Could Tree-related Microhabitats (TreMs) be relevant conservation forestry targets and/or biodiversity indicators?

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Could Tree-related Microhabitats (TreMs) be relevant conservation forestry targets and/or biodiversity indicators?

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Christophe BOUGET ²

¹INRA/CRPFOc
²IRSTEA
TReMs, biodiversity and forestry

TReM

- Monitoring
  - [Old-growth attributes]
    - Selective retention
    - Restoration Active creation

Structural forest biodiversity indicators?

Conservation forestry targets?
1-TreMs and biodiversity at the TreM scale
TReMs are morphological singularities borne by living or dead trees
TreMs host a wide diversity of taxa
TreMs host species-rich assemblages

Microhabitat preferences

- 435 not
- 227 Primary choice
- 45 Second choice

- 749 not
- 193 Primary choice

- 86 not
- 45 Second choice

Many beetles depend on TreMs!
2-TreMs and biodiversity at the stand scale
Saproxylic beetle species richness increases with the local amount of certain TreM-bearing trees in various but not all forest contexts.
TreMs are significantly associated to variations in species richness, but to a lesser extent than deadwood or openness.

### Key factors of saproxylic beetle diversity

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>rare sp</th>
<th></th>
<th>common sp</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>ns</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td><strong>Oak</strong></td>
<td>Abiotic</td>
<td>2=Openness</td>
<td>1=Deadwood diversity</td>
<td>1=Openness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Deadwood</td>
<td>1=Deadwood diversity</td>
<td></td>
<td>2=Lying deadwood volume</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TReMs</td>
<td>ns</td>
<td>3= Large lying deadwood volume</td>
<td>6=density cavity-bearing trees</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4= Deadwood diversity</td>
<td>5=density fungus-bearing trees</td>
<td></td>
</tr>
</tbody>
</table>

| **Beech**| Abiotic| ns |            | 1=Openness |
|          | Deadwood| ns |            | 2=Deadwood diversity |
|          | TReMs | 1=density fungus-bearing trees | 3=density crown-deadwood-bearing trees |

**TreMs** and **deadwood** are significantly associated to variations in species richness, but to a lesser extent than **openness**.

**lowland deciduous forests**
Some relationships between TreM density and saproxylic beetle diversity depend on stand openness.
TreM diversity only slightly correlates with saproxylic beetle assemblage structure.

Highland forests

<table>
<thead>
<tr>
<th>Trait</th>
<th>Mean trait CWM</th>
<th>Trait variance FDis</th>
<th>Sp. richness</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Size</td>
<td>ns</td>
<td>ns</td>
<td></td>
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<tr>
<td>Canopy prefer.</td>
<td>ns</td>
<td>ns</td>
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<tr>
<td>Decay prefer.</td>
<td>ns</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diameter prefer.</td>
<td>ns</td>
<td>ns</td>
<td></td>
<td></td>
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<tr>
<td>Low-dispersal</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>High-dispersal</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cavicolous</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fungicolous</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Forest continuity acts congruently with stand maturity in structuring the functional composition of saproxylic beetles.

Philippe Janssen a, Marc Fuhr a, Eugénie Cateau b, Benoit Nusillard, Christophe Bouget.
Why are TreM-biodiversity relationships so weak at stand scale in ecological studies?
TreM metrics

- TreM values are **too low** in managed forests?
  - Values below ecological thresholds?

  - Bad biodiversity sampling?
    - Analysis of the response of TReM-associated organisms only
    - Sampling methods dedicated to TReM-associated organisms

  - Bad TReM sampling?
Trem density and diversity are affected by forestry

Animal Conservation
Does a set-aside conservation strategy help the restoration of old-growth forest attributes and recolonization by saproxylic beetles?
C. Bouget1, G. Parmain1,2,3, O. Gilg1, T. Noblecourt2, B. Nusillard1, Y. Pailler1, C. Pernot1, L. Larrieu1,2 & F. Gosselin1

Diversity

TREM density

TREM diversity

Sap run density

Fungus density

Cavity density

Crown DW density

Harvested
Unharv > 30 yrs
Harvested
Unharv > 30 yrs
Harvested
Unharv > 30 yrs
TreM density and diversity are **higher** in and around veteran trees outside than inside forests.

Parmain & Bouget, 2017
TreM effects increase with TreM values

The effects of TreM metrics on saproxylic beetle diversity are stronger outside than inside forests!

Parmain & Bouget, 2017
TReM sampling

- Low TReM values in managed forests?
- Irrelevant TReM sampling?
  - Bad biodiversity sampling?
    - Analysis of the response pf TReM-associated organisms only
    - Sampling methods dedicated to TReM-associated organisms
    - Multi-taxon approaches
Facing low TreM detectability...by the use of proxies?

Environmental variables (1ha-plot)

- Density of very large trees (dbh>70cm)
- Density of living TreM-bearing trees

Taxa (Composition)

- Saproxylic beetles
- Bats
- Bryophytes
- Lichens
- Birds
- Hoverflies
- Fungi

487 plots
19 areas

Larrieu et al., in prep.

p<0.001
p<0.05
Biodiversity metrics

- Low TReM values in managed forests?
- Irrelevant biodiversity metrics?

- Diversity of TReM-associated taxa only vs overall diversity
- Sampling methods dedicated to TReM-associated organisms

- Bad TReM sampling?
TreMs are fostered by an extended rotation...

...but only TreM-associated (and not all saproxylic) taxa correlate to TreM rise

Extended rotation (+ 50 yrs)

TreM-associated beetles

All saproxylic beetles

SEM path diagram (glmm), Percel et al. in prep.
Biodiversity metrics

- Low TReM values in managed forests?
- Irrelevant biodiversity metrics?

- Saproxylic beetles only vs Multi-taxon approaches
- sampling methods dedicated to TReM-associated organisms

– Bad TReM sampling?
Monitoring more taxa --> more TreM-biodiversity relationships

...sometimes difficult to interpret

Environmental variables (1ha-plot)

- Density of cavity-bearing trees
- Density of fungus-bearing trees
- Density of missing-bark-bearing trees
- Density of epiphyte-bearing trees
- Diversity of TreM types
- Density of TreM-bearing trees

Sp richness/composition

- Saproxylic beetles
- Bryophytes
- Bats
- Birds
- Hoverflies
- Fungi
- Lichens

487 plots
19 French forest areas
Larrieu et al., in prep.

Effect + p<0.001
Effect - p<0.001
p<0.05
p<0.05
Biodiversity sampling

- Low TReM values in managed forests?
- Irrelevant biodiversity sampling?
  - Analysis of the response of TReM-associated organisms only
  - Freely hanging flight interception traps vs sampling methods explicitly dedicated to TReM-associated taxa
Stronger TreM effects are demonstrated by using dedicated methods to sample TreM-associated beetles

Selection of
1. Biodiversity metrics of TreM associated taxa (fungus-dwelling)
2. TreM metrics (polypore density)

Specific sampling: polypore emergence trap
Conclusion

- At the stand scale: study results about TreM effects on biodiversity showed low significance, magnitude and consistency.

- Need of protocol and analysis improvements:
  - taxon sampling method adequation
  - TreM sampling
  - relevant variables

TreMs are actually key structures for biodiversity

But...

Further research is required to inspire quantitative management guidelines...
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- Our PhD students
  - Aurore Lassauce
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  - Guillem Parmain
  - Philippe Janssen

- ...and technicians
  - Carl Moliard
  - Benoit Nusillard
  - Laurent Burnel
  - Jérôme Wilmm

Be patient, kid; come back in 2117!

Thank you for your attention