The GHG offset potential of the open woodland afforestation in the boreal forest of Eastern Canada

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Canadian boreal forest

- 295 Mha, approx. 30% of Canada’s total land and 22% of the world’s boreal forest
Natural crown cover patchiness of Canada’s boreal forest

1. Context
2. Simulated C balance
3. Support capacity
4. C stock permanence
5. Albedo
6. Carbone boréal

Cyclic natural regeneration after wildfire of black spruce stands within the closed-crown boreal forest (~100 years)

Regeneration “failure” after consecutive natural disturbances

Alternative stable state or cyclic maintenance of open black spruce-lichen woodlands (OWs)

Natural crown cover patchiness of Canada’s boreal forest

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Alternative stable state or cyclic maintenance of open black spruce-lichen woodlands (OWs)

OWs = 7% or 1.6 M ha within Québec’s closed-crown boreal forest

## Canadian extent of OWs?

<table>
<thead>
<tr>
<th>Terrestrial Ecozone</th>
<th>Land cover</th>
<th>Landscape position</th>
<th>Density class</th>
<th>Area (ha)</th>
<th>Volume per ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boreal Shield</td>
<td>Vegetated - treed*</td>
<td>Upland</td>
<td>Sparse**</td>
<td>14,907,131</td>
<td>54.8</td>
</tr>
<tr>
<td>Boreal Plains</td>
<td>Vegetated - treed*</td>
<td>Upland</td>
<td>Sparse**</td>
<td>1,514,075</td>
<td>61.9</td>
</tr>
<tr>
<td>Boreal Cordillera</td>
<td>Vegetated - treed*</td>
<td>Upland</td>
<td>Sparse**</td>
<td>6,825,763</td>
<td>91.6</td>
</tr>
<tr>
<td><strong>Total boreal</strong></td>
<td>Vegetated - treed*</td>
<td>Upland</td>
<td>Sparse**</td>
<td><strong>23,246,969</strong></td>
<td><strong>66.1</strong></td>
</tr>
</tbody>
</table>

*Vegetated - treed: Vegetated crown closure ≥ 5%, and Tree crown closure ≥ 10%

**Sparse: Treed cover 10–25%**

Source: Canada's National Forest Inventory 2006

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Map showing the extent of OWs in different ecozones: Boreal Shield, Boreal Plains, Boreal Cordillera.
Assets of afforestation in the boreal zone

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- Significant potential territories available across Canada
- No (or very few) loss of opportunities:
  - Forestry
  - Agriculture
- Cheap and low C-intensive mitigation method
The C balance of simulated OW afforestation (Gaboury et al. 2009)

- Life-Cycle Analysis (LCA) approach
- CO2 FIX model

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**Baseline scenario (intact OW)**

- Total stem
- Leaves
- Branches
- Roots
- Soil
- Total

(30 m³ ha⁻¹ at 120 years)

**Afforestation scenario (planted OW)**

- Total stem
- Leaves
- Branches
- Roots
- Soil
- Total

(Site index 6m at 25 years, 175m³ ha⁻¹ at 70 years)
The C balance of simulated OW afforestation (Gaboury et al. 2009)

- End-of-project sequestration (70 years) = 77 t C ha\(^{-1}\)
- Net C balance: positive after 27 years
  -> initial tree harvesting simulated
Operations related emissions (LCA)

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Seed production

Plantation

GHG quantification...

<1% of net C sequestration

Harvesting

Transport and site access

Containerized seedling

Scarification
Boreal OW afforestation: Known issues

1. Support capacity?
   - Growth and yield (C sequestration)
   - Soil fertility

2. C stocks permanence?
   - Natural disturbances related reversal risk
   - Harvested wood products

3. Albedo (surface radiative forcings)?
   - Albedo management
Support capacity projects: Site location

- 7 experimental blocks among 3 sites in Québec’s closed-crown boreal forest
Support capacity projects: experimental design

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- BSFM = “productive” control
• 65% less height growth in planted OWs than in planted BSFM
• 120% more height growth with jack pine than with black spruce in afforested OWs (posters #G-163 and #G-164)
Growth and yield of afforested OWs

Gaboury et al. (2009)
Site Index used (143 cm at 10 yrs)

• Projected yield: not with black spruce!
Support capacity: soil fertility

- Sustained (10 years) lower nutrient stocks in OW mineral soils → early growth limitation?

(poster #G-162)
Support capacity: C stock growth

- 10 years after afforestation = predominance of mineral soils (first B horizon)
- No evidence of net C emissions after 10 years

(poster #G-165)
Mature OWs VS mature BSFM stands

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Mature OWs (=Baseline scenario)
Mature BSFM stands (≈Afforestation scenario)
Comparable stand characteristics (stand age, soil deposits, slope, aspect, drainage, etc.)
1. Context

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Mature OWs VS mature BSFM stands

80 yr-old OWs

(=Baseline scenario)

15 t C ha⁻¹

80 yr-old BSFM stands

(≈Afforestation scenario)

113 t C ha⁻¹
Reversal risk management =
- Prevention (spatial dispersion, buffers, fuel management)
- Accounting (disturbance-explicit C balance, insurance products)
- Avoidance (harvested wood products + substitution)

(from Gaboury et al. 2009)
Albedo change related forcing

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Albedo change related forcing

- Some hypotheses to test:
  1. Deciduous planted tree species (larch, birch, etc.)?
  2. “Inclusive” baseline scenario = OWs + C-intensive products (concrete, steel, etc.)
Carbone boréal in the voluntary C market…
a new research funding opportunity

carboneboreal.uqac.ca
Merci!