Bioversity International

EUFGIS AGRI GEN RES action 009

co-funded by the European Commission under Council Regulation (EC) N° 870/2004[1]

www.eufgis.org

[1] Council Regulation (EC) No 870/2004 of 24 April 2004 establishing a Community programme on the conservation, characterisation, collection and utilisation of genetic resources in agriculture. Official Journal L 162, 30/04/2004 P. 0018 - 0028

1. Background

1.1. Forest genetic resources and the threats they face

Forests provide a vast array of products, socioeconomic benefits and environmental services. Sustainable forest management aims at managing forests in such a way that the capacity of forests to provide these products, benefits and services for human well-being does not diminish over time. Within the European Union (EU), there are 157 million hectares of forests and 35 million hectares of other wooded land, together covering 42 percent of the land area [(1)]. Some 56 percent of the population in the EU Member States live in rural areas [(2)], i.e. within or nearby forest and other wooded land, and the EU forest sector employs a total of 2.5 million persons [(1)].

The genetic diversity of forest trees is crucial for adaptation of forests to climate change [(3)] and for sustaining other species and entire forest ecosystems [(4)]. Genetic diversity is also needed to maintain the vitality of forests and to cope with pests and diseases. However, forest genetic diversity is facing several threats, such as habitat destruction, fragmentation, poor silvicultural practices and inappropriate use of forest reproductive material. Therefore, special attention should be given to conservation of forest genetic diversity while implementing sustainable forest management.

Forest trees differ from other plant species in their capacity to maintain high levels of genetic diversity within populations rather than among populations [(5)]. This is partly due to extensive gene flow as pollen typically travels distances of up to several kilometers in both wind and animal pollinated tree species [(6)]. Furthermore, trees have outcrossed mating systems, a long generation time, large population sizes and overlapping generations. Subsequently, trees can resist to some extent the negative consequences of forest degradation and fragmentation [(7)]. Despite the extensive gene flow, forest tree populations also demonstrate adaptation to local environmental conditions [(8)].

During the past 2.6 million years (Quaternary Period), the distribution ranges of tree species in Europe have not been stable but dynamically contracting, expanding or shifting as a result of climatic changes. Recent genetic and paleoecological studies have provided insights into the past dynamics of the distribution ranges by locating refugia areas and postglacial migration routes [(9, 10)]. Climate conditions will continue influencing the migration and distribution of forest trees in the future [(11)] but it is unclear how well tree populations, especially those ones on the trailing edge of the distribution range [(12)], can cope with the speed of the current climate change.

1.2. Conservation of forest genetic resources in Europe

In Europe, the need to improve conservation of forest genetic resources, i.e. genetic variation in trees valuable for present or future human use, was recognized by policymakers in 1990 when the first Ministerial Conference on the Protection of Forests in Europe (now FOREST EUROPE) adopted a resolution on these resources. In 1994, the countries established the European Forest Genetic Resources Programme (EUFORGEN) to facilitate and coordinate pan-European collaboration in this area. The Ministerial Conference in 1990 and the adoption of the Convention on Biological

Diversity (CBD) in 1992 prompted many countries to develop specific national programmes or strategies for managing their forest genetic resources.

In situ conservation is commonly the preferred approach for maintaining the genetic diversity of forest trees. Some forest trees are also conserved *ex situ* in seed banks, seed orchards, clone collections, provenance trials and planted conservation stands to complement *in situ* conservation efforts (particularly when population size is critically low in the wild). However, *in situ* conservation has several advantages as compared to *ex situ* conservation. Firstly, *in situ* conservation is dynamic allowing temporal and spatial changes in genetic diversity while *ex situ* conservation is mostly static maintaining the once-sampled genetic diversity. Secondly, trees within an *in situ* conservation unit remain exposed to evolutionary processes as they continue interacting with their environment and competing with other species. Thirdly, it is usually easier and cheaper to conserve tree populations in their natural habitat than in *ex situ* conditions. Finally, larger population sizes can be managed *in situ* than *ex situ*.

Europe is an example of a region where the distribution ranges of tree species extend across large geographical areas and include many countries. Conservation of forest genetic resources in Europe has been hampered by a lack of common understanding on the management requirements for genetic conservation units, and complexities of national legal and administrative structures. These have made it difficult to identify gaps in the conservation efforts and to develop genetic conservation strategies at the pan-European level. Furthermore, the diverse practices applied by the countries have complicated international reporting efforts, such as the monitoring of implementation of sustainable forest management in Europe. However, nearly all countries use the same conservation approach; networks of forest stands or areas harbouring tree populations which have adapted to specific environmental conditions or have distinct characteristics. Such stands, i.e. genetic conservation units, are typically located in forests managed for multiple uses, protected areas or seed stands.

As part of EUFORGEN, European experts have so far developed technical guidelines for genetic conservation and use of 33 tree species in Europe (available at www.euforgen.org). These guidelines provide basic conservation recommendations but they do not specify where new genetic conservation units should be established or how genetic conservation units should be managed. Several years ago, EUFORGEN also initiated the development of pan-European action plans for selected tree species to facilitate national conservation efforts and to identify gaps in the existing conservation efforts.

Unfortunately, the development of these action plans made slow progress as no harmonized and geo-referenced data on tree populations conserved in Europe was available. Subsequently, the EUFGIS project was designed by the EUFORGEN community to address these problems and to develop an online database on the genetic conservation units as well as pan-European minimum requirements and data standards for these units.

1.3. Project objectives

The overall goal of the project was to strengthen national inventories of forest genetic resources (FGR) and support practical implementation of FGR conservation as part of

sustainable forest management in Europe. The specific objectives of the project were to:

- establish a network of FGR inventories in 40 countries to provide data for the information system;
- develop minimum requirements for genetic conservation units of forest trees and common data standards for these units at pan-European level;
- provide training on FGR documentation to national focal points in these countries;
- create a web-based information system to serve as the European documentation platform for national FGR inventories; and
- make available, as a first step, harmonized data on the conservation units of 20 tree species from at least 80 % of the countries within each species' distribution range in Europe.

1.4. Network of national FGR inventories

The project created a network of national focal points in 36 countries across Europe (Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Former Yugoslav Republic of Macedonia, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Turkey, Ukraine and United Kingdom). The national focal points are experts who are involved in collecting and maintaining information on forest genetic resources as part of national inventories or any similar documentation arrangement a country may have in place. They were nominated by the EUFORGEN National Coordinators (or relevant authority in case of non-member countries) to compile information on the genetic conservation units of forest trees in their country and to provide the data to the EUFGIS database. The national focal points also received training for this purpose during the project.

1.5. Pan-European minimum requirements for genetic conservation units of forest trees

The pan-European minimum requirements for genetic conservation units of forest trees integrate scientific knowledge on population genetics into practical conservation of forest genetic resources. They are scientifically sound and practically feasible to implement for this purpose. The minimum requirements are based on the concept of dynamic conservation of genetic diversity which emphasizes the maintenance of evolutionary processes within tree populations to safeguard their potential for continuous adaptation. This means either managing tree populations at their natural sites within the environment to which they are adapted (*in situ*), or artificial, but dynamically evolving populations, elsewhere (*ex situ*). In the face of climate change, this approach is crucial for the long-term sustainability of forests and forestry in Europe.

The units entered into the EUFGIS database have a designated status as genetic conservation areas of forest trees at national level. The minimum requirements also specify a minimum population size depending on tree species and conservation objectives. One or more tree species have been recognized as target tree species for each unit. Active management measures and silvicultural techniques are applied, as

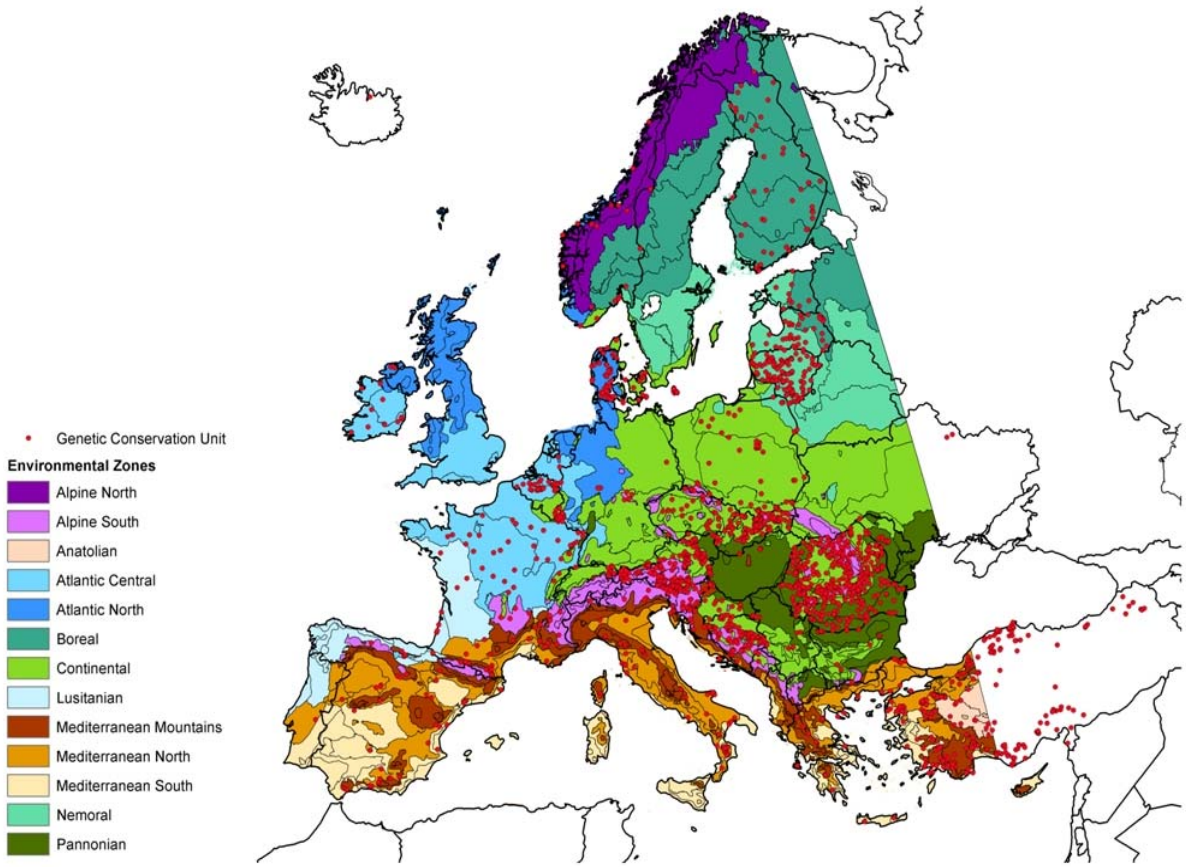
needed, to favour genetic processes within target tree populations. The monitoring of the units is carried out by field inventories every 5-10 years and between the inventories, the units are visited regularly to observe that they still serve their purpose and that they have not been damaged or destroyed.

1.6. Data standards

The data standards define the format, accuracy, quality and range of the information on the dynamic conservation units entered into the EUFGIS database. The units are characterized using 26 data standards at the unit level (designated forest area) and 18 data standards at the population level (target tree species within a unit).

1.7. Genetic conservation units in Europe

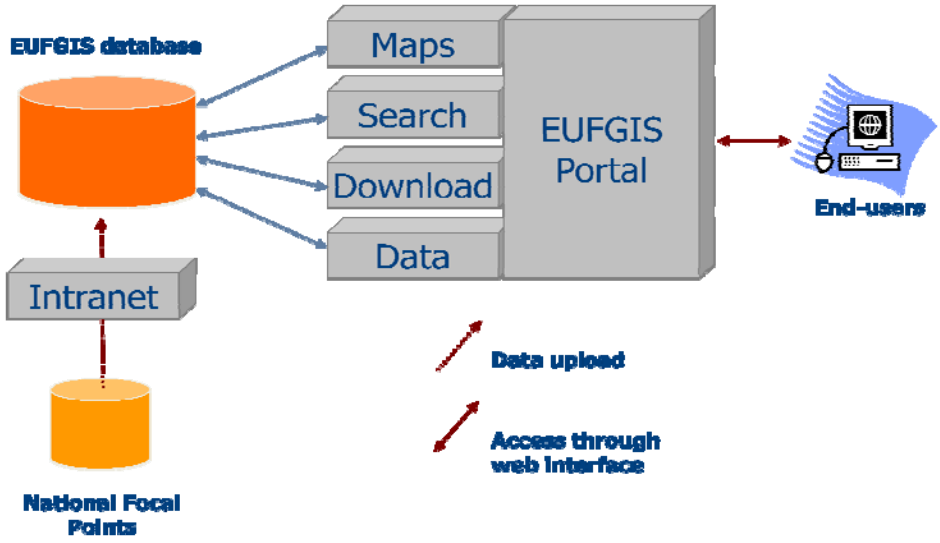
The data collected during the project provides a comprehensive picture of the dynamic FGR conservation efforts in Europe. In September 2011, the conservation network consisted of 2360 units, which are managed for genetic conservation of nearly 100 tree species in Europe. The units harbour a total of 3145 tree populations.



The location of the genetic conservation units of forest trees compared with the environmental stratification of Europe [13]

1.8. The EUFGIS information system

The EUFGIS information system consists of three components, 1) the intranet, 2) the database, and 3) the portal. The intranet is designed for uploading the national datasets into the database. Access to the intranet is limited to the national focal points and each of them has been given a username and a password. The data on each unit are stored in the database at two different levels (unit and target tree species) and it can be uploaded in a file format (e.g. Excel) or typed into online tables. The portal allows the end-users to view and search the data. The location of the units is displayed using a solution based on Google Maps.



The structure and components of the EUFGIS information system

2. Communicating value

2.1. Main outcomes of the project

The EUFGIS project constitutes a major step for improving the management of forest genetic resources in Europe. The pan-European minimum requirements for the genetic conservation units of forest trees have prompted several countries to enhance active management of their genetic resources. The minimum requirements have been particularly useful for small countries with limited budgets and human resources available for genetic conservation by helping them to focus their efforts to key issues. Forest owners and managers, forest geneticists and the broader biodiversity conservation community have increased collaboration to explore whether existing protected areas or production forests meet the minimum requirements, and whether new units could be established within these areas. There are still few countries with no units that meet the minimum requirements. Subsequently, the project has also been useful for making managers and policy makers in these countries aware of the shortcomings in dynamic conservation of forest genetic resources.

The project has strengthened regular monitoring of the genetic conservation units. In addition, the countries have already used the EUFGIS Portal for international reporting efforts, such as the State of Europe's Forests 2011 report and the forthcoming State of World's Forest Genetic Resources report.

Further efforts are underway as part of EUFORGEN to use the EUFGIS Portal for identifying gaps in genetic conservation efforts across Europe and developing pan-European genetic conservation strategies for forest trees. The project has also facilitated discussions on the development of a genetic monitoring system for the units in Europe. The EUGIS Portal provides a platform for implementing such a new monitoring system in the future.

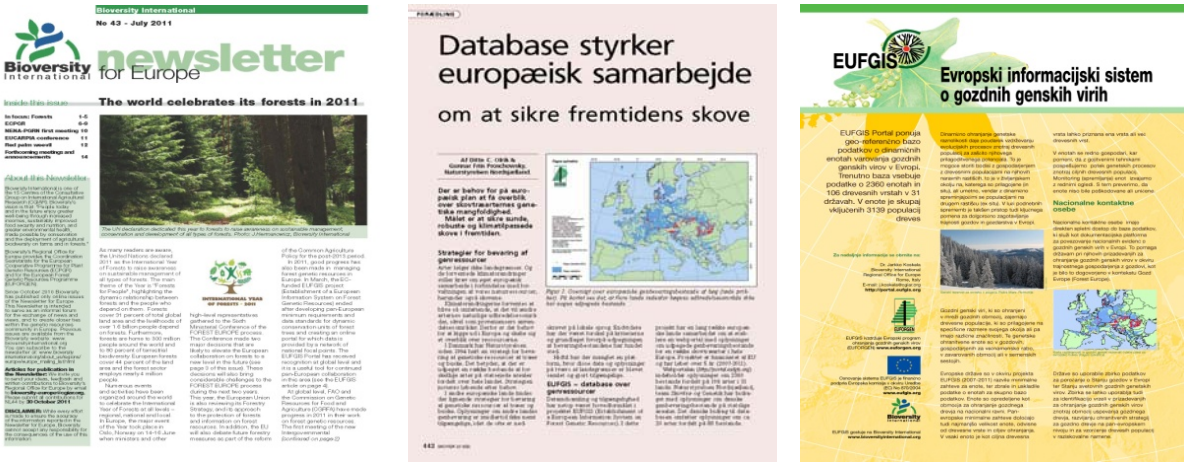
2.2. Dissemination

Numerous dissemination efforts were carried out during the project. They were targeted to policy-makers, forest managers, conservation specialists and the scientific community, as well as to general public and students.

Pictures from the final project meeting in Vienna, September 2010

The dissemination efforts included oral and poster presentations at the sessions of international policy processes and bodies (e.g. FOREST EUROPE, FAO Committee on Genetic Resources for Food and Agriculture, and FAO Committee on Forestry), technical meetings (e.g. EUFORGEN, national FGR committees or programmes, SBSTTA* of the Convention on Biological Diversity, and UNECE**/FAO Team of Specialists on monitoring of sustainable forest management), and scientific conferences (e.g. "Forest Ecosystem Genomics and Adaptation", San Lorenzo de El Escorial, Spain, 9-11 June 2010). Furthermore, articles for newsletters and professional magazines, leaflets and audio interviews were prepared.

* Subsidiary Body on Scientific, Technical and Technological Advice
** United Nations Economic Commission for Europe



Examples of dissemination materials produced in different languages (Newsletter for Europe in English, an article in the Danish journal "Skoven" and a poster in Slovenian).

In addition, two case studies were carried out to demonstrate the use of the information system for assessing FGR conservation efforts and for improving the FGR conservation strategies at the pan-European level. The first case study assessed the status of dynamic FGR conservation in Europe and identified gaps in the geographical coverage of the pan-European network of the genetic conservation units. The second case study focused on quantifying the impact of climate change on the genetic conservation units and identifying those units which are at the climatic limit of the species' distribution range and thus most susceptible to climate change. Furthermore, a review paper was written based on the pan-European minimum requirements for the genetic conservation units of forest trees.

Detailed list of the dissemination efforts can be found in the final technical report. Most of the articles and presentations on EUFGIS are also available on the project website (http://www.eufgis.org/dissemination.html).

3. The Project and the Partners

3.1. Project details

The EUFGIS project was launched on 1 April 2007 for a period of 42 months and it was later extended by additional six months as data screening and revision took more time than originally planned. The extension was also needed for finalizing two case studies based on the database and to carry out more dissemination efforts to non-scientific audience, users of the information system and other stakeholders. The total budget of the project was 1.1 million euros of which the EU-contribution was 553,000 euros.

3.2. Partner details

The EUFGIS project was coordinated by Bioversity International and participated by six other partners from Austria, Denmark, France, Slovakia, Slovenia and the United Kingdom. A large group of European experts and scientists from the EUFORGEN member countries also contributed to the implementation of the project activities.

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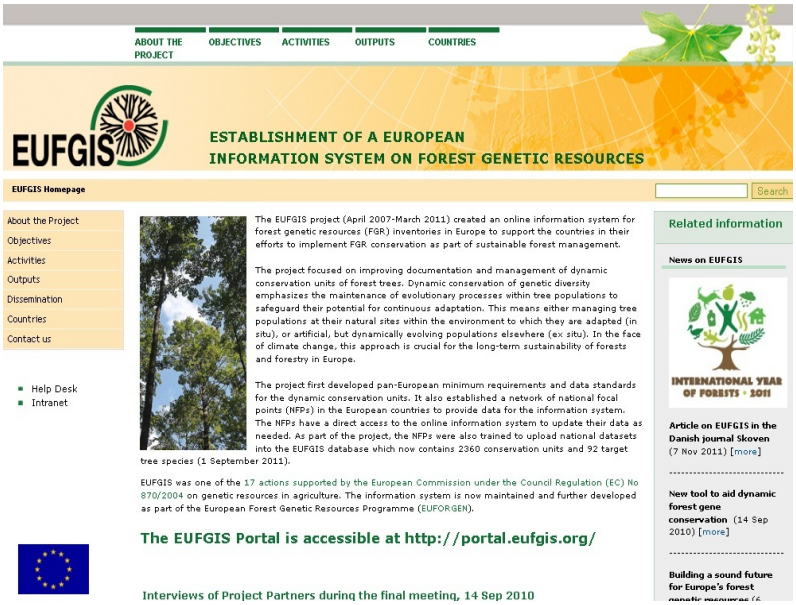
4. Links

4.1. The EUFGIS project website

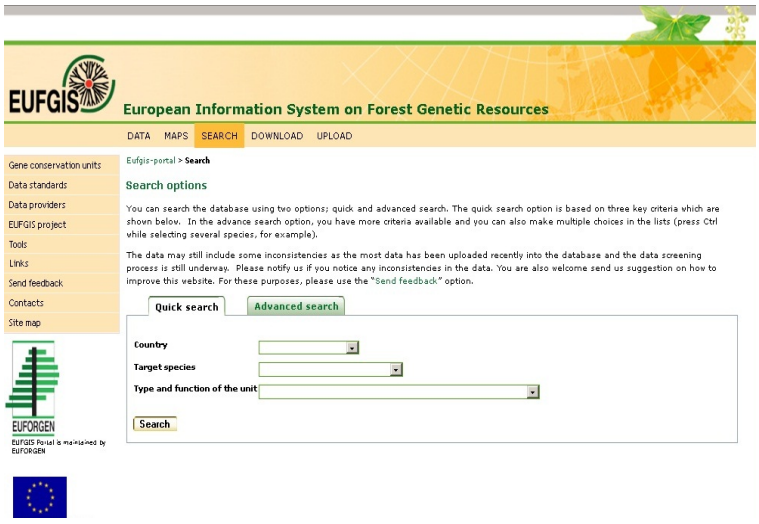
The project website (www.eufgis.org) was released soon after the project was launched in April 2007, and it was then used as a dissemination platform and a repository of project outputs.



Screenshot of the project website

4.2. The EUFGIS Portal

The EUFGIS Portal (http://portal.eufgis.org) was launched at the final project meeting that took place in Vienna, Austria from 13-15 September 2010.



Screenshot of the EUFGIS Portal

4.3. List of publications

Koskela, J., Lefèvre, F.,Schüler, S., Kraigher, H., Olrik, D.C. Hubert, J., Longauer, R., Bozzano, M., Yrjänä, L., Alizoti, P., Rotach, P., Vietto, L., Bordács, S., Myking, T., Eysteinsson, T., Souvannavong, O., Fady, F., De Cuyper, B., Heinze, H., von Wühlisch, G., Ducousso, A. and Ditlevsen, B. Translating conservation genetics into management: pan-European minimum requirements for dynamic conservation units of forest tree genetic diversity (manuscript).

Lefèvre, F., Koskela, J., Hubert, J., Kraigher, H., Longauer, R., Olrik, D.C., Schüler, S. and Bozzano, M. (with 33 national focal points as co-authors). Assessment of dynamic conservation of forest genetic resources in Europe (manuscript).

Schüler, S., Lefèvre, F., Koskela, J., Hubert, J., Kraigher, H., Longauer, R., Olrik, D.C., and Bozzano, M. Forest genetic resources under threat: quantifying the impact of climate change on dynamic conservation units of forest trees in Europe (manuscript).

4.4. Other links

Further information on EUFGIS and other projects co-funded by the European Commission's Community Programme on the conservation, characterisation, collection and utilisation of genetic resources in agriculture can be found at the following website (http://ec.europa.eu/agriculture/envir/biodiv/genres/index_en.htm).

References

(1) FOREST EUROPE, UNECE, FAO, 2011. State of Europe's Forests 2011. Status and Trends in Sustainable Forest Management. Ministerial Conference on the Protection of Forests in Europe, Aas, Norway, 337 p.

(2) EUROSTAT 2011. Forestry in the EU and the world – A statistical portrait. Publications Office of the EU, Luxembourg, 107 p.

(3) Neale, D. B. and Kremer, A. 2011. Forest tree genomics: growing resources and applications. Nature Reviews Genetics 12: 111–122.

(4) Whitham, T. G., et al. 2006. A framework for community and ecosystem genetics: from genes to ecosystems. Nature Reviews Genetics 7: 510–523.

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(6) Petit, R. J. and Hampe, A. 2006. Some evolutionary consequences of being a tree. Annual Review of Ecology, Evolution, and Systematics 37: 187–214.

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(8) Aitken, S. N., et al. 2008. Adaptation, migration or extirpation: climate change outcomes for tree populations. Evolutionary Applications 1: 95–111.

(9) Petit, R. J., et al. 2002. Identification of refugia and post-glacial colonisation routes of European white oaks based on chloroplast DNA and fossil pollen evidence. Forest Ecology and Management 156: 49–74.

(10) Magri, D., et al. 2006. A new scenario for the quaternary history of European beech populations: palaeobotanical evidence and genetic consequences. New Phytologist 171: 199–221.

(11) Meier, E. S., et al. 2011. Climate, competition and connectivity affect future migration and ranges of European trees. Global Ecology and Biogeography (in press) DOI: 10.1111/j.1466-8238.2011.00669.x

(12) Csaba, M. 2010. Forecast needed for retreating forests. Nature 464: 1271.

(13) Metzger M.J., et al. 2005. A climatic stratification of the environment of Europe. Global Ecology and Biogeography 14: 549–563.

Photographs: M.Čater (front page), B.Vinceti (p.7), J.Koskela, A.Rositi, J.Hermanowicz, EUFORGEN (p.12)

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