Research and application of Enhanced Forest Inventory across Canada

Development of Methods and applications of Enhanced Forest Inventory in Newfoundland

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1. Modeling wood fibre attributes using forest inventory and environmental data for Newfoundland’s boreal forest

Lessard et al. (2014)
Fibre Quality Mapping

2. Predicting wood quantity and quality attributes of balsam fir and black spruce using airborne laser scanner data

Luther et al. (2014)
3. Predicting wood fibre attributes using local-scale metrics from terrestrial LiDAR data: a case study of Newfoundland conifer species

Blanchette et al. (2015)
4. Assessing the impact of fine-scale structure on prediction models for fibre attributes

*Plot structure reconstructed from TLS scans of individual trees*

*Côté et al. (In Preparation)*

**Tree Level**
- Branching structure
- Crown attributes
- Crown heterogeneity
- Spatial distribution of material (foliage and wood)

**Plot Level**
- Branching structure
- Crown attributes
- Plot heterogeneity
- Canopy gaps
- Spatial distribution of material (foliage and wood)

**Fibre Attribute modeling**
as a function of new attribute derived from TLS data and Architectural modeling
Wood fibre attributes are correlated with forest structural variables that can be remotely sensed!!

<table>
<thead>
<tr>
<th>Scale</th>
<th>Species</th>
<th>Lessard et al. (Inventory + Environment)</th>
<th>Luther et al. (Airborne LiDAR)</th>
<th>Blanchette et al. (Terrestrial LiDAR)</th>
<th>Côté et al. (L-Architect)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plot</td>
<td>Black Spruce</td>
<td>0.52-0.61</td>
<td>0.51-0.62</td>
<td>0.63-0.72</td>
<td>0.79-0.89</td>
</tr>
<tr>
<td></td>
<td>Balsam Fir</td>
<td>0.35-0.48</td>
<td>0.28-0.61</td>
<td>0.37-0.63</td>
<td></td>
</tr>
<tr>
<td>Tree</td>
<td>Black Spruce</td>
<td></td>
<td></td>
<td></td>
<td>0.78-0.90</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Improving the characterization of forest structure generally improved our ability to predict fibre attributes
Area Based Approach

- Research involving the fusion of remote sensing data to enhance EFI predictions
Refinements to Area Based Approach

Evaluating of LiDAR-derived textural metrics to enhance predictions

Texture analysis using the Grey-Level Co-Occurrence Matrix (GLCM)

1m Canopy Height Model

20m GLCM metrics

Correlation
Homogeneity
Second Moment
Entropy
Dissimilarity

Forest Attributes
- avgHGT
- liveSTEMS
- Spercent
- sumGMV
- SWpercent
- SWsumGMV

Canadian Wood Fibre Centre
Working together to optimize wood fibre value - creating forest sector solutions with FPInnovations
Extending Enhanced Forest Inventories

- Development of sample-based methods for large area inventory applications where wall to wall ALS is not feasible
Surrogate Plot Development

- Fine-scale 3D reconstruction of boreal forest plots to improve forest characterization with remote sensing
  
  Côté et al. (Submitted)

**Reference plots**
- + in situ measurements
- Branching structure
- Crown attributes
- Plot heterogeneity
- Tree volume
- Spatial distribution of material

**Simulated ALS**
- HGT
- DBH
- Crown Projected Area

**Surrogate plots**
- Reference plots
- L-Architect

**Statistical relationships**
- Lacunarity
  - $y = 1.06x - 0.28$
  - $R^2 = 0.93$ (p = 0.000)
  - NRMSE = 0.084

- Canopy Surface Area ($m^2$)
  - $y = 0.95x + 125.49$
  - $R^2 = 0.95$ (p = 0.000)
  - NRMSE = 0.063

- Canopy Surface Volume ($m^3$)
  - $y = 0.97x + 193.76$
  - $R^2 = 0.95$ (p = 0.000)
  - NRMSE = 0.070

- Sidev CMM (m)
  - $y = 0.48x + 1.97$
  - $R^2 = 0.52$ (p = 0.000)
  - NRMSE = 0.155

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