EUFORGEN

EUROPEAN FOREST GENETIC RESOURCES PROGRAMME

FOREST GENETIC RESOURCES STRATEGY FOR EUROPE

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The European Forest Genetic Resources Programme (EUFORGEN) is an instrument based on international cooperation which promotes 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 contribute to the implementation of FOREST EUROPE Madrid Resolution M2 and Bratislava Declaration regarding forest genetic resources and relevant decisions of the Convention on Biological Diversity (CBD). In addition, 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 input 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, and the EUFORGEN Secretariat is hosted by the European Forest Institute (EFI). Further information about EUFORGEN can be found at www.euforgen.org.

During its Sixth Phase (2020-2024) 26 countries (Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Iceland, Ireland, Italy, Lithuania, Luxemburg, Malta, Netherlands, Norway, Poland, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom) are financially contributing to the Programme.

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FOREWORD

As Head of the Liaison Unit of Forest Europe it is my great pleasure and honour to congratulate the EUFORGEN programme on the launch of the Forest Genetic Resources Strategy for Europe. The conservation of a wide range of forest genetic materials is of the utmost importance for the resilience of our forests in Europe. Conservation initiatives are even more critical for mitigating the adverse effects of climate change.

EUFORGEN was established in 1994 as a result of a resolution adopted in 1990 by the first Ministerial Conference of the Forest Europe process in Strasbourg, France. It is important to remember that EUFORGEN is thus neither a spontaneous initiative of a few stakeholders or lobbyists, nor a short-term project. Rather EUFORGEN was established and has been funded by national governments, with national coordinators nominated by ministries responsible for forests in their respective countries. It is always important to remember that the programme is thus underpinned by a firm government-driven consensus. This confers extra gravitas on EUFORGEN, giving it a catalysing legitimacy.

Since its inception more than 25 years ago, EUFORGEN has enabled the cooperation and collaboration required for the pan-European conservation of forest genetic resources. The new Strategy is important and relevant because it defines a comprehensive and precise framework for the relevant stakeholders that indicates how best to implement such conservation. Several key commitments are both relevant for individual countries and also for Europe as a whole, and the Strategy gives a clear outlook on what is important in this context for the next decade.

When implementing the Work Programme of Forest Europe and the work of EUFORGEN, cooperation becomes more important than ever. Particularly in current times, dynamic developments throughout Europe have a direct impact on forest genetic resources such as changing forest-related policies or large-scale forest damage that affect the availability and sustainable utilization of genetic material or the restoration of degraded and damaged forest areas. Sustainable forest management initiatives must include collaboration for both increasing public awareness about the value and relevance of forest genetic material, and promoting conservation and sustainable use of forest genetic resources in Europe. The communication components of this Strategy will therefore also be an important aspect of EUGORGEN's cooperation initiatives.

I wish EUFORGEN all the best for a successful implementation of this new Strategy and I look forwards to a close and fruitful cooperation.

Thomas Haußmann

Thomas Haußmann

Head of the Liaison Unit Bonn of Forest Europe

Forest Europe growing life

EXECUTIVE SUMMARY

Genetic resources, defined by the Convention on Biological Diversity (CBD) as "genetic material of actual or potential value", are key elements of all biodiversity, and Article 1 of the CBD requires biological diversity to be protected and sustainably used. Forest genetic resources (FGR) include the genetic diversity inherent in seeds, standing trees and entire forests, within and between species and populations. FGR are important for ecological, economic and societal purposes now and in the future. The unpredictability of future needs requires a strategic approach to the conservation and sustainable use of FGR. The conservation and sustainable use of FGR are crucial for the European Green Deal and hence for the EU Biodiversity Strategy and the new EU Forest Strategy 2030, as well as for the commitments of the high-level Forest Europe process.

Trees and other forest organisms can withstand the pressure of biotic and abiotic challenges only if they are able to adapt and evolve, which requires sufficient genetic diversity. Genetic diversity also enables artificial selection and breeding, to improve forest products and ecosystem services. The conservation of genetic diversity is thus essential for forest resilience in the context of the deepening climate emergency and other disturbances. The *Forest Genetic Resources Strategy for Europe* (the Strategy) provides the means for European coordination at a level above national strategies. It permits European coordination through the EUFORGEN programme to achieve European goals, building on national efforts and ensuring the efficient use of resources.

CONSERVATION AND SUSTAINABLE USE

Conservation can be dynamic, allowing evolutionary forces to operate, or static, preserving existing genetic diversity, usually in a genebank. Conservation at the existing location *(in situ)* is the main conservation strategy for FGR. In addition, dynamic *ex situ* conservation is playing an increasing role in favouring adaptation to new environmental conditions. Effective conservation of genetic resources requires integrating *in situ* and *ex situ (dynamic and static)* approaches. It is important to establish minimum requirements for *ex situ* conservation and a system to store and share information.

The Strategy makes several recommendations relevant to characterisation, which helps to identify threats and provides essential information for the conservation and sustainable use of FGR. Characterisation describes diversity across the entire range of a species and at the level of the stand, where it also provides information about individual trees. Stand-level information is currently gathered in the European Information System on Forest Genetic Resources (EUFGIS), which is the only transnational information system on conserved FGR in Europe. EUFGIS contains information on more than 3,500 genetic conservation units of more than 100 tree species in 36 countries, although for many stands only the minimum mandatory information is available.

This Strategy recognises the need to upgrade EUFGIS to include information derived from remote sensing and from eco-physiological and genetic analyses. Gathering this additional data and incorporating it in EUFGIS requires financial support and faces technical challenges. The additional data will increase the value and utility of characterised information. The value of the data will be enhanced even further once linked to climate data to reveal stand-level responses to environmental shifts. Linking with the European Forest Reproductive Material Information System (FOREMATIS) and the Forest Information System for Europe (FISE) will add further value to forest data. At the same time, all EUFGIS data will adhere to the principles of FAIR: Findable, Accessible, Interoperable and Reusable.

Genetic Conservation Units (GCUs)[1] are the key element in the pan-European network for *dynamic* conservation of FGR. The coverage of GCUs must be expanded to encompass as much of a species' genetic diversity as possible, including marginal populations at the edges of existing distributions, which are likely to be pre-adapted to changing conditions. Monitoring GCUs is vital to assess the status of and changes in a population, and to flag any need for active intervention.

Effective GCU management maintains and enhances the long-term evolutionary processes of tree populations, where management measures and silvicultural techniques are applied, as needed, to favour genetic processes within target tree populations. Authorities responsible for conserving GCUs need to ensure that forest tree populations can reproduce, evolve and adapt under a rapidly changing environment.

Sustainable use of FGR needs to balance genetic gains and the provision of multiple goods and services against the need to maintain sufficient genetic diversity to ensure long-term sustainability. Information about the performance of specific forest reproductive material in different environments is valuable, and there is a need for a European online system that can collate national information of this nature. In the context of promoting the sustainable use of FGR, linking with FOREMATIS is even more important, to better enable access to information on conserved (and characterised) FGR for and from breeders, forest managers and forest

[1] A Genetic Conservation Unit is a clearly mapped area of forest or woodland where dynamic gene conservation is one of the main management priorities for one or more tree species.

restoration practitioners. At a time when Europe has committed to planting billions of new trees, this linking will support identifying appropriate seed sources, while supporting the conservation of FGR.

At the same time, countries should reassess their approach to using non-local material, to better cope with changing climates. Forest reproductive material should be chosen based on origin, provenance and genetic diversity. The current Regions of Provenance regime, further restricted by national boundaries, may not be a suitable framework for the transfer of forest reproductive material. Decision support tools should be further developed to enable better-informed choices. This will almost certainly require strengthening official controls and phytosanitary inspections, along with improved record-keeping. Additional research will help to reinforce science-based decisions, and recommendations rooted in diversity conservation should be mainstreamed in local forestry management decisions to ensure continued forest adaptability and health.

TRANSITION

The countries of Europe, recognising the need for cooperative efforts to conserve the diversity of species whose distribution spans many countries, have been supported by the EUFORGEN network for more than 25 years. The *Forest Genetic Resources Strategy for Europe* requires a pan-European understanding of the importance of genetic resources conservation and use, which EUFORGEN is uniquely positioned to encourage. This requires not only continuing support from member countries, but also secure central financing. A regular contribution from the European Union, for example, would allow all European countries to operate in the programme and would safeguard ongoing coordination and collaboration.

Financial support and additional research will also be needed for the transition to a more comprehensive information system, which will see additional data incorporated into EUFGIS as well as more frequent and more detailed monitoring of GCUs. Political commitment will be needed, not least to comply with Article 7 of the CBD, which calls for action to "monitor through sampling and other techniques the components of biological diversity". Countries that are not currently members of EUFGIS, including those outside Europe, will be encouraged to join, boosting coverage and increasing the capacity of EUFGIS to identify conservation gaps and improve forest management and tree breeding.

Many policy instruments directly impact forest genetic resources. At all levels from Regional to global, these instruments are often negotiated without sufficient forestry expertise, which can result in the forest sector being surprised by specific decisions in closely-related sectors. To some extent, this represents a lack of understanding about genetic diversity. It is often thought that a commitment to conserve biodiversity necessarily includes a commitment to conserve genetic diversity. There is a need to include genetic diversity specifically in conservation policies to ensure that implementation does not neglect safeguarding genetic resources. Crucial, in this regard, is understanding the need to enable adaptation and evolution. The EUFORGEN Secretariat plays a central role in representing the FGR community internationally, in monitoring policy developments and in keeping countries informed. It can also broker the pan-European consensus needed to ensure the free flow of equivalent and interoperable information about forest genetic resources and to align research approaches and goals. Finally, additional support will enhance and extend EUFORGEN's existing communications initiatives to reach audiences whose understanding of genetic resources issues will be essential to the full implementation of the FGR conservation strategy.

CONCLUSION

The *Forest Genetic Resources Strategy for Europe* is a coordinated and cooperative effort in the European Forest Genetic Resources Programme (EUFORGEN) to improve the conservation and sustainable use of European forest genetic resources.

The Strategy goes beyond current individual countries' efforts and encompasses not only conservation but also sustainable use of forest genetic resources. It introduces new key elements for more accurate characterisation and classification of conserved FGR. It also highlights the need to expand scientific knowledge, defines principles for coordination activities at policy level, and recommends future actions and collaborations among different entities and international organisations.

Forest genetic resources are at the root of sustainable forest management, providing forests with the basis to safeguard their health and adaptive capacity. The FOREST EUROPE process is committed to pan-European collaboration for the protection of forests in Europe, while European countries and the European Union are committed to address the key drivers of biodiversity loss. This Strategy will significantly contribute to both these commitments.

PREAMBLE

The *Forest Genetic Resources Strategy For Europe* is a product of EUFORGEN Programme, an implementation mechanism of the Forest Europe Process, financially supported by 26[2] European countries.

This *Strategy* complements the overarching *Genetic Resources Strategy for Europe* developed by European countries through the H2020 GenRes Bridge project[3] that created the momentum for the three European genetic resources networks, ECPGR[4], ERFP[5] and EUFORGEN to develop three domain specific strategies following a similar approach.

The *Forest Genetic Resources Strategy For Europe* should be seen as a policy document that provides the framework for enabling the transition to an effective genetic resources conservation and sustainable use in the region.

The *Forest Genetic Resources Strategy For Europe* has been developed building on twenty years of pan European collaboration on forest genetic resources.

Three progressive drafts were shared with the EUFORGEN National Coordinators of member countries and Focal Points of non-member European countries, to collect feedback for the improvement of the progressive drafts. In June 2021, all EUFORGEN member countries contributed to the identification of the key commitments and recommendations and in October 2021 validated the strategy.

The full implementation of the *Forest Genetic Resources Strategy For Europe* is dependent on the commitment of all involved actors, including the national and regional policymakers who will guide and monitor its implementation and provide the financial, human and institutional resources required to fully execute the action plan.

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2 At the time of this Strategy's release, EUFORGEN is financially supported by Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Iceland, Ireland, Italy, Lithuania, Luxemburg, Malta, Netherlands, Norway, Poland, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom

3 GenRes Bridge project is a coordination and support action funded under the EU Horizon 2020 Framework Programme www.genresbridge.eu

4 European Cooperative Programme for Plant Genetic Resources – www.ecpgr.cgiar.org

5 European Regional Focal Point for Animal Genetic Resources – www.animalgeneticresources.net

LIST OF COMMONLY USED ACRONYMS

CBD - Convention on Biological Diversity

DNA - Desoxyribonucleic Acid

EC - European Commission

EU - European Union

EUFGIS - European Information System on Forest Genetic Resources

EUFORGEN - European Forest Genetic Resources Program

FAIR - Findability, Accessibility, Interoperability, and Reusability (of data)

FAO - Food and Agriculture Organisation of the United Nations

FGM - Forest genetic monitoring

FGR - Forest Genetic Resources

FRM - Forest Reproductive Material

GCU - Genetic Conservation Unit

GDP - Gross Domestic Product

GPA-FGR - Global Plan of Action for the Conservation, Sustainable Use and Development of Forest Genetic Resources

IPPC - Intergovernmental Panel on Climate Change

INTRODUCTION

"THE SIGNATORY STATES AND INTERNATIONAL INSTITUTION COMMIT THEMSELVES TO IMPLEMENT IN THEIR OWN COUNTRIES, USING WHATEVER METHODS SEEM MOST APPROPRIATE, A POLICY FOR THE CONSERVATION OF FOREST GENETIC RESOURCES (...).

TO FACILITATE AND EXTEND THE EFFORTS UNDERTAKEN AT NATIONAL AND INTERNATIONAL LEVELS, A FUNCTIONAL BUT VOLUNTARY INSTRUMENT OF INTERNATIONAL COOPERATION SHOULD BE FOUND WITHOUT DELAY FROM AMONG THE EXISTING RELEVANT ORGANIZATIONS TO PROMOTE AND COORDINATE:

- *IN SITU* AND *EX SITU* METHODS TO CONSERVE THE GENETIC DIVERSITY OF EUROPEAN FORESTS;
- EXCHANGES OF REPRODUCTIVE MATERIALS;
- THE MONITORING OF PROGRESS IN THESE FIELDS."

1st Ministerial Conference for the Protection of Forests in Europe
Ministerial Resolution S2 - Conservation of Forest Genetic Resources
Strasbourg, France

18.12.1990

Forest Europe growing life

The Convention on Biological Diversity recognises that biological diversity, at all levels of organisation from genes to ecosystems, has an intrinsic value and sustains all living systems. As such, biological diversity needs to be protected and its components to be sustainably used (Article 1 of the CBD).

Genetic resources, defined in the CBD as "genetic material of actual or potential value", are a key element of biodiversity. Forest Genetic Resources (FGR) consist of entities such as seeds, standing trees, entire forests, etc., that contain valuable and unique genetic diversity that is important for ecological, economic, and societal purposes, now and in the future. Because it is difficult to predict what resources human societies will need from their forests in the future and what forests themselves will need to survive, adapt, and evolve, all forest tree species can be considered as resources of possible benefit to society and the environment.

The genetic diversity in FGR influences the development of forest ecosystems. The forest trees at a given location contain this genetic diversity in multiple combinations, and these combinations are extremely important as insurance for the future, because genetic diversity is the foundation of adaptation. Thus, it is necessary to conserve selected forests for their FGR and ensure that the trees can pass on their genes to offspring. Doing so will help to ensure that the offspring have sufficient diversity to allow adaptation and evolutionary forces such as mutation or selection to act in a changing environment.

Sustainable forest management depends on conserving genetic diversity and ensuring that it is passed on from one generation to the next. The capacity of trees and other forest organisms to develop resistance and tolerance to biotic and abiotic stresses as well as to adapt to changing climates depends upon genetic diversity. Genetic diversity also permits artificial selection and breeding for the optimisation of forest products and ecosystem services. The need to conserve genetic diversity, in addition to forest ecosystems and species, has become more urgent with increasing evidence of global climate change and the associated risks that species and populations will go extinct as a result. The Intergovernmental Panel on Climate Change (IPCC) projects that global average surface temperatures have already increased by 1°C and the increase may reach 1.5°C by 2040 (IPCC, 2019). Genetic diversity underpins the resilience of forests in the context of climate change and related disturbances. The need for urgent action to conserve that diversity is indisputable: whatever we lose today, cannot be recovered in the future. Forest genetic resources are therefore crucial to the European Green Deal and consequently the EU Biodiversity strategy and the new EU Forestry Strategy 2030.

Forest Europe[6], the pan-European voluntary high-level political process for intergovernmental dialogue and cooperation on forest policies in Europe, develops common strategies for its 46 signatories on how to protect and sustainably manage their forests. Since 1990, Forest Europe has been setting the agenda for policy making at national and European levels by providing a main policy framework for sustainable forest management. Forest Europe identified forest genetic resources as one of the key pillars of sustainable forest management and the need for European countries to collaborate in their conservation and sustainable use was addressed by one of the first Resolutions and then reiterated through the years with several commitments (see table 1 below).

TABLE 1 - FOREST EUROPE COMMITMENTS ON GENETIC RESOURCES

Commitments endorsed by the ministers serve as a framework for implementing sustainable forest management in the European countries, adapted to their national circumstances and carried out coherently with the rest of the region, at the same time strengthening international cooperation.

Year	Forest Europe commitment number		Text of the commitment
1990	**Strasbourg Resolution 2**[7] Conservation of Forest Genetic Resources	1	An instrument for cooperation on conservation of genetic diversity of European forests to facilitate and extend the efforts undertaken at national and international levels: a functional but voluntary instrument of international cooperation should be found without delay from among the existing relevant organisations to promote and coordinate:
		1.1	*in situ* and *ex situ* methods to conserve the genetic diversity of European forests;
		1.2	exchanges of reproductive materials;
		1.3	the monitoring of progress in these fields.
2003	**Vienna Resolution 4**[8] Conserving and enhancing forest biological diversity in Europe	16	"promote the conservation of forest genetic resources as an integral part of sustainable forest management and continue the pan-European collaboration in this area"

following table 1 →

6 Originally the Ministerial Conference on the Protection of Forests in Europe
7 https://www.foresteurope.org/docs/MC/strasbourg_resolution_s2.pdf
8 https://foresteurope.org/wp-content/uploads/2016/11/MC_vienna_resolution_v4.pdf

→ following table 1

Year	Forest Europe commitment number		Text of the commitment
2007	**Warsaw Declaration**[9]	12	"maintain, conserve, restore and enhance the biological diversity of forests, including their genetic resources, through sustainable forest management"
2015	**Madrid Resolution 2**[10] Protection of forests in a changing environment	12	"promote national implementation of strategies and guidelines for dynamic conservation and appropriate use of forest genetic resources under changing climate conditions"
		13	"continue pan-European collaboration on forest genetic resources through the European Forest Genetic Resources Programme (EUFORGEN)"
2021	**Bratislava Declaration** The Future We Want: The Forests We Need''	29	"To fully recognise the essential role of sustainably managed, genetically diverse and healthy forests in relation to the conservation of biological diversity and the sustainable use of its components"
		30	"To recognise the need for dynamic conservation and utilization of forest tree genetic resources and management of forest tree species populations for production of forest reproductive material (As reflected in the updated pan-European indicator for sustainable forest management 4.6 Genetic Resource) and continue pan-European collaboration on forest genetic resources through the EUFORGEN to this end"

9 https://www.foresteurope.org/docs/MC/MC_warsaw_declaration.pdf
10 https://foresteurope.org/wp-content/uploads/2016/11/II.-ELM_7MC_2_2015_MadridResolution2_Protection_adopted.pdf

The importance of genetic diversity and the selection of suitable genetic resources as Forest Reproductive Material (FRM) is vital for the present and future of sustainable and resilient forests and the multiple goods and services they provide. In the case of reforestation, non-optimal selection of FRM can result in irreversible deleterious consequences, since the impacts of genetic diversity extend to the ecosystem level.

This document presents the Forest Genetic Resources Strategy For Europe for conservation and use of FGR. It provides the means for European coordination one level above national strategies. As such, this document does not replace national conservation efforts, but strongly supports them. Furthermore, this European Strategy does not constrain any country that may wish to do more. The European FGR Strategy permits European coordination through the EUFORGEN programme to ensure that countries are pursuing the same objectives, efforts are not duplicated, and use of resources is optimised.

CONSERVATION AND SUSTAINABLE USE OF FOREST GENETIC RESOURCES

IMPROVING THE AVAILABILITY OF, AND ACCESS TO, INFORMATION ON FOREST GENETIC RESOURCES

CONSERVATION OF FOREST GENETIC RESOURCES

SUSTAINABLE USE, DEVELOPMENT AND MANAGEMENT OF FGR

IMPROVING THE AVAILABILITY OF, AND ACCESS TO, INFORMATION ON FOREST GENETIC RESOURCES

Characterisation is the process of identifying and describing distinctive features or traits of individuals and populations. As such, characterisation of Forest Genetic Resources provides essential information for the conservation and sustainable use of forest genetic resources. Several European mechanisms have been developed to make this information available and enable access. These mechanisms include European strategies, including this one, and relevant information systems, such as EUFGIS (the European Information System on Forest Genetic Resources), which contains information on Genetic Conservation Units (GCUs), specific recognised populations of a species.

CHARACTERISATION OF FOREST GENETIC RESOURCES

Characterisation enables us to understand the nature of FGR and thus the threats it faces and the potential it may hold. Characterisation takes place at two levels; the level of the species, across the whole distribution range of the species, and at the level of the stand or population.

At the level of the stand, characterisation can take place for the stand as a whole and, in some cases, for individual trees within a stand. Stand-level information on ecological and management characteristics is currently gathered in EUFGIS (see "Availability and Access to Information" below). For many stands, only mandatory information is available; it would be very useful if additional data were to be made available for all GCUs, covering characterisation data obtained by remote sensing, ecophysiological and genetic analyses.

The wealth of data captured by remote sensing can offer a broad range of information, albeit one not easily incorporated in EUFGIS. In addition to possibly filling gaps in existing stand-level information, remote sensing can provide information of physiological status, health and phenology for single stands. Such information is important because it adds a functional or ecological layer to stand descriptions, and this layer would become even more valuable if it were linked to climate data. Such linked data would, for example, provide insights into stand-level responses to environmental shifts, including the consequences of climate change, which would be of great value for conservation and management.

However, understanding this kind of resilience will also require studies of links between ecophysiological changes and the genetic properties of individual trees. Ecophysiological responses, summed over individuals, will inform us mostly about the capacity of a stand to deal with events, given that extreme and less extreme events will increase in frequency. Genetic properties will inform us about the long-term adaptive potential of the population as a whole, as well as the limits to selection and adaptation. But ecophysiology and genetics are both needed for a complete picture of the expected fate of a stand. Gathering these data will be more costly and will require a greater range of disciplines than currently mandatory information at stand- and species-level. The data will require their own set of standards that should be sufficiently general and easy to implement to be applied to any stand. Currently, the only descriptors that meet these requirements are molecular assessments of genetic diversity, but those methods are specific to individual species, making it impossible to generalise. Furthermore, current understanding of the links between molecular information on genetic diversity and resilience or adaptive potential is tenuous at best.[11] Pilot studies have demonstrated that intensive DNA sequencing can provide highly valuable information on adaptation and maladaptation of trees.

If full integration of data from remote sensing, ecophysiology and genetics could be achieved, it would allow EUFGIS data to be used to infer the dynamics of stand status. Integrating additional data will require investment to upgrade EUFGIS, but such an investment will be repaid by data of substantially improved quantity and quality and hence usefulness.

AVAILABILITY AND ACCESS TO INFORMATION

Information Needed for the Optimal Conservation and Use of FGR

Information on FGR should permit relevant stakeholders to assess the importance of those FGR in the pan-European context, help identify gaps and overlaps in conservation, and offer insights into potential for use. At the EU and European level, data on FGR conservation should support the interlinked goals of the Green Deal (i.e., the EU Biodiversity Strategy 2030, the New EU Forest Strategy 2030, etc.), and the Forest Europe process to address threats to FGR and the conservation and use of FGR.

[11] Limits to selection could be assessed in regard to the frequency of deleterious mutations, which are relatively straightforward to obtain, although these still require DNA sequence data that is unavailable for many species and stands.

The acquisition and use of standardised information of FGR requires an infrastructure that makes it possible to collect, store and process Findable, Accessible, Interoperable and Reusable (FAIR) data. This infrastructure must be supported by adequate long-term funding and extensive capacity development. At the same time, the FGR community would benefit from closer links with other genetic resources communities (animal genetic resources, plant genetic resources) and by working closely with existing sources of information about environmental, phenotypic and genetic data, forest reproductive material, and data from forest inventories. Data systems within the FGR community must therefore follow widely acceptable taxonomies and data standards in order to support the interoperability essential to establishing such links.

Consistent documentation of standardised information and management practices over time, an essential aspect of effective monitoring, will build knowledge of the impact of environmental changes and management actions on FGR. Even as tools and technologies improve, it will be important to maintain continuity of basic information. In this way, the availability of time series of data will in turn iteratively improve our understanding of FGR and GCU management.

The development of the State of the Europe's Forest Genetic Resources Report, as this strategy recommends, will serve as such documentation, since it will collect and synthesise all the available information, using existing reports and additional data, on the conservation and sustainable use of forest genetic resources.

Information Systems

The European Information System on Forest Genetic Resources (EUFGIS, www.eufgis.org), established in 2010, is the only transnational information system on FGR in Europe. It currently contains information on more than 3500 GCUs of more than 100 tree species from 36 European countries. All GCUs entered into EUFGIS must satisfy minimum requirements.[12] EUFGIS offers 43 data fields for stand-level ecological, management, and administrative information. The EUFGIS standard data ensures comparability of information across GCUs. However, many GCUs contain information only for 19 obligatory data fields. In addition, national forest inventories differ among countries, and the EUFGIS standard data requires additional input that may not be available through these inventories. For these reasons, standardised national inventories of *in situ* FGR should be developed

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

under the umbrella of EUFORGEN and made available in order to improve the quality and comparability of data on FGR. A data sharing agreement should govern the use of GCU data stored in EUFGIS. Currently, a subset of the obligatory data fields in EUFGIS is freely available through a web interface (http://portal.eufgis.org/search/) while the rest of the data can be accessed only by the providing country.

TRAINING AND OPERABILITY OF THE INFORMATION SYSTEM

EUFGIS is the reference information source on FGR at the European level and plays a central role in FGR conservation. It allows countries to identify gaps in the conservation of FGR and to set national priorities to fill these gaps. The system can be used as a national information system and it enables harmonised and reliable reporting in fulfilment of international commitments, such as monitoring for Forest Europe. At the same time, EUFGIS can inform more general conservation actions by ensuring access to information on FGR.

To meet these needs, EUFGIS relies on the following three pillars:

Training of national focal points is crucial to ensure high-quality data and to facilitate access by national and regional actors. Such training must be offered regularly, and national focal points encouraged to contribute to the further development of EUFGIS, for example by identifying new functionality of importance to their country.

Connectivity with other information systems allows FGR to benefit from knowledge generated elsewhere. It is particularly important to connect EUFGIS with the information included in FOREMATIS, the European Forest Reproductive Material Information System, to support the choice of FRM used and distributed across Europe, and FISE, the Forest Information System for Europe. to support the integrated monitoring of European forests. Other information systems with georeferenced data relevant to FGR conservation and use should be identified and linked with EUFGIS. These could include, for example, climatic databases, databases of genetic data and ongoing genetic monitoring efforts.

Development to upgrade EUFGIS is needed to ensure that as society evolves, information on FGR will also evolve to reflect new expectations and new ways of using information. Periodic consultations with national focal points and input from sector experts will prompt the further development of EUFGIS capabilities and expansion to include additional data on FGR. This development will need adequate funding to support technical expertise.

IMPROVING THE AVAILABILITY OF, AND ACCESS TO, INFORMATION ON FOREST GENETIC RESOURCES

Key commitments and recommendations:

1. The **EUFORGEN network** commits to develop, standardise, and regularly revise protocols for characterisation of FGR that could be applied across Europe.

2. The **European countries** and the **EUFORGEN network** commit to increase the proportion of characterised genetic resources, following the standardised protocols.

3. The **EUFORGEN network** commits to improve the characterisation of all genetic conservation units (GCUs) that are part of the European Information System on Forest Genetic Resources (EUFGIS) with environmental (including climatic) and remote sensing data.

4. The **EUFORGEN network** commits to further improve EUFGIS to support FAIR13 data principles and make FGR data FAIR.

5. The **European countries** commit to collect data on conserved forest genetic resources and provide the data to EUFGIS.

6. The **European countries** commit to sign a data sharing agreement between the holder and manager of EUFGIS to regulate and facilitate access to data.

7. The **EUFORGEN network** commits to conduct regular training of EUFGIS focal points on the use of EUFGIS and the curation of data.

8. The **European countries** and the **EUFORGEN network** commit to publish the State of Europe's FGR report.

[13] FAIR data are data which meet principles of findability, accessibility, interoperability, and reusability.

CONSERVATION OF FOREST GENETIC RESOURCES

Forest genetic resources can be conserved *in situ* or *ex situ*, statically or dynamically. Dynamic *in situ* conservation is the preferred method as it aims to conserve a large proportion of a tree population and its associated organisms that evolve in their natural environment. Genetic Conservation Units (GCUs) work as a basic source of information for *in situ* and *ex situ* conservation, and a selection of GCUs form the conservation core network. Efficient management and monitoring of the core network enable alerts and prioritisation, while serving as a useful reporting tool.

IN SITU AND *EX SITU* CONSERVATION

Conservation can in general be classified along two axes. One is the location of conservation, which may be *in situ*, at the existing site of the population, or *ex situ*, in another location. The second axis describes the objective of conservation, which may be static, to conserve the existing genetic diversity of the population, or dynamic, to conserve the evolutionary potential of the population. Most forest genetic resources are conserved *in situ* and with a dynamic orientation. *Ex situ* conservation of FGR tends to take place in genebanks (which by their nature are static) and on plantations, which may be more dynamic.

In situ conservation allows individuals in the population to interact and respond to biotic and abiotic elements of the location over the long term, allowing selective pressures to shape the future genetic make-up of the population through sexual reproduction and plastic responses.

Static conservation is represented by collections of trees or plant parts, including seeds, pollen and other tissues, that maintain a specific genetic composition. The genetic composition has been identified and the intention is to maintain it without change. The expected duration of conservation will depend on the specific material and method of preservation.

An appropriate combination of *in situ* and *ex situ* and static and dynamic conservation will generally be necessary. For example, a GCU may well be healthy and apparently well-conserved *in situ*; however, a fire could destroy the GCU. In such a case, *ex situ* conservation of the population's genetic resources would be valuable to restore the population on the original site. At the same time, it is important to recognise that a single population represents only part of a species' genetic resources, which ideally will be represented by several populations in different environments. Thus, the loss of a single population, while it should be guarded against to the extent possible, will not be as deleterious if that population is part of a network of conserved *in situ* populations.

Widespread local adaptation of forest trees is one of the important factors that has promoted *in situ* dynamic conservation strategies worldwide, and especially in the EUFORGEN programme.

Dynamic Conservation, *In situ* and *Ex situ*

The goal of dynamic conservation is to maintain evolutionary process and adaptive potential so as to ensure the long-term sustainability of natural populations and deliberately created stands. By maintaining wide genetic diversity and responsiveness to biotic and abiotic factors in the environment, it allows new genotypes to appear as a result of sexual reproduction. Without human intervention in either the selection of parent trees or offspring, natural selection will result in the adaptation of the population by acting on the new genotypes.

While dynamic *in situ* conservation links the original population with the environment to which it is adapted, dynamic *ex situ* conservation can be used to favour adaptation to new environmental conditions. Thus, if a suitably diverse population is established in a new environment, dynamic conservation will favour new genotypes pre-adapted to predicted changes at the original location (and elsewhere).

A variety of factors will determine the success of dynamic conservation *in situ* and *ex situ*, including the effective population size, the mating system, levels of genetic diversity and phenotypic plasticity and selection pressure.

Static Conservation, *Ex situ*

Established methods of *in situ* conservation will occasionally fail, especially in an age of rapidly changing biotic and abiotic conditions, many associated with the climate emergency. At the same time, there are cases, for example species that occur in highly fragmented populations such as *Sorbus domestica* and other Rosaceae, that do not form stands amenable to conservation and for which *in situ* conservation is not applicable. Indeed, passive conservation in such cases may result in loss of genetic diversity. For these reasons, *ex situ* conservation in living collections (e.g. seed orchards) and genebanks must be considered.

Existing information allows the development of appropriate protocols to collect seed (or other plant material) that represents the genetic diversity of the population to the greatest practical extent possible, for *ex situ* conservation. Although such conservation preserves genetic diversity in a static manner, in the event of it being needed the expectation is that it contains sufficient diversity to permit natural selection to act and, therefore, to elicit adaptation. Such potential use, whether as forest reproductive material or to re-establish an *in situ* conserved population, requires that stored material is regularly assessed for viability in accordance with nationally accepted standards. This information should be maintained locally and be linked through EUFGIS.

Based on seed collection through the above-mentioned protocols, and for an effective and efficient tracking of the seed conservation and availability, the data needed should be reduced using the least information possible. This will be achieved by developing the pan-European minimum requirements for *ex situ* conservation and simultaneously a platform to store those data, which will consequently assist the reporting of the static *ex situ* conservation status to Forest Europe.

Complementarity of *In situ* and *Ex situ* Conservation

The pan-European network of GCUs efficiently provides the benefits of dynamic *in situ* conservation. An efficient conservation strategy, however, requires additional action to respond to environmental change. Highly endangered populations will need backup static *ex situ* conservation outside the species' natural range. Dynamic *ex situ* conservation can prepare for adaptation to predicted future conditions, and for non-native species especially can promote evolutionary adaptation to a new environment.

There is a need to explore methods for the most efficient integration of *in situ* and *ex situ* conservation. While costs will always need to be considered, and funding sought where necessary, decisions on how best to combine various conservation methods should be based on an evaluation of the threats to each population, the risks associated with each threat, the value of the population to overall conservation and the existence of other conserved populations. Nevertheless, in most cases decisions will have to be made in the face of incomplete information. In that regard, the EUFORGEN Decision Support Tool provides a rationale for managing the GCUs in the network and guidance on how to move from dynamic *in situ* to static *ex situ* conservation through various intermediate levels.

ESTABLISHING A CONSERVATION PROCEDURE FOR FOREST GENETIC RESOURCES

Main Principles

The ultimate goal of FGR conservation is to maintain the adaptive potential of forest tree species and populations, accommodating wide ecological range and management options. There are two broad approaches to such successful conservation, regardless of the particular priority attached to a species.

Effective conservation aims to maximise the effectiveness of conservation, assuming that resources can be expanded and that more resources will be allocated to higher-priority species.

Efficient conservation aims to maximise the results from a given quantity of resources. In this case, little effort would be spent on highly threatened populations if the chance of success is low, even if that population is of high priority.

The balance between these needs to be struck in a national context.

Data and resources available differ across species and in different geographical areas. This implies that conservation decisions will be based on different layers of information, but some guiding principles can be offered. For all species, distribution range is known with more or less precision, which enables geo-localised environmental data to be used to identify populations growing under specific environmental conditions, as a proxy for adaptive potential. The environmental conditions, however, can go beyond climate variables to include other factors relevant to forest tree adaptation, such as soils, elevation, and pests and diseases. New downscaling techniques can make this type of information useful at spatial scales relevant to population adaptation and conservation.

Population genetic studies provide another, more direct source of information about adaptive potential. Most relevant, such studies can identify different gene pools that represent populations that have evolved under distinct evolutionary pressures. In most forest tree species, one finds only a handful of gene pools, often delimited by major biogeographical barriers to gene flow. Integrating information on gene pools into conservation processes would ensure the preservation of evolutionary units of different adaptive potential.

For a handful of species, more precise information about population structure exists based on three different kinds of studies:

Easiest to obtain are **gene-ecological studies**; for more than a century, gene-ecological studies of phenotypic variability in response to environmental differences have identified environmental drivers of population variability.

High throughput DNA sequencing has provided large datasets of **molecular markers**; although connections between molecular variation and fitness are hard to establish, these studies provide information that can help to refine conservation strategies. Molecular information can also enable more predictive models of evolutionary responses under climate change.

Common gardens are the "gold standard" for understanding adaptation and disentangling genetic variation from phenotypic plasticity. However, common gardens are difficult and costly to establish and maintain, and frequently cover a small number of populations and a reduced set of phenotypic traits. Nevertheless, it is important to make information from existing common gardens available to refine conservation strategies. New common gardens, for species and traits currently under-investigated, should be considered.

Generally speaking, conservation procedures will be more effective and more efficient when they are based on a wide range of information about the threats to forest tree populations and the diverse ways in which populations might adapt to or withstand such threats. For that reason, studies of forest tree populations are of great importance to conservation.

Genetic Conservation Units

Recent decades have seen steady improvement in how best to select genetic conservation units for forest trees. Questions of selecting suitable targets for GCUs, assessing threats and potential and management options all require greater knowledge of the genetic properties of the population and other relevant factors. GCUs will become part of a conservation network, which traditionally is expected to cover the entire range of genetic variation of the species. One approach to achieving such coverage is to focus on the additional genetic heterogeneity that would be obtained by adding a population to the network, and rests on a detailed genetic characterisation of each population. A second approach seeks to ensure that the future potential of the species is conserved to the greatest extent possible considering, for example, ecosystem services or the timber and non-timber resources that the GCU may be called upon to provide. This approach rests not on genetic information directly but on proxies such as ecological and geographical considerations. However, this approach suffers from unequal levels of knowledge about different species and from somewhat limited use in the past.

The existing European network of GCUs is evaluated based largely on environmental classification, assuming a close link between environmental – mainly climate – characteristics and genetic differentiation at adaptive gene loci. This approach does not require equal genetic information for all species and can be applied across the entire geographical distribution of the species, with the benefit of harmonisation at the European level (notwithstanding differences in national procedures). However, it does not take into account observations that the pattern of genetic variation does not always reflect the environmental classification. Rather, patterns of genetic variation are often related to demographic history and past migrations, and may also reflect mating system, fragmentation and other factors that affect genetic diversity, adaptation and phenotypic plasticity. For this reason, we believe that environmental classification, which in reality is more often climatic classification, should be used sparingly in the gap analysis of the network of GCUs, especially as other information becomes available. Neutral molecular markers, for example, may illuminate evolutionary divergence and demographic processes and thus improve on environmental classification for the purposes of identifying GCUs. Regions of Provenance, as defined in Council Directive 1999/105/EC, could also be a useful proxy where appropriate.

The problem remains that the genetic structure defined either by neutral markers or provenance may not be useful to quantify genetic changes in response to particular selection pressures, because patterns of adaptive traits frequently fail to match those indicated by neutral or weakly selected loci. A combined approach that uses molecular, quantitative and ecological data would be ideal, but is not yet available for all species. Integrating existing information on evolutionary processes, and extending the information available, would improve conservation planning by improving the identification of important GCUs.

Greater understanding of the threats faced by GCUs is needed too. Some GCUs may be threatened by intrinsic factors such as small population size or altered mating system that could in principle be mitigated by management of the population. Other threats may be external, for example the presence of non-native material planted nearby, which would need other measures to combat. The threats specifically due to climate change can also be modelled and, if necessary, the population can be managed to be more resilient.

Marginal or peripheral populations may require specific consideration for adoption as GCUs, because their characteristics can vary from expectations as a result of, say, founder effects or strong environmental adaptation. An agreed definition of marginality over the complete range of the species would help to ensure that suitable GCUs are identified from these populations.

Having outlined the various sources of information that could contribute to the identification of GCUs, strategic conservation of forest genetic resources will need to call upon all these various sources to assess conservation status. As a result, for coordinated conservation at the European level it will be important to harmonise the various assessment methods.

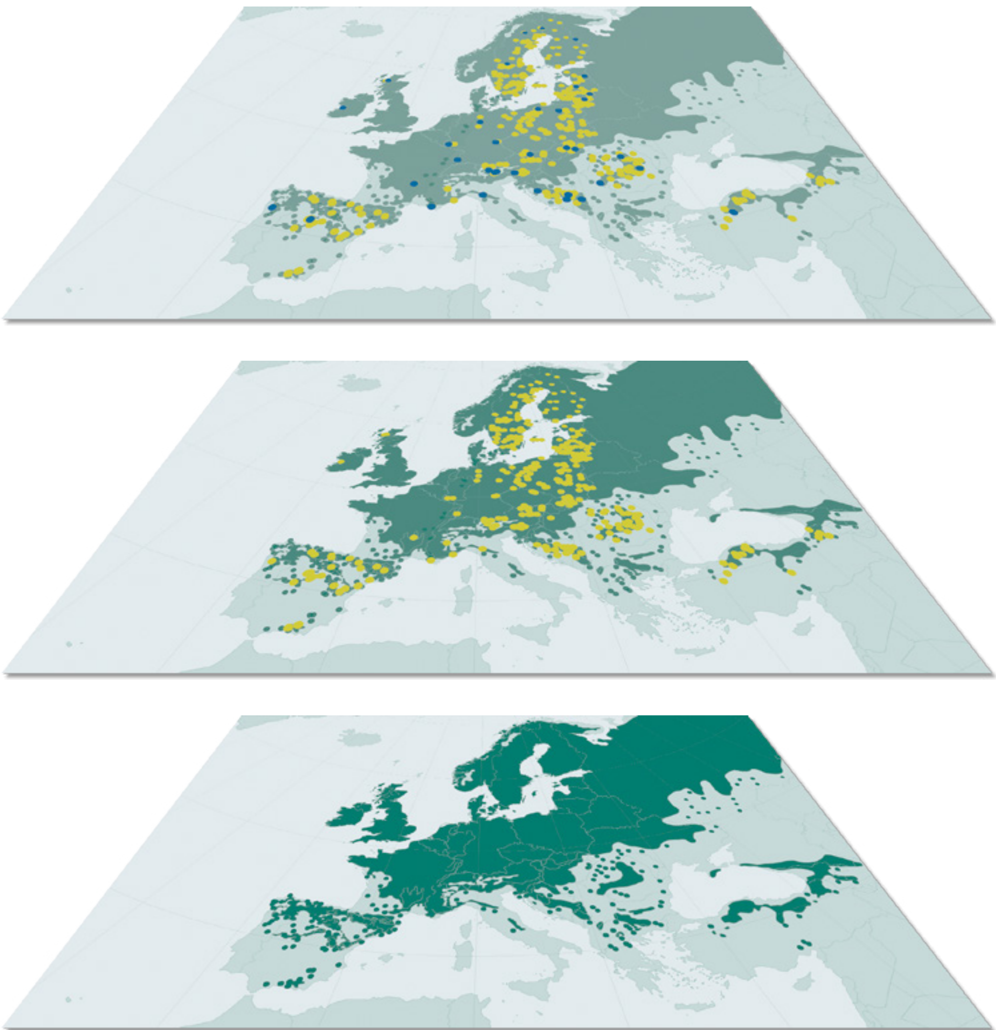
Pan-European Core Network

The purpose of a core network is to represent at the European level the diversity and variation present at national, regional and local levels, through a deliberate selection of GCUs. Representation is the crucial idea; a core network should not contain all the diversity at lower levels, but rather only a comprehensive sample that is as small as possible without losing essential information. The sample that constitutes the core network should be comprehensive in the sense that it contains examples of the broad diversity at lower levels, in proportions that mirror their presence throughout Europe. It is a non-trivial task to select units for the core network.

Selection implies that decisions have to be constantly taken about the completeness of the collection, such that GCUs can be added and removed as required. It requires a sufficient number of units to be proposed at national, regional and local levels, so that those in best locations and in the best condition can be selected to meet the network goals. It also requires that the European level initiate active measures to fill any gaps identified and for which no suitable conservation units have been proposed. This will be especially true for marginal areas, species that are less known and areas with few GCUs. EUFORGEN will thus need to encourage and support national efforts to select and manage GCUs to achieve a fully representative pan-European core network. This in turn will require clear guidelines for accepting new proposed CGUs into the core network.

FIGURE 1

The illustration shows the formation of the GCU core network for a given species (here *Pinus sylvestris*). The GCUs (middle map) are established within the species distribution range (lower map) and those representing the diversity and variation at the European level are then selected to form the core network (upper map).



DISTRIBUTION RANGE CORE NETWORK GENETIC CONSERVATION UNIT (GCU)

Selecting GCUs for the Core Network

As mentioned in "Establishing a Conservation Procedure for Forest Genetic Resources" above, selection of GCUs can make use of several sources of information. An accepted environmental classification of European territory will provide the base layer of information. This classification must be readily available and agreed to by competent experts, sufficiently detailed to be useful throughout Europe, and meaningful specifically for application to forest trees.

It goes without saying that mutually accepted taxonomic classification systems need to be in place. This is relevant for subspecies, any presumed hybrids, or taxonomically disputed or unclear entities. As an example, the rich variety of oak (*Quercus*) species in Europe has been treated differently by botanists. While some stress the high within-species variability of, e.g., *Quercus petraea* and *Q. pubescens*, others designate various subspecies and hybrids (e.g. *Q. petraea* subsp. m*edwediewii*, *Q. dalechampii* or *Q. virgiliana*). A similar situation obtains for ash (*Fraxinus*) species/subspecies/hybrids in more southern Europe.

Forest associations have long been viewed as a static phenomenon, with forests developing from typical pioneer to climax associations, following fixed laws determined by environment and climate. The closer scrutiny of forest history data in recent decades, however, has revealed that species re-colonised Europe largely independently. What appears to be a stable association of trees in a given forest type now may not have existed a few thousand years ago. Even human presence and activity is likely to have had a profound influence on this (for example, there are indications that the relatively late spread of beech (*Fagus sylvatica*) northwards from the Alps may have been initiated by the practice of shifting settlements of early farmers). It is also very likely that today's climate changes may lead to shifts in these associations in the near future.

Phylogenetic data, or even data on the functionally relevant genetic differentiation of species in Europe, would be an ideal further information layer, but is presently not available for any single stand. A number of phylogenetic studies have, however, established a rough and sometimes even finer differentiation among populations derived from different glacial refugia, or adapted to specific environmental and climatic conditions. It is in the absence of this detailed information that proxy data such as environmental classifications become important.

In constructing a core network, each species should be represented by at least one GCU for each environmental zone (phylogenetic strain/forest association/functionally characterised cohort) that the species occupies. If several GCUs have been proposed and are suitable, the most suitable will be selected using a ranking order that will be established by EUFORGEN experts. Additional factors that will feed into the selection process include the uniqueness of a GCU for a region or country and information on adaptive capacity, for example the successful use of planting material from that source under various conditions. Genetic make-up will also play a part, such that if there are two different gene pools present in the same environmental zone, both could be part of the core network.

As indicated in "*In situ* and *Ex situ* Conservation" above and elsewhere, the selection of GCUs for the core network will make use of many of the guiding principles, such as the level of threat, the potential future uses of the material and conservation efficiency. These principles, while generally valid, will require expert discussion in each individual case. EUFORGEN can play an important role in identifying gaps in the pan-European core network and suggesting potential candidate populations to national authorities, which will then need to assess their suitability as GCUs.

Management and Monitoring of GCUs in the Core Network

Climate change introduces considerable uncertainty into the management of forests, and particularly so for the management of GCUs. The network needs to be permanently upgraded, to come closer to the goal of representativeness, and to track climate change and human-induced effects on forests. New findings need to be rapidly communicated, permanently incorporated into the strategy, and into management plans. Monitoring needs to be carried out at all levels – pan-European, national, and individual GCUs – separately. The impact of climate change and forestry interventions will affect not only the tree species, but also associated organisms.

Management may focus on improving on-site growth and reproduction, as well as reducing competition between target species and other plants, and shortening regeneration time, aiming to speed-up adaptation. While recognising that in some cases a hands-off approach could be the best strategy (in the event that regeneration is sufficient, health conditions are optimal, and the genetic conservation unit is sufficiently diverse with regard to environmental variation), the scientific and professional community broadly supports the case for active management.

Reporting

FGR are an integral part of biodiversity conservation reporting efforts at different temporal and spatial scales. The EUFGIS system (which includes information on *in situ* and dynamic *ex situ* conservation) and information on static *ex situ* conservation are the essential data sources for any report on FGR. Additional components might include information on the characterisation of FGR, their value, threat assessments, and topics related to the use of FGR. The implementation of this strategy takes all these components into consideration, and they should be considered for reporting at different levels.

At national level, reporting is essential during the implementation phase of the strategy for setting priorities, identifying gaps, and resource allocation. Reporting will also be important to other aspects of the conservation of endangered plant species and populations, where genetic information is one key aspect, and adaptation to climate change, where dynamic conservation plays a major role. At European level, Forest Europe uses indicators for *in situ* and *ex situ* genetic conservation and forest reproductive material[14]. At a global level, the FAO State of the World's FGR report and monitoring the Global Plan of Action cover European countries and also Europe as a region.

Prioritisation at the European Level

There are between 120 and 200 relevant forest tree species in Europe. Ideally, the genetic diversity of all these species would be conserved and protected, for ethical reasons and because of high uncertainty over their resilience to climate change, since the needs of society tend to change over time. Time and financial resources being constrained, however, some level of prioritisation is required. From a continental viewpoint, prioritisation should have a European dimension, and yet it is up to individual countries to implement national conservation strategies. This adds to the complexity of setting priorities.

Species prioritisation should be based on two main lines of reasoning: the importance of the species for full ecosystem functioning and the level of threat. In many cases, the

[14] Lefèvre, F., Alia, R., Bakkebø Fjellstad, K., Graudal, L., Oggioni, S.D., Rusanen, M., Vendramin, G.G., Bozzano, M. 2020. Dynamic conservation and utilization of forest tree genetic resources: indicators for *in situ* and *ex situ* genetic conservation and forest reproductive material. European Forest Genetic Resources Programme (EUFORGEN), European Forest Institute. 33 p. http://www.euforgen.org/publications/publication/dynamic-conservation-and-utilization-of-forest-tree-genetic-resources-indicators-for-in situ/

economic importance of the species will play a part, not least because there is often more detailed information available about economically important species. In practice, threats, particularly those related to climate change and societal demands, are difficult to predict. Research suggests that forest managers are primarily concerned about pests and diseases, followed by windstorms and drought, often linked to climate change as an overarching worry. In addition, there are diverse types of threat to gene pools. For example, evolutionary history may render some populations less resilient, while human activity may threaten specific genotypes. At the same time, certain taxa should *a priori* be considered of high priority: those with low overall genetic diversity (compared to congeneric species); those with little demographic dynamism, for example as a result of low reproductive success or strong inbreeding; those that are vanishing in part of their range, depriving the future of local adaptive potential; those that are strongly endemic; and, finally, those for which there is currently little or no genetic information.

Further complications are introduced by marginal populations, which may be at the leading or trailing edge of a shifting distribution and which, research shows, can expect to experience strong effects of climate change. Trailing edge populations, which includes many Mediterranean populations of more widely distributed species, have survived many climate shifts, and may be a rich source of specific trait combinations. In mountainous areas, marginal populations may be able to move and track changing conditions, but those on islands or plains would be at greater risk of extirpation and so deserve a higher priority.

EUFORGEN pioneered a functional approach to prioritising species based on aspects of the species' role in the ecosystem and its reproductive behaviour. The US CAPTURE programme outlines a risk assessment framework for climate change based on exposure and sensitivity to climate change along with the capacity to adapt. Combined, the US CAPTURE framework and EUFORGEN's existing process could be adapted and modified to construct an integrated risk assessment and management procedure, recognising the importance of marginal populations. Such an effort would contribute to a comprehensive European conservation strategy, built on national priorities, reached through the harmonised procedure.

CONSERVATION OF FOREST GENETIC RESOURCES

Key commitments and recommendations:

9. The **European countries** commit to establish new Genetic Conservation Units, according to the pan-European minimum requirements, in order to fill existing conservation gaps.

10. The **EUFORGEN network** commits to develop quality management and monitoring strategies for long-term conservation of forest genetic resources.

11. The **European countries** commit to implement quality management and monitoring strategies for long-term conservation of forest genetic resources.

12. The **EUFORGEN network** commits to develop a methodology to improve the identification of conservation gaps in the pan-European core network of GCUs based on additional data (genetic, phenotypic etc.)

13. The **EUFORGEN network** commits to develop pan-European minimum requirements for static ex situ genetic conservation of forest trees.

14. The **EUFORGEN network** commits to develop a platform to store static ex situ conservation data when needed.

15. The **EUFORGEN network** commits to develop criteria for assessing the threat status of GCUs.

16. The **EUFORGEN network** commits to develop criteria for the selection of species whose genetic resources should be prioritised for conservation at European level.

SUSTAINABLE USE, DEVELOPMENT AND MANAGEMENT OF FOREST GENETIC RESOURCES

The use, development and management of FGR needs to balance genetic gain and the provision of multiple ecosystem services (including timber production) against the need to maintain sufficient genetic diversity to ensure long-term sustainability. For this reason, silvicultural practices at every stage of forest development and management should ensure the original level of genetic diversity in the population is at least maintained.

FGR is the basis of selection and breeding programmes that produce forest reproductive material (FRM), which is used in forestry to generate and regenerate forests. Even where natural regeneration replaces deliberate planting, management relies on local FGR and will contribute to shaping the diversity of FGR. In addition, FRM is also important in the production of, for example, Christmas trees and ornamental trees for parks and gardens. The correct choice of FRM is important to ensure genetic gain and to sustain genetic diversity.

BALANCING GENETIC GAIN AND GENETIC DIVERSITY

With respect especially to climate change, FRM has a potential role in enhancing the production of biomass and, under appropriate circumstances, as a carbon sink. There is a temptation to use a small number of out-performing genotypes to achieve these goals. However, this temptation should be resisted as there is a need to maintain the ability of forests to adapt to uncertain threats and to continue to provide a high level of ecosystem services. Genetic gain must be balanced against genetic diversity.

INFORMATION SYSTEMS FOR FRM AND SHARING GOOD PRACTICES

Information about the performance of FRM under different environmental conditions and management regimes is extremely important for the selection of FRM and, as the need arises, to enable guidelines on transfer to be developed. National actors in the management of FRM and other genetic resources have developed their own procedures and practices to collect and store information, and this should continue. However, there is a need for a European online system that would keep and make available geo-referenced records on the origin, production, marketing, movement, use and, where possible, performance of FRM, collating national information systems. At a European level, a procedure for sharing examples of good practices would improve the sustainable use and management of forest genetic resources.

NON-LOCAL FOREST REPRODUCTIVE MATERIAL

In many countries, certification and other schemes related to the forest sector have a strong preference for regeneration based on local FGR. This, however, may not be enough to allow forests to adapt to climate change. Natural regeneration constrains the speed of adaptation, which might be improved by introducing pre-adapted FRM from other locations. Stakeholders should be encouraged to familiarise themselves with the potential benefits of using non-local genetic material for generation and regeneration of forests in the context of rapid climate change. Given that natural evolutionary processes such as adaptation, gene flow and migration are not rapid enough to allow many forest tree populations to adapt to climate change, the current Regions of Provenance regime, further restricted by national boundaries, is not a suitable framework for the transfer of FRM. Relevant authorities should support end users in their efforts to choose the most appropriate FRM, based on origin, provenance and genetic diversity. National decision support tools can assist these efforts, based on the best available scientific evidence and taking future climates into consideration. Key information should include, *inter alia*, provenance recommendations, indicators of genetic diversity and, when available, results of genetic tests. It will also be crucial to continue to monitor transferred material to inform future decisions.

REINFORCE RESEARCH AND SCIENCE-BASED DECISIONS

Climate change increases the urgency of research on tree breeding, domestication and bioprospecting, to unlock the potential of forest genetic resources. For example:

Current models for FRM transfer are typically based on fitness proxies such as survival and growth. To gain a better understanding of adaptive responses and phenotypic plasticity of tree populations and their geographic patterns, future studies should place greater emphasis on phenology and physiological traits. Research on epigenetics in adaptive variation should be promoted, along with the role of associated organisms and symbiotic interactions. Such studies would provide a more detailed picture of adaptation in trees.

Provenance experiments should include noble hardwoods and rare stand-forming or mixed trees in addition to today's commercially important tree species. Lack of information, as a result of the neglect of provenance trials for these types of tree species, is an obstacle to the use of a wider selection of species in multipurpose forestry.

Management practices and chance factors may reduce the genetic diversity of seeds, seedlings and populations at all stages of production. More research is needed on the actual levels of genetic diversity in FRM and the effects of the different production phases and management activities on genetic diversity.

INTEGRATE CONSERVATION RECOMMENDATIONS IN FOREST MANAGEMENT

The conservation of existing genetic diversity is essential to sustainable forest management. In this, proper management is essential. Incorrect management practices may, for example, select individuals with some good productive traits but lacking in adaptability and resilience, leading to avoidable losses of adaptive potential through fire, forest pests and diseases and invasive species. Fundamental forest management activities should not only conserve forest genetic diversity, but also recognise that a variety of naturally distributed non-wood species and wildlife are also essential to ecosystem functioning and may be impacted by these activities. For example, the continuity of mixed-species forests, the preservation of associated microbiota and the minimal use of fertilisers, herbicides and plant health measures require thorough consideration.

Globally, large-scale forest restoration and afforestation are taking place with production, ecosystem services and carbon sequestration among the goals. In selecting FRM for these activities, it is essential that material is chosen both for production abilities and the ability to maintain or enhance the genetic diversity of the forest, enabling it to adapt to future climate conditions. Ideally, conservation strategies will combine genetic conservation with forest management to ensure that the evolutionary potential of all species is maintained.

THREATS TO FOREST HEALTH

Forest health depends largely on weather and climate, both directly through frost, drought and wind and indirectly through climate's influence on the occurrence of forest pests and diseases. Poor forest health is clearly a threat to the genetic diversity of forest trees, and yet the solution lies in genetic diversity, which makes it important to preserve genetic diversity as a source of resilience. The responses of forest ecosystems to climate change differ with region and will depend both on the sensitivity of the system to climate change and its resilience when perturbed by climate change. This means that the adaptation of forest management becomes a highly localised process, influenced by local interactions between climate and forests and the capacity and needs of local societies.

Forest trees are assailed throughout their lives by several abiotic and biotic stresses, and maladaptation to climate change may increase their susceptibility to these stresses. Harmful biological agents, those already established and those that may arrive with changing climate, are potential challenges for the management of forests now and in the future. Many forest pests can spread quickly over long distances, naturally and with unwitting human assistance, and climate change may increase their ability to survive and establish. In addition, the much shorter generation time of forest pests and diseases, especially relative to their host trees, enables them to adapt much faster to climate change. For all these reasons, the introduction and establishment of new forest pests and diseases in tree populations without genetic resistance can be expected to have large economic and ecological consequences.

Official controls[15] and inspections should be intensified and better coordinated among countries in order to respond to changing patterns of trade and, hence, in patterns of movement of forest pests and diseases. Existing phytosanitary regulations and local decision processes need to be continually updated with science-based evidence. At the same time, the effects of forest pests and diseases on forests and forest genetic resources should be monitored, both to provide the science-based evidence and to enable actions to prevent further spread to be taken as quickly as possible.

EUFORGEN was established in 1994 to fulfil the 1990 resolution of the 1st Forest Europe Ministerial Conference by contributing to the implementation of Forest Europe commitments on forest genetic resources and relevant decisions of the Convention on Biological Diversity.

[15] Risk-based official controls in relation to plant health have been harmonised in the EU (Reg. 2017/625). However, official controls on the marketing of forest reproductive material are not harmonised throughout the EU.

SUSTAINABLE USE, DEVELOPMENT AND MANAGEMENT OF FOREST GENETIC RESOURCES

Key commitments and recommendations:

17. The **EUFORGEN network** commits to develop standards and explore options for creating an online information system(s) for geo-referenced records of forest reproductive material end use and where available, performance data.

18. **The EUFORGEN network** commits to develop guidelines for climate change adaptation of GCUs.

ENABLING THE TRANSITION

NETWORKING AND CAPACITY DEVELOPMENT

POLICIES

SCIENCE TO SUPPORT THE STRATEGY

COMMUNICATION AND OUTREACH

ENABLING THE TRANSITION

The efficient conservation and use of forest genetic resources requires a combined effort of all countries within the distribution of a given tree species. With this understanding, the countries of Europe have long promoted a highly inclusive and mutually supportive approach that encourages all to participate in the scientific research that underpins assessment and conservation. EUFORGEN has, over the past 25 years, been central to these cooperative efforts, assisting member countries to support one another in developing the capacity and abilities of the entire community. One of the strengths provided by EUFORGEN's coordination is that it enables countries to bring their own perspectives and knowledge to the communal table, creating a shared ability to understand, analyse and solve issues that no country could handle separately. It also enables sharing across conservation in other domains, such as animal genetic resources and plant genetic resources. Finally, this coordination plays a crucial role in creating a pan-European understanding of what needs to be conserved and how and communicating this understanding to policymakers and other stakeholders with a unified voice.

NETWORKING AND CAPACITY DEVELOPMENT

Over the past decade, the programme has additionally coordinated the development of pan-European strategies and guidelines while serving as a science-policy interface. EUFORGEN has proved an effective mechanism for countries to collaborate, with an important role in conserving forest genetic diversity and contributing to sustainable resource management.

Despite its success to date, EUFORGEN should have the backing and full participation of all relevant countries. If some countries do not support such international efforts, the responsibility and costs of developing effective pan-European conservation strategies fall unfairly and the lack of full participation reduces the prospects of proper conservation of important genetic resources.

For these reasons, EUFORGEN member countries should cooperate to put in place appropriate policy and legal frameworks, along with secure financing of the network and collaboration, to allow all European countries to operate equally and comprehensively in the programme.

The EUFORGEN Secretariat's mandate is to communicate internationally representing the programme, reaching out to various European and international entities, whereas EUFORGEN's National Coordinators are responsible for national communications with their respective national entities. Those entities include policy makers, forest owner associations, conservation communities, scientific communities, international organisations, possible funding agencies, and any other relevant forestry disciplines.

EUFORGEN MEMBERSHIP

The conservation of forest genetic resources is an ongoing process, continually challenged by emerging threats and needs. To ensure that the genetic diversity of forest trees in Europe is properly conserved, all countries need to join together collectively to address the issue. The European Union has an important part to play in long term support of EUFORGEN, so that the network can facilitate and coordinate the essential participation of all relevant countries.

At various times in its 25-year history, 42 countries have been members of EUFORGEN, with a maximum in any one year of 37 member countries. As of October 2021, 26 countries (among them 21 EU members) are supporting the Programme. To some extent, the number of members may reflect the costs of membership. In addition to a financial contribution that depends on a country's GDP and that covers only the direct costs of meetings and coordination, the cost of membership also includes an equivalent amount of staff time by participating national experts.

To reach the full potential of a networking programme such as EUFORGEN, a permanent funding mechanism is needed. A regular contribution from the European Union would guarantee the continued coordination efforts of EUFORGEN and ongoing interactions among stakeholders, with the expectation that current member countries will maintain their existing contributions to the programme. Having recognised the benefits of EUFORGEN to date, and acknowledging the need for full cooperation across species distributions, a long-term programme such as EUFORGEN, which has proven its worth, represents the best approach for the European Union to ensure the conservation and sustainable use of its forest genetic resources, through mechanisms it deems most suitable.

EUFGIS EXPANSION

The European Forest Genetic Resources Information System (EUFGIS) collates information from genetic conservation units (GCUs) across Europe, providing an inventory of conserved FGR that supports sustainable forest management. At present, the information in EUFGIS is limited to general stand-level descriptive data. The further development of an improved EUFGIS will see the addition of ecological, environmental, genetic and phenotypic data, as outlined in "Availability and Access to Information".

All EUFORGEN member countries will contribute to expanding the utility and value of EUFGIS, by adding this additional data to the system. In addition, countries that are not currently members of EUFGIS will be encouraged to join, boosting coverage and the amount of information available. An enhanced information system will improve the conservation and sustainable use of FGR in part by helping to identify conservation gaps and also, ultimately, by providing information that can improve forest management and tree breeding.

FOREST MANAGEMENT AND GCUS

To ensure the adaptability of tree populations in the GCUs and that their diversity is conserved, it is important that these areas are monitored continually and authorities responsible for their conservation are ready to intervene to properly manage them by supporting regeneration and speeding up adaptation, if and when required.

In the case of artificial regeneration or reforestation, forest managers need information on the forest reproductive material available on the market in order to make decisions on what to plant and where to source it. Such choices would be improved by the development of decision support tools for managers to choose the most suitable FRM. Integrated with EUFGIS, such a decision support tool could also alert national authorities of possible threats to a GCU. Alerts would help authorities to adopt a long-term perspective in the management of GCUs, notably by simplifying the identification of threats to the population as a whole and linking appropriate management actions to the threats. As a next step, the tool could continue to assess the status of GCUs by tracking the monitoring cycles of the GCUs.

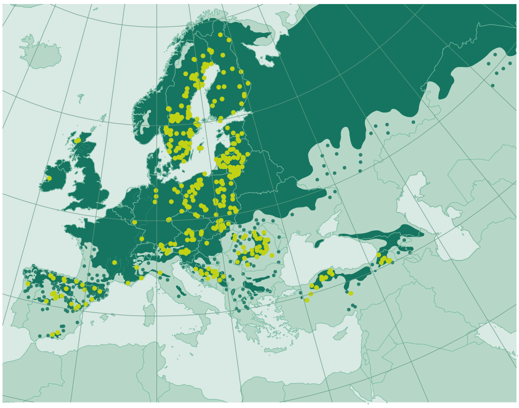
NEIGHBOURING COUNTRIES

The distribution of many European tree species extends into countries outside the political and geographic confines of Europe. Effective conservation of genetic diversity requires those countries to implement a conservation strategy that is aligned with the strategy within Europe. This is particularly important in light of climate change, because in future Europe may need genetic diversity that is currently outside its administrative and geographical boundaries.

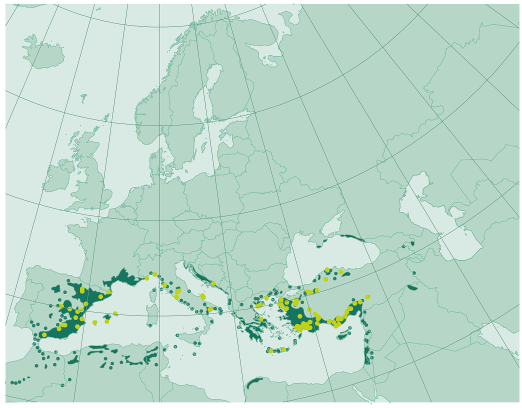
EUFORGEN member countries commit to mobilise resources and partnerships to include countries outside Europe that contain FGR of interest. The broadened effort will develop capacity in and strengthen collaboration with neighbouring countries. Increased collaboration will improve early warnings of threats to FGR and, along with increased communication and dissemination in neighbouring countries, will increase the impact of future policy decisions.

FIGURE 2

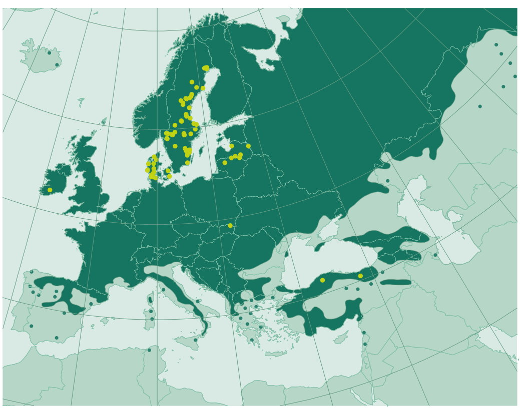
Many forest tree species have their edge limits in neighbour countries. For an effective conservation of species diversity, these countries should be implementing a similar conservation strategy. Such conservation effort is needed to ensure the diversity of the species is properly safeguarded.



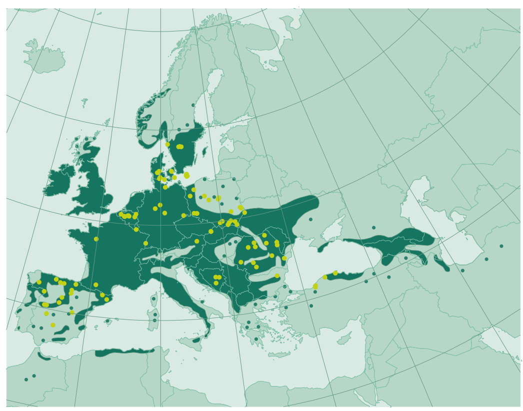
Pinus sylvestris



Pinus halepensis/P. brutia



Populus tremula



Prunus avium

● DISTRIBUTION RANGE ● GENETIC CONSERVATION UNIT (GCU)

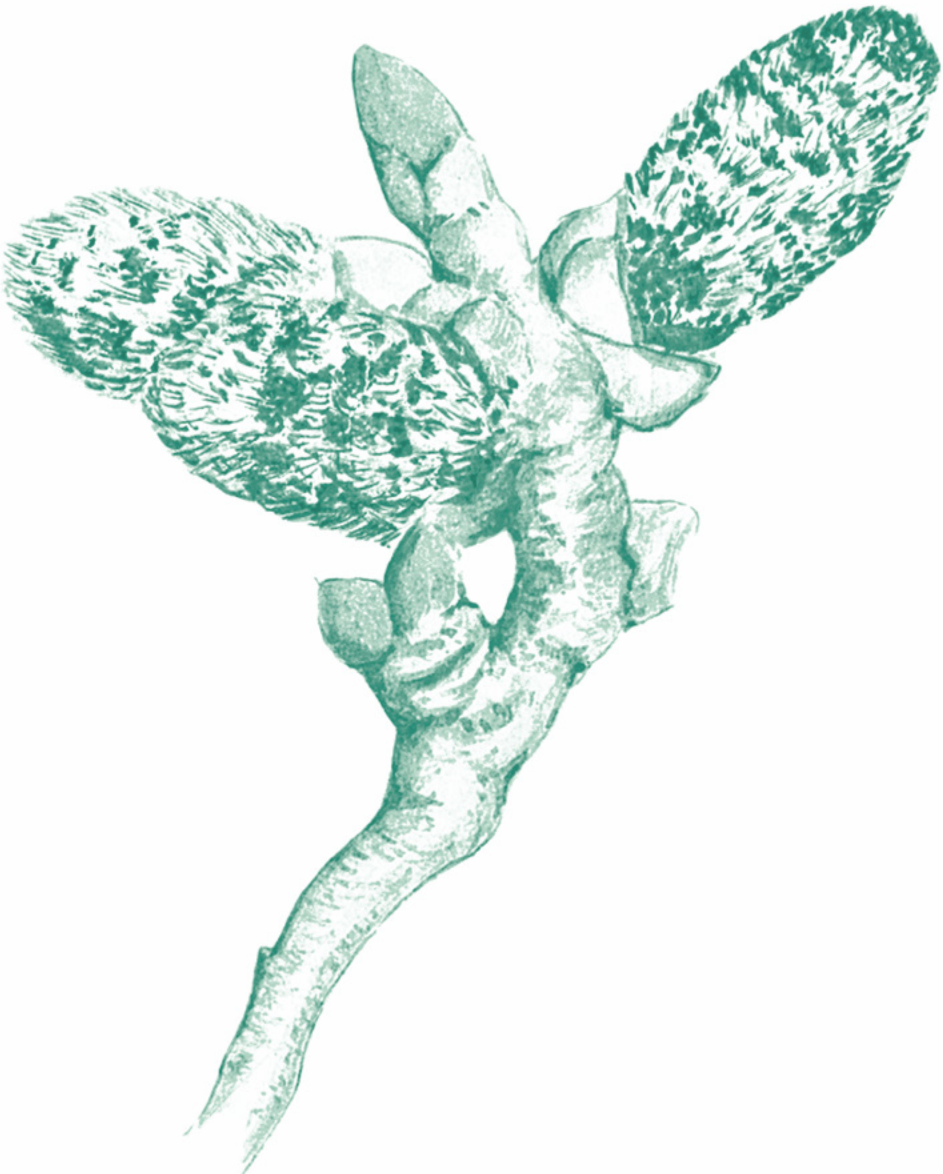
NETWORKING AND CAPACITY DEVELOPMENT

Key commitments and recommendations:

19. The **European Commission is urged** to provide direct funding to the EUFORGEN Programme in order to strengthen its capacity and ensure the participation of all European countries.

20. The **EUFORGEN network** commits to link EUFGIS with other relevant Information Systems in Europe.

21. The **European countries** are encouraged to mobilise resources and develop partnerships to support non-European countries, especially those of Caucasus, Near East and North Africa, to conserve and sustainably manage Forest Genetic Resources.



POLICIES

CONSERVATION OF FOREST GENETIC RESOURCES IN EUROPE AND INTERNATIONAL POLICIES

Many policy instruments directly impact forest genetic resources. Some are global, like the Convention on Biological Diversity (CBD) and the Nagoya Protocol, legally binding commitments that call for countries to develop and implement national FGR conservation programmes. Others operate at several levels. The FAO Commission on Genetic Resources for Food and Agriculture in 2015 adopted a strategy for the implementation of the Global Plan of Action for the Conservation, Sustainable Use and Development of Forest Genetic Resources (GPA-FGR) at global, regional and national levels. In Europe, the major regional policies that impact FGR are the Forest Europe process, the New EU Forest Strategy for 2030, the EU Rural Development Programme, the EU Directive on Plant Reproductive Material and the EU Regulation on Invasive Alien Species. In addition, other sub-regional and national policies also have an impact on FGR.

Many of the international policies that affect FGR consider different aspects, such as biodiversity, commercialisation, production, use and others. These instruments are often negotiated without sufficient forestry expertise, despite the tight coupling between FGR and biodiversity, climate change, trade and sustainable use. As a result, the forestry sector is sometimes taken unawares by policy decision in closely related sectors.

The consideration of genetic resources within policies is itself often a difficulty. There is general agreement scientifically that genetic diversity is, by definition, part of overall biodiversity, and hence that any commitment to conserve biodiversity necessarily includes the conservation of genetic resources. In practice, however, unless genetic diversity is specifically spelled out in policy papers, biodiversity is considered only as habitat and species diversity. Consequently, genetic diversity is ignored in the implementation phase because there is no specific reference to forest genetic diversity and genetic resources.

ACCESS AND BENEFIT SHARING

The CBD gives countries sovereign rights over the genetic resources found in their territory. Benefits that arise from research and development on genetic resources should be shared fairly and equitably with the country that provided the genetic resources. The Nagoya Protocol, on access to genetic resources and the fair and equitable sharing of benefits arising from their utilisation, establishes a legally binding framework for how researchers and the private sector can obtain access to the genetic resources of a country and to traditional knowledge associated with these resources. As there is no other specific and internationally recognised instrument for forest genetic resources, all research and development on FGR must comply with the principles of the Nagoya Protocol and, in EU member states, with EU Regulation (511/2014), to ensure fair and equitable sharing of benefits. Compliance will also provide legal certainty and transparency for both providers and users of genetic resources and associated traditional knowledge.

PAN-EUROPEAN COLLABORATION

Within Europe, the implementation of genetic conservation is based on national programmes that are developed according to the specific geographical, political and societal conditions in each country. Nevertheless, coordination at the European level is desirable to ensure that genetic conservation in Europe is cost efficient and scientifically sound. EUFORGEN should continue to be a central platform to exchange and disseminate information about scientific and technical advances to make them available for countries to develop their national programmes. The EUFORGEN Secretariat will also represent the community internationally and will have an important role in following policy developments internationally and in Europe and keeping countries informed, further supporting their national policies and programmes. Coordinated guidance at European level, as can be provided by EUFORGEN, will facilitate and support the development and review of national FGR programmes. Countries should also be encouraged to include considerations of FGR in their National Forest Programmes and other relevant strategies.

SUPPORT FOR GENETIC MONITORING

Forest genetic monitoring (FGM) seeks to assess the status of genetic resources and to quantify changes over time with a view to preserving long-term adaptive evolutionary potential. The basis for FGM is a genecological approach, which sees that the important drivers of evolution at the level of the individual are natural selection, genetic drift and gene flow. A system of informative demographic and genetic parameters, along with environmental data, enables researchers to evaluate the impact of these drivers and to examine the maintenance of genetic diversity over time.

Tracking changes over time in turn provides data that permit the inference of causal relationships and evaluation of their relative importance, making FGM a predictive tool that can help to secure the processes that maintain genetic variation in natural populations. Monitoring should apply to species of biological and economic importance for conservation, potentially with an initial emphasis on populations at the trailing edge of shifting species distributions, because these are likely to experience the consequences of climate change more rapidly and perhaps more extensively. A programme of forest genetic monitoring should begin in established GCUs, where existing data would permit FGM to check whether the diversity being conserved continues to be of significant adaptive potential or is under significant threat.

Political commitment for long-term genetic monitoring is needed, not least to comply with Article 7 of the CBD, which calls for action to “monitor through sampling and other techniques the components of biological diversity”. FAO’s first State of the World Forest Genetic Resources Report refers to the need for genetic monitoring, and there is a growing international effort to include specific genetic indicators in the CBD’s post-2020 Global Biodiversity Framework. The need for genetic monitoring resulted in the development of global biodiversity indicators and the Aichi Biodiversity Target Indicators. Other international processes, such as the Montreal Protocol and the International Tropical Timber Organization, and those at regional level, such as the Helsinki Process, call for the establishment of criteria and indicators for genetic diversity. European processes too (see "Conservation of Forest Genetic Resources in Europe and International Policies" above) may directly affect FGR and require monitoring.

FGM answers these needs. Proof-of-principle exercises have shown that FGM can provide valuable information on the future state of genetic diversity and population survival, but gathering the data is a long-term and costly exercise. Against this background, this strategy encourages long-term political commitment to forest genetic monitoring, which will also complement the Forest Europe pan-European indicators for sustainable forest management, in particular those under Criterion 4.

POLICIES

Key commitments and recommendations:

22. The **European countries** and the **EUFORGEN network** commit to monitor progress of *in situ* and *ex situ* conservation and use of FRM for the FOREST EUROPE Process (Indicator 4.6).

23. The **European countries** and the **EUFORGEN network** commit to promote the importance of genetic diversity in nature conservation-related and forest-related policies and decision-making processes.

24. The **European countries** commit to contribute to the FAO State of the World FGR and Global Plan of Action on FGR reporting.

25. The **EUFORGEN network** commits to strengthen its role in contributing to the international processes relevant to FGR.

SCIENCE TO SUPPORT THE STRATEGY

Different countries, and in some cases regions, will necessarily make their own choices about the selection and characterisation of GCUs. Nevertheless, a pan-European strategy requires a consensus on core criteria and calls for shared objectives and a shared research programme. This sharing flows in both directions. National efforts need to exchange equivalent and interoperable information and at the same time need to consider continent-level conservation needs. Such an alignment of research approaches and goals between national and international actors, based on strategically agreed guidelines, adds value at both levels by enabling the direct comparability of national data sets with larger data sets compiled across the continent. The information available will represent a greater range of environmental zones and management practices and thus will help tackle major research issues such as local adaptation, phenotypic plasticity and their interaction with climate, topics of high societal importance.

The collection and exchange of agreed information requires national funding agencies and forest management offices to allocate resources specifically to this kind of research, which is required by the pan-European strategy. At the same time, EU-level coordinated actions should foster collaborative projects along these lines and relevant information systems (e.g. EUFGIS) can make data available for scientific purposes. Existing European-scale research networks like EVOLTREE can support the conservation strategy by providing basic genetic information and by identifying knowledge gaps that need to be addressed and the experts who might address them. In this context too, the forestry community should aim to leverage the presence of FGR scientists in the steering committees of relevant funding agencies. As advocates, they can encourage national and regional funding agencies to include the Forest Genetic Resources Strategy For Europe in their research objectives and funding recommendations.

Specific research needs that would support the Forest Genetic Resources Strategy For Europe have been identified throughout this document.

Periodically, European countries collaborate under the umbrella of the EUFORGEN programme to identify the research needs on the European forest genetic resources and disseminate them to implementing agencies, funding bodies and donors.

SCIENCE TO SUPPORT THE STRATEGY

Key commitments and recommendations:

26. The **EUFORGEN network** commits to make continual assessments of research needs on FGR.

27. The **EUFORGEN network** commits to contribute to scientific discussions relevant to the FGR field.

COMMUNICATION AND OUTREACH

The conservation and sustainable use of forest genetic resources in future will depend to a large extent on helping actors outside the sector to share an appreciation of the importance of genetic diversity in coping with uncertain futures.

The FGR sector understands that genetic diversity underpins the ability of forest trees to survive, adapt and evolve under changing conditions and that genetic diversity is crucial to maintain the vitality of forests and to cope with forest pests and diseases. Genetic resources are the basis for forests to deliver actual and potential economic, environmental, scientific and societal benefits now and going forward. However, there is a gap between the sector's understanding of the pivotal role of FGR and the awareness and recognition of that role among other actors in society.

EUFORGEN has already developed a communication strategy to give direction to the Programme's work. This strategy seeks to support communication on FGR for a variety of audiences within countries, regions and in Europe as a whole.

Target audiences include any group that has the opportunity to influence the conservation of FGR. This ranges from policy and decision makers, through managers and researchers of forests and the environment, including those concerned with the conservation of other domains of genetic resources. The target audiences encompass too the broader public, for whom forests and the genetic resources they require supply a range of benefits. These audiences are present in Europe and in neighbouring countries. The specific messages that should be shared with each audience will, of course, be tailored to the actions that audience should take, but the overarching goal is to ensure that all understand and acknowledge that the conservation and sustainable use of FGR is an integral part of sustainable forest management and is essential to cope with an uncertain future.

EUFORGEN creates and maintains communication channels for its members. The network provides its services wherever relevant in order to strengthen engagement between different entities. In addition, EUFORGEN periodically undertakes conversations on research and policy needs and actions, which enable it to create links with the scientific community and with key stakeholders. These links and dialogues foster cooperation with the scientific community, allowing new technologies and outcomes to be successfully implemented in practice.

European funding could enable extraordinary networking opportunities and joint work between EUFORGEN and similar regional networks within the FAO work on forest genetic resources. According to the most recent scientific estimates, there may be at least 60 000 tree species on Earth, not all having been inventoried yet. Scientific knowledge on intraspecific genetic diversity and the possible sustainable use of forest trees is still not far advanced. Joining all participants in this sector for collective action is an urgent necessity.

COMMUNICATION AND OUTREACHS

Key commitments and recommendations:

28. The **EUFORGEN network** commits to develop, strengthen and maintain communication channels with relevant stakeholders through all EUFORGEN bodies (Secretariat, Steering Committee and National Coordinators)

CONCLUSION

“WE AS REPRESENTATIVES OF THE SIGNATORIES OF FOREST EUROPE, COMMIT OURSELVES TO CONTINUE PAN-EUROPEAN COLLABORATION ON FOREST GENETIC RESOURCES THROUGH THE EUROPEAN FOREST GENETIC RESOURCES PROGRAMME (EUFORGEN).”

Forest Europe 7th Ministerial Conference
Ministerial Resolution 2 - Protection of forests in a changing environment
Madrid, Spain

20-21.10.2015

Forest Europe growing life

Forest genetic resources serve as the basis for sustainable use of forests and safeguard the forests' health and adaptive capacity. The FOREST EUROPE process is committed to pan-European collaboration on forest genetic resources.

In addition, the European countries and the EU are committed to sustainable forest management and to address the key drivers of biodiversity loss, through the European Green Deal, the new EU Forest Strategy 2030 and the EU biodiversity strategy. The effective conservation and sustainable use of forest genetic resources will reinforce the sustainability and resilience of forests and forest tree species under the threats posed by the climate emergency.

The Forest Genetic Resources Strategy For Europe is a coordinated effort by the European Forest Genetic Resources Programme to improve the conservation and sustainable use of European forest genetic resources. It goes beyond the current individual countries' efforts and furthermore deals not only with conservation but also with the sustainable use of forest genetic resources, while introducing additional new elements for more accurate characterisation and classification. It also identifies the need to expand scientific knowledge, defines the principles for coordination activities at policy level, and recommends future actions and collaborations among different entities and international organisations.

The implementation of the Strategy will be a continual process to reach the same level of coherence and alignment across all European countries. It will ensure stronger cooperation in the pan-European region for the conservation and sustainable use of forest genetic resources.

IMPLEMENTATION PLAN

"WE, THE REPRESENTATIVES OF THE SIGNATORIES OF FOREST EUROPE COMMIT OURSELVES TO RECOGNISE THE NEED FOR DYNAMIC CONSERVATION AND UTILIZATION OF FOREST TREE GENETIC RESOURCES AND MANAGEMENT OF FOREST TREE SPECIES POPULATIONS FOR PRODUCTION OF FOREST REPRODUCTIVE MATERIAL (AS REFLECTED IN THE UPDATED PAN-EUROPEAN INDICATOR FOR SUSTAINABLE FOREST MANAGEMENT 4.6 GENETIC RESOURCES) AND CONTINUE PAN-EUROPEAN COLLABORATION ON FOREST GENETIC RESOURCES THROUGH THE EUROPEAN FOREST GENETIC RESOURCES PROGRAMME TO THIS END."

Forest Europe 8th Ministerial Conference
Bratislava Ministerial Declaration - ''The Future We Want: The Forests We Need''
Bratislava, Slovakia

14-15.04.2021

Forest Europe growing life

IMPROVING THE AVAILABILITY OF, AND ACCESS TO, INFORMATION ON FOREST GENETIC RESOURCES

Key Commitment	Action	Indicator	Timeframe	Actor
1				
The **EUFORGEN network** commits to develop, standardise, and regularly revise protocols for characterisation of FGR that could be applied across Europe	Protocol development, standardisation, and revision for the characterisation of FGR	Protocols available and revised as needed	New reference available by 2025, then revised as needed	**EUFORGEN network**
2.				
The **European countries** and the **EUFORGEN network** commit to increase the proportion of characterised genetic resources, following the standardised protocols	Increase the proportion of characterised genetic resources	Number of tree populations (can be GCUs), where genetic resources are characterised, available	Ongoing	**European countries** and **EUFORGEN network**
3.				
The **EUFORGEN network** commits to improve the characterisation of all genetic conservation units (GCUs) that are part of the European Information System on Forest Genetic Resources (EUFGIS) with environmental (including climatic) and remote sensing data	Characterisation of GCUs (in EUFGIS) based on environmental and remote sensing data	Environmental characterisation of **all** GCUs available on EUFGIS	By 2025	**EUFORGEN network**
4.				
The **EUFORGEN network** commits to further improve EUFGIS to support FAIR[15] data principles and make the FGR data FAIR	EUFGIS upgrade	EUFGIS upgraded version available and FAIR compliant	By 2025	**EUFORGEN network**

15 FAIR data are those that meet principles of findability, accessibility, interoperability, and reusability.

→ Improving the availability of, and access to, information on forest genetic resources

Key Commitment	Action	Indicator	Timeframe	Actor
5.				
The **European countries** commit to collect and data on conserved forest genetic resources and provide the data to EUFGIS	EUFGIS data collection and provisioning	Updated GCU data on EUFGIS	Ongoing	**European countries**
6.				
The **European countries** commit to sign a data sharing agreement with the holder and manager of EUFGIS to regulate and facilitate access to data	Develop data sharing agreement	Signed data sharing agreements by all countries	By 2025	**European countries**
7.				
The **EUFORGEN network** commits to conduct regular training of EUFGIS focal points on the use of EUFGIS and the curation of data	Organise regular trainings to add and curate EUFGIS data and use EUFGIS as a tool for their own work. Their training has been updated as EUFGIS has been evolved.	Number of Focal Points that are trained. Number of training events organised.	Ongoing	**EUFORGEN network**
8.				
The **European countries** and the **EUFORGEN network** commit to publish the State of Europe's FGR report	(a) Provide reports on the country's state of FGR (b) Collect and analyse all data/ national reports	Report published		(a) **European** countries and (b) **EUFORGEN network**

CONSERVATION OF FOREST GENETIC RESOURCES

Key Commitment	Action	Indicator	Timeframe	Actor
9.				
The **European countries** commit to establish new Genetic Conservation Units, according to the pan-European minimum requirements, in order to fill existing conservation gaps	Establish new GCUs in each country	Reduced conservation gaps in each country (positive trends based on revised indicator 4.6)	Ongoing	**European countries**
10.				
The **EUFORGEN network** commits to develop quality management and monitoring strategies for long-term conservation of forest genetic resources	Develop quality management and monitoring strategies through a cooperative discussion platform (and working group)	Strategy on quality management and monitoring for long-term conservation of FGR available	2025-2030	**EUFORGEN network**
11.				
The **European countries** commit to implement quality management and monitoring strategies for long-term conservation of forest genetic resources	Implement the strategy on quality management and monitoring for long-term conservation of FGR	Number of countries where the strategy on quality management and monitoring for long-term conservation of FGR is implemented	After 2030	**European countries**
12.				
The **EUFORGEN network** commits to develop a methodology to improve the identification of conservation gaps in the pan-European core network of GCUs based on additional data (genetic, phenotypic, etc.)	Develop a new methodology to improve the identification of conservation gaps in the core network	New methodology to improve the identification of conservation gaps in the core network available	2025-2030	**EUFORGEN network**

→ Conservation of Forest Genetic Resources

Key Commitment	Action	Indicator	Timeframe	Actor
13.				
The **EUFORGEN network** commits to develop pan-European minimum requirements for static *ex situ* genetic conservation of forest trees	Develop the pan-European minimum requirements for static *ex situ* genetic conservation of forest trees	Pan-European minimum requirements for static *ex situ* genetic conservation of forest trees available	By 2025	**EUFORGEN network**
14.				
The **EUFORGEN network** commits to develop a platform to store static *ex situ* conservation data when needed	Develop a platform to store static *ex situ* conservation data	Platform to store static *ex situ* conservation data available	2025-2030	**EUFORGEN network**
15.				
The **EUFORGEN network** commits to develop criteria for assessing the threat status of GCUs	Develop threat assessment indicators of FGR	Threat assessment indicators of FGR available	2025-2030	**EUFORGEN network**
16.				
The **EUFORGEN network** commits to develop criteria for the selection of species whose genetic resources should be prioritised for conservation at European level	Develop the criteria for the selection of species with prioritised genetic resources for conservation at European level	Criteria for the selection of species with prioritised genetic resources for conservation at European level available	2025-2030	**EUFORGEN network**

SUSTAINABLE USE, DEVELOPMENT, AND MANAGEMENT OF FOREST GENETIC RESOURCES

Key Commitment	Action	Indicator	Timeframe	Actor
17.				
The **EUFORGEN network** commits to develop standards and explore options for creating an online information system(s) for geo-referenced records of forest reproductive material end use and, where available, performance data	Identify standards and options for creating an online information system(s) for geo-referenced records of FRM and performance data	Standards and options for creating an online information system(s) for geo-referenced records of FRM and performance data available	2025-2030	**EUFORGEN network**
18.				
The **EUFORGEN network** commits to develop guidelines for climate change adaptation of GCUs	Launch discussion platform (and working group) on climate change adaptation of GCUs	Guidelines for climate change adaptation of GCUs available	By 2025	**EUFORGEN network**

NETWORKING AND CAPACITY DEVELOPMENT

Key Commitment and recommendations	Action	Indicator	Timeframe	Actor
19.				
The **European Commission is urged** to provide direct funding to the EUFORGEN Programme in order to strengthen its capacity and ensure the participation of all European countries	**The European Commission identifies the modalities to** provide direct funding to the EUFORGEN Programme	Direct funding by the EC to the EUFORGEN Programme provided	By 2025	**European Commission**
20.				
The **EUFORGEN network** commits to link EUFGIS with other relevant Information Systems in Europe	Identify and apply the information technology to link EUFGIS with other relevant information systems in Europe and develop agreements as appropriate	EUFGIS linked with other relevant information systems in Europe	2025-2030	**EUFORGEN network**
21.				
The **European countries** are encouraged to mobilise resources and develop partnerships to support non-European countries, especially those of Caucasus, Near East and North Africa, to conserve and sustainably manage Forest Genetic Resources	European countries individually or through joint funding mechanisms support projects to conserve and sustainably manage Forest Genetic Resources in neighbour countries	Number of projects to conserve and sustainably manage Forest Genetic Resources in neighbour countries	Ongoing	**European countries**

POLICIES

Key Commitment	Action	Indicator	Timeframe	Actor
22.				
The **European countries** and the **EUFORGEN network** commit to monitor progress of *in situ* and *ex situ* conservation and use of FRM for the FOREST EUROPE Process (Indicator 4.6)	Monitor progress of *in situ* and *ex situ* conservation and use of FRM	Progress of *in situ* and *ex situ* conservation and use of FRM reported to the State of Europe's Forests	Ongoing	**European countries** and **EUFORGEN network**
23.				
The **European Countries** and the **EUFORGEN network** commit to promote the importance of genetic diversity in nature conservation-related and forest-related policies and decision-making processes	Actively engage in nature conservation-related and forest-related policies and decision-making processes.	Number of events or initiatives where National Representatives or the EUFORGEN Secretariat have promoted the importance of genetic diversity in nature conservation-related and forest-related policies and decision-making processes	Ongoing	**European countries** and **EUFORGEN network**
24.				
The **European countries** commit to contribute to the FAO State of the World FGR and Global Plan of Action on FGR reporting	Contribute to the FAO State of the World FGR and GPA-FGR reporting	Number of European countries that contributed to the FAO State of the World FGR and GPA-FGR reporting	Ongoing	**European countries**
25.				
The **EUFORGEN network** commits to strengthen its role in contributing to the international processes relevant to FGR	Identify international processes relevant to FGR and developing communication channels	Number of communication channels used for relevant processes	Ongoing	**EUFORGEN network**

SCIENCE TO SUPPORT THE STRATEGY

Key Commitment	Action	Indicator	Timeframe	Actor
26.				
The **EUFORGEN network** commits to make continual assessments of research needs on FGR	Organise workshops for the identification of research needs for FGR	Regular assessments of FGR research needs	Ongoing	**EUFORGEN network**
27.				
The **EUFORGEN network** commits to contribute to scientific discussions relevant to the FGR field	Contribute to scientific discussions relevant to the FGR field	List of scientific discussions where the EUFORGEN network contributed	Ongoing	**EUFORGEN network**

COMMUNICATION AND OUTREACH

Key Commitment	Action	Indicator	Timeframe	Actor
28.				
The **EUFORGEN network** commits to develop, strengthen, and maintain communication channels with relevant stakeholders through all EUFORGEN bodies (Secretariat, Steering Committee and National Coordinators)	Develop, strengthen and maintain communication channels with relevant stakeholders through all EUFORGEN bodies	List of relevant stakeholders outreached through all EUFORGEN bodies	Ongoing	**EUFORGEN network**

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