CASES STUDIES - EXPERIENCE WITH LIDAR IN FOREST OPERATIONS (EASTERN BOREAL)

January, 2020
Agenda

- Introduction marginal stands
- Process and analysis
- Forest structures identification
- Cases studies
- Budworm slavaging
Marginal stands

Applications

- Stands with small DBHs
- Stands with low merchantable volumes
- Two-story stands
Need

- Characterize the variability of stands caused by all sorts of natural disturbances
- Support the operator decision (partial cutting)
- Evaluate harvesting viability
Objective

- Develop mapping process that would ease the harvesting operations in marginals stands by identifying typical structures
Where it started...No tree marking

2008 - Silvicultural approach to rehabilitation of low value stands
- History of high-grade harvesting or natural disturbances
- High variability in stand structure
- No unique treatment
Combinaison of three innovations
Process

Keys to success:

1. Simple
2. Reproducible
3. Efficient
4. Low cost
Process

Raw data → Analysis → Prescription → Harvesting

<table>
<thead>
<tr>
<th>Tiles id</th>
<th>POSITION</th>
<th>Stand structure</th>
<th>CODE</th>
<th>PRESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2377009</td>
<td>7608008 0</td>
<td>010</td>
<td>% Medium</td>
</tr>
<tr>
<td>2</td>
<td>2377029</td>
<td>7608008 1</td>
<td>100</td>
<td>Wait</td>
</tr>
<tr>
<td>3</td>
<td>2377049</td>
<td>7608008 1</td>
<td>111</td>
<td>% Large</td>
</tr>
</tbody>
</table>
Forest structure identification

Related to:

- Canopy height
- Variation of height within the same stand
- Number of cohorts
- Stage of maturity
- Presence of gaps
Forest structure identification

- Canopy Height
  - Stage of maturity
  - Presence of gaps
Forest structure identification

- Canopy Height

Profile view
Forest structure identification

- Canopy Height

Profile view

Height (m)

Maturity (locally validated)

CHM
Forest structure identification

- Canopy Height
Forest structure identification

- Canopy Height
  From the top

![Forest structure diagram showing canopy height variations](image-url)
Forest structure identification

- Vertical Complexity Index (VCI)
  - Help to interpret the maturity stage and also the number of cohorts in the stand
Forest structure identification

- Vertical Complexity Index (VCI)
  - Help to determine the stage and also the number of cohorts

Forest structure identification

- Young structure, initiation stage
Forest structure identification

- Mature uniform structure, 1 cohort
Forest structure identification

- Young to mature uniform structure, 1-2 cohorts
Forest structure identification

- Mature irregular structure, multistory
Forest structure identification

Prescription: Interpretation of the CHM support by the VCI

LiDAR \[\text{CHM} + \text{VCI}\]
Case 1: Edmundston, N-B, 2016

Summary of the trial

- Optimize harvesting
- Minimise traveling

Potential savings of 17%
=> 150$/day
Case 2: Baie-Comeau, Qc, 2017

Summary of the trial

<table>
<thead>
<tr>
<th></th>
<th>Test 1</th>
<th>Test 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average harvested stem</td>
<td>0.081</td>
<td>0.094</td>
</tr>
<tr>
<td>(m³/stem)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Productivity (m³/PMH)</td>
<td>11.3</td>
<td>12.5</td>
</tr>
<tr>
<td>Hourly rate ($/PMH)</td>
<td>175</td>
<td>175</td>
</tr>
<tr>
<td>Savings ($/m³)</td>
<td>1.49</td>
<td></td>
</tr>
</tbody>
</table>

Test 1: Clearcut as usual
Test 2: Clearcut using an improved prescription
Case 3: Baie-Comeau, Qc, 2017

Cutting with protection of smalls merchantables stems
- DBH 10-12-14 cm left as valid regen

Summary of the trial

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<thead>
<tr>
<th></th>
<th>Test 1</th>
<th>Test 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average harvested stem (m³/stem)</td>
<td>0.117</td>
<td>0.121</td>
</tr>
<tr>
<td>Productivity (m³/PMH)</td>
<td>13.0</td>
<td>13.8</td>
</tr>
<tr>
<td>Hourly rate ($/PMH)</td>
<td>175</td>
<td>175</td>
</tr>
<tr>
<td>Savings ($/m³)</td>
<td>0.75</td>
<td></td>
</tr>
</tbody>
</table>

Test 1 : Clearcut as usual
Test 2: Clearcut using an improved prescription
Budworm salvaging

Why?

- Tree degradation classification
- Minimise salvaging costs
- Wood basket value-added
Budworm salvaging

Step 1
- Classification of each tree according to the adapted Hunter tree classification
Budworm salvaging

Step 2
- RGB with a drone
Budworm salvaging

Step 3

- Building the vigor map
Budworm salvaging

Step 3

- Integrate the classification into mapping process
Budworm salvaging

Step 4

Validation

<table>
<thead>
<tr>
<th></th>
<th>Healthy</th>
<th>Moderate</th>
<th>Severe</th>
<th>Dead</th>
<th>% Match</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Moderate</td>
<td>75</td>
<td>5</td>
<td></td>
<td></td>
<td>93</td>
</tr>
<tr>
<td>Severe</td>
<td>2</td>
<td>38</td>
<td></td>
<td></td>
<td>94</td>
</tr>
<tr>
<td>Dead</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>100</td>
</tr>
</tbody>
</table>

...94% match
Case 4: Baie-Comeau, Qc, 2018

Summary of the trial

<table>
<thead>
<tr>
<th></th>
<th>Test 1</th>
<th>Test 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvested volume (m³)</td>
<td>584</td>
<td>513</td>
</tr>
<tr>
<td>Productivity (m³/PMH)</td>
<td>13.3</td>
<td>13.8</td>
</tr>
<tr>
<td>Hourly rate ($/PMH)</td>
<td>175</td>
<td>175</td>
</tr>
<tr>
<td>Savings ($/m³)</td>
<td>0.41</td>
<td></td>
</tr>
</tbody>
</table>

Test 1 : Clearcut as usual
Test 2: Salvaging using the logging map
Our next challenge

Two stages stands...
Thank you

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