Decomposition of above and belowground deadwood in managed Sitka spruce forests in Ireland

Samuel Olajuyigbe, Brian Tobin and Paul Gardiner and Maarten Nieuwenhuis

UCD Forestry, University College Dublin, Ireland
Overview

- Introduction:
  - Irish forests
  - Sitka spruce (*Picea sitchensis* (Bong) Carr.)

- Deadwood types

- Measuring decomposition

- Some findings

- Conclusions
The Irish Forest (NFI 2007)

- 10% of the land area
- 90% is coniferous plantation
- Deadwood found in 45% of forest
  - Exceeding 5.6 million m³
  - Decomposition of coniferous deadwood (specifically that of Sitka spruce) and its contribution to managed-forest C stocks is therefore essential for C-reporting
  - Sitka spruce forests covers 327,000 ha (52% of total forest)
  - Annual output: Over 1.4 million m³
Methods: Coarse deadwood types

- Main sources of deadwood
  - Thinning and harvesting residues
  - Extreme climatic events (wind throws)
- Aboveground:
  - Logs (≥ 7cm minimum end diameter)
  - Stumps
- Belowground:
  - Small roots (2 - 10mm)
  - Medium roots (10 – 50mm)
  - Large roots (≥ 50mm)
Method: Measuring decomposition

• Five-decay class (DC) system
  – Physical characteristics
  – Volume estimation

• Root excavation (assuming roots belong to the same DC as stump)

• Decay class density
  – Ovendry weight
  – Volume displacement
Methods: Decay dynamics

- C:N analysis
- Density decay rate ($k$)
  - Single exponential decay curve
    - $D_t = D_0 \exp^{-kt}$
  - $D_t =$Density at time $t$
  - $D_0 =$ Density constant
  - $t =$ time since harvest (years)
  - Half life ($t_{0.5}$ or 50% decay) = $0.693/k$
  - Residence time ($t_{0.05}$ or 95% decay) = $3/k$
Results: C-fraction

<table>
<thead>
<tr>
<th>CWD</th>
<th>% C-fraction</th>
<th>S.E</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logs</td>
<td>46.61</td>
<td>0.07</td>
<td>24</td>
</tr>
<tr>
<td>Stumps</td>
<td>47.47</td>
<td>0.09</td>
<td>21</td>
</tr>
<tr>
<td>Small roots</td>
<td>46.98</td>
<td>0.46</td>
<td>21</td>
</tr>
<tr>
<td>Medium roots</td>
<td>47.49</td>
<td>0.49</td>
<td>21</td>
</tr>
<tr>
<td>Large roots</td>
<td>47.89</td>
<td>0.37</td>
<td>21</td>
</tr>
<tr>
<td>All CWD</td>
<td>47.26</td>
<td>0.15</td>
<td>108</td>
</tr>
</tbody>
</table>

- No differences across DCs (ranged from 46 - 48%)
- Tobin et al., (2007)
Results: Density loss

Density decrease in Logs (45%) and Stumps (58%)

Density decrease in small roots (38%), medium roots (50%)
large roots (38%)
Results: C:N ratio

C:N ratio decreased with increased decay in logs (46%), stumps (41%)

C:N ratio decreased with increased decay in small roots (51%), medium roots (72%), large roots (57%)
Decay Curves: Logs and Stumps

**CARBiFOR II**

(a). Logs

\[ D_t = 369.88e^{-0.059t} \]

\[ R^2 = 0.51 \]

(b). Stumps

\[ D_t = 410.40e^{-0.048t} \]

\[ R^2 = 0.62 \]
Decay curves: Roots

(c) Small roots

\[ D_t = 454.97 \exp^{-0.030t} \]

\[ R^2 = 0.55 \]

(d). Medium roots

\[ D_t = 489.88 \exp^{-0.044t} \]

\[ R^2 = 0.68 \]

(e). Large roots

\[ D_t = 428.57 \exp^{-0.032t} \]

\[ R^2 = 0.63 \]
Belowground decays slower than aboveground
Medium roots had the lowest decay rate
Residence time maybe be an overestimation
Density and C:N interaction: Logs and Stumps

(a). Logs
\[ y = 118.84 - 0.223x + 0.002x^2 \]
\[ R^2 = 0.69, \ n = 24 \]

(b). Stumps
\[ y = -273.822 + 3.034x - 0.004x^2 \]
\[ R^2 = 0.74, \ n = 21 \]

- Density was positively correlated with C:N ratio
Density and C:N interaction: Roots

(c). Small roots

\[ y = -78.810 + 0.713x - 0.001x^2 \]
\[ R^2 = 0.71, n = 21 \]

(d). Medium roots

\[ y = 58.396 - 0.235x + 0.001x^2 \]
\[ R^2 = 0.72, n = 21 \]

(e). Large roots

\[ y = 123.325 - 0.537x + 0.002x^2 \]
\[ R^2 = 0.60, n = 21 \]

(f). Whole root system

\[ y = 107.998 - 0.556x + 0.002x^2 \]
\[ R^2 = 0.93, n = 21 \]
Conclusions

• Aboveground decayed faster than belowground

• Density and C:N ratio are positively correlated in deadwood

• IPCC 10-year decay period may be an underestimation

• 87% of Irish forest still in the juvenile stage (unthinned)

• Deadwood will become increasingly important as these forests are thinned in the future
Acknowledgements
Thanks for listening

CARBiFOR II