

POTENTIAL FOR REVISION OF FOREST EUROPE INDICATORS UNDER CRITERION 4

“MAINTENANCE, CONSERVATION AND APPROPRIATE
ENHANCEMENT OF BIOLOGICAL DIVERSITY IN
FOREST ECOSYSTEMS”

Background paper

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INTRODUCTION

Pan-European Criteria and Indicators (C&I) for Sustainable Forest Management (SFM) have a history of 30 years and have been constantly developed since then. After the first set of C&I for SFM in 1998 and its improvement in 2003 and a revision in 2015, experience has shown that C&I for SFM are a very important tool for national and European forest policy (Linser et al. 2018; Linser & Wolfslehner 2022; Lier et al. 2021) and the data collection and analysis systems which accompany them, regularly published in the State of Europe's Forests reports (Forest Europe 2020; Forest Europe et al. 2011; Forest Europe 2015, 2007; MCPFE 2003).

DEMAND FOR A PARTIAL REVISION OF THE INDICATOR SYSTEM

Forests are invaluable reservoirs of biodiversity, providing habitat for numerous species and offering critical ecosystem services. Forest biodiversity concerns were already prominent in the 1990s, which is shown by the fact that 9 indicators were formulated for Forest Europe Criterion 4 on the maintenance and enhancement of forest biological diversity. The revision in 2015 added a tenths indicator ("Forest birds" under Criterion 4).

With the escalating threats of climate change triggering more forest damages, habitat change and species loss, society is pronouncing new and complex demands on forests (Prins et al. 2023). Ambitions have risen, also as a consequence of the Aichi Targets, with regard to the share of protected land and to biodiversity on all types of forest (i.e., not only those which are protected for biodiversity conservation) and the focus of EU policy instruments on reversing biodiversity loss and protecting Europe's remaining primary and old growth forests. Thus, the situation demands that the existing pan-European indicators for SFM need to evolve to address these challenges adequately.

As agreed with the Forest Europe Liaison Unit Bonn and in accordance with the Forest Europe Think Tank activities this report presents options to adapt the present Forest Europe indicators to actual political needs and requirements of national and international forest biodiversity-related requirements and strategies.

Presently, biodiversity indicators are high on the international political agenda and should be in coherence with the main political instruments and goals, such as the Global Forest Goals, SDGs, Aichi-Targets, Forest Europe Oslo Goals & Targets, the Global Core Set of Forest-related Indicators and the EU forest biodiversity-related Strategies and Regulations. For instance, only about two thirds of all the identified objectives and commitments in the New EU Forest Strategy for 2030 can be monitored at least partially by the Forest Europe indicators, whereas new indicators

or approaches need to be developed for the remaining third. Several of the Forest Europe indicators are not linked to the New EU Forest Strategy for 2030, and some of them are only weakly linked to the policy issues addressed in the Strategy. A comparison of Lier et al. (2022) shows some significant differences between the comprehensive vision of sustainable forest management formulated in the Forest Europe indicator set and the scope of the objectives and commitments in the New EU Forest Strategy for 2030. In particular, the forest policy concerns reflected in the Strategy address some issues (also biodiversity related) which are not fully covered in the pan-European indicator set. Also, a contribution to the recent indicator developments of the CBD should be considered. In other forest C&I processes (e.g. the Montreal Process or ITTO) and in other countries outside Europe (e.g. Canada and USA) biodiversity is likewise a major focus. Adapting and amending forest biodiversity-related indicators creates an opportunity to align the monitoring and assessment frameworks with these global commitments, fostering greater accountability and facilitating the implementation of targeted conservation strategies.

Looking at the actual policy discussions, it is noticeable that new data and information on the current management approaches and their effects particularly on forest biodiversity are required (e.g. also on close(r)-to-nature-forest management areas, old-growth forests, plantations, integrative forest management etc.). Advancements in scientific knowledge and technological capabilities have opened up new opportunities for assessing and monitoring forest biodiversity. With the advent of remote sensing and geospatial data, there is now access to more precise and detailed information about forests than ever before. By amending and evolving the indicators, we can enhance our understanding of forest biodiversity, inform evidence-based decision-making, and catalyse effective conservation and sustainable management efforts for the benefit of present and future generations.

OVERVIEW ON FOREST BIODIVERSITY RELATED DATA AND INFORMATION AVAILABLE AT NATIONAL LEVEL

To obtain information of what is available in the countries, an investigation was conducted on additional forest biodiversity parameters that are not yet covered by the Forest Europe Indicators for SFM under Criteria 4.

In autumn 2022, information on biodiversity-relevant parameters that are part of biodiversity monitoring in other countries was requested from the 56 national correspondents for Forest Europe and FAO/UNECE forest data reporting as well as from the members of the UNECE Team of Specialists on Monitoring Sustainable Forest Management. The focus was extended beyond Forest Europe to UNECE countries, as both Canada and the USA have just revised forest biodiversity indicators, and indicator sets have recently been developed in Central Asia and in the Caucasus, with UNECE assistance, as a basis for forest inventories.

The survey was well received with the provision of information (inventory guides, forest reports, biodiversity reports, links to websites and databases, etc.) from 73% of the contacted national correspondents. All information was analysed according to further biodiversity relevant parameters (in addition to the ten Forest Europe C4 indicators) which are collected/monitored by 41 countries (34 of it are pan-European countries).

Further research was conducted on international forest C&I for SFM processes (Montreal Process, ITTO, Low-Forest-Cover-Countries Process, ASEAN Process, FAO Global Core Set, SDG 15 indicators) and other indicator processes (CBD, UNEP-WCMC).

In total, more than 100 additional parameters were identified which are monitored and reported by countries and organisations (see Annex 1). However, several of those parameters are either qualitative or relate to lower level assessments (local or even stand level).

In addition, methodological approaches for the indicator-based presentation of causal models were

1 https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd589689.pdf; https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fse-prd657375.pdf

2 [Protecting old-growth forests in Europe A review of scientific evidence to inform policy implementation.](#)

3 [Quantifying old-growthness of lowland European beech forests by a multivariate indicator for forest structure](#)

4 [The long way back: Development of Central European mountain forests towards old-growth conditions after the cessation of management.](#)

explored. The first results were already presented at the 2nd Forest Europe Think Tank meeting on 30 November 2022.

Scientific literature survey

A scientific literature review on individual forest biodiversity indicators has also been conducted with a particular focus on indicators related to naturalness. However, there were no approaches found to be feasibly applicable in all pan-European countries.

The US Forest Service used a “scenic integrity” scale to capture naturalness based on historical land-cover and vegetation changes (e.g. Gimmi, U., & Radeloff, V. C., 2013, and further references¹).

Some use „Old-growthness Indicators“ as proxies for naturalness (see for instance: O’Brien et al., 2021², Meyer et al., 2021³; Albrich et al., 2021⁴). The approaches are based on different parameters related to forest composition, structure, and functions by comparing old-growth with formerly managed stands. However, the variation within each investigated parameter is very large in old-growth stands, and makes it difficult to quantify old-growthness.

Causal indicator model

For the indicator-based presentation, methodological approaches were explored. The OECD Pressure-State-Response (PSR) Model seems suitable to depict the causal chains of forest biodiversity related issues as the PSR framework is a widely recognized conceptual model used in environmental policy and sustainability assessments. It provides a systematic approach for analysing and understanding the relationships between human activities, environmental pressures, the state of the environment, and policy or stakeholder responses.

In the context of forest biodiversity, pressures refer to the human activities and factors that exert stress on forest ecosystems and contribute to forest

biodiversity loss or degradation. Pressures can include deforestation, forest fragmentation, unsustainable logging practices, invasive species introduction, pollution, climate change impacts, and illegal wildlife trade. These activities and factors directly or indirectly impact the composition, structure, and functioning of forest ecosystems, leading to biodiversity decline.

The state component of forest biodiversity focuses on the current condition of forest ecosystems and their associated biodiversity. It includes various indicators such as forest species abundance, genetic diversity, ecosystem composition, and the presence of threatened species. The state component provides an assessment of the status and trends of forest biodiversity, reflecting the outcomes of the pressures exerted on the forests.

The response component involves the policies, management approaches, and actions implemented to address the pressures on forest biodiversity and maintain or enhance its state. Responses can include protected area designations, integrative management practices, reforestation and restoration initiatives, forest management plans, and international agreements to conserve or enhance biodiversity. Responses aim to mitigate the negative impacts of pressures, maintain, enhance, protect and restore forest biodiversity.

The below figure 1 presents for the example of 'regeneration' various suitable indicators in a causal model.

Figure 2 shows the results of the above-mentioned survey on nationally used forest biodiversity indicators classified by Pressure, State and Response categories. Also, the ten Forest Europe biodiversity indicators are depicted. The comparison shows that there are a number of nationally used Pressure and Response indicators which could serve as amendments for the existing indicators or as pool for additional indicators.

Relations between the Forest Europe C&I set and the global sets: SDG 15 and Global Core Set of forest-related indicators

About every 5 years (2015, 2020), the Forest Europe national correspondents, in their function as also being the FRA national correspondents were and will be asked to also provide data for the FRA parameters and for the forest-related SDG indicators and most probably also for the Global Core Set of forest-related indicators (FAO and CPF 2022; Linser & Prins 2022).

Therefore, in the following, there is also information for each Forest Europe biodiversity indicator concerning counterparts in the SDG and GCS indicators paying particular attention which SDG (sub)indicators and GCS indicators have exact counterparts in the Forest Europe indicator set and if matching or deviating definitions have to be considered.

If a global indicator is not reflected in the Forest Europe indicator set, it should be broadly discussed if the Forest Europe C&I be expanded to include it (this mainly concerns the entire indicator sets, not only under Criterion 4 Biodiversity).

Key indicators

Some of the following indicators are proposed as a potential key indicator out of the whole set of the pan-European indicators for sustainable forest management (SFM). Conceptually all 34 SFM indicators are equally important, however, the wealth of information is hardly digestible by decision-makers. By selecting key indicators, one can distil the most informative measures where high-quality data and information is available in the majority of countries. The key indicators serve as representative proxies for decision-makers and the interested stakeholders. Professionals and scientists are nevertheless provided on a regular basis with the full range of information on the whole set of SFM indicators.

Figure 1: Causal chain of forest regeneration related issues presented by suitable indicators in the PSR Framework (own presentation).

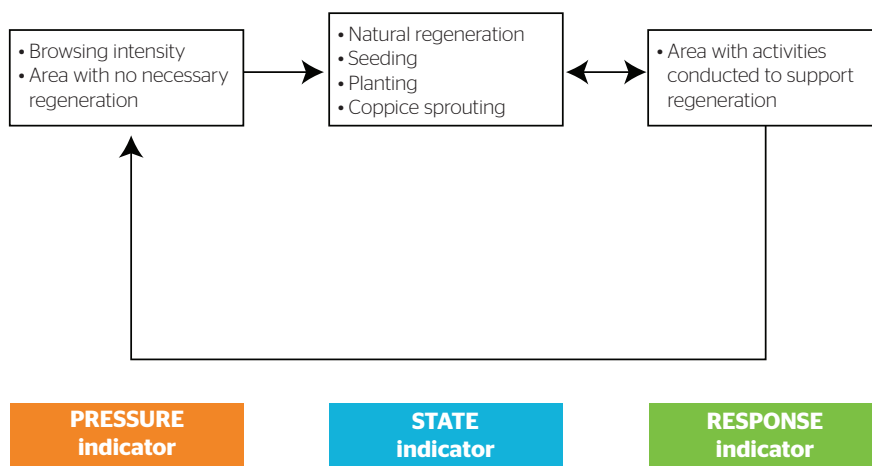


Figure 2: Results of the survey on additional forest biodiversity relevant parameters classified by Pressure, State and Response categories. On the right are the ten Forest Europe Biodiversity indicators

112 additional indicators/parameters, 14 indices		FOREST EUROPE Indicators
Ecosystem diversity	➔ 7 ind. ➔ 5 State, 2 Indices	4.1 Diversity of tree species (State)
Species diversity	➔ 21 ind. ➔ 1 Pressure, 13 State, 2 Response, 5 Indices	4.2 Regeneration (State)
Naturalness	➔ 4 ind. ➔ 1 Pressure, 3 States	4.3 Naturalness (State)
Introduced species	➔ 6 ind. ➔ 4 Pressure, 2 Response	4.4 Introduced tree species (Pressure)
Genetic resources	➔ 3 ind. ➔ 1 Pressure, 1 State, 1 Response	4.5 Deadwood (State)
Protected forested areas	➔ 26 ind. ➔ 1 Pressure, 7 State, 17 Response, 2 Indices	4.6 Genetic resources (State)
Forest management	➔ 17 ind. ➔ 2 Pressure, 7 State, 17 Response, 2 Indices	4.7 Forest fragmentation (Pressure)
Regeneration	➔ 13 ind. ➔ 3 Pressure, 7 State, 17 Response, 2 Indices	4.8 Threatened forest species (State)
Forest structure	➔ 11 ind. ➔ 7 State, 17 Response, 2 Indices	4.9 Protected forest areas (Response)
Others	➔ 17 ind. ➔ 5 Pressure, 7 State, 17 Response, 2 Indices	4.10 Common forest bird species (State)

DISCUSSION OF THE INDIVIDUAL INDICATORS

C.4 Policies, institutions and instruments to maintain, conserve and appropriately enhance the biological diversity in forest ecosystem

In the FE country replies some countries mentioned a lack of convergence of nature conservation, forest policy and climate policy objectives. It would therefore be of interest to request information on forest relevant policy coherence/convergence systematically from the countries. However, for many countries it might be politically sensitive to report their own countries' policies as inconsistent and no full overview will be obtainable.

4.1 Diversity of tree species

» *Area of forest and other wooded land, classified by number of tree species occurring*

Separate figures to be reported on: Area of forest, other wooded land and total with number of tree species

occurring (1; 2-3; 4-5; ≥6).

Tree species diversity is a fundamental component of forest ecosystems and can provide essential information about overall biodiversity. It may serve as a proxy for habitat complexity, and functional diversity. Multispecies forests are usually richer in biodiversity than monospecific forests. However, it has to be considered that some natural forest ecosystems have only one or two tree species, e.g. natural subalpine spruce stands.

References to information and data needs in international documents:

- The indicator is misleading if one starts from the simple - but wrong - idea that more tree species means higher biodiversity. Multispecies forest and other wooded land are usually richer in biodiversity than monospecies forest and other wooded land. However, it has to be considered that some natural forest ecosystems have only one or two tree species, e.g. natural subalpine spruce stands.

Instruments	Main forest-related data needs	FE data
Draft EU Nature Restoration Law	Tree species diversity	Available
	Share of forests dominated by native tree species	n/a
Draft EU Forest Monitoring Regulation	Tree species composition and richness	Available
	(14) Forest types	was partly available in SoEF 2011

Thus, a low amount of tree species reported is not automatically a negative indication.

- Some countries report in their national forest reports also on share of native and non-native species (the latter needs definition). E.g. Native/non-native Larch, Oak, Poplar. To avoid negative connotation of non-native species it might be considered to request information on site-resilient tree species. In the light of climate change this might be interesting additional information.
- Many countries report in their national forest reports also on underbrush trees and shrubs, an important information for structural diversity.

>To increase the force of expression of this indicator at national level, a distinction could be made on data reported for ecosystems which are usually low of various tree species (e.g. in the boreal region or towards higher elevations) and for ecosystems which are usually rich in tree species (e.g. tree species abundance larger than 3 tree species according to potential natural vegetation).

The distinction between regions, as done so far, may not be sufficient as not only in Northern Europe occur forest ecosystems with naturally low tree species diversity. Also, in the other Forest Europe regions there are natural forest ecosystems where the potential natural vegetation consists of a few tree species only, e.g. on higher elevations, on peatland or on sandy soil). As all indicators are national indicators and only national figures are reported, such a distinction of the forest area could be either done under this indicator or under Ind. 11 “Forest area” to have an appropriate reporting base.

In fact, this indicator is another proxy for the natural/unnatural distinction with the assumption that monospecific stands are not “natural”. There is thus an overlap with the naturalness indicator 4.3. As we are looking to simplify and shorten the list, and give each indicator a strong meaning, it might be considered to absorb 4.1 into 4.3. The advantage of 4.1 as it stands is that number of species in a stand is objective, and always measured by inventories.

4.2 Regeneration

» *Total forest area by stand origin and area of annual forest regeneration and expansion*

Separate figures to be reported on:

- Total forest area by expansion and regeneration type:
 - * Natural expansion and natural regeneration
 - * Afforestation and regeneration by planting and or seeding
 - * Coppice
- Annual forest expansion and regeneration, classified by:
 - * Expansion of forest area: Afforestation / Natural expansion
 - * Regeneration of forest area: Natural regeneration / Planting and seeding / Coppice

Assessing regeneration provides insights into the reproductive success and resilience of tree species within the forest. Natural regeneration contributes to conserving the diversity of the genotype and to maintaining the natural species composition, structure and ecological dynamics. However, it has to be considered, that natural regeneration is not always feasible to reach adequate management and conservation goals, particularly when facing climate change induced changes of soil moisture.

References to information and data needs in international documents:

- Natural regeneration contributes to conserving the diversity of the genotype and to maintaining the natural species composition, structure and ecological dynamics. However, it has to be considered, that natural regeneration is not always feasible to reach adequate management and conservation goals. Also, natural regeneration does not allow the use of higher quality genetic material.
- Some countries report in their national forest reports also on ‘Number of regenerated tree

Instruments	Main forest-related data needs	FE data
New EU Forest Strategy for 2030	Plant 3 billion additional trees	n.a.
EU Biodiversity Strategy for 2030	Regeneration/afforestation (plant at least 3 billion additional trees)	n.a.

species', on 'Necessary regeneration not available' (for instance in overmature protective forests or on unstocked forest areas), on 'Plantings of native or non-native, respectively site-resilient tree species' and on 'Natural regeneration of invasive species'.

- One of the proposed indicators of the Draft EU Monitoring Regulation is 'Post-disturbance recovery' which will be crucial for assessing the impact of disturbances on forest biodiversity. It may inform on the rate and extent of regeneration and its various species available, and allowing conclusions to be drawn about the effectiveness of restoration efforts enabling timely interventions to restore biodiversity and mitigate potential long-term ecological consequences of disturbances.

> **In the light of climate change the above-mentioned additional (sub-)indicators, particularly the one on planting of site-resilient tree species and of post-disturbance recovery might be interesting additional information, data on the first one could be obtainable via the NFIs and data on the second one could be obtainable from remote sensing.**

The reporting on the 'planting of additional trees' as requested by the EU Biodiversity Strategy for 2030 cannot be done by this indicator, as the indicator is related to regenerated forest area in ha and not to number of additional trees planted. For the reporting to the respective EEA webtool, it is not clear how countries treat planting of trees on already existing

forest areas or if they report actually only those trees planted on newly established forest areas.

4.3 Naturalness

- » Area of forest and other wooded land by class of naturalness (undisturbed by man, semi-natural, plantation)

The degree of naturalness of forest ecosystems is the result of human intervention or lack of it, and is a good indicator of how far forest biodiversity has diverged from natural conditions.

Undisturbed by man refers to the degree to which a forest ecosystem retains its ecological integrity and functions without significant human-induced modifications. It reflects the extent to which the ecosystem represents its original, undisturbed state. Semi-natural forests can keep certain characteristics, allowing natural dynamics and biodiversity closer to the original ecosystem. Plantations usually represent ecosystems on their own, with artificial dynamics establishing species communities completely distinct from the original ecosystem.

The availability and quality of data on naturalness could be improved in many pan-European countries.

References to information and data needs in international documents:

Instruments	Main forest-related data needs	FE data
EU Biodiversity Strategy for 2030	<ul style="list-style-type: none"> • Primary forests 'Naturally regenerated forest of native tree species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed' (EC, SWD(2023)62 final)	Data on forest area undisturbed by man is available
EU Biodiversity Strategy for 2030	<ul style="list-style-type: none"> • Old-growth forests 'A forest stand or area consisting of native tree species that have developed, predominantly through natural processes, structures and dynamics normally associated with late-seral developmental phases in primary or undisturbed forests of the same type. Signs of former human activities may be visible, but they are gradually disappearing or too limited to significantly disturb natural processes' (EC, (SWD(2023) 62 final)	n.a.
New EU Forest Strategy for 2030	"Close To Nature" (CTN)-compliant forest management	n.a.
New EU Forest Strategy for 2030	Naturalness	Available
Renewable Energy Directive (RED III)	Primary and old-growth forests	n.a.
Ind. 5 of Global Core Set of Forest-related Indicators	Change in area of primary forests	Available (undisturbed by man)
Draft EU Forest Monitoring Regulation	Location of primary and old-growth forests	n.a.



- The degree of naturalness of forest ecosystems is the result of human intervention or lack of it, and is a good indicator of how far forest biodiversity has diverged from natural conditions.
- This Forest Europe classification of “undisturbed by man”, “semi-natural”, “plantations” is not consistent with the FAO FRA reporting on “primary forests”. The trends are not very sure because of definition changes
- The FE reporting on forests undisturbed by man and the FRA reporting on primary forests faces methodological problems, as many countries simply reported in both cases the area of forest in legally established protected areas or reported climax, old-growth forest as undisturbed or primary forest and did not consider early successional stages of undisturbed/primary forests (after natural disturbances) in their reporting.
- The multiple international data needs on primary and old-growth forests cannot be fully covered by this indicator. The EC definition includes forest stands that originate not only from natural regeneration, but also from planted or sown native tree species (provided that they meet the rest of the definition). Old-growth forest stands do not include stands for which there is evidence that they are under active productive management. This includes low-intensity silvicultural regimes and coppicing
- Semi-natural forests can keep certain characteristics, allowing natural dynamics and biodiversity closer to the original ecosystem. In practice, they are the left-over forest areas reported after the subtraction of areas of undisturbed forests and plantations, with little in common. Thus, the category “semi-natural forest” is very broad. Looking at the actual policy discussions, it is noticeable that information on forest areas under close(r)-to-nature-forest management is required rather than on semi-natural forest areas.
- Plantations usually represent ecosystems on their own, with artificial dynamics establishing species communities completely distinct from the original ecosystem.

> **Already three decades ago there was an intense debate at the Global Forest Resource Assessment expert meeting (in Kotka) about the terms**

“undisturbed by man”, “primary”, “natural” and “old growth” forests each of which has its own emotional resonance, as well as major problems of definition.

That time “undisturbed by man” was chosen, but the discussion continued and FRA changed later to primary forests which is presently again under discussion. The EU refers in different documents to different terms related to naturalness, more recently publishing EC Guidelines for Defining, Mapping, Monitoring and Strictly Protecting EU Primary and Old-Growth Forests⁵. As a result, international reporting requirements on naturalness are diverse and lack harmonization. This should be addressed at higher level.

4.4 Introduced tree species

» *Area of forest and other wooded land dominated by introduced tree species*

Forestry in Europe is to a large extent based on native tree species. However, due to climate change induced necessities of changing site conditions, introduced tree species are increasingly preferred. Some countries have already a significant share of introduced forest tree species. However, through their ecological characteristics, e.g. competitiveness, introduced tree species may change the dynamics of forest ecosystems and may influence sites, species composition, structure and functional diversity. Some introduced species have become problematic, i.e. invasive, influencing native biodiversity and altering forest ecosystem processes.

The availability and quality of data on introduced tree species could be improved in many pan-European countries.

References to information and data needs in international documents:

- Forestry in Europe is to a large extent based on native tree species. However, some countries have a certain share of introduced forest tree species (up to 63%, on average covering up to 3% of the forest area in pan-Europe). Through their ecological characteristics like competitiveness and better drought resistance the dynamics of forest

Instruments	Main forest-related data needs	FE data
Draft EU Forest Monitoring Regulation	Invasive species presence	Available

⁵ Commission Guidelines for Defining, Mapping, Monitoring and Strictly Protecting EU Primary and Old-Growth Forests, <https://data.consilium.europa.eu/doc/document/ST-7736-2023-INIT/en/pdf>



ecosystems, may change and the introduced forest tree species may influence sites, species composition, structure and functional diversity.

- On around 0,5% of the pan European forest area, some introduced species have become problematic, i.e. invasive, influencing native biodiversity and potentially altering forest ecosystem processes. Information on spread of invasive species in protected forest areas is of particular interest.

> Only 21 countries so far repeatedly reported information on introduced tree species. The connotation of the indicator, particularly its part on invasive species, is rather negative, however, in the in the scope of adapting forests to climate change there is an increasing need to rely on introduced tree species for wood production, coping better with changing site conditions (e.g. droughts, calamities, storms) which will increase the importance of this indicator and reliable data.

The reporting on invasive tree species could follow the EU list of invasive alien species of Union concern.

4.5 Deadwood

- » *Volume of standing deadwood and of lying deadwood on forest and other wooded land*

Deadwood is a habitat for a wide array of organisms and after humification an important component of forest soil. Many species are dependent, during some part of their life cycle, upon dead or dying wood of moribund or dead trees (standing and fallen), or upon wood-inhabiting fungi or other species. Because of lack of deadwood many of the dependent species are endangered. The amount of deadwood per hectare, which is now usually measured by forest inventories, varies considerably between ecosystems, but trends in deadwood are accepted as a proxy for trends in biodiversity.

The availability and quality of data on deadwood could be improved in many pan-European countries.

References to information and data needs in international documents:

- The amount of deadwood is dependent on the specific forest ecosystem, as well as on silvicultural practice and harvesting methods.
- In the light of climate change and subsequent droughts, there is a trade-off between biodiversity supporting deadwood accumulation and forest fire precautionary measures which include deadwood reduction/minimization/prescribed burns, which may lead to low deadwood amounts/ha and a decreasing deadwood trend.
- The data quality and comparability between countries is an issue, as the various NFIs apply very different measures of deadwood.

> **There seem to be no need to revise this indicator.**

It seems sufficient for the related reporting obligations as data on deadwood is meanwhile monitored in all NFIs as its presence and appropriate management are widely recognized as essential for maintaining biodiversity, supporting ecosystem resilience, and promoting sustainable forestry practices. Monitoring deadwood abundance helps inform conservation strategies and guide management interventions aimed at enhancing and conserving forest biodiversity. Therefore, deadwood-related information can be considered as a key indicator (within the whole set of indicators for SFM).

4.6 Genetic Resources

- » *Area managed for conservation and utilisation of forest tree genetic resources (in situ and ex situ genetic conservation) and area managed for seed production*

Genetic diversity enables forest trees to survive, adapt and evolve in changing environmental conditions. It is critical to maintaining the vitality of forests and to cope with pests and diseases. Conserving this diversity is a key element of sustainable forest management, ensuring the ecological and economical resilience of forests.

The concept of the international data provider EUFORGEN to display the information is complex and

Instruments	Main forest-related data needs	FE data
Proposal on EU Nature Restoration Regulation	Standing Deadwood Lying Deadwood	Available
Draft EU Forest Monitoring Regulation	Deadwood	Available

cannot be intuitively understood.

for the forest-related reporting part of SDG 2.5.1 and for national reporting within the EU Biodiversity Strategy for 2030.

References to information and data needs in international documents:

- 39 countries reported their 2020 data on the revised indicator (or part of it) to the EUFORGEN Secretariat. The same data would also be suitable

> There seem to be no need to revise this indicator as the indicator was revised by EUFORGEN/Bioiversity International in 2017/2018 and seems sufficient for the related reporting obligations.

Instruments	Main forest-related data needs	FE data
New EU Forest Strategy for 2030	Genetic resources	Available
EU Biodiversity Strategy for 2030	Forest genetic conservation and diversity	Available
SDG 2.5.1	Number of plant and animal genetic resources for food and agriculture secured in either medium or long-term conservation facilities	Available (forest-related)

4.7 Fragmentation

- » *Area of continuous forest and of patches of forest separated by non-forest lands*

Fragmentation refers to the breaking up of continuous forest landscapes into smaller, isolated patches due to human activities such as deforestation, infrastructure development, and land conversion.

Assessing fragmentation provides critical insights into the impacts of habitat loss and degradation on forest biodiversity. Fragmented forests are characterized by reduced connectivity between patches, increased edge effects, and altered microclimates, leading to changes in species composition, reduced genetic diversity, and disrupted ecological processes.

For the State of Europe's Forests reports the information was processed by the international data provider EC JRC Ispra for whole pan-Europe.

References to information and data needs in international documents:

- This indicator, reported by an International Data Provider, allows no national derivations.
- The added value of the indicator deployment method should be discussed. As stated in

the SoEF 2020 p.133 "Forest fragmentation is generally considered at the ecosystem level. The presentation of the state and changes in forest fragmentation at the regional level, as done for the SoEF reports, renders a simplified approach". The whole analysis is based on Corine Land Cover satellite images which do not have a very high resolution. The chosen five fragmentation classes which range from "<100 ha" to ">100 000 ha" constitute a very general classification, which does not allow an analysis at the country scale, but only at the regional scale. Several countries have reservations about how this indicator is presented. Also, the added value for the assessment of forest biodiversity is to be questioned, as the five broad fragmentation classes used are not related to species ranges.

- More desirable would be to set the spatial resolution of fragmentation in relation to the ranges of threatened species – e.g. coarser resolution for larger mammals like wolf or bear - and finer dissolved fragmentation classes for smaller threatened species like birds and small animals.
- Even though indicators on landscape pattern and fragmentation were highly promoted by EEA 20 years ago, the EEA within its FISE Portal discontinued the presentation of the fragmentation indicator and no new assessments will be produced⁶.

Instruments	Main forest-related data needs	FE data
Proposal on EU Nature Restoration Law	Forest connectivity	n.a.
Draft EU Forest Monitoring Regulation	Forest connectivity	n.a.

⁶ <https://www.eea.europa.eu/data-and-maps/indicators/fragmentation-of-natural-andsemi-1/assessment1>

- Information on forest connectivity became recently more important as e.g. mentioned in the EU Biodiversity Strategy for 2030 and in the proposal on an EU Nature Restoration Law as one of five indicator-based restoration measures which need to be put in place to enhance the biodiversity of forest ecosystems across the Union. Also, recently funded EU projects focus on Designing coherent Trans-European Networks for Nature (e.g. NaturaConnect, CERES) and various national forest connectivity projects (e.g. in AT, UK).
- There are methodological problems/uncertainties on how to monitor which forest-related species. The data collection is not part of NFIs, additional expert knowledge is necessary leading to high human and financial resources to obtain reliable data.
- The various national data on the various threatened forest species are very heterogeneous and fragmented although IUCN has a global standardised classification system for all species (www.iucnredlist.org). Countries report to FE numbers on very different species in the various species groups. E.g. mammals are one species group. However, if 5 endangered mammals are reported, there is no information if those are large carnivores or small rodents. There is no transparency on comparable species reported.
- The number of threatened species should be put in context, as a “threatened” species might be on its way out (“least concern” a few years before) or on its way back (reintroduced after being extinct in that country. Should a trend element be built into the indicator, like “Trend in numbers of threatened forest species”? However, presently, trends can hardly be derived from this data base nor any evaluation if “the loss of forest biodiversity in Europe is halted (halved)” (European Forest Goal 5, European 2020 Target for Forests 6) as changes in the reported numbers on threatened species may not represent actual changes in species’ status, due to increased efforts in data collection for Red Lists or changes in taxonomical categorisation.
- Also, not all threatened forest species are automatically protected under specific conservation statuses like being listed as “Red-listed” or under legal protection. The share of those threatened (key) species under a protection status would provide some information on political response.
- Although this indicator is part of many environment related indicator sets and is/was always promoted by environmental NGOs and environmental stakeholders to be included in various indicator sets, the added value of this indicator should be discussed, as:

> **The information provided by this indicator has practically no significance at the country level and low force of information at regional level.** However, fragmentation/connectivity are important landscape features for biodiversity, and deserve policy attention. The methodology for monitoring information on fragmentation and connectivity should be considered by potential users of the information (policy makers and biodiversity experts) rather than by remote sensing specialists. In any case, it should be possible to present the results at the national level.

4.8 Threatened forest species

- » *Number of threatened forest species, classified according to IUCN Red List categories in relation to total number of forest species*
 - *vulnerable*
 - *endangered*
 - *critically endangered*
 - *extinct in the wild*

The most recognisable form of depletion of biodiversity lies in the loss of species (fauna and flora). Slowing down the rate of species extinction is a key objective of the conservation of biodiversity. Changes in forest species population levels may also provide an early warning of changes in vital forest ecosystem functions. The availability and quality of data on threatened forest species could be improved in many pan-European countries.

References to information and data needs in international documents:

Instruments	Main forest-related data needs	FE data
EU Biodiversity Strategy for 2030	Trends and status of all protected species	Partly available
SDG 15.5.1	Red List Index	n.a.

- I. Data for this indicator are generally not assessed by NFIs but by Red List assessments (where data are gathered from published and unpublished sources, species experts, scientists, and conservationists through correspondence, workshops, and electronic fora⁷) or by special expert monitoring⁸, which are not regularly conducted and do often cover only small areas. Thus, the results may not be representative for the whole country.
- II. If a country can report high numbers of threatened species, this does not necessarily mean, that there is a particular issue of that country. Instead it means, that the country invested resources in monitoring threatened species and therefore is able to report on it, or even that it has made successful efforts to protect species faced with extinction at the edge of their natural range. Countries which do not report or only report few threatened species are therefore not in a more favourable condition but may lack respective and intensive monitoring.
- III. Repeated reporting of the number of extinct species can be misleading, as this does not take into account the migration of threatened species across national borders. The loss of individual species in a country can be compensated by the immigration of previously extinct species, e.g. bear and wolf come back while lynx and wild cat got extinct. This kind of developments are not represented by the figures.

Several species groups of threatened species are requested which currently cannot be covered in the scope of NFIs. Specialists, e.g. in taxonomy and ecology, are needed to collect the respective information and summarize the situation at the country level. However, there are justified doubts as to whether this will be feasible in every country. In addition, there is the inherent problem that Red Lists are only periodically updated resulting in a lack of timely information for all requested species (groups).

It should also be considered to focus only on a limited number of agreed key species for each species group representative for each of the pan-European regions and to report also on the number of protected forest species.

4.9 Protected forests

- » *Area of forest and other wooded land protected to conserve biodiversity, landscapes and specific natural elements, according to MCPFE categories*

Protected forest areas per se focus on the conservation of biological diversity and the maintenance of natural ecological processes as forests are key ecosystems for conserving biodiversity. Protected forest areas represent one of the oldest instruments for protecting nature and natural resources. Protected forest areas are included as a main pillar in nature conservation laws in all pan-European countries.

> **A feasible method for countries to monitor and report the requested information would be needed.**

Instruments	Main forest-related data needs	FE data
New EU Forest Strategy for 2030	Protected forest	Available
EU Biodiversity Strategy for 2030	Protected areas	Available
Ind. 4 of Global Core Set of Forest-related Indicators	Proportion of forest area located within legally established protected areas	Available
SDG 15.2.1	Proportion of forest area within legally established protected areas	Available
Global Forest Target 3.1	Area of forests worldwide designated as protected areas or conserved through other effective area-based conservation measures is significantly increased	Available
Global Forest Goal 3 ⁹	Increase significantly the area of protected forests worldwide	Available
Draft EU Forest Monitoring Regulation	Forests not available for wood supply	Available

⁷ <https://unstats.un.org/sdgs/metadata/files/Metadata-15-05-01.pdf>

⁸ For EU MS a species list used for Natura 2000 reporting is available under: <https://www.eea.europa.eu/data-and-maps/indicators/species-of-european-interest-2/assessment>

⁹ Global Forest Goals and Targets of the UN Strategic Plan for Forests 2030.

The concept of the various MCPFE classes is difficult and thus the availability and quality of data on protected forests could be improved in many pan-European countries.

References to information and data needs in international documents:

- During the revision of the FE Indicators in 2003 there was a strong opposition of the IUCN classification of protected areas. Therefore, so-called 'MCPFE classes' were elaborated to measure and report protected forest areas in the SoEF reports:
 - Class 1: Main management objective "Biodiversity"
 - Class 1.1: No active Intervention
 - Class 1.2: Minimum Intervention
 - Class 1.3: Conservation through active management
 - Class 2: Main Management Objective "Protection of Landscapes & Specific Natural Elements"
 - Class 3: Main Management Objective Protective Functions
- Reporting according MCPFE classes is only done for the SoEF Reports.
- For FOREST EUROPE, FRA and Natura 2000 reporting is done according to different classifications which are not compatible with each other and which entail a high workload for the national correspondents.
- As the SoEF reports present also separate figures for EU countries, it would be of interest to have also the forest area under Natura 2000 in comparison to the overall forest area under a designated protection regime. However, many countries cannot distinguish the forest area from the total area under Natura 2000 protection.
- Private forest areas under contract with organisations/public forest/environmental administrations to not utilize those forest areas and to conduct active nature protection activities are not reported by some countries as the contracts are not publicly (and can therefore also not be reported to the respective EEA database on

protected forest areas as no GIS coordinate can be provided). However, those protected forest areas are considerably large in some countries (e.g. in Austria)

- The available data on protected forest areas do not provide information as to whether all forest ecosystem types are properly covered by the protected forest areas and if forest biodiversity is actually maintained or not.
- In the FE country replies some countries commented on limited effectiveness of biodiversity protection in protected forest areas. It could be considered to additionally elaborate and request a subindicator on effectiveness of biodiversity protection (could also be requested under the qualitative indicator C4).

> **As many countries face problems to report protected areas in consistence with the requested classes it should be considered to use the IUCN approach which is applicable worldwide**, used by FRA, has a strong infrastructure of definitions for reporting and is backing up the World Commission on Protected Areas.

Due to the important of reliable data on protected forest areas for various political instruments, information on protected forest areas can be considered as a key indicator (within the whole set of indicators for SFM).

4.10 Forest birds

» *Occurrence of common breeding bird species related to forest ecosystems*

Birds can act as excellent indicators of trends in the state of nature and sustainability of land use. Birds occur in all habitats, and can reflect trends in ecosystems, other animals and plants, and can be sensitive to environmental changes. Therefore, this indicator is an excellent way to report not only on general trends within forest bird populations, but also allows conclusions on environmental changes.



Instruments	Main forest-related data needs	FE data
Aichi Biodiversity Target 7	Wild Bird Index for specialist forest birds	Available for FE region
Proposal on EU Nature Restoration Law	Common forest bird index	Available for FE region
Draft EU Forest Monitoring Regulation	Abundance of common forest birds	Available for FE region

The available data on a forest bird index presented by the international data provider BirdLife et al. does not allow any conclusions on certain endangered bird species in a certain country but only on the overall status and trend of 34 common European forest bird species

References to information and data needs in international documents:

- The recent SoEF Report (Fig. 5, page 84) shows that forest bird species in the FE region have dropped by only 3%, while farm birds have reduced by 32%. However, the information presented by the international data providers does not allow for national derivations that could show stronger deviations than the average presented.
- The SoEF2020 informs on p. 146 that birds are popular among the public which makes the message of an indicator more compelling as well as suitable for being monitored by citizen science initiatives. However, the list of the 34 common European forest bird species contains only Latin names and is therefore only of information for bird specialists, but not for forest generalists or citizen.
- The number of birds is strongly dependent on the chosen forest management approach; however, it does not “solely” depend on the state of the forest ecosystem. Other influences would be climate change and hunting practice outside forests (e.g. on migrations), or pollution/pesticide use.

> **With regard to the above-mentioned reporting needs of the various EU Instruments it might be good to show that the forest bird index was quite stable in comparison with other indices** of other land-use classes, particularly farmland birds. The information that forest birds are not becoming less common seems important in a way to take birds as a proxy for other animal species which are not as well studied as birds.

Threatened bird species are reported under Ind. 4.8, based on Red List Information which might be linked to the common forest bird species to have a more complete picture on forest birds.

Biodiversity relevant parameters not covered by 4.1-4.10

» *Multi-layer stands*

The occurrence of multi-layer stands can be an important indicator for forest biodiversity as they refer to forests with multiple distinct vegetation layers, such as a canopy layer, understory layer, shrub layer. The different vegetation layers in multi-layer stands provide ecological niches that support a wide array of plant and animal species which adapt to specific light conditions and utilize resources at different heights, enabling a higher level of food resource partitioning and coexistence, nesting sites, cover, and shelter from predators.

References to information and data needs in international documents:

» *Forest management indicators*

Instruments	Main forest-related data needs	FE data
Draft EU Forest Monitoring Regulation	Stand structure	n.a.

The following forest management-related indicators might also be of importance for forest biodiversity:

Forest area under integrative forest management:

Integrative forest management aims to balance ecological, economic, and social objectives in forest management practices and considers biodiversity conservation as a key component. Monitoring the forest area under integrative forest management provides insights into the extent to which sustainable practices are being implemented and can help evaluate their effectiveness in maintaining or enhancing forest biodiversity.

Forest area with special traditional management types like coppice or forest pasture:

Traditional management types, such as coppice systems or forest pastures, often have unique ecological characteristics and support specific biodiversity. These management types may promote the persistence of certain plant and

animal species adapted to these habitats. Monitoring the forest area under such traditional management types helps track their conservation value and the associated biodiversity benefits.

Agroforestry areas: By integrating trees into agricultural landscapes, agroforestry systems create more diverse habitats, and enhance connectivity, contributing also to genetic diversity and ecosystem resilience.

Forest area under clear cutting: The complete removal of all trees has significant impacts on forest biodiversity, including habitat loss, disruption of ecological processes and related species changes. Forest area with (site/non-site-resilient) tree species change after cutting or forest damage: Changes in tree species composition after cutting or forest damage impact biodiversity. The active seeding or planting of site-resilient tree species might be more preferable than natural regeneration of a not (anymore) site-resilient tree species.

Forest area with no intervention: Forest areas with no intervention, including also those without a designated protection (wilderness areas) harbour high levels of biodiversity and ecologically important habitats. Monitoring the forest area with no intervention helps also identify and protect areas with high conservation value.

Close(r)-to-nature forestry: Close(r)-to-nature forestry, also known as continuous-cover forestry, is a management approach that aims to emulate natural forest dynamics and processes in management practices to contribute to habitat preservation, species and genetic diversity and provides a holistic approach to forest management that prioritizes biodiversity maintenance and enhancement.

Monitoring these forest management-related indicators helps assess the impact of different management approaches on forest biodiversity, supports evidence-based decision-making, and facilitates the development of sustainable forest management strategies.

GENERAL RECOMMENDATIONS

Revising and amending the indicators should consider accordance with major policy goals and instruments, including the Global Forest Goals, the SDGs, the Aichi Targets, the Oslo goals and targets, the Global Core Set, SEBI and contribute also to measuring EU targets (if possible even so EU ≠ FE) to ease the national reporting burden, avoiding to monitor and report similar but not the same information. Examples are:

The Global Forest Target 1.3: By 2020, promote the implementation of sustainable management by all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.

Aichi Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

Oslo Goal 5: The loss of forest biodiversity in Europe is halted and degraded forests are restored or rehabilitated which is closely related to the more normative.

Oslo Target 6: The rate of loss of forest biodiversity at habitat level is at least halved and where feasible brought close to zero, and measures are taken to significantly reduce forest fragmentation and degradation and to restore degraded forests. Both Oslo Goal 5 and Target 6 are in line with the **EC 2020 headline target** Halting the loss of biodiversity and the degradation of ecosystems services in the EU by 2020. Goal 5 is also revealed in **SDG 15** Protect,

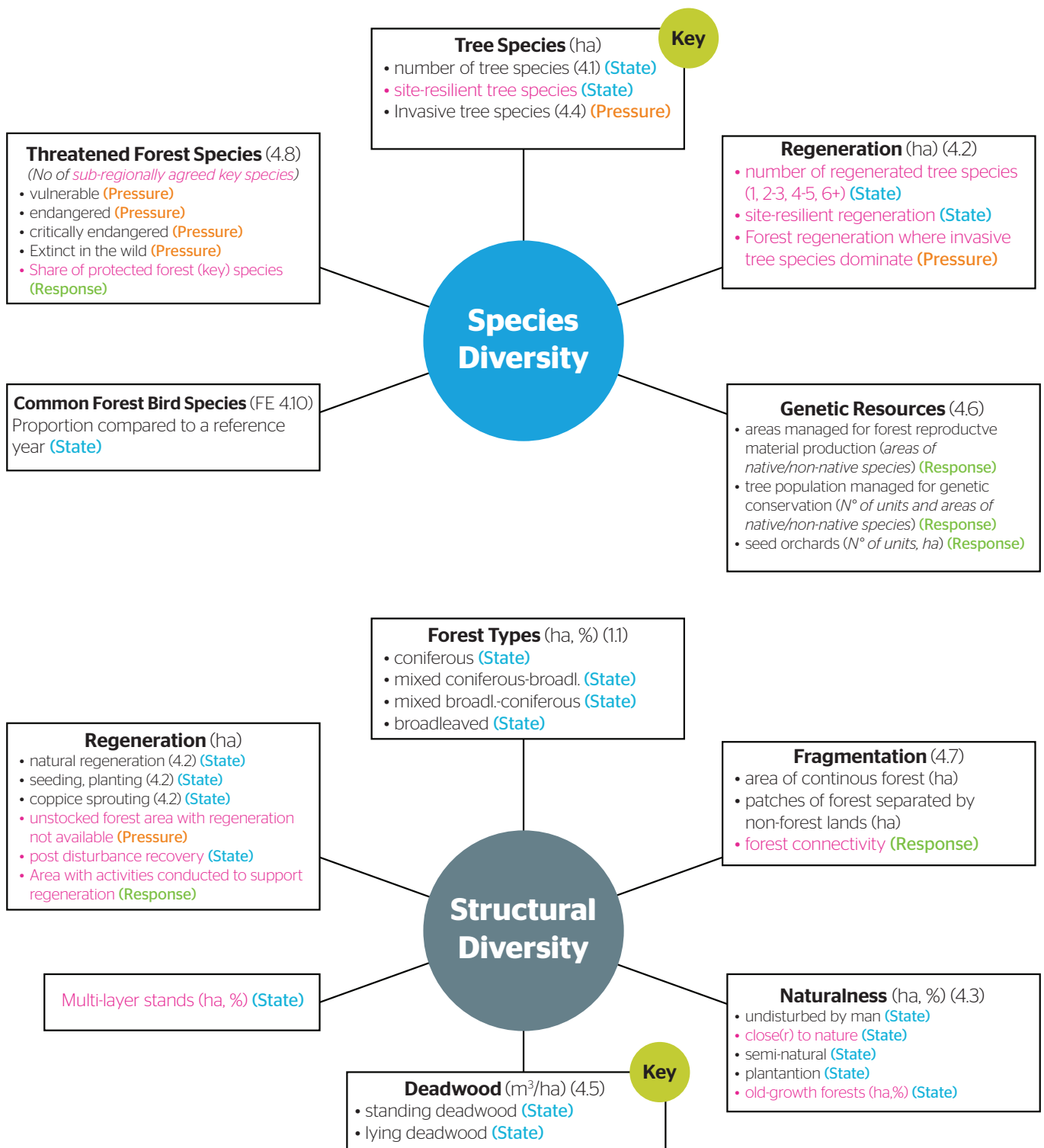
restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and **halt and reverse land degradation and halt biodiversity loss.**

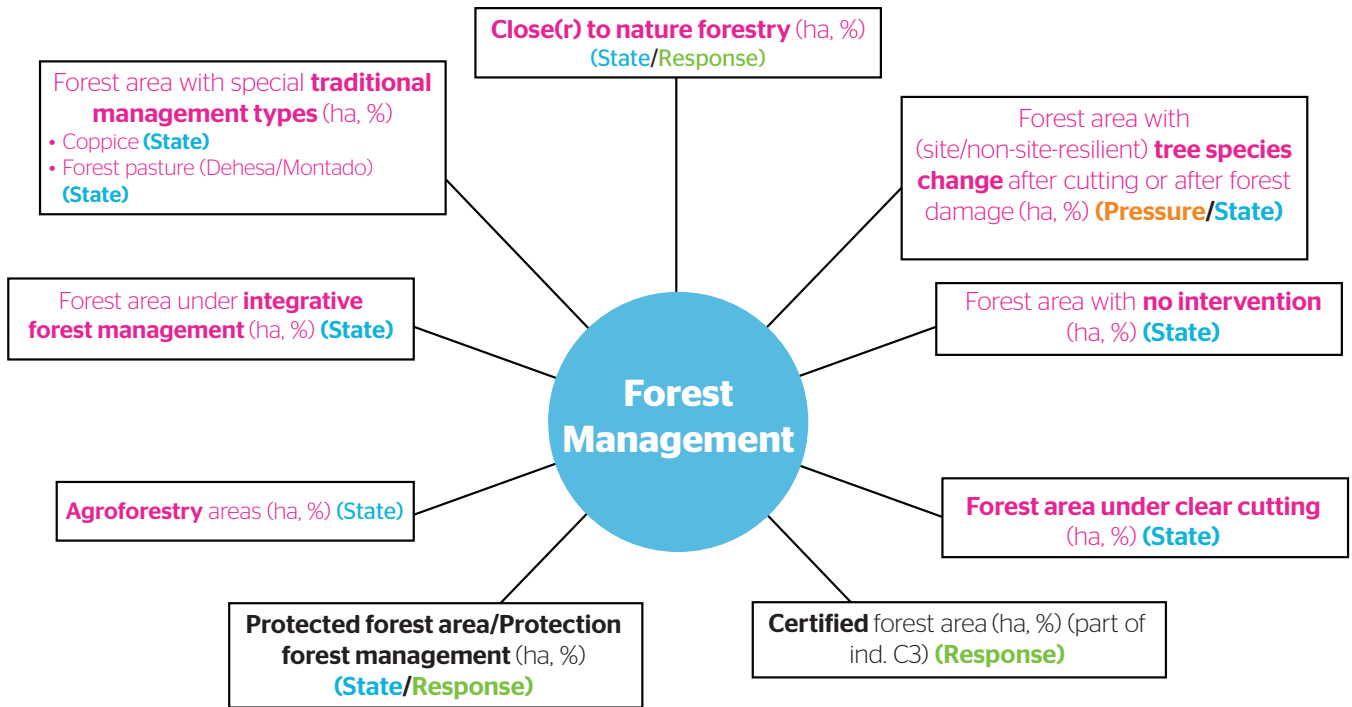
EU Biodiversity Strategy for 2030: strictly protect one third (representing 10% of EU land and 10% of EU sea) of legally protected areas; legally protect a minimum of 30% of land; strictly protect all remaining EU primary and old-growth forests; ensure no deterioration in conservation trends and status of all protected habitats and species by 2030; plant three billion new trees in the EU; integrate ecological corridors as part of a true Trans-European Nature Network to prevent genetic isolation; continue and further develop biodiversity-friendly practices such as closer-to-nature-forestry; strengthen forest genetics conservation and diversity within species and within populations.

The New Forest Strategy for 2030: Protect 30% of EU land area of which 10% strictly; All primary and old-growth forests strictly protected; Common definition for primary and old growth forests and for the strict protection regime; Keep natural processes in primary forests; Ensure all forests sufficiently biodiverse; Essential management practices to support biodiversity and resilience; Caution on management practices which affect biodiversity; No removal of stumps and roots; No logging during bird-nesting period; Restore and reforest better; Secure genetic resources; Guidelines on closer-to-nature forestry; Plant 3 billion additional trees; In public forests strengthen forest protection and restoration efforts.

SUGGESTION FOR FUTURE REPORTING UNDER FOREST EUROPE CRITERION 4: MAINTENANCE, CONSERVATION AND APPROPRIATE ENHANCEMENT OF BIOLOGICAL DIVERSITY IN FOREST ECOSYSTEMS

So far, reporting under Criterion 4 was always based on a description and assessment indicator by indicator, but it seems appealing to also apply the causal presentation model (as introduced above) for the main issues 'Species diversity', 'Structural diversity', 'Forest management' and 'Protected forests' including parameters on **Pressures**, **State**, **Responses**. Examples are presented below. In **pink** are additional/new (sub)indicators where data is so far already available in at least some countries (see information above on the conducted investigation).





OVERVIEW OF EXISTING AND PROPOSED INDICATORS BY PSR CATEGORIES

Potential additional indicators are displayed in pink.

Topic	Issue	Pressure	State	Response	
Species Diversity	Tree Species	Invasive tree species (ha, %)	Number of tree species (1, 2-3, 4-5, 6+)		
			Site-resilient tree species (ha, %)		
	Regeneration	Forest regeneration where invasive tree species dominate (ha, %)	Forest area with certain number of regenerated tree species (1, 2-3, 4-5, 6+) (ha, %)		
			Regeneration with site-resilient species (ha, %)		
	Genetic Resources			Areas managed for forest reproductive material production (<i>native/non-native species</i>) (ha)	
				Tree populations managed for genetic conservation (<i>native/ non-native species</i>) (ha, No of units)	
				Seed orchards (ha, No of units)	
	Threatened Forest Species			No of agreed key species	No of protected forest key species
				No of vulnerable key species	
				No of endangered key species	
No of critically endangered key species					
No of extinct in the wild key species					
Forest Bird Species			Common forest bird species		

Topic	Issue	Pressure	State	Response	
Structural Diversity	Forest Types		Coniferous (ha, %)		
			Mixed coniferous-broadleaved (ha, %)		
			Mixed broadleaved-coniferous (ha, %)		
			Broadleaved (ha, %)		
	Regeneration	Unstocked forest area with regeneration not available		Natural regeneration (ha, %)	Forest area with activities conducted to support natural regeneration (ha, %)
				Planting or seeding (ha, %)	
				Coppice sprouting (ha, %)	
				Post disturbance recovery	
	Naturalness			Undisturbed by man (ha, %)	
				Close(r) to nature (ha, %)	
				Semi-natural (ha, %)	
				Old-growth forests (ha, %)	
				Plantation	
Deadwood			Standing deadwood (m ³ /ha)		
			Lying deadwood (m ³ /ha)		
Fragmentation			Area of continuous forest (ha)	Forest connectivity	
			Patches of forest separated by non-forest lands (ha)		
Vertical structure			Multi-layer stands (ha, %)		

Topic	Issue	Pressure	State	Response
Forest Management	Forest Management	Forest area with non-site-resilient tree species change after cutting or after forest damage (ha, %)	Area and share of forests under clear cutting (ha, %)	Forest areas with site-resilient tree species change after cutting or after forest damage (ha, %)
			Forest area under integrative forest management (ha, %)	
			Area and share of close(r)-to-nature forestry (ha, %)	
			Area and share with no intervention over x years (ha, %)	Certified forest area (ha, %)
			Protection forest management (ha, %)	
			Agroforestry areas (ha, %)	
			Area of forests with special traditional management types (e.g. coppice, forest pastures) (ha, %)	

Topic	Issue	Pressure	State	Response
Protected Forest Areas	Protected Forest Areas			No active intervention (ha, %)
				Minimum intervention (ha, %)
				Conservation through active management (ha, %)
				Protection of landscapes (ha, %)
				N2000 areas in the forest (No, ha)
				Private forest areas under contract for nature protection (ha, %)
				Implementation/Effectiveness of biodiversity protection (Part of FE Ind. C4)

OVERVIEW ON REVISION PROPOSALS BY FOREST EUROPE INDICATORS 4.1-4.10

FOREST EUROPE Status Quo	Forest-related data needs of international Instruments	Proposal to add parameter
<p>4.1 Diversity of tree species</p> <p>➤ <i>Area of forest and other wooded land, classified by number of tree species occurring</i></p> <p>Separate figures to be reported on: Area of forest, other wooded land and total with number of tree species occurring (1; 2-3; 4-5; ≥6)</p>	<p>New EU Forest Strategy for 2030: Diversity of tree species</p> <p>Draft EU Forest Monitoring Regulation: Tree species composition and richness</p>	<p>Site-resilient tree species (ha, %)</p> <p>Shrubs/bushes in the forest (not OWL) (ha, %)</p>
<p>4.2 Regeneration</p> <p>➤ <i>Total forest area by stand origin and area of annual forest regeneration and expansion</i></p> <p>Separate figures to be reported on:</p> <ul style="list-style-type: none"> • Total forest area by expansion and regeneration type: <ul style="list-style-type: none"> • Natural expansion and natural regeneration • Afforestation and regeneration by planting and or seeding • Coppice • Annual forest expansion and regeneration, classified by: <ul style="list-style-type: none"> • Expansion of forest area: Afforestation / Natural expansion <p>Regeneration of forest area: Natural regeneration / Planting and seeding / Coppice</p>	<p>New EU Forest Strategy for 2030: Regeneration</p> <p>EU Biodiversity Strategy for 2030: Regeneration/ afforestation (plant at least 3 billion additional trees)</p> <p>Draft EU Forest Monitoring Regulation: Post disturbance recovery</p>	<p>Forest area with certain number of regenerated tree species (1, 2-3, 4-5, 6+) (ha, %)</p> <p>Forest regeneration where invasive tree species dominate (ha, %)</p> <p>Regeneration with site-resilient species (ha, %)</p> <p>Area with necessary regeneration not available</p> <p>Area with activities conducted to support natural regeneration</p> <p>Post disturbance recovery</p>
<p>4.3 Naturalness</p> <p>➤ <i>Area of forest and other wooded land by class of naturalness</i></p> <p>Separate figures to be reported on: Undisturbed by man, semi-natural, plantation</p>	<p>EU Biodiversity Strategy for 2030: -Primary forests -Old-growth forests</p> <p>New EU Forest Strategy for 2030: -“Close To Nature” (CTN)-compliant forest management -Naturalness</p> <p>Renewable Energy Directive (RED III): Primary and old-growth forests</p> <p>Global Core Set of Forest-related Indicators 5: Change in area of primary forests</p> <p>Draft EU Forest Monitoring Regulation: Location of primary and old-growth forests</p>	<p>Close(r) to nature (ha, %)</p> <p>Old-growth forests (ha, %)</p>
<p>4.4 Introduced tree species</p> <p>➤ <i>Area of forest and other wooded land dominated by introduced tree species</i></p>	<p>Introduced tree species</p>	

FOREST EUROPE Status Quo	Forest-related data needs of international Instruments	Proposal to add parameter
<p>4.5 Deadwood</p> <ul style="list-style-type: none"> ➤ <i>Volume of standing deadwood and of lying deadwood on forest and other wooded land</i> 	<p>New EU Forest Strategy for 2030: Deadwood Revision of the LULUCF- Regulation (2021-2035): Deadwood Draft EU Forest Monitoring Regulation: Deadwood Proposal on EU Nature Restoration Regulation: - standing deadwood - lying deadwood</p>	
<p>4.6 Genetic Resources</p> <ul style="list-style-type: none"> ➤ <i>Area managed for conservation and utilisation of forest tree genetic resources (in situ and ex situ genetic conservation) and area managed for seed production</i> 	<p>EU Biodiversity Strategy for 2030: Forest genetics conservation and diversity New EU Forest Strategy for 2030: Genetic resources SDG 2.5.1: Number of plant and animal genetic resources for food and agriculture secured in either medium or long-term conservation facilities</p>	
<p>4.7 Fragmentation</p> <ul style="list-style-type: none"> ➤ <i>Area of continuous forest and of patches of forest separated by non-forest lands</i> 	<p>EU Biodiversity Strategy for 2030: Forest connectivity Proposal on EU Nature Restoration Regulation: Forest connectivity Draft EU Forest Monitoring Regulation: Forest connectivity</p>	<p>Forest connectivity</p>
<p>4.8 Threatened forest species</p> <ul style="list-style-type: none"> ➤ <i>Number of threatened forest species, classified according to IUCN Red List categories in relation to total number of forest species</i> -vulnerable -endangered -critically endangered -extinct in the wild 	<p>EU Biodiversity Strategy for 2030: Trends and status of all protected species New EU Forest Strategy for 2030: Conservation status of forest species SDG 15.5: Red List Index</p>	<p>N° of sub-regionally agreed key species Share of protected forest key species</p>
<p>4.9 Protected forests</p> <ul style="list-style-type: none"> ➤ <i>Area of forest and other wooded land protected to conserve biodiversity, landscapes and specific natural elements, according to MCPFE categories</i> 	<p>EU Biodiversity Strategy for 2030: Protected areas New EU Forest Strategy for 2030: Protected forest Global Core Set of Forest-related Indicator 4: Proportion of forest area located within legally established protected areas SDG 15.2.1: 3. Proportion of forest area within legally established protected areas Global Forest Target 31: The area of forests worldwide designated as protected areas or conserved through other effective area-based conservation measures is significantly increased Global Forest Goal 3: Increase significantly the area of protected forests worldwide Draft EU Forest Monitoring Regulation: FNAWS</p>	<p>Private forest areas under contract for nature protection (ha, %) Implementation/ Effectiveness of biodiversity protection (Part of FE Ind. C4) Natura2000 areas in the forest (No, ha)</p>

FOREST EUROPE Status Quo	Forest-related data needs of international Instruments	Proposal to add parameter
<p>4.10 Forest birds</p> <p>➤ <i>Occurrence of common breeding bird species related to forest ecosystems</i></p>	<p>Proposal on EU Nature Restoration Regulation: Common forest bird index</p> <p>Draft EU Forest Monitoring Regulation: Abundance of common forest birds</p> <p>Aichi Biodiversity Target 7: Wild Bird Index for specialist forest birds</p>	
<p>Additional indicators</p>	<p>EU Monitoring Proposal: Stand structure</p> <p>SDG 15.2.1: 5. Forest area under independently verified forest management certification schemes</p> <p>Global Core Set of Forest-related Indicator 20: 5. Forest area under independently verified forest management certification schemes</p>	<p>Forest area with non-site-resilient tree species change after cutting or after forest damage (ha, %)</p> <p>Forest area with site resilient tree species change after cutting or after forest damage (ha, %)</p> <p>Conc. Forest Management: Management approach in place (% each type e.g. CTN practices¹⁰, clear cutting, no intervention etc.) OR</p> <p>Area and share of forests under clear cutting (ha, %)</p> <p>Area and share of close(r)-to-nature forestry (ha, %)</p> <p>Protection forest management (ha, %)</p> <p>Area and share with no intervention (ha, %)</p> <p>Agroforestry areas (ha, %)</p> <p>Area of forests with special traditional management types (ha, %)</p>

¹⁰ CTN forest managements practices: retention forestry, continuous cover forestry, selection system etc (Bo Larsen et al, 2022)

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ANNEX 1: ADDITIONAL FOREST BIODIVERSITY RELATED PARAMETERS MONITORED AND REPORTED BY COUNTRIES AND ORGANISATIONS

Table: Next to FE C4 indicators, additional parameters of particular national and international interest

Topic	English	PSR
Ecosystem Diversity	Forest ecosystem (types) (ha, %) (CA, ES, HR, IT, NO, PT, RU, SK, MP)	State
	Area of forest in -wetlands, split forests, floodplain, riparian forests (CA, KZ, LI) -mountain forest (KZ) -desert (KZ)	State
	Status of target habitat types (HR)	State
	Abundance/frequency of habitat trees (GE, DE)	State
	Red List of Ecosystems (CBD)	State
	Species Habitat Index (CBD, GEO BON, UNEP-WCMC)	
	Ecosystem Integrity Index (CBD)	
Species Diversity (4.1)	Endangered shrub species (PT)	Pressure
	Abundance/frequency/cover, composition of shrub layer species (HU, KG, LI, LT, PT, RU, UK)	State
	Tree species abundance/frequency and its proportion in the total forest area (AT, DK, GE, KG, RU) -dominating tree species (%) (PT, RU)	State
	Endemic (tree) species (CY, GE, IT, TR, LFCC, ASEAN)	State
	Proportion of endemic tree species in the total forest area (GE)	State
	Detailed inventories for all forest species (CY)	State
	Population levels of selected forest-associated species (CA, FI, DE, GR, IE, LI, MD, UK) birds, bats, small mammals, vascular plants, herbaceous plants, lichens, insects (beetles, ants, web spiders, beaked spiders, etc.), fungi	State
	Distribution of selected forest-associated species (CA)	State
	Species occasionally present in forest areas (GR)	State
	Target species/ status of target species (priority forest species of conservation interest) (HR, IT)	State
	Native tree species (CY, ES, IE, LI, MD, RU, UK, MP)	State
	Native forest associated species (MP)	State
	Number and status of native forest-associated species at risk (MP)	State
	Area of native species forest stands and area of introduced species forest stands (ratio) (MD)	State
	On site and off site efforts focused on conservation of species diversity (MP)	Response
	Strictly protected forest species (vas-cular flora, mammals, birds, amphibians and reptiles, insect, mushrooms) (HR)	Response
	Onsite and offsite efforts focused on conservation of species diversity (US)	Response
	Woodland bird index (UK, BIP)	
	Forest Species Diversity Index (RU)	
	Species status information index (CBD, GEO BON)	
Species Protection Index (CBD, GEO BON)		
Red List Index of forest dependent species (CBD, IUCN)		
Introduced species 4.4	Types of invasive forest plant species (herbs, shrubs, trees) (AT, PT)	Pressure
	Forest area with dominant exotics (CH)	Pressure
	Rate of Invasive Alien Species Spread Indicator (GEO BON)	Pressure
	Agreement of the municipality to plant non-native tree species (NO)	Pressure
	Funds to combat invasive species (AT)	Response
	Measures to eradicate non-native species (IT)	Response

Genetic Resources 4.6	Number of forest associated species at risk of losing genetic variation (US, MP)	Pressure
	Seed resources (UZ)	State
	Status of on site and off site efforts focused on conservation of genetic diversity of native tree species (CA; MP)	Response
Protected forest areas 4.9	Area of forest by (represented and under-represented) forest ecosystem type in protected areas (CA, MP, ASEAN)	Response
	Extent of protected areas classified according to forest protection classes (national, IUCN or others) (ha) (PT, SK, ASEAN)	Response
	Biodiversity conservation sites in commercial forests (ha) (FI)	Response
	Special biodiversity sites in commercial forests, no forestry measures (ha) (FI)	Response
	Biodiversity sites in commercial forests, restricted forestry use (ha) (FI)	Response
	Natural forest reserves (number, forest area) (AT)	Response
	Private forests: Environmental forestry subsidy agreement for 10 years (FI)	Response
	Incentives/subsidies for forest protection/ Compensation for restrictions to forest management due to protection (CZ, SK, UNEP-WCMC)	Response
	Private forest areas: fixed - term agreement for 20 years (FI)	Response
	(voluntary) Contractual nature conservation (forest area in nature reserves, biosphere reserves, NPs, other) (ha) (AT, SE)	Response
	Private forests: strictly protected (FI)	Response
	Wildlife rest areas with access prohibitions (GR, LI, CH)	Response
	High conservation value forest area (KG, RU)	State
	Special forest areas (targeted interventions with nature conservation objectives allowed, i.e. forests in which old forms of forest management (e.g. middle forest, coppice, forest pastures, etc.), rare plant communities, rare animal or plant species (e.g. orchids) or the currently existing ecological conditions are to be maintained and preserved. (LI, LV)	State
	Forest areas in Natura 2000 areas (AT, CY, ES, HR, HU, IE, LT, NL, PL, PT, SK)	Response
	Natura 2000 conservation status (favourable, unfavourable-inadequat, unfavourable-bad, unknown; Habitat Dir) (AT, EE, IE, IT, SK, UK)	State
	Natura 2000 - use of financial subsidies (AT)	Response
	Tree Nature Monuments (CY, GR, PL)	State
	Areas of settlements in protected forest areas (KG)	Pressure
	Protected area coverage (BIP)	Response
	Protected Area Coverage of Key Biodiversity Areas (BIP)	Response
	Protected Areas Management Effectiveness (CBD, BIP)	Response
	Protected Area Coverage of Ecoregions (BIP)	Response
	Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type (BIP)	Response
	Connectivity of protected forest areas (ProtConn) (BIP, ITTO)	State
	Protected Area Connectedness Index (PARC-Connectedness) (BIP, GEO BON)	State
	Protected Area Representativeness Index (PARC-Representativeness) (BIP, GEO BON)	State
PA buffer zone management (ITTO)	State	
Forest Management	Area and share of forests under clear cutting (EE, PT)	Pressure
	Forest area with tree species change after cutting (NO)	Pressure OR Response
	Area of forests not managed in clear cutting system (Shelterwood, Selection system, transition system, continuous cover etc. (EE, HU, NO, SE)	Response
	Area and share of close-to-nature forestry (HU, PT)	Response
	Forest area without forestry interventions for more than 50 years (CH)	Response
	Forest area with biodiversity as the primary management objective (DK, IE)	Response
	Forest area under integrated forest management (KG)	Response
	Area of forests with special traditional management types (coppice, ...) (AT, DK, LI, NO)	State

Forest Management	Agroforestry areas (ES, IT)	State
	Area of forests with forest pastures (KG)	Pressure
	Certified forest areas under sustainable management with verified impacts on biodiversity conservation (FSC reports every 5 years on this) (CBD, GCS)	Response
	Certified forest areas under sustainable management with verified impacts on habitat conservation/restoration (FSC reports every 5 years on this)	Response
	Management plans for native woodlands (IE)	Response
	Threat Response Plans (for threats to biodiversity) (IE)	Response
	Area of protected or environmentally constrained forests managed by forest management plans by degree of protection (IT)	Response
Regeneration 4.2	Plantings of native tree species (IL)	State
	Planting of native broadleaved tree species (IE, IL)	State
	at least 10% of broadleaved trees in regenerations are saved (NO)	State
	Status of rowan, aspen, willow and oak in young forest (SE)	State
	Tree species diversity of regeneration (DE, SK)	State
	Naturally difficult-to-stock areas (LI)	Pressure
	Proportion of lightly stocked areas (LI)	Pressure
	Activities carried out to support natural regeneration of forests (AM)	Response
	Proportion with competition of trees and plants (LI)	Pressure
	Area of regeneration with invasive tree species (NL)	Pressure
	Area of new woodland planted (Reforestation) (ES, NO, UK)	Response
	Anthropogenic areas difficult to stock (LI)	Pressure
	Area of mechanical and manual site preparation in the State forests (for planting or seeding mainly after forest fires) (CY)	Pressure
Forest structure	Structure of forest stands classified according to number of layers (vertical structure) and stem distribution (horizontal structure) (CZ, GE, LI, LT)	State
	Area and share of old growth forests (starting from various years) (BG, CH, GE, IE, IL, IT, LI, LT, LV, MD, NL, NO, PT, RU, SE, SK)	State
	- Forest area with vital giant trees (various BHD) (LI, LT, CH, SE)	
	-- No of giant trees BHD >80 cm (CH)	
	- Forest area beyond the age of exploitability / over mature (MD, RU)	
	- Broadleaved, conifer, mixed (ha) (LI, SE)	
	Forest edge (structure, width, density, diversity) (CZ, LI)	State
	- with more than 10 woody species (CH)	
	Open space within the forest (ha) (target: 5-10%) (IE)	State
	Unproductive forest areas (ha, %) (SE)	State
	Fragmentation (AT FR, IT, RO, TR, US)	Pressure
	Nature areas if 1-5 km away from roads, wilderness area if more than 5 km away from roads (NO)	State
	Habitat connectivity (UK)	State
	Maintenance and restoration of connectivity of natural ecosystems (CBD)	Response
	Forest Fragmentation Index (CBD)	
Forest Structure Index (DE)		
Stand Density Index (CH)		
Naturalness (4.3)	Hemerobie stages: artificial, heavily modified, semi-natural, close-to-nature, natural (AT)	Pressure
	Areas of primary/untouched/pristine forests (AT, NO, PT, RU)	State
	Naturalness of tree species composition:	State
	- natural, close-to-nature, deviating from the potential natural vegetation (AT)	
	- Native, Near native & fragments, Non-native (woodland TYPES) (UK)	
Native forests (native tree species) (ha, %) (CY, ES, IE, LI, MD, RU, UK)	State	
	Share of forest areas with forest stands not corresponding to the growing conditions (usually strongly degraded) (MD)	Pressure
	Cleaning of branches and wood residuals from streams and paths (NO)	Pressure
	Forest area encumbered by civic and collective uses (IT)	Pressure
	Trees with caves, hollow trunks, broken crowns (LI, LV)	State
	Trees with lichens (ha, %) (NO)	State
	Landscape characteristics (CZ)	State

	Public financial resources allocated to the protection and monitoring of forest biodiversity by financial instruments (IT)	Response
	Public financial resources allocated to conserve and improve the structural, functional, ecological, landscape diversity, complexity of the forest by financial instruments (IT)	Response
	Expenses for scientific studies on flora, fauna, soil, coenosis, ecosystems, etc. (IT, KG)	Response
	Expenses for scientific research for the conservation of biodiversity (KG)	Response
	Forest area undergoing projects aimed at increasing ecological structural and functional complexity (IT)	Response
	Forest area subjected to projects aimed at increasing the landscape value of forests (IT)	Response
	Ecological network management plans (HR)	Response
	Restoration of forest borders after logging (NO)	Response
	Maintenance of a tree border next to peatlands and waters (5-10 m with no logging) (NO)	Response
	Biodiversity Intactness Index (CBD)	

Country	Country code
Albania	AL
Armenia	AM
Austria	AT
Belarus	BY
Belgium (Wallonia)	BE
Bulgaria	BG
Croatia	HR
Cyprus	CY
Czech Republic	CZ
Denmark	DK
Estonia	EE
Finland	FI
France	FR
Georgia	GE
Germany	DE
Greece	GR
Hungary	HU
Iceland	IS
Ireland	IE
Israel	IL
Italy	IT

Kazakhstan	KZ
Kyrgyzstan	KG
Latvia	LV
Liechtenstein	LI
Lithuania	LT
Luxembourg	LU
Malta	MT
Moldova	MD
Montenegro	ME
Netherlands	NL
Norway	NO
Poland	PL
Portugal	PT
Russia	RU
Serbia	RS
Slovakia	SK
Slovenia	SI
Spain	ES
Sweden	SE
Switzerland	CH
Turkey	TR
United Kingdom	UK
Ukraine	UA

Processes	Abbreviation
Montreal Process	MP
Low-Forest-Cover-Countries	LFCC
Association of South East Asian Nations	ASEAN
Internationale Timber Trade Organization	ITTO
Low-Forest-Cover-Countries Process	LFCC
Association of Southeast Asian Nations	ASEAN
Convention on Biological Diversity	CBD
Biodiversity Indicators Partnership	BIP



ANNEX 2: GLOBAL CORE SET INDICATORS AND SDG INDICATORS IN RELATION TO FOREST EUROPE INDICATORS

Global Core Set Indicators	SDG Indicators	FE Indicators	Comments
1 Forest area as a proportion of total land area	15.1.1: Forest area as a proportion of total land area	1.1 Forest area	GCS and SDG Ind can be displayed by FE data
None	15.2.1: Progress towards sustainable forest management	None	Whole set relevant, but impossible at present to combine indicators (SDG has a "dashboard"). The various sub indicators are listed below.
2 Annual forest area change rate	15.2.1 sub ind: Annual forest area change rate	1.1 Forest area	GCS and SDG Ind can be displayed by FE data
8 Aboveground biomass stock in forest	15.2.1 sub ind: Above-ground biomass in forest	1.2 Growing stock	GCS and SDG Ind can be displayed by FE data
3 Net greenhouse-gas emissions (source)/removals (sink) of forests, and carbon balance of harvested wood products	none	None	No FE data collection on GHG emissions This indicator has various data sources. Developed countries report national historical anthropogenic LULUCF GHG emissions and removals as part of the LULUCF component of national GHG inventories (GHGIs) or in biennial reports and national communications, which are submitted periodically to the UNFCCC (Source, FAO, 2022 Status and Trends of the GCS ind)
4 Proportion of forest area located within legally established protected areas	15.2.1 sub ind: Proportion of forest area within legally established protected areas	4.9 Protected forests	GCS and SDG Ind can be displayed by FE data
5 Change in area of primary forests	none	4.3 Naturalness	FE uses term "Undisturbed by man". Trends are not very sure because of definition changes.
None	2.5.1 Number of plant and animal genetic resources for food and agriculture secured in either medium or long-term conservation facilities	4.6 Genetic resources	Tree genetic resources part of the SDG Ind can be displayed by FE data
6 Proportion of forest area disturbed	none	2.4 Forest damage	Issues of monitoring disturbance/damage in FE and GCS
7 Area of degraded forest	15.3.1 Proportion of land that is degraded over total land area	2.5 Forest land degradation	SOEF 2020: "missing data render quantitative analysis impossible" FRA 2020: Fifty-eight countries, representing 38 percent of the global forest area, reported that they monitor the area of degraded forest. Only seven were from Europe. (Source: FRA 2020, Table 78).
9 Volume of wood removals	none	3.1 Increment and felling	Fellings and removals not the same
10 Share of wood-based energy in total final energy consumption	Part of 7.2.1 Renewable energy share in the total final energy consumption	6.9 Wood energy (Share of wood energy in total primary energy suppl)	FE focus on of wood in total primary energy supply, GCS and SDI Ind. focus on consumption. Both supply and consumption are relevant. SDG data for EU via Eurostat available The draft EU Forest Monitoring Regulation proposes "Forest biomass for bioenergy" which could be a more expressive alternative for FE 6.9
11 Forest area with a designated management objective to maintain and enhance its protective functions	none	5.1 Protective forests	FE "designated to prevent soil erosion, preserve water resources" (no mention of "management objective")
12 Employment related to the forest sector	none	6.5 Forest sector workforce	Employment ≠ Workforce

Global Core Set Indicators	SDG Indicators	FE Indicators	Comments
none	8.8.1 Frequency rates of fatal and non-fatal occupational injuries, by sex and migrant status	6.6. Occupational safety and health	SDG data for EU via Eurostat available
none	8.4.2 Domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP 12.c.1 Amount of fossil-fuel subsidies per unit of GDP (production and consumption) and as a proportion of total national expenditure on fossil fuels	6.7 Wood consumption	SDG data for EU via Eurostat available
13 Number of forest-dependent people in extreme poverty	1.1.1 Proportion of population below the international poverty line, by sex, age, employment status and geographical location (urban/rural) 1.2.1 Proportion of population living below the national poverty line, by sex and age 1.2.2 Proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions	None	Missing concepts: "Forest dependent" (in Europe, might include owners + workforce?) and "extreme poverty" SDG data for EU via Eurostat available
14 Contribution of forests to food security and nutrition	none	3.3 Non-wood goods	The New EU Forest Strategy for 2030 recognizes the role of forests in supporting food security and nutrition.) Data on Non-wood goods is in some countries available
15 Financial resources from all sources for the implementation of sustainable forest management	15.b.1 Official development assistance and public expenditure on conservation and sustainable use of biodiversity and ecosystems	None	Relevant information might be found in the qualitative indicators, especially 4 Financial and economic instruments (although "instruments" are quite different from "resources")
16 Existence of national or subnational policies, strategies, legislation, regulations and institutions which explicitly encourage sustainable forest management	none	Qualitative indicators Forest policy and governance	FE is more descriptive, while GCS need a Yes/No answer
17 Existence of national or subnational forest assessment process	none	Not a defined indicator, but this information is supplied in the questionnaire	The ECE/FAO/FE enquiries have always requested a lot of detail on the source of the data
18 Existence of national or subnational stakeholder platform for participation in forest policy development	none	1 National Forest programme or equivalent	NFPs by definition involve stakeholders. Should this be made explicit in the title of the indicator
19 Proportion of forest area under a long-term forest management plan	15.2.1 sub ind: Proportion of forest area with a long-term management plan	Part of C.3: Policies, institutions and instruments to maintain and encourage the productive functions of forests	It is reported in the SoEF2020, see Indicator C.3: and Table 57
20 Forest area under an independently verified forest management certification scheme	15.2.1 sub ind: Forest area under an independently verified forest management certification scheme	Part of C.3: Policies, institutions and instruments to maintain and encourage the productive functions of forests	from FSC/PEFC (problem of double counting). It is reported in the SoEF2020, see Indicator C.3: and Table 58
21 Existence of traceability system(s) for wood products	none	None	Reported in the Global FRA 2020