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Tree-related Microhabitat (TreM) spatial patterns in European beech-dominated forests

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A TreM is a specific above-ground tree morphological singularity

- distinct, well delineated structure
- borne by standing living or dead trees
- essential substrate or life-site for taxa
- encompassing decaying wood (|=saproxylic TreM) or not (|=epixylic TreM)
TReMs are key features for many taxa and participate in a complex functional habitat network in species life cycles

- By harvesting TreM-bearing trees, management impacts both TreM density and diversity (e.g. Larrieu & Cabanettes 2012)
- We observe poorer communities of TreM-dwelling taxa in managed stands (e.g. Bouget et al. AC 2014)
- Is this lower biodiversity due to a lower TreM supply only or also to changes in spatial distribution pattern?
Are spatial distribution patterns of TreMs different in harvested stands compared to unharvested ones?

Hypothesis 1: TreM distribution is spatially structured in old-growth forests (>100 years)

Hypothesis 2: The spatial distribution of TreMs is mainly driven by the spatial distribution of tree dbh

Hypothesis 3: Management affects these patterns by controlling dbh range, density and location of TreM-bearing trees
An analysis focusing on beech-dominated stands, recently harvested or not

International standardized TreM database: 267 sites, 1492 plots, 86 754 trees, 17 TreM groups

- **Beech-dominated** (>50% trees) stands
  - Tree coordinates
  - >20 trees/plot
  - >10 TreM/plots

- **2 time categories since the last harvest**
  - < 50 y: managed forest
  - > 100 y: old-growth forest

  55 sites, 408 plots (0.05-1ha), 20346 living and standing dead trees

11 TreM-subgroups selected from Larrieu et al. EI 2018

Set of 6 TreMs common to all databases

L. Apfelbacher
A multi-scale exploratory analysis

**Harvested and unharvested stands**
- Set of 6 TreMs pooled
- Marked point process (MPP)

**Plot scale**
- Set of 6 TreMs pooled
- 11 individual TreMs
- Binomial GLM
- Y (tree bears at least a TreM)~dbh+ 6 variables describing neighbourhood

**Plot-grouping scale**
- Set of 6 TreMs pooled
- Binomial GLM
- Y (tree bears at least a TreM)~dbh+site+site-plot
  +time since the last harvest

**Forest scale** (Uholka, OGF)
- 8 individual TreMs
- Binomial GLM/GLMM
- 266 x 500m²-plots

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**Introduction**

**Results: Plot scale/Set of plots scale/Forest massif scale/TreM/Set of TreMs**

**Conclusion**

Harvested and unharvested stands

Unharvested forest
No consistent spatial pattern, neither in managed nor in old growth forests

General case

Aggregation of TreM-bearing trees

Repulsion

$L_{1,1}(r)$ function: counts the nb of TreM-bearing trees in the $r$-radius disc

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random distribution of the TreM-bearing trees

Confidence interval
Neighbourhood features have a significant effect on TreM bearing tree occurrence

for 50% of the plots in Managed forest

+ 10% of variance explained by neighbourhood (in addition to dbh)

for 25% of the plots in Old-growth forest

+ 18% of variance explained by neighbourhood (in addition to dbh)
The effect of dbh on TreM occurrence depends on both TreM and forest status

Old Growth Forests

- + for 97% of the plots
- + for 52% of the plots
- - for 65% of the plots

Managed forest

+ + for 100% of the plots
+ + for 88% of the plots
+ + for 94% of the plots

% var. explained by plot:dbh >> % var. explained by dbh
Local conditions are the main driver of TreM occurrence

- dbh ***, but low explanatory power (3%)

- Time since the last harvest (dbh*time) ***, medium explanatory power (17%)

- Site (dbh*site)***, high explanatory power (36%)

- Site-plot (dbh*site-plot)***, the highest explanatory power (42%)

Same trend observed at the individually TreM level!
In addition to dbh, plot features matters for explaining the occurrence of most of the TreMs

**Drivers**
- DBH
- Plot features
  - canopy cover
  - slope
  - elevation

**TreMs**

*GLM & GLMM, binomial Y=tree bears a TreM or not*
Crown deadwood is mostly driven by a spatially-autocorrelated plot random effect.

Bayesian CAR

Distance decay=260m
In a nutshell

- Tree dbh spatial distribution is not a consistent surrogate within plot for TreM spatial distribution in old-growth forests
- Strong effect of local conditions on TreM spatial structuration
- Management influences the way TreM spatialization occurs (mainly by changing relationship between TreM and dbh)

Thanks for your attention