Trends in boreal forest productivity: post-disturbance recovery considerations

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Boreal forest productivity

- Large biome where tree density, height and biomass generally decrease from south to north

- A system driven by disturbances (stand-replacing or not)

- Remote sensing work suggested that over a 12-yr period: 8.5% of forest cover loss, compared to only 2.9% in gain (Hansen et al. 2013)

Main-stand replacing disturbances
(fires and harvesting)


Hansen et al. 2013. Science 342, 850
Fires vs harvesting

Forest cover losses:
-- largely due to fire in lower productivity forests
-- mostly due to harvest in higher productivity forests

Forest cover gains:
-- on sites with similar productivity, gains greater on harvested sites than in burns
-- as fires burn both productive and non-productive forests and kill understory regeneration

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For disturbances that occurred in 1990: Gains in tree cover (>5m) were slower and lower in burned than in harvest areas

Post-disturbance juvenile growth is slow and non-linear

<table>
<thead>
<tr>
<th>Time to reach 2m</th>
<th>Black spruce (between 51 N and 53 N)</th>
<th>Black Spruce (49 N)</th>
<th>Jack Pine (between 51 N and 53 N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25th</td>
<td>22 yrs</td>
<td>5 yrs</td>
<td>12 yrs</td>
</tr>
<tr>
<td>Median</td>
<td>30 yrs</td>
<td>10 yrs</td>
<td>17 yrs</td>
</tr>
<tr>
<td>75th</td>
<td>40 yrs</td>
<td>20 yrs</td>
<td>22 yrs</td>
</tr>
</tbody>
</table>

Assessment of productivity in eastern Canada

- Limit of commercial forestry
- Closed conifer boreal forest meets the open woodland area
- Scientific assessment of the possibility to extend forestry up north with work on forest productivity and fire

Potential and current productivity

1) Stand potential productivity: Based on site index only
2) Stand current productivity: Based on site index and stem density

To reduce uncertainty of stand-level estimates, compute and compare the proportion of potential and current productive sites (commercial volume within 120 years) in ecodistricts (3-500 km²)
Potential productivity

Potential productivity: proportion of ecological districts with forest stands that can reach the commercial volume (Explained by climate, surficial geology and topography)

Current productivity

Current productivity: proportion of ecological districts with forest stands that can reach the commercial volume (Explained by climate, surficial geology, topography, open woodland % and Fire)

Potential and current productivity
From closed forest to open woodland (LW)

Girard et al. 2008. J. Biogeography 35:529 537

From closed forest to open woodland

Closed forests → Crown fire
Viable seeds & adequate germination and survival conditions for seedlings → Stand density is maintained
Stand density is reduced → Open woodland
Fire → Open woodland

Lack of viable seeds & inadequate germination and survival conditions for seedlings

Density changes: *(from pre-fire to post-fire conditions)*

Density can change because of:

- Lack of seed supply (fire interval, tree size, seed prod)
- Post fire climate/weather conditions
- Competition (ericaceous)
Juvenile growth changes \textit{(from pre-fire to post-fire conditions)}

**Black spruce**

**Jack pine**

Early growth can change:

- Fire severity
- Post fire climate/weather conditions
Summary

- Post-fire recovery is a slow process; a long time is required to assess it.

- Observed change in stand density; related to fire return intervals and weather conditions at establishment.

- Observed change in juvenile growth.

- Difficult to conclude on the processes involved in the trends (high variability).
Summary

- Increase number of short intervals between disturbances + dryer climate: more open woodland

- Interaction between post-disturbance climate/weather conditions, landscape physical set-up and stand density

- Combining disturbance history, field work and remote sensing will help to understand these processes
• In the coniferous boreal forest (Québec) there were large fire years at a frequency of 6-7 years:

• Over a 30 yrs period: only a few of these
• Usually under extreme weather
• burning a diversity of physical conditions