From Sapling to Maturity - Exploring Structural Diversity in Urban Forests

Justin Morgenroth
New Zealand School of Forestry
University of Canterbury

David Nowak
USDA Forest Service
Motivation for Study

Big trees seemed to be disappearing from the landscape all around me
Perception of a Problem

“Large old trees are disproportionately vulnerable to loss in many ecosystems worldwide as a result of accelerated rates of mortality, impaired recruitment, or both”


Perception or Reality?

• Do our cities have proportionally low numbers of large trees?
• Is loss of large trees problematic in our cities?
• To answer these questions, we need an urban forest inventory
Tree Diameter Distributions

• From tree inventories, we can get diameter distributions
• Gain understanding of tree size patterns
  • Size used as a surrogate for age
• What is the ideal distribution?
Ideal Diameter Distribution?

French forester François de Liocourt (1898) is first to formally describe diameter distributions for uneven aged forest management.

Commonly referred to as the Reverse-J distribution.

What is the ideal UF dbh distribution?

- Richards most cited in UF literature
- But is distribution ideal or generally applicable?
- Richards calls them “my approximate guidelines”
Richards’ “approximate guidelines”

“For adapted, long-lived species [...] in Syracuse, [...] a good age distribution for population stability would be about 40% trees under 20 cm diameter, 30% 20 – 40 cm trees in the early functional stage, 20% 40 – 60 cm functionally mature trees, and 10% older trees with most of their functional life behind them.”

What is the ideal distribution?

- Millward & Sabir modify Richards and propose:

  “…a generalized ideal distribution […] that would see 40% of a tree population fall within a DBH class of 0 – 15 cm, 30% from 15 – 60 cm, 25% in class 60 – 90 cm, and 5% classified as 90 cm and above.”

Ideal Distributions vs. Reality

• How does reality compare to these ‘ideal’ distributions?
• Let’s look at a meta-analysis of existing tree inventory data
Diameter Distribution Meta-Analysis

- 23 i-Tree inventories →
- Plot diameter distributions of % trees by 7.5 cm DBH classes
## i-Tree Inventory Cities

<table>
<thead>
<tr>
<th>City</th>
<th>State</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlanta</td>
<td>Georgia</td>
<td>456,002</td>
</tr>
<tr>
<td>Baltimore</td>
<td>Maryland</td>
<td>622,793</td>
</tr>
<tr>
<td>Boston</td>
<td>Massachusetts</td>
<td>655,884</td>
</tr>
<tr>
<td>Casper</td>
<td>Wyoming</td>
<td>60,086</td>
</tr>
<tr>
<td>Chicago</td>
<td>Illinois</td>
<td>2,722,389</td>
</tr>
<tr>
<td>Freehold</td>
<td>New Jersey</td>
<td>11,973</td>
</tr>
<tr>
<td>Gainesville</td>
<td>Florida</td>
<td>128,460</td>
</tr>
<tr>
<td>Golden</td>
<td>Colorado</td>
<td>20,201</td>
</tr>
<tr>
<td>Hartford</td>
<td>Connecticut</td>
<td>124,705</td>
</tr>
<tr>
<td>Jersey City</td>
<td>New Jersey</td>
<td>262,146</td>
</tr>
<tr>
<td>Lincoln</td>
<td>Nebraska</td>
<td>272,996</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>California</td>
<td>3,928,864</td>
</tr>
<tr>
<td>Milwaukee</td>
<td>Wisconsin</td>
<td>599,642</td>
</tr>
<tr>
<td>Minneapolis</td>
<td>Minnesota</td>
<td>407,207</td>
</tr>
<tr>
<td>Moorestown</td>
<td>New Jersey</td>
<td>20,594</td>
</tr>
<tr>
<td>Morgantown</td>
<td>West Virginia</td>
<td>31,073</td>
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<tr>
<td>Philadelphia</td>
<td>Pennsylvania</td>
<td>1,560,297</td>
</tr>
<tr>
<td>Sacramento</td>
<td>California</td>
<td>485,199</td>
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<tr>
<td>San Francisco</td>
<td>California</td>
<td>852,469</td>
</tr>
<tr>
<td>Scranton</td>
<td>Pennsylvania</td>
<td>75,281</td>
</tr>
<tr>
<td>Syracuse</td>
<td>New York</td>
<td>144,263</td>
</tr>
<tr>
<td>Washington</td>
<td>D.C.</td>
<td>658,893</td>
</tr>
<tr>
<td>Woodbridge</td>
<td>Virginia</td>
<td>4,055</td>
</tr>
</tbody>
</table>
Meta-Analysis ➔ Results

- Graph showing the proportion of total population (%) against stem diameter (DBH in cm).
Meta-Analysis $\Rightarrow$ Results

![Graph showing the relationship between stem diameter (DBH in cm) and proportion of total population (%). The blue line represents Richards (1983/83) and the red line represents Millward & Sabir (2011).]
Meta-Analysis → Results
Meta-Analysis → Results
Ideal Distributions vs. Reality

- Reality certainly does not match ‘ideal’
- In reality, we have lower proportion of large trees than under ‘ideal’ conditions
- But this is assuming that the ‘ideal’ distributions are correct
- What do the ‘ideal’ distributions tell us about our UF?
Segway into Population Demography
Tree Size Distribution

- What we have: Rapidly expanding
- What we want (according to Richards): Expanding
- What we want (according to Millward & Sabir): Stationary
- What do these demographic descriptions mean with respect to our urban tree populations?
Tree Size Distribution

### Table: Tree Size Distribution

<table>
<thead>
<tr>
<th></th>
<th>Rapidly Expanding (Actual Distribution)</th>
<th>Expanding (Richards)</th>
<th>Stationary (Millward &amp; Sabir)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planting Rate</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Mortality Rate</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Large Tree Proportion</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
</tr>
</tbody>
</table>
• **Do our cities have proportionally low numbers of large trees?**
  • Yes we do

• **Is loss of large trees problematic in our cities?**
  • To answer this, we need a long-term urban forest inventory
Long-Term UF Inventory

- Changes in diameter distribution across 10 years in Syracuse, NY
- Sample of whole UF population
- What can we infer about large trees?

Where Have all the Mature Trees Gone?

• Meta-analysis identified rapidly expanding tree populations

• High mortality/removal rates prevent higher proportion of large trees

• Need for long-term UF inventory to fully understand the issues
Comments and Questions Welcome
Don’t miss the TREE Fund Live Auction!
Monday 6:00 – 8:00 p.m.
Gaylord Palms Resort, Sun Ballroom C

Auction proceeds fund tree research and education!