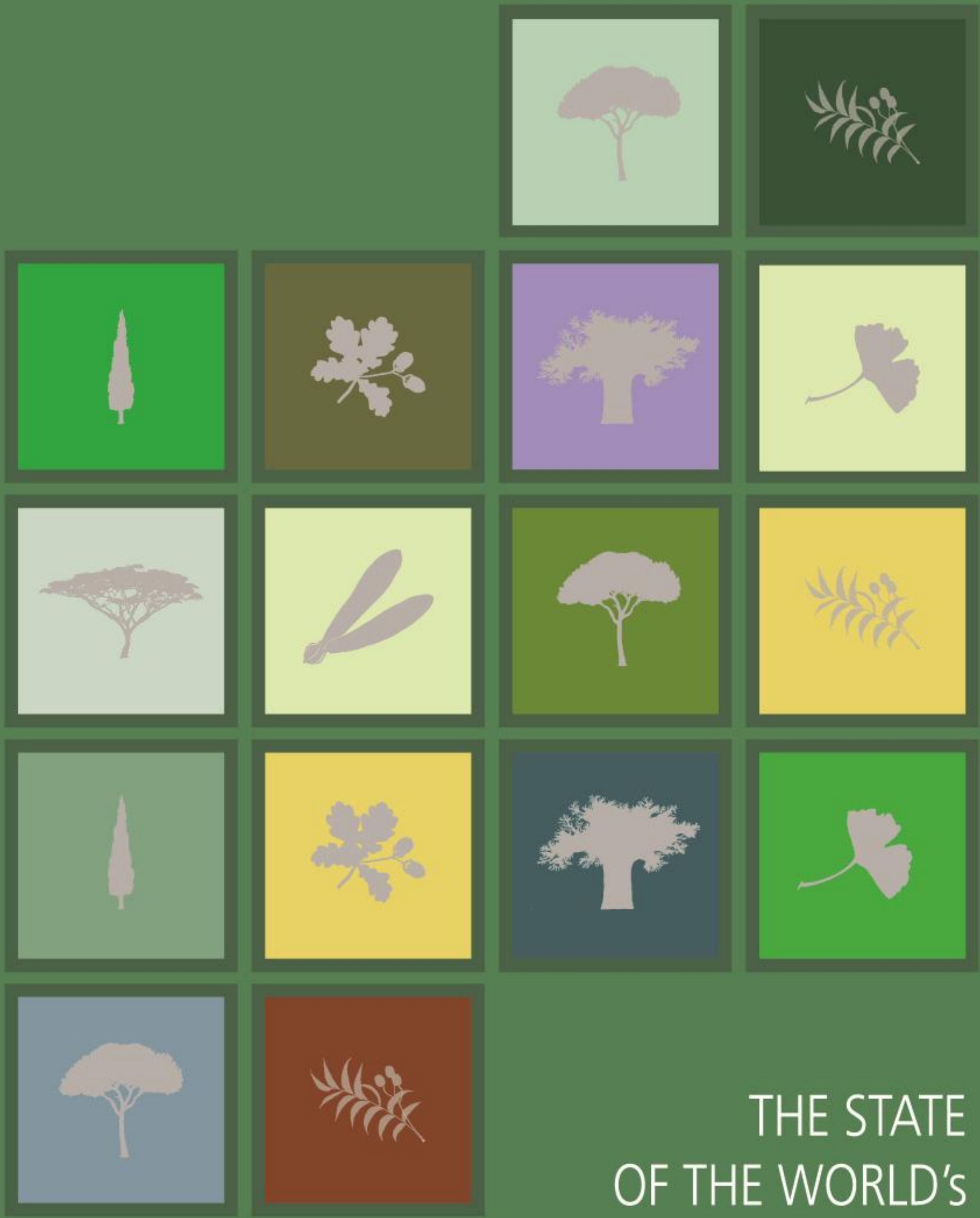

THE STATE OF THE WORLD's FOREST GENETIC RESOURCES

COUNTRY REPORT

AUSTRIA

This country report is prepared as a contribution to the FAO publication, The Report on the State of the World's Forest Genetic Resources. The content and the structure are in accordance with the recommendations and guidelines given by FAO in the document Guidelines for Preparation of Country Reports for the State of the World's Forest Genetic Resources (2010). These guidelines set out recommendations for the objective, scope and structure of the country reports. Countries were requested to consider the current state of knowledge of forest genetic diversity, including:

- Between and within species diversity
- List of priority species; their roles and values and importance
- List of threatened/endangered species
- Threats, opportunities and challenges for the conservation, use and development of forest genetic resources

These reports were submitted to FAO as official government documents. The report is presented on www. fao.org/documents as supportive and contextual information to be used in conjunction with other documentation on world forest genetic resources.

The state of the world's forest genetic resources

Country Report

Austria

2013

Impressum

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SECTION I: EXECUTIVE SUMMARY

Austria is covered by forests by 47.6%, though forest cover varies strongly among regions. In parts of the country forested area has been lost to human infrastructure (settlements, roads, manufactures, construction of power plants, recreation areas etc). However, on average the forest area has increased indeed. This is due to natural scrub encroachment in abandoned Alpine meadows and afforestation of marginally productive land. The increase in forest area amounts approximately to 4,300 ha annually. In total, forest cover currently extends to almost 4.0 million ha (2010). The forest plays an important role for Austrian economy as well as for soil and water protection and recreation. Approximately 3.3 million ha are used for wood production. Almost one fifth of the forest area has been classified as protection forest, mainly providing shelter for the settlements against avalanches and wet landslide.

Since the mid-eighties, Austria has taken specific measures to implement the national programme on Forest Genetic Resources (FGR). In doing so, the ecological and economic importance of genetic resources for political action was recognized. In order to ensure adaptational processes over tree generations and thus evolution of forest trees species over longer time, *in situ* measures have been strongly favored as dynamic means. Since data on adaptive genetic variation were not available, a network of forest genetic reserves distributed along environmental gradients was established. Today, this network represents reserves from many ecoregions and comprises 281 conservation units totaling 8,900 hectares. As static means, *ex situ* measures were chosen and a seed bank and 47 conservation clonal orchards for 13 tree species, for five additional species conservation orchards using seedlings form selected mothers were established. For these *ex situ* measures a total area of 77 hectares has been dedicated.

The ecological and economical importance of the main tree species (spruce, beech, pines, larch, fir) in Austria did not changed over time. However, more recently European larch is increasingly planted instead of Norway spruce, partly due to bark beetle problems and other abiotic stress factors. A recent inventory of the genetic diversity in Norway spruce using mitochondrial and nuclear markers has shown that the species harbors a very high level of genetic diversity. This investigation was done together with the Austrian Forest Inventory (AFI) and could build the basis for a genetic monitoring for this and other important species. A forest biodiversity index for the Austrian forest is currently being developed and discussed with political stakeholders. This index (aggregated over several referenced indicators) also includes genetic indicators, such as the genetic naturalness, the number of gene reserve forests, the number of conservation seed orchards, or the number of seed collection stands. If this index will be implemented, Austria would have an appropriate monitoring tool both for forest biodiversity including forest genetic resources.

The importance of FGR is more and more realized by Austrian forest managers. While in previous decades forest managers were relatively careless regarding the use of appropriate forest reproductive material, more recently the importance of provenance selection in order to increase yield and ecological stability is increasingly recognized . This is mainly due to improved education at the university level, but also to the improved extension service of BFW (Dept. of Forest Genetics) and the Austrian Chamber of Agriculture, as well as others. Recently, an online platform was installed to inform forest managers about provenances, registered selected seed stands, and forest nurseries (www.herkunftsberatung.at); this tool can also be used by forest managers to get into contact with suppliers of forest reproductive material.

Tree improvement programmes in Austria mainly have dealt with Norway spruce, European larch, oak species, wild cherry (native) and Douglas-fir (introduced). Recently, new provenance and progeny trials have been installed for *Quercus robur* and *Q. petraea*, as well as wild cherry; and for

Norway spruce and European larch, molecular marker based breeding approaches have been initiated and are currently implemented. Targeted improvement for all species is yield, quality and resistance to drought (climate change). For most programmes, improvement is on the first generation level; the new initiative towards European larch will develop seed orchards of the second generation. Improvement programmes in Norway spruce and European larch have a strong participatory aspect, as partners from the timber industry as well as the forestry and nursery sector are directly involved. The results of these improvement programmes will be made publicly available (clones, germplasm).

The conservation of FGR in Austria is generally suffering from a lack of public interest. Therefore, it will be important to continue the efforts to inform all relevant stakeholders in the forestry and non-forestry sector about the significance of FGR. Raising awareness about rare and threatened tree and shrub species as flagship species in the general public is probably a very efficient way.

The Austrian Forest Dialogue was initiated in 2003 by the Federal Ministry of Agriculture, Forestry, Environment and Water Management. The objectives of this institutionalized, transparent and long-term dialogue are to ensure and permanently optimize the sustainable management of Austrian forests including FRG. Together with all stakeholders and persons interested in forests a careful approach to forests has been developed and the effects of forests are to be safeguarded for the long term. Participation in this dialogue is open to all groups, institutions and interested persons dealing with Austrian forests. To allow well-structured implementation, various institutions have been established. Their political centerpiece is the Round Table, which is headed by the Federal Minister. Technical discussions take place in so-called Forest Forums as well as in working group meetings. An important milestone in the Forest Dialogue was the first Austrian Forest Programme, which was jointly developed by 80 organizations and institutions and was consensually adopted in late 2005.

SECTION II: INTRODUCTION TO THE COUNTRY AND FOREST SECTOR

Austria is a small, predominantly mountainous country in Central Europe, approximately between Germany, Italy and Hungary. It has a total area of 83,859 km². Austria may be divided into three unequal geographical areas. The largest part of Austria (62%) is occupied by the relatively young mountains of the Alps, but in the east, these give way to a part of the Pannonian plain, and north of the River Danube the Bohemian Forest, an older, but lower, granite mountain range is located.

Land-use patterns in Austria change from Alpine to non-Alpine regions. Approximately one-tenth of Austria is bare or unproductive land, normally found above the tree line. Forty-six percent of Austria is covered by forests, the majority of which is in Alpine regions. Less than one-fifth of Austria is arable and suitable for conventional agriculture. The percentage of arable land in Austria increases in the East as the country becomes less mountainous. More than one-fifth of Austria is pasture and meadow located at varying altitudes. Almost half of this grassland consists of high Alpine pastures. Because of the Alps, the country as a whole is one of the least densely populated states of Western and Central Europe (93 inhabitants/ km²).

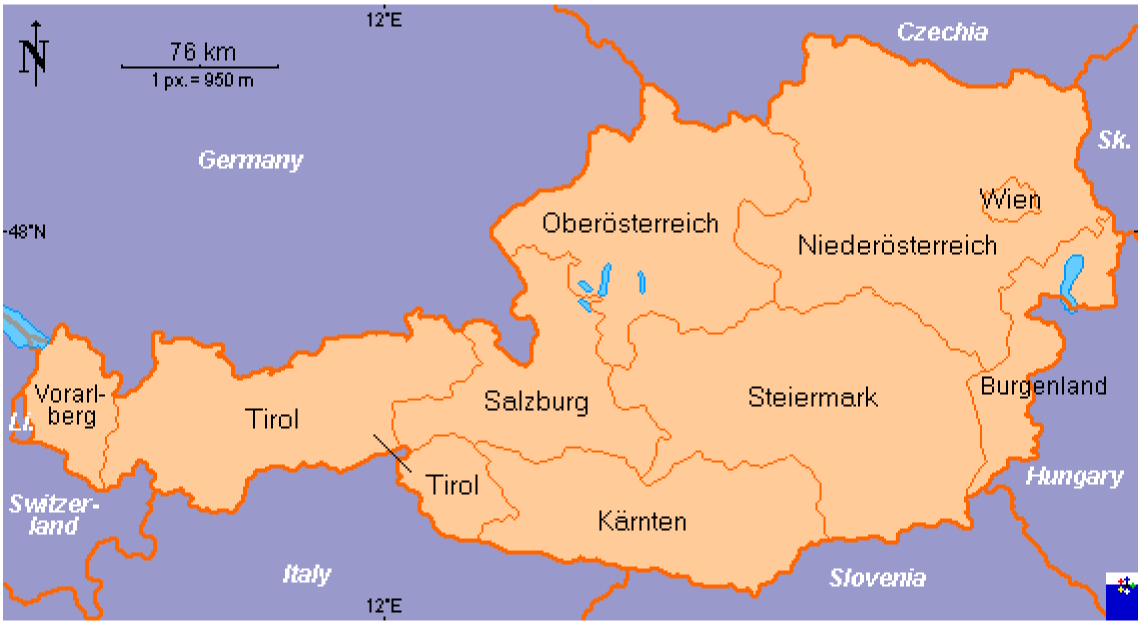

Fig. 1. Map of Austria with the nine provinces indicated.

The Alps serve as a watershed for Europe's three major kinds of weather systems that influence Austrian weather. The Atlantic maritime climate from the northwest is characterized by low pressure fronts, mild air from the Gulf Stream, and precipitation. It has the greatest influence on the northern slopes of the Alps, the Northern Alpine Foreland, and the Danube valley. The continental climate is characterized by low pressure fronts with precipitation in summer and high pressure systems with cold and dry air in winter. It affects mainly eastern Austria. Mediterranean high-pressure systems from the south are characterized by few clouds and warm air, and they influence the weather of the southern slopes of the Alps and that of the Southeastern Alpine Foreland, making them the most temperate part of Austria.

The Austrian forest coverage is 47.6 %, though this proportion varies strongly among regions. In parts of the country forested area has been lost to human infrastructure (i.a, construction of power plants, settlements and recreation areas), in total the forested area has indeed increased. For instance, this is due to natural scrub encroachment in abandoned Alpine meadows and afforestation of marginally productive land. The increase in forest area is around 4,300 ha annually. In total, forest cover currently extends to almost 4.0 mio. ha (2010). The forest is important for the Austrian economy as well as for soil and water protection and recreation. Approximately 3.3 mio. ha are used for wood production. Almost one fifth of the forested area is classified as protection forest. The proportion of protection forest is highest in the westernmost (Alpine) provinces: 46% in Tyrol, 42% in Vorarlberg, and 32% in Salzburg.

Table 1. Forest characteristics and areas. From FRA 2005 (NE - not evaluated), values only available for the year 2000.

	Area (1000 hectares)	
	Forest	**Other wooded land**
Primary	119	-
Modified natural	870	-
Semi-natural	1977	-
Productive plantation	989	-
Protective plantation	NE	-
TOTAL	**3955**	**-**

Approximately, 53.9 % of the forest is owned by forest enterprises with less than 200 ha, 31.2 % are owned by enterprises exceeding 200 ha, and 14.9 % of the forest is owned by the Österreichische Bundesforste (ÖBf), a stock cooperation which shares are hold exclusively by the Austrian Confederacy. The ownership structure indicates that 65.1 % of the forest are privately owned, 13.6 % are community forests (local cooperatives 9.5 %, church 4.1 %), and 21.3 % are publicly owned (ÖBf, provinces, communities, and others).

The Austrian Forest Inventory (AFI) commissioned by the Federal Ministry for Agriculture and Forestry has been monitoring the Austrian forests since 1961. According to this national inventory, around 1,135 million m^3 standing wood volume are present in the Austrian forests, which corresponds to 283 m^3 per ha. This entails that Austrian forests have the second highest standing volume in Europe, second only to Switzerland. On average, wood volume increment is 31.4 million m^3 or 9.4 m^3 per hectare. Over the last decades harvest has always been lower than the annual increment. Between 1981 and 1990, total harvest accounted to only 19.4 million m^3, 70 % was final harvest, 30 % thinnings and coincidental harvest. Only 33 % of harvest operations are done on an area larger than 500 m^2, giving evidence of the small structures of forest management in Austria.

Table 2. Forest ownership and area (FRA)

Forest ownership	Area (1000 hectares)
Public	723
Private	3,268
Others	-

In recent years there has been a marked change in wood harvest practices in Austria. The results of the AFI of 2007/09 show that compared to the previous evaluation period of 2000/02 there is a strong increase of 34 % in the wood volume extracted. This figure changed from 17.5 to 23.5 million m^3.

Employment in the forestry sector is declining and is around 5,000 workmen and 3,600 office staff and civil servants. A major part of work in the forest sector is done by farmers as part of their farm business. A precondition for an intensive forestry including management of protection forests and a rationalization of forest work is a high level of infrastructure including forest roads; the mean density of forest roads is about 42 m per ha including public roads running through forests.

The legal basis for management of the Austrian forest is formed by the Forestry Law from 1975, in its amended version from 1987. The Federal Forest Office, a body exercising control commissioned by the Federal Ministry for Agriculture and Forestry, has been installed to secure sustainability of material and immaterial effects of forest management. The Federal Ministry for Agriculture and Forestry is also responsible for protection against mountain torrents and avalanches including associated infrastructure. To secure appropriate forest management, forest enterprises of more than 500 ha must be headed by a properly trained forester. Smaller enterprises are supported in management by the Chamber of Agriculture.

While in previous decades wood harvest was mostly done by the large forest owners, also small-scale forest businesses have increased the harvested volume by about 8 %. Thus in recent years, the percentage of annual harvests has become similar between large and small forest owners. This is mainly due to the relatively high price for wood during this period, but also due to efforts to mobilize fuel for biomass heating plants. Harvest due to calamities (storm break mainly) also has increased. Still the annual increment is larger than the annual volume extracted, however, this is largely due to the small forest owners, while some large forest enterprises have exceeded the annual sustained yield.

The annual harvested amount of wood is 23.5 million m^3 (without bark). Eighty-three percent of this harvest stems from conifers and 17 % from broadleaves, respectively. Fuel wood accounts for 21 %, while the rest of the harvest is processed by the timber industry. Raw wood is only exported to a very limited amount (ca. 0.6 million m^3) while large amounts of raw wood are imported (ca. 4.3 million m^3).

In total, the Austrian timber industry produces around 9.5 million m^3 of sawn timber, further 0.7 million m^3 are being imported. Almost 4 million m^3 of sawn timber are exported, of which two thirds are shipped to Italy. Wood processing industries (pulp, paper and chipboard industry) are mostly exporting their products and require around 8 million m³ of wood annually; of this, 52 % are directly coming from the forest, the rest are offcuts from the timber industry; in addition ca. 2.5 million metric tonnes of recovered paper are also processed. Employment in the wood industry is (depending on branch) slightly declining over time. In the timber industry approximately 10,000, in pulp and paper industry 11,000, and in the wood processing industry approximately 26,000 people are employed, respectively.

The contribution of forestry to the Gross Domestic Product (GDP) is around 0.5 % despite the high forest cover and high annual volume increment. When including the wood industry, the contribution to GDP is 4.2 %. The export share of the wood and forest business is around 12-15 % of the total exports. In the balance of trade, an annual surplus of around 3.42 billion EUR is realized. Forestry and wood processing industries (paper and cardboard factories, timber mills, etc) are important factors in agriculture in general. Austria ranks fifth in the list of global exporters of wood (surpassed only by Canada, Russia, Sweden, Finnland; Germany ranks sixth). Of the annual 8.68 million m³ (in 2010) a large proportion is exported to southern Europe. Because the wood increment is still higher than recent harvest, this sector has a growing potential.

Table 3. Major forest type categories and main tree species. Forest types may be drawn from the categories used in your country or from the list below (Forest Types and Ecological Zone breakdown used in FRA 2000).

Major Forest Types	Area (covered by forest type)	Main species for each type	
		Trees	Area (1000 hectares)
TeDc temperate continental forest	784	*Fagus sylvatica*	265
		Fraxinus excelsior	32
		Acer pseudoplatanus	27
		Quercus robur	18
		Quercus petraea	32
		Pinus sylvestris	71
		Picea abies	1,411
TM temperate mountain systems	2,583	*Abies alba*	66
		Fagus sylvatica	71
		Larix decidua	149
		Pinus sylvestris	81
		Pinus cembra	15

SECTION III: MAIN BODY OF THE COUNTRY REPORT

Chapter 1: The Current State of Forest Genetic Resources

Since the mid-eighties, Austria has taken specific measures to implement the national programme on Forest Genetic Resources. In doing so, the ecological and economic importance of genetic resources for political action was recognized. In order to ensure adaptational processes over tree generations and thus evolution of forest trees species over longer time, *in situ* measures have been strongly favored as dynamic means. Since data on adaptive genetic variation were not available, a network of genetic reserves distributed along environmental gradients was established. Today, this network represents reserves from many ecoregions and comprises 281 conservation units totaling 8.900 hectares. As static means, *ex situ* measures were chosen and a seed bank and 47 conservation clonal orchards for 13 tree species, for five additional species conservation orchards using seedlings form selected mothers were established. For these *ex situ* measures a total area of 77 hectares has been dedicated.

New international commitments, growing knowledge in conservation genetics and related fields, changes in the dynamics of forest health conditions, and different future risks including climate change required an update of the programme. The conservation of genetic resources is still an important political goal. The EU-council directive 1999/105 puts emphasis on the genetic diversity when moving forest reproductive material in trade. The initial priority to maintain the adaptability as the main prerequisite to ensure evolutionary processes and therefore the maintenance of adaptability is still valid in an unrestricted manner. In the last decades, the importance of certain threats has changed. Global climate change, loss and alteration of habitats, bottlenecks of regional supplies of appropriate forest reproductive material, natural regeneration of genetically inferior stands, inappropriate use of forest reproductive material, and especially high abundance of game species impel conservation goals. Additional *in situ* genetic reserves should be installed in the following ecoregions: Pannonic Lowlands, Pannonic hills, Bohemian Mass and northern pre-Alps. Certain ex situ measures (seed storages in the seed bank) will not be maintained and the management intensity of certain seed orchards will be restricted in the future. National Parks and the core zones of Biosphere Parks should be declared as gene protection areas where autochthonous forest reproductive material is exclusively used. To achieve adaptable and genetically sustainable forest, genetic aspects should increasingly be embedded in regular forest management. Afforestation that is subsidized should be evaluated from a genetic point of view and the data obtained should be used for monitoring and modelling. This was recently done (2012) in the province of Upper Austria for European larch afforestations. Supplemental data should be collected within the framework of controlling the domestic trade with forest reproductive material, data on the movement of forest reproductive material in trade, especially with the EU, should also be used as an information source.

Austria harbors a vast number of forest types: from high Alpine pine scrub to lowland dry forest. From the economic viewpoint Norway spruce, European larch, the white oaks, Scots pine and Douglas fir are the most important species. Improvement programs are currently under way to obtain clones and seed orchards of superior genetic material in spruce and larch. There is also considerable effort put into the identification of high quality reproductive material in oak and Douglas fir.

A recent inventory of the genetic diversity in Norway spruce using mitochondrial and nuclear markers has shown that the species harbors a very high level of genetic (molecular) diversity. This investigation could be done since the collection of the DNA material was achieved within the framework of the AFI and could build the basis for a genetic monitoring including other important species.

From the conservation side some effort has been put to conserve and improve genetic diversity in *Sorbus domestica*, *S. torminalis*, yew, poplar, crabapple, wild pear. Most of these species are rare in all of their distribution range; the Austrian efforts concentrate on conserving local genetic resources of these species. While Silver fir is still relatively common in the forest, young trees are becoming rare due to overbrowsing by deer. Therefore this species is considered threatened in all parts its distribution in Austria, although afforestation with fir is subsidized in most regions of the country.

There have been only few studies addressing genetic diversity in species over the whole Austrian range (mainly on Norway spruce and common beech), but knowledge gained from Pan-European inventories are used to prioritize conservation efforts.

Some tree species from southern and south-eastern Europe reach Austria in their most northern populations, e.g. *Ostrya carpinifolia*, *Fraxinus angustifolia* , *F. ornus*. Though there are some conservation units with these species, they have not been prioritized in the conservation strategy of Austria.

The main factors influencing the state of forest genetic diversity with an emphasis on threatened and endangered species and resources are climate change, fragmentation, transfer of FRM, and the change of silviculture systems.

Still there are challenges ahead conserving FGR in Austria. Little is known about adaptive genetic diversity in most tree species and how they will react to climate change. Although Austria is participating in international research projects investigating species reaction to climate change (e.g., EU-funded FORGER project), actually limited knowledge is available on intraspecific variation in most species, both from provenance trials and molecular genetics.

Also the importance of FGR for economic and ecological sustainability of forests is still not acknowledged by many forest managers in Austria. Forest managers (esp. small-scale) have to be better informed about the importance of FGR in forestry in general and ecological and economic influence of the seed sources on quality and yield in particular. However, the situation has drastically improved over the last years.

Diversity within and between forest tree species:

The forest ecoregions of Austria have been classified based on forest ecology and can be differentiated into nine major units. These units are used as a basis of regional planning, statistical forestry inventory, monitoring networks, ecologically oriented silviculture, and as a major delimitation of seed zonation. Within these major units, 22 smaller ecoregions are distinguished with regard to its regional climate and to the respective woodland communities that prevail. Within the ecoregions, seven altitudinal zones, representing three altitudinal belts, are distinguished from phytocoenological and climatical points of view. The descriptions of the individual ecoregions include information about the old classification systems, about locations and altitudinal extension, limit values of the borderline of the altitudinal zones as well as chapters dealing with climate, geomorphology, soils and natural woodland communities. These ecoregions are used to delimit seed zones for all tree species in Austria, i.e. there is no specific seed zonation for single species.

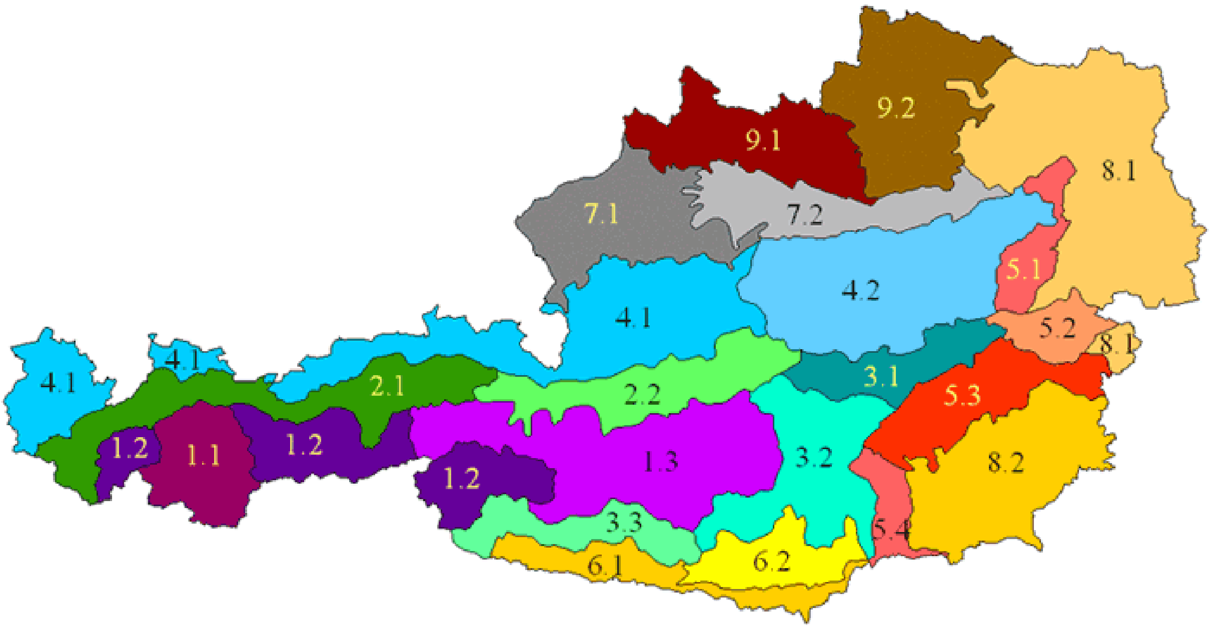

Fig. 2 Map of the ecological zonation used for forest genetic resources in Austria. There are nine main major units, with a total of 22 ecoregions (sub-zones).

Table 4. List priority forest tree and other woody plant species and reason for priority (e.g. economic importance, threatened, etc.).

Scientific name	Tree (T) or other (O)	Native (N) or exotic (E)	
Abies alba	T	N	Threatened
Acer campestre	T	N	Biodiversity
Acer platanoides	T	N	Economic
Acer pseudoplatanus	T	N	Economic
Alnus glutinosa	T	N	Economic
Alnus incana	T	N	Protection forests
Carpinus betulus	T	N	Economic
Castanea sativa	T	N	Biodiversity
Fagus sylvatica	T	N	Economic
Fraxinus angustifolia	T	N	Biodiversity
Fraxinus excelsior	T	N	Biodiversity
Fraxinus ornus	T	N	Biodiversity
Larix decidua	T	N	Economic
Malus sylvestris	T	N	Threatened
Ostrya carpinifolia	T	N	Biodiversity
Picea abies	T	N	Economic
Pinus cembra	T	N	Economic
Pinus mugo ssp. uncinata	T	N	Biodiversity
Pinus nigra ssp. austriaca	T	N	Economic
Pinus sylvestris	T	N	Economic
Populus alba	T	N	Biodiversity
Populus nigra	T	N	Biodiversity
Pyrus pyraster	T	N	Threatened
Quercus cerris	T	N	Biodiversity
Quercus petraea	T	N	Economic
Quercus pubescens	T	N	Biodiversity
Quercus robur	T	N	Economic
Salix alba	T	N	Biodiversity
Salix fragilis	T	N	Biodiversity
Sorbus aria	T	N	Biodiversity
Sorbus domestica	T	N	Threatened
Sorbus torminalis	T	N	Biodiversity
Taxus baccata	T	N	Threatened
Tilia cordata	T	N	Biodiversity
Tilia platyphyllos	T	N	Biodiversity
Ulmus glabra	T	N	Threatened
Ulmus laevis	T	N	Biodiversity
Ulmus minor	T	N	Threatened

Table 5. Forest species currently used in your country; for each species please indicate (N or E) whether native or exotic (using the codes for uses listed below).

Species (Scientific name)	Native (N) or Exotic (E)	Current uses (code)	If managed, type of management system (e.g. natural forest, plantation, agroforestry)	Area managed if known (ha)
Picea abies	N	1, 2	managed forests	1707576
Abies alba	N	1, 2	managed forests	80832
Larix decidua	N	1	managed forests	154928
Pinus sylvestris	N	1	managed forests	15156
Pinus nigra	N	1, 3, 4	managed forests	20000
Pinus cembra	N	1, 4	managed forests	5000
Fagus sylvatica	N	1, 2, 3	managed forests	336800
Quercus spp.	N	1, 3	managed forests	43784

1 Solid wood products, 2 Pulp and paper, 3 Energy (fuel), 4 Non wood forest products (food, fodder, medicine, etc.), 5 Used in agroforestry systems

Table 6. Main tree and other woody forest species providing environmental services or social values. For each species please indicate (N or E) whether native or exotic.

Species (scientific name)	Native (N) or Exotic (E)	Environmental service or social value (code)
Abies alba	N	1, 2, 3
Acer pseudoplatanus	N	2
Alnus glutinosa	N	1
Alnus incana	N	1
Alnus viridis	N	1
Fagus sylvatica	N	1
Fraxinus excelsior	N	1, 2
Larix decidua	N	1
Picea abies	N	1
Pinus cembra	N	1
Pinus mugo	N	1
Pinus nigra ssp. austriaca	N	1
Pinus sylvestris	N	1
Populus alba	N	1
Populus nigra	N	1
Quercus petraea	N	1, 3
Quercus pubescens	N	1, 3
Quercus robur	N	1, 3
Salix alba	N	1
Salix fragilis	N	1
Sorbus aria	N	1
Sorbus torminalis	N	1
Taxus baccata	N	1, 3
Tilia cordata	N	1
Tilia platyphyllos	N	1
Ulmus glabra	N	1, 2, 3
Ulmus laevis	N	1, 2, 3
Ulmus minor	N	1, 2, 3

1 Soil and water conservation including watershed management
2 Soil fertility
3 Biodiversity conservation
4 Cultural values
5 Aesthetic values
6 Religious values

Table 7. List of tree and other woody forest species considered to be threatened in all or part of their range from genetic conservation point of view.

Species (scientific name)	**Proportion of species' natural distribution that is in your country (%)	Distribution in the country: widespread (W), rare (R), or local (L)	Type of threat (Code)	Threat category***		
				High	Medium	Low
Abies alba	<15	W	2	X		
Acer campestre	<5	W	2		X	
Acer platanoides	<5	W	2			X
Alnus glutinosa	<5	W	7			X
Alnus incana	<5	W	2			X
Carpinus betulus	<5	W	2			X
Castanea sativa	<1	L	11	X		
Fraxinus angustifolia	<5	L	2	X		
Fraxinus excelsior	<5	W	11	X		
Fraxinus ornus	<5	L	2	X		
Malus sylvestris	<5	R	2, 7	X		
Ostrya carpinifolia	<5	R	2	X		
Pinus cembra	<25	L	7		X	
Pinus mugo ssp. uncinata	<10	L	7	X		
Pinus nigra ssp. austriaca	<10	L	7			X
Populus alba	<5	L	7		X	
Populus nigra	<1	L	7	X		
Pyrus pyraster	<5	R	2	X		
Quercus cerris	<5	L	2			X
Quercus pubescens	<5	L	2			X
Salix alba	<1	W	7			X
Salix fragilis	<1	W	7		X	
Sorbus aria	<5	L	2		X	
Sorbus domestica	<5	R	2	X		
Sorbus torminalis	<5	L	2		X	
Taxus baccata	<1	R	2	X		
Tilia cordata	<1	W	2		X	
Tilia platyphyllos	<5	L	2		X	
Ulmus glabra	<1	W	11	X		
Ulmus laevis	<1	L	11	X		
Ulmus minor	<1	L	11	X		

1 Forest cover reduction and degradation
2 Forest ecosystem diversity reduction and degradation
3 Unsustainable logging
4 Management intensification
5 Competition for land use
6 Urbanization
7 Habitat fragmentation
8 Uncontrolled introduction of alien species
9 Acidification of soil and water
10 Pollutant emissions
11 Pests and diseases
12 Forest fires
13 Drought and desertification
14 Rising sea level

Table 8a. Annual quantity of seeds produced and current state of identification of forest reproductive material of the main forest tree and other woody species in the country.

Species		Total quantity of seeds used (kg)	Quantity of seeds from documented sources (provenance/ delimited seed zones)	Quantity of seeds from tested provenances (provenance trials established and evaluated)	Quantity that is genetically improved (from seed orchards)
Scientific name	Native (N) or exotic (E)				

Unfortunately these data are not available.

Table 8b. Annual number of seedlings (or vegetative propagules) planted and the state of identification of the reproductive material used for the main forest tree and other woody species in the country.

Species						
Scientific name	Native (N) or exotic (E)	Total quantity of seedlings planted	Quantity of seedlings from documented sources (provenance/ delimited seed zones)	Quantity of seedlings from tested provenances (provenance trials established and evaluated)	Quantity of vegetative reproductive material used	Quantity of seedlings that are genetically improved

Unfortunately these data are not available.

Table 9. List forest species for which genetic variability has been evaluated and check each column that applies.

Species		Morphological traits	Adaptive and production characters assessed	Molecular characterization
Scientific name	Native (N) or exotic (E)			
Abies alba	N		X	
Acer pseudoplatanus	N			
Alnus glutinosa	N			
Fagus sylvatica	N	X	X	X
Fraxinus excelsior	N		X	X
Larix decidua	N		X	
Picea abies	N	X	X	X
Pinus nigra ssp. austriaca	N	X	X	
Pinus sylvestris	N		X	
Populus alba	N			X
Populus nigra	N	X	X	X
Pseudotsuga menziesii	E		X	X
Quercus petraea	N		X	X
Quercus robur	N		X	X

Importance of genetic resources and factors influencing the state of forest genetic diversity :

Detailed genetic inventories for all forest tree species are missing, but since there is no major change in silviculture and natural regeneration, it can be deduced that for the main tree species genetic diversity remain at a high level. This certainly holds true for European beech, which is probably the least affected, widely distributed forest tree species in Austria. On the other side, Norway spruce and European larch are the major species that are used for afforestation and, hence, the natural gene pool is altered. Taking the actual numbers of plants used for afforestation as well as the total distribution area into account, with exception of rare forest tree species (see below) European larch is probably one of the most affected tree species. For this species, a major part of the reproductive material is derived from few seed orchards that have been already established for several decades; this may have had a negative impact on the genetic diversity of the species. Rare tree species are probably heavily affected by fragmentation of the remnant populations; however, especially in Rosaceae species conservation efforts are high and planting is encouraged, so there might even be a positive trend, at least in some regions.

A recent inventory of the genetic diversity in Norway spruce using mitochondrial and nuclear DNA markers has shown that the species harbors a very high level of genetic (molecular) diversity supporting older data based on isozyme studies covering at least major parts of the Austrian distribution area of Norway spruce. The former investigation was made possible since DNA sampling was done within the framework of the AFI and could build a future basis for a genetic monitoring for this and other important species.

A biodiversity index for the Austrian forest is currently being developed and discussed with political stakeholders. This index (aggregated over several referenced indicators) also includes genetic indicators, such as the genetic naturalness, the number of forest genetic reserves , the number of conservation seed orchards, or the number of seed collection stands and the use of seed stands. If this indicator will be implemented, Austria would have an appropriate monitoring tool for forest biodiversity including forest genetic resources.

Chapter 2: The State of *in situ* genetic conservation

Although there are several national parks, and a multitude of forest reserves and conservation areas in Austria, here we deal not with those as they have not been specifically installed to conserve important FGR.

In Austria, almost 8,900 ha of forest are registered as *in situ* forest genetic reserves (originally termed gene conservation forests) , these consist of 281 units from 21 forest community types. Each unit usually contains more than one tree species. For yew, service tree and chestnut, special gene conservation have been designated. The forest genetic reserves have been exclusively installed in managed forests. By specific silvicultural management measures loss of genetic diversity shall be avoided and natural regeneration shall be induced. Long regeneration periods should allow as many individuals as possible of different age and from different vertical and horizontal layers to pass their genes to the next generation. The selection of these *in situ* means was done to represent as many natural forest communities as possible. It was assumed, that the genetic diversity of the species in question was sufficiently captured in this way, by selecting populations from diverse ecological units. Since climate is a very strong selection factor, it has been amply used to classify the Austrian forest types. *In situ* units are to conserve adaptability of these Austrian forest types, therefore genetic reserves should be distributed evenly among these forest types. There is currently a lack of forest genetic reserves in the eastern Pannonic lowland and hills, the Mühlviertel, as well as the Northern Pre-Alps. In these areas, very few or no *in situ* units have been selected. On the other hand, efforts need to be prioritized, based on the results of new research. Units with highest priority for conservation have already been designated in 144 cases (6,200 ha). This high priority needs to be evaluated by regular inspection. Based on the known distribution of tree species, it needs to be assessed if further *in situ* means are to be installed. Establishment of these forest genetic reserves is done according to international agreed upon selection criteria (EUFGIS - Establishment of a European and EUFORGEN - European Forest Genetic Resources Programme). Moreover, other protected areas (e.g. national parks, natural forest reserves) that do not aim specifically at the conservation of FGR are taken in account.

Also weak competitor and/ or endangered tree species should be conserved *in situ*, because this is both from a scientific and economic viewpoint the most sustainable measure. In particular, specific silvicultural measures can easily help to protect small populations or populations threatened by changes in management. In Austria, efforts have been focused on yew, rare species of *Sorbus* (esp. service tree) as well as the elm species. In all these cases, the species are highly endangered, that need constant support for survival.

Forest genetic reserves are monitored and evaluated by inspection of BFW experts every 10 years. A major constraint to the forest gene conservation programme is the lack of incentives that could be provided to forest owners. Therefore, the programme is largely dependent on the good-will of forest owners to implement suggested management measures. Also due to a lack of human resources at the implementing institution (BFW-Department of Forest Genetics) the goal of a 10-year circle of re-evaluation is lagging behind. Owners and the general public also need to become better informed about the importance of these gene conservation forests.

Table 10. Target forest species included within *in situ* conservation programmes/units.

Species (scientific name)	Purpose for establishing conservation unit	Number of populations or stands conserved	Total Area
Abies alba	dynamic gene conservation	75	3829.4
Acer pseudoplatanus	dynamic gene conservation	22	368.5
Alnus glutinosa	dynamic gene conservation	1	5.7
Alnus incana	dynamic gene conservation	4	66.1
Betula pubescens	dynamic gene conservation	1	10
Carpinus betulus	dynamic gene conservation	4	165.7
Castanea sativa	dynamic gene conservation	2	9.8
Fagus sylvatica	dynamic gene conservation	78	3285.1
Fraxinus excelsior	dynamic gene conservation	5	181.8
Fraxinus ornus	dynamic gene conservation	1	20
Larix decidua	dynamic gene conservation	78	3377.5
Ostrya carpinifolia	dynamic gene conservation	2	22
Picea abies	dynamic gene conservation	164	6472.8
Pinus cembra	dynamic gene conservation	32	1374.9
Pinus mugo	dynamic gene conservation	4	133.8
Pinus nigra	dynamic gene conservation	3	211.7
Pinus sylvestris	dynamic gene conservation	26	962.1
Prunus avium	dynamic gene conservation	1	8.5
Quercus cerris	dynamic gene conservation	2	114.7
Quercus petraea	dynamic gene conservation	12	384.3
Quercus robur	dynamic gene conservation	12	428
Sorbus domestica	dynamic gene conservation	1	2
Sorbus torminalis	dynamic gene conservation	3	19.5
Taxus baccata	dynamic gene conservation	30	505.4
Tilia cordata	dynamic gene conservation	7	256.8
Tilia platyphyllos	dynamic gene conservation	8	60.9
Ulmus glabra	dynamic gene conservation	6	516.5

Chapter 3: The State of *ex situ* Genetic Conservation

Species with small distribution area and low abundance are difficult to protect *in situ*. In such cases genetic diversity can be better conserved by *ex situ* measures. This kind of conservation measure is static, because the gene pool of this population does not change over time. In Austria, two different approaches for *ex situ* conservation have been applied. Only regional species and provenances have been included in the Austrian *ex situ* conservation strategy.

First, long term storage of seeds for the main tree species with orthodox seeds was done. By this method shortage of seeds caused by low or a lack of fructification of forest trees can be buffered. The amount of seeds for this purpose should be large enough to conserve the genetic diversity of the tree populations in questions. For this purpose between 1986 and 1988 a cold storage house was installed at BFW (Deaprtment of Forest Genetics, experimental nursery Tulln) with a capacity of 260 m^3 to store seeds at a temperature between +5°C and -20°C.

Conservation seed orchards are another method of *ex situ* conservation. These seed orchards have been created by propagating certain clones of endangered species, resulting in artificial populations. The seeds harvested in these orchards then have enhanced genetic diversity and can be used to produce reproductive material (plants), to actively conserve variation in these tree species.

The seed orchard sites were chosen in a way to avoid pollen contamination by outside sources. Pollen shedding has been monitored using pollen traps. Selected clones were propagated by grafting. Shoots for grafting were collected in the upper part of tree crowns, to obtain early flowering ramets. The two to four year old ramets were planted following a spatial distribution, i.e. each clone is surrounded by different clones and in each replication new combinations are planted in order to minimize selfing (withing differents ramtes of a certain clone). The average size of a clonal seed orchard is 1.5 ha with an average of 50 clones in 4 to 5-times replications. Currently 48 clone orchards for 14 tree species covering an area of 70.5 ha exist. In addition, eight seedling collections from eight tree species are used (Table 11).

For the conservation seed orchard, priority categories have been established. Category 1 covers the most important species for ex situ conservation; this includes the rare species, e.g. *Malus sylvestris*, *Pyrus pyraster* (new seed orchards have been planned, e.g. for *Taxus baccata*). Category 2 covers species that are endangered but from which there are still viable natural populations, e.g. Ulmus spp., *Quercus robur*, *Pinus mugo* sp. *uncinata*, *Abies alba*, as well as regionally endangered Salix and *Populus* populations. Category 3 covers orchards important for seed production but with lower conservation priority, e.g. *Acer pseudoplatanus*, *Fraxinus excelsior*, *Carpinus betulus*, *Larix decidua, Alnus glutinosa*, *Quercus petraea*, *Prunus avium*. Category 4 orchards have low priority for conservation and seed production, e.g. *Pinus sylvestris* and *Picea abies*. Based on this categorization future efforts will concentrate on species in category 1, while orchards in category 4 may be abandoned.

Storage of tree seeds with a possible storage time of less than 10 years has proven to be ineffective. In the future, long term storage of seeds will be an exemption in the FGR conservation strategy of Austria. Seeds that can be stored less than 10 years will only be stored in certain cases (e.g. rarity of species, scientific research). Seeds that can be stored longer than 10 years will be conserved only if this makes sense due to rare fructification in the species.

Table 11. ***Ex situ*** **conservation.**

Species		Field collections				Germplasm bank			
Scientific name	Native (N) or exotic (E)	Collections, provenance or progeny tests, arboreta or conservation stands		Clone banks		In vitro (including cryo conservation)		Seed banks	
		No. stands	No. acc.	No. banks	No. clones	No. banks	No. acc.	No. Banks	No. acc.
Abies alba	N	0	0	13	897	0	0	0	0
Acer pseudoplatanus	N	0	0	9	470	0	0	0	0
Alnus glutinosa	N	0	0	3	150	0	0	0	0
Alnus incana	N	1	283	0	0	0	0	0	0
Carpinus betulus	N	0	0	1	52	0	0	0	0
Fraxinus excelsior	N	0	0	2	121	0	0	0	0
Larix decidua	N	0	0	5	329	0	0	0	0
Malus sylvestris	N	1	125	0	0	0	0	0	0
Picea abies	N	0	0	2	153	0	0	0	0
Pinus uncinata	N	0	0	3	120	0	0	0	0
Prunus avium	N	0	0	4	209	0	0	0	0
Pyrus pyraster	N	1	120	1	52	0	0	0	0
Quercus petraea	N	1	240	0	0	0	0	0	0
Quercus robur	N	1	216	1	51	0	0	0	0
Sorbus domestica	N	1	51	0	0	0	0	0	0
Sorbus torminalis	N	1	260	1	45	0	0	0	0
Tilia cordata	N	0	0	2	117	0	0	0	0
Ulmus minor	N	1	124	0	0	0	0	0	0

Chapter 4: The State of Use and Sustainable Management of Forest Genetic Resources

The importance of FGR is more and more realized by Austrian forest managers. While in previous decades forest managers were relatively careless on the forest reproductive material used, today the awareness of the importance of appropriate forest reproductive material especially its effects on quality and yield is growing. This is mainly due to improved education at the university level, but also due to the extension service of BFW (Dept. of Genetics) and the Austrian Chamber of Agriculture, as well as others. Recently, an online platform was installed to inform forest managers about provenances, registered seed stands, and forest nurseries (www.herkunftsberatung.at); this tool can also be used by forest managers to get in contact with suppliers of forest reproductive material.

Only a small proportion of the seeds needed is imported from other countries. Mainly seed stands (selected according to EU-Directives) are the main seed source. It is a goal of the Austrian strategy for FGR conservation to gradually increase the area of selected seed stands to around 20,000 ha and to use this resource evenly. By comparing the seed stand area per species with the forest area covered by each species, a nominal value can be defined per species and elevation layer. Currently this value has not been reached by any species. A genetic indicator monitors whether the seed harvests are using available resources evenly and thus avoiding that seeds originating from a single seed stand or only few ones are used. This genetic indicator is part of the Austrian Forest Biodiversity Index. For certain species there are actually not enough stands available, therefore, an option would be to create stands specifically as seed collection forests.

During the last decade not only intermittent seed production in the stands, but also failure of forest managers to organize seed collection has created a regional shortage of seed material even in common species, e.g. Norway spruce or European larch. Although there are incentives for seed collection by the EU funds for regional development, seed harvesting in stands needs to be propagated more intensively in the future.

Many forest genetic reserve are also registered as seed stands, so there is no obstacle to using these valuable FGR as seed sources.

Forest tree seed orchards have also been installed for seed production. Most orchards exist for European larch, Silver fir, and sycamore maple. A proportion of these seed orchards are also part of the national *ex situ* conservation strategy. Most of these seed orchards have been installed during the 1980s and '90s, but the oldest orchards (e.g. in European larch) date back to the 1950s. Seed production is varying, depending also on management intensity and site conditions. For some species, e.g. sycamore maple, more seed material is used from orchards than from harvesting of stands.

Long-term monitoring is important to detect changes in the genetic composition of tree populations or of their reproductive potential. An evaluation of the status quo of a species' genetic diversity has been done in Austria for Norway spruce. By collecting needle samples during the AFI (2007-2009) and the consecutive analysis of mitochondrial and nuclear DNA markers, it was found that the Austrian population of Norway spruce harbors extremely high values of genetic (molecular) diversity; the pattern of genetic diversity also suggested a comparatively natural composition of the Austrian spruce population, particularly in the Alpine range. These results provide an important baseline for future monitoring. Such an inventory could also be done easily for further species (e.g. oak, larch, fir). Each or every second AFI survey (usually taking place every 5 years) could be used to obtain monitoring data.

Genetic improvement programmes and their implementation:

Tree improvement programmes in Austria mainly have dealt with Norway spruce, European Larch, oak species, wild cherry (native) and Douglas-fir (introduced). Recently, new provenance and progeny trials have been installed for *Quercus robur* and *Q. petraea*, as well as wild cherry; and for Norway spruce and European larch DNA marker based breeding approaches have been initiated. Improved yield, quality and resistance to drought (climate change) are targeted by the tree improvement programmes. For most programmes improvement is on the first generation level; the new initiative towards European larch will develop seed orchards of the second generation. Generally, the level of tree improvement is low compared to Sweden or North America. Improvement programmes in Norway spruce and European larch have a strong participatory aspect, as partners from the timber industry as well as the forestry and nursery sector are directly involved. The results of these improvement programmes will be made publicly available (clones, germplasm).

Table 12. Seed and vegetative propagules transferred internationally per annum (average of last 5 years).

Scientific name	Native (N) or Exotic (E) ?	Quantity of seed (Kg) Harvested	Number of vegetative propagules		Number of seedlings		Seeds		Purpose
			Import	Export	Import	Export	Import	Export	
Acer pseudoplatanus *	N	1233	x	x	128845	10616	295	12	forestry
Fagus sylvatica	N	798	x	x	189369	2161	801	215	forestry
Fraxinus excelsior	N	94	x	x	36017	1400	7	13	forestry
Quercus petraea	N	984	x	x	27811	2550	352	0	forestry
Quercus robur	N	4171	x	x	86085	6920	1074	170	forestry
Quercus rubra	E	2192	x	x	21815	1764	401	20	forestry
Abies alba *	N	6793	x	x	74925	18096	5	23	forestry
Larix decidua *	N	5823	x	x	199018	13092	5	2	forestry
Picea abies	N	5058	x	x	217380	45551	36	7	forestry
Pinus sylvestris	N	1587	x	x	13700	9902	1	0	forestry

Legend
Import: (2008-2012 (exception: * = 2008-2011))
EU-member states & non EU-member states
Export: (2008-2012)
EU-member states & non EU-member states
Production: (2008-2012)
Weight after harvest
X= no data available

Table 13. Forest improvement programmes.

Species	Native (N) or exotic (E)	Improvement programme objective					
Scientific name		Timber	Pulpwood	Energy	MP*	NWFP**	Other
Larix decidua	N	x					
Picea abies	N	x	x				
Populus spp.	N/ E			x			
Salix spp.	N/ E			x			

Table 14. Tree improvement trials.

Species		Plus trees*	Provenance trials		Progenies trials		Clonal testing and development			
Scientific name	Native (N) or exotic (E)	Number	No. of trials	No. of prov.	No. of trials	No. of families	No. of tests	No. of clones tested	No. Clones selected	No. Clones used
Picea abies	N		10	ca. 500			8	ca. 800		
Larix decidua	N		1	19	1	10				
Pseudotsuga menziesii	E		18	190						
Quercus robur	N		5	16	5	352				
Quercus petraea	N		5	6	5	132				
Fagus sylvatica	N		1	49						
Prunus avium	N		10	33						
Abies cephalonica	E		2	44						
Abies grandis	E		1	12						
Pinus cembra	N		1	13	1	24				

Table 15. Seed orchards.

Species (scientific name)	Seed orchards*		
	Number	**Generation	Area
Abies alba	11	1	17.56
Alnus glutinosa	3	1	4.43
Alnus incana	1	1	1.50
Acer pseudoplatanus	10	1	12.29
Carpinus betulus	1	1	0.48
Fraxinus excelsior	3	1	3.66
Larix decidua	15	1	41.97
Picea abies	5	1	12.34
Prunus avium	6	1	6.24
Pinus cembra	1	1	1.50
Pseudotsuga menziesii	1	1	2.20
Pinus sylvestris	7	1	13.76
Quercus robur	1	1	1.8
Tilia cordata	3	1	3.59

*Seed orchards are plantations specifically planted and managed for seed production, not natural seed stands.
**Generation refers to 1st, 2nd, 3rd, etc., breeding cycle

Table 16. Type of reproductive material available.

Species (scientific name)	Type of material	Available for national requests only		Available for international requests	
		Commercial	Research	Commercial	Research

Currently there is no specific information available on the availability of improved reproductive material.

Chapter 5: The State of National Programmes, Research, Education, Training and Legislation

Table 17. Institutions involved with conservation and use of forest genetic resources.

Name of Institution	Type of Institution	Activities or Programs	Contact Information
Dept. of Forest Genetics, Federal Research and Training Centre for Forests, Natural Hazards, and Landscape (BFW)	Research Institute	Department Head, National and International Strategy for FGR	Thomas Geburek, Dept. of Genetics, BFW, Hauptstrasse 7, A-1140 Vienna; thomas.geburek@bfw.gv.at
		In situ, Ex situ conservation of forest genetic resources	Heino Konrad, Dept. of Genetics, BFW, Hauptstrasse 7, A-1140 Vienna; heino.konrad@bfw.gv.at
		Tree Breeding, Provenance trials	Silvio Schueler, Dept. of Genetics, BFW, Hauptstrasse 7, A-1140 Vienna; silvio.schueler@bfw.gv.at
		Genome Research	Berthold Heinze, Dept. of Genetics, BFW, Hauptstrasse 7, A-1140 Vienna; berthold.heinze@bfw.gv.at
University of Natural Resources and Life Sciences (BOKU), Vienna	University	Education, rare tree species	Raphael Klumpp, Institute of Silviculture, BOKU, Peter-Jordan-Straße 82, A-1190 Vienna, raphael.klumpp@boku.ac.at
		Education, molecular genetics of tree species	Marcela van Loo, Institute of Silviculture, BOKU, Peter-Jordan-Straße 82, A-1190 Vienna, marcela.vanloo@boku.ac.at
Austrian Institute of Technology (AIT)	Research Institute	Research, Genomics of forest tree species	Silvia Fluch, AIT, Health and Environment, Konrad-Lorenz-Straße 24, 3430 Tulln, silvia.fluch@ait.ac.at

National Programmes:

The conservation of FGR in Austria is generally suffering from a lack of public interest. Therefore, it will be important not only to inform forest enterprises but also the general public about the significance of FGR. One way to achieve this goal his, is to raise public awareness about rare and threatened tree and shrub species especially in the general public.

The Austrian Forest Dialogue was initiated in 2003 by the Federal Ministry of Agriculture, Forestry, Environment and Water Management. The objectives of this institutionalized, transparent and long-term dialogue are to ensure and permanently optimize the sustainable management of Austria's forests. Together with all stakeholders and persons interested in forests a careful approach to forests is to be developed and the effects of forests are to be safeguarded for the long term. Participation in the Forest Dialogue is open to all groups, institutions and interested persons dealing with Austrian forests. To allow well-structured implementation, various institutions have been established. Their political centerpiece is the Round Table, which is headed by the Federal Minister. Technical discussions take place in so-called Forest Forums as well as in working group meetings. An important milestone in the Forest Dialogue is the first Austrian Forest Programme, which was jointly developed by 80 organizations and institutions and was consensually adopted in late 2005.

National Biodiversity Strategy

In 1992, Austria signed (and ratified in 1994) the Convention on Biological Diversity at the United Nations Conference on Environment and Development held in Rio de Janeiro. This resulted in the establishment of a national strategy for implementing the agreement, carried out by a committee consisting of representatives from the administration, the scientific community and nongovernmental organizations. This main thrust of this strategy involved, as laid down in the agreement, the conservation and sustainable use of biological diversity, along with research and systems of monitoring. The strategy, which has already been subjected to a multi-stage process of evaluation, is to be updated on a regular basis. Suggested measures designed to stop the loss of biological diversity include the setting up of buffer zones and protected areas, improvements in the financial and staffing resources available to nature conservation, the reduction of the permanently sealed land by controlling land use, the restoration of linear streams and rivers and the restoration of damaged wetlands.

Austrian Ecological Forest Programme

In 2011, the Austrian Ecological Forest Programme was launched mainly in order to identify how forestry can support biodiversity including forest genetic resources and to develop respective financial incentives.

National Forest Strategy

Among the seven areas of activities of the National Forestry Programme , one is focusing specifically on biodiversity including forest genetic resources. This strategy utterly stresses that genetic sustainability is needed for long-term stability and economic productivity of forests and that national biodiversity monitoring must take into account genetic aspects as well.

In particular the strategy mentioned:

- The development of a genetic monitoring,
- recording of changes in the reproduction of forest trees,
- investigation of the effects of silvicultural treatments in terms of the genetic composition of the stands with special consideration of their adaptability,
- establishment and analysis of provenance tests along temperature gradients.

National Programme on Forest Genetic Resource

Since the mid-eighties, Austria took specific measures to implement the national programme on forest genetic richness. In doing so the ecological and economic importance of genetic resources for political action was recognized. In order to insure adaptational processes over tree generations and thus evolution of forest tree species over longer time, *in situ* measures were strongly favoured as dynamic means. Since data on adaptive genetic variation were not available, a network of genetic reserves distributed along environmental gradients was established. Today, this network represents forests from many ecoregions and comprises more than 280 conservation units totalling almost 8.900 hectares. As static means, *ex situ* measures were chosen and a seed bank and 55 conservation orchards (clone banks and seedling orchards) comprising 18 tree species, with a total area of 77 hectares were established. New international commitments, growing knowledge in conservation genetics and related fields, changes in the dynamics of forest health conditions and different future risks including climate change require an update of the programme. The conservation of genetic resources is still an important political goal. Hence, the *Agrarrechtsänderungsgesetz* explicitly mentioned as one of the tasks the implementation of forest genetic conservation or the EU- Council Directive 1999/105 puts emphasis on the genetic diversity when moving forest reproductive material in trade. The initial priority to maintain the adaptability as the main prerequisite to ensure evolutionary processes and therefore the maintenance of adaptability is still valid in an unrestricted manner.

In the last decades, the importance of certain threats has changed. Global climate change, loss and alteration of habitats, bottleneck of regional supplies of appropriate forest reproductive material, natural regeneration of genetically inferior stands, inappropriate use of forest reproductive material and especially overstocking of game species impel conservation means. Additional *in situ* genetic reserves should be identified in following ecoregions: *Pannonisches Tiefland*, *Pannonisches Hügelland*, *Mühlviertel* and *Nördliches Alpenvorland*. Certain *ex situ* measures (seed storages in the seed bank) will not be maintained and the management intensity of certain seed orchards will be restricted in the future. National Parks and the core zones of Biosphere Parks should be declared as gene protection areas where autochthonous forest reproductive material is exclusively used. To achieve adaptable and genetically sustainable forests, genetic aspects should increasingly be embedded in regular forest management. It is proposed that the conservation of genetic resources follows the principles of a Passive Adaptive Management. An important component is that selected forest enterprises are involved. Reforestation that is subsidized should be evaluated from a genetical point of view and the data obtained should be used for monitoring and modelling. Supplemental data could be collected within the framework of controlling the domestic trade with forest reproductive material and could be used as additional input for the Adaptive Management. It is further proposed that data on the movement of forest reproductive material in trade, especially within the EU is used as additional information source. The revised programme 'Sustained Utilization of Forest Genetic Resources' should be one important element of the National Forest Programme of Austria as it was addressed in the Resolution 4 in the 4th Ministerial Conference on the Protection of Forests (Vienna 2003) in Europe.

Education, Research and Training:

Forest management can be studied only at the University of Natural Resources and Life Sciences (BOKU), Vienna. There are BSc and MSc grade studies available. Genetics is included in these studies, and students have the opportunity to take additional courses in the subject.

The budget allocated to FGR research is marginal considering the whole budget allocated to this topic in Austria (<1%). When considering the budget dedicated to forest research alone this proportion is probably also <10%. There is a high need for research funds for the relevant institutions to maintain and improve the current infrastructure.

There is a strong need to integrate genetics in the lower level education of foresters, since many practical forest managers have none or only a very basic training in the importance of FGR and the use of appropriate reproductive material.

National Legislation:

There is no legal framework particularly focusing on FGR. The legislative basis for forest reproductive materials, seed stands and orchards are covered by the national law on forest reproductive material (Forstliches Vermehrungsgutgesetz 2002) and the associated decree implementing EU Council Directive 1999/105/EC and others. It should be highlighted that the Austrian law on forest reproductive material has tighten respective EU laws by introducing the category "enhanced genetic diversity" for seeds when collected from more than 50 mother trees. This additional category mirrows that Austrian legislation has realized the importance of FGR.

Table 18. Needs for developing forest genetic resources legislation.

Needs	Priority level			
	Not applicable	Low	Moderate	High
Improve forest genetic resources legislation		x		
Improve reporting requirements			x	
Consider sanction for non-compliance			x	
Create forest genetic resources targeted regulations				x
Improve effectiveness of forest genetic resources regulations				x
Enhance cooperation between forest genetic resources national authorities		x		
Create a permanent national commission for conservation and management of forest genetic resources			x	

Information Systems and Public Awareness:

There is no specific awareness programme for FGR in Austria, although for forest managers the platform www.herkunftsberatung.at is an important tool to become informed on reproductive material available.

Table 19. Awareness raising needs.

Needs	Priority level			
	Not applicable	Low	Moderate	High
Prepare targeted forest genetic resources information				x
Prepare targeted forest genetic resources communication strategy		x		
Improve access to forest genetic resources information				x
Enhance forest genetic resources training and education				x
Improve understanding of benefits and values of forest genetic resources				x

Chapter 6: The State of Regional and International Collaboration

International agreements

Table 19b. The most important legally and politically binding norms for FGR conservation relevant for Austria.

Level	**Primary Sector**	**Legally binding norms (hard laws)**	**Politically binding norms (soft laws)**
International	Environment	Convention on Biodiversity (CBD) (1993)	World Charter for Nature (1982) Brundtland Report (1987) Agenda 21 (1992) International Union for the Conservation of Nature IUCN categories (1994) Recommendations of the Conference-of-Parties (COP) and Subsidiary Scientific Technical and Technological Advice (SBSTTA) OECD Biodiversity Strategy
	Forest	International Tropical Timber Agreement ITTA (1983, 1993)	UNCED Statement of Forest Principles (1992)
European	Environment	Alpine Convention (1991) Protocol Mountain Farming Protocol Conservation of Nature and the Countryside Directive 79/409/EEC(1979) ('Birds Directive') Directive 92/43/EEC (1992) ('Habitats Directive')	Pan-European Biological and Landscape Diversity Strategy (PEBLDS) (1995) Working programme of the PEBLDS
	Forest	Protocol Mountain forests of the Alpine Convention Directive 1999/105/EC (Directive on marketing of forest reproductive material)	Strasbourg Resolution S2 (1992) (Conservation of FGR) Helsinki Resolution H1 (1993) (Sustainable Management) Helsinki Resolution H2 (1993) (Conservation of biodiversity) Helsinki Resolution H4 (1993) (Climate change strategy) Lisbon Resolution L2 (1998) (Criteria for sustainable management) Vienna Resolution V4 (2003) (FGR as integral part of sustainable management) Working program for the MCPFE (1999)

International Programmes:

Austria has been participating and is currently involved in a number of international programmes and projects concerning FGR:

Table 20. Overview of the main activities carried out through networks and their outputs

Network name	Activities *	Genus/species involved (scientific names)
EUFORGEN	Information exchange: Networks, Workshops, national reports	see: http://www.euforgen.org
EUFORGEN	Development of shared databases: EUFGIS database (BFW)	see: http://portal.eufgis.org
EVOLTREE	Development of shared databases: DNA repository center at AIT	see: http://www.evoltree.eu
TREEBREEDEX	Development of databases on forest tree breeding (BFW)	see: http://treebreedex.eu

EUFORGEN
For the implementation of resoltuion S2 of the European ministerial conference in Strasbourg 1994 the Eurpean Forest Genetic Resources Programme (EUFORGEN) has been established. EUFORGEN supports national FGR programmes by promoting the international exchange of information, defining joint conservation strategies, developing guidelines and tools as well as by initiating research projects. Austria was a founding member of this international programme, but had to withdraw her membership in 2010 due to budget cuts. However, the associated EUFGIS-database records on dynamic gene conservation units (*in situ*) are still maintained.

Currently Austria is involved in the following projects on the EU and international level dealing with FGR:

Trees4Future (participants: BFW, AIT)
Trees4Future is an Integrative European Research Infrastructure project that aims to integrate, develop and improve major forest genetics and forestry research infrastructures. It will provide the wider European forestry research community with easy and comprehensive access to currently scattered sources of information (including genetic databanks, forest modelling tools and wood technology labs) and expertise. This will help forestry researchers and the European forestry sector to respond, in a sustainable manner, to increasing demands for wood products and services in a context of genetic adaptation and changing climatic conditions. It will create a new and better linked research infrastructure which will increase our knowledge about the adaptation of forests to climate change and tree characteristics suited for tailor-made wood supply - thus optimising the short- and long-term exploitation of forest resources.

FORGER (BFW-Department of Forest Genetics)
Forest genetic resources (FGR) form the base for adaptation of European forests to future environmental conditions and societal demands. Appropriate use and sustainable management of FGR is therefore of utmost importance. Past decades have shown: (1) an immense progress in detecting patterns of genetic diversity, due to fast technological advances increased knowledge on the modelling of responses of tree species to changing environmental conditions, (2) increased awareness by policy makers across Europe, leading to increased efforts for the conservation of FGR in all European member states. E.g. by the establishment forest stands with the aim to conserve

genetic diversity. However, currently there is no sound management on the sustainable use of FGR neither in these gene conservation units nor in production forests, to meet future changes

The FORGER project aims at integrating and extending existing knowledge to provide science-based recommendations on the management and sustainable use of FGR for EU-policy makers, national stakeholders, forest managers, and managers of natural areas.

ProCoGen (BFW- Department of Forest Genetics)
Promoting a functional and comparative understanding of the conifer genome- implementing applied aspects for more productive and adapted forests.

In the midst of a climatic change scenario, the genetics of adaptive response in conifers becomes essential to ensure a sustainable management of genetic resources and an effective breeding. Conifers are the target of major tree breeding efforts worldwide. Advances in molecular technologies, such as next-generation DNA sequencing technologies, could have an enormous impact on the rate of progress and achievements made by tree breeding programmes. These new technologies might be used not only to improve our understanding of fundamental conifer biology, but also to address practical problems for the forest industry as well as problems related to the adaptation and management of conifer forests. In this context, ProCoGen will address genome sequencing of two keystone European conifer species. Genome re-sequencing approaches will be used to obtain two reference pine genomes. Comparative genomics and genetic diversity will be closely integrated and linked to targeted functional genomics investigations to identify genes and gene networks that efficiently help to develop or enhance applications related to forest productivity, forest stewardship in response to environmental change or conservation efforts. The development of high-throughput genotyping tools will produce an array of pre-breeding tools to be implemented in forest tree breeding programmes. ProCoGen will also develop comparative studies based on orthologous sequences, genes and markers, which will allow guiding re-sequencing initiatives and exploiting the research accumulated on each of the species under consideration to accelerate the use of genomic tools in diverse species. ProCoGen will integrate fragmented activities developed by European research groups involved in several ongoing international conifer genome initiatives and contribute to strengthening international collaboration with North American initiatives (US and Canada).

DouglAS (BFW Department of Forest Genetics , BOKU- Institute of Silvicluture)
Douglas fir is an exotic tree species with very high potential for forestry in Central Europe. The aim of the project is to combine growth and climatic data collected until now to develop a growth model for different climatic regions of Austria. This tool shall help forest managers to decide which provenance has the most potential in their forest.

There are several other projects currently running at BFW –Department of Forest Genetics on FGR in Africa:

Fighting climate change in Burkina Faso through technical cooperation and knowledge transfer in the agroforestry sector

The objective of the project is the development of improved land management concepts in the agroforestry parklands of Burkina Faso. It aims at improved agroforestry to diminish negative climate change impact to support the national government, as well as local and regional communities of Burkina Faso. This will be achieved through capacity building and supply of forest reproductive material to local communities. The work and the results of this project have a strong focus on education and training, as well as are implementation oriented.

Threats to priority food tree species in Burkina Faso: Drivers of resource losses and mitigation measures (together with Bioversity International, Rome)

This project addresses the vulnerability of key food tree species to current and future threats (eg., changes in land use and tenure, fragmentation of habitat, global environmental change) in order to propose sustainable management practices including conservation methods that are practical, comprehensive, aligned with traditional uses, and can be expected to improve human well-being in the short term as well as securing long-term sustainability of food tree resources.

Table 21. Awareness raising needs/ Needs for international collaboration and networking

Needs	Level of priority			
	Not applicable	Low	Medium	High
Understanding the state of diversity				x
Enhancing in situ management and conservation				x
Enhancing ex situ management and conservation				x
Enhancing use of forest genetic resources				x
Enhancing research				x
Enhancing education and training				x
Enhancing legislation			x	
Enhancing information management and early warning systems for forest genetic resources.				x
Enhancing public awareness				x
Any other priorities for international programmes	x			

Chapter 7: Access to Forest Genetic Resources and Sharing of Benefits Arising from their Use

Access to forest genetic resources:

There is no legal framework particularly focusing on access and benefit sharing (ABS) for FGR. However, Austria signed the Nagoya Protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilization.

Sharing of benefits arising out of the use of forest genetic resources:

So far the use of forest genetic resources in Austria is free and no mechanism for sharing benefits arising out of the use of FGR exists.

Chapter 8: Contribution of Forest Genetic Resources to Food Security and Poverty Reduction

Apart from a few local gourmet initiatives (e.g. SlowFood) there is little economic value of foods derived from woody forest species in Austria.

Table 22. Tree and other woody species that are important in your country for food security or livelihoods

Species		Use for food security	Use for poverty reduction
Scientific name	Native (N) or exotic (E)		

There are no forest tree species significantly used for food security or livelihoods in Austria.