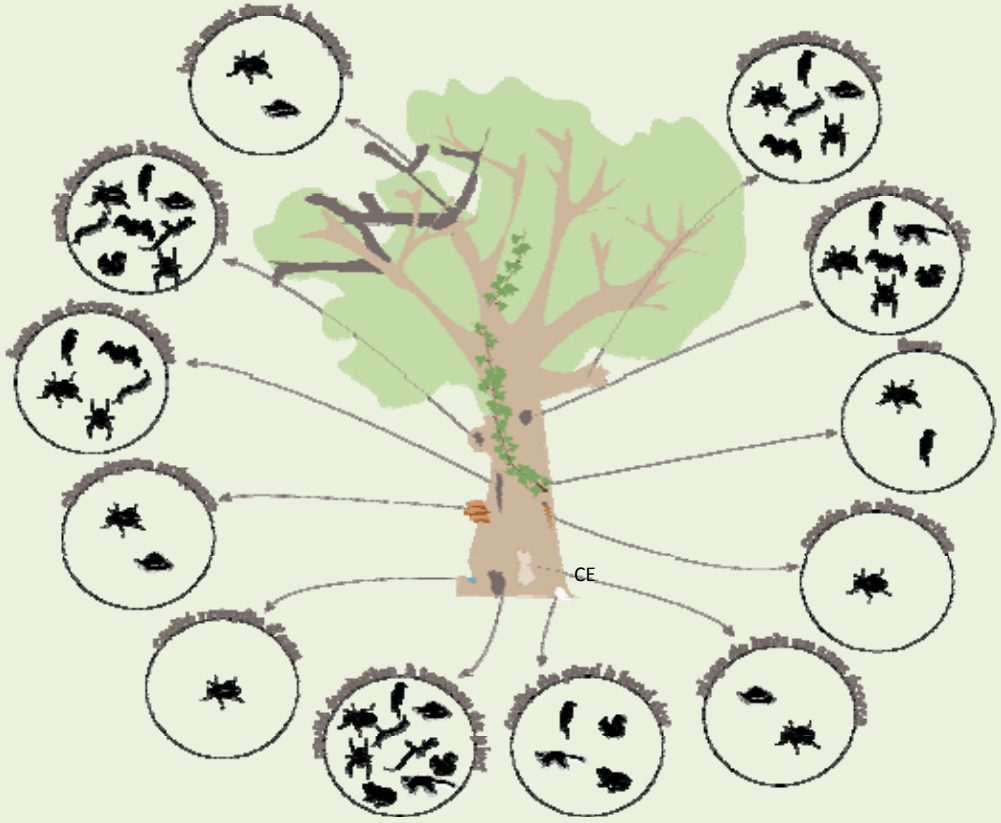
Tree-related microhabitats (TReMs) in European temperate forests

New insights for biodiversity conservation



Laurent LARRIEU

INRA Dynafor CNPF

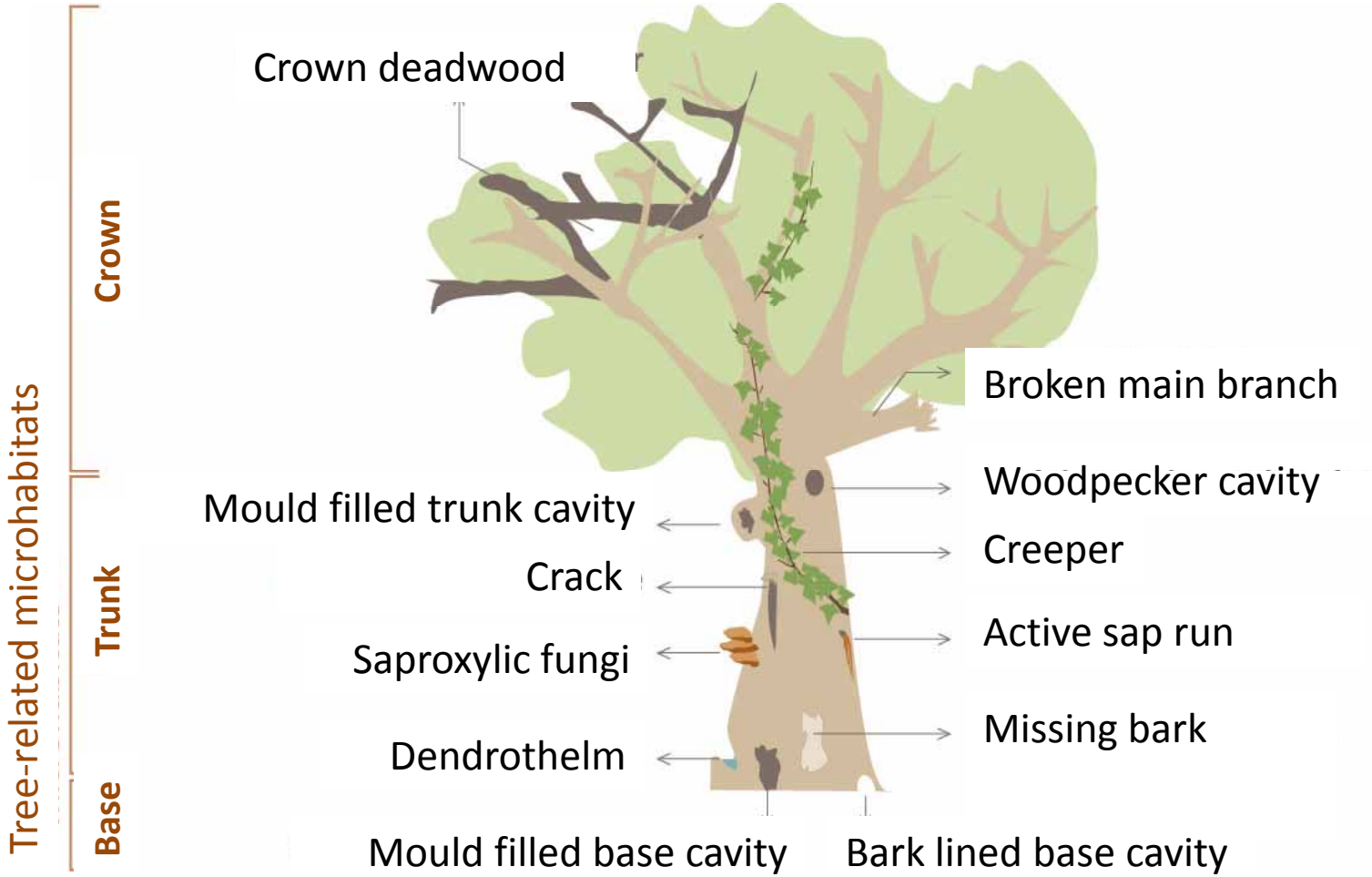
WSL, Birmensdorf, 2015, April 1st

TReMs: tree singular features hosting a wide range of life forms

(Temporary definition)

- **Singular morphological features borne by a tree, dead or living, and strongly dependant on it**
- **Encompassing decaying wood (=saproxylic) or not (=epixylic)**
- **Habitats for species with preferentially-associated biodiversity**
- **Small-size habitats (cm/cm^3 → m/m^3)**

All the tree parts can bear a TReM



Emberger et al. 2013

TReMs are observed daily and are a key issue for forest management

Managers

- silvicultural items
- flaw depreciating wood

→ **As little as possible**

Naturalists
Conservation biologists

- ecological items
- singular features hosting life

→ **Conservation**

Conflict

Compromise = **negotiated standards** (e.g. PEFC, FSC)
ecological relevance?

Do scientists have the answers?

Talk plan

I-TReMs in theoretical frameworks

II-Why and how I studied TReMs?

- History of TReM research
- Contexts and methods

III-Selection of results with practical implications for management

- Are TReMs drivers for biodiversity at stand level?
- Role of the largest trees in unharvested forests
- Effects of harvesting on TReM “communities”
- Conservation of TReM diversity

IV-Towards future research

I-TReMs as ecological items

Proposal of theoretical frameworks

1-Nested system

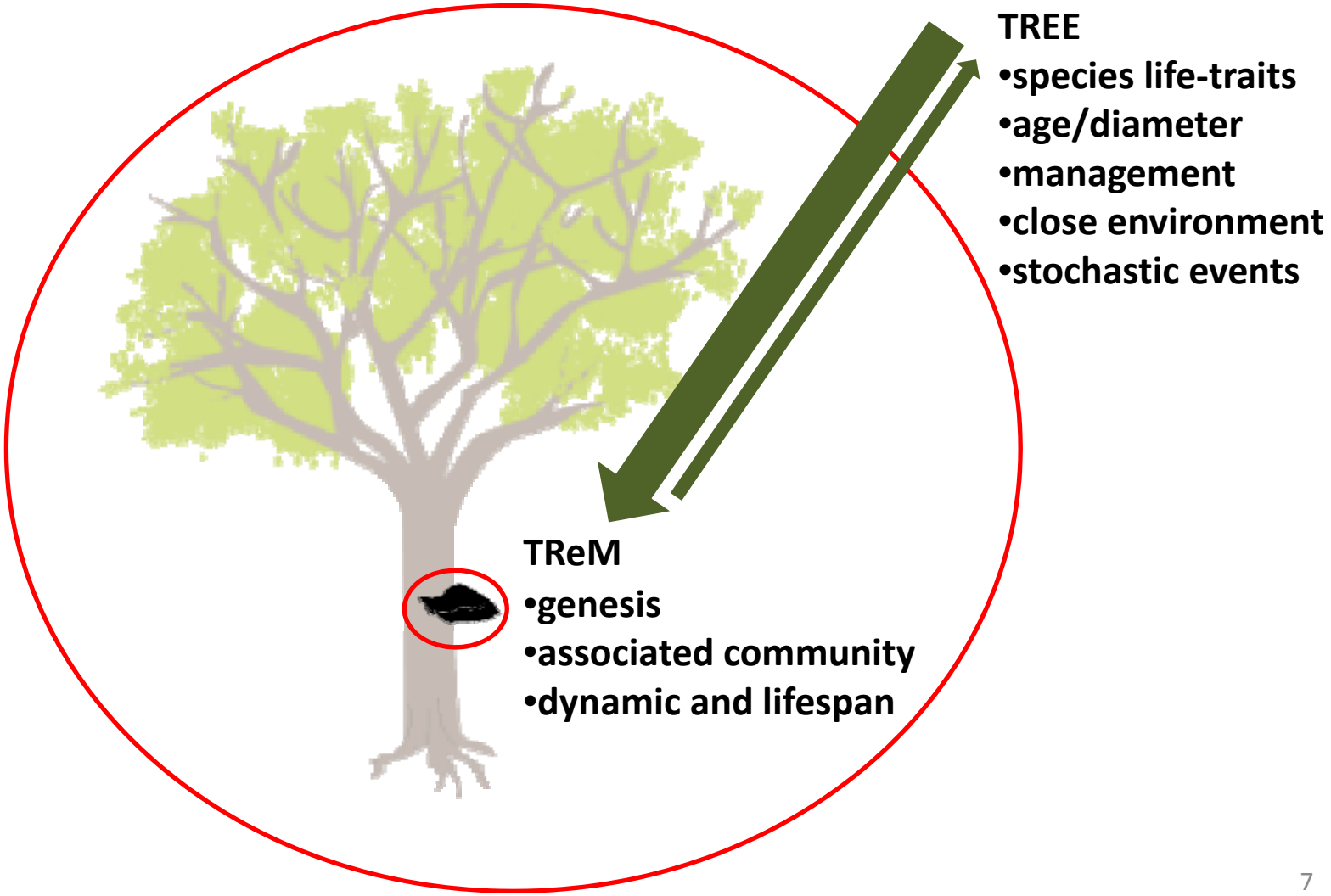
2- « Ephemeral Resource Patches »

Crucial, discrete and ephemeral resource

3- Landscape Ecology concepts

Complementation and supplementation resources, metapopulation, connectivity, matrix

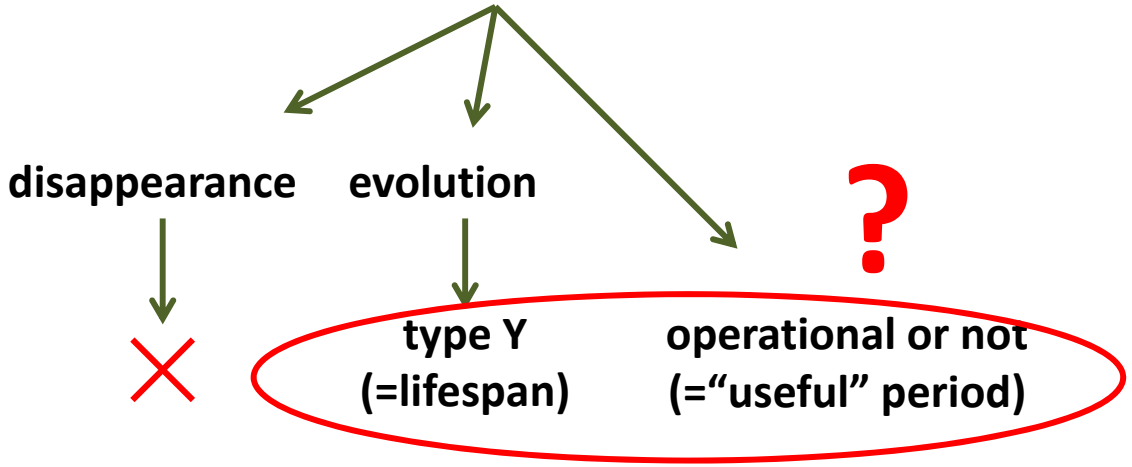
TReM and its TReM-bearing tree show a nested pattern



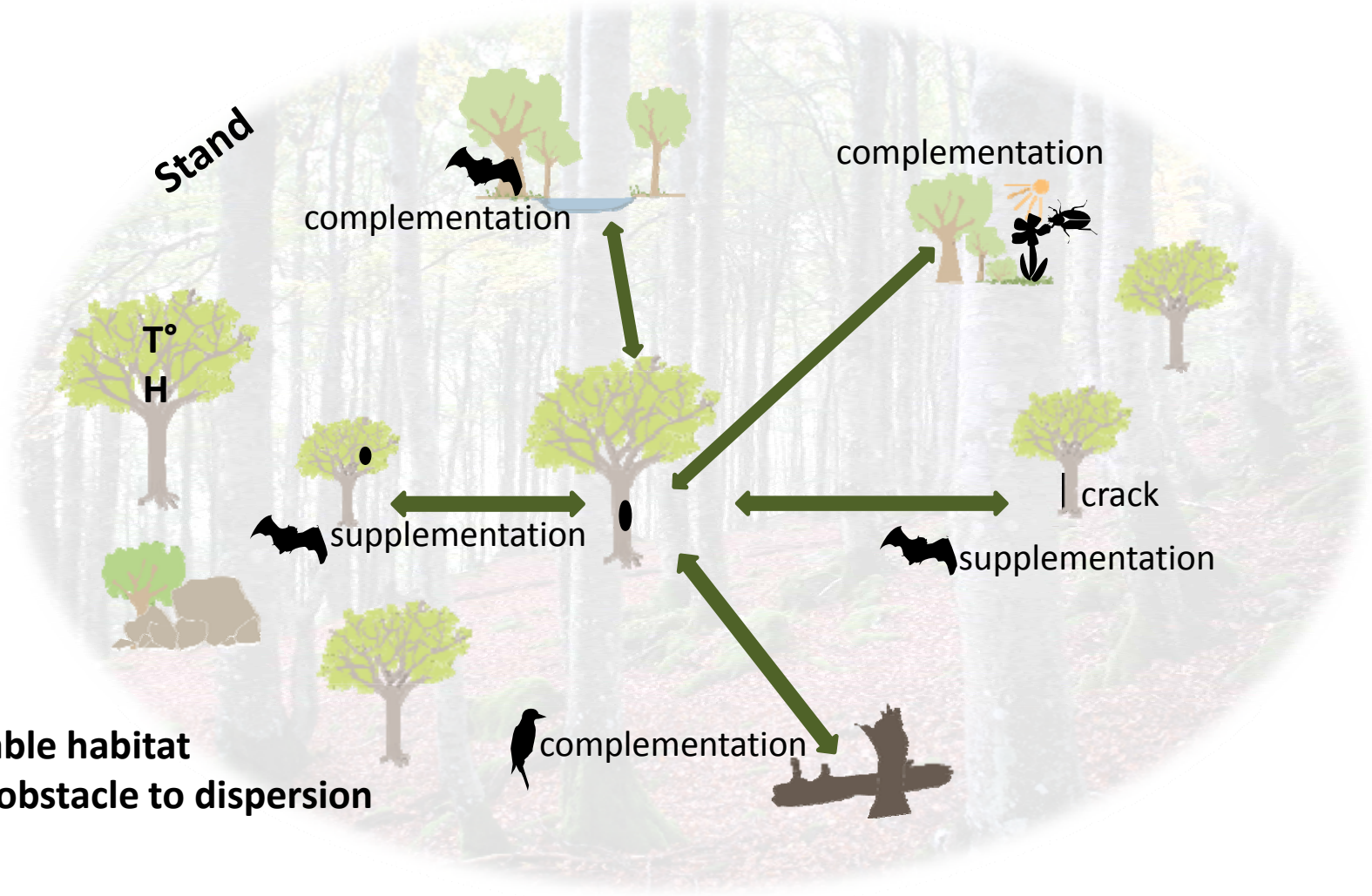
TReMs as «ephemeral resource patches » ? (Finn 2001)

Resource:

- **high quality** → **Dependence gradient** (1)
- **spatially limited** → **Small size and limited by the tree size**
- **temporary** → **TReM of type X**



What is the "matrix" for the species associated with TReMs?



Matrix

- **inhospitable habitat**
- **brake or obstacle to dispersion**

IIa-Some elements of history

From…

Roughly
15 000 y.

…to

- *Limoniscus violaceus*
- *Ischnodes sanguinicollis*
- …

Until 2003, studies focused on biodiversity at TReM level

➢ Cavities

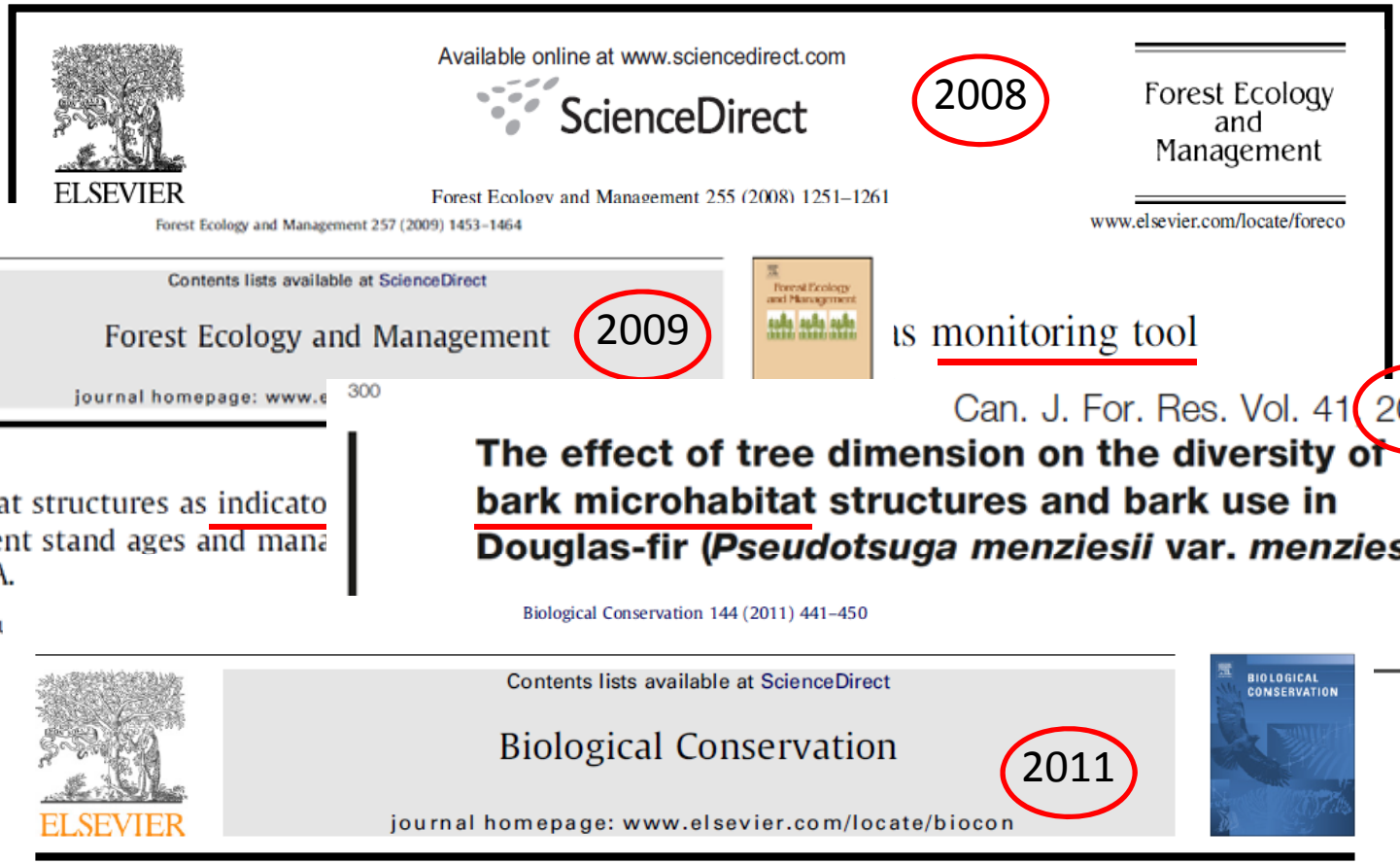
- filled by mould
  (e.g. Ranius 2000)
- drilled by woodpeckers
  (e.g. Martin & Eadie 1999; Penicaud 2000)
- dendrothelms
  (e.g. Kitching 1971; Vaillant 1978; Sota 1998)

➢ Sporophores of saproxylic fungi

(e.g. Bader et al. 1995)

In 2008, TReMs were identified as a relevant tool for biodiversity monitoring at stand level

Founding article



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Forest Ecology and Management

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Tree microhabitat structures as indicato
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Northwest, U.S.A.

Alexa K. Michel [a,*], St

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The effect of tree dimension on the diversity of bark microhabitat structures and bark use in Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*)

Biological Conservation 144 (2011) 441–450

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2011

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BIOLOGICAL CONSERVATION

Influence of tree characteristics and forest management on tree microhabitats

Aurélie Vuidot, Yoan Paillet *, Frédéric Archaux, Frédéric Gosselin

Cemagref, UR EFNO, Domaine des Barres, Nogent-sur-Vernisson, France

In 2011, knowledge of TReMs was still fragmentary and more studies were required

Requirements

- **A definition of a TReM**
- **A typology of TReMs**
- **Quantitative data for practical recommendations**

→ **Research approach focusing on data collection**

Finalized research to take biodiversity associated with TReMs better into account in forest management

- Practical recommendations
- Tools

1-Unharvested forests (reference)

Sampling

- TReM typology
- "natural" patterns
- Modelling

Differences?

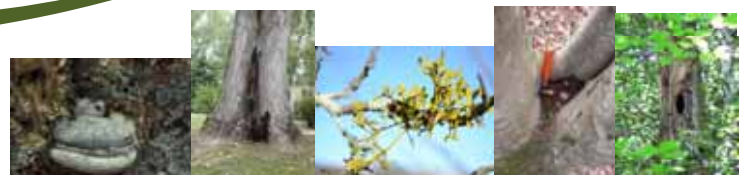
2-Harvested stands

Sampling

3-Taxonomic biodiversity

?

TReMs (stand level)



IIb-Methodology: an overview







Sampling has been done mainly in two forest types

Mixed mountain forest **Hilly beech-oak forest**

- **Roughly 35% of French forest dedicated to timber production**
- **Huge economic value**

TReMs have been sampled using two procedures

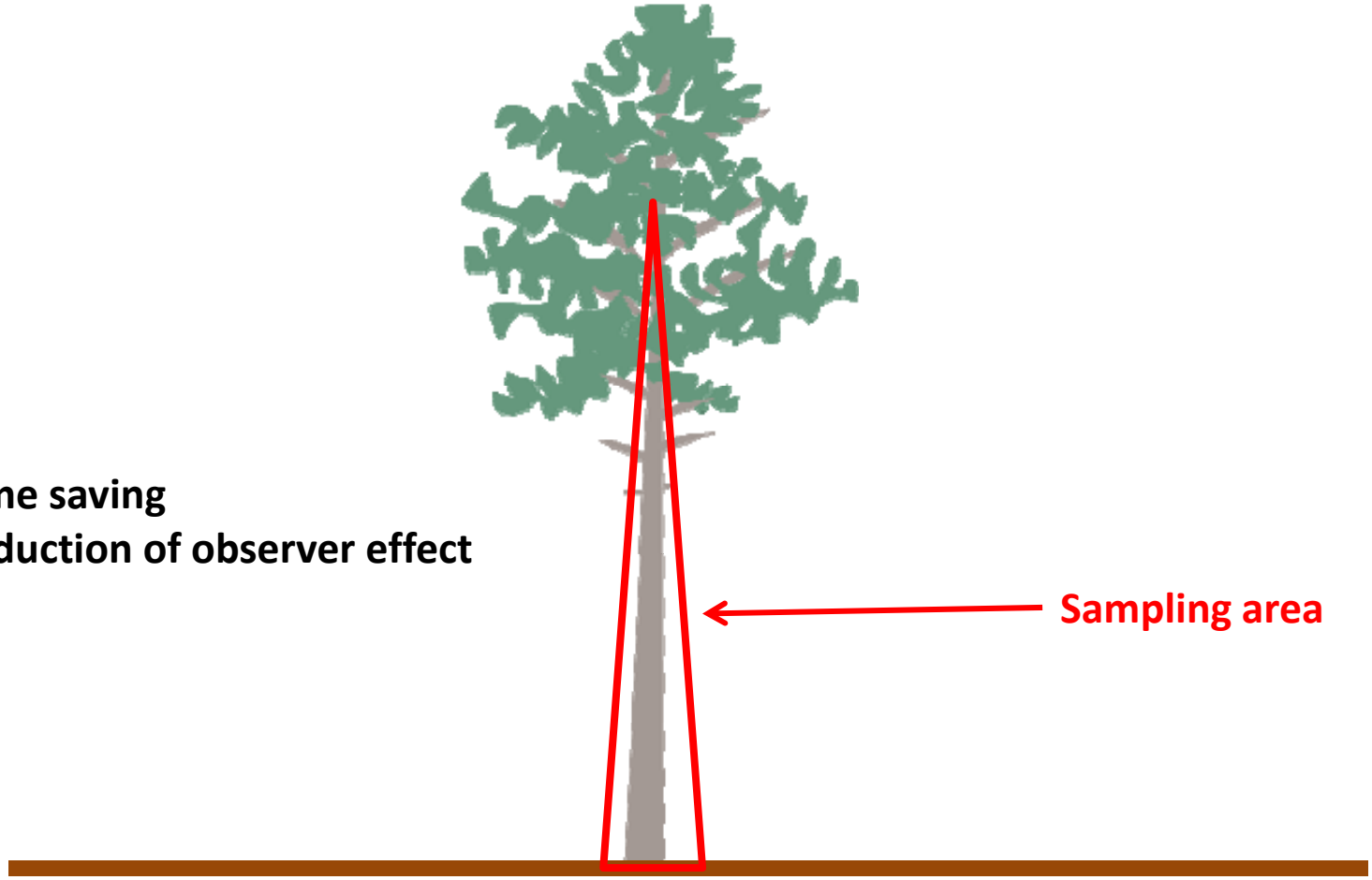
1-TReMs / tree level-management

“exhaustive” recording
of TReMs on all the trees of the plot

2-TReM / stand level-biodiversity

rapid habitat assessment protocols
centered on available taxonomic data

Only the trunk TReMs have been sampled



- time saving
- reduction of observer effect

“Direct” biodiversity sampling used a diversified set of 9 potential taxa “bio-indicators”

➢ **Available data**

➢ **Standardized protocols**

- Corticolous bryophytes
- Diptera Syrphidae
- Vascular flora
- Saproxylic beetles
- Coleoptera Carabidae
- Saproxylic fungi
- Bats
- Corticolous lichens
- Birds



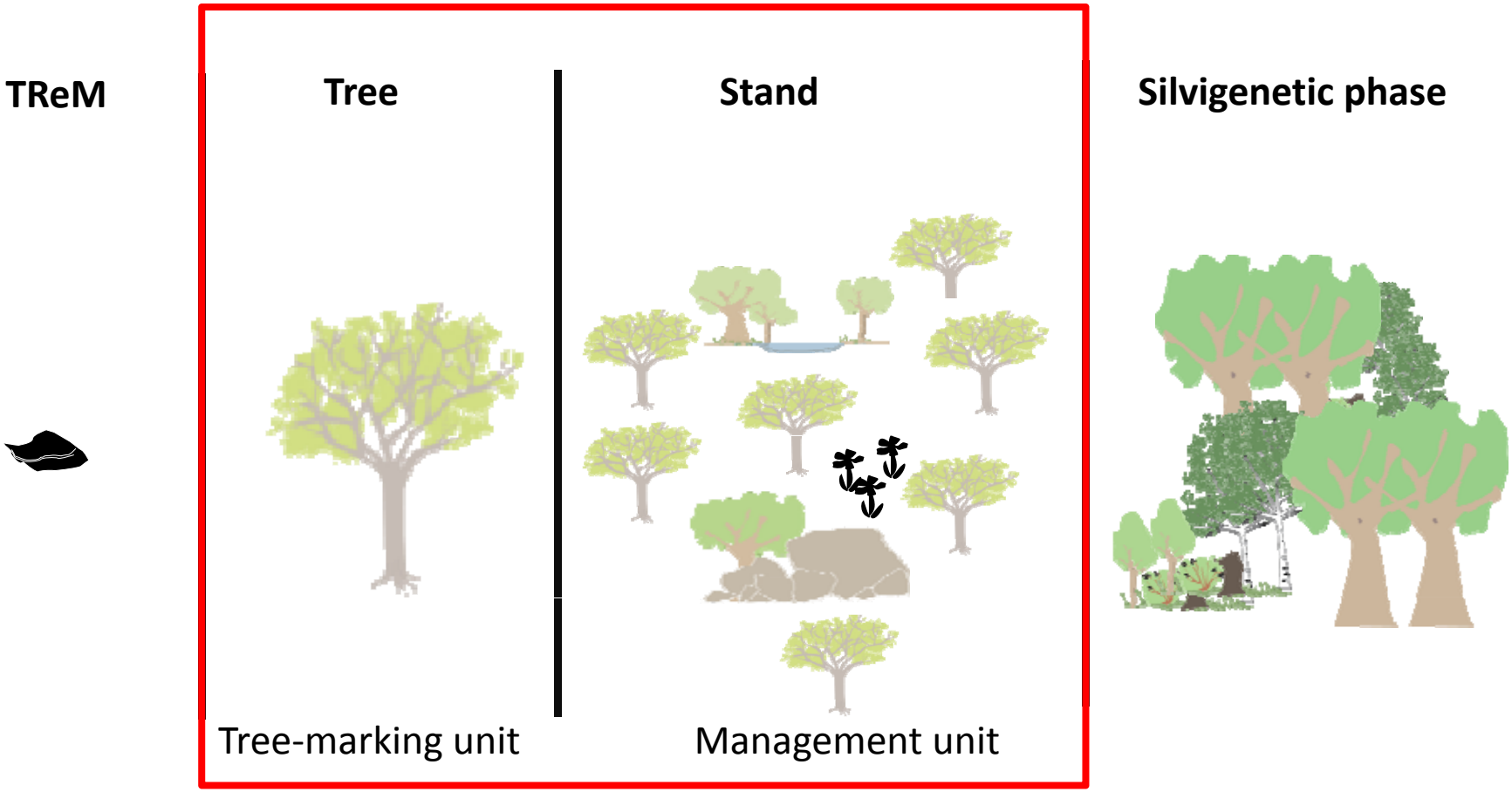






➡ **Pluritaxonomic approach**

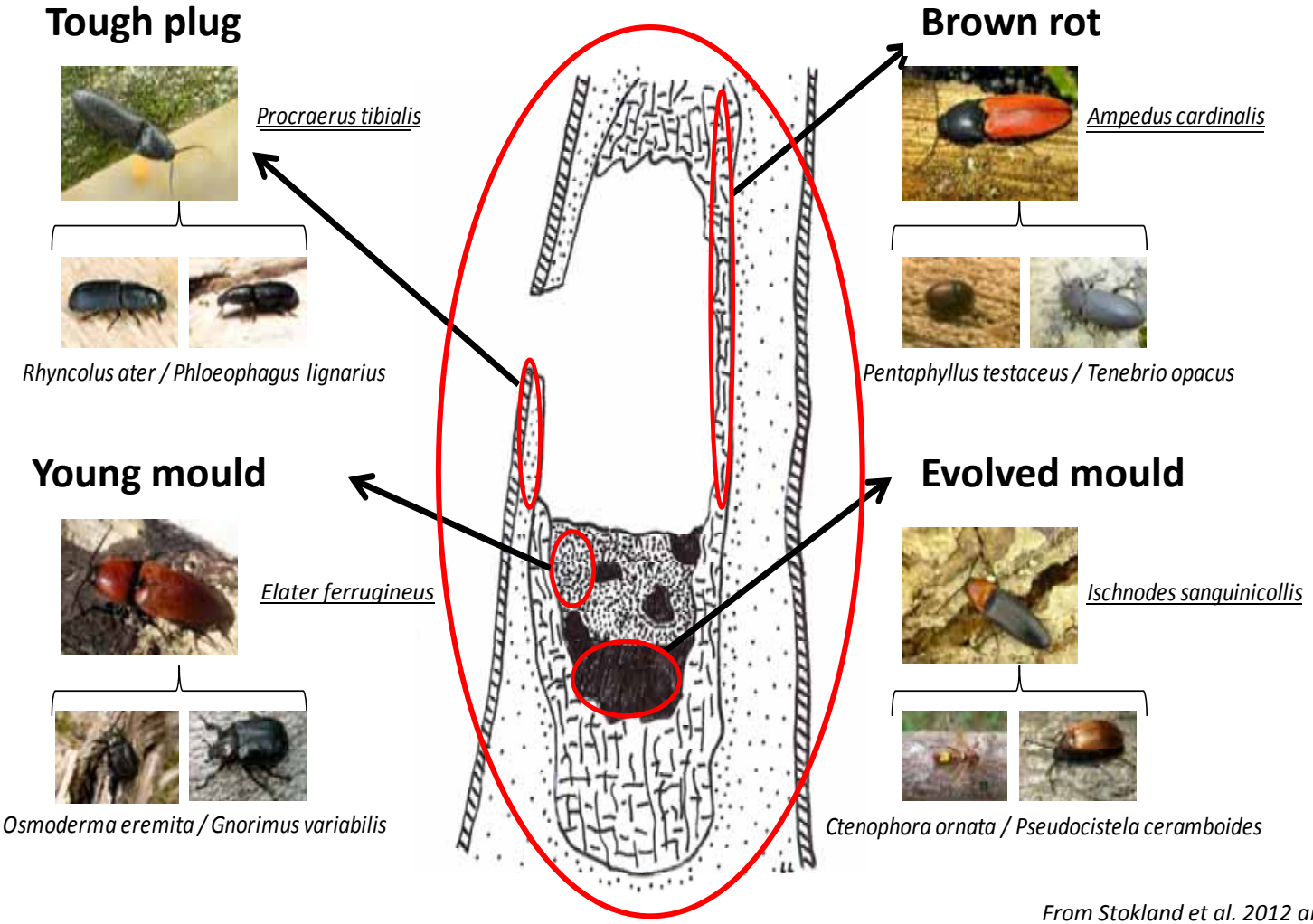
Results have been mainly expressed at the spatial scales used by forest managers



An “elementary” TReM is sometimes difficult to define

Outside: a “simple” woodpecker hole…

…inside: a set of habitats



From Stokland et al. 2012 and Brustel pers. com.

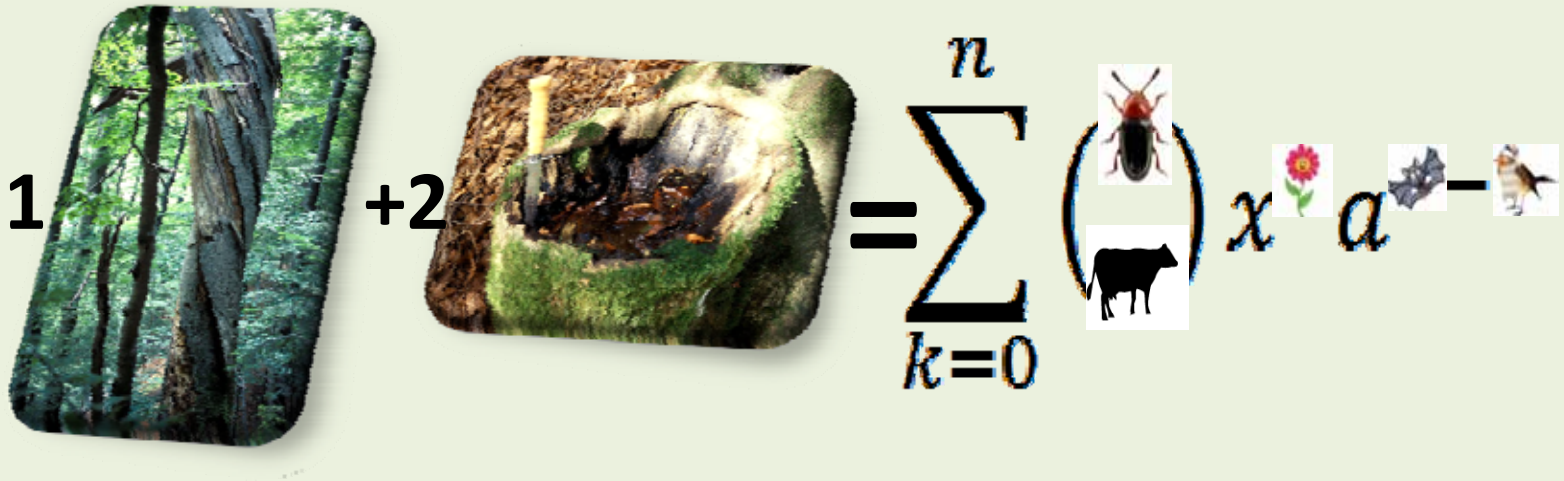
Commitment: the whole singular feature is the "elementary" TReM

III: Results

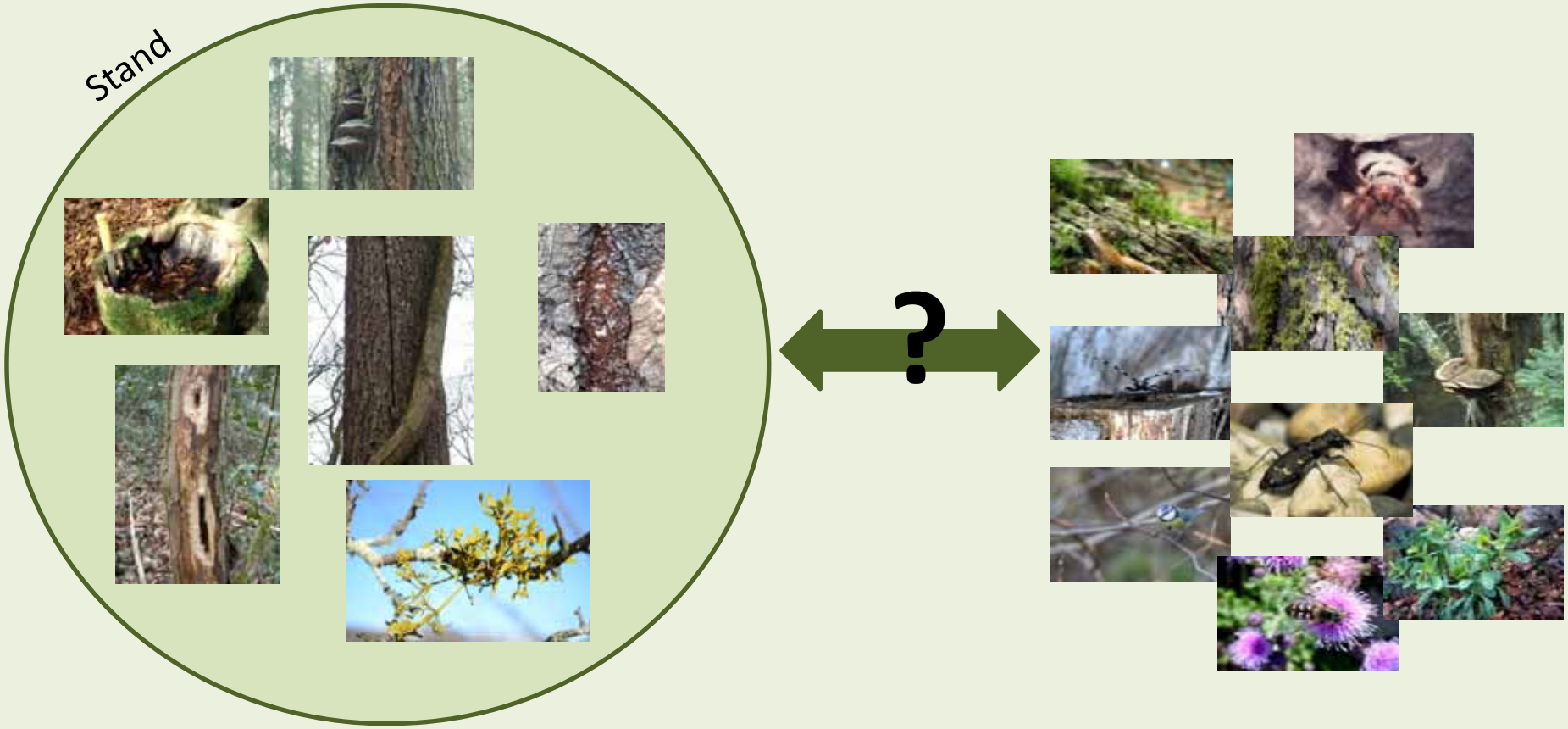
a-TReMs as key factors in biodiversity at stand level

b-Role of the largest trees in unharvested forests

c-Effects of harvesting on TReM “communities”



IIIa: TReMs as key factors in biodiversity at stand level



TReMs contributed significantly to biodiversity at stand level

(Larrieu et al. in prep.)

➢ **Density of TReM-bearing trees** → **<u>Assemblage composition</u>** of:

- Saproxylic beetles
- Ground beetles
- Lichens
- Birds
- Vascular plants
- Polypores

→ **<u>Species richness</u>** of polypores

102 forests, harvested or not, France

For saproxylic beetles, TReM contribution depends on forest type and taxon status (Bouget et al. BC 2013)

Contribution of TReM-bearing tree density to species richness

	Common species	Rare species
Oak forest	5th rank	ns
Beech forest	ns	1st rank

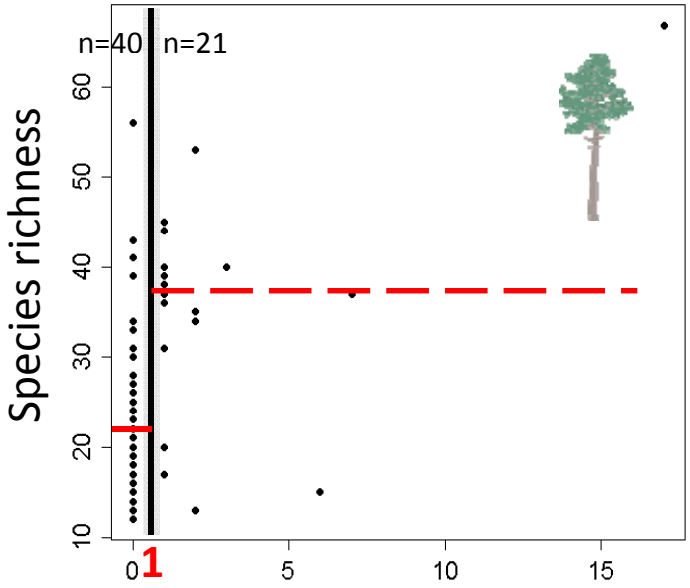
7 forests, harvested or not, France

Positive relationships between TReM density and species richness of saproxylic beetles were sometimes thresholded

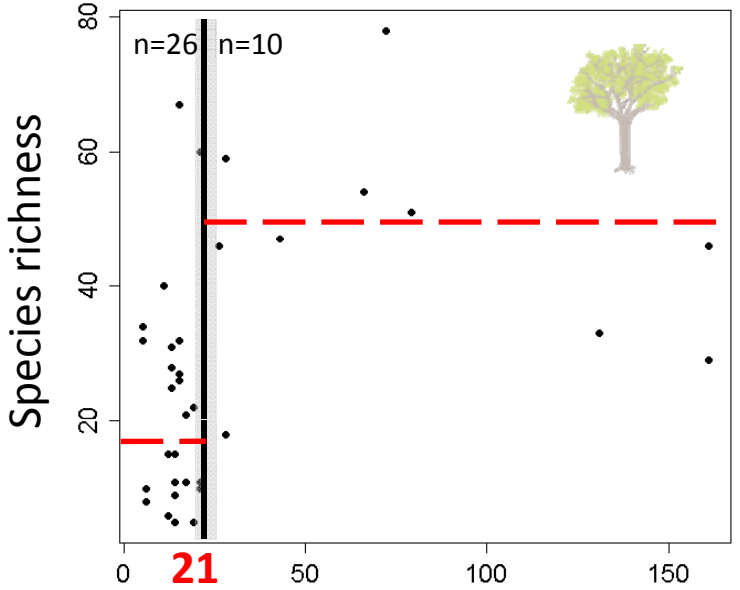
(Bouget et al. EI 2014)

Local biodiversity was, on average, higher above the threshold of:

1 cavity-bearing tree/ha in pine stands

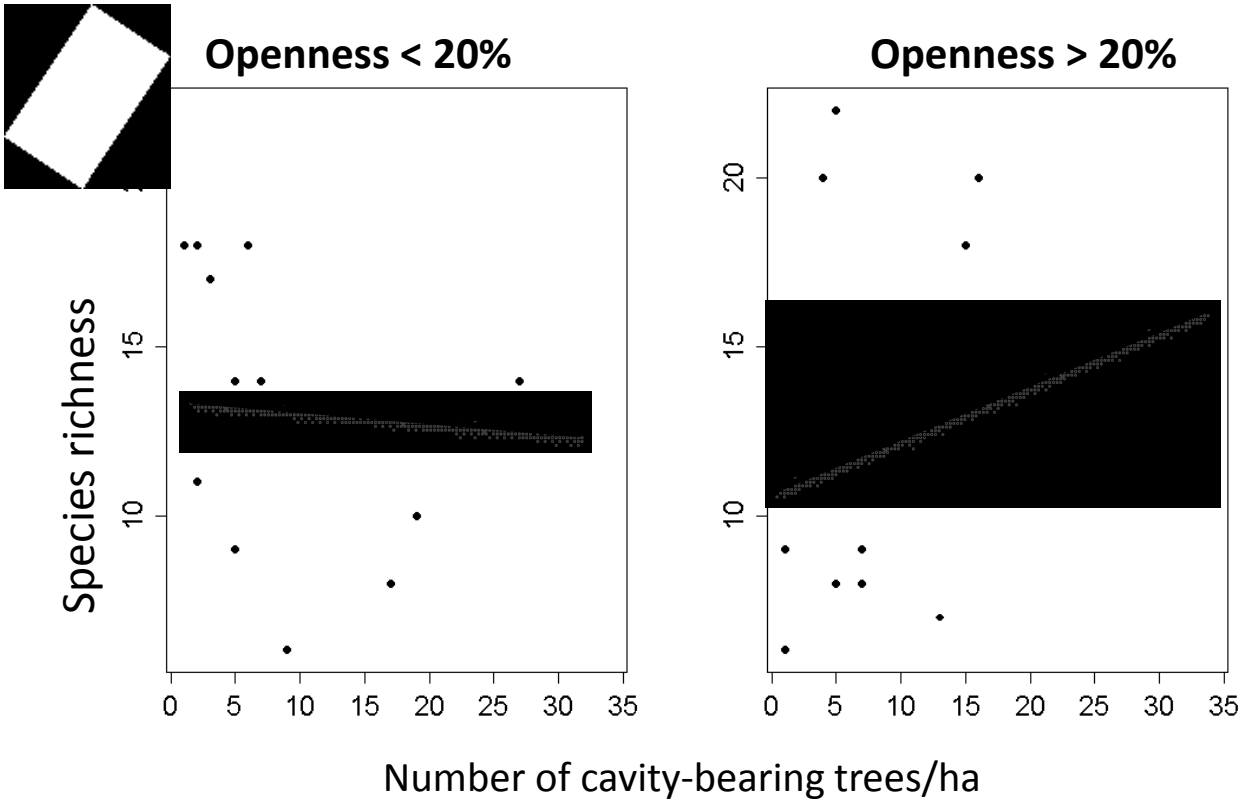


21 cavity-bearing trees/ha in beech stands



46 forests, harvested or not, France

Relationship between TReM density and diversity of saproxylic beetles depended on stand openness (Bouget et al. EI 2014)



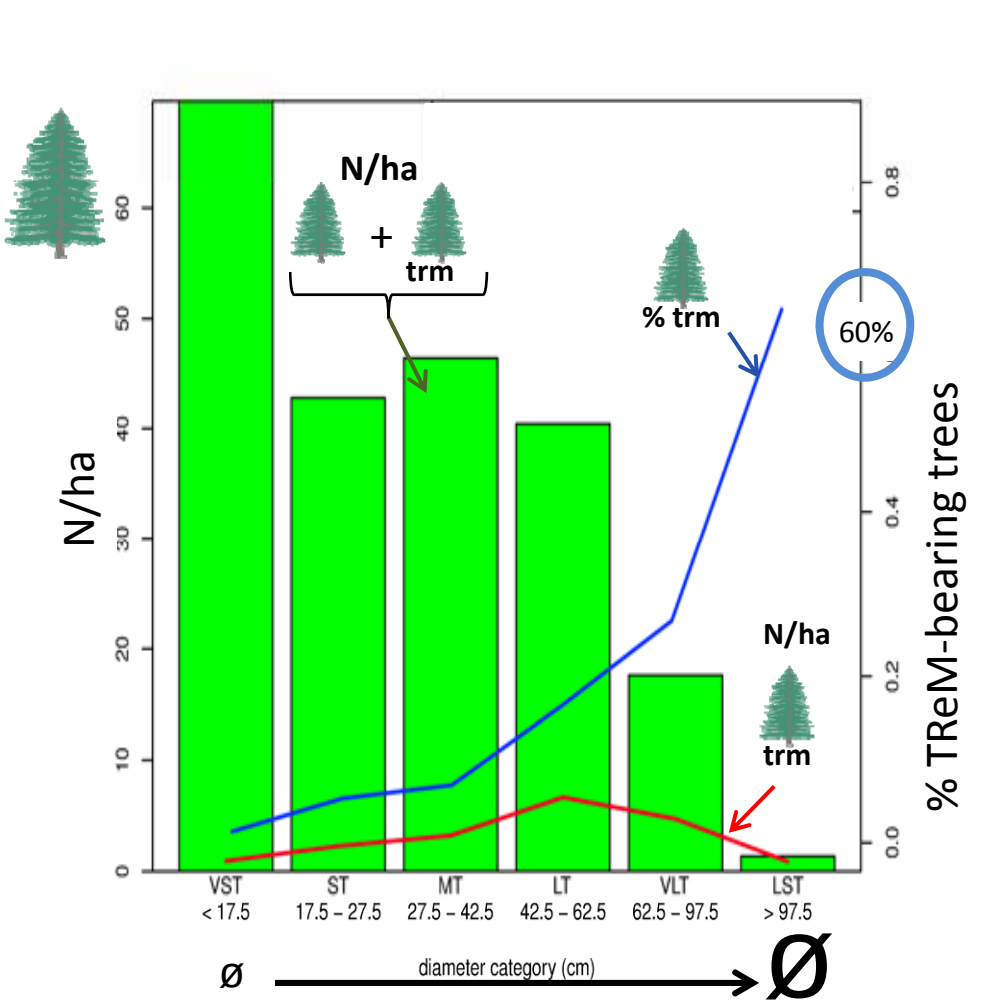
Significant interaction effect (lme)

16 mountain forests, harvested or not, France

IIIb: TReM sampling in unharvested forests

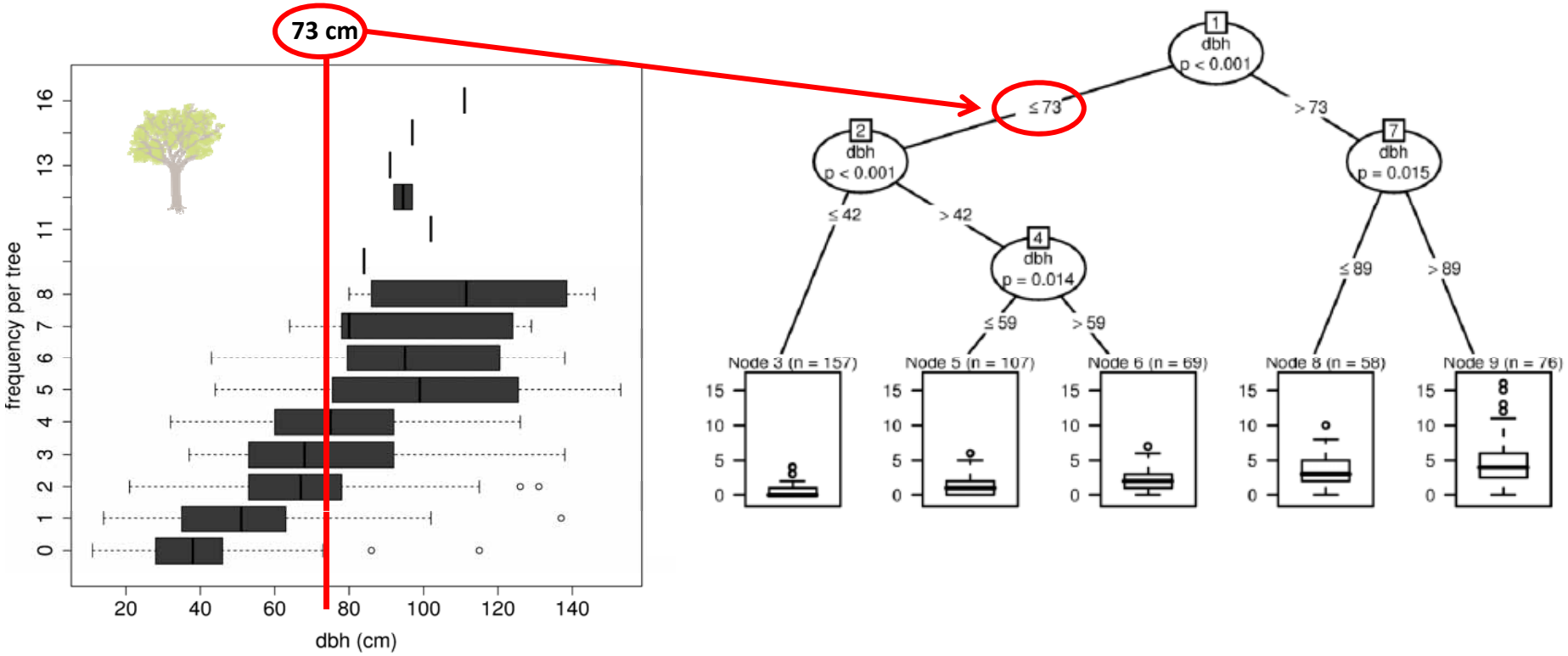
Very large trees play a crucial role for TReM availability

(Larrieu et al. EJFR 2014)



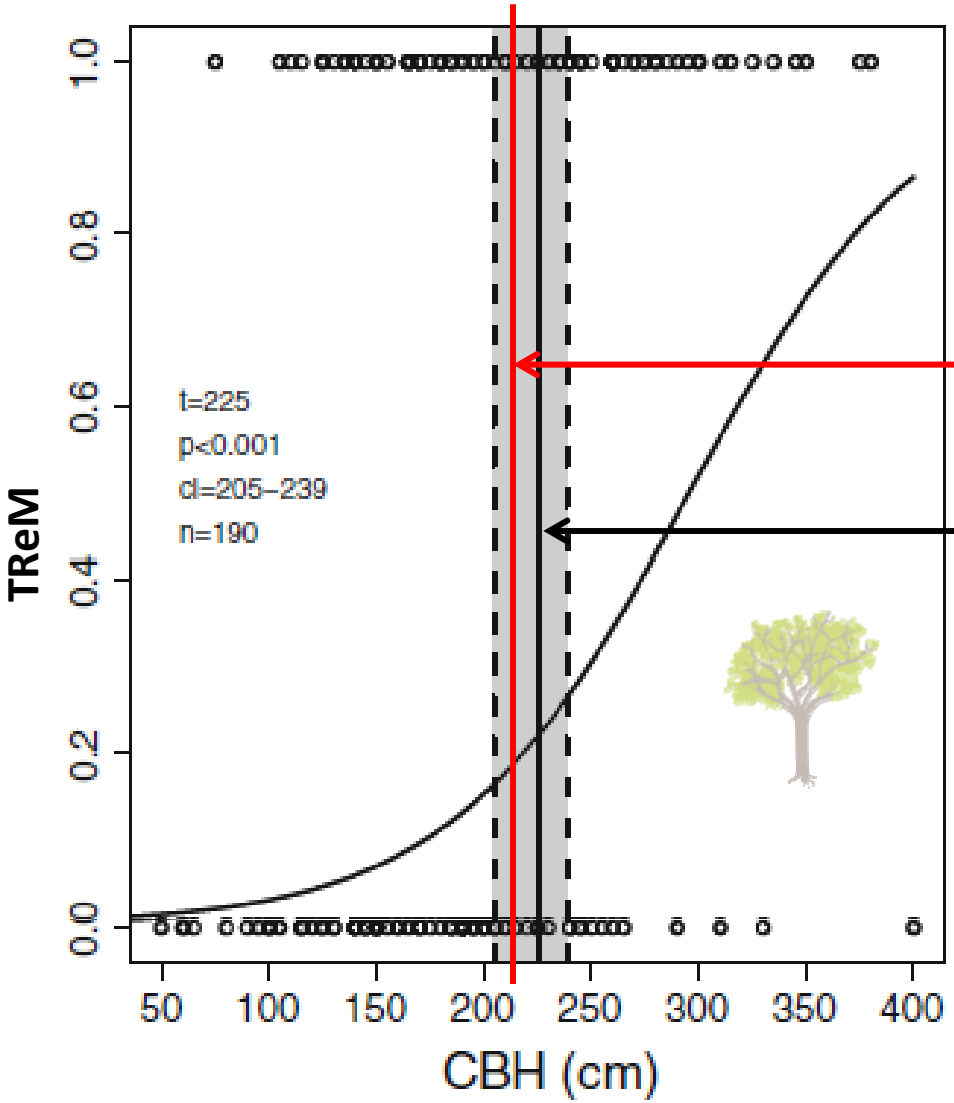
9 unharvested forests, Pyrénées

A thresholded relationship between tree girth and TReMs (Larrieu et al. EJFR 2012; Larrieu &Cabanettes CJFR 2012)



recursive partitioning method (Hothorn et al. 2006)

Statistical thresholds matched with management girth thresholds (Larrieu et al. EJFR 2012)



Management threshold= 70 cm (CBH 220 cm)

Statistical threshold= 73 cm (CBH 225 cm)

Confidence interval at 80% (CBH 205-239 cm)

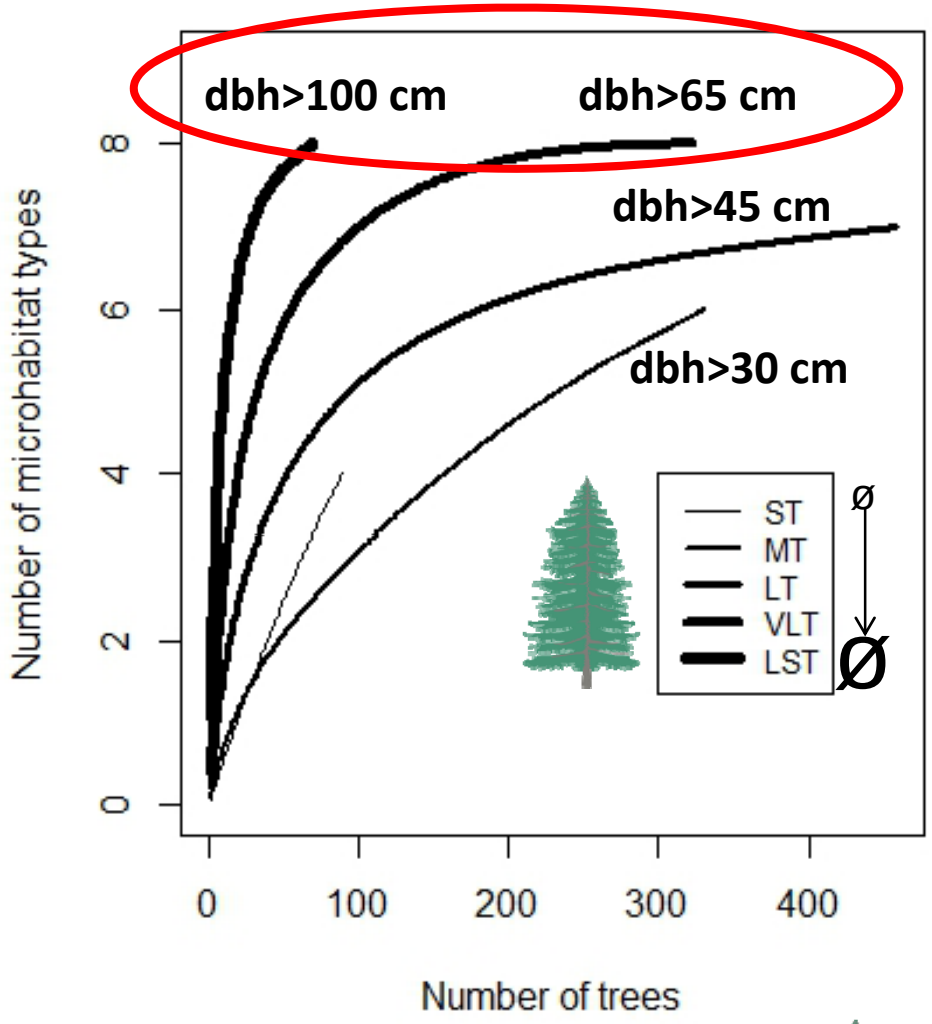
We suggest a new girth category: "Largest Trees"

- European Beech : dbh> 90cm
- Silver fir : dbh>100cm

9 unharvested forests, Pyrénées

Only the largest trees bore all TReM types

(Larrieu et al. EJFR 2012 ; Larrieu et al. EJFR 2014)



9 unharvested forests, Pyrénées

IIIc: TReM sampling in harvested stands

TReM distribution patterns were quite different in harvested vs unharvested stands (Larrieu et al. EJFR 2012)

TReMs

Harvested stands →

- wide range of total density
- ↘ number of bearing-trees
- ↘ diversity
- patterns of relative proportions quite different

"favoured" by harvesting *VS* **"unfavoured" by harvesting**

Dendrothelm

Missing bark

Cracks

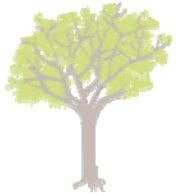
Cavities

Sporophores

2 harvested & 1 unharvested forests, Pyrénées

The decrease of density of TReM-bearing trees in harvested stands resulted mainly from selection during tree-marking for beech but from large-tree harvesting for fir (Larrieu et al. EJFR 2014)

Effect on density of TReM-bearing trees (TReM "unfavored" by harvesting)

	Cutting dbh = 70 cm	*VS*	Selection during tree-marking
	-16% (ns)		-39%***
	-30% (ns)		0%

2 harvested & 10 unharvested forests , Pyrénées

What about TReM knowledge now?

- **Almost accomplished and stable definition and typology, shared by the European TReM team → towards standardized protocols**
- **Database of TReM-associated taxa at the TReM level**
- **Quantitative relationships and thresholds inspiring practical recommendations**
- **Influence of tree-species on harvesting effects**
- **TReM-bearing trees drive biodiversity at stand level**
- **Current negotiated standards are not enough demanding**

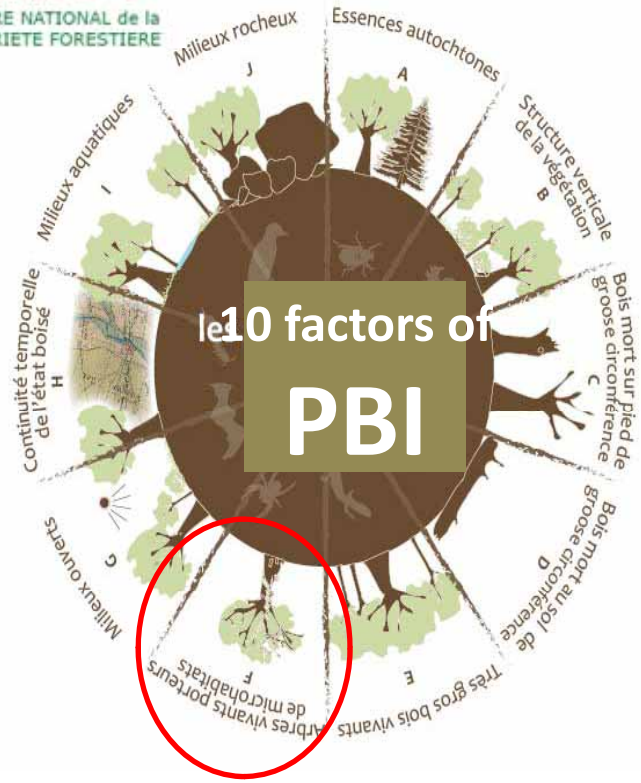
From results to practical recommendations

To technicians

To forest owners

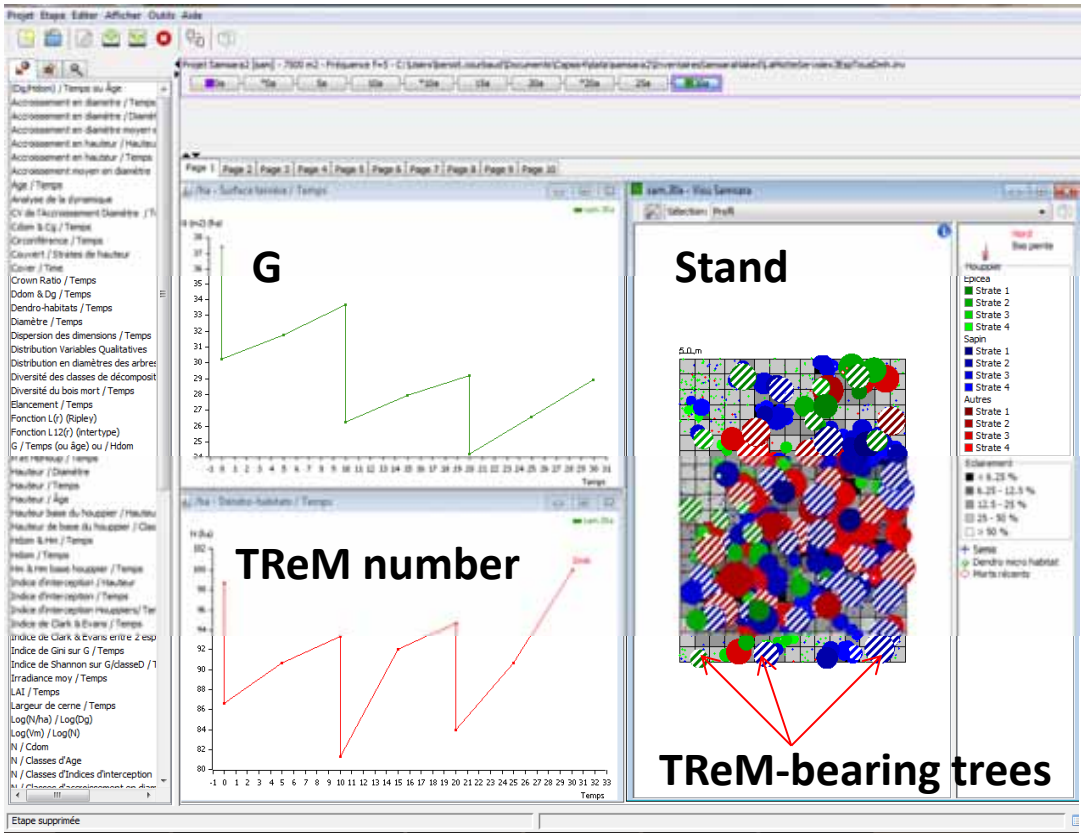
From results to tools

FORET ET BIODIVERSITE
CENTRE NATIONAL de la PROPRIETE FORESTIERE



Factor F: TReM

Samsara2 (Irstea)



IV: Towards future research

Data about spatio-temporal distribution of TReMs might open new research fields

➢ **Distribution patterns in <u>unharvested</u> forests**

➢ **Relationships between TReMs and associated biodiversity**
- relevant study scale
- study of species dispersion capacity
- matrix permeability
- redundancy/complementarity between saproxylic TReMs and deadwood

➢ **What are the key factors for TReM genesis and co-occurrence?**

➢ **TReM "lifespans"**

➢ **Distribution patterns in <u>harvested</u> forests**

➢ **Effects of TReM density vs effects of TReM spatial distribution?**

➢ **Better conservation of associated biodiversity**

This work required a lot of funding organizations and scientific collaborations

Forest owners
Forest access

Irstea Nogent
Taxonomic data
Papers
Statistics
Ecological theories

WSL/Univ. Dresde/IDF
Dendrometrical data

Irstea Grenoble
Modelling

GEVFP/ONF/RNF/PNM
Taxonomic data

Bavarian NP
Papers

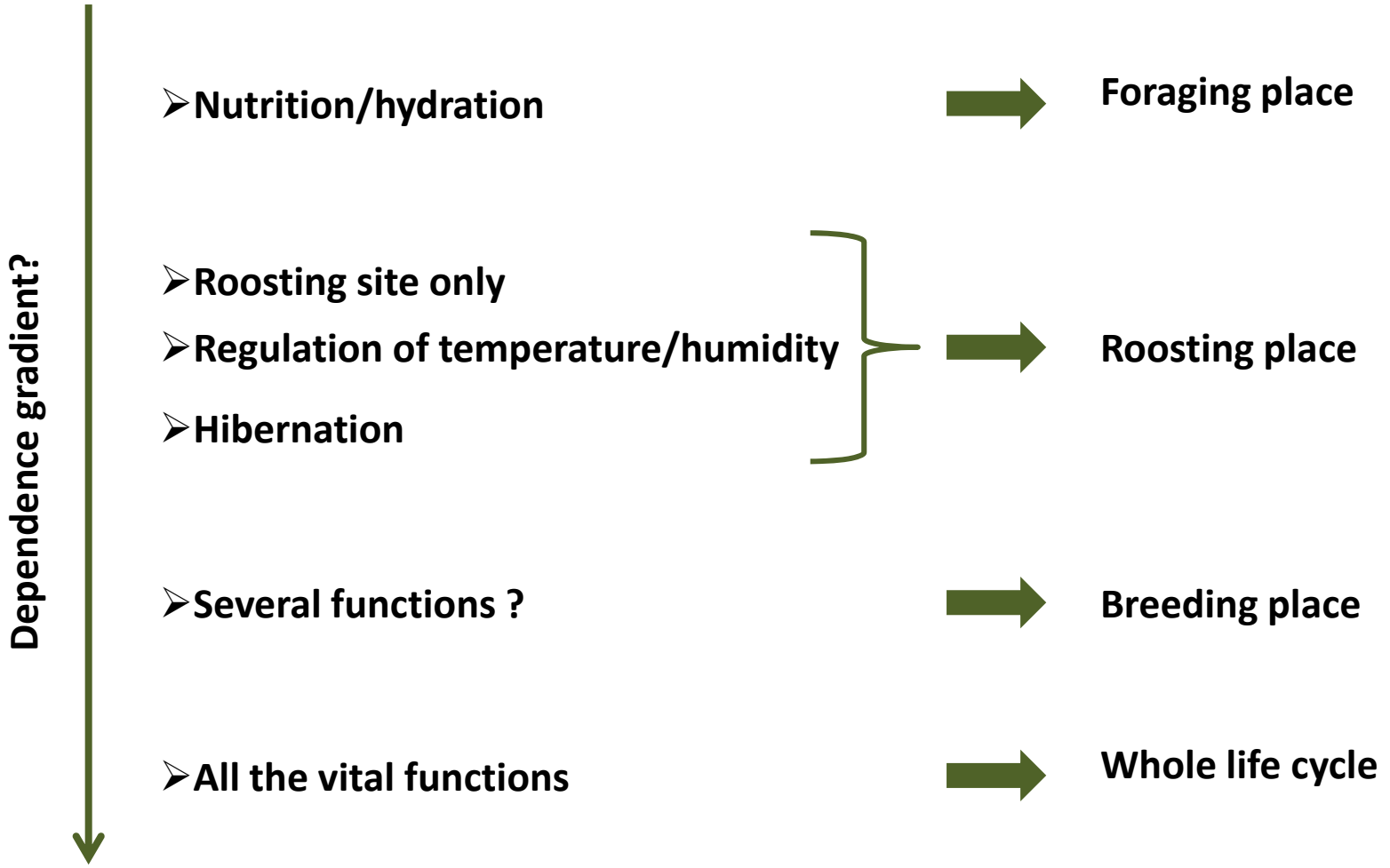
CRPF CA, MP
Sampling

INRA

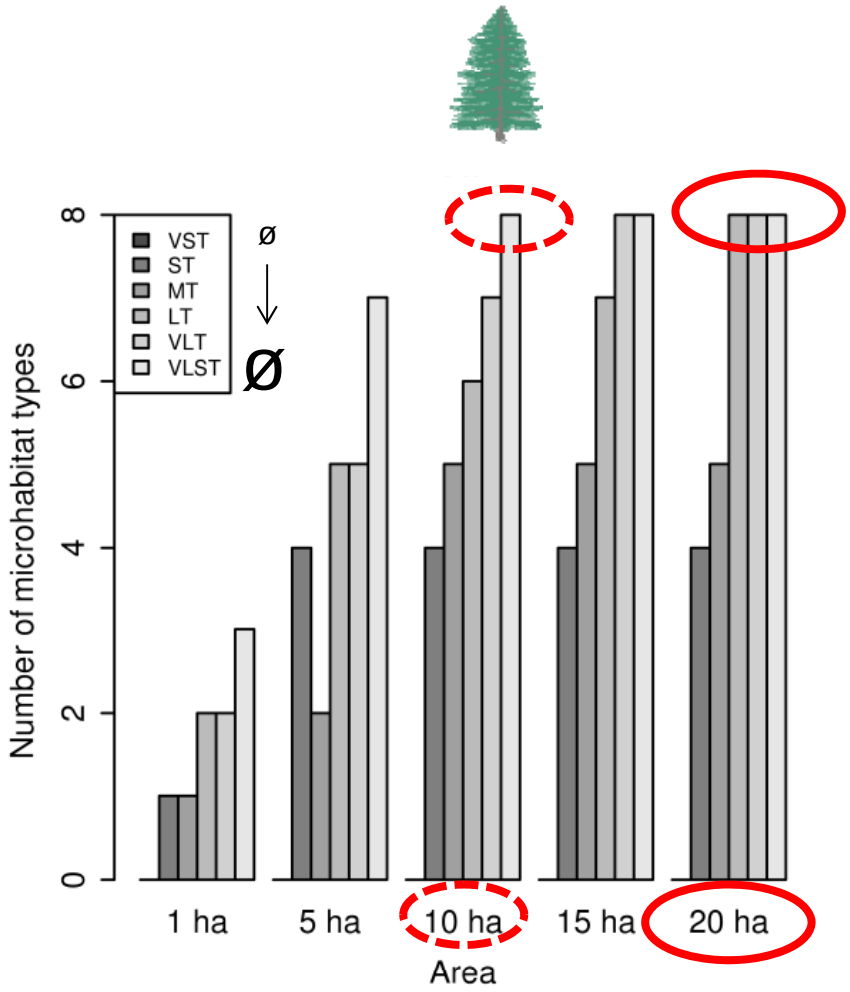
UMR-Dynafor
Geomatic/Remote sensing
Logistics
Sampling
Papers
Statistics/Modelling
Ecological theories

Thanks for your attention

TReMs support a wide range of biological functions which determine species dependence

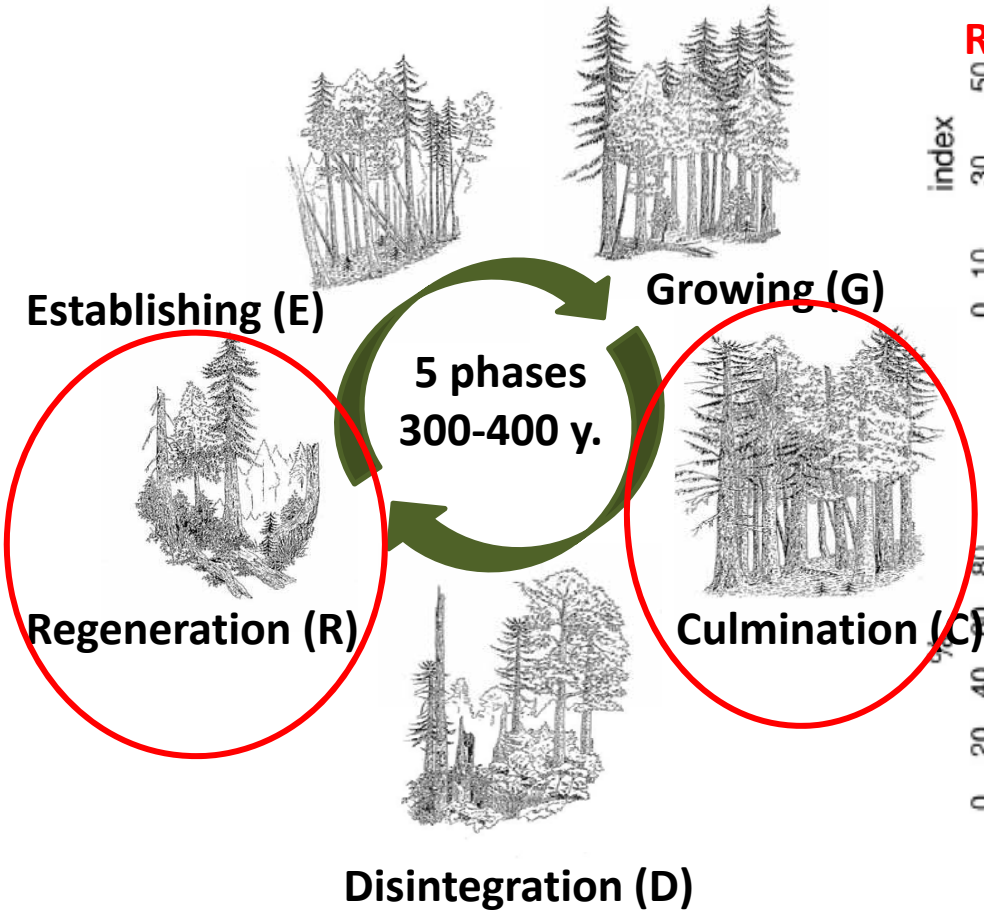


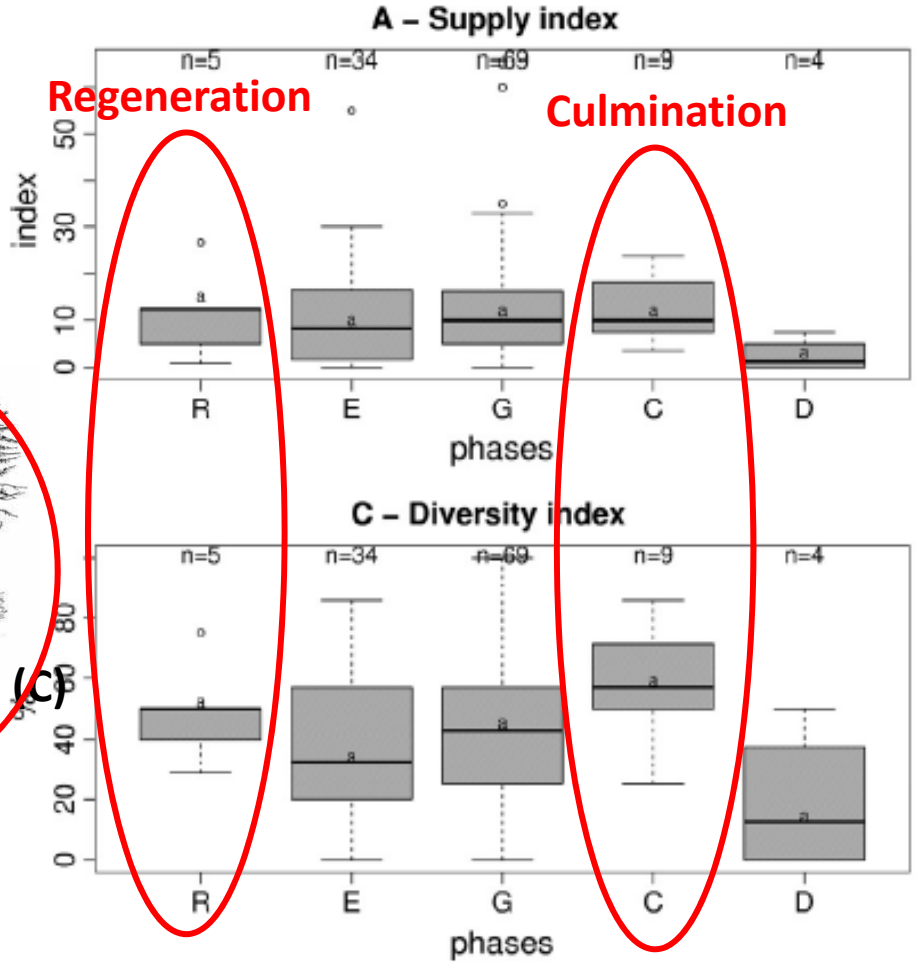
Large set-aside patches are necessary to conserve the largest TReM diversity (Larrieu et al. 2014)



10 unharvested beech-fir forests, Pyrénées

TReMs are naturally abundant and diversified throughout all silvigenetic cycle (Larrieu et al. FEM 2014)





32 forêts inexploitées, France, Suisse, Allemagne

Silvigenetic phase vs eco-unit vs forest stand