



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

Laurent Larrieu, Christophe Bouget

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

Laurent LARRIEU <sup>1</sup>  
Christophe BOUGET <sup>2</sup>

<sup>1</sup>INRA/CRPFOc

<sup>2</sup>IRSTEA



LIFE MIPP

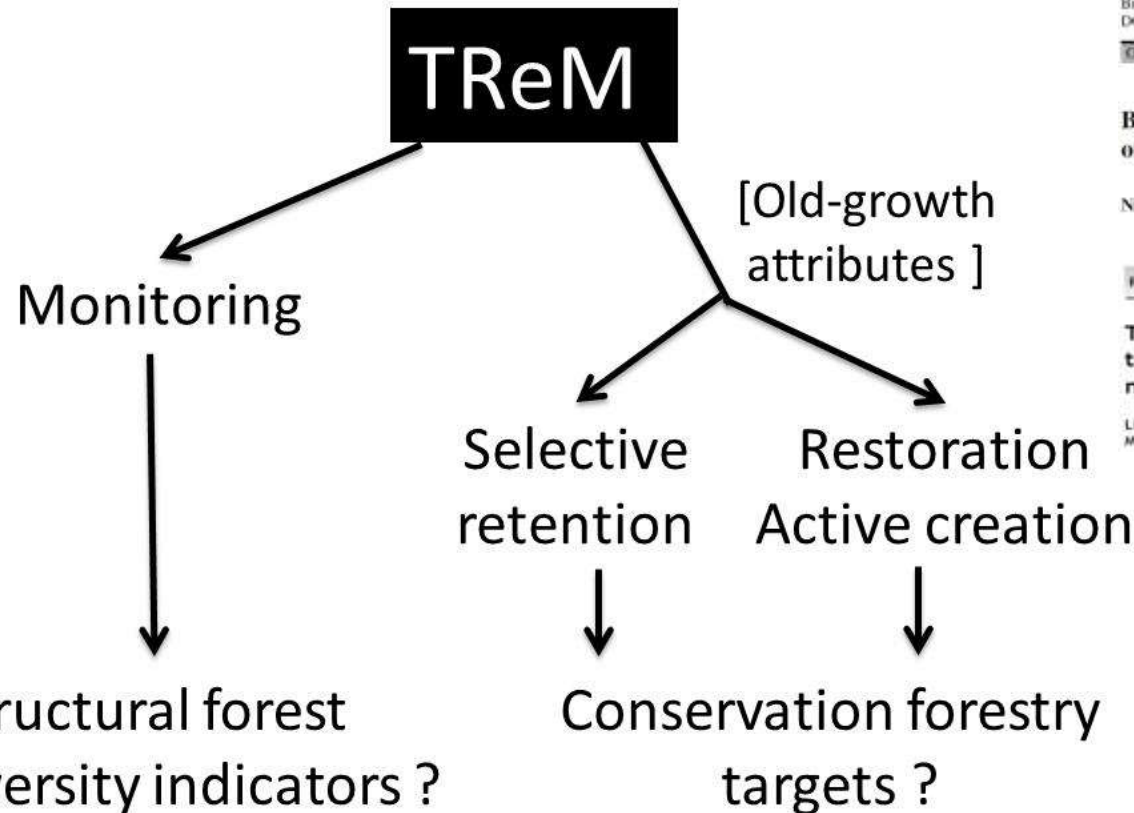
European Workshop

Monitoring of saproxylic beetles and other insects protected in the European Union

Mantova (Italy), 24<sup>th</sup> - 26<sup>th</sup> May 2017



# TReMs, biodiversity and forestry



Biodivers Conserv (2009) 18:3891–3908  
DOI 10.1007/s10531-009-9687-2

ORIGINAL PAPER

**Boxes mimicking tree hollows can help conservation of saproxylic beetles**

Nicklas Jansson · Thomas Ranius · Anna Larsson · Per Milberg

Research Article · doi: 10.3832/for1281-007

"iForest – Bi

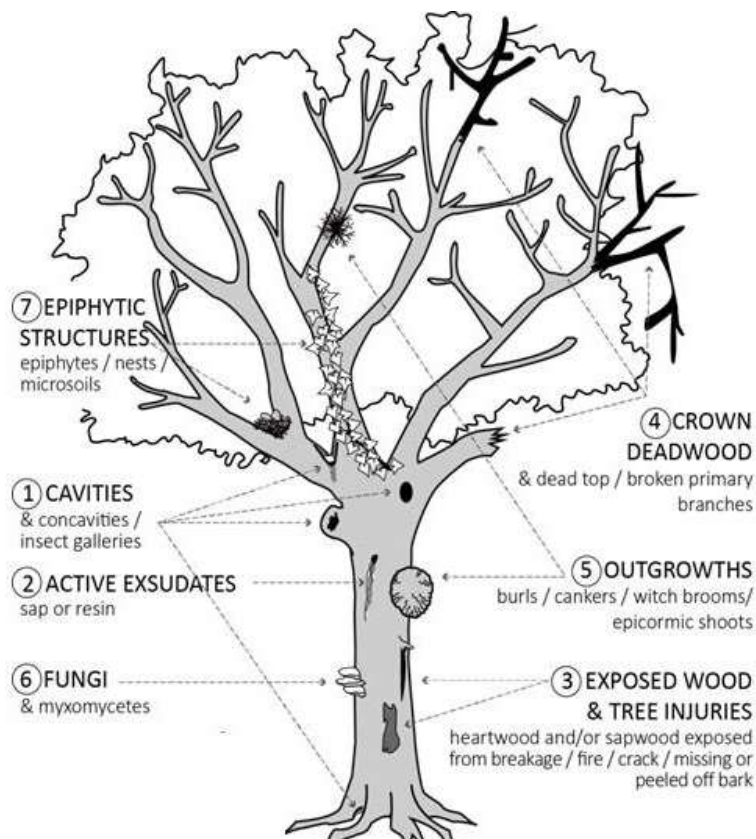
**The Habitat-Trees experiment: using exotic tree species as new microhabitats for the native fauna**

Livia Zapponi<sup>1,2</sup>, Emma Minari<sup>1</sup>, Luca Longo<sup>1</sup>, Ilaria Toni<sup>1</sup>, Franco Mason<sup>1</sup>, Alessandro Campanaro<sup>1,3</sup>

as come  
the thin  
line of a  
habitat-  
tree for  
saproxy-  
lic be-  
etles. The  
trees in  
practice  
trees in



# TReMs are morphological singularities borne by living or dead trees



© Emberger (Larrieu & Heinz 2016)

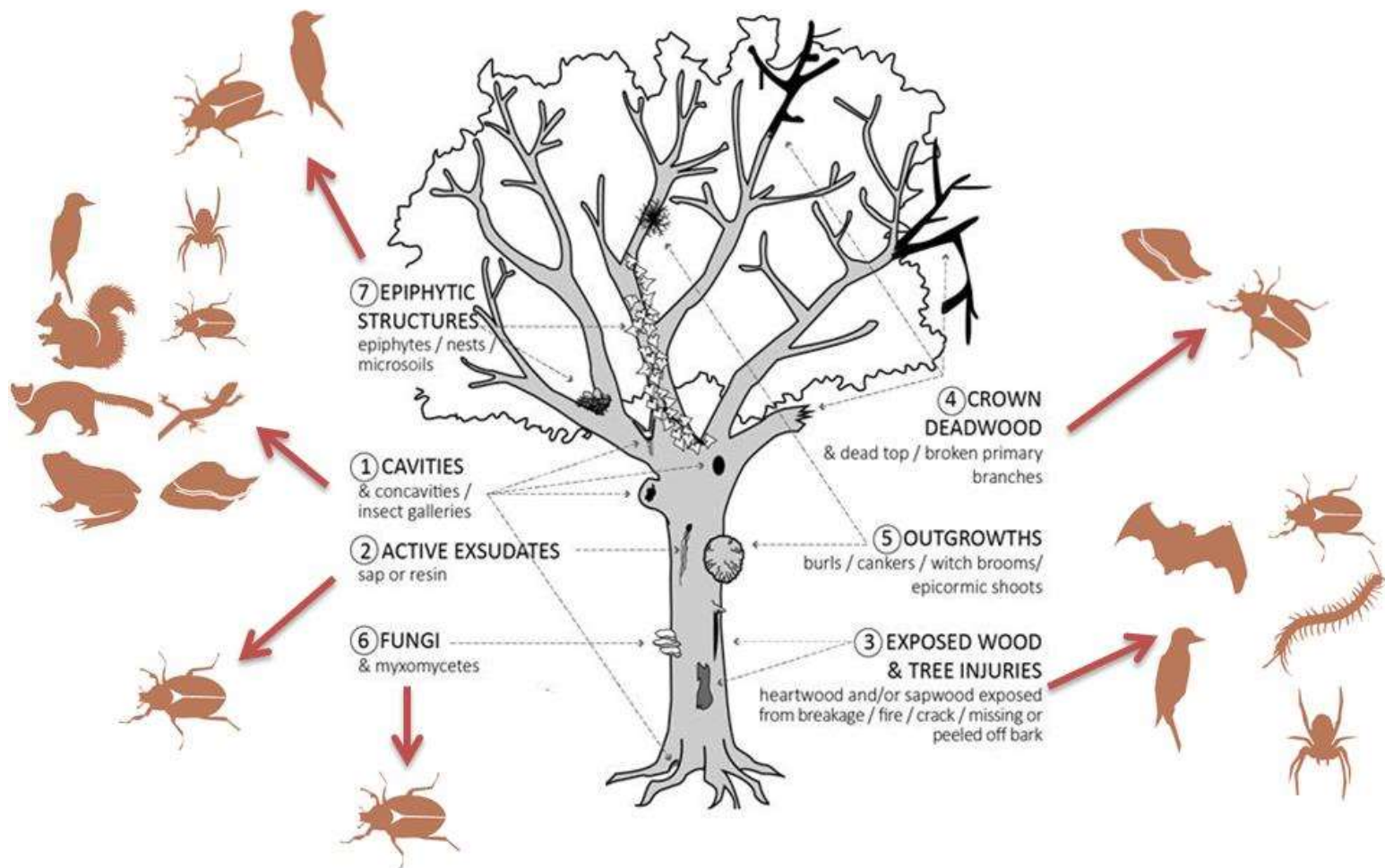


Italian Journal of Agronomy 2016; volume 11(s1)

## Forest management for invertebrate conservation

Maarten de Groot,<sup>1</sup> Livia Zapponi,<sup>2,3</sup> Davide Badano,<sup>2,3</sup> Serena Corezzola,<sup>2,3</sup> Franco Mason<sup>2,3</sup>

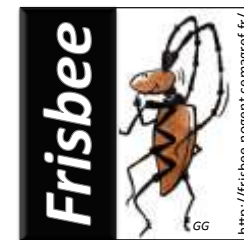
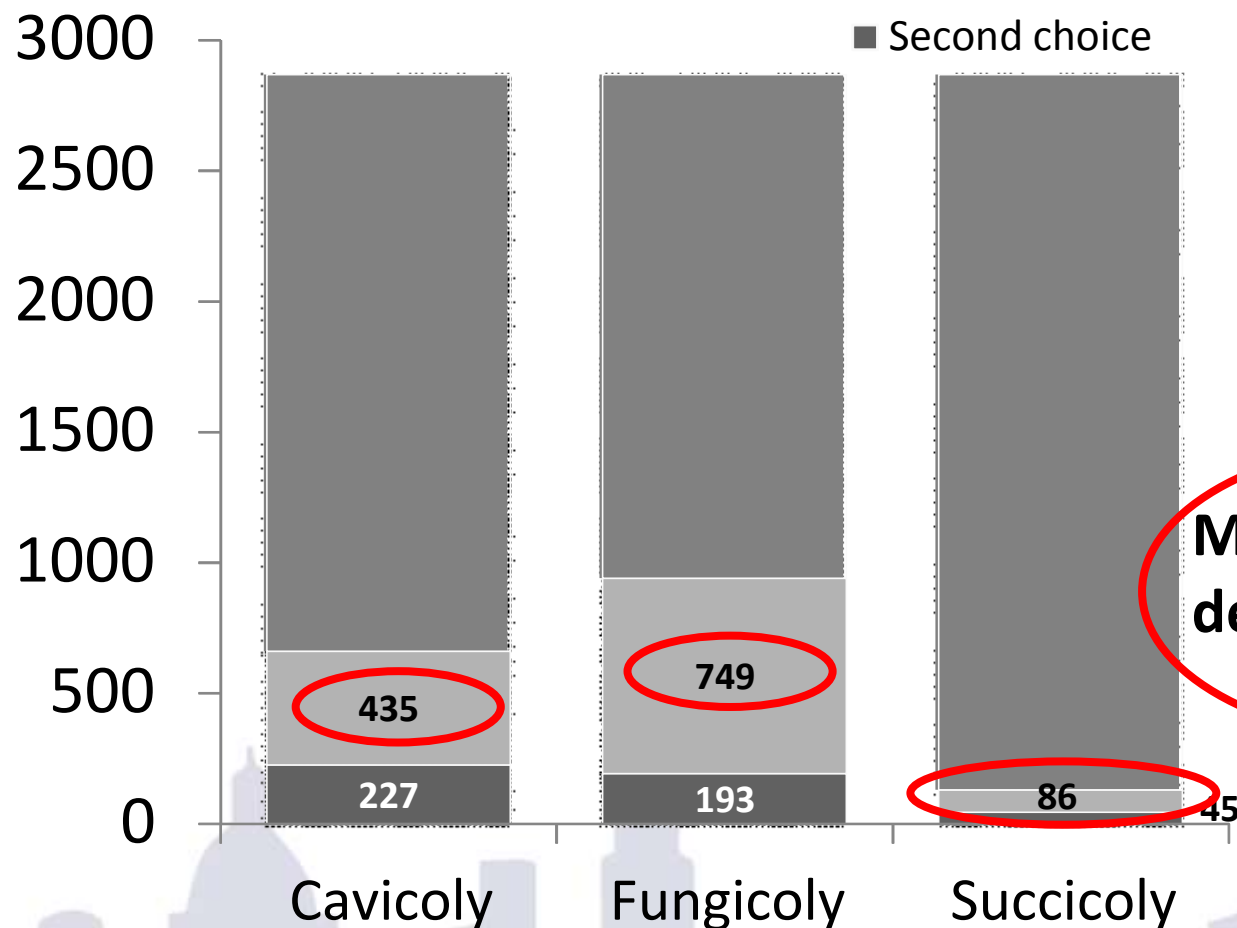
# TreMs host a wide diversity of taxa



# TreMs host species-rich assemblages



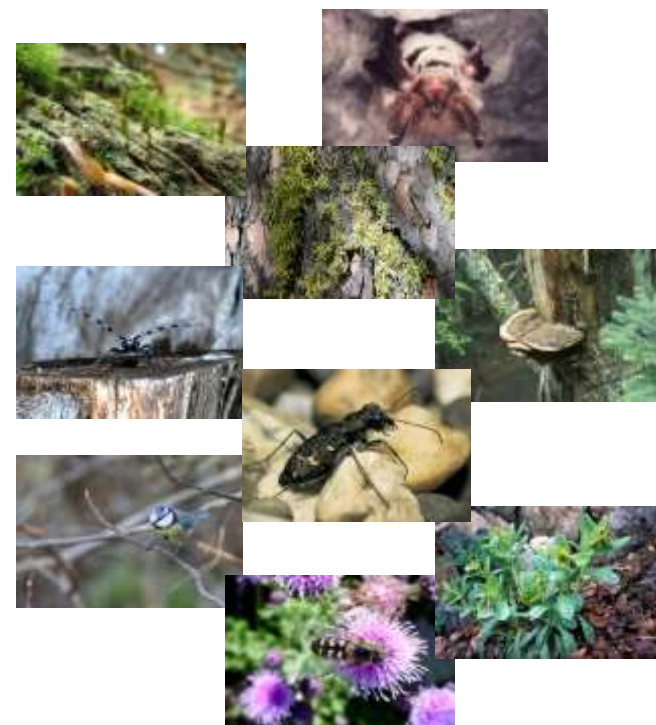
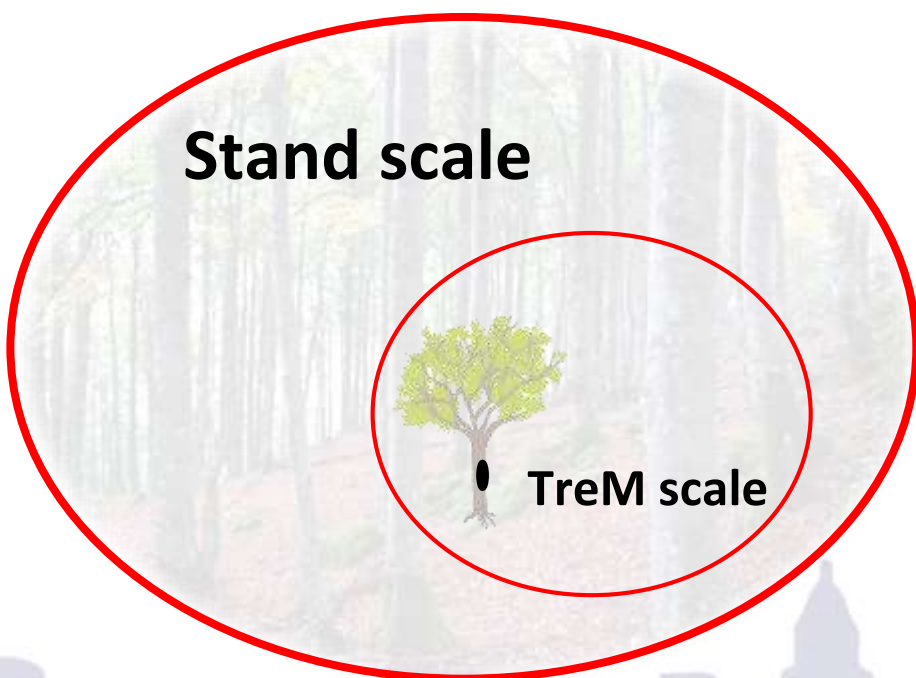
## Microhabitat preferences



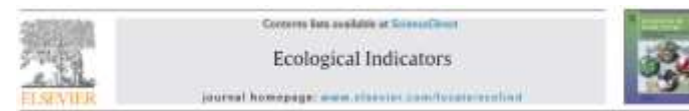
Bouget et al., in prep.

**Many beetles  
depend on TreMs !**

## 2-TreMs and biodiversity at the stand scale

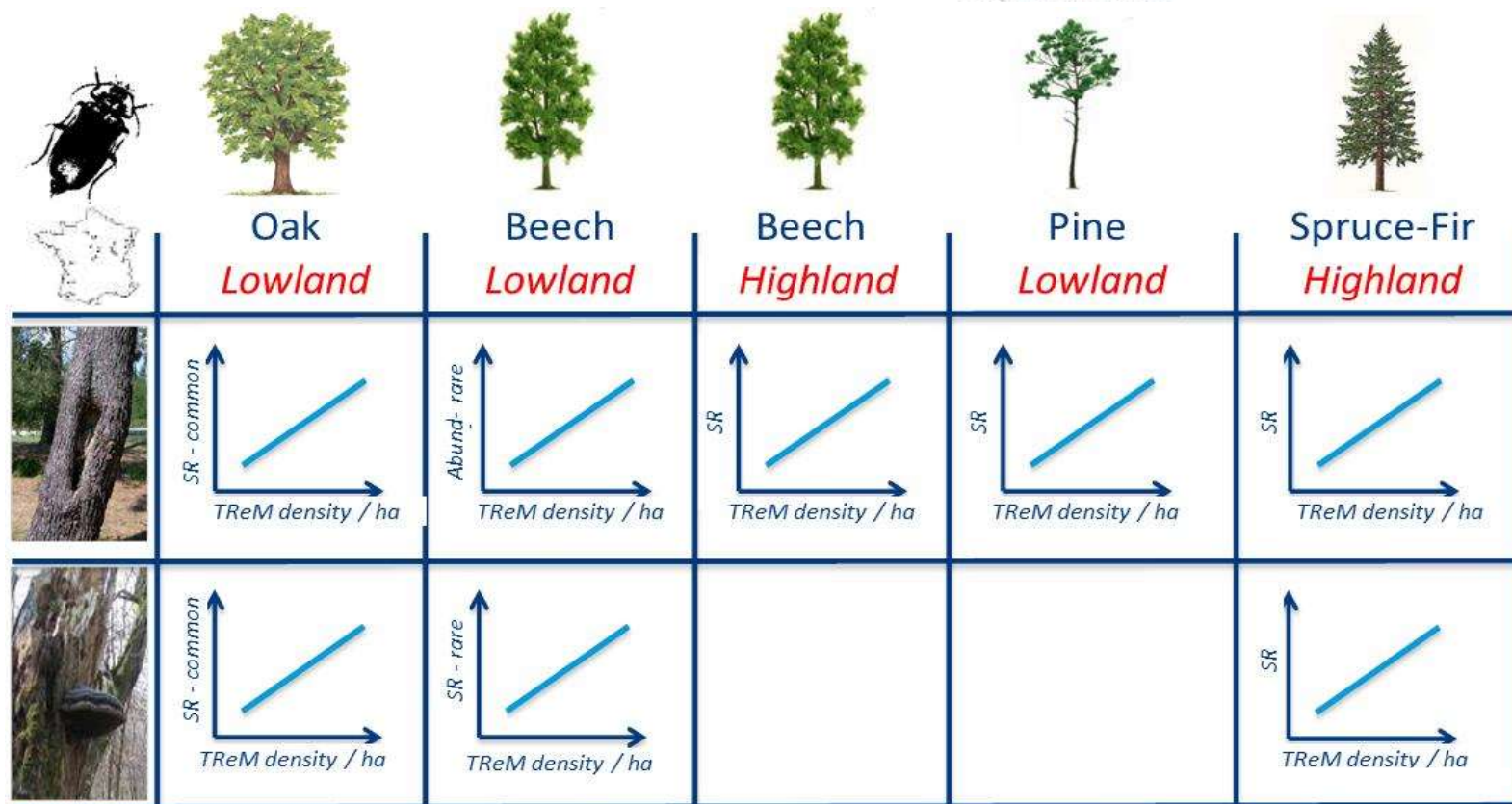


# Saproxylic beetle species richness increases with the local amount of certain TreM-bearing trees in various but not all forest contexts



Key features for saproxylic beetle diversity derived from rapid habitat assessment in temperate forests

C. Bouget<sup>a,\*</sup>, L. Larrieu<sup>b,c</sup>, A. Brin<sup>d</sup>



# TreMs are significantly associated to variations in species richness, but to a lesser extent than deadwood or openness

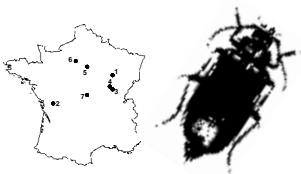
Biodivers Conserv (2013) 22:2111–2130  
DOI 10.1007/s10531-013-0531-3

ORIGINAL PAPER



In search of the best local habitat drivers for saproxylic beetle diversity in temperate deciduous forests

C. Bouget · L. Larrieu · B. Nusillard · G. Parmain

## Key factors of saproxylic beetle diversity



lowland  
deciduous  
forests

		<u>rare sp</u>	<u>common sp</u>
Oak 	Abiotic	2=Openness	1=Openness
	Deadwood	1=Deadwood diversity	2= Lying deadwood volume 3= Large lying deadwood volume 4= Deadwood diversity
	TReMs	ns	5=density fungus-bearing trees 6=density cavity-bearing trees
Beech 	Abiotic	ns	1=Openness
	Deadwood	ns	2=Deadwood diversity
	TReMs	1=density fungus-bearing trees	3=density crown-deadwood-bearing trees

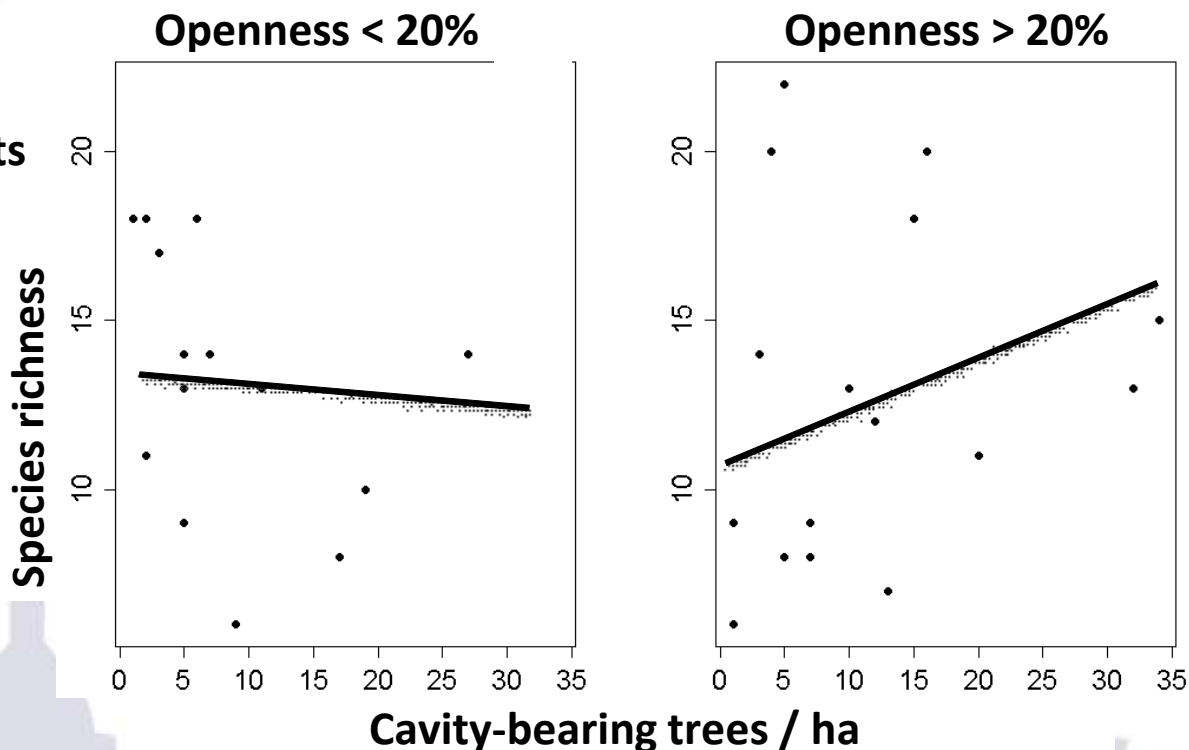
9

# Some relationships between TreM density and saproxylic beetle diversity depend on stand openness



Key features for saproxylic beetle diversity derived from rapid habitat assessment in temperate forests

C. Bouget<sup>1,\*</sup>, L. Larrieu<sup>2,3</sup>, A. Brin<sup>4</sup>



# TreM diversity only slightly correlates with saproxylic beetle assemblage structure



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

Philippe Janssen <sup>a,\*</sup>, Marc Fuhr <sup>a</sup>, Eugénie Cateau <sup>c</sup>, Benoit Nusillard <sup>b</sup>, Christophe Bouget <sup>b</sup>



highland forests



	Mean trait CWM	Trait variance FDis	Sp. richness	Abundance
Body Size	ns	ns		
Canopy prefer.	ns	ns		
Decay prefer.	↗	↗		
Diameter prefer.	↗	ns		
Low-dispersal			ns	ns
High-dispersal			ns	ns
Cavicolous			ns	ns
Fungicolous			ns	ns

### 3-Why are TreM-biodiversity relationships so weak at stand scale in ecological studies?



# TreM metrics

## ❑ TreM values are too low in managed forests?

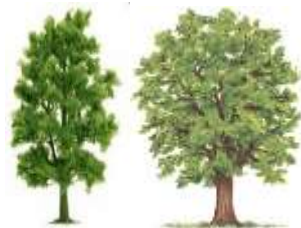
- Values below ecological thresholds ?

### – 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



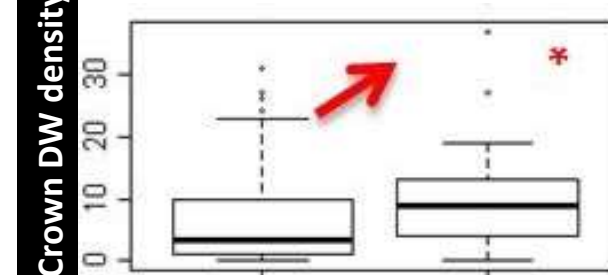
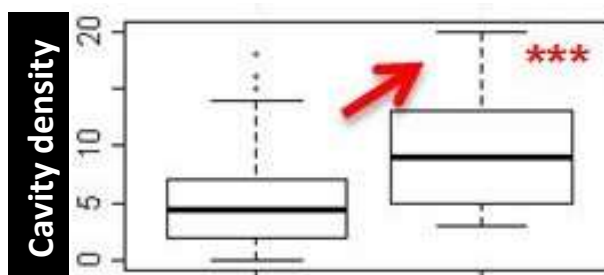
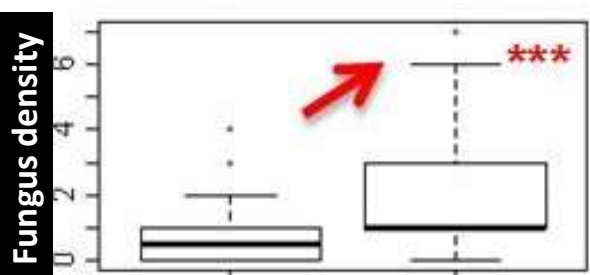
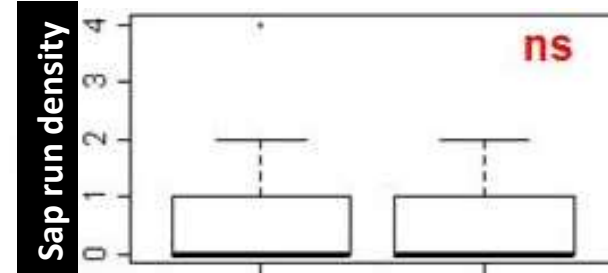
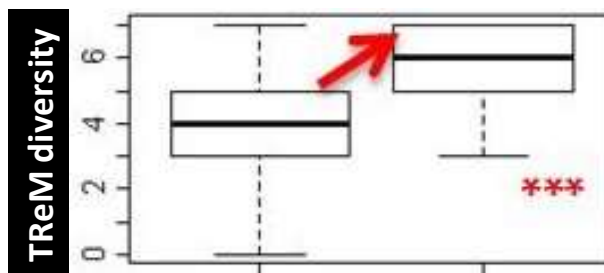
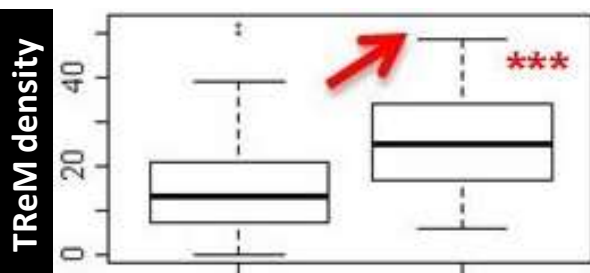
Animal Conservation

ZSL

Animal Conservation, Print ISSN 1367-8430

## Does a set-aside conservation strategy help the restoration of old-growth forest attributes and recolonization by saproxylic beetles?

C. Bouget<sup>1</sup>, G. Parmain<sup>1,2,3</sup>, O. Gilg<sup>4</sup>, T. Noblecourt<sup>2</sup>, B. Nusillard<sup>3</sup>, Y. Paillet<sup>1</sup>, C. Pernot<sup>1</sup>, L. Larrieu<sup>5,6</sup> & F. Gosselin<sup>1</sup>



Harvested Unharv > 30 yrs

Harvested Unharv > 30 yrs

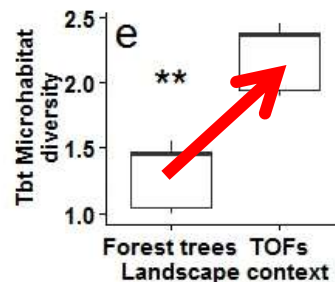
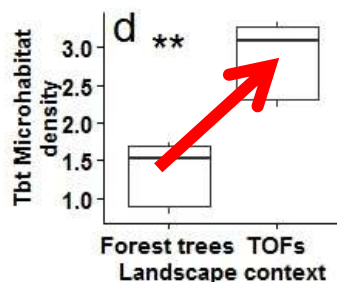
Harvested Unharv > 30 yrs

# TreM density and diversity are higher in and around veteran trees outside than inside forests

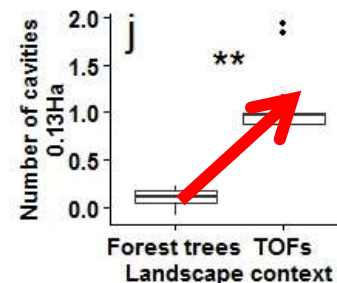
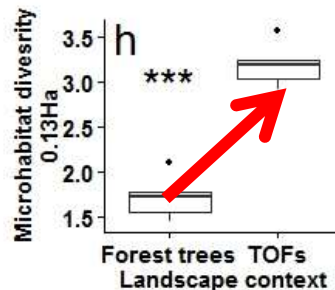
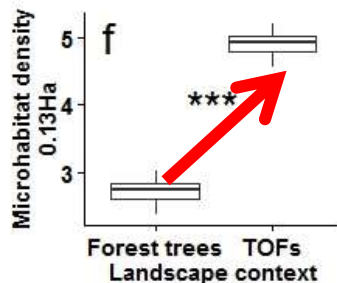
## Insect Conservation and Diversity

Parmain & Bouget, 2017

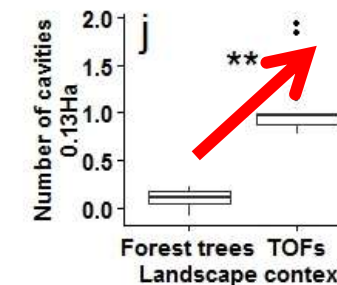
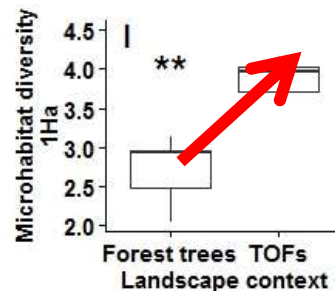
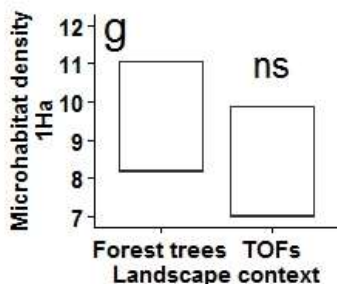
Veteran tree scale



0.13ha-scale



1ha-scale



# TreM effects increase with TreM values

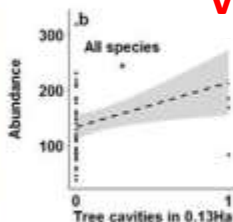
➔ The effects of TreM metrics on saproxylic beetle diversity are stronger outside than inside forests!



Veteran trees  
inside forest

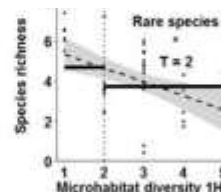


All sx beetle species



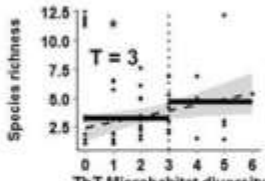
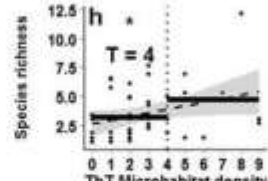
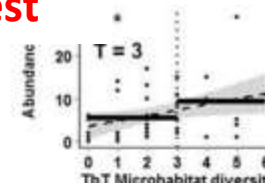
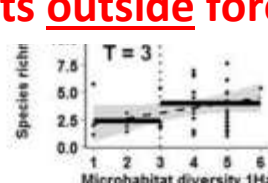
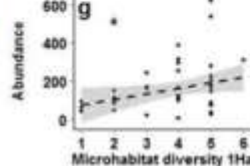
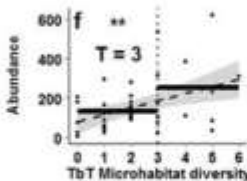
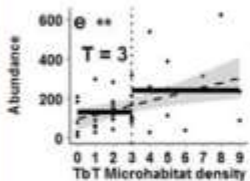
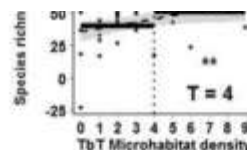
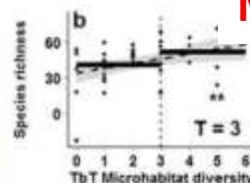
Very few positive effects inside forest

Rare sx beetle species



Veteran trees  
outside forests

Many positive effects outside forest



Insect Conservation and Diversity

Parmain & Bouget, 2017

# TReM sampling

❑ Low TReM values in managed forests ?

❑ Irrelevant TreM sampling ?

– Bad biodiversity sampling ?

- Analysis of the response of TReM-associated organisms only
- Sampling methods dedicated to TReM-associated organisms
- Multi-taxon approaches

# Facing low TreM detectability...by the use of proxies?



487 plots  
19 areas

Larrieu et al., in prep.

## 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

→ 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 ?

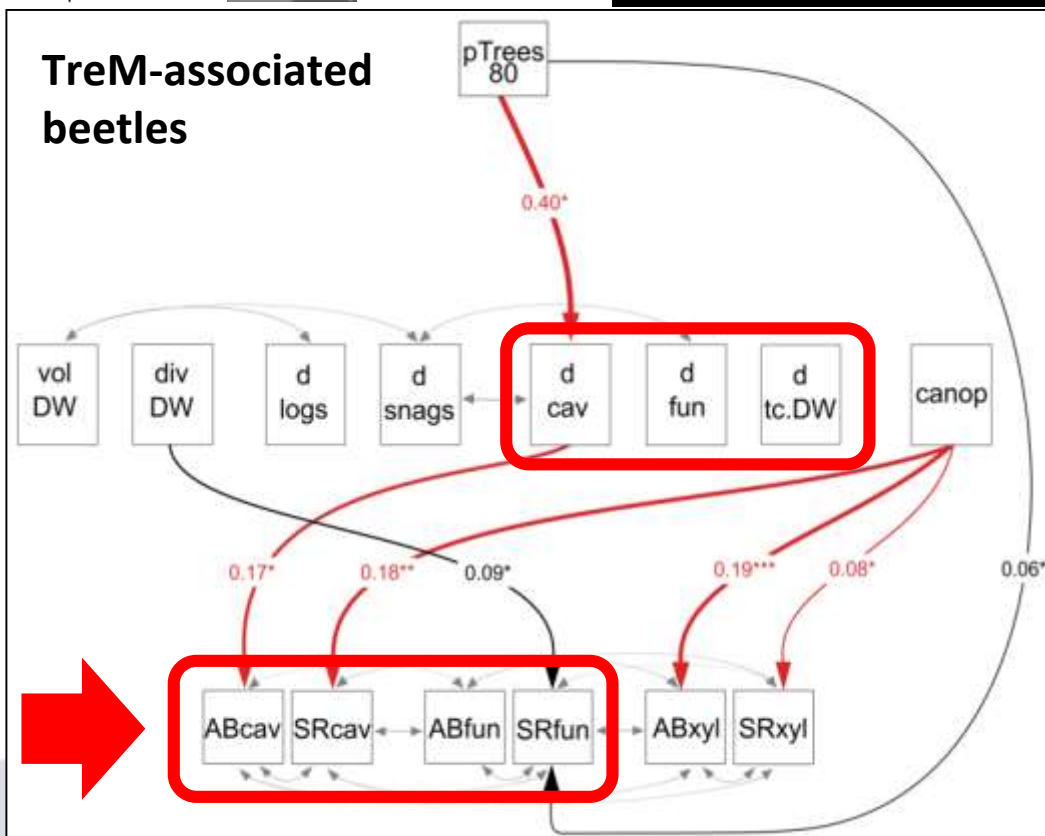
# TreMs are fostered by an extended rotation...

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

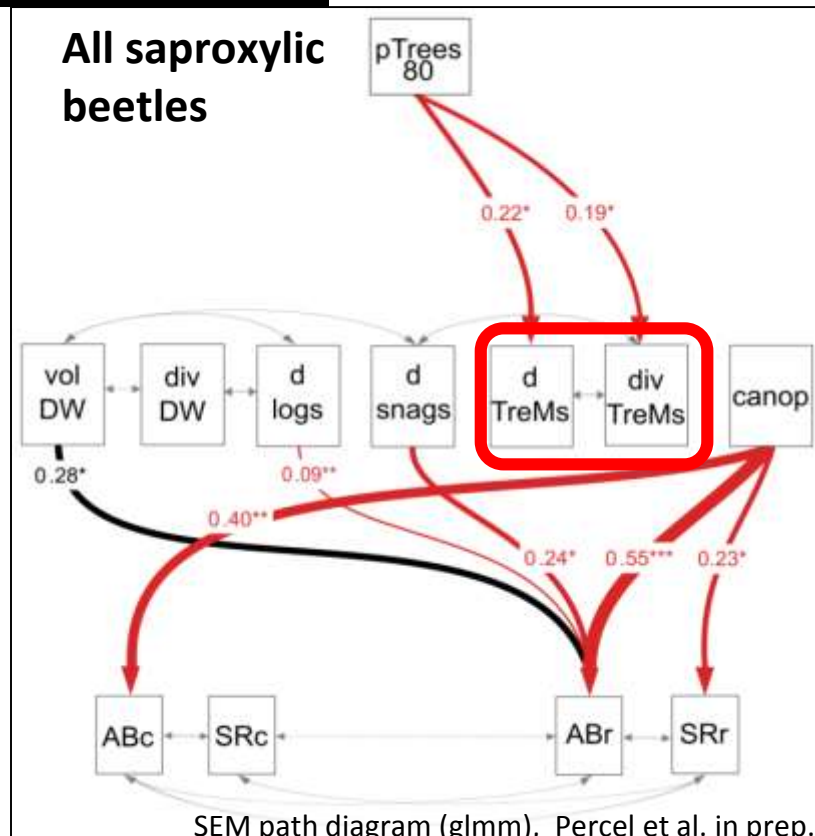


Extended rotation (+ 50 yrs)

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



487 plots

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

## 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

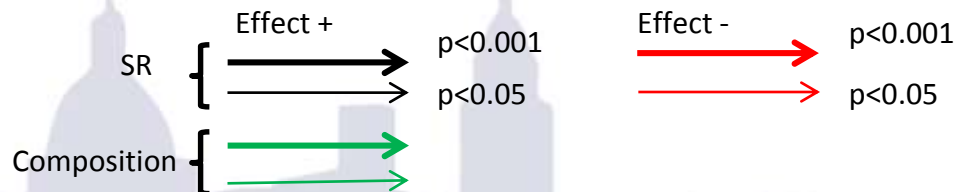
Bats

Birds

Hoverflies

Fungi

Lichens



# 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

– Bad TReM sampling ?

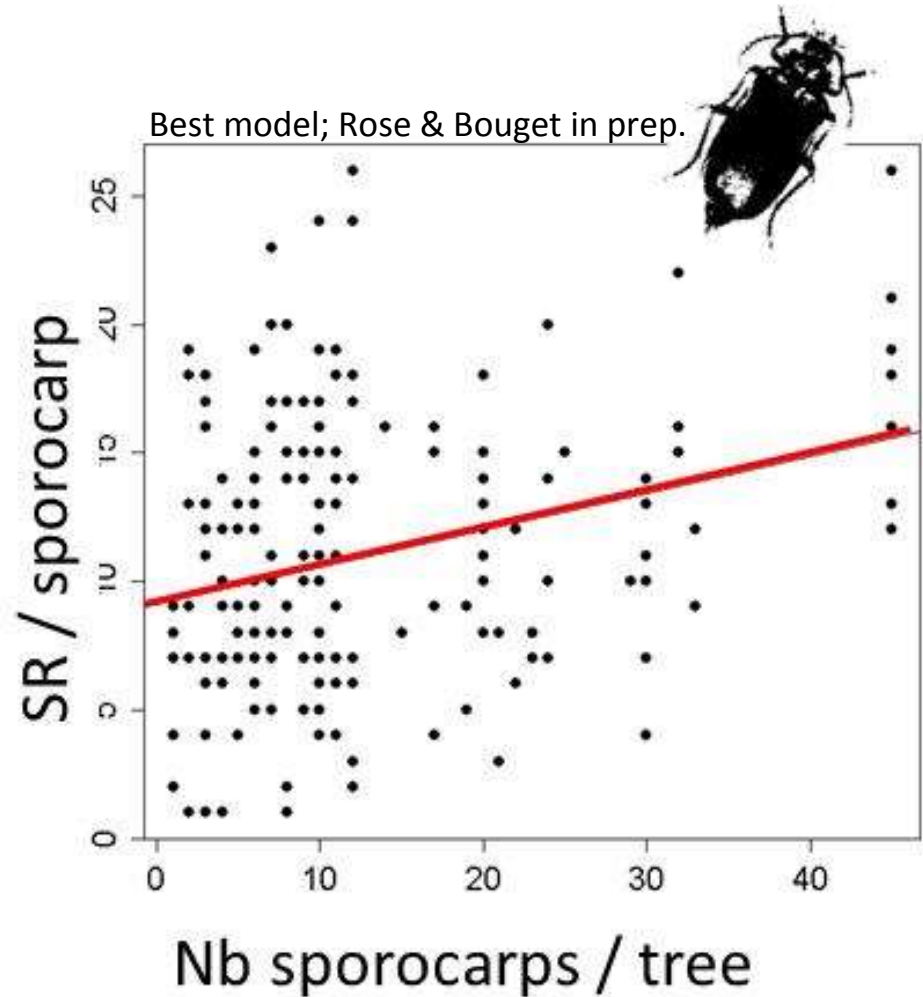
# Stronger TreM effects are demonstrated by using dedicated methods to sample TreM-associated beetles

## 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...**

# Acknowledgements

## ☐ Our PhD students

Aurore Lassauce

Gwendoline Percel

Guillem Parmain

Philippe Janssen

## ☐ ...and technicians

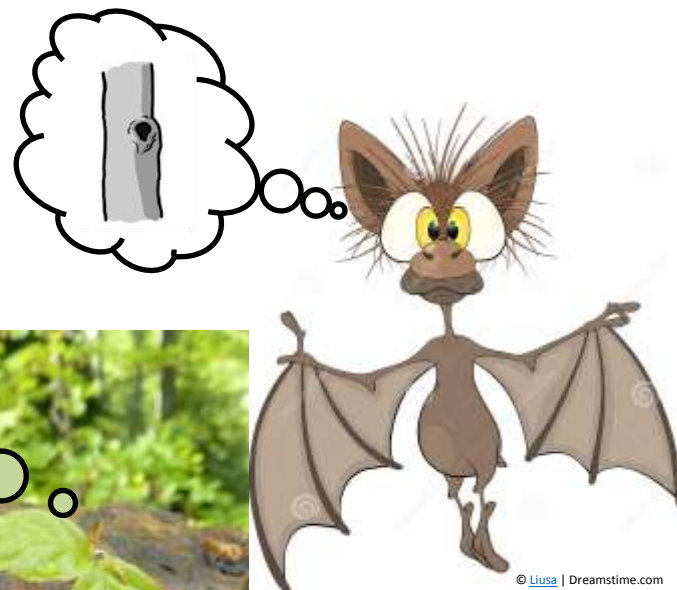
Carl Moliard

Benoit Nusillard

Laurent Burnel

Jérôme Wilmm

Be patient,  
kid;  
come back  
in 2117!



# Thank you for your attention