Dynamic conservation and utilization of forest tree genetic resources

Indicators for \textit{in situ} and \textit{ex situ} genetic conservation and forest reproductive material

François Lefèvre, Ricardo Alia, Kjersti Bakkebø Fjellstad, Lars Graudal, Silvio Daniele Oggioni, Mari Rusanen, Giovanni Giuseppe Vendramin, Michele Bozzano
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European Forest Genetic Resources Programme (EUFORGEN) is an instrument of international cooperation promoting the conservation and appropriate use of forest genetic resources in Europe. It was established in 1994 to implement Strasbourg Resolution S2 adopted by the first Ministerial Conference of the FOREST EUROPE process, held in France in 1990. EUFORGEN also contributes to implementation of other FOREST EUROPE commitments on forest genetic resources and relevant decisions of the Convention on Biological Diversity (CBD). Furthermore, EUFORGEN contributes to the implementation of regional-level strategic priorities of the Global Plan of Action for the Conservation, Sustainable Use and Development of Forest Genetic Resources (GPA-FGR), adopted by the FAO Conference in 2013. The Programme brings together experts from its member countries to exchange information and experiences, analyse relevant policies and practices, and develop science-based strategies, tools and methods for better management of forest genetic resources. Furthermore, EUFORGEN provides inputs, as needed, to European and global assessments and serves as a platform for developing and implementing European projects. EUFORGEN is funded by the member countries and its activities are mainly carried out through working groups and workshops. The EUFORGEN Steering Committee is composed of National Coordinators nominated by the member countries. The EUFORGEN Secretariat is hosted by the European Forest Institute (EFI). Further information on EUFORGEN can be found at www.euforgen.org.

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Developed and endorsed by Forest Europe, indicator 4.6 on genetic resources of the pan-European criteria and indicators for sustainable forest management¹ is a functional tool to assess and support the conservation of forest genetic resources (FGR) at the pan-European level.

Since 2003, the European Forest Genetic Resources Programme (EUFORGEN) has been responsible for collecting and presenting data on the conservation status of forest genetic resources for the State of Europe’s Forest (SoEF) report under indicator 4.6.

Until 2015, European countries were reporting the number of hectares managed for the conservation and utilisation of forest tree genetic resources, across a network of Genetic Conservation Units (GCUs) and area managed for seed production.

At its 11th meeting (November 2015), the EUFORGEN Steering Committee noted that an assessment based on the number of hectares was not appropriate for evaluating status and progress of FGR conservation in Europe and for monitoring changes. They argued that the indicator in use did not give information about the amount of genetic diversity conserved within each country or about the added contribution of within-country conservation units to the overall genetic diversity conserved at the pan-European scale. Moreover, the information on genetic resources was not harmonised among countries; therefore, it was not possible to assess the conservation of FGR in Europe as a whole.

In 2015, the Steering Committee decided to revise indicator 4.6 so that a proper assessment of the conservation of forest genetic resources could be carried out at pan-European level. A Working Group (the authors of this report) was subsequently established to undertake the work.

¹ https://foresteurope.org/sfm-criteria-indicators2/
The Working Group presented a first version of the revised indicator to the Steering Committee at its 12th meeting in May 2017. The National Coordinators provided suggestions and recognised the impossibility at that time of formulating the component of the indicator which would assess “static ex situ conservation”. They agreed that this component could be developed in due course, in collaboration with the wider plant genetic resources community.

The working group finalised the report in 2017 and opened it to a wider group of experts within the EUFORGEN community for comments. In particular, we acknowledge the contributions received from Kristel Järve (Estonia) and Jutta Buschbom (Germany) who provided constructive feedback on the revised approach.

At its 13th meeting in June 2018, the Steering Committee endorsed the revised indicator as formulated by the Working Group. The Chair of the Working Group, in consultation with Working Group members, incorporated the received feedback.

The draft revised indicator was presented by the EUFORGEN Secretariat at the Second meeting of the Advisory Group - in preparation for the State of Europe’s Forests Report 2020 - on 21 and 22 November 2018, in Vienna, Austria, where it was unanimously welcomed.

During the 14th meeting of the Steering Committee (April 2019), the EUFORGEN Secretariat gave a demonstration of the possible assessment of FGR conservation in Europe based on the revised indicator. All member countries and associated countries received data extracted from the EUFGIS information system for revision from the Secretariat. The compiled data was used as a basis for reporting to FOREST EUROPE for the SoEF 2020.

The process described in this page covers five years, but that which led to the formulation of this revised indicator started 25 years ago, as soon as EUFORGEN was established. This is a story of mutual capacity building between countries and of creating common understanding among scientists; a process which has led to the development of the pan-European conservation strategy and its implementation throughout Europe, with the contribution of scientist, practitioners and policy makers involved in EUFORGEN activities.

The revision of this indicator is a successful example of pan-European collaboration: from now on, it will be possible to make a very precise and sound assessment of the real situation in forest genetic conservation in Europe and to monitor any progress in sustainable forest management.

Michele Bozzano, EUFORGEN Coordinator,
February 2020
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Within the Forest Europe set of indicators, the proposed revised indicator 4.6 (Genetic resources) aims to support forest genetic resources (FGR) conservation strategies at the pan-European level. It is based on common standard indexes provided at national levels and comprises verifiers in order to quantify the conservation efforts and assess the conservation strategies in multiple dimensions.

These verifiers are designed to serve a specific function and, as presented here, are **not recommended** for other purposes. In particular they should not be used for:

- **Evaluating (or monitoring) priorities in the national conservation strategies.** The verifiers provide a common standard assessment of the overall achievements in FGR conservation scaling for each axis of the strategy. They must therefore be considered jointly and not independently (to improve the achievements, the countries may decide to prioritise efforts in one or the other direction);

- **Evaluating individual national strategies based on high resolution environmental zoning or specific genetic information.** In such cases, additional verifiers providing more detailed insight are needed, using the most appropriate information for the given country (e.g., using higher resolution environmental zoning or taking into account additional levels of genomic information).

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2 https://foresteurope.org/sfm-criteria-indicators2/
A set of Criteria and Indicators (C&I) for sustainable forest management was adopted by the Forest Europe process as a tool to aid forest policy formulation and decision making, forest monitoring and communication. Six criteria reflect complementary aspects of sustainable forest management in the pan-European region. These are currently being assessed (2019) by a set of 34 quantitative and 11 qualitative indicators.

Indicator 4.6 is a quantitative indicator which contributes to Criterion 4 (Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems) by focusing on the conservation and use of genetic resources. Between 2016 and 2019 the indicator was revised by a working group established by the EUFORGEN Programme, with the aim of addressing a number of shortcomings in the existing system.

The report, Revised indicator on genetic resources (4.6) of the pan-European criteria and indicators for sustainable forest management, addresses the reasoning behind the revision of the indicator and provides details regarding its composition and the reporting of conservation efforts linked to each of the sub-indicators.

The revised indicator comprises four sub-indicators:
1. **Dynamic conservation (in situ and ex situ) of native species populations**;
2. **Dynamic conservation (ex situ) of populations of non-native species**;
3. **Static ex situ conservation**;
4. **Forest reproductive material production**;

resulting in informative and comparable verifiers and therefore an improvement in its overall reliability, robustness and resolution. Temporal monitoring of progress made can be carried out using EUFORGEN’s synthetic radar chart representation.
To ensure the effective use of the revised indicator, the working group gives a number of recommendations:

• EUFORGEN member countries should continue to implement and further develop the Pan-European strategy for genetic conservation of forest trees.

• Through the EUFORGEN Programme, member countries should work together to develop an agreed set of “minimum requirements” for static ex situ conservation.

• Countries should support the development of the national lists of native tree species occurring in each country.

With over twenty years of experience in FGR conservation and ten years in managing the EUFGIS information system on in situ conservation units of FGR in Europe, EUFORGEN can guarantee the reliability, specificity, relevance and usefulness of the revised indicator and sub-indicators, which come with a set of more precise definitions and standard scales.
INTRODUCTION

A set of Criteria and Indicators (C&I) for sustainable forest management was adopted by the Forest Europe process as a tool to aid forest policy formulation and decision making, forest monitoring and communication. Six criteria reflect complementary aspects of sustainable forest management in the pan-European region. These are currently being assessed (2019) by a set of 34 quantitative and 11 qualitative indicators.

The quantitative indicators provide information on the current status and changes in European forests and can be used to monitor progress in sustainable forest management. Via a range of means (policies, institutions, regulatory and financial instruments, information), the changes reported in the qualitative indicators over time reflect the responses of policy-makers to challenges and opportunities related to forests and sustainable forest management.

Criterion 4 describes the “Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems.”

It is evaluated using ten quantitative indicators and one qualitative indicator. Indicator 4.6, a quantitative indicator which focuses on genetic resources, is justified as follows: “The conservation and use of forest genetic resources is a vital component of sustainable forest management. Genetic diversity ensures that forest trees can survive, adapt and evolve under changing environmental conditions. Genetic diversity is also needed to maintain the vitality of forests and cope with pests and diseases” (State of Europe’s Forests 2015).

Until now, indicator 4.6 has consisted of three sub-indicators: the area managed for in situ conservation, the area managed for ex situ conservation and the area managed for seed production. European countries have been reporting the area in hectares managed for the conservation and utilisation of forest tree genetic resources and the area managed for seed production.

Reliable, informative and robust verifiers, which provide sufficient resolution, are needed in order to evaluate the current state of the indicator and its sub-indicators. However, we do not consider the assessment based on the number of hectares to provide a sufficiently infor-
mative means of evaluating the status of Forest Genetic Resources (FGR) in Europe, nor of monitoring progress towards their conservation. This is because it provides no indication of the fraction of genetic diversity conserved within each country, nor of the contribution that within-country conservation units make to the overall genetic diversity conserved at the pan-European scale. It also does not provide a sufficient measure with which to assess progress over time in the conservation of genetic diversity. Moreover, the analysis of current information reveals a lack of harmonisation among countries regarding the type of genetic resources included, due to which a meaningful comparison cannot be obtained.

In order to address the above-mentioned shortcomings in the current system, a working group has been established by EUFORGEN to revise the indicator on genetic resources conservation and use. On the basis of over twenty years of experience in FGR conservation and ten years in managing the EUFGIS information system on in situ conservation units of FGR in Europe, EUFORGEN guarantees that the revised indicator and sub-indicators are reliable, specific, simple, relevant and useful. They come with a set of more precise definitions and standard scales.

It is generally recognised that using a single numeric value for each country will not result in a comprehensive assessment. We therefore propose that the indicator be composed of a set of four sub-indicators corresponding to four simple values. In addition, our synthetic radar chart representation illustrates the indicator globally, thereby allowing temporal monitoring of progress to be made per country and species, as well as at the continental level.

In order to obtain a meaningful comparison of different strategies among countries or species, and to monitor progress, the sub-indicators are expressed as ratios whenever possible; values range between 0 and 1, where 0 means no conservation activities in the area and 1 means fully achieved conservation activity in the area.

Data on three of these four sub-indicators can be retrieved retrospectively as far back as 2010 from the EUFGIS database.
The rationale behind the revised indicator 4.6 on the conservation and use of forest genetic diversity remains unchanged. However, it comprises four, rather than three, sub-indicators in order to improve reliability and specificity, and, more precisely, to capture, distinguish and represent the different components of genetic resources. This results in more informative and comparable verifiers, and therefore an improvement in the overall reliability, robustness and resolution (specificity and sensitivity) of the revised indicator.

The four sub-indicators are as follows:
1. Dynamic conservation *(in situ and ex situ)* of native species populations
2. Dynamic conservation *(ex situ)* of non-native species populations
3. Static *ex situ* conservation
4. Forest reproductive material production

In order for conservation efforts to be assessed and monitored, all countries will report species data in two ways: first, across species per country and, second, across countries per species at continental level.

The EUFORGEN National coordinators, via the EUFGIS Focal Points\(^4\), are responsible for reporting conservation efforts regarding native and non-native species that occur in their respective countries. Native species populations are local populations of species which are officially recognised as part of the natural flora of the country and which have evolved locally through at least one generational turnover. They can be conserved *in situ*, i.e., at their place of origins, or *ex situ*, i.e., a representative sample of individuals is transplanted to another site within the country or to another country. Non-native species populations relevant to the purpose of this indicator are either those that were introduced from exotic species to Europe or those that are non-native in the country, which have undergone at least one generational turnover of *in situ* natural regeneration.

The reference list of priority species for which conservation is monitored is presented in Annex 1 and will be made available via the EUFGIS portal.

**Dynamic conservation of populations of native forest tree species (including *in situ* and dynamic *ex situ*) as genetic resources**

Comprehensive data on genetic diversity and its pattern of distribution across European forests is only available for a very limited number of species. To com-

\(^4\) [http://portal.eufgis.org/data-providers](http://portal.eufgis.org/data-providers)
pensate for this lack of knowledge, we have made the following assumptions: local adaptation is a general feature in tree populations (Savolainen et al., 2007) and where native species occur naturally, their adaptive genetic diversity is likely to reflect the ecological conditions in which they grow. Efforts should therefore be made to conserve representative populations of each native species, as well as selected non-native species and ex situ populations which are present in each environmental zone. This should be done by following the Pan-European strategy for genetic conservation of forest trees set out by de Vries et al. (2015).

To use this proxy for sub-indicators 1 and 2 (dynamic conservation) appropriately, each country has to provide

the number of native species and environmental ecological zones within each species distribution area, as well as information about their potential adaptive characteristics. De Vries et al. (2015) defined a modified classification of the environment in Europe based on Metzger et al. (2013). The modified classification consists of a total of eight environmental zones for Europe.

The list of environmental zones for each country is provided in Annex 2.

The Pan-European strategy for genetic conservation of forest trees defines a classification and assessment approach to genetic conservation activities based on political borders and environmental zones in each country. This allows each genetic conservation unit in a given country to

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**TABLE 1.** Definitions of the verifiers related to the dynamic conservation of native populations of forest tree species as genetic resources.

<table>
<thead>
<tr>
<th>Value or verifiers</th>
<th>Definition</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic conservation effort <em>(nb_populations)</em></td>
<td>total number of conserved populations in Genetic Conservation Units (GCU) in the country</td>
<td>This value is important for monitoring conservation activities at national level, since it is not influenced by pan-European classification and prioritisation</td>
</tr>
<tr>
<td>Species diversity index <em>(ind_species)</em></td>
<td>number of species listed as target species in genetic conservation units / number of priority species occurring within the country</td>
<td>The index is calculated based on the priority species listed in Annex 1, occurring in the country</td>
</tr>
<tr>
<td>Ecozones diversity index <em>(ind_ecozones)</em></td>
<td>number of ecozones represented in the national conservation network / number of ecozones occurring within the country* (summed over conserved species only)</td>
<td>The index is calculated based on the species conserved in the country and the existing environmental zones per species in the country.</td>
</tr>
<tr>
<td>Insurance index <em>(ind_insurance)</em></td>
<td>number of ecozones represented in the conservation network with a minimum number of 2 units / number of ecozones occurring within the country* (summed over conserved species only)</td>
<td>The index is calculated based on the species conserved in GCUs in the country and the existing environmental zones in the country.</td>
</tr>
</tbody>
</table>

* In a first round, the number of ecozones occurring in each country will be automatically computed by overlaying species distribution maps and environmental zones. Artifactual ecozones which could result from automatic GIS computation will be progressively removed based on national expertise.
be classified in terms of its membership of an environmental zone on the basis of its location on the map in Figure 1.

In order to properly assess the dynamic conservation of forest tree genetic resources derived from native species populations, countries should report four verifiers:

- Dynamic conservation effort ($nb\_populations$).
- Species diversity index ($ind\_species$).
- Ecozones\(^5\) diversity index ($ind\_ecozones$).
- Insurance index ($ind\_insurance$).

Retrospective data to report on this sub-indicator are available as far back as 2010 in the EUFGIS information system. An example is provided in Annex 3.

**Dynamic conservation of populations of non-native forest tree species as genetic resources**

Non-native populations (i.e., introduced populations that have had at least one generational turnover in natural regeneration in the country), have had little time to evolve in their current locations, even when occurring in several environmental zones. Nevertheless, these populations may have particular characteristics and contain valuable genetic resources; both local adaptation and random genetic evolution are presumed for these populations (both evolutionary forces always co-exist, but in this short-term evolutionary timescale, we expect random evolution to have an important role and structuration of genetic diversity by ecozones not to be fully achieved). Therefore, while the conservation effort of non-native species is to be recognised, only the total number of conserved populations must be reported by each country.

Countries will report the following verifier:

- Number of dynamic conservation populations of non-native species ($nb\_units\_non\_native$).

Retrospective data to report on this sub-indicator are available as far back as 2010.

An example is provided in Annex 4.

**Static ex situ conservation**

Static ex situ conservation efforts will be reported as the number of collections, which include clonal archives and genebank collections meeting minimum requirements. Data will be reported for native and non-native species.

Countries will report the following verifier:

- Number of collections (including clonal archives and genebank collections meeting the minimum requirements).

\(^5\) “Ecozones” are in this context defined as the different environmental zones where the different species occur in each country (e.g., two species that occur in two and four environmental zones respectively represent a total of six ecozones).
To date, November 2019, it has not been possible to formulate the minimum requirements for static *ex situ* conservation. The EUFORGEN programme is undertaking a consultative process that aims to define these requirements. Until this is completed, countries will not report on static *ex situ* conservation in the framework of this indicator.

**Potential for the production of Forest Reproductive Material**

Forest Reproductive Material (FRM) can consist of fruits, seeds and cones, as well as all parts of plants obtained by vegetative propagation, including embryos, and plants produced from any of these. For those species that are regulated under council directive 1999/105/EC, marketable reproductive material has to come from registered basic material.

There are four categories of reproductive material according to the Basic Material from which it is derived:

- **Source-identified** FRM comes from basic material which is either a seed source or stand located within a single region of provenance, with no recognised superior qualities.
- **Selected** FRM comes from registered stands which are selected based on their superior phenotypic characteristics, e.g., better form, growth rate, health.
- **Qualified** FRM comes from designed populations (seed orchards, parents of families, clonal mixtures) or clones, where the individuals have been phenotypically selected for their outstanding characters.
- **Tested** FRM comes from designed populations where the components have been genetically evaluated and proven to be superior. Alternatively, the superiority of the reproductive material itself may be shown through comparative testing.

Countries will report the following verifiers:

- Total number of FRM production units (for each of the 4 categories).
- Total number of species for which there is at least one FRM production unit.

Data will be reported for all species for which there are available data. In the European Union, for the 48 species listed in Annex 1 of the COUNCIL DIRECTIVE 1999/105/EC of 22 December 1999 on the marketing of forest reproductive material (cp. Annex 1), specific recording is required; for other non-listed species there may be additional ongoing recording in individual countries. These will all be reported per species.

Retrospective data to report on this sub-indicator are available as far back as 2015 in the FOREMATIS Information system, but countries have been collecting and reporting using this approach since 1999.

An example is provided in Annex 5.
Data for populating the indicator can be obtained from existing information systems, databases and national registers. For example, information on species and country in situ and ex situ efforts can be retrieved from the EUFGIS information system, while information on forest reproductive material production is available from the FOREMATIS information system.

**EUFGIS Information System (sites managed for the conservation of forest tree genetic resources)**

Since the establishment of the European Information System on Forest Genetic Resources (EUFGIS) in 2010, European countries have started to follow the “pan-European minimum requirements for dynamic genetic conservation units of forest trees” for the data reported as “area managed for in situ conservation”.

The minimum requirements are based on the concept of dynamic conservation of genetic diversity, which emphasises the maintenance of evolutionary processes within tree populations to safeguard their potential for continuous adaptation. The units entered into the EUFGIS database have a designated status as genetic conservation areas of forest trees at national level. The minimum requirements also specify a minimum size of a unit, depending on tree species and conservation objectives. The management of the units aims to maintain and enhance the long-term evolutionary potential of tree populations. This means that management measures and silvicultural techniques are applied as needed, to reduce genetic erosion and enhance adaptive processes within target tree populations.

The EUFGIS information system is regularly maintained by National Focal Points in European countries. On 3 December 2017, the EUFGIS database contained information on 3390 units and 101 tree species in 34 countries. The units contain a total of 4301 tree populations.

Since 2010, the EUFGIS information system has been used as a source of data for assessing in situ genetic conservation activities in Europe. The EUFORGEN programme will provide support to countries that have not entered data into EUFGIS in the form of ad-hoc training and helpdesk access.

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The EUFGIS information system is also a source of data for *ex situ* dynamic conservation. *Ex situ* genetic conservation units consist of stands and clone collections established with collected or multiplied genetic material.

**FOREMATIS Information System (Potential for the production of Forest Reproductive Material)**

The Council directive of 22 December 1999 on the marketing of forest reproductive material lays down rules for tree seed and plant stock production in the EU. In order to harmonise data across EU Member States, the EC Directorate General for Health and Food Safety (DG SANTE) developed the Forest Reproductive Material Information System (FOREMATIS), an information system on approved planted forest tree species. Released in 2016, FOREMATIS provides a search tool for forest tree breeders, forestry nursery staff, experts and the general public, functioning as a repository of Member State data of regulated planted forest tree species.

FOREMATIS collects information of approved basic material based on EU Member States’ national lists. Currently the European Commission is exploring the possibility to open the database to all European tree species.

It provides information on the location, origin and type of forest tree species important for the production of high quality and diverse forest reproductive material.

FOREMATIS currently (November 2019) contains information in approximately 90,000 records on 50 tree species. With the information system, EU Member States are able to manage their national lists on the Commission’s website. FOREMATIS uses semantic technologies that allow it to be connected to other structured public data sources. The use of these new technologies will create a central hub for a vast amount of information on planted forest tree species in a range of domains.

**European Atlas of Forest Tree Species**

Since 2016 the European Commission’s Joint Research Centre (JRC) maintains the European Atlas of Forest Tree Species, a comprehensive publication which presents the species distribution and suitability maps, of the main European forest tree species.

The atlas is regularly maintained and new chorological maps are regularly produced.

Some of these maps are based on previous work of the EUFORGEN programme. The Atlas will be used as primary source of information on species chorology.

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8 [https://ec.europa.eu/forematis/](https://ec.europa.eu/forematis/)
9 Member countries of the OECD Forest Seed and Plant Scheme have been invited to test the system.

• EUFORGEN member countries should continue to implement and further develop the Pan-European strategy for genetic conservation of forest trees.

• Through the EUFORGEN Programme, member countries should work together to develop an agreed set of “minimum requirements” for static \textit{ex situ} conservation.

• Countries should support Botanic Gardens Conservation International (BGCI) via its initiative “GlobalTreeSearch”\textsuperscript{11} in the development of the national lists of native tree species occurring in each country.

\textsuperscript{11} https://tools.bgci.org/global_tree_search.php


ANNEX 1. Pan-European List of priority species for which conservation is monitored

For the assessment of the indicator 4.6, the EUFORGEN Programme has developed a list of priority species, which was compiled by merging the following species lists:

- All species listed in Annex 1 of the COUNCIL DIRECTIVE 1999/105/EC of 22 December 1999 on the marketing of forest reproductive material.

- All species already entered in the EUFGIS Information system as of November 2019.

- All tree species identified as model tree species by the species-Network that were active during Phase II and III of the Programme.

- All tree species for which JRC has developed species distribution maps\(^{12}\).

When relevant, countries can submit a request to the Secretariat for species not currently listed to be added (following the standard taxonomy listed in the GlobalTreeSearch database, maintained by the Botanic Gardens Conservation International (BGCI)). The decision regarding whether the new species will be added or not will be made by the Steering Committee.

Any addition to the species list will affect the calculation of the indicators retroactively for all the countries in which the species is present. Therefore, each re-computation using the revised species list will be linked to the previous version to ensure proper comparison and to monitor real progress.

## Compiled List for Geographical Europe:

<table>
<thead>
<tr>
<th>Species</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abies alba*</td>
<td><em>Abies alba</em></td>
</tr>
<tr>
<td>Abies borisii-regis</td>
<td>*Abies borisii-regis</td>
</tr>
<tr>
<td>Abies bornmuelleriana</td>
<td>*Abies bornmuelleriana</td>
</tr>
<tr>
<td>Abies cephalonica*</td>
<td><em>Abies cephalonica</em></td>
</tr>
<tr>
<td>Abies cilicica</td>
<td><em>Abies cilicica</em></td>
</tr>
<tr>
<td>Abies equi-trojani</td>
<td>*Abies equi-trojani</td>
</tr>
<tr>
<td>Abies grandis*</td>
<td><em>Abies grandis</em></td>
</tr>
<tr>
<td>Abies marocana</td>
<td><em>Abies marocana</em></td>
</tr>
<tr>
<td>Abies nebrodensis</td>
<td>*Abies nebrodensis</td>
</tr>
<tr>
<td>Abies nordmanniana</td>
<td>*Abies nordmanniana</td>
</tr>
<tr>
<td>Abies numidica</td>
<td><em>Abies numidica</em></td>
</tr>
<tr>
<td>Abies pinsapo*</td>
<td><em>Abies pinsapo</em></td>
</tr>
<tr>
<td>Acer campestre</td>
<td><em>Acer campestre</em></td>
</tr>
<tr>
<td>Acer lobelii</td>
<td><em>Acer lobelii</em></td>
</tr>
<tr>
<td>Acer monspessulanum</td>
<td>*Acer monspessulanum</td>
</tr>
<tr>
<td>Acer opalus</td>
<td><em>Acer opalus</em></td>
</tr>
<tr>
<td>Acer platanoides*</td>
<td><em>Acer platanoides</em></td>
</tr>
<tr>
<td>Acer pseudoplatanus*</td>
<td><em>Acer pseudoplatanus</em></td>
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</table>
ANNEX 3. Dynamic conservation of populations of native forest tree species (including in situ and dynamic ex situ) as genetic resources - Data presented per Country

**TABLE 2.** Numerical visualisation: Dynamic conservation effort, Species diversity index, Ecozone diversity index, and Insurance index. (Source EUFGIS - November 2019).

<table>
<thead>
<tr>
<th>Testing Countries</th>
<th>Dynamic conservation effort</th>
<th>Species diversity index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total number of conserved populations in Genetic Conservation Units (GCU) in the country</td>
<td>Number of species occurring within the country (Based on the Pan-European List of priority species, Annex 1)</td>
</tr>
<tr>
<td>Denmark</td>
<td>218</td>
<td>44</td>
</tr>
<tr>
<td>Estonia</td>
<td>10</td>
<td>36</td>
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<tr>
<td>Finland</td>
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<td>33</td>
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<tr>
<td>France</td>
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<tr>
<td>Spain</td>
<td>308</td>
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<tr>
<td>Number of ecozones occurring within the country (summed over all conserved species)</td>
<td>Number of ecozones in GCUs</td>
<td>Number of ecozones conserved within a minimum number of 2 GCUs</td>
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<tr>
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<tr>
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<tr>
<td>75</td>
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<td>51</td>
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</table>
TABLE 3. Graphical visualisation per country: Scatter plot of Dynamic conservation effort and Radar chart of Species diversity index, Ecozone diversity index, and Insurance index. The numeric values are provided in the table below. (Source EUFGIS - November 2019).

### Denmark
Dynamic conservation of populations of native forest tree species as genetic resources

<table>
<thead>
<tr>
<th>Years</th>
<th>2000</th>
<th>2005</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
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<tbody>
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<td>0.477</td>
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<tr>
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</table>

### Estonia
Dynamic conservation of populations of native forest tree species as genetic resources

<table>
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<td>0.106</td>
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### Finland
Dynamic conservation of populations of native forest tree species as genetic resources

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### France
Dynamic conservation of populations of native forest tree species as genetic resources

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(Table3. continued)

**Iceland**

Dynamic conservation of populations of native forest tree species as genetic resources

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**Italy**

Dynamic conservation of populations of native forest tree species as genetic resources

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**Norway**

Dynamic conservation of populations of native forest tree species as genetic resources

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**Poland**

Dynamic conservation of populations of native forest tree species as genetic resources

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<td>0.465</td>
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DATA PRESENTED PER NATIVE SPECIES AT A PAN EUROPEAN LEVEL

TABLE 4. Data presented per species at a pan European level - numerical visualisation: Dynamic conservation effort, Country involvement index (nº of countries where the species is conserved/ nº of countries where the species is occurring), Ecozone diversity index, and Insurance index. (Source: EUFGIS - November 2019).

<table>
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<th>Species name</th>
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<th>Country involvement</th>
<th>Ecozone diversity index</th>
<th>Insurance index</th>
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<td>345</td>
<td>0.658</td>
<td>0.376</td>
<td>0.297</td>
</tr>
</tbody>
</table>
FIGURE 2. Data presented per species at a pan European level - graphical visualisation: Histogram of Dynamic conservation effort and Radar chart of Country involvement index, Ecozone diversity index, and Insurance index for nine European forest tree species. (Source EUFGIS - November 2019).
ANNEX 4. Dynamic conservation of non-native populations of forest tree genetic resources

<table>
<thead>
<tr>
<th>Testing Countries</th>
<th>Number of non-native species occurring</th>
<th>Number of non-native species conserved</th>
<th>Number of dynamic conserved population of non-native species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>19</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Estonia</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Finland</td>
<td>30</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>France</td>
<td>28</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Iceland</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Italy</td>
<td>14</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Norway</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Poland</td>
<td>28</td>
<td>6</td>
<td>79</td>
</tr>
<tr>
<td>Slovenia</td>
<td>16</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Spain</td>
<td>15</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
## ANNEX 5. Potential for the production of Forest Reproductive Material


<table>
<thead>
<tr>
<th>Testing Countries</th>
<th>Total number of FRM production units (for all 4 categories combined)</th>
<th>Total number of species for which there is at least 1 FRM production unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>314</td>
<td>35</td>
</tr>
<tr>
<td>Estonia</td>
<td>175</td>
<td>11</td>
</tr>
<tr>
<td>Finland</td>
<td>351</td>
<td>13</td>
</tr>
<tr>
<td>France</td>
<td>1,656</td>
<td>55</td>
</tr>
<tr>
<td>Iceland</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Italy</td>
<td>897</td>
<td>36</td>
</tr>
<tr>
<td>Norway</td>
<td>67</td>
<td>19</td>
</tr>
<tr>
<td>Poland</td>
<td>29,141</td>
<td>38</td>
</tr>
<tr>
<td>Slovenia</td>
<td>238</td>
<td>38</td>
</tr>
<tr>
<td>Spain</td>
<td>8,328</td>
<td>58</td>
</tr>
</tbody>
</table>

NA: not available