Deadwood diversity and their decay-class dynamics in the northwestern boreal black spruce forests of Quebec

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In unmanaged boreal forests snags and deadwood are important components of stand structure.

Deadwood and snags are significant for biodiversity.

Many organisms are often confined to certain qualities of deadwood.
Black-backed Woodpecker

Mushrooms

Lichen (Peltigera)

Flying squirrel

White-spotted Sawyer
Objectives

(1) Describe structural attributes of deadwood in mature, overmature and old-growth spruce stands

(2) Determine the influence of time since fire on the abundance of snags in mature, overmature and old-growth spruce forests

(3) Describe the variability of the diameter structure of snags and deadwood and in their degree of decomposition
Methods
Study area

Location of the study area and the Clay Belt of eastern Canada

Two forest management units with a total area estimated around 15000 km²

FMU 85-51

FMU 87-63
The first cohort begins dying off around 100 years since fire.

The third cohort includes all age classes over 200 years.

We refer to fire severity as the effects of fire on the organic matter accumulated above the mineral soil.
Sampling

129 pure black spruce stands, based on maps derived from forest inventories, were sampled. The number of each type of stands is representative of their occurrences in the area.

<table>
<thead>
<tr>
<th>% Crown closure (class)</th>
<th>61-80 (B)</th>
<th>41-60 (C)</th>
<th>D 25-40 (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (m) (class)</td>
<td>12-17 (3)</td>
<td>12-17 (3)</td>
<td>12-17 (3)</td>
</tr>
<tr>
<td></td>
<td>7-12 (4)</td>
<td>7-12 (4)</td>
<td>7-12 (4)</td>
</tr>
<tr>
<td>Nclass</td>
<td>25</td>
<td>40</td>
<td>22</td>
</tr>
<tr>
<td>Nclass /Ntot=129</td>
<td>19</td>
<td>31</td>
<td>17</td>
</tr>
<tr>
<td>% surface area class/ total surface area</td>
<td>19</td>
<td>28</td>
<td>16</td>
</tr>
</tbody>
</table>

129 pure black spruce stands, based on maps derived from forest inventories, were sampled. The number of each type of stands is representative of their occurrences in the area.
### Variables

#### Structural attributes

- **LTBA** = Live tree basal area (m²/ha)
- **SNAG** = SNAG abundance (SNAGS/ha)
- **CWD** = Coarse woody debris abundance (CWD/ha)
- **CWDV** = Coarse woody debris volume (CWDV/ha)
- **CANOPY** = Canopy closure classes (CANB, CANC, CAND)
- **STRUCTURE** = Age structure (Even, Uneven)
- **HEIGHT** = Height classes (3, 4)

#### Independent variables

- **COHORTS** = Age classes (Cohort1, Cohort2, Cohort3)
- **FIRE SEVERITY** = (FIS severe; FIPS low severity)
- **OM** = Organic matter thickness (0-30 cm, 30-60 cm, 60-100 cm and more)
- **SOIL TEXTURE** = Clay vs Organic
- **SLOPE** = Slope classes (A, B, C)
- **VP** = Van post classes of organic matter decomposition (VP2, VP4)
RESULTS
Redundancy Analysis allows studying the relationship between the two tables of variables (Structural attributes and independent variables)
Redundancy analysis

Variable vectors

Eigenvalues, contribution to the variance

<table>
<thead>
<tr>
<th></th>
<th>RDA1</th>
<th>RDA2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eig.value</td>
<td>423.001</td>
<td>0.2111</td>
</tr>
<tr>
<td>Accounted</td>
<td>0.325</td>
<td>0.3252</td>
</tr>
</tbody>
</table>

RDA1
- Clay     0.089023
- Organic -0.084007
- TSF      11.492636
- OM30     0.081126
- OM60     0.003378
- OM100    -0.084503
- VP2      0.066564
- VP4      -0.050349
- FIS      0.091938
- FIPS     -0.091938

(CanocoDrawforWindows 4.5)
Three stand groups

Old-growth stands

Uneven

CAND

OM100

VCWD

SNAG

CWD

STM

CAND

CANB

CANC

FIS

FIPS

OM30

OM60

OM100

CWD

VCWD

SNAG

CWD

STM

CAND

CANB

CANC

FIS

FIPS

OM30

OM60

OM100

Three stand groups

Overmature stands

Heighth

Even

LTBA

STM

CAND

CANB

CANC

FIS

FIPS

OM30

OM60

OM100

CWD

VCWD

SNAG

CWD

STM

CAND

CANB

CANC

FIS

FIPS

OM30

OM60

OM100

Three stand groups

Mature stands
Influence of some environmental variables on SNAG abundance
Abundance of snags

Analysis using generalized linear models (GLM’S)
GLMs with model selection

I proceeded with negative binomial distribution GLMs with model selection

I set 15 candidate models

And the best model that explains the variability of snag abundance includes both TSF (cohorts) and fire severity
Snag density is significantly higher in stands of the second cohort.

Snag abundance is significantly higher on well-drained boreal black spruce sites than on poorly drained sites.
*Multinomial analysis*: Influence of time since last fire on snag abundance

It is more likely to have a low density of snags in first cohort stands.

It is more likely to have a high density of snags in second cohort stands.
Deadwood diversity and their decay-class dynamics
Snag diameter structural diversity and their decay-class dynamics

Snags in second cohort stands peak in diameter structural diversity on both organic and mineral sites.

The paludified old-growth stands have a greater diameter structural diversity of snags.

Snags in old-growth stands have the most diversified decay classes.
Deadwood diversity and their decay-class dynamics

Deadwood in second cohort stands have diversified diameter classes on both organic and clay sites. However, oldest stands on clay have the most diversified deadwood diameter classes.
Conclusion

Time since last fire (TSF) and stand origin were the two variables that best explained the variability in the abundance of snags.

Overmature stands were also significantly richer in deadwood than the youngest and the oldest stands.

They had the most diverse snags and deadwood diameter structure and the most diverse decay classes.

Unmanaged overmature forests must be preserved to ensure better availability of deadwood in the landscape.
I’d like to acknowledge the people who helped me. Many thanks to Louis Dumas who spent long hours looking at maps and to Nicole Fenton who reviewed this presentation.

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