Why the EU should launch an in-situ multi-taxon forest monitoring

Photo: D. Kozak

Policy needs

The Forest Monitoring Law's proposed by the EU Commission in November 2023 has the operational objective to establish a framework for the collection and reporting of forest data. By integrating earth observation and in-situ monitoring such framework should encourage consistent long-term integrated forest planning by Member States.

The EU Forest Strategy for 2030 aims to integrate the current set of indicators to assess management sustainability for forest biodiversity accounting for biogeographic regions and forest types.

State of the art

Current monitoring tools do not completely fulfill these objectives: national forest inventories have been partly harmonised, mainly for variables related to timber resources. This is not the case for ground-based data on biodiversity, for which an EU-wide assessment is still lacking.

Existing monitoring schemes use indirect biodiversity indicators that do not allow to assess precisely the multiple dimensions of biodiversity. Since different species groups respond differently to changes in forest structure, multi-taxon biodiversity assessments are a direct approach to comprehensively monitor forest biodiversity[1–3] and its response to forest management[4].

The COST Action BOTTOMS-UP (https://www.bottoms-up.eu/en/) gathered European researchers involved in studies on multi-taxon forest biodiversity performed across Europe over the last 20 years. This network harmonised for the first time forest multi-taxon biodiversity data and measurements on stand structural variables, e.g., tree sizes and deadwood. The BOTTOMS-UP platform comprises a total of 3,591 sampling units across 13 EU countries (Fig. 1) covering all European forest types, although unevenly[5]. This effort aims to support forest policies towards an effective monitoring of forest ecosystems in Europe.

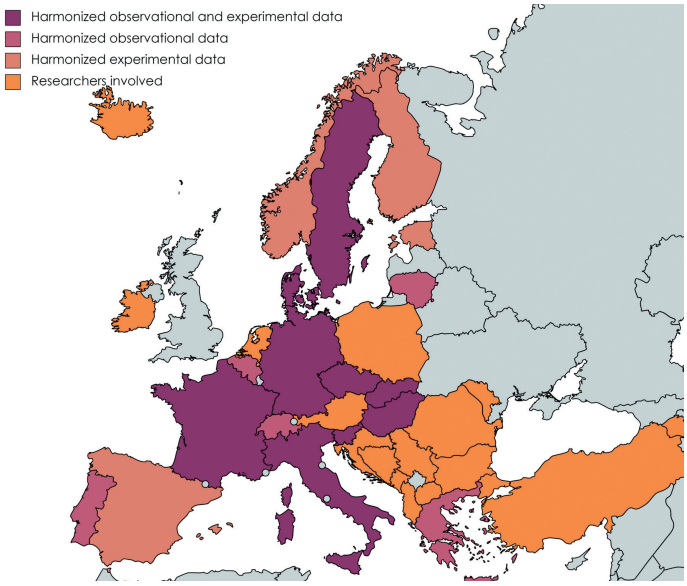

Figure 1. Available harmonized information on forest multi-taxon biodiversity and stand structure and researchers involved in the BOTTOMS-UP network.

What is needed?

To set an operational framework for forest biodiversity, it is important to know:

- What to sample?
- How to sample?
- How much effort is needed?
- Which indicators work for biodiversity?

What to sample?

Based on the BOTTOMS-UP forest biodiversity data, we found that researchers most often focused on: **beetles**, **birds**, **bryophytes**, **fungi**, **lichens**, and **vascular plants**.

These taxonomic groups were more often deemed effective to assess the effects of forest management on biodiversity[6].

How to sample?

We collected and standardized information on the protocols used for biodiversity field sampling. A handbook for field sampling of forest biodiversity[6] was thus compiled, proposing two standard methods for biodiversity sampling (Fig. 2):

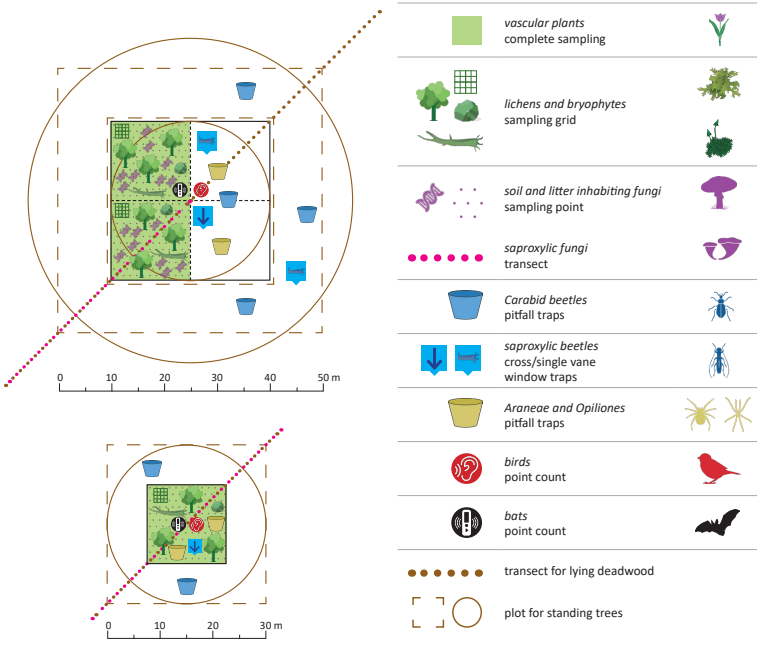

Figure 2. Schemes of the sampling units for forest multi-taxon biodiversity and structure sampling according to the first (a) and second (b) standard. For the first standard (a), the right and left halves of the plot schemes report respectively the sampling methods used for sessile organisms and for invertebrates.

- The first standard allows for fine assessment of biodiversity but is more costly;
- The second standard allows fast and relatively cheap biodiversity inventory but lacks the precision needed to detect fine changes.

These two standards were designed in a nested way to allow a direct comparison between them. For the sampling of each taxonomic group and structural element a rough estimate of the time and people/experts needed and of the equipment costs in euros is provided[6].

How much effort is needed?

For the six most commonly sampled groups we estimated the effort needed to assess their species richness and variation in species composition with a reliable degree of precision, also accounting for the differences across forest categories[7].

Such effort varies across taxonomic groups: fungi, vascular plants and beetles need a higher effort than birds and bryophytes and depends on the spatial scale. The groups requiring a higher effort are also those that can give a nuanced indication of the different conditions occurring across space and time. For example, wood-inhabiting fungi need a high effort in terms of number of plots due to their high within-site diversity, but less in terms of sites due to a relative homogeneity across regions. Deadwood-dependent beetles and vascular plants would need a high effort both in terms of plots and sites, allowing to differentiate both fine and broad scale conditions. The variation across forest types are less evident but still relevant.

Which indicators work for biodiversity?

Forest Europe indicators currently comprise ten indicators dedicated to biodiversity which should help decision makers to monitor biodiversity-friendly sustainable forest management across Europe. Among them, only two indicators involve species other than trees, i.e., "Threatened forest species" and "Common forest bird species", and to date, no systematic assessment of the correlations between Forest Europe indicators and multi-taxonomic biodiversity has been attempted. We used the BOTTOMS-UP platform to provide an ex-post validation of these indicators and propose improvements to the reporting process.

Policy recommendations

The scientific community spent multiple efforts in the study of forest multi-taxon biodiversity, and contributed to upscale such efforts to the EU scale providing indications on what, how and how much should be sampled.

The time is ripe to include direct biodiversity assessments in European forests as a guide towards the sustainable management and increased forest resilience advocated in the EU Forest Strategy for 2030 and towards the use of specific indicators to monitor the increase in the quality and resilience of forests as targeted in the EU Biodiversity Strategy for 2030.

Launch an in-situ multi-taxon forest monitoring

Existing knowledge on forest multi-taxon biodiversity, coupled with the harmonization effort by BOTTOMS-UP, may underpin a direct monitoring of forest biodiversity in the EU.

The need for hard skills to sample forest multi-taxon biodiversity would be counterbalanced by an increasing number of jobs in fields related to the environment. Such hard skills are also progressively 'softened' by the advancements of artificial intelligence[8], and genetic[9] tools that have made in-situ monitoring and species identification progressively easier.

Design a nested sampling method accounting for diversity patterns and forest types

Biodiversity patterns differ across taxonomic groups and forest types[10]. These should guide the monitoring network of European forest biodiversity, but are not mapped yet. Within their boundaries a network of representative sites, including a different number of plots for different taxonomic groups, should be identified (Fig. 3).

Focus on organisms directly influenced by management

Birds, saproxylic beetles and fungi, vascular plants and epiphytic lichens and bryophytes were repeatedly chosen by forest scientists to assess the impacts of forest management on biodiversity. The wide knowledge and wealth of geo-referenced data for these groups informed the definition of sampling protocols and sampling efforts that, in the opinion of forest scientists from most EU countries, represent a sound basis for a coordinated monitoring program.

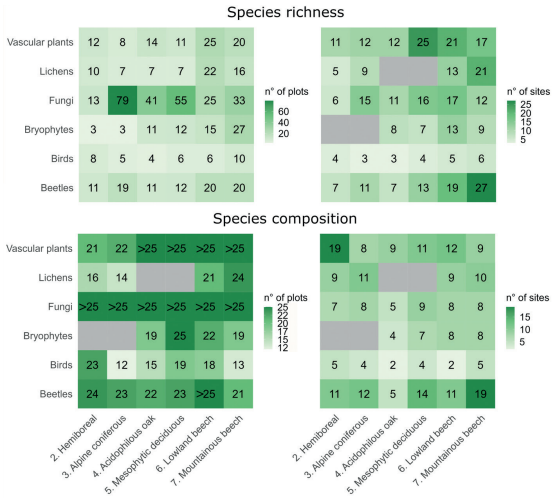

Figure 3. Estimates of the number of plots and sites needed to achieve a sound species diversity assessment in 6 out of 14 European forest categories. Green shades indicate the number of plots (left) and sites (right). Gray quadrats indicate insufficient data.

Address especially Mediterranean and boreal forests

Data harmonization showed relevant knowledge gaps for southern Europe and boreal forests, which display a large part of European forest biodiversity both at the species and ecosystem level. Such gaps need to be promptly addressed by coordinated efforts to monitor the effects of human and natural pressures on forest ecosystems.

Revise the indicators of management sustainability for biodiversity

Only some Forest Europe indicators perform relatively well (e.g., deadwood volume) but without representing all biodiversity (Fig. 4). Other indicators showed no or weak links with biodiversity. Biodiversity monitoring should not be based on indirect indicators only, but on direct multi-taxon sampling taking into account the environmental context. Analyzing the performance of other metrics is needed for the reporting on biodiversity[11,12], to assess management and policy actions and set biodiversity targets[12].

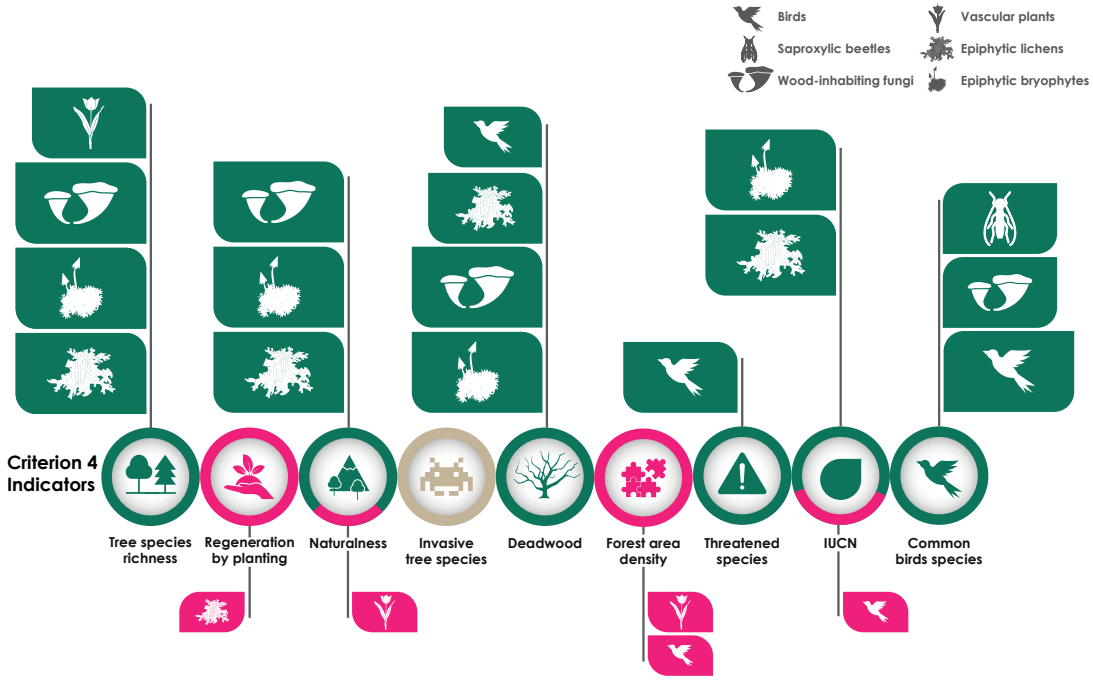

Figure 4. Forest Europe indicators as predictors of species richness of different taxonomic groups. Green and red flags indicate respectively positive and negative relations; flags' size is proportional to the strength of the relationship (estimate).

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