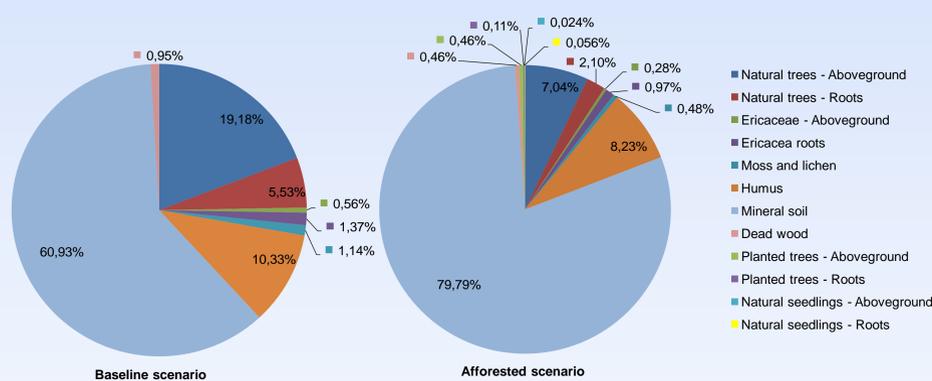


Figure 3. Contribution of each compartment in the total carbon stocks for both scenarios.

## Conclusion

This study is the very first one that presents the C balance of the afforestation of boreal open woodlands (OWs), with allometric equations specific to OWs, after ten years of plantation growth.

The results support the hypothesis that the C balance of afforested OWs is positive ten years after afforestation. This is substantially shorter than the 26 years estimated by the model used in Gaboury et al. (2009). The predominant mineral soil C stocks mitigates any modest difference that results from the afforestation related operations and changes in C pools, ten years after afforestation.

## Reference

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