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

Laurent LARRIEU [1]

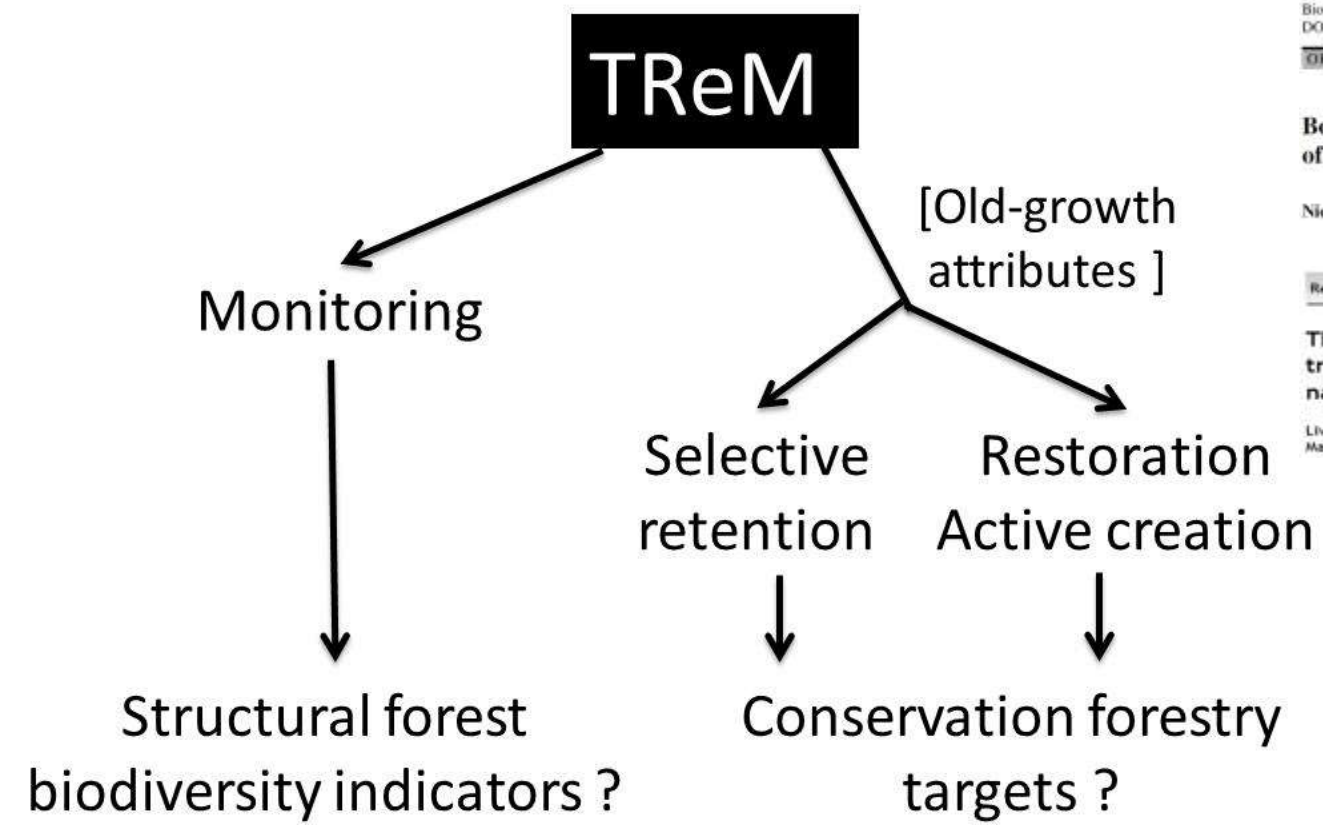
Christophe BOUGET [2]

[1]INRA/CRPFOc

[2] IRSTEA

LIFE MIPP
European Workshop
Monitoring of saproxylic beetles and other insects protected in the European Union
Mantova (Italy), 24th - 26th 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

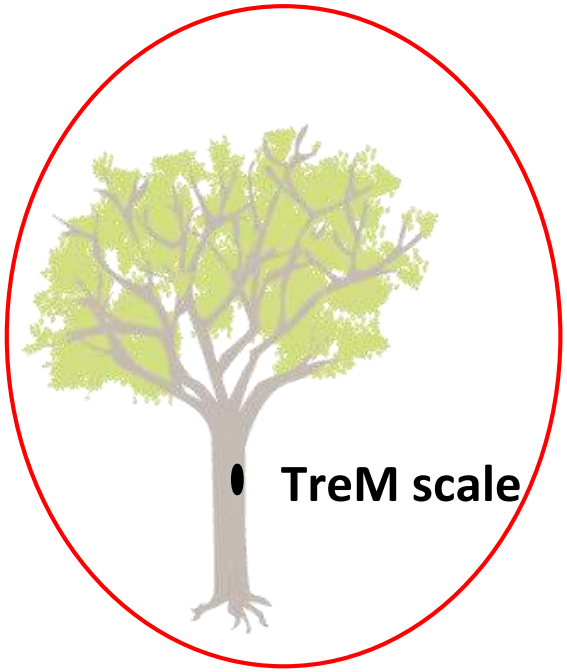
Nicklas Jansson · Thomas Ranius · Anna Larsson · Per Milberg

Research Article - doi: 10.3832/ifor1281-007

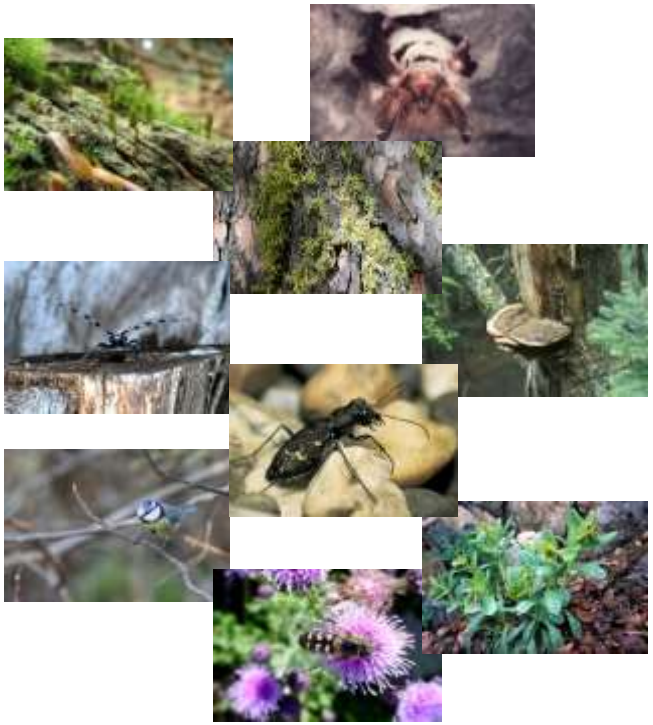
The Habitat-Trees experiment: using exotic tree species as new microhabitats for the native fauna

Livia Zapponi, Emma Minari, Luca Longo, Ilaria Toni, Franco Mason, Alessandro Campanaro

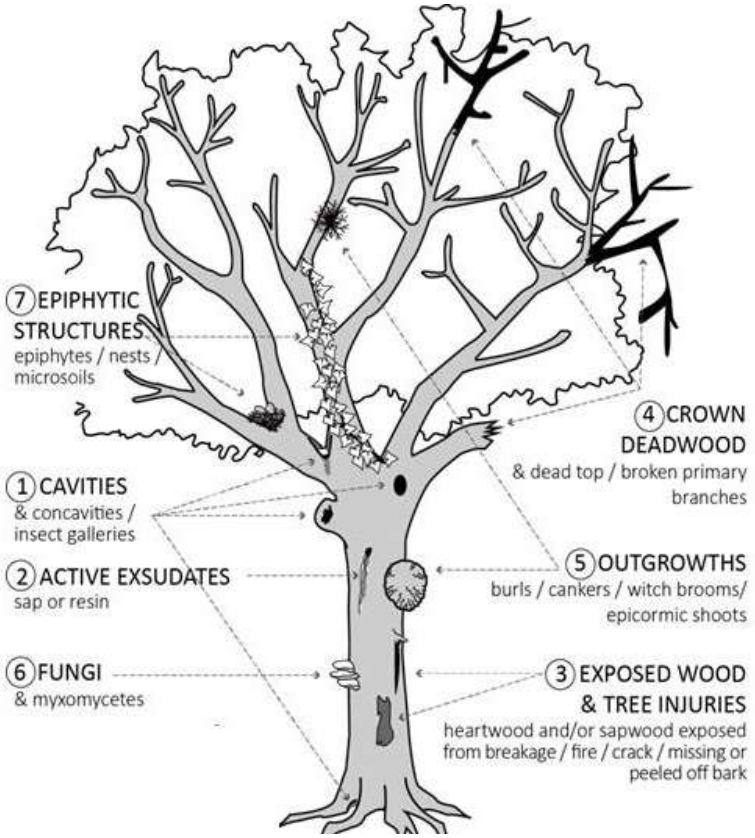
1-TreMs and biodiversity at the TreM scale



?



TReMs are morphological singularities borne by living or dead trees



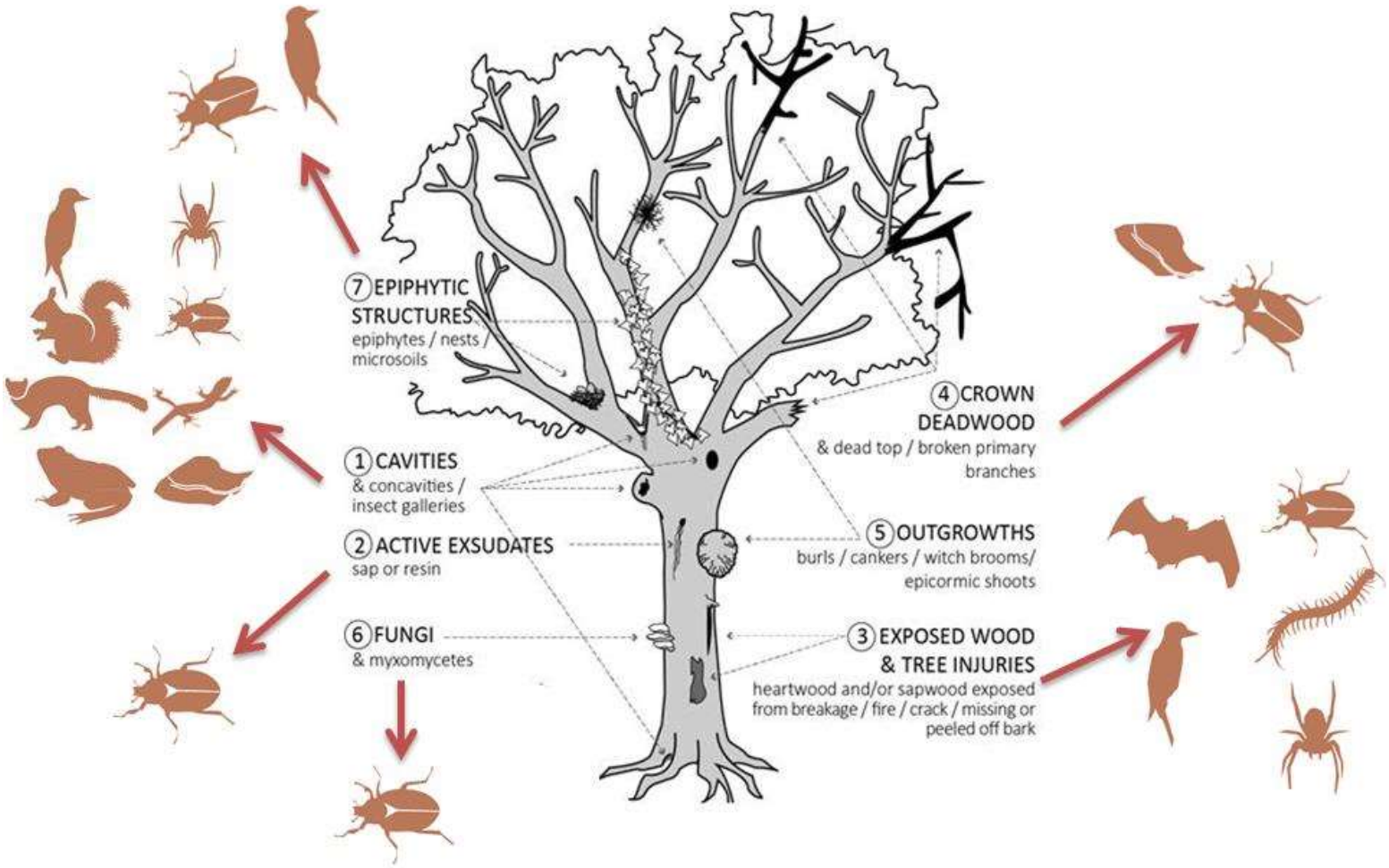
© Emberger (Larrieu & Heinz 2016)

Italian Journal of Agronomy 2016; volume 11(s1)

Forest management for invertebrate conservation

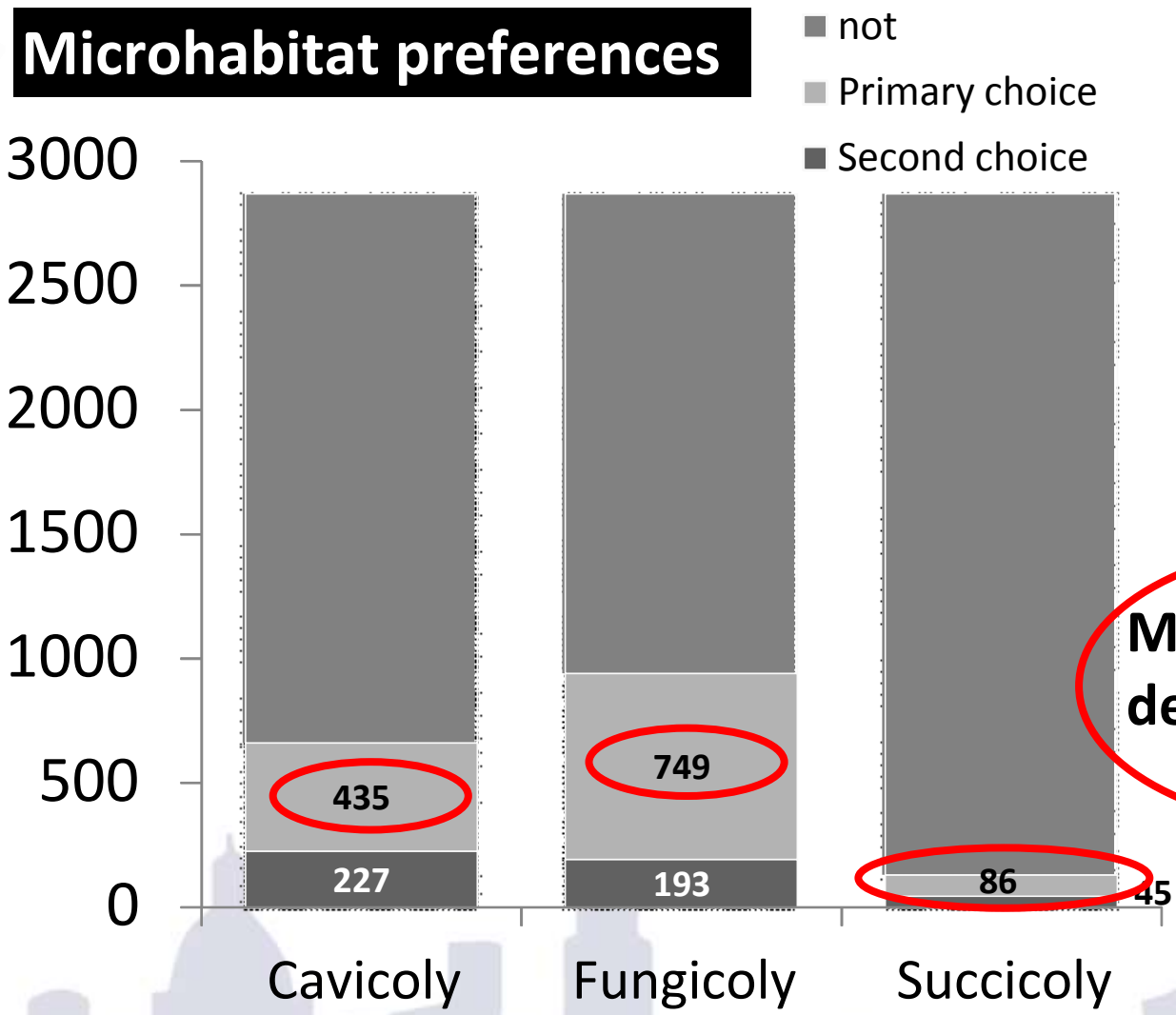
Maarten de Groot,[1] Livia Zapponi,[2,3] Davide Badano,[2,3] Serena Corezzola,[2,3] Franco Mason[2,3]

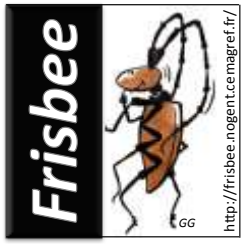
TreMs host a wide diversity of taxa



TreMs host species-rich assemblages

Microhabitat preferences

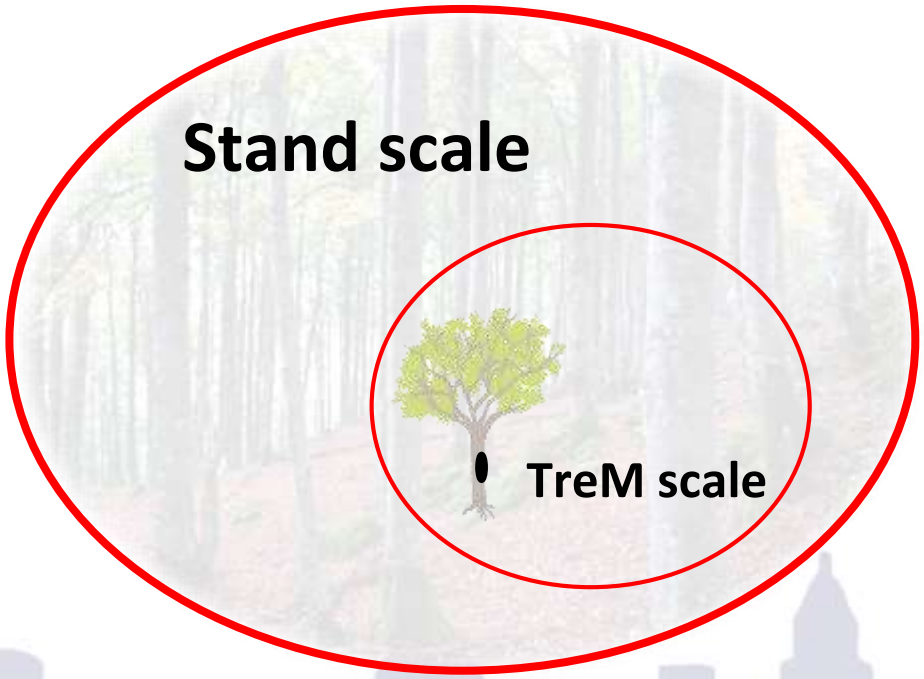


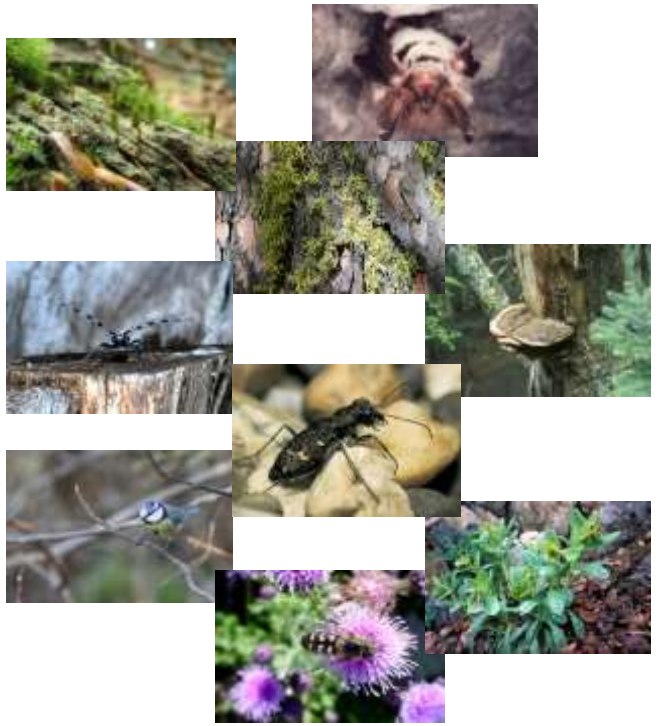


Bouget et al., in prep.

Many beetles depend on TreMs !

2-TreMs and biodiversity at the stand scale



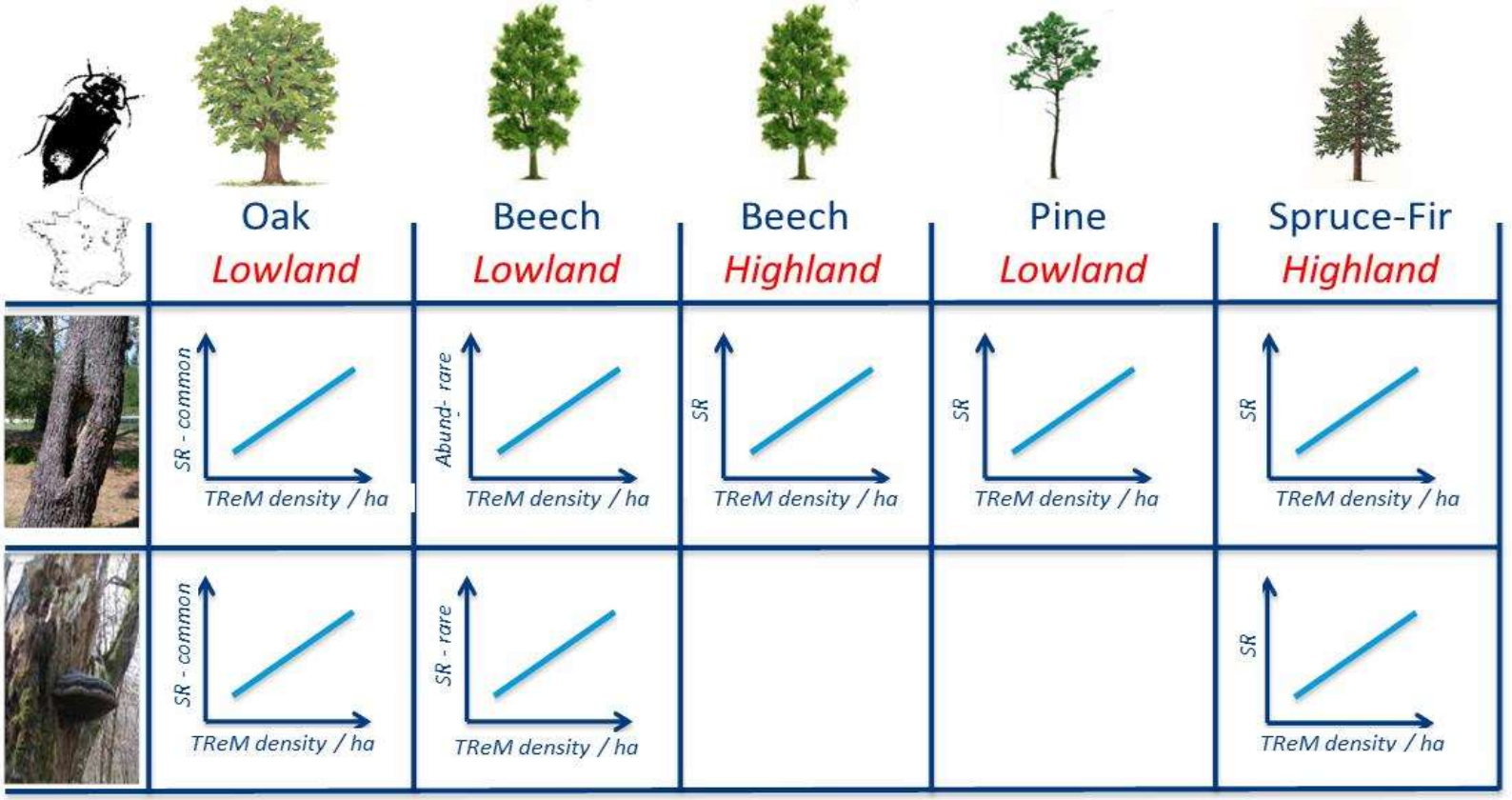


Saproxylic beetle species richness increases with the local amount of certain TreM-bearing trees in various but not all forest contexts

Ecological Indicators
journal homepage: www.elsevier.com/locate/ecolind

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

C. Bouget [a,*], L. Larrieu [b,c], A. Brin [d]



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

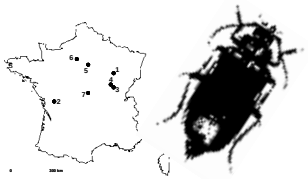
Biodivers Conserv (2013) 22:2111–2130
DOI 10.1007/s10531-013-0531-3

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

		rare sp	common sp
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

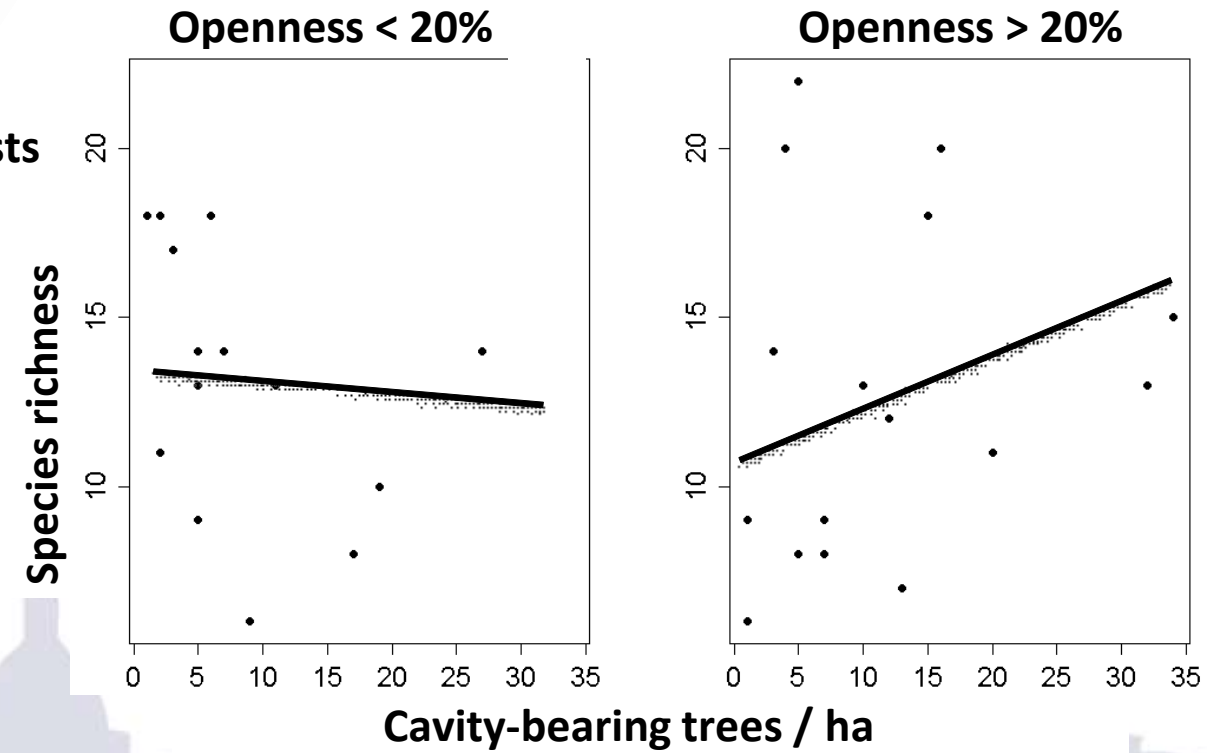
Some relationships between TreM density and saproxylic beetle diversity depend on stand openness

Contents lists available at ScienceDirect
Ecological Indicators
journal homepage: www.elsevier.com/locate/ecolind

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

C. Bouget [a,*], L. Larrieu [b,c], A. Brin [d]

highland forests



TreM diversity only slightly correlates with saproxylic beetle assemblage structure

highland forests

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/bioc

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

Philippe Janssen [a,*], Marc Fuhr [a], Eugénie Cateau [c], Benoit Nusillard [b], Christophe Bouget [b]

	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 thesholds ?

– Bad biodiversity sampling ?

- Analysis of the response pf TReM-associated organisms only
- sampling methods dedicated to TReM-associated organisms

– Bad TReM sampling ?

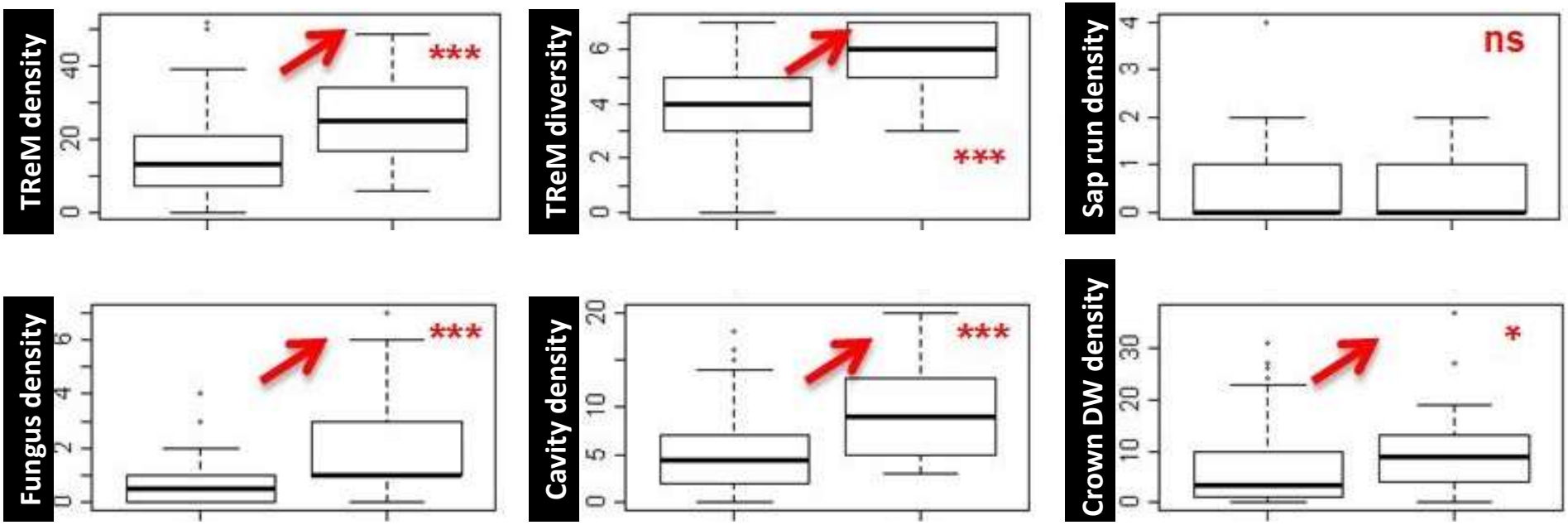
Trem density and diversity are affected by forestry

Animal Conservation ZSL

Animal Conservation. Print ISSN 1367-9430

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

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

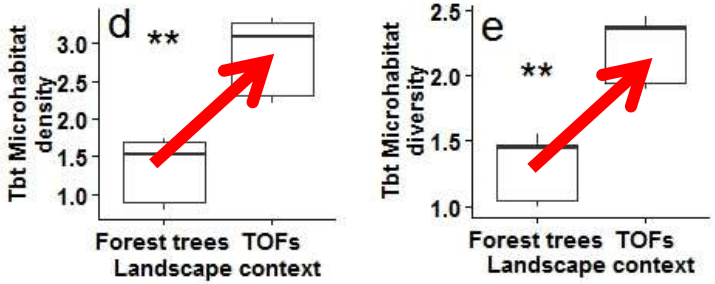


TreM density and diversity are higher in and around veteran trees outside than inside forests

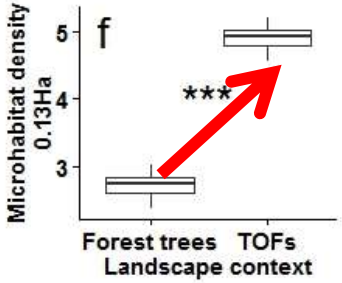
Insect Conservation and Diversity

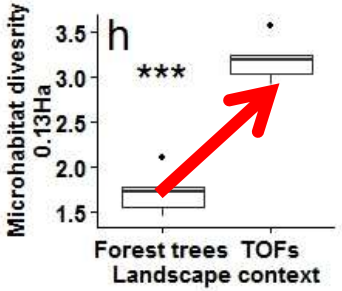
Parmain & Bouget, 2017

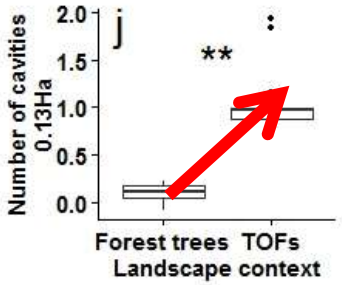
Veteran tree scale



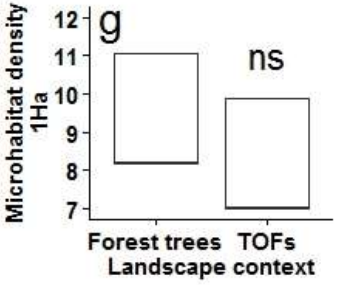
0.13ha-scale

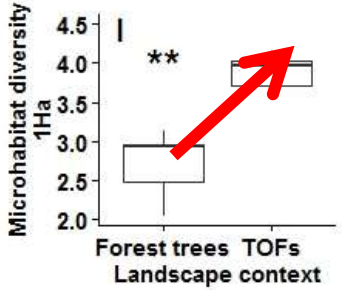


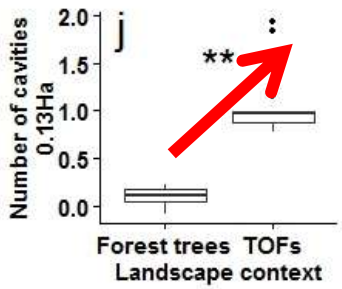




1ha-scale







TreM effects increase with TreM values

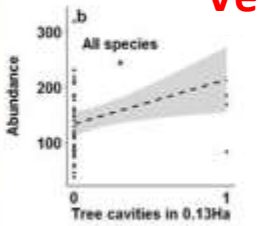
The effects of TreM metrics on saproxylic beetle diversity are stronger outside than inside forests!

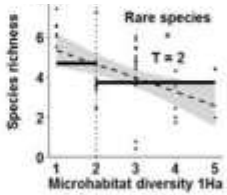
All sx beetle species

Rare sx beetle species

Very few positive effects inside forest

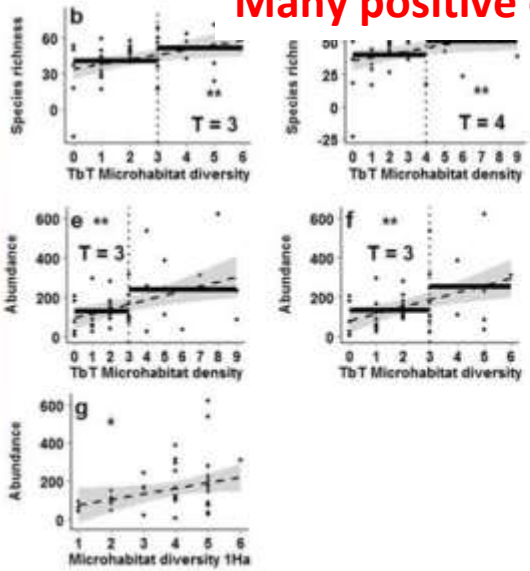
Veteran trees inside forest

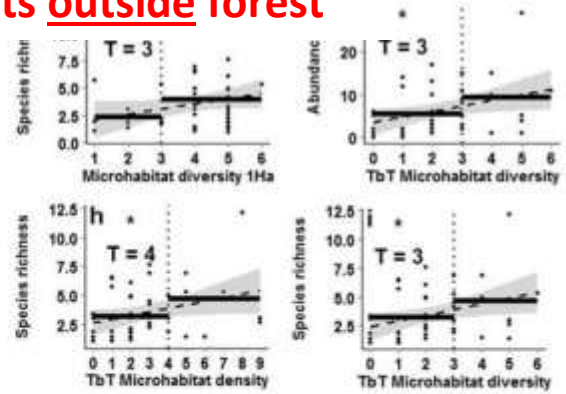




Many positive effects outside forest

Veteran trees outside forests





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 pf 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

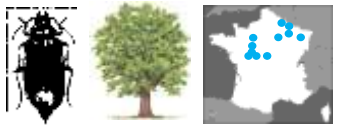
p<0.001
p<0.05

Biodiversity metrics

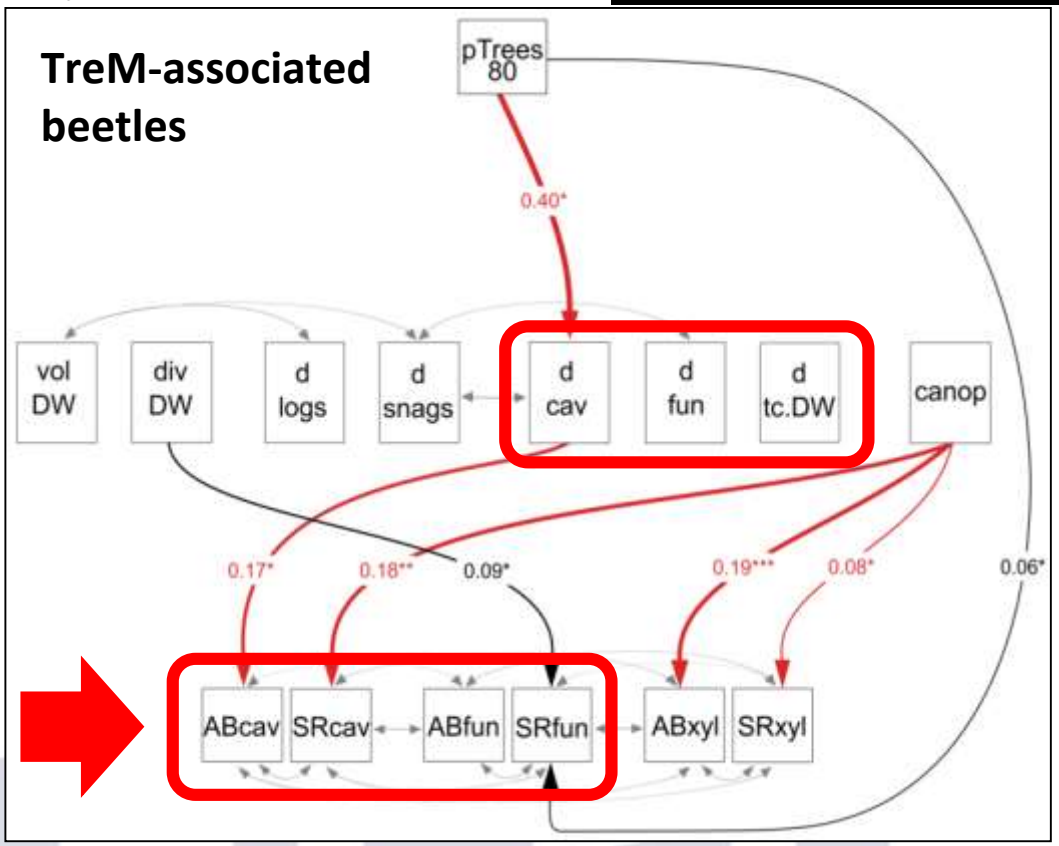
- Low TReM values in managed forests ?
- **Irrelevant biodiversity metrics ?**
  - Diversity of TreM-associated taxa only *vs* overall diversity
  - sampling methods dedicated to TReM-associated organisms
- Bad TReM sampling ?

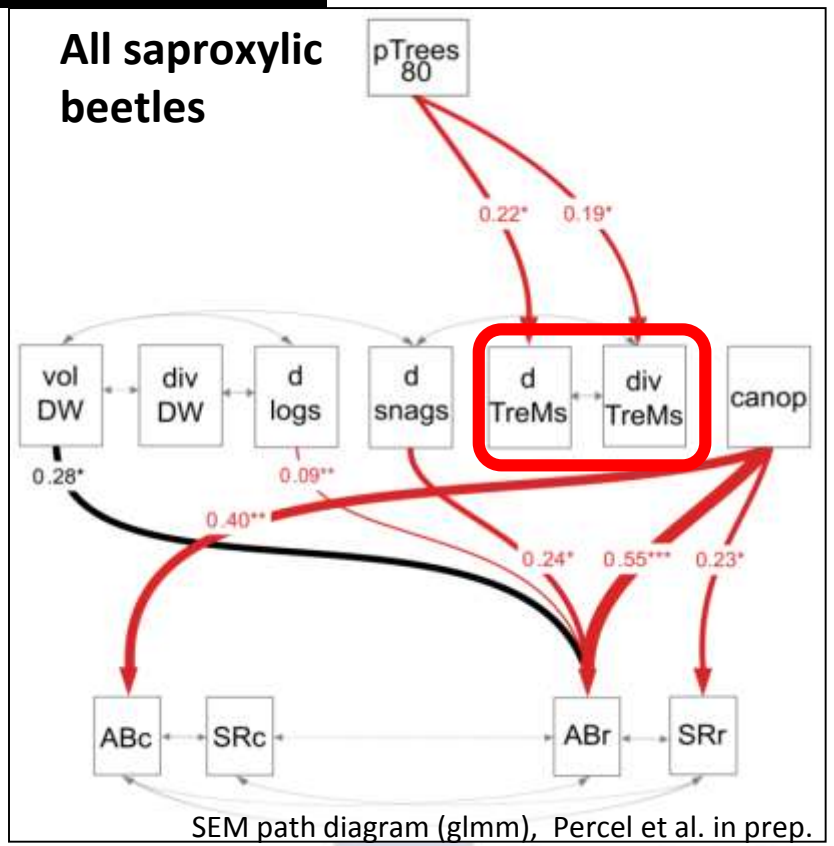
TreMs are fostered by an extended rotation…

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



Extended rotation (+ 50 yrs)





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

Effect +
SR: p<0.001; p<0.05
Composition

Effect -
p<0.001
p<0.05

Biodiversity sampling

- Low TReM values in managed forests ?

- Irrelevant biodiversity sampling ?
  - Analysis of the response pf 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

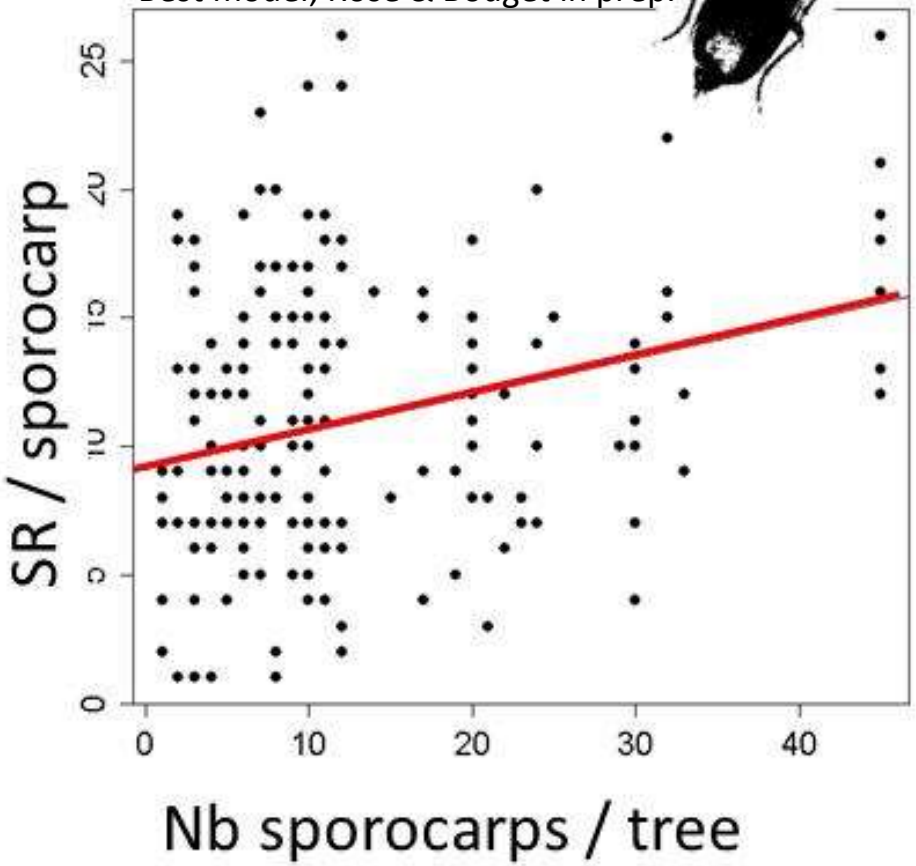
1. Biodiversity metrics of TreM associated taxa (fungus-dwelling)
2. TreM metrics (polypore density)

+

Specific sampling:

polypore emergence trap

Best model; Rose & Bouget in prep.



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

Thank you for your attention