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Potential contribution of marteloscopes to a forest biodiversity monitoring system in Europe -strengths, limitations and challenges

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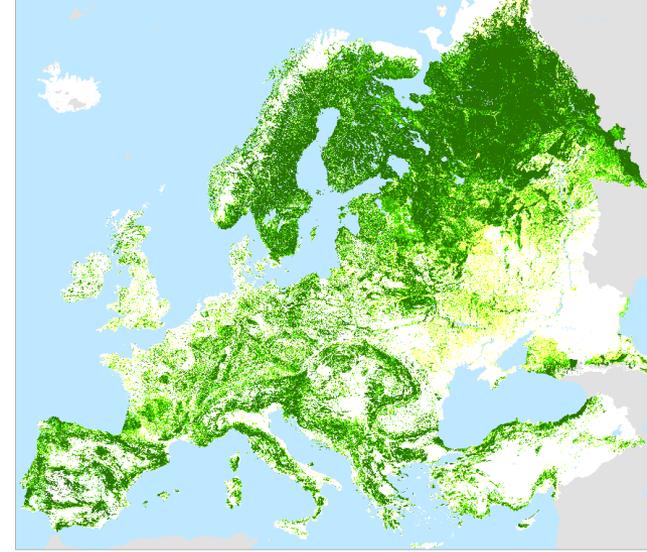
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INRAE



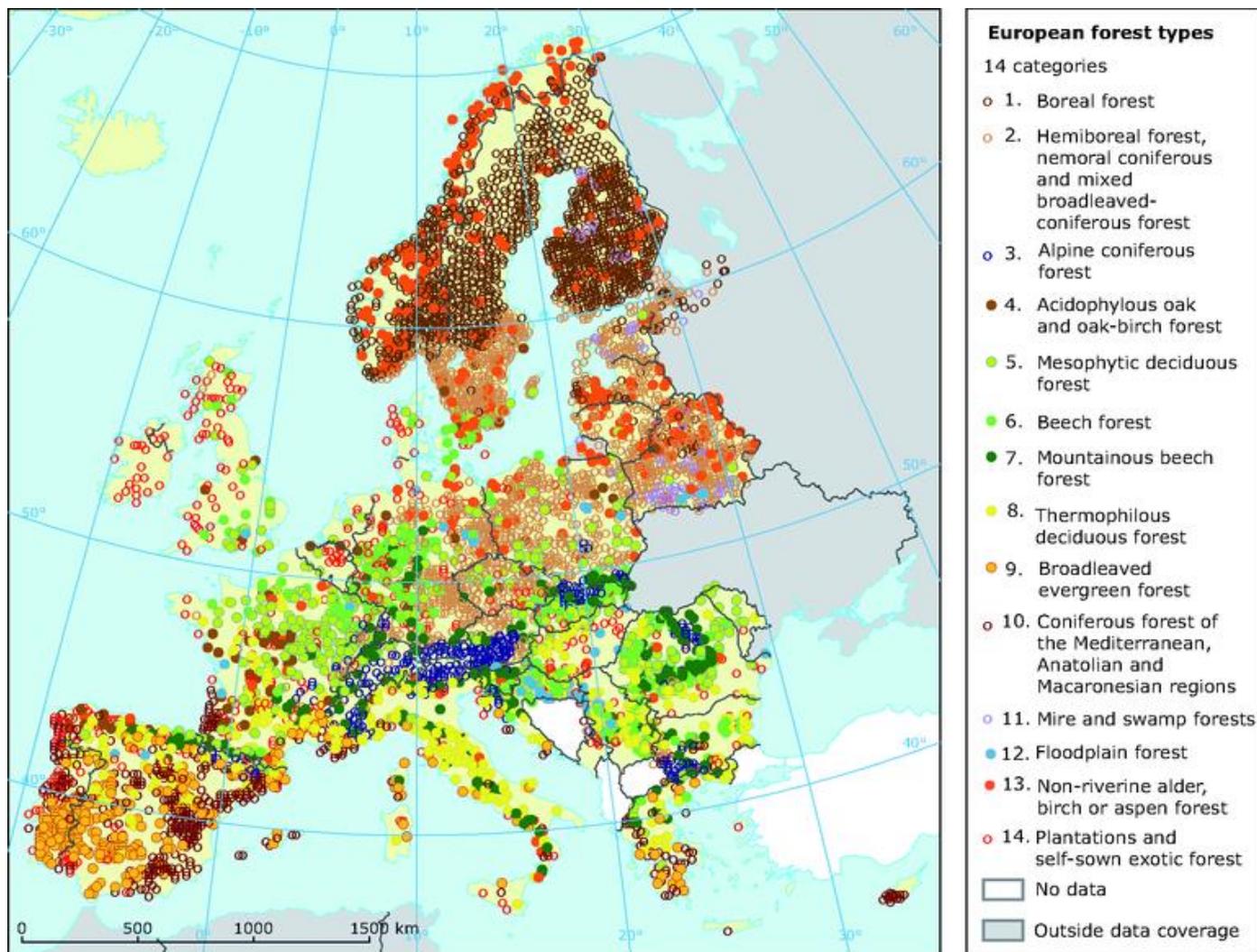
- Potential contribution of marteloscopes to a forest biodiversity monitoring system in Europe
- strengths, limitations and challenges

Larrieu, L. & Bouget, C.

➤ Gaps in monitoring systems of forest biodiversity in Europe

Pan-European level I network

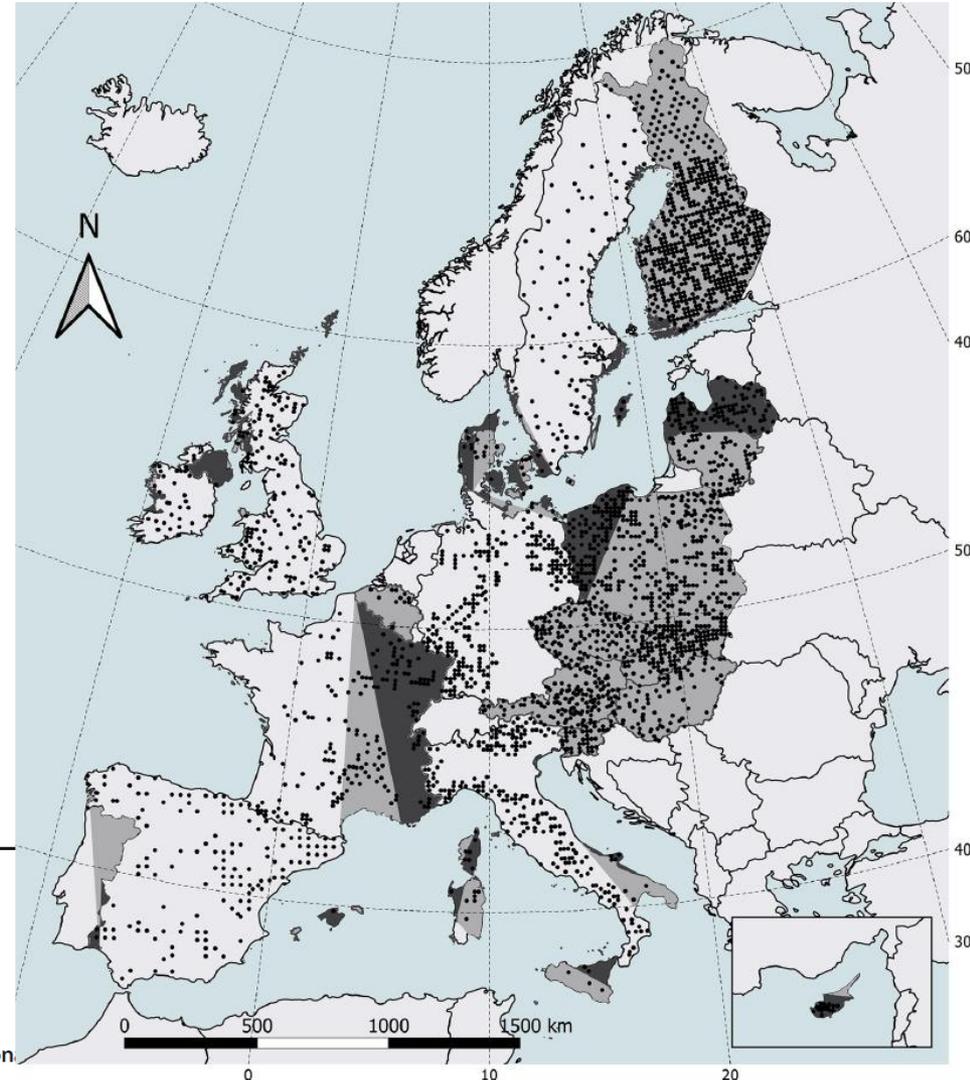
Circa 6000 small plots dedicated to other issues than biodiversity monitoring (tree defoliation...)



➤ Gaps in monitoring systems of forest biodiversity in Europe

The Pan-European level I network has supported one-off initiatives, such as Forest Focus Biosoil 2005-2008

Deadwood and vascular plants recorded in ca 3,000 plots in 19 countries



Annals of Forest Science (2019) 76: 68
<https://doi.org/10.1007/s13595-019-0832-0>

DATA PAPER

A dataset of forest volume deadwood estimates for Europe

Nicola Puletti¹  • Roberto Canullo^{2,3} • Walter Mattioli¹ • Radosław Gawryś⁴ • Piernaria Coron

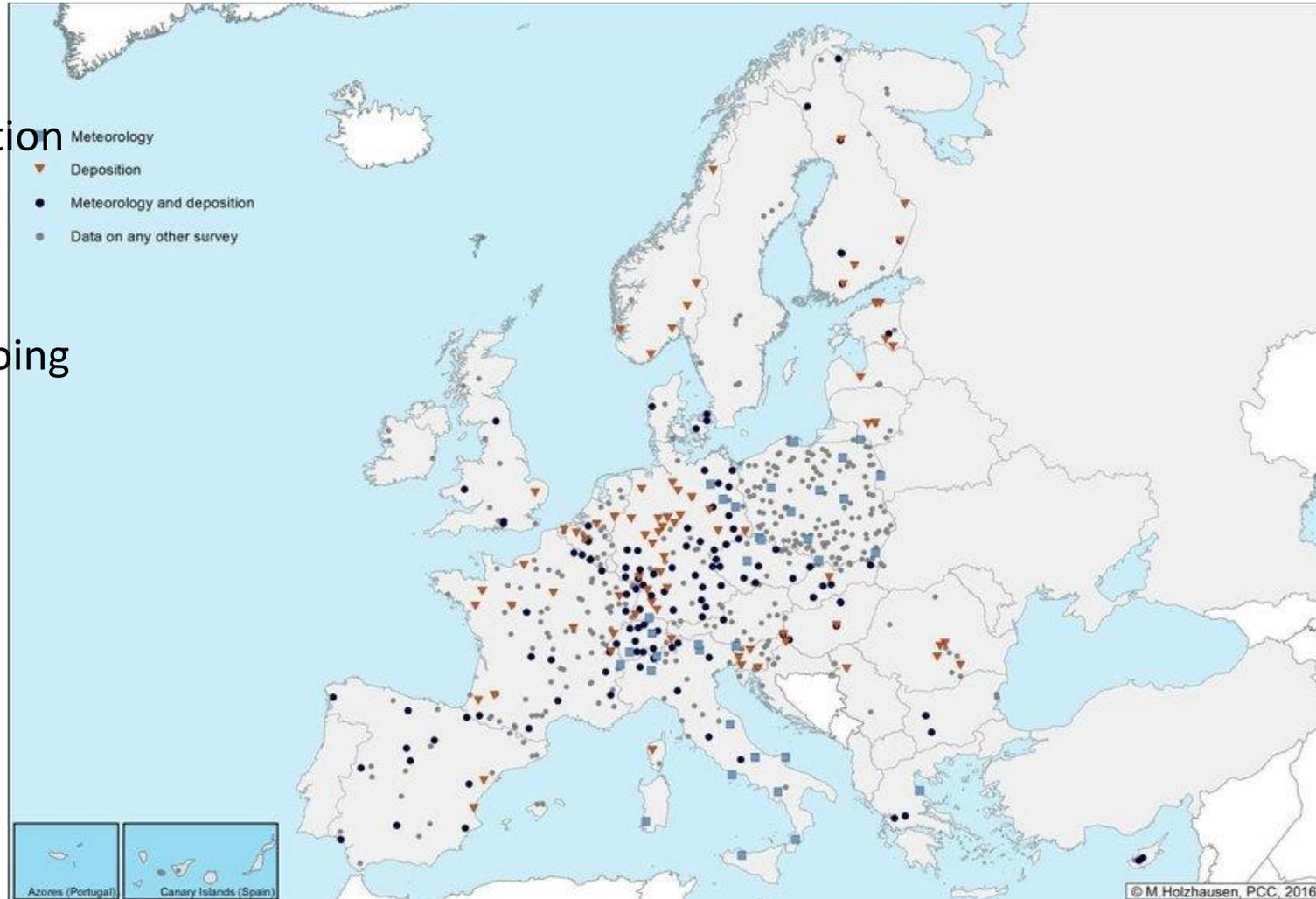
➤ Gaps in monitoring systems of forest biodiversity in Europe

Pan-European level II network

Circa 600 plots dedicated to other issues than biodiversity monitoring (forest condition)

BUT including :

- ground vegetation
 - deadwood and epiphytic lichens
- in test phase ongoing



➤ Gaps in monitoring systems of forest biodiversity in Europe

Data from NFI are highly heterogeneous and mainly relate to indirect biodiversity indicators

Chirici et al. 2012:

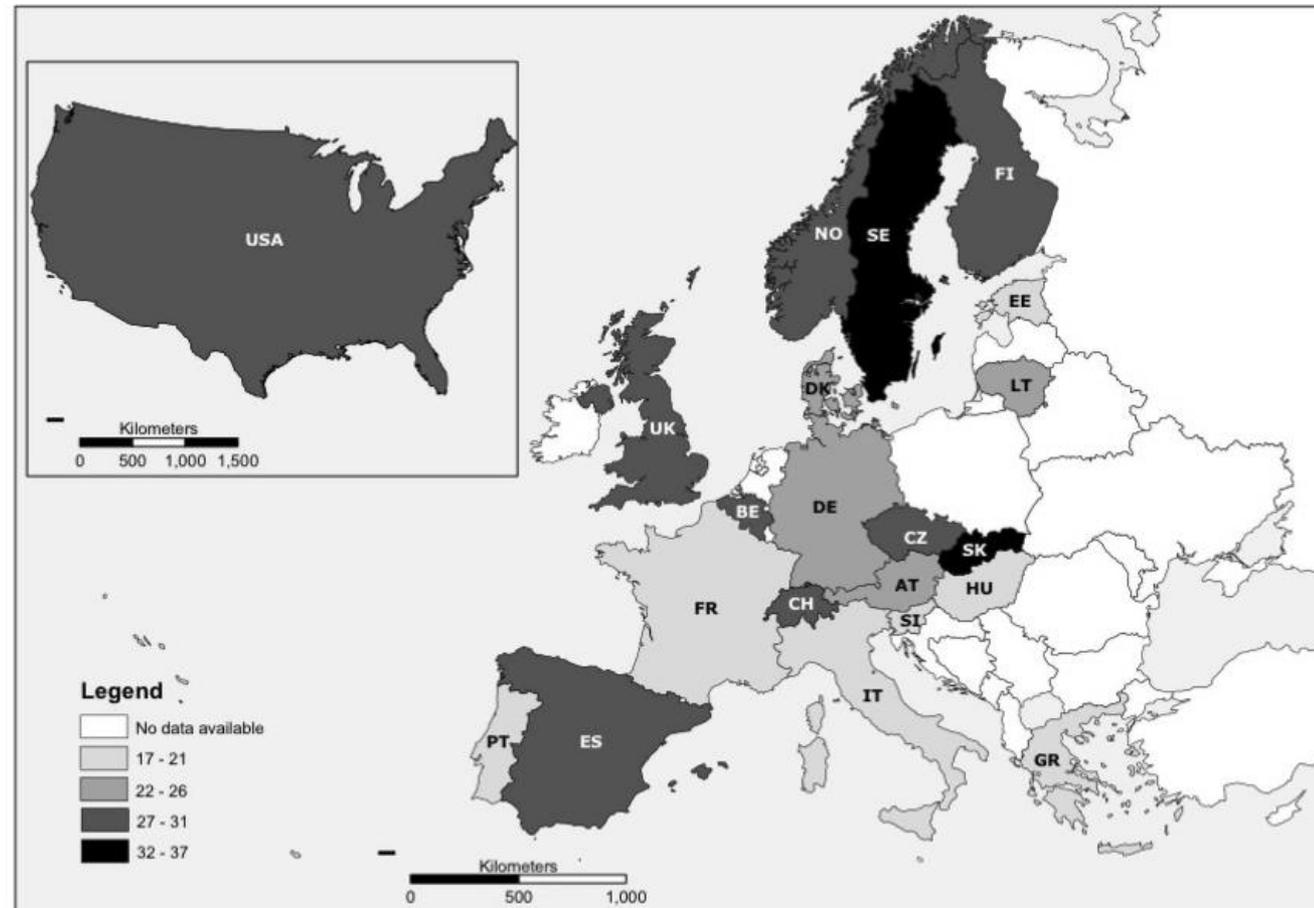


Figure 1. Number of forest biodiversity variables currently assessed by the NFIs of European countries and by the United States of the 41 proposed in the first questionnaire developed by WG3 of COST Action E43. See Chirici et al. (2011) for a detailed description of the variables investigated.

➤ Gaps in monitoring systems of forest biodiversity in Europe

Only a few national initiatives are focusing on the direct monitoring of taxa

Switzerland - all ecosystems
Vascular Plant
Bryophytes
Molluscs
Rhopalocera
Breeding birds

Hesse (All.) – Forests
Flora
Coleoptera
Macrolepidoptera
Annelida
Aculeata
Araneae
Heteroptera
Breeding birds

Sweden - all ecosystems
Vascular Plants (incl. trees)
Bryophytes
Lichens
Soil fungi
Small mammals



Review

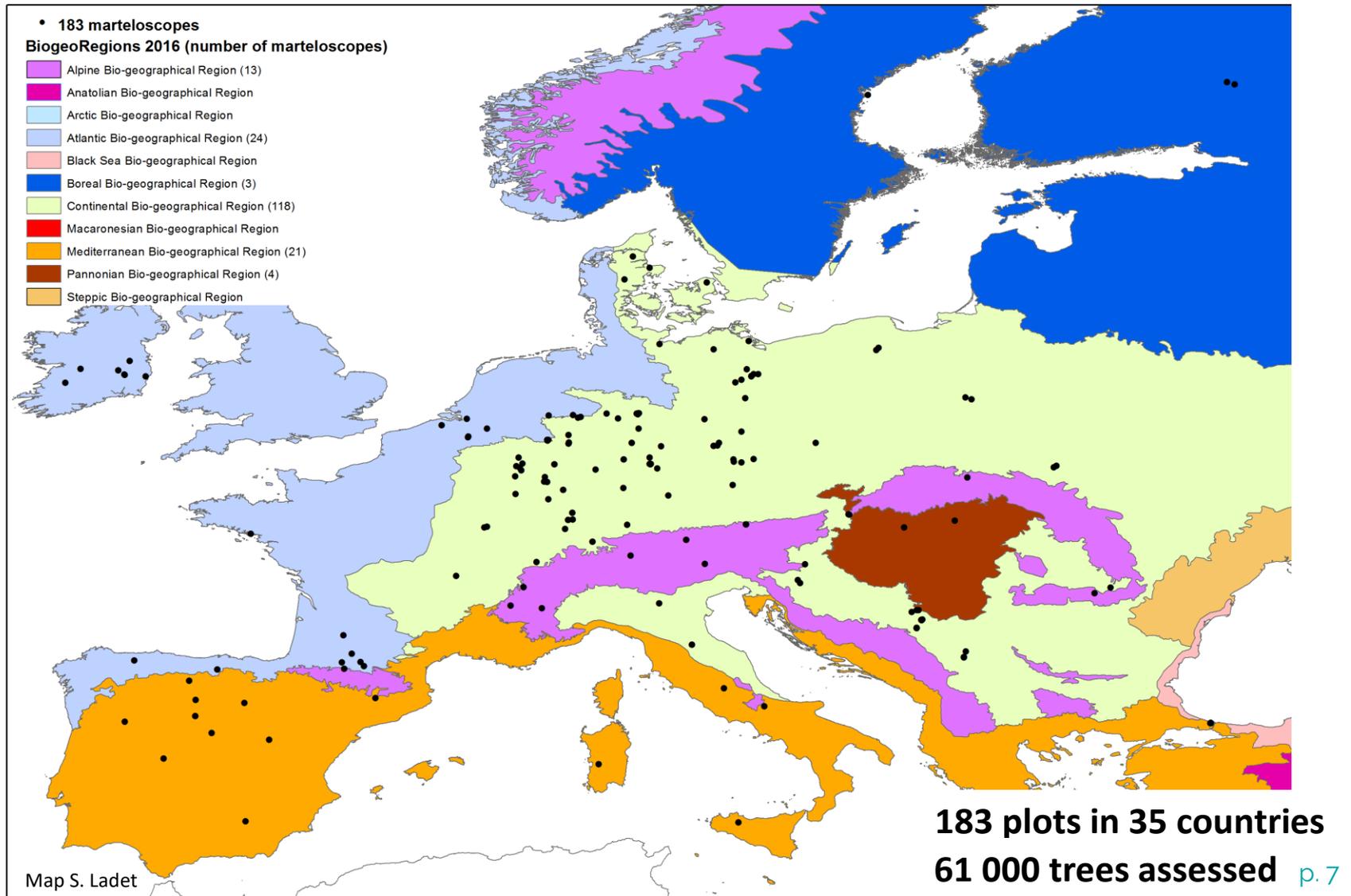
Handbook of field sampling for multi-taxon biodiversity studies in European forests

Sabina Burrascano^{a,*,1,42}, Giovanni Trentanovi^{b,2,42}, Yoan Paillet^{c,3}

Burrascano et al. 2022

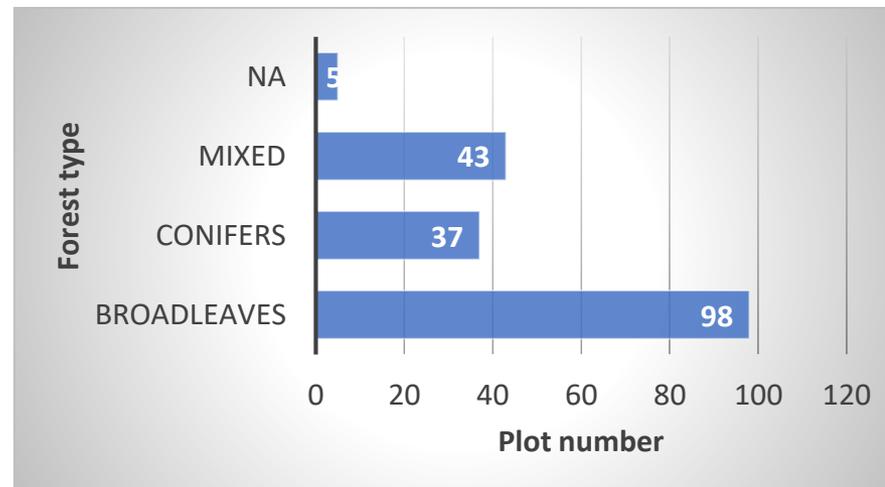
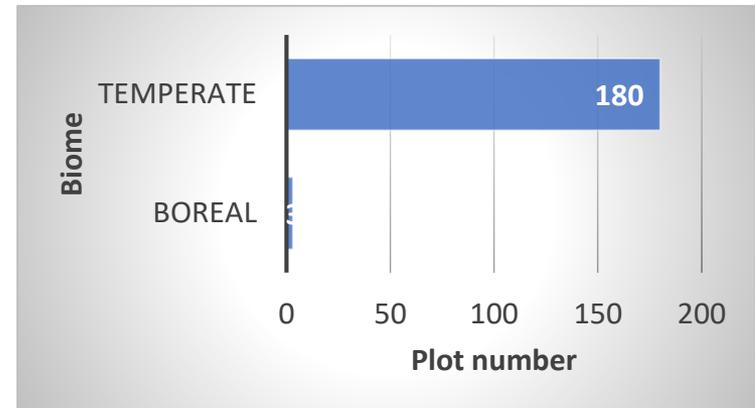
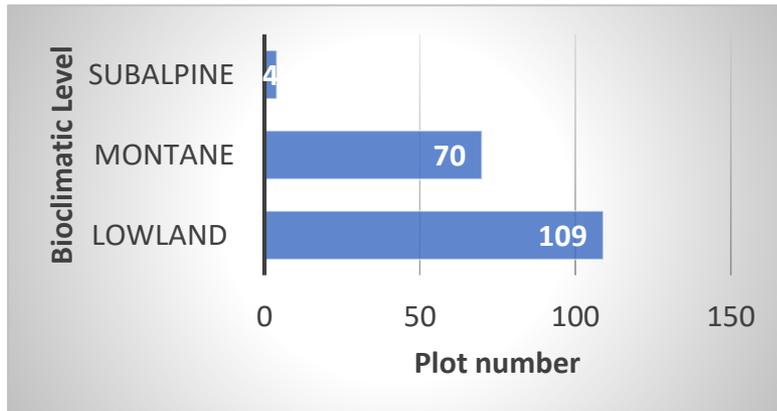
Vascular plants (incl. trees)
Bryophytes
Lichens
Fungi
Birds
Bats
Coleoptera
Araneae & Opiliones

➤ The European Marteloscope network (October 2022)



➤ The European Marteloscope network

A very wide array of forest contexts, however unbalanced



➤ The European Marteloscope network

Environmental data collected in plots

Plot scale

- Natural forest community
- Climate
- Elevation

Optional

- **Lying deadwood**

Tree scale

Mandatory

- Tree species
- Tree location
- Tree status (living vs standing dead)
- Diameter at breast height
- Timber quality
- **Tree-related Microhabitats**

Optional

- Crown base height
- Total height



No direct sampling of biotic communities (except **tree species diversity**)

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Stand structure metrics may be considered indirect biodiversity indicators p. 9

➤ Deadwood as a key feature for forest biodiversity

Facts and figures

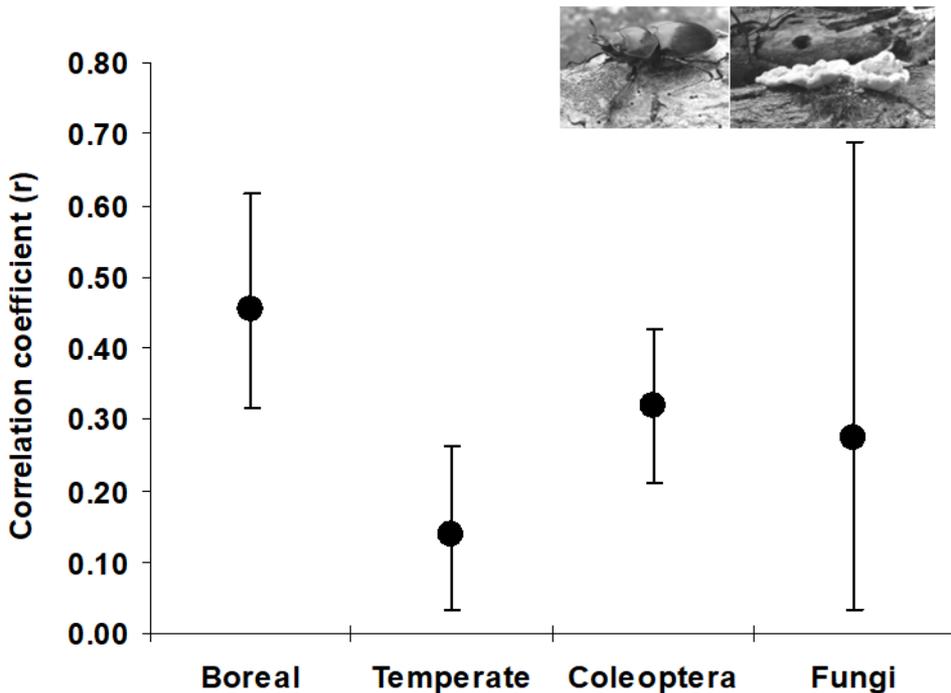


25% of forest species
depend on DW

➤ Deadwood volume as an indirect biodiversity indicator

Relevance/Limitations

Biome-dependent & thresholded relationships



Ecological Indicators

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



MCPFE indicators of sustainable management,
BEAR biodiversity indicators

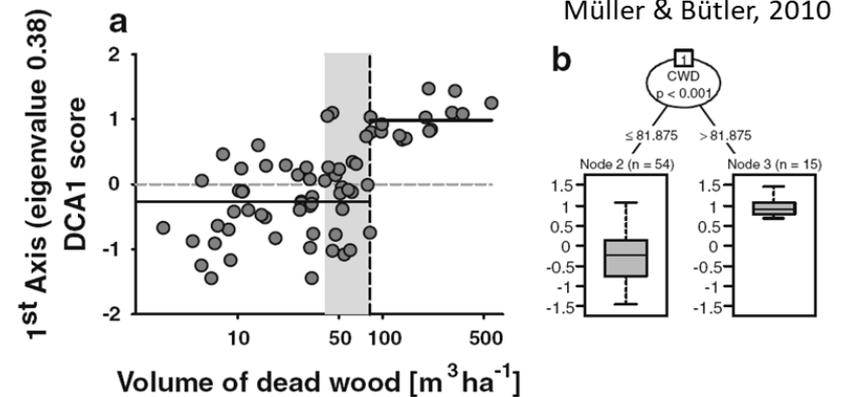


Fig. 4 **a** Threshold (dashed line) for wood-inhabiting fungi derived by maximally selected rank statistics **(b)** of a shift in communities of

Review

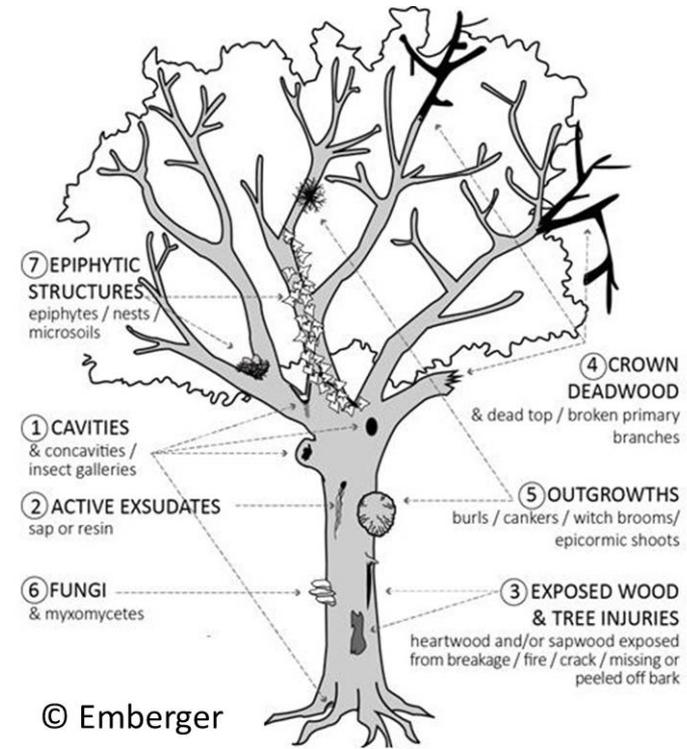
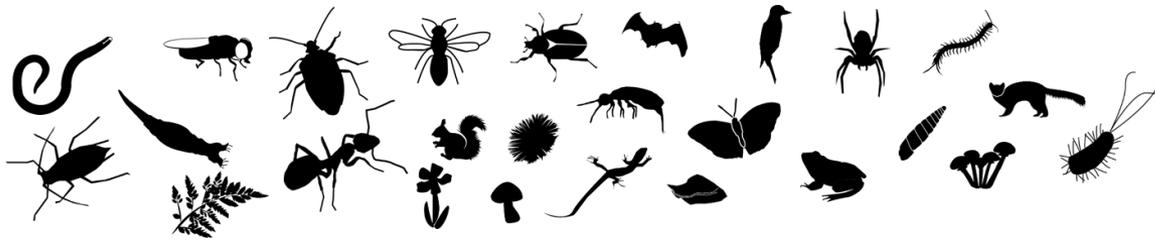
Deadwood as a surrogate for forest biodiversity: Meta-analysis of correlations between deadwood volume and species richness of saproxylic organisms

Aurore Lassauce^{a,b,*}, Yoan Paillet^a, Hervé Jactel^c, Christophe Bouget^a

Tree-related microhabitats (TreMs) as key features for forest taxa

Facts and figures

TReMs host a wide range of taxonomic forest groups

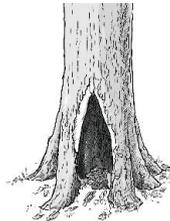


Fomes fomentarius



> 600 sp arthropods in Europe (Friess et al. 2019)

Base rot-holes borne by oaks



380 sp beetles (Gouix & Brustel BC 2012)

➤ TreMs as indirect biodiversity indicators at the stand scale

Facts and figures

Positive relationships between TreMs and species richness and/or abundance of taxa



Bats (Regnery et al. 2013; Paillet et al. 2018; Basile et al. 2020)



Saproxylic beetles (Bouget et al. 2013, 2014a,b; Larrieu et al. 2019; Winter and Möller 2008)



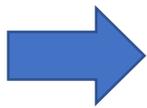
Birds (Regnery et al. 2013; Paillet et al. 2018)



Polypores (Larrieu et al., 2019)



Hoverflies (Larrieu et al. 2019)



several authors have suggested using TreMs as indirect biodiversity indicators in forest ecosystems and as tools to promote integrative forest management

(Kraus and Krumm 2013; Winter and Möller 2008, Regnery et al. 2013; Paillet et al. 2018; Bütler et al. 2013; Larrieu et al. 2018; Asbeck et al. 2021)

➤ TreMs as indirect biodiversity indicators at the stand scale

Limitations

At stand scale, the relationships between TReMs and biodiversity are strongly context-dependent

(Bouget et al. 2013, 2014a,b; Paillet et al. 2018)

This is likely due to:

- **complex interactions between TreMs and other resources** such as deadwood items, flowering plants in clearings and water bodies (Larrieu 2014)
- **flaws in procedures for assessing both taxa and TreMs** (Larrieu and Bouget 2017)
- **time lags in the response of certain TreM-dwelling species** to TreM presence (Herrault et al. 2016)
- **spatial distribution of source populations** (Komonen and Müller, 2018)

➤ Using marteloscope data for biodiversity monitoring and marteloscope sites for additional biodiversity data collection

Which assets ?

- 1. Standardized protocol (fixed 1 ha-plots, location of each tree...)**
- 2. A person in charge of each plot**
- 3. Wide range of contexts (forest types, climate conditions...) throughout the whole network**
- 4. A database to gather plot data**

➤ Using marteloscope data for biodiversity monitoring and marteloscope sites for additional biodiversity data collection

Which limitations ?

- Opportunistic strategy to implement marteloscope sites : no sampling strategy to cover European forest types
 - Low representativeness at the European scale, and few replicates for each forest context
- Difficult to set up binding instruments
- Great heterogeneity of management between plots
- Large variations in plot size
 - 30% of plot areas differ in fact from 1 ha
- DW is not systematically measured

➤ Using marteloscope sites for additional biodiversity data collection

Which additional challenging variables?

Field measurements

- Recording ground-lying deadwood everywhere (not only snags and dead trees)
- Vertical structure (number of strata)
- Canopy openness

Ex situ measurements using GIS data

- Landscape context (forest cover, fragmentation index...)
- Forest tradition (ancientness)

➤ Using marteloscope sites for biodiversity monitoring

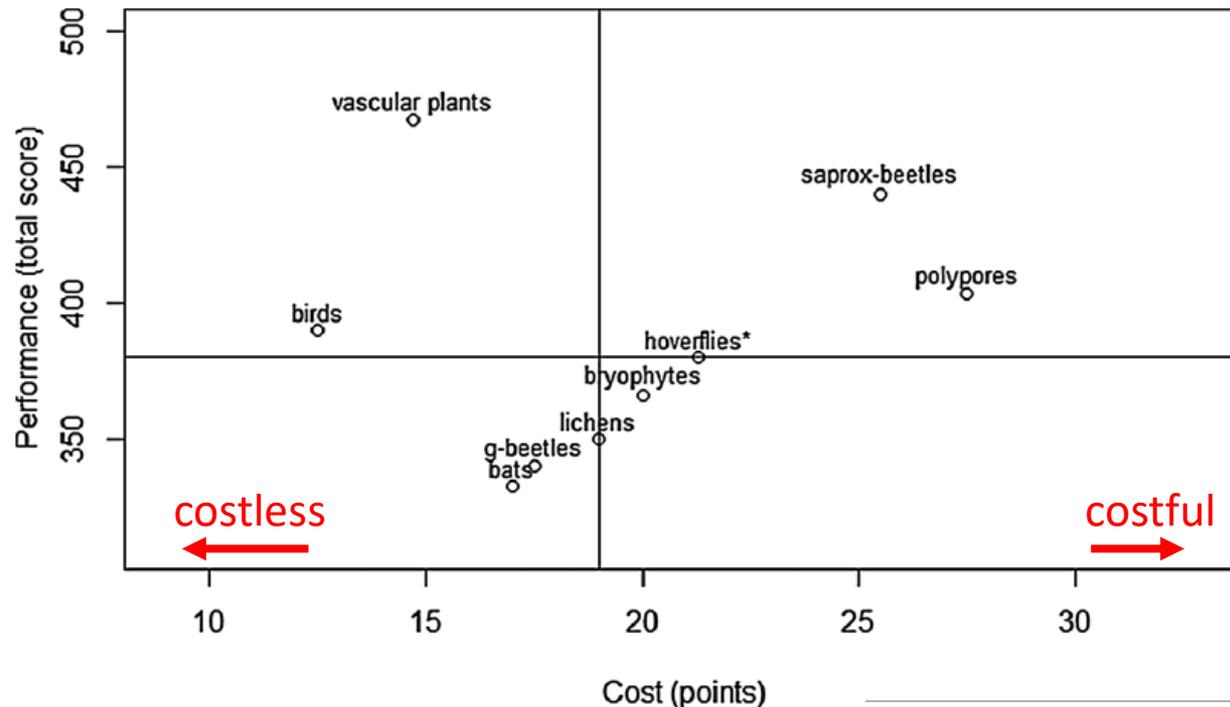
Direct taxon sampling

Key **properties** for candidate taxa

1. Specific to forests
2. Responsive to environmental changes
3. Adequacy between sampling scale and plot area
4. Pivotal for ecosystem functioning
5. High species diversity
6. Between-taxon complementarity
7. Low redundancy with NFI data (e.g. flora)
8. Supplemental to indirect indicators
9. Standardized & cost-efficient sampling method

➤ Using marteloscope sites for biodiversity monitoring

Selection of priority taxa: a first attempt using the relevance/cost ratio



Ecological Indicators 87 (2018) 56–65



Contents lists available at ScienceDirect

Ecological Indicators

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

Original articles

Cost-efficiency of cross-taxon surrogates in temperate forests

Laurent Larrieu^{a,b,*}, Frédéric Gosselin^c, Frédéric Archaux^c, Richard Chevalier^c, Gilles Corriol^d, Emmanuelle Dauffy-Richard^{c,1}, Marc Deconchat^a, Marion Gosselin^c, Sylvie Ladet^a, Jean-Marie Savoie^a, Laurent Tillon^e, Christophe Bouget^c

➤ Using marteloscope sites for biodiversity monitoring

Selection of priority taxa using Multi-Criteria Decision Analysis (MCDA)

Arthropoda	Collembola	Fungi
Ephemeroptera	Crustacea Isopoda	Hydnes Bankeraceae
Mecoptera	Myriapoda Diplopoda	Ectomycorhizal
Neuropterida	Myriapoda Chilopoda	Pezizales
Odonata	Araneae	Polyporoids
Orthoptera	Opiliones	(Hymenochaetales + Gloeophyllales + Polyporales)
Plecoptera	Acarii Phytoseiidae	Lichens
Raphidioptera	Acarii Tetranychidae	Myxomycetes
Hymenoptera Apoidea	Invertebrates	
Hymenoptera Chalcidoidea	non.Arthropoda	
Hymenoptera Braconidae	Annelida Enchytreids	Plants
Hymenoptera Parasitica	Annelida earthworms	Algae
Hymenoptera Symphyta	Gasteropoda.aquatic	Algae Bacillariophyta
Hymenoptera Formicidae	Gasteropoda.terrestrial	Algae Charophyta
Coleoptera Carabidae	Nematods	Algae Chlorophyta
Dung beetles	Rotifers	Bryophytes
Saproxylic beetles	Vertebrates	Vascular plants
Coleoptera Scolytinae	Amphibians	Phanerogams
Diptera Ceratopogonidae	Anura	Pteridophytes
Diptera Syrphidae	Urodela	Trees
Diptera Tipuloidea	Reptiles	
Hemiptera	Bats	
Lepidoptera Heterocera	Ungulates	
Lepidoptera	Small mammals (Rodents + Insectivores)	
Lepidoptera Rhopalocera	Birds	
	Picidae	

MCDA



Birds
Vascular plants
Bats
Ectomycorhizal fungi
Gasteropoda.terrestrial
Bryophytes

Using innovative sampling methods:
acoustic records, eDNA...

➤ Using marteloscope sites and data for biodiversity monitoring

Conclusion and perspectives

- Ensuring the network **sustainability**
- Giving **added value** to the marteloscope network
- **Coordinating** with other EU-level networks :
 - Focusing on interactions with *pan-European ICP* level I and level II networks and with NFI data