Structural diversity and height growth models in urban forest plantations: a case-study in northern Italy

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Estimation of growth models and forest vertical structure are important for:

• forest species differentiation;
• biomass analysis;
• biodiversity studies;
• setting of management strategies;
• visitors preferences studies.
Structural patterns are affected by:

- environmental factors;
- spatial heterogeneity;
- disturbances and competition;
- age of plantations;
- tree mortality;
- plantation typologies.
Environmental benefits provided by urban forests can be analyzed with dendrometric variables at different ages.

This study assessed urban forest plantations in terms of tree height growth, crown width and vertical structural diversity using as a case study the urban forest plantation of Parco Nord.
Methods

Tree inventory data collected have been used for:
• developing tree growth models assessing height and crown width for the main taxonomic units
• analyzing the temporal pattern of increments in tree height
• assessing the vertical forest structure
Methods

Tree growth models
Field data were used to build models based on variables (DBH, soil fertility, stand density, age of trees) according to Bennet and Clutter algorithm (1968)

\[ \ln(H) = b_0 + b_1 SI + b_2 N + b_3 \frac{1}{\text{AGE}} + b_4 \frac{1}{\text{DBH}} \]
Methods

*Vertical structure*
Were applied a quantitative method based on the Latham algorithm that defines a vertical cut-off point and assigns trees to vertical strata based on tree height and crown lengths layers:

\[ CPS = 0.40CL + HBLC \]
Tree growth models

The 546 trees were divided in 8 different taxonomic units grouped at genus level
Results

Tree growth models

![Graph showing current annual increment of height vs age for different clusters.](image-url)
Results

Tree growth models

- **Acer spp.**
  - 10 years
  - 18 years
  - 26 years

- **Carpinus betulus**
  - 10 years
  - 18 years
  - 26 years

- **Fraxinus spp**
  - 10 years
  - 18 years
  - 26 years

- **Prunus avium**
  - 10 years
  - 18 years
  - 26 years
Results

*Vertical structure*

Were identified:
• 2 plots with 2 layers
• 4 plots with 3 layers
• 1 plot with 4 layers
Results

Reduced complexity of stand
Dominant layer is represented by 82% of trees (96% of basal area)
Results

Major complexity of stand
Top layer is represented by 50% of trees (81% of basal area)
Results

Vertical stratification is explained by four distinct layers:

<table>
<thead>
<tr>
<th>layer</th>
<th>min Height (m above ground)</th>
<th>mean DBH (cm)</th>
<th>mean Height (m)</th>
<th>number of trees %</th>
<th>basal area %</th>
<th>species</th>
</tr>
</thead>
<tbody>
<tr>
<td>top/ dominant</td>
<td>13</td>
<td>23</td>
<td>17</td>
<td>38</td>
<td>77</td>
<td>Q. cerris, Q. robur, Fraxinus spp.</td>
</tr>
<tr>
<td>second</td>
<td>7</td>
<td>12</td>
<td>10</td>
<td>37,5</td>
<td>21</td>
<td>C. betulus, Fraxinus spp., Acer spp.</td>
</tr>
<tr>
<td>third</td>
<td>3,7</td>
<td>2 – 4,5</td>
<td>5</td>
<td>24,5</td>
<td>1,8</td>
<td>P. avium, Acer spp., Tilia spp., Ulmus spp.</td>
</tr>
<tr>
<td>fourth</td>
<td>1,6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
✓ Competition between trees is mainly affected by diametrical differentiation rather than hypsometric variation

✓ The presence of multiple layers of vegetation can ensure high levels of biodiversity

✓ Diameter and height are key parameters for structure analysis
Conclusion

Well formed and differentiated forest stands play a key role in providing benefits in urban contexts.

The analysis of dendrometric variables at different ages allow a better understanding of the structure and the evolutorial dynamics of forest stands.

Longitudinal and radial tree growth have different temporal patterns.
Next steps

LIDAR data analysis
• “Low cost” tool to study forest structure
• 3D view of reality
• Based on low number of ground control points
• Highly sensitive
• User friendly viewing of results
Next steps