IMPROVING ON-FARM ECOSYSTEM SERVICES WITH POPLAR BUFFERS

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Riparian buffers in Québec

Narrow herbaceous strips or no buffer at all!

- Low water quality functions
- Low terrestrial, riparian and aquatic biodiversity
- Reservoirs of agricultural weeds & exotic plants
- Low hydrological regulation
- Low erosion control & poor soil formation
- Low C and nutrient storage in biomass

Hybrid poplar riparian buffers as an alternative...
Establishing a poplar buffer

Planting poplars in agricultural riparian zones

• Why? Adapted to disturbed riparian environments
• No site preparation, no fertilizer needed
• Fencing needed in pasture
• Large planting stocks (cervids)
• Weed control
  • Herbicide (1m²/tree, once in the first year)
  • Large strips of black plastic mulch (flat terrain)
• Target small streams first
• Avoid areas with beavers or fence the buffer

One example of narrow hybrid poplar buffers

• Planted in 2003 (B. Truax & D. Gagnon)
• 2222 trees/ha (1.5 m between x 3 m within rows)
• 3 Poplar rows (4.5 m wide / streambank)
• 5 Poplar hybrids (N×M, D×N, M×B, T×D, DN×M)
• 1 row of silver maple in the active channel zone
Brompton site (at planting) – High fertility
Brompton site (1st year) – After weed control
Brompton (6 yrs) – Upstream of the buffer
St-Isidore site (9 yrs) – Moderate fertility
St-Isidore (9 yrs)
St-Isidore (9 yrs)
- Service I -

Wood & biomass production
How much Wood & Biomass?

<table>
<thead>
<tr>
<th>Sites</th>
<th>Volume (m³/ha/yr)</th>
<th></th>
<th>Biomass (t/ha/yr)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 yrs</td>
<td>9 yrs</td>
<td>6 yrs</td>
<td>9 yrs</td>
</tr>
<tr>
<td>Brompton</td>
<td>37.8</td>
<td>49.9</td>
<td>16.1</td>
<td>21.4</td>
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<tr>
<td>St-Isidore</td>
<td>15.6</td>
<td>30.7</td>
<td>6.6</td>
<td>13.3</td>
</tr>
<tr>
<td>Roxton</td>
<td>11.3</td>
<td>26.3</td>
<td>4.9</td>
<td>11.4</td>
</tr>
<tr>
<td>Magog</td>
<td>3.9</td>
<td>12.8</td>
<td>1.8</td>
<td>5.7</td>
</tr>
</tbody>
</table>

Fortier et al. 2013 – Sustainability

Some comparatives

- Natural forests of Québec (1-3 m³/ha/yr)
- Aspen stands – best sites in Québec (10 m³/ha/yr)
- SRC with willows – best sites in Québec (20-25 t/ha/yr)
- Eucalyptus – tropical countries (40 m³/ha/yr or +)
Soil Nitrate & Poplar Growth

Fortier et al. 2010 – Biomass Bioenergy
Hybrid poplar = Fuelwood for farmhouses
Pruned poplar buffer for solid wood products (dense understory = good runoff control)
- Service II -

Phytoremediation & C storage
Enlargement of the nutrient capture zone (laterally and at depth)
Instream nutrient capture
### C, N & P biomass storage (9 yrs)

<table>
<thead>
<tr>
<th>Sites</th>
<th>Gain in storage after 9 yrs</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C (t/ha)</td>
<td>N (kg/ha)</td>
<td>P (kg/ha)</td>
<td></td>
</tr>
<tr>
<td>Brompton</td>
<td>107</td>
<td>1120</td>
<td>141</td>
<td></td>
</tr>
<tr>
<td>Magog</td>
<td>29</td>
<td>284</td>
<td>29</td>
<td></td>
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<tr>
<td>Roxton</td>
<td>59</td>
<td>495</td>
<td>56</td>
<td></td>
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<tr>
<td>St-Isidore</td>
<td>63</td>
<td>628</td>
<td>52</td>
<td></td>
</tr>
</tbody>
</table>

Fortier et al. 2015 – J. Env. Management

### Replacing herbaceous buffers by poplar buffers

- **Trees** = New on-farm storage pool for C, N & P
- **Unharvested grass buffers** = No long-term storage
- **Trees harvest** = N & P exportation offsite
Sites with high N and P load

• High growth rate
• High N & P conc.
  • Leaves
  • Branches
  • Stems
  • Coarse roots
• Synergy N & P storage
• High N & P phytorem. in agricultural riparian soils

Soil Nitrate & Buffer Types

Fortier et al. 2015 – J. Env. Management
Soil Phosphorus & Buffer Type

Fortier et al. 2015 – J. Env. Management
Soil NO₃, Tree Species & Weed manag.

Results from 4th growing season (Truax et al., under review)
- Service III -

Microclimate Creation & Corridors for Biodiversity
Canopy closure above the stream (6 yrs)
Positive Effects on Plant Diversity

Canopy closure: shading out introduced (exotic) plants

- Reduction in exotic species diversity & abundance
- No effect on native plants (more shade-tolerant)

Fortier et al. 2011 – New Forests
Impatiens capensis (native wetland species)
Reduction of water temperature & algal blooms
Nurse crop for natural regeneration
(Boothroyd et al. 2013 – Forest Ecol. Management)
Nurse crop for underplanted hardwoods
(B. Truax, unpublished data)
Nurse crop for high value forest herbs
(Boothroyd-Roberts et al. 2013 – Springer Plus)
Poplar buffers as nesting & feeding sites for birds
Poplar buffers as refuge for predator species
(Pageault 2013, M.Sc. Thesis)
Poplar trees, ideal for burrow location!
Understory of a M×B hybrid (6 yrs)
Understory of a D×N hybrid (6 yrs)
Service IV

Hydrological Regulation, Channel Formation & Soil Protection
Source of coarse woody debris (11 yrs)
Woody debris & tree trunks dissipate stream energy (less erosion, more sediment & debris trapping)
Trees allow channel widening vs. downcutting
(Bank erosion is normal along straightened streams)
For concentrated flow path used wider buffers, stiff-stemmed grass filter strips, grassed waterways
Management Considerations

(1) Intensive buffers (5-10 year rotations)
   - **Objective**: Maximize biomass and nutrient uptake
   - Whole tree harvest, clearcutting & coppicing
   - Select clones with high juvenile productivity

(2) Semi-Intensive buffer (10-20 year rotations)
   - **Objective**: Higher quality wood logs
   - Tree pruning, partial & periodic harvest
   - Select most resilient clones with straight bole

(3) Forest reconstruction buffer
   - **Objective**: improve biodiversity & habitat complexity
   - Underplanting (conifers, hardwoods, wetland plants)
   - Snags & deadwood retention / production
   - Maintain closed canopy
   - Improve spatial heterogeneity (landscape scale)
   - Connect with upland and riparian forests
What’s next? Wide bioenergy filter strips located downslope of agricultural fields
Acknowledgments!

To the private landowners

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References


