Estimating and modelling harvester productivity in pine stands of different ages, densities and thinning intensities

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Content

1) Introduction: productivity in wider context
2) Hypothesis
3) The objective: age, density and thinning intensity
4) Materials and methods
5) Results
6) Conclusion
Material and methods: sample plots

Drawno Forest District - sample plots in selected compartments

Legend
- AC3
- AC4
- AC5
- borders

1:20 000
Material and methods: stands and trees
Material and methods
Results: productivity in AC’s and THI’s

<table>
<thead>
<tr>
<th></th>
<th>P SMH</th>
<th>std error</th>
<th>r</th>
<th>min</th>
<th>max</th>
<th>groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>3</td>
<td>18.57</td>
<td>0.9198</td>
<td>17</td>
<td>12.64</td>
<td>27.60</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>22.24</td>
<td>1.0960</td>
<td>19</td>
<td>12.99</td>
<td>32.61</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>22.60</td>
<td>0.8834</td>
<td>20</td>
<td>17.84</td>
<td>30.90</td>
</tr>
<tr>
<td>THI</td>
<td>A</td>
<td>16.19</td>
<td>1.1337</td>
<td>4</td>
<td>12.99</td>
<td>18.07</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>21.44</td>
<td>0.7398</td>
<td>32</td>
<td>12.64</td>
<td>32.61</td>
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<tr>
<td></td>
<td>C</td>
<td>21.98</td>
<td>1.0793</td>
<td>20</td>
<td>15.56</td>
<td>30.90</td>
</tr>
</tbody>
</table>
Results: productivity as function of

- thinning intensity, m³ ha⁻¹
- mean DBH of harvested trees, cm
- number of trees in the stand before thinning, n. ha⁻¹
- number of harvested trees, n. ha⁻¹
## Results: correlation matrix

<table>
<thead>
<tr>
<th></th>
<th>Number of whole stand trees</th>
<th>Number of harvested trees</th>
<th>Mean DBH of whole stand trees</th>
<th>Mean DBH of harvested trees</th>
<th>THI</th>
<th>Harvested volume</th>
<th>Mean volume from one tree</th>
<th>Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of whole stand trees</td>
<td>1</td>
<td>0.81</td>
<td>-0.7</td>
<td>-0.67</td>
<td>0.47</td>
<td>0.11</td>
<td>-0.55</td>
<td>-0.46</td>
</tr>
<tr>
<td>Number of harvested trees</td>
<td>0.81</td>
<td>1</td>
<td>-0.71</td>
<td>-0.62</td>
<td>0.56</td>
<td>0.04</td>
<td>-0.72</td>
<td>-0.36</td>
</tr>
<tr>
<td>Mean DBH of whole std trees</td>
<td>-0.7</td>
<td>-0.71</td>
<td>1</td>
<td>0.94</td>
<td>-0.21</td>
<td>0.46</td>
<td>0.83</td>
<td>0.64</td>
</tr>
<tr>
<td>Mean DBH of harvested trees</td>
<td>-0.67</td>
<td>-0.62</td>
<td>0.94</td>
<td>1</td>
<td>-0.09</td>
<td>0.47</td>
<td>0.72</td>
<td>0.78</td>
</tr>
<tr>
<td>THI</td>
<td>0.47</td>
<td>0.56</td>
<td>-0.21</td>
<td>-0.09</td>
<td>1</td>
<td>0.5</td>
<td>-0.31</td>
<td>0.22</td>
</tr>
<tr>
<td>Harvested volume</td>
<td>0.11</td>
<td>0.04</td>
<td>0.46</td>
<td>0.47</td>
<td>0.5</td>
<td>1</td>
<td>0.41</td>
<td>0.37</td>
</tr>
<tr>
<td>Mean volume from one tree</td>
<td>-0.55</td>
<td>-0.72</td>
<td>0.83</td>
<td>0.72</td>
<td>-0.31</td>
<td>0.41</td>
<td>1</td>
<td>0.35</td>
</tr>
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<td>Productivity</td>
<td>-0.46</td>
<td>-0.36</td>
<td>0.64</td>
<td>0.78</td>
<td>0.22</td>
<td>0.37</td>
<td>0.35</td>
<td>1</td>
</tr>
</tbody>
</table>
Results: modelling

\[ Y = -7.8920 + 1.2494 \times DBH_{\text{mean}} - 0.8587\delta_4 - 1.3237\delta_5 + 3.7631\delta_b + 5.2550\delta_c \]

\[ Y \] mean productivity per PMH,

\[ DBH_{\text{mean}} \] mean DBH of harvested trees,

\[ \delta_i \] Kronecker’s delta,

\[ \delta_i = \begin{cases} 1 & \text{stand of } i - \text{age class (of } i - \text{thinning intensity)} \\ 0 & \text{in other case} \end{cases} \]

\[ Y = 8.607 + 6.990 \times V_{\text{mean}} + 3.901\delta_4 + 2.891\delta_5 + 7.720\delta_b + 9.401\delta_c \]

\[ R^2 = 0.7168 \]

\[ R^2 = 0.3934 \]
The productivity of the Komatsu 931.1 harvester increased along with:

1) older AC,
2) the decreasing number of trees in the initial stand in each AC,
3) the lowering number of trees for harvesting in AC3 and AC5, and
4) the increasing THI only in older AC (AC4 and AC5).

The model presents, the larger the mean DBH of the trees for harvesting, the greater the productivity.

**However, within the same mean DBH, the older the AC, the lower the productivity.**
Thx

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**full paper will be published in CROJFE:**

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