REPORT of EUFORGEN working group

Revised indicator on genetic resources (4.6) of the pan-European criteria and indicators for sustainable forest management

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Content

DISCLAIMER

Within the Forest Europe set of indicators[1], the proposed revised indicator 4.6 (Genetic resources) is directed towards supporting forest genetic resources (FGR) conservation strategies at the pan-European level. It is based on common standard indexes provided at national levels. The indicator is composed of verifiers that aim to quantify the conservation efforts and assess the conservation strategies in multiple dimensions.

The 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**. These verifiers provide a common standard assessment of the overall achievements in FGR conservation scaling for each axis of the strategy and must be considered jointly not independently (to improve the achievements the countries may decide to prioritize 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).

[1] http://foresteurope.org/sfm-criteria-indicators2

1. 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. They are assessed, currently (2019) by a set of 34 quantitative and 11 qualitative indicators[2]. 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. The changes reported in the qualitative indicators over time reflect the responses of policy-makers through a range of means (policies, institutions, regulatory and financial instruments, information) to the 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 based on ten quantitative and one qualitative indicators. 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).

So far, indicator 4.6 consists 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. Up until now, European countries have been reporting the area in hectares managed for the conservation and utilization of forest tree genetic resources and the area managed for seed production.

For the evaluation of the current state of the indicator and its sub-indicators, reliable verifiers are needed that are informative, robust and provide sufficient resolution. However, we consider that the assessment based on the number of hectares does not provide a sufficiently informative means for evaluating the status of Forest Genetic Resources (FGR) in Europe or for monitoring progress towards their conservation, because it provides no indication of the fraction of genetic diversity conserved within each country nor the contribution that within-country conservation units make to the overall genetic diversity conserved at the pan-European scale. Furthermore, it 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 harmonization among countries regarding the type of genetic resources included, which does not allow for a meaningful comparison.

EUFORGEN established a working group to revise the indicator on genetic resources conservation and use, aiming to address the above-mentioned shortcomings in the current system. On the basis of over 20 years of experience in FGR conservation and 10 years in managing the EUFGIS information system on *in situ* conservation units of FGR in Europe,

[2] www.foresteurope.org/wp-content/uploads/2017/03/CI_4pages.pdf

EUFORGEN guarantees that the revised indicator and revised sub-indicators are reliable, specific, simple, relevant and useful. It comes with a set of more precise definitions and standard scales.

There is general recognition that a single numeric value for each country will not allow for a comprehensive assessment, so we are proposing that the indicator is composed of a set of four sub-indicators corresponding to four simple values. A synthetic radar chart representation is also proposed to illustrate the indicator globally, thereby allowing temporal monitoring of the progress made per country, per species, or at continental level.

In order to permit meaningful comparison of different strategies among countries or among species and enable progress to be monitored, the sub-indicators are expressed as ratios, whenever possible, generating a value 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 back to 2010 from the information stored within EUFGIS database.

2. Revised indicator on genetic resources

The rationale behind the revised indicator 4.6 on the conservation and use of forest genetic diversity remains unchanged, but the revised indicator is composed of four rather than three sub-indicators in order to improve reliability and specificity more precisely capture, distinguish and represent the components of genetic resources, thus leading to more informative and comparable verifiers. Thereby, the overall reliability, robustness and resolution (specificity and sensitivity) of the revised indicator are improved:

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

All countries will report data by species, which will allow an assessment and monitoring of conservation efforts with two focuses: first, across species by country and, second, across countries by species at the continent level.

The EUFORGEN National coordinators, through the EUFGIS Focal Points[3], are responsible for reporting conservation efforts of native and non-native species' that occur in their respective countries. **Native species' populations** are local populations of species officially recognized as part of the natural flora of the country that have evolved locally through at least one generational turnover on site. They can be conserved *in situ*, i.e. their original locations, or *ex situ*, i.e. after transplantation of a representative sample of individuals from another site within the country or from another country. **Non-native species' populations** relevant for the purpose of this indicator are those that were introduced either from exotic species to Europe or non-native in the country, that have had at least one generational turnover in natural regeneration in the country.

The list of native tree species occurring in each country is defined in collaboration with Botanic Gardens Conservation International and its GlobalTreeSearch Database[4].

2.1. Dynamic conservation of native species' populations (including *in situ* and dynamic *ex situ*) of forest tree 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 compensate for this lack of knowledge, we make the following assumptions; local adaptation is a general feature in tree

[3] http://portal.eufgis.org/data-providers

[4] http://www.bgci.org/global_tree_search.php

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. Thus, efforts should 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 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 be characterized by the number of native species and the number of environmental ecological zones within each species distribution area, providing 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.

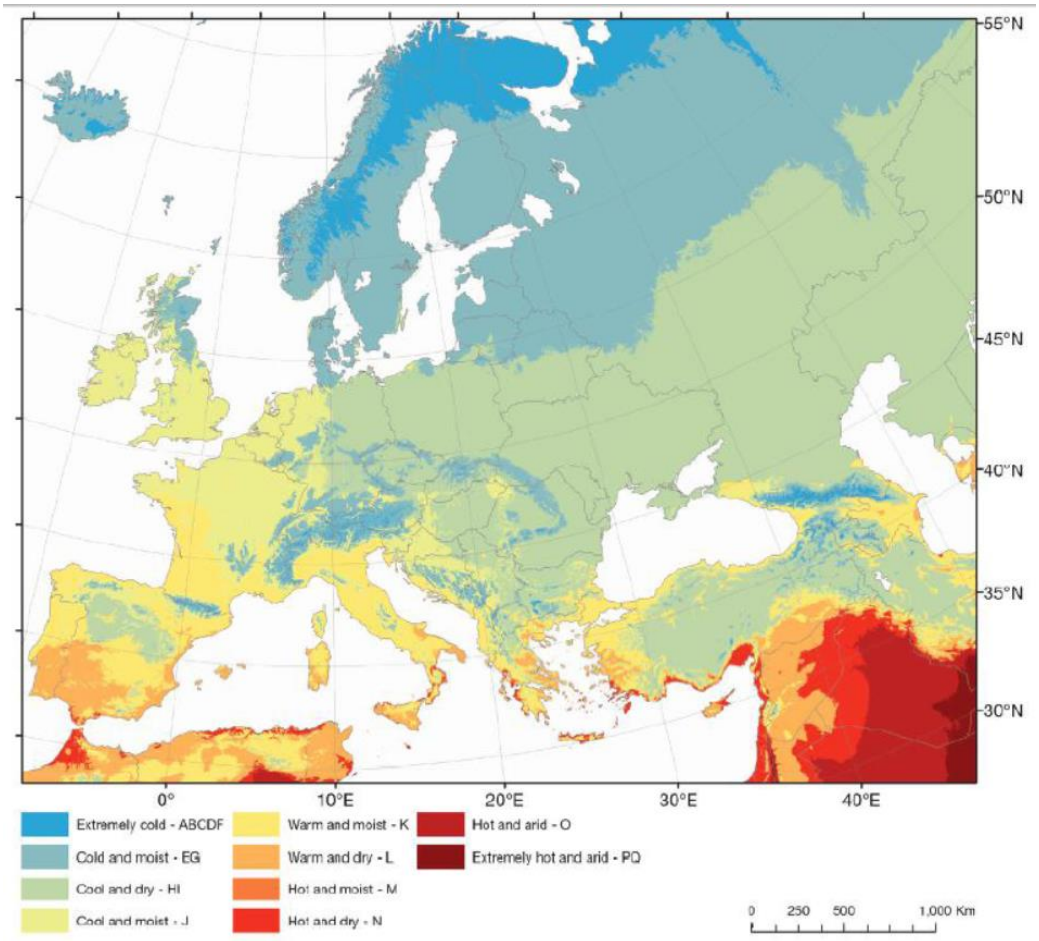


Figure 1. Map of environmental zones occurring in Europe following the classification from Metzger *et al.* (2013) modified by de Vries *et al.* (2015).

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 for genetic conservation activities based on political borders and environmental zones in each country. This allows each genetic conservation unit in a country to be classified in terms of its membership of an environmental zone on the basis of its location on the map in Figure 1.

To properly assess dynamic conservation of forest tree genetic resources of 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***)

Value or verifiers	**Definition**	**Observation**
Dynamic conservation effort (***nb_populations***)	total number of conserved populations in Genetic Conservation Units (GCU) in the country	This value is an important element to monitor conservation activities at national level, since it is not influenced by pan-European classification and prioritization
Species Diversity index (***ind_species***)	number of species listed as target species in genetic conservation units / number of species occurring within the country	The index will be calculated based on the species listed in Chapter 4, occurring in the country
Ecozones diversity index (***ind_ecozones***)	number of ecozones represented in the national conservation network / number of ecozones occurring within the country (summed over conserved species only)	The index will be calculated based on the species conserved in the country and the existing environmental zones per species in the country
Insurance index (***ind_insurance***)	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)	The index will be calculated based on the species conserved in GCUs in the country and the existing environmental zones in the country.

Data to report on this sub-indicator are available since 2010 in the EUFGIS information system.

An example is provided in Annex 3.

[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 ecotypes)

2.2. 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), even if occurring in several environmental zones, had little time to evolve in their current locations. Nevertheless, these populations may have particular characteristics and contain valuable genetic resources, and both local adaptation and random genetic evolution are presumed for these populations (both evolutionary forces always co-exist but in this short-term evolution time scale, we expect random evolution to have an important role and structuration of the genetic diversity by ecotypes not fully achieved). Therefore, conservation effort of non-native species is to be recognized, but only the total number of conserved populations will be reported by each country.

- Number of dynamic conservation populations of non-native species (***nb_units_non_native***)

Retrospective data to report on this sub-indicator are available back to 2010.
An example is provided in Annex 4

2.3. Static *ex situ* conservation

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

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

To date March 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 such minimum requirements. Until this is completed, countries will not report on static *ex situ* conservation in the framework of this indicator.

2.4. Potential for production of Forest Reproductive Material

Forest Reproductive Material (FRM) can consist of fruits, seeds and cones; 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 recognized 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.

Forest Reproductive Material production will be reported by each country for each species as:

- 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 recording ongoing in individual countries. These will all be reported by species.

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

3. Data sources

Data to populate the indicator can be obtained from the existing information systems, databases and national registers. For example, information on species and countries' *in situ* and *ex situ* efforts can be retrieved from the EUFGIS information system and information on forest reproductive material production is available from the FOREMATIS information system.

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

Following 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"[6] 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 emphasizes 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. 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 harbour a total of 4301 tree populations.

The EUFGIS information system is, since 2010, 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.

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

[6] http://portal.eufgis.org/fileadmin/templates/eufgis.org/documents/EUFGIS_Minimum_requirements.pdf

3.2. FOREMATIS Information System (Potential for production of Forest Reproductive Material)

The Council directive of 22 December 1999 on the marketing of forest reproductive material[7] lays down rules for tree seeds and plant stocks production in the EU. In order to harmonize data across Member Countries, the EC Directorate General for Health and Food Safety (DG SANTE) developed the Forest Reproductive Material Information System (FOREMATIS)[8], an information system on approved planted forest tree species. Released in 2016, FOREMATIS, provides a search tool for forest tree breeders, forestry nurserymen, experts and the general public, functioning as a repository linked with Member States data of regulated planted forest tree species.

FOREMATIS collects information of approved basic material, based on the Member States' national lists and will soon be available for all OECD-member countries.

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

FOREMATIS currently (March 2019) contains information on approximately 90.000 records on 50 tree species[9]. 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.

3.3. 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[10].

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.

[7] http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A31999L0105

[8] http://ec.europa.eu/forematis

[9] Currently the European Commission is exploring the possibility to open the database to all European tree species. OECD member countries have been already invited to contribute to the system.

[10] https://www.sciencedirect.com/science/article/pii/S2352340917301981

3.4. GlobalTreeSearch database

For the computation of the dynamic conservation of native species' populations (including *in situ* and dynamic *ex situ*) of forest tree genetic resources, in particular for the species for which a chorology map is not available, the list of species occurring in each country developed and maintained by Botanic Gardens Conservation International (BGCI) via its initiative "GlobalTreeSearch" (http://www.bgci.org/global_tree_search.php)
will be used.

The same list is used by FAO for its State of the World FGR report. Countries are encouraged to support BGCI directly to improve the list of species.

4. 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 BGCI in the development of the national lists of native tree species occurring in each country.

5. References

de Vries, S.M.G., Alan, M., Bozzano, M., Burianek, V., Collin, E., Cottrell, J., Ivankovic, M., Kelleher, C.T., Koskela, J., Rotach, P., Vietto, L. and Yrjänä, L. 2015. Pan-European strategy for genetic conservation of forest trees and establishment of a core network of dynamic conservation units. European Forest Genetic Resources Programme (EUFORGEN), Bioversity International, Rome, Italy.

Metzger, M.J., Bunce, R.G.H., Jongman, R.H.G., Sayre, R., Trabucco, A. & Zomer, R. 2013. A high-resolution bioclimate map of the world: a unifying framework for global biodiversity research and monitoring. Global Ecology and Biogeography, 22(5): 630–638.

Savolainen O, Pyhajarvi T, Knurr T (2007) Gene flow and local adaptation in trees. Annual Review of Ecology Evolution and Systematics, 38, 595–619

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 composed by the merge of the following list of species:

- All species listed in the 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 March 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 [11]

Countries can submit to the Secretariat a request to add not currently listed species (following the standard taxonomy listed in the GlobalTreeSearch database, maintained by the Botanic Gardens Conservation International (BGCI)), when relevant.

Any change in the total number of species per country will affect the calculation of the indicators retroactively to allow proper comparison and to monitor real progresses.

The following is the compiled list for the geographical Europe:

*Abies alba**
Abies borisii-regis
Abies bornmuelleriana
*Abies cephalonica**
Abies cilicica
Abies equi-trojani
*Abies grandis**
Abies marocana
Abies nebrodensis
Abies nordmanniana
Abies numidica
*Abies pinsapo**
Acer campestre
Acer lobelii
Acer monspessulanum
Acer opalus
*Acer platanoides**
*Acer pseudoplatanus**
Acer tataricum
Acer trautvetteri
Aesculus hippocastanum
Ailanthus altissima
Alnus cordata
*Alnus glutinosa**
*Alnus incana**
Alnus orientalis
Alnus viridis
Arbutus unedo
Berberis vulgaris
*Betula pendula**
*Betula pubescens**
Buxus balearica
Buxus sempervirens
*Carpinus betulus**
Carpinus orientalis
Carya ovata
*Castanea sativa**
*Cedrus atlantica**
*Cedrus libani**
Celtis australis

[11] http://forest.jrc.ec.europa.eu/european-atlas-of-forest-tree-species/atlas-data-and-metadata/

Cornus mas
Cornus sanguinea
Corylus avellana
Corylus colurna
Cotoneaster integerrimus
Cotoneaster melanocarpus
Crataegus laevigata
Crataegus monogyna
Crataegus rhipidophylla
Cupressus sempervirens
Fagus orientalis
*Fagus sylvatica**
Fraxinus americana
*Fraxinus angustifolia**
*Fraxinus excelsior**
Fraxinus ornus
Fraxinus pennsylvanica
Gleditsia triacanthos
Hippophae rhamnoides
Ilex aquifolium
Juglans nigra
Juglans regia
Juniperus communis
Juniperus excelsa
Juniperus foetidissima
Juniperus oxycedrus
Laburnum anagyroides
*Larix decidua**
*Larix kaempferi **
*Larix sibirica **
Liquidambar orientalis
Lonicera periclymenum
Lonicera xylosteum
Malus sylvestris
Morus alba
Ostrya carpinifolia
Phoenix theophrasti
*Picea abies**
Picea omorika
Picea orientalis
*Picea sitchensis**
*Pinus brutia**
*Pinus canariensis **
*Pinus cembra**
*Pinus contorta**
*Pinus halepensis**
*Pinus heldreichii**
Pinus mugo
*Pinus nigra**
Pinus peuce
*Pinus pinaster**
*Pinus pinea**
*Pinus radiate**
Pinus strobus
*Pinus sylvestris**
Pinus uncinata
Pistacia atlantica
Pistacia terebinthus
Platanus orientalis
*Populus alba**
*Populus nigra**
*Populus tremula**
*Prunus avium**
Prunus cerasifera
Prunus mahaleb
Prunus padum
Prunus padus
Prunus spinosa
*Pseudotsuga menziesii**
Pterocarya fraxinifolia
Pyrus communis
Pyrus pyraster
*Quercus cerris**
Quercus coccifera
Quercus frainetto
*Quercus ilex**
Quercus palustris
*Quercus petraea**
*Quercus pubescens**
*Quercus robur**
*Quercus rubra**
*Quercus suber**
Quercus trojana
Quercus virginiana
Quercus vulcanica
Rhamnus cathartica
*Robinia pseudoacacia**
Salix alba
Salix caprea
Salix cinerea
Salix fragilis
Salix myrsinifolia
Salix pentandra
Salix rosmarinifolia
Sambucus nigra
Sorbus aria
Sorbus aucuparia
Sorbus domestica
Sorbus intermedia
Sorbus torminalis
Styphnolobium japonicum
Taxodium distichum

Taxus baccata
*Tilia cordata**
*Tilia platyphyllos**
Tilia tomentosa
Ulmus foliacea
Ulmus glabra
Ulmus laevis
Ulmus minor
Ulmus pumila
Viburnum opalus

Species under Annex 1 of the COUNCIL DIRECTIVE 1999/105/EC of 22 December 1999 on the marketing of forest reproductive material

Non-native species (i.e. introduced species that have had at least one generational turnover in natural regeneration in Europe), are also listed here

Annex 2: Environmental zones in each country

Country	Environmental zone name	Environmental zone code
Albania	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
	Warm and moist	K
Andorra	Extremely cold	ABCDF
	Cold and moist	EG
Armenia	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Warm and moist	K
Austria	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
Azerbaijan	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
	Warm and moist	K
	Warm and dry	L
Belgium	Cold and moist	EG
	Cool and moist	J
Bulgaria	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
	Warm and moist	K
Bosnia and Herzegovina	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
	Warm and moist	K
Belarus	Cold and moist	EG
	Cool and dry	HI
Switzerland	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
Cyprus	Warm and moist	K
	Warm and dry	L
	Hot and dry	N
Czech Republic	Extremely cold	ABCDF
	Cold and moist	EG

Country	Environmental zone name	Environmental zone code
	Cool and dry	HI
Germany	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
Denmark	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
Spain	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
	Warm and moist	K
	Warm and dry	L
	Hot and moist	M
	Hot and dry	N
Estonia	Cold and moist	EG
Finland	Extremely cold	ABCDF
	Cold and moist	EG
France	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
	Warm and moist	K
United Kingdom	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and moist	J
Georgia	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
	Warm and moist	K
Greece	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
	Warm and moist	K
	Warm and dry	L
	Hot and dry	N
Croatia	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
	Warm and moist	K
	Warm and dry	L
Hungary	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
Ireland	Cold and moist	EG
	Cool and moist	J

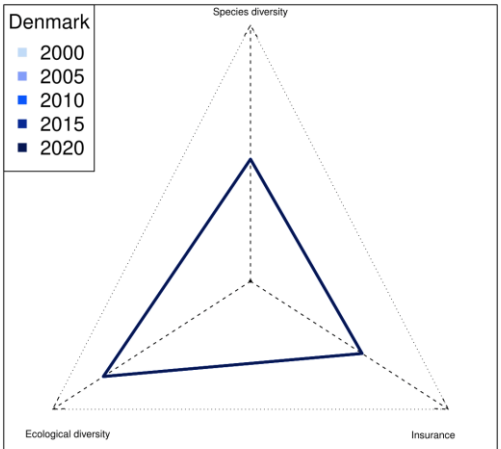
Country	Environmental zone name	Environmental zone code
Iceland	Extremely cold	ABCDF
	Cold and moist	EG
Italy	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
	Warm and moist	K
	Warm and dry	L
	Hot and dry	N
Liechtenstein	Cold and moist	EG
	Cool and moist	J
Lithuania	Cold and moist	EG
	Cool and dry	HI
Luxembourg	Cold and moist	EG
	Cool and moist	J
Latvia	Cold and moist	EG
Moldova	Cool and dry	HI
Former Yugoslav Rep. of Macedonia	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
	Warm and moist	K
Malta	Hot and dry	N
Montenegro	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and moist	J
	Warm and moist	K
Netherlands	Cool and moist	J
Norway	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and moist	J
Poland	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
Portugal	Cool and dry	HI
	Cool and moist	J
	Warm and moist	K
	Warm and dry	L
	Hot and dry	N
Romania	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
Russia	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
	Warm and moist	K

Country	Environmental zone name	Environmental zone code
Serbia	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
	Warm and moist	K
Slovakia	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
Slovenia	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
	Warm and moist	K
Sweden	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
Turkey	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J
	Warm and moist	K
	Warm and dry	L
	Hot and dry	N
Ukraine	Extremely cold	ABCDF
	Cold and moist	EG
	Cool and dry	HI
	Cool and moist	J

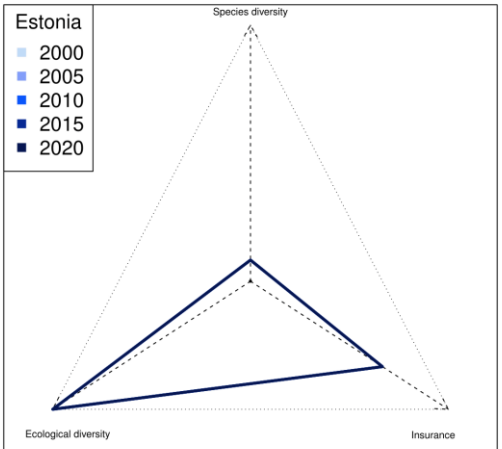
Annex 3: Dynamic conservation of native species' populations (including *in situ* and dynamic *ex situ*) of forest tree genetic resources - Data presented by Country

Testing Countries	**Dynamic conservation effort** total number of conserved populations in Genetic Conservation Units (GCU) in the country	Number of species occurring within the country (Based on the Pan-European List of priority species, Annex 1)	Number of ecozones per country	Number of target species in GCUs (i.e. conserved species	**Species Diversity index** number of species listed as target species in genetic conservation units / number of species occurring within the country	Number of ecozones occurring within the country (summed over all conserved species)	Number of ecozones in GCUs	Number of ecozones conserved within a minimum number of 2 GCUs	**Ecozone diversity index** number of ecozones represented in the national conservation network / number of ecozones occurring within the country (summed over conserved species only)	**Insurance index** 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)
Denmark	**218**	44	3	21	**0,477**	39	29	22	**0,744**	**0,564**
Estonia	**10**	36	1	3	**0,083**	3	3	2	**1**	**0,667**
Finland	**71**	33	2	10	**0,303**	14	14	12	**1**	**0,857**
France	**100**	90	5	10	**0,111**	37	19	11	**0,514**	**0,297**
Iceland	**1**	3	2	1	**0,333**	2	1	0	**0,5**	**0**
Italy	**218**	101	7	32	**0,317**	129	60	38	**0,465**	**0,295**
Norway	**30**	23	3	10	**0,435**	20	12	11	**0,6**	**0,55**
Poland	**536**	63	4	23	**0,365**	63	39	33	**0,619**	**0,524**
Slovenia	**40**	71	5	23	**0,324**	59	28	9	**0,475**	**0,153**
Spain	**43**	76	8	5	**0,066**	23	12	8	**0,522**	**0,348**

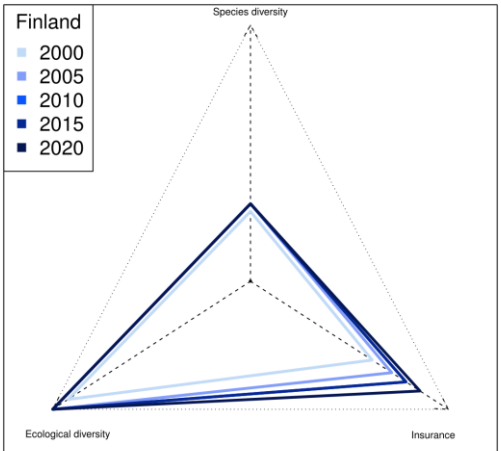
Table 1. Numerical visualization: Species Diversity index, Ecotype diversity index, and Insurance index. Source EUFGIS - March 2019



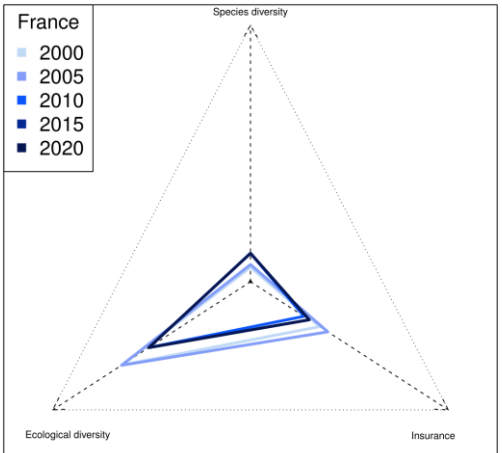
	Dyn. Conserv. Eff.	Species diversity	Ecological diversity	Insurance
2000	218	0.477	0.744	0.564
2005	218	0.477	0.744	0.564
2010	218	0.477	0.744	0.564
2015	218	0.477	0.744	0.564
2020	218	0.477	0.744	0.564



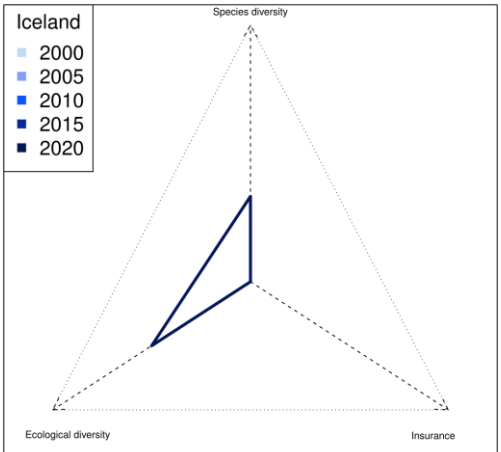
	Dyn. Conserv. Eff.	Species diversity	Ecological diversity	Insurance
2000	10	0.083	1	0.667
2005	10	0.083	1	0.667
2010	10	0.083	1	0.667
2015	10	0.083	1	0.667
2020	10	0.083	1	0.667



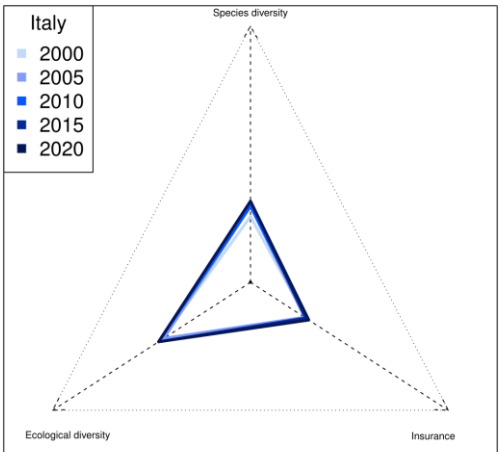
	Dyn. Conserv. Eff.	Species diversity	Ecological diversity	Insurance
2000	54	0.273	0.923	0.615
2005	61	0.303	1	0.714
2010	64	0.303	1	0.786
2015	69	0.303	1	0.786
2020	71	0.303	1	0.857



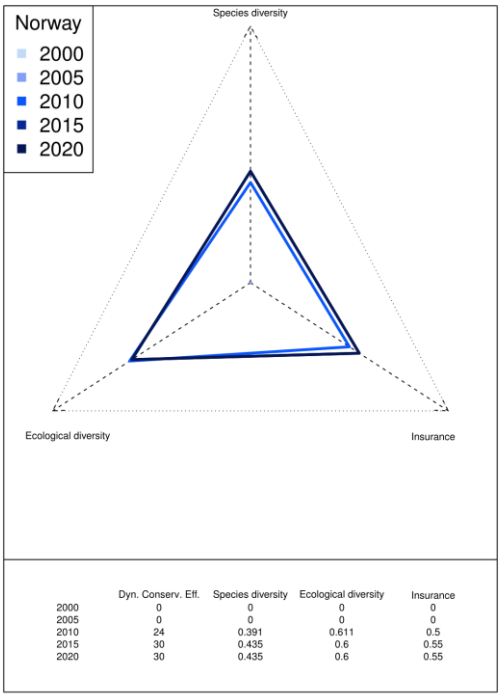
	Dyn. Conserv. Eff.	Species diversity	Ecological diversity	Insurance
2000	71	0.056	0.65	0.35
2005	78	0.067	0.652	0.391
2010	87	0.111	0.514	0.27
2015	99	0.111	0.514	0.297
2020	100	0.111	0.514	0.297



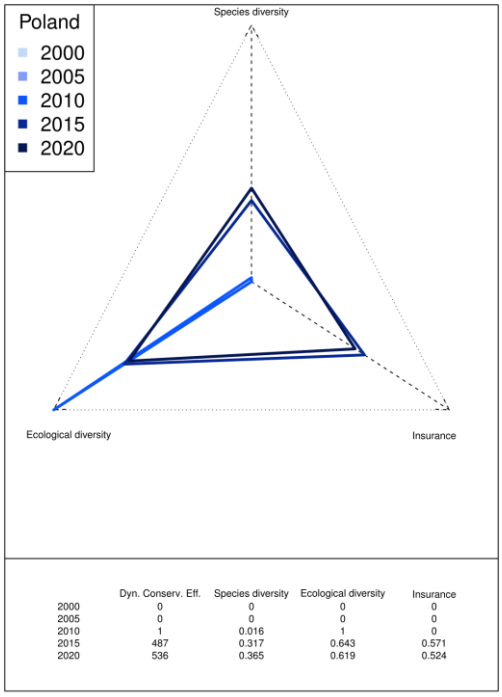
	Dyn. Conserv. Eff.	Species diversity	Ecological diversity	Insurance
2000	0	0	0	0
2005	0	0	0	0
2010	1	0.333	0.5	0
2015	1	0.333	0.5	0
2020	1	0.333	0.5	0



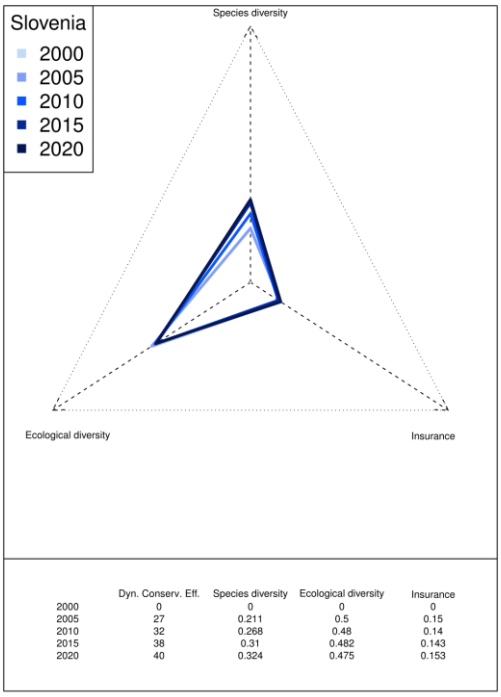
	Dyn. Conserv. Eff.	Species diversity	Ecological diversity	Insurance
2000	173	0.257	0.456	0.282
2005	190	0.297	0.438	0.273
2010	202	0.297	0.463	0.289
2015	212	0.317	0.465	0.279
2020	218	0.317	0.465	0.295



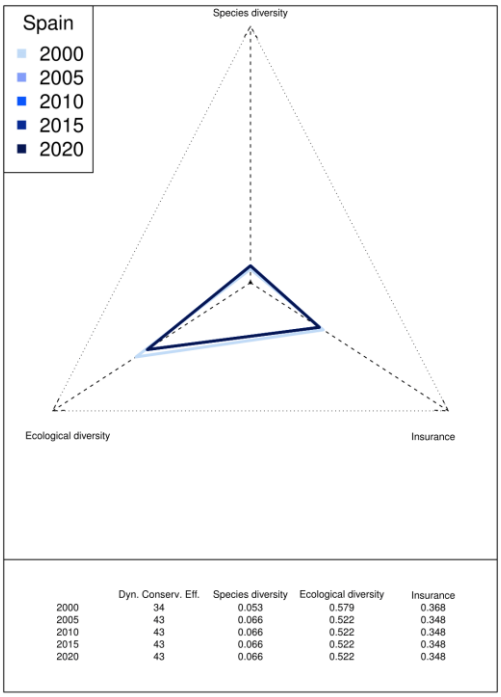
	Dyn. Conserv. Eff.	Species diversity	Ecological diversity	Insurance
2000	0	0	0	0
2005	0	0	0	0
2010	24	0.391	0.611	0.5
2015	30	0.435	0.6	0.55
2020	30	0.435	0.6	0.55



	Dyn. Conserv. Eff.	Species diversity	Ecological diversity	Insurance
2000	0	0	0	0
2005	0	0	0	0
2010	1	0.016	1	0
2015	487	0.317	0.643	0.571
2020	536	0.365	0.619	0.524



	Dyn. Conserv. Eff.	Species diversity	Ecological diversity	Insurance
2000	0	0	0	0
2005	27	0.211	0.5	0.15
2010	32	0.268	0.48	0.14
2015	38	0.31	0.482	0.143
2020	40	0.324	0.475	0.153



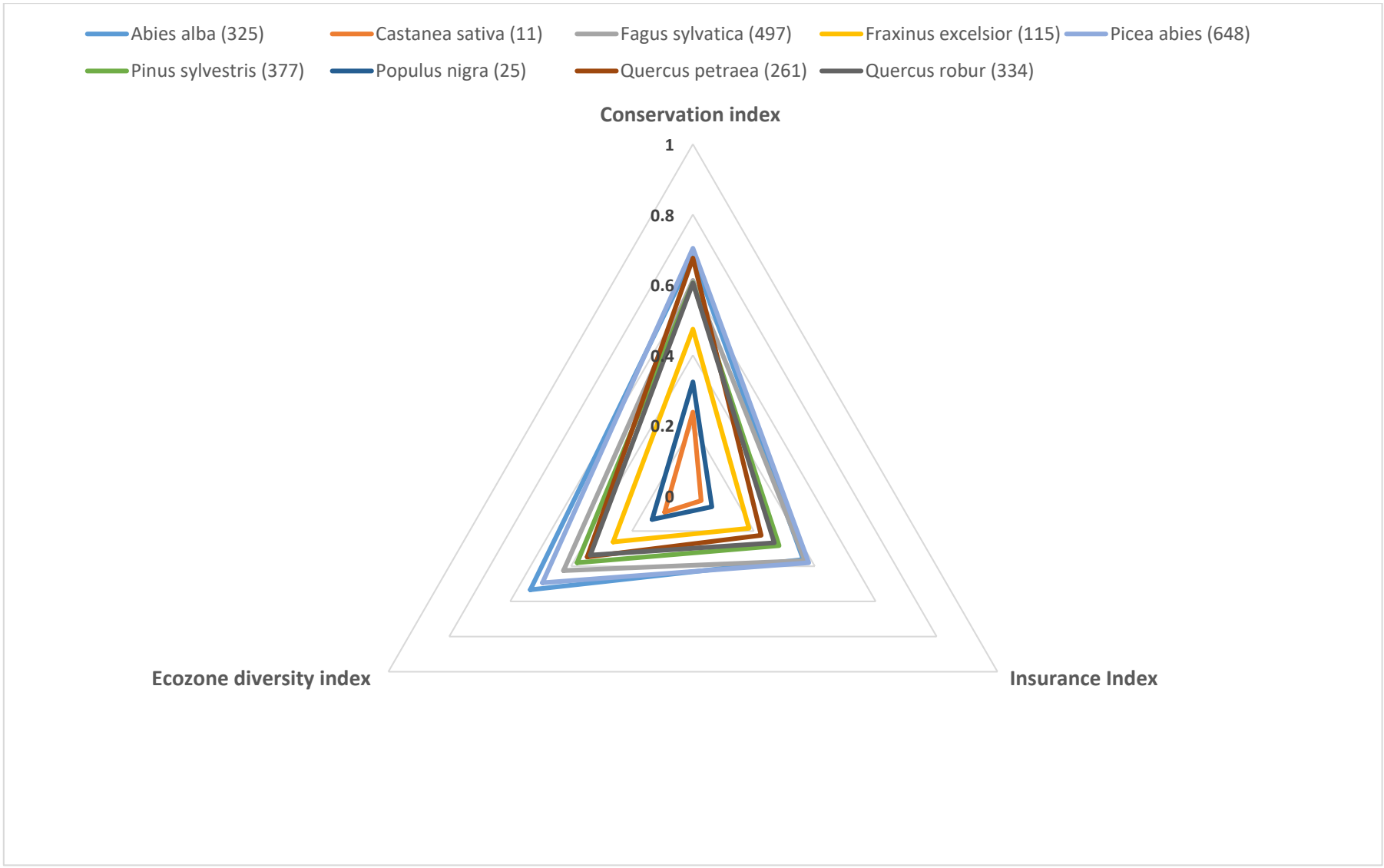
	Dyn. Conserv. Eff.	Species diversity	Ecological diversity	Insurance
2000	34	0.053	0.579	0.368
2005	43	0.066	0.522	0.348
2010	43	0.066	0.522	0.348
2015	43	0.066	0.522	0.348
2020	43	0.066	0.522	0.348

Table 2. Graphical visualization - Radar graphs of Species Diversity index, Ecozone Diversity index, and Insurance index. Dynamic Conservation Effort is provided in the table below. Source EUFGIS - March 2019.

Data presented by species at a pan European level

Species name	Dynamic conservation effort	Conservation index	Ecozone diversity index	Insurance Index
Abies alba	325	0,682	0,534	0,362
Castanea sativa	11	0,238	0,093	0,027
Fagus sylvatica	497	0,613	0,425	0,368
Fraxinus excelsior	115	0,474	0,262	0,184
Picea abies	648	0,704	0,494	0,38
Pinus sylvestris	377	0,606	0,38	0,283
Populus nigra	25	0,324	0,134	0,062
Quercus petraea	261	0,676	0,347	0,224
Quercus robur	334	0,605	0,337	0,267

Table 3. Data presented by species at a pan European level - numerical visualization: Species Diversity index, Ecotype diversity index, and Insurance index. Source EUFGIS - March 2019



Radar chart of Conservation Index, Ecozone Diversity Index, and Insurance Index for nine European forest tree species. Source EUFGIS - March 2019.

Annex 4. Dynamic conservation of non-native populations of forest tree genetic resources

Testing Countries	Number of non-native species occurring	Number of non-native species conserved	**Number of dynamic conserved population of non-native species**
Denmark	19	2	3
Estonia	4	0	0
Finland	30	0	0
France	28	0	0
Iceland	9	0	0
Italy	14	3	6
Norway	8	0	0
Poland	28	6	79
Slovenia	16	0	0
Spain	15	0	0

Table 4. Source EUFGIS - March 2019.

Annex 5. Potential for production of Forest Reproductive Material

Testing Countries	Total number of FRM production units (for all 4 categories combined)	Total number of species for which there is at least 1 FRM production unit
Denmark	*NA*	*NA*
Estonia	106	9
Finland	645	13
France	13	2
Iceland	*NA*	*NA*
Italy	897	36
Norway	*NA*	*NA*
Poland	64.697	30
Slovenia	185	22
Spain	4.427	31

NA: not available

Table 5. Source FOREMATIS – March 2019