Federal Office for
Agriculture and Food

National Report

on the Conservation and Sustainable Use of Forest Genetic Resources in the Federal Republic of Germany

Agrobiodiversität | Band 36
Schriftenreihe des Informations- und Koordinationszentrums für Biologische Vielfalt

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List of abbreviations and acronyms

A	
aid	*aid Infodienst Ernährung, Landwirtschaft, Verbraucherschutz e. V.* aid info-service consumer protection, food, agriculture
ASP	*Bayerisches Amt für forstliche Saat- und Pflanzenzucht* Bavarian Office for Forest Seeding and Planting

B	
B. C.	Before Christ
BB	Brandenburg
BBSR	*Bundesinstitut für Bau-, Stadt- und Raumforschung* Federal Institute for Research on Building, Urban Affairs and Spatial Development
BfN	*Bundesamt für Naturschutz* Federal Agency for Nature Conservation
BLAG-FGR	*Bund-Länder-Arbeitsgruppe „Forstliche Genressourcen und Forstsaatgutrecht“* Federal government/*Länder* Working Group “Forest Genetic Resources and Legislation on Forest Reproductive Material”
BLE	*Bundesanstalt für Landwirtschaft und Ernährung* Federal Office for Agriculture and Food
BMBF	*Bundesministerium für Bildung und Forschung* Federal Ministry of Education and Research
BMEL	*Bundesministerium für Ernährung und Landwirtschaft* Federal Ministry of Food and Agriculture (until 2013 *Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz*, BMELV)
BMUB	*Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit* (until 2013 *Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit*, BMU) Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

BMZ	*Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung* Ministry for Economic Cooperation and Development
BUND	*Bund für Umwelt und Naturschutz Deutschland* Friends of the Earth Germany
BW	Baden-Württemberg
BWI	*Bundeswaldinventur* Federal Forest Inventory
BWI^2	Second Federal Forest Inventory (reference year 2002)
BY	Bavaria
C	
CBD	Convention on Biological Diversity
COP	Conference of Parties, in this case to the CBD
CO_2	Carbon dioxide
D	
DBH	Diameter at breast height
DE	Federal Republic of Germany
DNA	Deoxyribonucleic acid
DNR	*Deutscher Naturschutzring* German League for Nature and Environment
E	
EU	European Union
EUFORGEN	*Europäisches Programm forstgenetische Ressourcen* European Forest Genetic Resources Programme

F	
FAO	Food and Agriculture Organization of the United Nations
FAWF	*Forschungsanstalt für Waldökologie und Forstwirtschaft Rheinland-Pfalz* Research Institute for Forest Ecology and Forestry Rhineland-Palatinate
FLEGT	Forest Law Enforcement, Governance and Trade
FoVDV	*Forstvermehrungsgut-Durchführungsverordnung* Implementing Regulation on Forest Reproductive Material
FoVG	*Forstvermehrungsgutgesetz* Act on Forest Reproductive Material
FSC	Forest Stewardship Council
FVA	*Forstliche Versuchs- und Forschungsanstalt Baden-Württemberg* Forest Research Institute Baden-Württemberg
H	
ha	hectares
HE	Hesse
I	
IBV	*Informations- und Koordinationszentrum für Biologische Vielfalt* Information and Coordination Centre for Biological Diversity
IPEN	International Plant Exchange Network
IS2008	2008 Inventory Study
ITPGR	International Treaty on Plant Genetic Resources for Food and Agriculture

ITTA	International Tropical Timber Agreement
IUCN	International Union for Conservation of Nature
IUFRO	International Union of Forest Research Organizations
K	
kg	kilogramme
km	kilometre
km^2	square kilometres
L	
l	litre
LFE	*Landeskompetenzzentrum Forst Eberswalde* Eberswalde forestry state centre of excellence
M	
m	metre
m^3	cubic metre
MCPFE	Ministerial Conference on the Protection of Forests in Europe, today Forest Europe
MLS	Multilateral System of the ITPGR
MV	Mecklenburg-Western Pomerania
N	
NABU	*Naturschutzbund Deutschland e. V.* Nature and Biodiversity Conservation Union
NW	North-Rhine Westphalia
NI	Lower Saxony

NW-FVA	*Nordwestdeutsche Forstliche Versuchsanstalt* Northwest German Forest Research Institute
O	
OECD	Organisation for Economic Co-operation and Development
P	
PEFC	Programme for the Endorsement of Forest Certification Schemes
PIC	Prior Informed Consent of CBD
Q	
QTL	Quantitative Trait Locus
R	
RP	Rhineland-Palatinate
S	
SDW	*Schutzgemeinschaft Deutscher Wald e. V.* German Association for the protection of forests
SH	Schleswig-Holstein
SL	Saarland
SMTA	Standard Material Transfer Agreement of the ITPGR
SN	Saxony
SNP	Single Nucleotide Polymorphism
ST	Saxony-Anhalt

T	
TH	Thuringia
Thünen-Institut	*Johann Heinrich von Thünen-Institut* Johann Heinrich von Thünen-Institute (formerly vTI)
U	
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNFF	United Nations Forum on Forests
W	
WWF	World Wide Fund for Nature

Summary

The Federal Republic of Germany is a federal state comprising 16 *Länder*. Conservation of the forests and therefore also conservation of forest genetic resources is on principle a task of the *Länder*. They harmonize their measures for the conservation of forest genetic resources among one another and with the Federal government in the Federal government/*Länder* Working Group "Forest Genetic Resources and Legislation on Forest Reproductive Material" (BLAG-FGR).

Approximately 11.1 million hectares of forests cover Germany, or 31% of the national area. Of the over 70 tree species occurring in German forests, the common spruce, pine, common beech and oak species take up the largest area percentages. Presently, the forests are managed according to the principles of sustainable and close to nature forestry. This usually simultaneously fulfils production, protective and recreational functions. Many of the measures of *in situ* conservation of forest genetic resources are also integrated in ordinary forest management operations.

Following the major waves of clearing in the Middle Ages, the forest area initially stabilized and has increased again since the 19th century. Therefore, there is no longer any risk to forest genetic resources through forest area losses in Germany. Also, over-exploitation and clear-cutting are largely things of the past. Nonetheless, influences from the past still have effects today. Centuries-long management greatly changed the forests compared to the vegetation that would have grown naturally. Presently, risks exist through fragmentation, loss of habitats due to site changes, browsing by game, air pollutants and, as a special challenge, climate change. The latter requires the exhaustion of all of the genetic potential of domestic populations as well as, if needed, targeted enhancement of the genetic spectrum with imported tree species and provenances that are less sensitive to future climate changes in order to establish adapted and adaptable forests. In addition, the forests must satisfy growing demands on their protective and recreational functions and the increased demand for timber.

In Germany, *in situ* measures form the focal point of measures for conservation of forest genetic resources. For the main tree species this is done chiefly in the

scope of sustainable management of the forests by means of care and natural regeneration on site as well as sowing and planting site-adapted reproductive material. These are supplemented with targeted identification of gene conservation objects and *ex situ* measures (e.g. storage of seed, seed orchards). In the case of rare tree and shrub species, usually targeted recording and genetic characterization of the populations are necessary in order to decide on conservation measures in the form, for example, of conservation plantations.

Presently (as of 2010) *in situ* conservation stands have been designated for approx. 170 tree and shrub species on about 7,079 hectares in Germany. By area, the common beech, the domestic oak species English and sessile oak, common spruce and Scots pine as well as the Russian elm dominate these. *Ex situ* stands of tree and shrub species exist (as of 2010) on a total area of approximately 1,254 hectares, whereby the largest area percentages are taken up by Douglas fir, common spruce, common beech and common yew. Seed orchards for tree and shrub species presently take up a total area of almost 800 hectares. Another *ex situ* measure is the storage of seeds and pollen. At present seeds of 84 species are being stored in nine *Länder* facilities and one Federal facility for storage of seed.

At present 25,963 seed crop stands to supply forestry with reproductive material are approved under the Act on Forest Reproductive Material, whereby the lion's share is from the category “selected”. About 1,600 forest seed and forest plant holdings ensure the production and marketing of forest reproductive material. They are under the control of the strict provisions of the Act on Forest Reproductive Material, which regulates commercial production, marketing as well as the import and export of forest reproductive material.

As early as the 1980s, the BLAG-FGR presented its first Concept for the Conservation and Sustainable Utilization of Forest Genetic Resources in the Federal Republic of Germany. Following fundamental revisions in the year 2000, the current new edition of 2010 serves as a National Programme.

The nine *Länder* institutions represented in the BLAG-FGR, the Johann Heinrich von Thünen Institute *(Thünen-Institut)* as well as universities and universities of applied sciences are active in research on forest genetic resources. The Federal government supports research with funding programmes.

Knowledge of tree and shrub genetics and the importance of the forest genetic resources are taught in the courses of study at universities and universities of applied sciences and in the vocational educational programmes of forestry professionals and related vocations. The collaboration between training enterprises and vocational schools in a dual system is a distinctive feature of vocational training in Germany. In addition to public authorities, numerous non-governmental organizations are involved in public relations to make the public aware of the importance of forests and the necessity of their conservation. Germany took advantage of the International Year of Forests designated by the United Nations for a national campaign coordinated by the Federal Ministry of Food, Agriculture and Consumer Protection, in which over 100 organizations took part in with their own events.

Germany cooperates in various regional and international networks, programmes and projects for the conservation and sustainable utilization of forest genetic resources and is a signatory of a number of international treaties such as the CBD. Access to forest genetic resources in Germany is free on principle. The steps that must be taken to implement the Nagoya Protocol signed by Germany are presently under consideration.

Introduction to the Country and its Forestry Sector

Governmental Structure, Competencies

The Federal Republic of Germany is a federal state comprising 16 *Länder* (Figure 2). One of the characteristics of this federal state is the distribution of governmental tasks among the various state levels (municipalities, *Länder*, Federal government). The distribution of tasks and legislative competencies are laid down in Germany's constitution, the *Grundgesetz* or German Basic Law. According to the constitutionally determined distribution of competencies, fundamental responsibility for fulfilling state tasks is that of the *Länder*, unless the constitution itself contains or allows for other provisions (Article 30 of the *GG* = basic law). This applies both to legislative and to administrative competence. Funding is on principle the responsibility of the authority exercising the functions (Article 104a of the *GG*). The *Länder* fulfil and fund their tasks under their own jurisdiction. Hence, in Germany forest conservation and therefore also conservation of forest genetic resources is on principle among the tasks of the *Länder*. The Federal government has only limited competencies here. The Federal government supports the *Länder* chiefly through the design of the legal framework and, where necessary, through coordinating functions and represents Germany internationally. In addition, it promotes research, funding of individual measures through specific support programmes. The practicability of the measures cited in this report is dependent upon the respective budget situation and parliamentary approval (budgeting rights of the parliament).

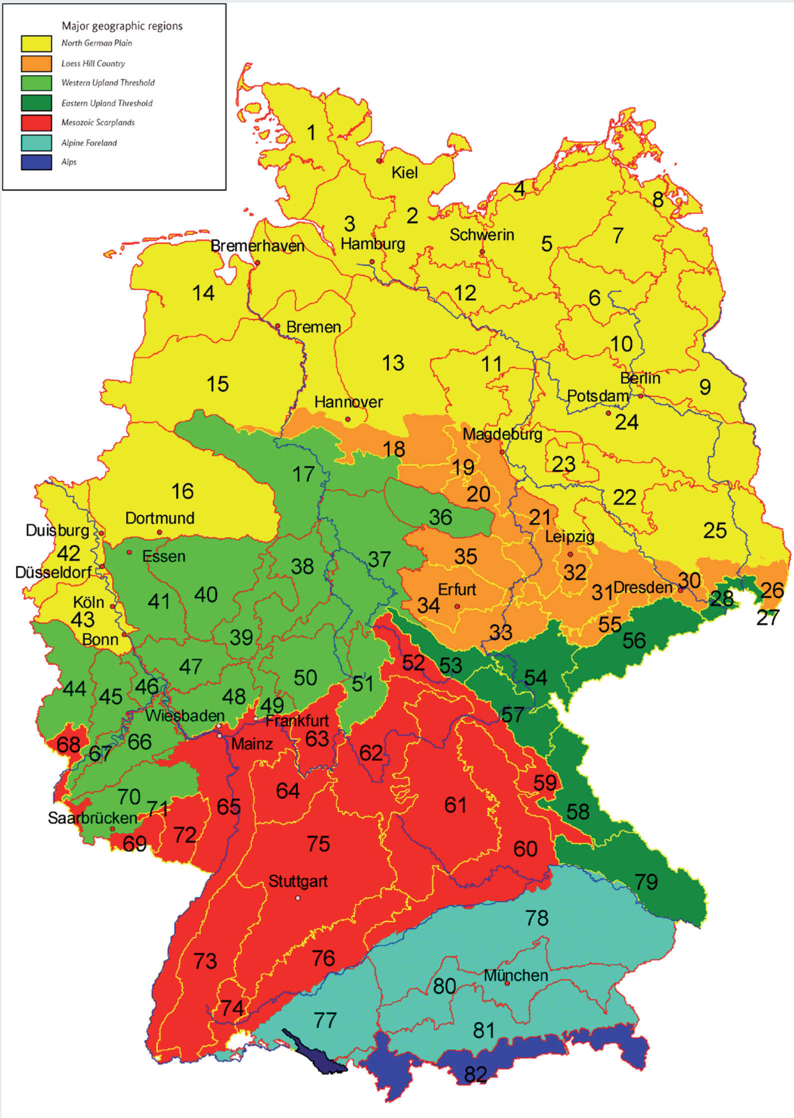

Figure 1: Major geographic regions of Germany (Gauer and Aldinger 2005)

Landscape and Climate

The Federal Republic of Germany (referred to as "Germany" in the following) is situated in Central Europe and covers an area of 357,114 km². Germany is composed of seven major geographic regions (Figure 1). The North German Plain reaches from the North Sea islands and marshes through the upper moraines into the lower moraine region in the plain bays. It encompasses glacially characterized, lowland landscapes run through with rivers with moraines, lakes and moors. Its southern edge is made up of the Loess Hill Country, whose geological subsoil is covered chiefly by fertile loess soils. This is followed to the south by the western and eastern Upland Threshold, formed from sediments from the Tertiary, Cretaceous and Jura periods. The Mesozoic Scarplands were formed from the up to 5-km deep rift valley on the Upper Rhine. The crystalline bedrock was raised here and from here the sediment-covered area falls to the southeast. The Alpine Foreland lies south of the Danube; it consists of abundant sediments from the Tertiary and Mesozoic periods. A narrow part of the northern limestone Alps (German Alps) forms the southern border of Germany (Gauer and Aldinger 2005). The sea level rises from the northwest to the southeast. The Northwest German Plain lies only a few metres over sea level, some areas lie below sea level and must be protected with dykes. The uplands reach heights of 600 m to almost 1,500 m, the German Alps rise to almost 3,000 m. Germany's highest mountain, *Zugspitze*, is also located here (2,962 m above sea level). The longest rivers of Germany are the Rhine (865 km), the *Weser* (744 km) the *Elbe* (727 km) and the Danube (647 km within Germany).

The country's location in the temperate zone is decisive for the climate in Germany, with characteristic frequent changes in the weather and precipitation at all times of the year. In most regions, half to two-thirds of annual precipitation falls in the months May to September. Moving from the northwest to the east and southeast, a gradual transition is perceptible from a more oceanic to a more continental climate. The daily fluctuations as well as the seasonal temperature differences are not subjected to any extremes (with the exception of mountainous locations). The average annual temperature is + 7 to + 9°C and the annual amounts of precipitation are on average 600 - 800 l/m² in the west and 500 - 600 l/m² in the east, in some places also distinctly under 450 l/m². In accumulation areas of the northern Alps and higher uplands precipitation rises distinctly and the average temperatures drop. Longer snow conditions frequently occur in the higher uplands and the Alps.

Population

Approximately 82 million inhabitants reside in Germany, corresponding to a population density of 230 persons per square kilometre. According to calculations by the Federal Statistical Office, until the year 2050 the population will decline due to lowered birth rates to an averaged 74 million inhabitants. 82% of the population live in urban communities. Over 60% of the area is made up of rural communities, but only 18% of the population lives there (BBSR 2010). In the rural regions, the landscape is characterized by farmland, green areas, pastures and forests. Yet even some urban regions feature astonishingly large forested areas.

Structure of the Forestry Sector

Germany, with 11.1 million hectares of forest (31% of the total national area) is one of the nations within the European Union (EU) with median forest coverage. In area use, the forests take second place in Germany after agriculture. The percentage of forested areas in the federal *Länder* varies considerably from 10% in Schleswig-Holstein to over 42% in Rhineland-Palatinate and Hesse (Table 1, Figure 2). The total forested area has increased by approx. 1 million hectares or 10% over the past 40 years due to afforestation and natural succession – in spite of continuing forest claims for other uses (deforestation).

Table 1: Forest area and forest area percentages in Germany

Länder	Forest area (hectares)	Percentage of forest area in the land area (%)
Hesse	880,257	42
Rhineland-Palatinate	835,558	42
Baden-Württemberg	1,362,299	38
Saarland	98,458	38
Bavaria	2,558,461	36
Brandenburg and Berlin	1,071,733	35
Thuringia	517,903	32
Saxony	511,578	28
North-Rhine Westphalia	887,550	26
Saxony-Anhalt	492,128	24
Lower Saxony, Hamburg and Bremen	1,162,522	24
Mecklenburg-Western Pomerania	534,962	23
Schleswig-Holstein	162,466	10
Germany total	**11,075,799**	**31**

(BWI^2, BMELV 2004)

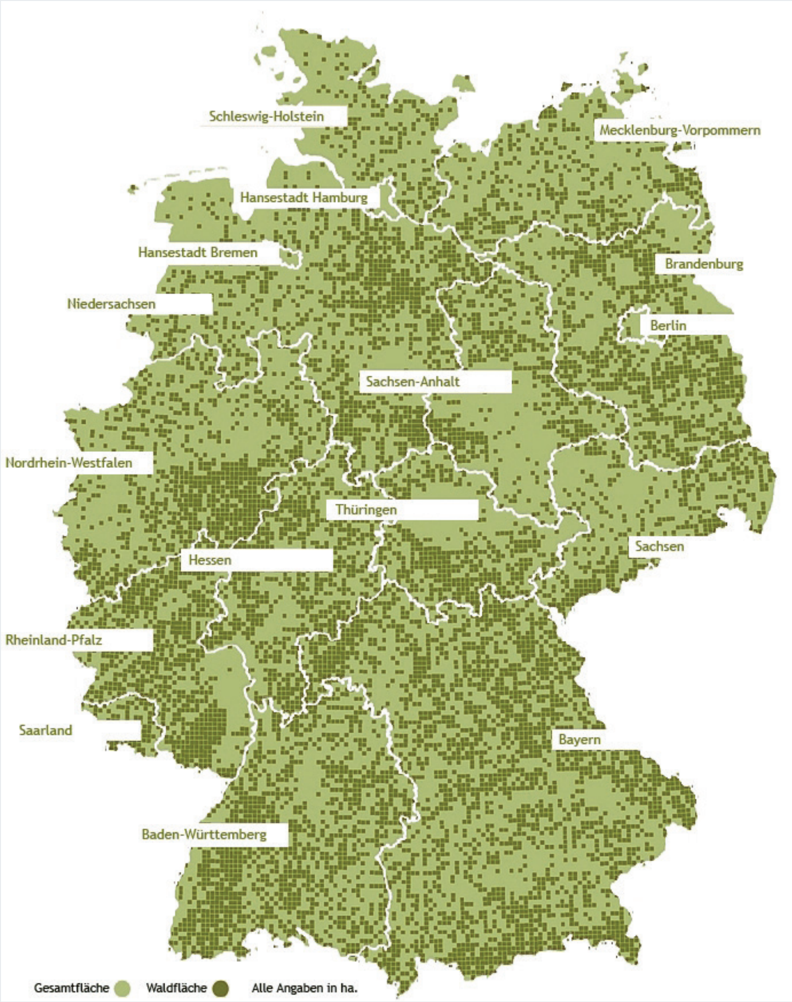

Figure 2: Map of forest distribution in Germany
Dark spots: BWI² samples in the forests (BWI², BMELV 2004)

Almost half (47%) of the German forest area are private forests, the other half (53%) is publicly owned. Of these, one third are state-owned (Federal government and *Länder*) and one fifth are communal forests (Figure 3).

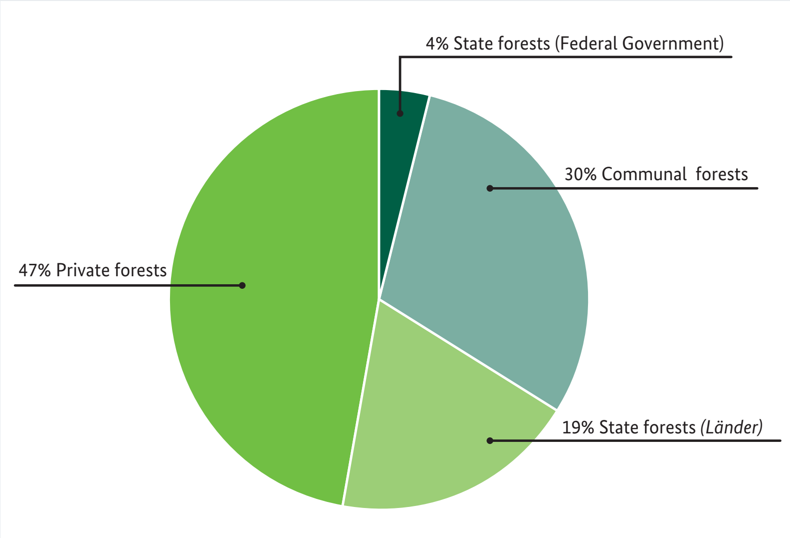

Figure 3: Forest area broken down by type of ownership
(BWI², BMELV 2004)

Various regional and national studies of recent years confirm the outstanding national economic significance of forestry and forest-based industries in Germany (Seintsch 2007, 2008). With annual turnover of approximately 170 billion euros, the forest-based industries contribute roughly 3 to 4% to the gross domestic product and employ approx. 1.2 million people (reference year 2008).

The average compact wood stocks (wood with a diameter over 7 cm) is approx. 330 m^3 per hectare of stocked timberland area. Germany takes a lead place in a European comparison with 3.4 billion m^3 of timber stock. Table 2 shows the stock according to type of ownership and tree species group. The average timber increment in Germany in 2008, according to the results of the Inventory Study, was 11.1 m^3/a*hectares (Polley et al. 2009b). The annual forest cuts over the past 10 years fluctuated between 39.5 million m^3 in 2001 and 76.7 million m^3 in 2007. The chief influencing factors for these cut results are major storm damage events as that in the year 2007 (the storm Kyrill), cyclical domestic and foreign demand and their effects of the respective prices. The markets for energy timber products had particularly dynamic developments due to considerably increasing energy prices. The average timber cut of the past 10 years (2001 - 2010) was 54.1 million m^3. Compared with the previous decade (average: 36.8 million m^3) the timber cut rose by about 47%. According to the present increment estimates, it continues to lie distinctly under the current annual increment of approx. 100 million m^3.

Table 2: Stock according to type of ownership and tree species group
1000 m^3 in solid volume over bark

Tree species group	State forest		Communal forest	Private forest incl. *„Treuhand“*	All ownership types
	Federal Government	*Länder*			
Oak	5 738	80 052	73 905	144 468	304 162
Sampling error [%]	*29.5*	*9.5*	*9.4*	*6.7*	*4.6*
Beech	7 162	213 582	160 526	288 966	610 236
Sampling error [%]	*35.9*	*7.0*	*8.1*	*7.0*	*4.1*
Other deciduous trees					
with a long life expectancy	4 039	41 129	46 571	88 835	180 633
Sampling error [%]	*34.0*	*11.9*	*11.3*	*8.0*	*4.6*
with a short life expectancy	6 948	42 089	34 613	104 560	188 210
Sampling error [%]	*23.5*	*11.8*	*14.4*	*7.3*	*5.5*
All deciduous tree species	23 887	376 852	315 615	626 829	1 283 241
Spruce	16 238	345 229	185 638	559 864	1 107 015
Sampling error [%]	*27.8*	*6.6*	*8.5*	*5.1*	*3.5*

Tree species group	State forest		Commu-nal forest	Private forest incl. *„Treu-hand“*	All owner-ship types
	Federal Govern-ment	*Länder*			
Fir *Sampling error [%]*	127 *100.0*	21 165 *18.1*	18 467 *23.5*	40 554 *16.2*	80 313 *11.0*
Douglas Fir *Sampling error [%]*	234 *71.4*	23 442 *17.3*	25 631 *20.8*	23 813 *19.0*	73 119 *10.9*
Pine *Sampling error [%]*	38 192 *18.0*	205 595 *7.7*	79 391 *11.8*	440 480 *5.3*	763 658 *3.9*
Larch *Sampling error [%]*	3 002 *47.7*	40 119 *12.3*	16 393 *19.1*	38 968 *12.2*	98 482 *7.7*
All coniferous tree species	57 793	635 550	325 520	1 103 679	2 122 587
All tree species *Sampling error [%]*	**81 739** *13.6*	**10 112 402** *4.3*	**641 180** *5.2*	**1 670 507** *3.1*	**3 405 828** *2.0*

Explanation of Table 2: Results of the 2008 inventory study. Timberland excluding “inaccessible timberland area”. The relative sampling error is cited in the table and equals the ratio of simple sampling error and recorded value. With a probability of 68%, the true value of the population studied lies within a range of +/- the simple sampling error of the value recorded with the sample. (BMELV 2010)

Chief Types of Forests and Management Systems for Forest Genetic Resources

The area of the German forests consists of 58% coniferous trees and 40% deciduous trees; the remaining 2% consists of gaps and unstocked areas. It is managed to 99% as high forest. Under this manner of operations common today, the tree stand originates generatively (afforestation from seedlings through natural regeneration, sowing or planting) and serves the production of logs. As opposed to sowing or planting, the age range within naturally regenerated stands can encompass a number of years to decades.

Almost half of the forests (46%) are single storied. Double storied forests are represented with 45% and 9% of the forests are multi-storied or plenter forests. The plenter forest is a special form of high forest management: trees of any age stand next to one another, the timber is harvested selectively and the forest regenerates continuously. Plenter forests occur particularly in southern Germany (Bavaria, Baden-Württemberg).

In the scope of close to nature forestry, a high degree of structural diversity is strived for to increase ecological stability and biodiversity in the forests. One parameter for registering this structural diversity is the tree species composition. Forests that are more than 10% mixed with other tree species are defined as mixed forests (BWI[2]). In the German forests, mixed forests dominate with almost three quarters of the forest area. Pure forest covers are formed mainly by Scots pine (*Pinus sylvestris*; 44.5% of all pine forest covers are pure), followed by the common spruce (*Picea abies*; 32.7%) (Chapter 1.1).

Composite and coppice forests are historic, once widespread forms of management and occur only on 0.7% of the forest area today. In coppice forests, trees are regenerated in short vegetative rotations (15 - 30 years) from coppice shoots. The composite forest is a combination of high and coppice forest: under a light canopy of trees of varied ages in the upper storey, which are supposed to get old, the lower storey is utilized as firewood in a 20 to 30-year rotation.

Short rotation plantations with fast-growing tree species have been established to date on approx. 5,000 hectares of agricultural area. With the amendment of the Federal Forest Act of 31.07.2010 they are nationally no longer legally considered forests. This is intended to increase acceptance of short rotation plantations in agriculture.

The History and the Future of the Forestry Sector

The remigration of tree species following the last Ice Age and anthropogenic forest use in historic times as well as modern-day immission loads define today's image of the landscape and the capacities of the forests. The decisions made today in forestry and yet little known effects of climate change will define the tree species spectrum and therefore the image of forests and landscapes in the coming century.

Remigration

Following the last Ice Age, trees migrated back to Central Europe from their refuges in Southern and Eastern Europe (Firbas 1949). About 10,000 years B.C. pines and birches re-migrated, followed, after a hazel and oak mixed forest period, by the beech period, which then led to the times of great utilization of forests. Today there are over 70 tree species in German forests.

Forest use

Almost all of the forests in Germany have been changed by humans. During the late Neolithic age, humans began to clear the forests to gain farmland and pasture. Large-scale clearances occurred as early as the Middle Ages. In an initial phase, between 500 and 800 A.D., the regions best suited for agriculture were cleared. This was followed by a second phase of deforestation between 1100 and 1300, which also encompassed remote areas and mountain regions. This was the age of the greatest deforestation of Germany. The forests were utilized intensively and mainly unregulated and often over-utilized near cities and settlements. Timber use and firewood, wood pasture and much more changed the forests' their structure and composition. From the 17th century, forest litter utilization in the woodlands was commonplace in agriculture. This led to the loss of humus and nutrients and to the degradation of forest soils.

The drop in the population as a result of the Thirty Years' War alleviated pressure on the forests and the forest area enlarged at first. Until the 18th century wood, with the exception of water and wind power, was the sole source of energy for households, trade and industries such as mining, the production of glass, metal smelting, saltworks and limekilns. All of these required large amounts of firewood and wood charcoal.

As early as the Middle Ages, laws were decreed at the local level intended to ensure sustainable forest management. However, the diverse demands on the forests were so great that it was very difficult to assert these laws. Not until the 18th century, under the effect of great timber shortages, were new laws asserted: the Electoral Saxon mining administrator HANS CARL von CARLOWITZ, who was responsible for the mines in Saxony and their supply of timber, first defined a concept of sustainable forest management[1] in 1713 in his book *Sylvicultura Oeconomica Oder hauswirthliche Nachricht und Naturmäßige Anweisung Zur Wilden Baum-Zucht*. The term *Nachhaltigkeit* (sustainability) became the central idea and identifying heart of German forestry. Today, it has found its way into general linguistic usage and is used worldwide in all areas of society, in particular in environmental policy.

Then, in the first half of the 19th century, modern forestry laws arose in German countries, which were imposed upon the forest users. At the same time, the intensity of forest utilization lessened: fossil fuels became useable as new energy sources and the use of mineral fertilizers in agriculture led to increased production, making forest litter utilization superfluous. However, 19th century liberalization had varying effects on the forests: in some regions, the regulations protecting the forests were even repealed and state forests were sold to private individuals, who cleared them. The opening of the markets and new means of transport such as railways facilitated the import and long-distance transport of agricultural products. Agriculture was given up in low-yield areas and they reverted back to forests.

In some regions, such as the southern Black Forest and in the heath lands of Lower Saxony, the state purchased impoverished farming estates and established new forests. Devastated forest areas were re-afforested extensively, main-

1 “Wird derhalben die größte Kunst, Wissenschafft, Fleiß, und Einrichtung hiesiger Lande darinnen beruhen, wie eine sothane Conservation und Anbau des Holtzes anzustellen, daß es eine continuirliche beständige und nachhaltende Nutzung gebe, weiln es eine unentbehrliche Sache ist, ohnewelche das Land in seinem Esse (= im Sinne von Bestand) nicht bleiben mag” (“Therefore the greatest art, science, diligence and appliance of local lands will be to engage in the conservation and cultivation of wood, that there will be a continuously constant and sustained utilization because this is an indispensible thing without which the essence of the land cannot endure.”) *from Sylvicultura Oeconomica Oder hauswirthliche Nachricht und Naturmäßige Anweisung Zur Wilden Baum-Zucht* […], pp. 105-106.

ly with coniferous tree species, which were unproblematic on the large, mostly nutrient-poor open spaces. In this way, large spruce and pine forests were established. In the two World Wars of the 20th century and thereafter, large cleared areas also were produced (armament and energy demands, reparation cuts), which were replanted with conifers. Today, coniferous trees cover more than half of the forest area in Germany, 15% are beech forests and 10% oak forests. The common spruce is of great economic importance as the main tree species and chief source of income of many forestry holdings, in particular in the Uplands and the southern Germany, as well as the Scots pine in the eastern and northern parts of Germany. In recent years, interest has grown in the Douglas fir, which originated in North America. It now takes up 2% of the forest area, but is suited for replacing the common spruce on specific sites with advancing climate change.

Forest renewal

As early as the Middle Ages, the local laws decreed for the utilization of the forests frequently tied the rights to forest utilization with the obligation to plant trees. Oaks were primarily planted or sown. Their fruits were the main basis for raising swine in the Middle Ages. In the year 1368, Peter Stromer, an alderman of the city of Nuremberg, demonstrated for the first time that is was possible to sow conifer seeds. This technique was then further perfected and came into widespread use in other regions of Germany. At first, the seed was attained from trees that were easy to harvest. Seed was traded Europe-wide in particular following the construction of the railways in the second half of the 19th century. Since the 19th century, forest scientists have been experimenting with provenance. It was recognized that timber quality and properties, tree growth, susceptibility to pests and adaptability to site conditions were controlled in part through genetic factors. A first law on forest reproductive material was enacted in 1934. In 1957, it was replaced by a Federal law, which was amended in 1969. Presently effective Act on Forest Reproductive Material (FoVG) was enacted in 2002 on the basis of an EU directive (Chapter 5.2).

The Modern forms of forest management have developed over the course of 300 years in Germany: the principle of sustainability is implemented in German forestry according to strict legal provisions. The sustainability principle is anchored in the forest and nature conservation legislation of the Federal government and the *Länder*. The distribution of competencies between the Federal government and *Länder* is laid down in the federal system of Germany: the *Länder* are legally responsible for all matters of agriculture and forestry.

The forest laws regulate the observance of sustainability through planned and orderly forestry as well as ensuring the forests' diversity of functions. Today, forest owners are obligated to render all forest functions (ecological, economical and social) sustainably.

Figure 4: European beech planticeles (© BLE/IBV)

Sustainability in forestry means:

1. Area sustainability – every free space arising from timber cutting is promptly re-afforested in order to keep the forest size constant. Conversion of forests to other forms of use requires approval.

2. Mass sustainability – only as much timber may be used as can grow back steadily.

3. Functional sustainability – takes not only the utilization functions, but also functions as protective forest and recreational forest into account.

Modern-day damages to forests

Since the mid-1970s, increasing forest damages appeared in Central Europe, which could not be attributed to previous experience. It began with large-area crown transparency in the European silver fir (*Abies alba*) occurring predominantly in southern Germany. At the beginning of the 1980s, damages were also visible in other coniferous and deciduous tree species. It was feared that some tree species or regional populations, and as a result parts of the genetic diversity, could be lost. In the year 1987 this led in Germany to a strategy for the conservation of genetic resources in the forest by a Federal government/*Länder* Working Group (BLAG-FGR, Chapter 5.1 and Annex 9.1).

Development in the Years 2000 - 2010: Trends in Conservation, Management and Production

Until the 1980s, conversion of the forests from coniferous to deciduous trees took place in rather isolated cases, but since then has received support in forestry policy and nature conservation and been funded by state measures. The funding primarily serves the goal of improving biological diversity and ecological stability. Ecologically sound forms of management are employed in particular in state-owned forests and mixed forests are being increasingly established.

In addition, an increased demand for coniferous timber, in particular the common spruce, and various storm damage events of recent decades have contributed to a decrease in the coniferous forest area in all *Länder*. The areas are increasingly being re-afforested with site-suitable deciduous tree species.

The loss of area for the common spruce *(Picea abies)* between the second Federal Forest Inventory (BWI², BMELV 2004) and the 2008 Inventory Study (Oehmichen et al. 2011), which was conducted to gain current data for reporting on carbon stocks in forests under the Kyoto Protocol, is over 200,000 hectares (- 7%). In contrast, fir and Douglas fir *(Pseudotsuga menziesii)* increased their area by almost 50,000 hectares. The area of deciduous trees increased by 2%; the largest area increase for deciduous trees was recorded for the common beech (*Fagus sylvatica*) with over 80,000 hectares (+ 5%).

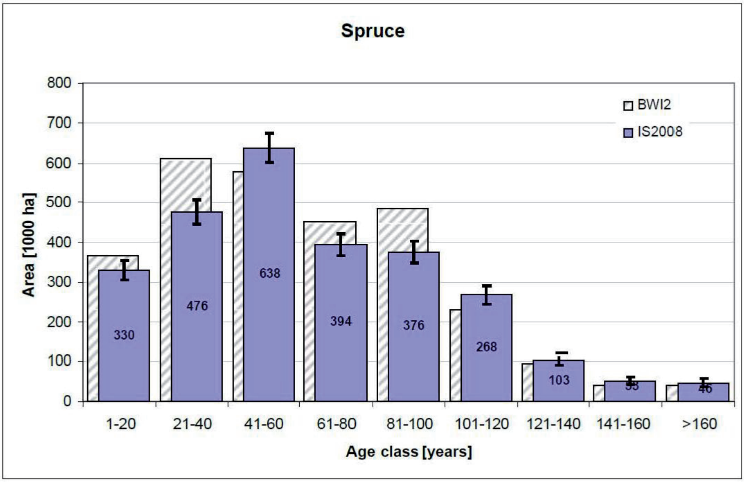

Figure 5: Age structure of the common spruce (*Picea abies*)
(Polley et al. 2009a)

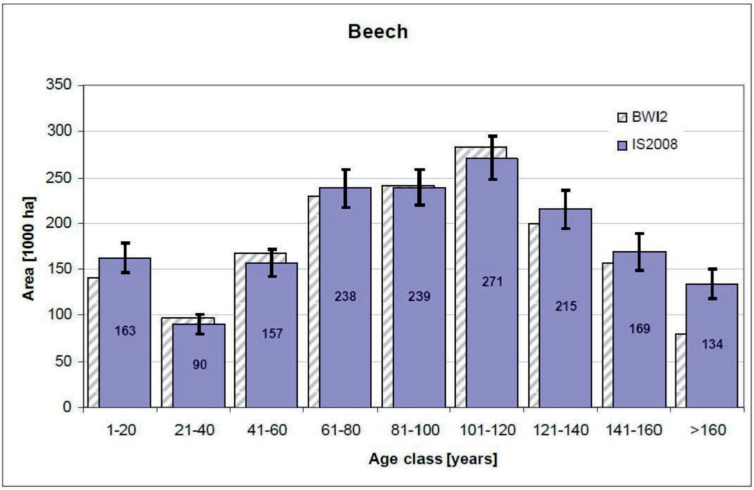

Figure 6: Age structure of the common beech (*Fagus sylvatica*)
(Polley et al. 2009a)

This increase in the area percentage of deciduous trees is ascertained in state-owned, communal and private forests. The deadwood stock[2] in the forests also rose and is now 14.7 m³/hectare. Deadwood is very important for the survival of a variety of plants, animals and microorganisms and thereby contributes to the diversity and stability of ecosystems.

However, the domestic demand for timber also rose in the time under report (see page 5). The chief cause for the increased demand for timber was the world market demand for raw material timber products. Other causes are the increasing scarceness of fossil energy sources as well as the national energy policy, which strives for the enhancement of renewable energies. Nonetheless, the 2008 Inventory Study shows that for the total balance of timber stock, timber increment and cuts even with distinctly increased timber demand in the time under investigation, 10% more timber grew back than was harvested and that since 2002 the timber stock continued to increase by 2% (Polley et al. 2009b).

Future Development (2010 - 2020): Requirements for Production and Service Provision

The increased standard of living in many countries of the earth will continue to cause a worldwide increase in the demand for products such as sawn timber, derived timber products, cellulose and paper. In addition to the demand for timber as a raw material, the need for biomass for energy production is also growing. We also anticipate an increased demand for timber in Germany. The analysis of expert scenarios for the year 2020 reveals an annual timber raw material demand in Germany of up to 168 million m³ per year. In this analysis, the demand for material timber use is estimated at up to 83 million m³ and for use as energy at up to 85 million m³ (Dieter et al. 2008). The estimation of the total timber assumes that the growing stock in the forest will be kept at a high level, so that in the year 2020 a sustained timber potential (incl. logging residues, waste wood, imports, etc.) of about 134 million m³ will be available for utilization. Therefore the potential timber supply, of a prospective magnitude of up to 34 million m³,

2 Deadwood from 20 cm at the thicker end (in the case of standing dead timber, the DBH) as well as stumps from at least 50 cm height or 60 cm diameter at felling height

will be lower than the demand. Since not all available potentials are mobilized, the predicted gap will possibly be far greater. Demands on the forests and forestry in Germany will continue to increase. Changing leisure time behaviours, growing demands for safeguarding the environmental and nature conservation functions of the forests and by hunting as well as the growing timber demand need to be satisfied in the scope of sustainable management of the forests.

The growing demands from practically all areas – utilization, conservation and recreation – can, however, in future lead to target conflicts of regionally different kinds. The challenge for policymakers is to assess the different demands in an overall consideration and to set framework conditions, which enable forestry and forest-based industries to fulfil the challenges as optimally as possible in the long term. The Federal government has contributed to this with the September 2011 publication of the "Forest Strategy 2020".

The Importance of Forest Genetic Resources for the Forest Ecosystem

Forest genetic resources are of fundamental importance for the development potential of forest ecosystems. The genetic variation of individual trees and populations enables diversity of species and ecosystems. It is the prerequisite for adaptation processes to environmental changes and therefore for the long-term stability and productivity of the forests.

According to our knowledge today, the natural adaptation mechanisms of forest ecosystems to rapid climate change are limited. Even if adaptive measures can be introduced by forest management, the success of these measures depends on the speed and extent of climate change not exceeding certain thresholds. An intense and exceedingly rapid change in the present climate conditions may overtax the adaptability of forest ecosystems. Adaption of the forests to the future climate requires the exhaustion of the total genetic potential of domestic populations as well as targeted expansion of the genetic spectrum with climate-adapted, imported tree species and provenances. Structural and genetic diversity are the guarantors of the conformity and adaptability of the species and symbiotic communities in the forest ecosystem.

1 The Current State of the Diversity of Forest Genetic Resources

Over 70 tree species have been identified in German forests in the scope of the second National Forest Inventory (BWI[2]). Nonetheless, they are dominated by the common spruce (*Picea abies*), Scots pine (*Pinus sylvestris*), common beech (*Fagus sylvatica*) as well as sessile oak (*Quercus petraea*) and English oak (*Quercus robur*) and these tree species are also, measured by timber yield, the economically most important. Regardless of this, some rarer tree species have special regional importance. For instance, the European silver fir (*Abies alba*) is one of the characteristic tree species in southern Germany. Additionally, the tree species spectrum is enhanced by the cultivation of introduced tree species (e.g. American red oak (*Quercus rubra*), Douglas fir (*Pseudotsuga menziesii*), acacia (*Robinia pseudoacacia*), Austrian pine (*Pinus nigra*), giant fir (*Abies grandis*)).

1.1 The state of diversity between and within species

Preserving the adaptability of the forests by conserving the diversity of genetic resources is the foundation of future-oriented forest management. The forests in Germany possess a wide variety of changing site conditions and forest communities both over large and smaller areas.

By nature, primarily beech and oak forests would dominate in Germany (Figure 7). Although the common beech is dominant over a broad site spectrum, it is mixed with other tree species in changing degrees depending on the site. For instance, the fir-beech forests of the montane level are counted among beech forests. However, due to the history of forest development there are only a few isolated examples of forest ecosystems in a natural state. Today's distribution of traffic and settlement areas, agriculturally used areas and forest areas is the result of centuries-long human intervention. The remaining forests are marked by human forestry activities and diverse uses. Over the past two centuries, the production of the raw material timber has almost always been given priority.

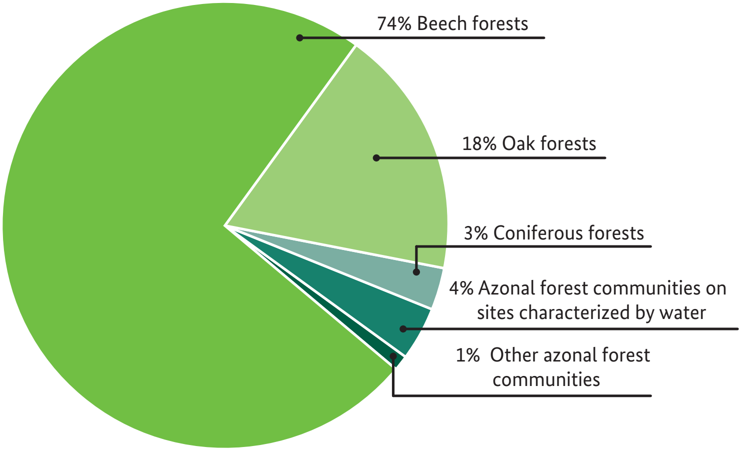

Figure 7: Percentages of natural forest communities in Germany, in relation to the present timberland area (BWI[2], BMELV 2004)

For this reason, for example, the major re-afforestation of the cleared areas in the 19th century and following the two World Wars (reparation cuts) primarily involved the cultivation of rapidly growing coniferous trees, such as the common spruce and pine. This historical development explains why today, the area of German forests consists of roughly 58% coniferous trees and approx. 40% deciduous trees. The spruces are the largest group (28%) of the tree species, followed by pines (23%), common beech (15%) and oaks (10%) (Figure 8, Annex 9.3). Not only have deciduous trees lost out in this development, but also the European silver fir.

As a result of different site conditions (soil and climate) as well as regionally differing historical developments and types of ownership, the tree species composition demonstrates distinct regional differences.

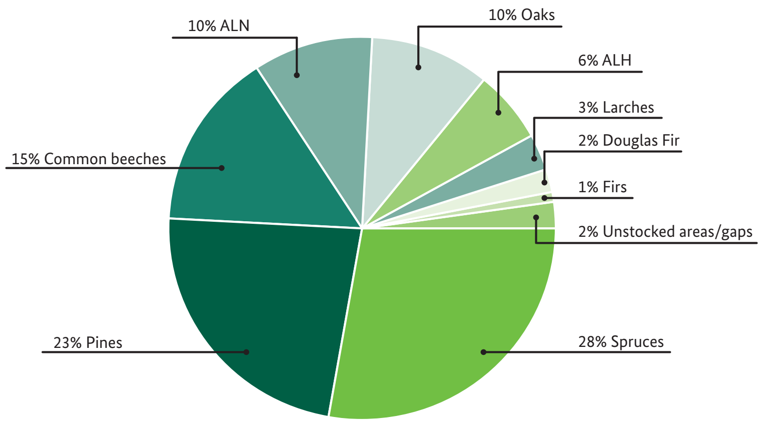

Figure 8: Area percentages of tree species groups in main stands in relation to timberland (incl. gaps and unstocked areas)

Spruces = all spruce species, pines = all pine species, ALN = other deciduous tree species with a short life expectancy (e.g. birches, alders, poplars, willows), oaks = all oak species, ALH = other deciduous tree species with a long life expectancy (e.g. ashes, maples, elms, limes), larches = all larch species, firs = all fir species.

(BWI², BMELV 2004)

The large-scale forest zones can be described as follows: the pine-abundant north (percentage of pines in Brandenburg and Berlin 73%, in Saxony-Anhalt 46.6%, in Mecklenburg-Western Pomerania 39.5% and in Lower Saxony with Hamburg and Bremen 30.2%), the deciduous uplands (percentage of deciduous trees in the Saarland 71.5%, in Rhineland-Palatinate 57.2%, in Hesse 55.6% and in North-Rhine Westphalia 51.7%) as well as the coast with a deciduous tree percentage of 60.9% in Schleswig-Holstein and 46.7% in Mecklenburg-Western Pomerania and finally the spruce-dominant regions of southern Germany (percentage of spruce in Bavaria 44.6%, Baden-Württemberg 37.7%) as well as Saxony (35.3%) and Thuringia (42.3%).

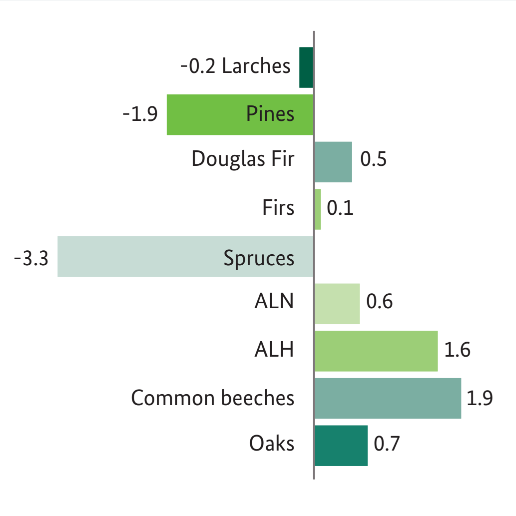

Figure 9:
Change in the percentages of tree species groups in the forest area (in %) in the period 1987 – 2002, only the old *Länder*

Spruces = all spruce species,
pines = all pine species,
ALN = other deciduous tree species with a short life expectancy (e.g. birches, alders, poplars, willows),
oaks = all oak species,
ALH = other deciduous tree species with a long life expectancy (e.g. ashes, maples, elms, limes),
larches = all larch species,
firs = all fir species.

(BWI², BMELV 2004)

Based on the tree species composition of the BWI² sample, the forests are differentiated by types of forest cover[3]. The dominant types are the spruce type (32% of stocked timberland area) and the pine type (24%). The beech type takes up almost 16%, the oak approx. 8%. Beech and oak types are categorized as primarily natural to very natural, while the spruce and pine types are only conditionally natural and highly defined by management (BWI²). Pure spruce forests are common by nature only in the high altitudes of the Alps and in some uplands. Due to silviculture and forest policy decisions it has been possible over recent decades to raise the percentage of mixed forests to at present approx. 73%. Mixed forests are forests containing two or more tree species. The distinct dominance of coniferous trees has been countered since the 1980s in favour of deciduous trees (Figure 9). The objective of this is to improve the nutrient cycle and stabilize the stands. As BWI² illustrates, this increase primarily is at the expense of spruces. The results of the 2008 Inventory Study reveal that the increase in the deciduous timber percentage at the expense of the common spruce has continued since 2002 (Polley et al. 2009a). The common spruce, which is often grown in pure stands and on sites that do not suit it (mainly outside of its natural range) increasingly suffers from the effects of pests and storms.

3 Definition of the type of forest cover: The eponymous tree species takes up the largest percentage of the sample.

Methods for characterizing and evaluating tree species

The natural range of most native tree species in Germany also encompasses broad areas outside of Germany. Within this territory, there is a broad array of different site conditions (http://www.euforgen.org/distribution_maps.html).

The provenance tests conducted since the 19th century show that tree populations of the same species react differently to the site conditions at the site of cultivation depending on the provenance. This is a result of the genetic adaptation to the environmental conditions at the respective site of provenance. In recent times, progress in forest genetics has made it possible to identify differences in the hereditary dispositions between the populations using laboratory methods. In addition to the differences between populations, these methods also reveal the high degree of genetic variation within the forest stands. They are also used to differentiate species and sub-species. This great genetic variation within and between forest tree populations in Germany is accounted for in the Act on Forest Reproductive Material (FoVG) with its designation of forest regions of provenance. Thereby, forestry reproductive material is produced and offered separately according to its natural differentiation by regions of provenance. The forestry holdings can therefore procure reproductive material according to and adapted to their different site conditions to achieve their long-term economic objectives.

For the entire Federal Republic of Germany, 46 basic ecological units were designated (Figure 10) as a basis for the horizontal demarcation of forest regions of provenance. They are usually categorized with one or more growth zone and, where applicable, growth regions. In forest ecology, growth zones are defined as major geographic regions, which differ from others through their geomorphology, climate, natural forest communities and landscape history. These major geographic regions usually coincide with those used in geography and phytogeography. A growth region is a smaller, regional spatial unit with a very uniform physiographic character, whose demarcation is based primarily on forest ecological criteria. The basic ecological unit is the smallest element describing the horizontal demarcation of a region of provenance (http://fgrdeu.genres.de/). In the demarcation of regions of provenance, the horizontal demarcation is supplemented in mountainous regions (Alps, uplands) by taking altitudinal belts into account. Within the regions of provenance, seed crop stands are primarily selected according to phenotypic properties. Genetic characterizations with genetic markers have been conducted from case to case in recent years to supplement the phenotypic selection. Detailed knowledge of genetic variation is the basis for assessing genetic resources. This applies both for commercially important main and secondary tree species and for rare or endangered tree species. In the case of commercial tree species, genetic tests provide important decision-making aids for silvicultural actions, in particular for the choice of suitable regeneration methods (artificial, natural regeneration). In the case of rare tree species, the identification and genetic assessment of the populations or stands is an essential step towards conservation measures. In order to investigate the genetic variation of tree species, field studies, phenotypic observations, testing with genetic markers (isoenzyme, DNA markers) and biomarkers as well as early testing are conducted. The emphasis is on provenance tests and testing with genetic markers.

Until 2010 the BLAG-FGR institutions carried out tests to determine genetic variation using genetic markers for the tree and shrub species cited in Annex 9.5 and 9.5.1. Because of these tests, we have knowledge concerning the genetic variation of, for example, the tree species common beech, European silver fir, Scots pine, common spruce, sessile and English oak, wild cherry (*Prunus avium*) and sycamore (*Acer pseudoplatanus*) for large parts of Germany. This knowledge will be used in decisions on natural and artificial regeneration of forest stands, in the provenance controls of forest reproductive material and in the choice of gene conservation forests.

For a number of decades provenance tests have been conducted in Germany with a focus on commercially important main tree species (common spruce, Scots pine, common beech, sessile and English oak, European silver fir) but also for important introduced tree species (Douglas fir, American red oak, giant fir (*Abies grandis*)). “Provenance” is what we call reproductive material that originates from a stand or a group of stands from a particular geographical region. The field studies are designed so that the same provenances can be tested at different production sites. Frequently, parallel experimental areas are located in other European countries (e.g. the provenance tests with common spruce, pine, larch, Douglas fir and oak by the International Union of Forest Research

Organizations, IUFRO). The objective of the experiments is to ascertain the provenances with the best production suitability (adaptedness, vigour, growth quality) for the respective production region and to draw up provenance recommendations. Due to climate change these experiments are becoming more important since they demonstrate the reaction of the same provenance to different climate conditions.

The Federal Ministry of Food and Agriculture (BMEL) commissions survey projects to record and document the genetic resources of selected rare tree species. In recent years, for example, the occurrence of threatened and rare tree species such as the black poplar (*Populus nigra*) and native elm species (Wych elm (*Ulmus glabra*), European field elm (*Ulmus minor*) and Russian elm (*Ulmus laevis*)) were mapped nationwide on BMEL's request and assessed for their conservation requirements and urgency. At the present time, a similar survey of ten other tree species is underway: field maple (*Acer campestre*), wild pear (*Pyrus pyraster*), wild apple (*Malus sylvestris*), downy oak (*Quercus pubescens*), common yew (*Taxus baccata*), European bird cherry (*Prunus padus*), wild service tree (*Sorbus torminalis*) and service tree (*Sorbus domestica*) as well as the green alder (*Alnus viridis*) and grey alder (*Alnus incana*).

In addition, studies on various aspects of the sustainable utilization of forest genetic resources are being funded in the framework of "model and demonstration projects on the conservation and innovative utilization of biological diversity" commisioned by the Federal Ministry. Within one of these projects, for instance, a management method for forest edges similar to a coppice with standards system is being tested to promote the main tree species English oak, sessile oak and hornbeam (*Carpinus betulus*) as well as rare valuable deciduous and coniferous woody plants such as the wild service tree, common juniper (*Juniperus communis*) or common yew. Within the project, by linking modern utilization requirements and historic forms of use, new possibilities will be opened up to conserve or promote tree and shrub species that are on the decline in Central European forests for the long term and over large areas in an economically acceptable way and in a context in line with landscape ecology standards.

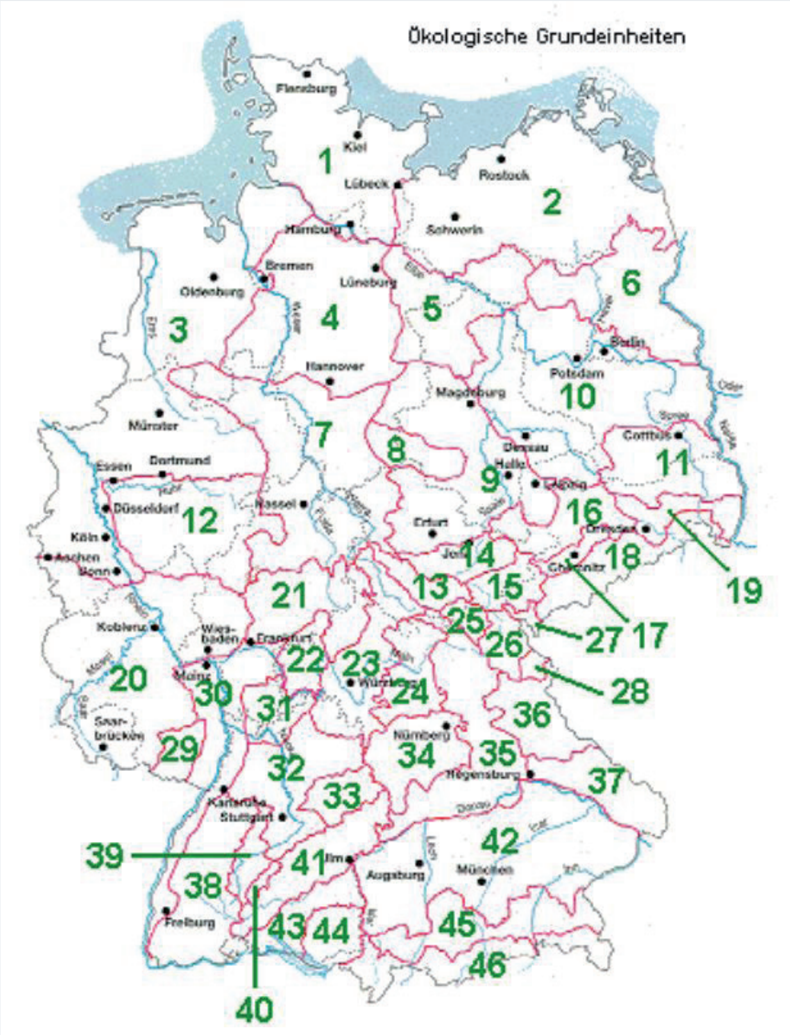

Figure 10: Basic ecological units

The aim of another model and demonstration project currently underway is to develop a standard method for ascertaining the minimum area and minimum number of trees as well as the minimum number of trees for harvest in approved seed stands for genetically sustainable seed harvesting. Using genetic inventories, studies will be done on selected examples as to the extent to which the genetic composition and genetic diversity of the harvested reproductive material corresponds to that of the initial stand and whether or how the genetic composition of the seed changes depending on the number and distribution of trees on which the seeds are collected. More information on these and other projects can be found at http://www.ble.de.

A group of experts commissioned in 2009 by the BLAG-FGR is examining ways to improve the supply situation with high-quality Douglas fir reproductive material. The background for this is the increasing demand for Douglas fir seeds and seedlings for converting the forests to adapt them to climate change. The group is analyzing the harvest situation in Germany, Europe and the USA, recording data on the quality of the seed and on the present and future supply situation and is preparing a joint evaluation of the provenance tests in Germany.

The numerous studies on the genetic effects of silvicultural measures on the genetic structure of forest stands have been summarized and published accordingly (Konnert et al. 2007). This is an important contribution to the sustainable utilization of forest genetic resources. Both the work conducted by the BLAG-FGR and the *Länder* on the conservation of forest genetic resources are documented in detail, for example in the progress reports by the BLAG-FGR. Another example are the Crop Authorization Registers of the *Länder* for the seed stands in the categories “selected”, “qualified” and “tested” forest reproductive material. Moreover, the Federal Office for Agriculture and Food (BLE) provides a summary of the annually conducted survey on the supply situation with forest reproductive material in the Federal Republic of Germany.

In summary, various information systems on the genetic diversity of forest genetic resources have been established and others are being set up: FGRDEU - stands of forest genetic resources in Germany (http://fgrdeu.genres.de/), progress reports by the BLAG-FGR (http://blag-fgr.genres.de/), information on genetic monitoring as well as the databases on surveys of rare tree species (Chapter 5.1.1).

1.1.1 Objectives and priorities for improved awareness of genetic diversity

In the scope of their work plans, the responsible forest institutions set down the respective objectives and priorities for the genetic studies and field studies. Two aspects are important here: the conservation of broad genetic diversity as the basis of adaptability in the scope of sustainable forest management and the reassessment of the provenance issue in the light of climate change or the assessment of provenances from warmer and dryer regions. Shrub species are also increasingly the focus of the studies.

One important objective is to convey to forest managers and political decision-makers the role of genetic diversity as the basis of adaptability, so that they support and fund measures for forest genetic resource conservation. Results of studies such as the above-cited documentation of rare tree species (e.g. the black poplar) but also on the effects of management measures on genetic diversity support the awareness of the necessity and the informative value of genetic studies regarding the adaptability of tree species based on their intraspecific variation.

1.1.2 Chief requirements for improving the assessment of inter- and intraspecific variation

In Germany, qualified capacities and infrastructures are available for conducting genetic field and laboratory research in the forest sector. The majority of these capacities are governmental, but an increasing number of private institutions and initiatives also carry out genetic studies and field surveys on commission. *Länder* and Federal institutions as well as universities work together closely. This is the only way to tackle nationwide inventories of selected tree species and conduct nationwide provenance tests. In future, this collaboration will be optimized and expanded to attain synergies and best utilize the limited financial means and available capacities. In addition, regarding the conservation of forest genetic resources long-term genetic research projects (e.g. monitoring) are necessary but national and EU-wide funding programmes are often focussed on short to medium term projects.

Regarding the variation studies it should be noted that the genetic markers employed so far for genetic inventories in the forests only insufficiently record the genetic variation of genes that are directly relevant for adaptation. Genetic markers of adaptive genes are under development (e.g. SNP with relevance for the shooting period and drought tolerance) and should be employed in the future.

In the scope of the National Programme a scheme was drawn up (Anonymous 2008) for detailed genetic monitoring to control the development of genetic diversity in forest ecosystems. The objective is to record the spatial and temporal changes to genetic structures of tree and shrub species. In two pilot projects with the financial support of the EU from 2005 to 2007 (Forest Focus) and of the Federal government from 2005 to 2008 nine selected genetic long-term observation areas were established for the common beech and wild cherry. The establishment of further areas and the addition of other tree species as well as the adoption of genetic monitoring in general environmental monitoring appear expedient.

Choice and assessment of forest genetic resources

At present, the effects of climate change are leading to a modified forestry assessment of individual tree species. Therefore, special attention should be given to those tree species and provenances that appear particularly suitable from this aspect. For this purpose, the progress in genetic markers (e.g. in adaptive markers) should be utilized specifically to select suitable provenances or to accelerate breeding progress (genetic marker-based breeding). The issue of provenance conservation using genetic analysis is also classified as urgent.

Since broad genetic diversity is important in climate change, the available genetic resources and silvicultural activities must be constantly reassessed and further developed under this aspect. This will result in new demands for conservation measures. In view of the dimension of predicted climate change the collaboration at the European level, for example in the designation of gene conservation stands and the creation of cultivation recommendations, is very significant.

1.2 The main value of forest genetic resources

Genetic diversity determines the adaptability and productivity of forest trees; it is the foundation for sustainable development of forests. It is therefore also an essential prerequisite for multifunctional forestry. The objective of conserving forest genetic resources is to retain the diversity of tree and shrub species and the genetic variability of species and populations, to sustainably utilize forest genetic resources, re-establish viable populations of endangered tree and shrub species as well as to contribute to conserving the adaptability of forest ecosystems.

1.2.1 Setting priorities for tree species in Germany

The National Programme on forest genetic resources, the *Konzept zur Erhaltung und nachhaltigen Nutzung forstlicher Genressourcen in der Bundesrepublik Deutschland* (Concept for Conservation and Sustainable Utilization of Forest Genetic Resources in the Federal Republic Germany (Paul et al. 2010, Chapter 5)), provides a framework for setting priorities for tree species in Germany. It was drawn up by a Federal government/*Länder* Working Group (BLAG-FGR) set up in 1985 as a reaction to the endangerment to the genetic diversity of forest tree species through air pollution *("Waldsterben")* and published for the first time in 1987 (BLAG 1989). In 2000 a revised version was written (Paul et al. 2000), which now also takes Germany's obligations from the Convention on Biological Diversity (CBD) into account. In 2010 an updated version of the revised version (2000) was drawn up and published. Due to the distribution of competencies, the *Länder* are responsible for the conservation of forest genetic resources by means of practical implementation of the concept's guidelines. The *Länder*-specific priorities are summarized and published accordingly in the progress report of the BLAG-FGR.

1.2.2 Important tree species for the forest ecosystem

Because of the multifunctional nature of forestry in Germany, on principle the integrated production, protection and recreational functions are rendered and ensured on the same area, albeit with locally differing focus. Separating tree species managed for production purposes and those managed because of their importance for the environment is therefore neither advisable nor desired.

For example, the common beech is both a significant commercial tree species and important for the fulfilment of protective functions. As the characteristic tree species of the most important natural forest communities by size, it is highly significant for biodiversity and nature conservation. Rare tree species, such as the wild service tree, must not only be conserved because of their importance for the biodiversity of the forests, but also supply valuable timber. Notwithstanding, the tree species occurring in Germany do not all possess the same economic importance.

Over 70 tree species occur in Germany's sustainably managed forests, of which 26 deciduous and seven coniferous tree species are commercially utilized.

Figure 11: Common spruce stand (© BLE/IBV)

Broken down by their percentage of area and stock in the forests and by their importance on the timber market, the main native tree species are the common spruce, Scots pine, common beech as well as sessile and English oak (Figure 8, Table 3). They make up 76% of the forest area, 82% of the timber stocks and 91% of the usable lumber. Together with an area percentage of approximately 66%, the common spruce, Scots pine and common beech are the "staple trees" of German forestry.

Table. 3: Main tree species and their utilization

Tree species	Utilization*
Common spruce	1,2,3,4
Scots pine	1,2,3
Common beech	1,2,3
Sessile and English oak	1,3

*Utilization: 1 = Solid wood products, 2 = Pulp and paper,
3 = Energy (fuel), 4 = Decorative sprays and Christmas trees

Other coniferous trees that are relevant for forestry include the Douglas fir and larches (e.g. European larch (*Larix decidua*)) as well as the European silver fir in southern Germany.

Together with the beech, common spruce and sycamore, the latter forms mountain mixed forests, which frequently also must fulfil protective functions. From region to region, valuable deciduous trees such as the European ash (*Fraxinus excelsior*), sycamore, Norway maple (*Acer platanoides*) and wild cherry are important. Other deciduous tree species such as the European hornbeam (*Carpinus betulus*), European birch (*Betula pendula*), little leaf linden (*Tilia cordata*) and large-leaved lime (*Tilia platyphylla*), poplars as well as the native alders (black alder (*Alnus glutinosa*), grey alder (*Alnus incana*)) and elm species play only selective roles in timber production. The European hornbeam and little leaf linden are important as secondary stands in the production of high-grade oak wood. Because of their rarity, only small quantities of the wild service tree, wild fruit and nut tree species are put on the timber market. However, high quality logs from these tree species yield top prices on high-grade timber submissions, and this is why there is an economic interest in these tree species as well. The black locust (*Robinia pseudoacacia*) and Spanish chestnut (*Castanea sativa*) produce particularly durable timber, which is well suited for outdoor use. Because of their limited cultivation to date, they are only of regional importance in marketing (e.g. black locust in Brandenburg, Spanish chestnut in Rhineland-Palatinate and Baden-Württemberg).

1.2.3 State of the genetic diversity of important tree species

Detailed information concerning the genetic diversity of many tree species in Germany is available from comprehensive genetic studies and provenance tests. A high degree of genetic diversity can be assumed in most of the forest tree species both within and between stands.

The close to nature forestry management practiced in Germany, with natural regeneration over large areas and long regeneration periods, contributes to conserving diversity. A large number of seed stands of various tree species are available for artificial regeneration. By complying with the number of harvest trees per stand set down in the FoVG, the existing control mechanisms and private certification systems for forest reproductive material, sufficient amounts of reproductive material with high genetic diversity are available for artificial regeneration of most provenances. Studies with genetic markers demonstrated hardly any differences in the genetic diversity of naturally and artificially regenerated stands in Germany. In a number of genetic studies both of the wind-pollinated abundant main tree species (common spruce, common beech, sessile and English oak, European silver fir) and of rare insect-pollinated species (e.g. wild cherry) different development stages from the same stand were examined (e.g. old trees, seed of various years and natural regeneration). These studies showed mainly only minor differences between the various development stages of a stand.

Therefore, an overall stabile level of genetic diversity in most of the tree species in Germany can be assumed.

1.2.4 Rare tree species in Germany

Tree species taking up a percentage of area of under 1% are considered rare. Their survival is also often threatened, in particular at the fringes of their natural ranges. A red list of endangered animal and plant species has been in existence in Germany since 1977, following the Red List of the International Union of Conservation of Nature (IUCN). By attribution of specific endangerment categories, the list provides information on the state of species diversity. Today, there are Red Lists both at the national and *Länder* level (Annex 9.4). *Sorbus decipiens* is the only species in Germany listed on the IUCN Red List of Threatened Species.

Figure 12: Field maple (© BLE/IBV)

The promotion of rare tree species in the scope of sustainable and close to nature forestry therefore contributes to the conservation of biological diversity. This objective is also anchored in the PEFC (Programme for the Endorsement of Forest Certification Schemes) and FSC (Forest Stewardship Council) certification systems, according to which approximately three-fourths of the forest area in Germany is managed. In this way, numerous forest owners of all ownership types actively work towards conserving and increasing species diversity and the biological diversity of our forests going beyond the demanding legal provisions.

1.2.5 Forest reproductive material in Germany

In Germany, seed stands or seed orchards are approved for all tree species governed by the FoVG. They are recorded in the Crop Authorization Registers of the *Länder*. Every year, the BLE in Bonn conducts a survey for these tree species of, among other things, the harvested amounts with the competent offices of the *Länder*. The harvest amounts are recorded separately according to regions of provenance and the seed is recorded according to the categories “source identified”, “selected”, “qualified” and “tested” (http://www.forstvermehrung- online.de). Table 18 provides an overview of the harvest results of the harvest years 2000 - 2010; the quantity of the harvested seed totalled 6,645,727 kg. By nature, the heavy-fruited tree species with the largest harvest amounts recorded are the common beech (1,241,214 kg), English and sessile oak (1,872,525 kg and 2,327,222 kg respectively) as well as the American red oak (652,231 kg). Due to the extent of the approved seed stands in Germany, the supply of seed for all tree species is lastingly ensured.

1.2.6 Factors influencing the state of the diversity of forest genetic resources

The genetic composition of today's forest stands in Germany is characterized by the post-Ice Age remigration of tree species from the Ice Age refuges located in the south of Europe, by natural selection over the course of adaptation to small-scale site conditions and by human interventions in the forest ecosystems. While the two former factors are distinguished by their long-running nature, changes caused by humans, such as forest utilization, fragmentation through road construction, artificial introduction of tree species and provenances, can lead to rapid and drastic changes in genetic diversity both in the form of an increase and a decrease in such. The area percentage of the forests in Germany is however steady at approx. 31% of the national area and is even increasing slightly. Possible effects of forest fragmentation in Germany can therefore not be compared with those of the drastic changes in some other countries, in particular in tropical climates.

Genetic studies on pollen distribution for tree species in the temperate climate zone show that although most of the pollen is of local provenance, a significantly perceptible part of the pollen does come from sources further away. This gene flow has a stabilizing effect on genetic diversity. Genetic diversity can also be positively influenced by the artificial introduction of forest reproductive material. In particular during climate change, which occurs faster than natural adaptation processes in tree populations, this measure is being discussed and considered a necessary possibility.

State of the genetic erosion of forest genetic resources

We cannot yet provide substantiated information on the erosion of genetic resources since so far hardly any repeat inventories have been conducted. Comparative genetic studies of old stands, natural regeneration and artificial regeneration in particular among main tree species reveal, however, that genetic variation remains preserved over the generations, i.e. we cannot speak here of erosion. Nonetheless, in individual cases the genetic diversity of rare tree species may be threatened by genetic erosion, for example when natural regeneration takes place only from a few old trees in residual populations. This is the case, for instance, in some regions for the European silver fir. There is danger of the erosion of forest genetic resources also for tree species whose habitats have been changed to such a degree that natural regeneration is no longer possible, for example in the case of the black poplar on regulated rivers and streams.

In order to estimate the state and the development trends of forest genetic resources in Germany a method of genetic monitoring has been developed and successfully tested on some tree species. It is not yet being used nationwide however. Genetic monitoring, which records the state and the development of genetic systems based on criteria, indicators and verificators, can therefore also provide information on possible erosion of genetic resources. Genetic monitoring is an important foundation for ensuring and controlling sustainable management of forest stands while conserving their genetic diversity. It therefore makes an essential contribution to estimating and assessing the effects of influencing factors on the genetic system of forests. Table 4 provides an overview of present implementation of genetic monitoring.

Table 4: Overview of the tree species for which genetic monitoring is conducted in the *Länder*

Tree species	*Land*
Common beech, English oak, wild cherry	Bavaria
Common beech, sessile oak, wild cherry	Brandenburg
Common beech, English and sessile oak, wild cherry	Hesse, Lower Saxony, Saxony-Anhalt
Common beech, Douglas fir, English and sessile oak	Rhineland-Palatinate
Common beech, wild cherry	Saxony
Common beech, wild cherry	Schleswig-Holstein

(BLAG-FGR 2011)

Chief factors influencing the state of forest genetic resources

Among the factors that have had a strong impact on the genetic diversity of our forests today are human interventions, for example through intensive utilization, the introduction of non-adapted provenances, habitat destruction (e.g. river regulation) or fragmentation (e.g. through the construction of settlements and roads). Browsing by game also has a strong influence. The consequence of all of this is that some tree species, such as the wild service tree or wild pear, and in some regions also the European silver fir, are found only rarely in the forests or have been greatly impaired in their regeneration process (e.g. black poplar). In addition to browsing by game, other biotic factors (e.g. insects, fungi) have also gained greater influence. One factor that is gaining importance in this context is the far more rapid adaptation of insects or fungi, for example, to new climate conditions than long-living forest trees. At the same time, measures have been introduced that can be assessed positively for the conservation of forest genetic resources. These include the conservation and promotion of tree species on site, the targeted introduction of rare tree species in natural forest ecosystems, the establishment of conservation seed orchards and display orchards as well as the optimization of reproductive techniques of rare tree species.

Due to the strict legal provisions and largely practiced close to nature forestry, over-exploitation and clear-cutting are no real threat to the state of the forests' genetic diversity in Germany. Legal provisions, the silvicultural guidelines in state-owned forests, provenance recommendations and support guidelines of the *Länder* as well as the requirements of the PEFC and FSC certification systems have positive effects on the conservation and sustainable utilization of forest genetic resources and have greatly limited the introduction of unsuitable reproductive material.

Genetic erosion of forest genetic resources: Assessment and prevention mechanisms

The close to nature forestry practiced in Germany makes use of natural processes and aims for ecologically and economically valuable forests. In this way, an increasing amount of mixed forests are growing with a high percentage of natural regeneration and long periods of regeneration. The natural regeneration methods used are intended to include as large numbers as possible of parent trees in regeneration in order to prevent, among other things, genetic constriction. Wherever suitable tree species or provenances are lacking for natural regeneration, additional trees are planted, i.e. artificially regenerated. In many regions of Germany climate change will probably require the transformation of pure spruce stands to mixed stands. Suitable plant material will be needed for this. The specifications of the FoVG for the approval of seed stands and the minimum quantities of harvest trees are basic prerequisites for the provision of high-quality forest reproductive material and an important contribution to the conservation of genetic diversity in the forests.

The National Programme drawn up by the BLAG-FGR defines measures for *in situ* and *ex situ* conservation of forest genetic resources. For the main tree species conservation occurs primarily in the scope of sustainable management of the forests and is supported by the targeted designation of genetic conservation objects and *ex situ* measures (e.g. storage of seed, seed orchards). For rare tree and shrub species usually a targeted identification and genetic characterization of the populations is necessary to then decide about conservation measures such as the establishment of conservation seed orchards.

In addition, certification under PEFC and FSC supports the sustainable management of the forests and thus promotes the conservation of genetic diversity of the entire forest ecosystem. In Germany, approximately 66% of the forest area (7.30 million hectares) are certified according to PEFC criteria, 4.3% (0.48 million hectares) according to FSC criteria and 0.5% (0.05 million hectares) according to *Naturland* criteria. However, areas may be subject to more than one certification system.

Additionally, there have been two private certification systems for forest reproductive material in Germany for about five years (ZüF – *Zertifizierungsring für überprüfbare Forstliche Herkünfte Süddeutschland e.V.* and FfV – *Verein Forum forstliches Vermehrungsgut e.V.*). They were developed in a collaboration of state and private establishments with the financial support of the Federal government. By genetically comparing reference samples gathered in various stages of the production of forest reproductive material, they enable increased controls of the provenance of forest seed and plants.

1.3 State of the diversity of forest genetic resources: Future requirements and priorities

In forestry the most important adaptation option to climate change from today's perspective is great diversity in the choice of tree species for the purpose of risk distribution. In addition to tree species from the natural forest community, tree species and provenances should be included that are better adapted to possible future site conditions. In the light of the non-foreseeable consequences of climate change for the specific forest sites, forests with manifold species composition and broad genetic amplitude offer the best prerequisite for adaptable forest ecosystems that will remain stable in future. Species diversity and genetic diversity must therefore be equally heeded and promoted, for example through the cultivation of mixed stands. Natural regeneration methods should be given priority when the stand to be regenerated is adapted to the site and contains suitable parent trees for the mixed stand of desired future tree species. We cannot, however, solely rely on natural regeneration in the course of the transformation of forest stands to create mixed stands. The same holds true if the old stand has poor qualities or was established with provenances that are not adapted to the site. In such cases, the artificial introduction of site-suitable, more productive tree species and provenances is an opportunity to ecologically and economically increase the quality of the stand and minimize future risks. This can also help to counter a future shortage of timber.

1.4 Setting up monitoring systems to assess forest genetic resources

For a long time, forest genetic resources as the basis for sustainable forestry were not the focus of industry, science and the public. The cause of the lack of understanding was, not least, the lack of monetary valuation of genetic resources. However, against the background of climate change they are gaining importance for safeguarding the adaptability of the forests.

Although the genetic monitoring developed in the scope of the National Programme for controlling the development of genetic diversity in forest ecosystems has proven itself, further establishment of monitoring areas and inclusion of more tree species is delayed due to the high costs. Expanding genetic monitoring is considered urgently necessary for an improved assessment of the state of forest genetic resources. In addition, the further development and use of genetic markers for ascertaining adaptive genetic variation will promote understanding of the importance of forest genetic resources.

2 The State of *in situ* Genetic Conservation

Presently, forests in Germany are managed to a large extent according to the principles and the necessities of conserving forest genetic resources (including consideration of a broad array of site-suitable tree species, priority given to natural regeneration). In addition, specific measures are carried out for the targeted conservation of individual tree species as well as for the conservation of genetic diversity among different tree species. The identification and documentation of existing genetic resources is a chief foundation of all conservation measures and is conducted area wide and among all forest ownership types. The type and the time of necessary measures is decided upon following assessment of the recorded resources based on the criteria of conservation worthiness and conservation urgency. Depending upon the result of this evaluation, *in situ* and/or *ex situ* measures (Chapter 3) are introduced.

2.1 Conservation of forest genetic resources within and inside protected areas and sustainably managed forests

In Germany, *in situ* conservation is defined as conservation measures that are carried out on the site where the gene resource occurs under the given site and stand conditions. These include conservation of the gene resource in itself and its natural regeneration or, if natural regeneration does not occur, artificial regeneration with the resource's own reproductive material. The prerequisite for this is the existence of a sufficiently large reproductive unit as well as environmental conditions that enable sustainable conservation on site. Individual trees and groups that no longer form sufficiently large reproductive units can be promoted *in situ*. Their sustained conservation through regeneration is, however, only possible under certain conditions. In such cases as well as under environmental conditions that do not allow sustainable conservation of a gene resource, suitable *ex situ* measures must be carried out.

In situ conservation measures are particularly important since, under certain conditions, they can be integrated in forestry management. Moreover, *in situ* measures enable the conservation of a large amount of genetic information and its further development under the predominant conditions on the site of growth. The prerequisite for the integration of *in situ* measures in forestry management is to consistently carry out management that is oriented to the principles of close to nature silviculture. Among these measures are the establishment and maintenance of site-suitable, species-rich and mixed forest ecosystems and the natural regeneration of forest stands that also takes tree species into consideration that are not as economically significant. Conservation of stand vitality, lengthening of rotation periods, cultivation of provenance-proven and adapted populations with great genetic diversity as well as the establishment of species-rich and tiered forest edges are particularly beneficial for *in situ* conservation of forest genetic resources. The designation of seed stands and the production of reproductive material for all tree and shrub species oriented to genetic principles are the most important measures in artificial regeneration.

As long as there are no target conflicts with forest genetic resource conservation, the designation of protected areas of various categories such as national parks, biosphere reserves, nature conservation areas and nature parks (Table 5) as well as natural forest reserves or closed forests by nature conservation and forest authorities on principle also contributes to genetic conservation. However, in most cases the designation and protection status of such areas is not necessarily conducted from the standpoint of forest genetic resource conservation. Target conflicts usually occur when action dictates and prohibitions restrict conservation measures or make them impossible. These include for example interventions promoting species that are not very competitive or isolated populations, removal of material for particularly essential conservation measures or the prevention of infiltration of original populations by unsuitable, artificially introduced material.

Table 5: Nature conservation areas* in Germany

Protection area category	Nature conservation areas	National parks	Biosphere reserves	Landscape conservation areas	Nature parks	Natura 2000
As of	31.12.2009	05/2011	05/2011	31.12.2009	01.01.2011	12/2009
Number	8,481	14	16	7,409	102	5,266
Area (km²)	13,014	10,295	18,469	101,646	95,730	50,061

* Including coastal and mudflat areas, not including sea areas. The areas of the protection area categories cannot be totalled as they overlap. BfN 2011 (http://www.bfn.de/0308_gebietsschutz.html and http://www.bfn.de/0316_gebiete.html)

Since species and area-related biotope protection is the focus of the establishment of protected areas under the implementation of the Federal Nature Conservation Act, the conservation of genetic diversity has not played a great role in management, care and conservation measures by nature conservation so far. In general, it has been shown that the conservation of genetic resources is best ensured through sustainable utilization (protection through utilization) in the scope of sustainable, close to nature forestry.

The principle of sustainability has a long tradition in the forestry of Germany. Forest management is sustainable if the forest heritage remains safeguarded as a natural resource for the long term for the provision of utilization, protection and social functions. In Germany, an extensive body of legislation exists for the forests and their management, which was always developed further based on centuries of experience in forestry. The separation of responsibilities between the Federal government and the *Länder* anchored in the Basic Law of the Federal Republic of Germany makes necessary adaptations to regional circumstances possible, which leads to a certain diversification in forestry legislation (Chapter 5.2). On principle, however, according to the laws of the Federal government and the *Länder* all forest owners are obligated to undertake “sustainable, orderly management” of their forests.

2.2 *In situ* conservation measures

The measures of the Federal government and the *Länder* for *in situ* conservation of forest genetic resources are coordinated in Germany by the BLAG-FGR. For this purpose, the BLAG-FGR has agreed on a list of tree and shrub species for which measures of various types and intensity appear necessary for their conservation while taking regional aspects into account. The list contains approx. 200 tree and shrub species occurring in Germany (Chapter 9). These tree and shrub species can be divided into the groups “tree species that are governed by the provisions of the FoVG (FoVG tree species)” (Table 6), “tree species that are not governed by the provisions of the FoVG (non-FoVG tree species)” (Table 7) and “shrub species” (Table 8). Presently, approx. 170 species have been included in *in situ* measures of a more or less intensive nature.

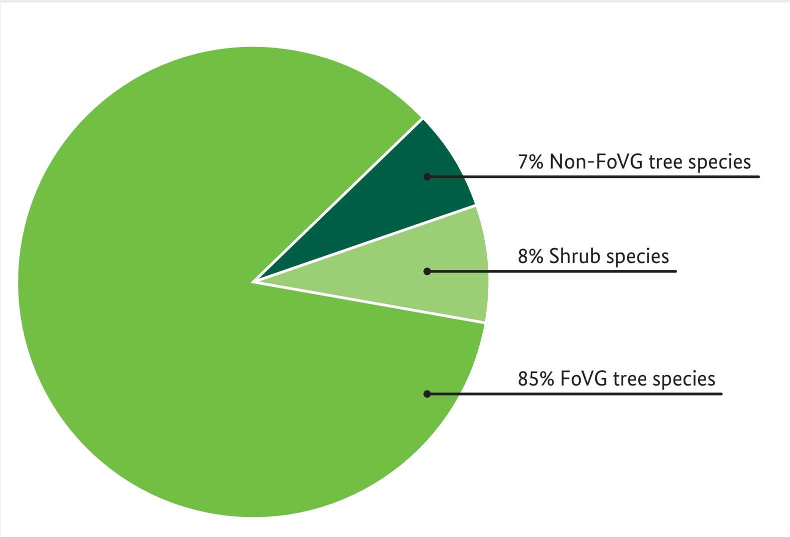

Figure 13: Area percentages of designated *in situ* genetic conservation stands for FoVG tree species, non-FoVG tree species and shrub species (2010)

(BLAG-FGR 2011)

The group of FoVG species also contains those tree species that are of commercial importance for forestry in Germany. This group is dominated by the common beech (43%), the native oak species English and sessile oak (18%) as well as common spruce (13%) and Scots pine (8%). The remaining area percentage of 18% within the FoVG tree species includes another 29 tree species (Figure 14). Usually, entire stands forming a reproductive community (population) are designated as gene conservation objects. In the cases of rare tree species or particularly valuable genetic resources (e.g. trees with unique growth properties, resistance to pests or diseases, tolerance to adverse environmental influences) it may be advisable to also conserve individual trees *in situ*. These are listed in the last columns of tables 6 to 8. The section "individual trees" hence does not refer to the number of trees in the *in situ* stands.

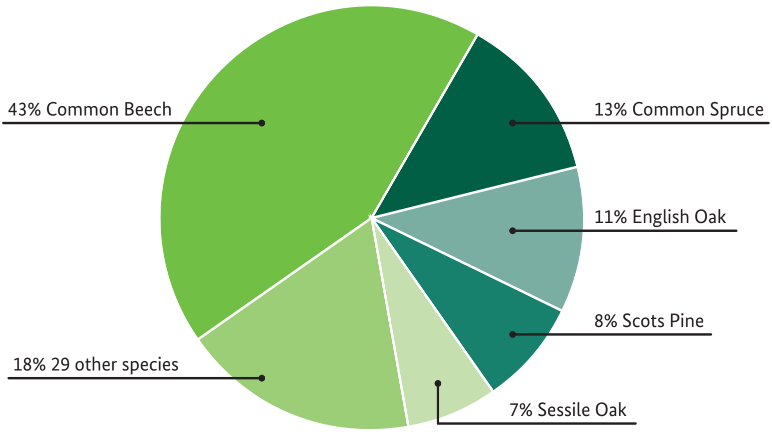

Figure 14: Area percentages (%) of designated *in situ* gene conservations stands for individual tree species that are governed by the FoVG (2010)

(BLAG-FGR 2011)

Table. 6: Overview of *in situ* genetic conservation objects of tree species that are governed by the FoVG (2010)

Tree species		*in situ* Stands		Trees *in situ*
Scientific Name	Common Name	Quantity	Area (ha)	Quantity
Abies alba	European Silver Fir	119	144.77	1 946
Abies grandis	Giant Fir, Grand Fir	39	39.37	2
Acer platanoides	Norway Maple	99	39.53	716
Acer pseudoplatanus	Sycamore	247	271.88	356
Alnus glutinosa	Common Alder, European Alder	237	596.15	75
Alnus incana	Grey Alder	14	5.20	3
Betula pendula	European Birch, Silver Birch	62	145.17	102
Betula pubescens	Downy Birch	65	567.64	76
Carpinus betulus	Common Hornbeam, European Hornbeam	165	386.59	785
Castanea sativa	Spanish Chestnut, Sweet Chestnut	9	5.16	27
Fagus sylvatica	Common Beech, European Beech	1226	12 882.04	243
Fraxinus excelsior	Common Ash, Euro-pean Ash	294	700.46	140
Larix decidua	European Larch	140	200.96	38
Larix x eurolepis	Dunkeld Larch	3	7.20	
Larix kaempferi	Japanese Larch	63	98.57	3
Picea abies	Common Spruce, Norway Spruce	663	3 874.02	53

Tree species		*in situ* Stands		Trees *in situ*
Scientific Name	Common Name	Quantity	Area (ha)	Quantity
Picea sitchensis	Sitka Spruce	5	18.88	1
Pinus nigra	Austrian Pine, Black Pine	64	175.75	26
Pinus sylvestris	Scots Pine	411	2 520.47	123
Populus alba	White Poplar			4
Populus canadensis	Canadian Poplar			157
Populus x canescens	Grey Poplar	3	6.60	2
Populus jackii	Balm of Gilead			1
Populus nigra	Black Poplar	137	900.50	3 030
Populus tremula	Aspen	5	6.58	10
Populus trichocarpa x maximowiczii	Black Cottonwood, Western Balsam Poplar			1
Prunus avium	Gean, Mazzard, Wild Cherry	131	73.88	3 105
Pseudotsuga menziesii	Douglas Fir	398	556.82	109
Quercus petraea	Sessile Oak	472	2 164.20	1 388
Quercus robur	English Oak, Oak, Pedunculate Oak	751	3 121.99	205
Quercus rubra	American Red Oak	98	199.33	36
Robinia pseudoacacia	Acacia, Black Locust,	5	5.29	13
Tilia cordata	Little Leaf Linden	166	239.62	175
Tilia platyphyllos	Large-Leaved Lime	47	20.52	214

(BLAG-FGR 2011)

The species in the two other groups are of less commercial importance for forestry due to their distribution, their cultivation or their habitus, yet are particularly important for ecological stability, species diversity and habitat diversity.

Table 7: Overview of *in situ* genetic conservation objects of tree species that are not governed by the FoVG (2010)

Tree species		*in situ* Stands		Trees *in situ*
Scientific Name	Common Name	Quantity	Area (ha)	Quantity
Abies nordmanniana	Caucasian Fir			4
Abies procera	Noble Fir	2	1.56	1
Acer campestre	Field Maple, Hedge Maple	41	19.53	575
Acer negundo	Ash Leafed Maple			4
Acer saccharinum	Silver Maple			7
Aesculus hippocastanum	Horse Chestnut			23
Carya ovata	Shagbark Hickory	5	3.51	19
Chamaecyparis lawsoniana	Lawson‘s Cypress, Oregon Cedar	2	0.29	3
Fraxinus pennsylvanica	Red Ash			1
Juglans nigra	Black Walnut			9
Juglans regia	English Walnut, Persian Walnut	1	2.52	39
Liriodendron tulipifera	Canary Whitewood, Tulip Polar			5
Malus sylvestris	Apple, Wild Crab	105	25.57	4 256
Picea glauca	White Spruce			1

Tree species		*in situ* Stands		Trees *in situ*
Scientific Name	Common Name	Quantity	Area (ha)	Quantity
Picea omorika	Serbian Spruce	1	9.00	1
Picea pungens	Blue Spruce, Colorado Spruce			1
Pinus contorta	Lodgepole Pine, Shore Pine			1
Pinus ponderosa	Ponderosa Pine			2
Pinus x rotundata	Bog Pine	10	30.80	95
Pinus strobus	Eastern White Pine, Weymouth Pine	8	8.92	23
Platanus hispanica	London Plane, Plane	1	0.30	
Prunus padus	European Bird Cherry	50	24.98	663
Prunus serotina	American Bird Cherry, Black Cherry	1	5.31	7
Pyrus pyraster	Wild Pear	28	5.67	2 255
Quercus x rosacea				2
Salix alba	White Willow	27	53.40	79
Salix aurita	Eared Willow	34	10.44	21
Salix bicolor		1	0.01	1
Salix caprea	Goat Willow, Pussy Willow	13	7.40	41
Salix cinerea	Grey Willow	25	17.34	18
Salix fragilis	Crack Willow	3	0.12	14
Salix myrsinifolia	Dark Leaved Willow			1
Salix pentandra	Bay Willow, Laurel Willow			11

Tree species		in situ Stands		Trees in situ
Scientific Name	Common Name	Quantity	Area (ha)	Quantity
Salix triandra	Almond Leaved Willow	12	46.53	64
Sequoiadendron giganteum	Giant Sequoia, Wellingtonia			6
Sorbus acutisecta				40
Sorbus aria	Whitebeam	2	0.05	63
Sorbus aucuparia	Rowan, Mountain Ash	67	39.00	358
Sorbus decipiens				40
Sorbus domestica	Service Tree	3	0.70	649
Sorbus heilingensis		1	0.30	260
Sorbus intermedia	Swedish Whitebeam			3
Sorbus isenacensis				20
Sorbus latifolia agg.	Service Tree of Fontainebleau			20
Sorbus multicrenata				50
Sorbus parumlobata				3
Sorbus pinnatifida		3	4.45	8
Sorbus subcordata				20
Sorbus torminalis	Wild Service Tree	218	35.44	995
Taxodiaceae				2
Taxodium distichum	Swamp Cypress			10
Taxus baccata	Common Yew, English Yew	175	28.69	1 636

Tree species		*in situ* Stands		Trees *in situ*
Scientific Name	Common Name	Quantity	Area (ha)	Quantity
Thuja occidentalis	Arborvitae, Red Cedar			3
Thuja orientalis	Oriental Arborvitae			1
Thuja plicata	Western Red Cedar	12	2.45	12
Tsuga canadensis	Eastern Hemlock	1	0.30	4
Tsuga heterophylla	Western Hemlock	6	1.96	3
Ulmus glabra	Elm, Scotch Elm, Wych Elm	536	260.46	10 131
Ulmus x hollandica (*minor x glabra*)	Dutch Elm			21
Ulmus laevis	Russian Elm	557	1 699.73	5 141
Ulmus minor	European Field Elm	171	180.33	1 224

(BLAG-FGR 2011)

All conservation measures are based on the identification, characterization and evaluation of existing forest genetic resources. Occurrences over the entire area are mapped. Depending upon the available capacities and the regional circumstances, the *Länder* have chosen different courses of action. In a number of the *Länder*, such as Brandenburg, Mecklenburg-Western Pomerania, Schleswig-Holstein and Saxony, all tree species are registered regardless of forest ownership types. Lower Saxony initially gave highest priority to state forests. Saxony-Anhalt focussed its capacities on complete identification of all rare tree species. By contrast, Rhineland-Palatinate and Hesse pursue different schemes: while in Hesse only FoVG approved stands are considered as gene conservation stands, Rhineland-Palatinate only designates gene conservation resources following prior genetic characterization. In the other *Länder* with the exception of the city-states the identification work is only in initial stages or is conducted according to necessity .

By area, the *in situ* gene conservation objects are almost balanced with 7% (Figure 13) of the 63 tree species (Table 7) that are not governed by the FoVG and another 8% of 74 shrub species. In addition to the 53 shrub species cited in Table 8 individuals or small groups of a few individuals of 21 more shrub species are conserved.

Table 8: Overview of *in situ* genetic conservation objects of shrub species (2010)

Shrub species		*in situ* Stands		Individuals *in situ*
Scientific Name	Common Name	Quantity	Area (ha)	Quantity
Berberis vulgaris	Common Barberry	4	0.14	9
Betula humilis	Shrub Birch	4	0.04	1
Clematis vitalba	Old Man's Beard, Traveller's Joy			4
Colutea arborescens	Bladder Senna			4
Cornus mas	Cornelian Cherry	3	0.55	4
Cornus sanguinea	Common Dogwood, Dogberry	45	94.23	118
Corylus avellana	Cob, Hazel	171	181.65	196
Corylus colurna	Turkish Hazel			6
Cotoneaster integerrimus	Cotoneaster	2	0.02	5
Crataegus laevigata	English Hawthorn	98	180.03	141
Crataegus x macrocarpa		9	3.40	

Shrub species		*in situ* Stands		Individuals *in situ*
Scientific Name	Common Name	Quantity	Area (ha)	Quantity
Crataegus x media		32	5.41	
Crataegus monogyna	Single Seed Haw-thorn, Mayhaw	120	178.55	154
Crataegus rhipidophylla				5
Crataegus x subsphaericea		36	11.10	
Cytisus scoparius	Broom, Scotch Broom	7	3.00	16
Daphne mezereum	February Daphne, Mezereon	6	0.06	22
Euonymus europeus	Common Spindle	104	1 236.68	195
Frangula alnus	Alder Buckthorn, Common Buckthorn	47	73.36	52
Genista germanica	German Greenweed			9
Hedera helix	Common Ivy, English Ivy			10
Hippophae rhamnoides	Sea Buckthorn	2	1.10	3
Humulus lupulus	Common Hop			13
Ilex aquifolium	Common Holly, English Holly	67	35.09	483
Juniperus communis	Common Juniper, Juniper	20	15.95	436
Ledum palustre	Wild Rosemary	3	4.20	1
Ligustrum vulgare	Common Privet	8	3.40	31

Shrub species		*in situ* Stands		Individuals *in situ*
Scientific Name	Common Name	Quantity	Area (ha)	Quantity
Lonicera xylosteum	Fly Honysuckle	11	1.39	32
Mespilus germanica	Medlar			6
Myrica gale	Bog Myrtle, Sweet Gale	33	19.42	2
Prunus mahaleb	Mahaleb Cherry, St Lucie Cherry			5
Prunus spinosa	Blackthorn, Sloe	236	80.92	398
Rhamnus cathartica	Common Buckthorn, European Buckthorn	108	185.21	146
Ribes alpinum	Alpine Currant, Mountain Currant	1	0.01	1
Ribes nigrum	Blackcurrant	16	1.40	4
Ribes rubrum	Currant	8	0.37	1
Ribes uva-crispa	Gooseberry			8
Rosa canina	Common Briar, Dog Rose	156	144.90	124
Rosa corymbifera	Rose	47	8.60	8
Rosa elliptica		3	0.20	1
Rosa rubiginosa	Eglantine, Sweet Briar	8	4.70	7
Rosa tomentosa	Downy Rose	9	30.50	1
Salix helvetica	Swiss Sallow	1	0.02	1
Salix purpurea	Purple Osier, Purple Willow	3	1.40	18
Salix repens	Creeping Willow	7	0.82	52

Shrub species		*in situ* Stands		Individuals *in situ*
Scientific Name	Common Name	Quantity	Area (ha)	Quantity
Salix x rubens	Hybrid Crack Willow	13	46.60	76
Salix viminalis	Common Osier, Osier	9	47.17	58
Sambucus nigra	Common Elder, Elderberry	167	88.46	125
Sambucus racemosa	Red Berried Elder, Red Elderberry	14	2.98	23
Spartium junceum	Spanish Broom			8
Symphoricarpos albus	Snowberry, Waxberry	1	0.01	17
Ulex europaeus	Furze, Gorse	4	0.04	1
Viburnum lantana	Wayfaring Tree	7	3.05	23
Viburnum opulus	European Cranberry-bush, Guelder Rose	20	9.73	77

(BLAG-FGR 2011)

Of more than 45,000 individual trees and shrubs designated, the non-FoVG tree species are the most frequent with 64% of all identified individuals (Figure 15).

The high percentages of wild fruit, Sorbus and elm species as well as the common yew are of particular note (Figure 16). Among the FoVG tree species, which include 29% of the identified individuals, the wild cherry, black poplar, European silver fir and sessile oak have the highest numbers of trunks (Table 6).

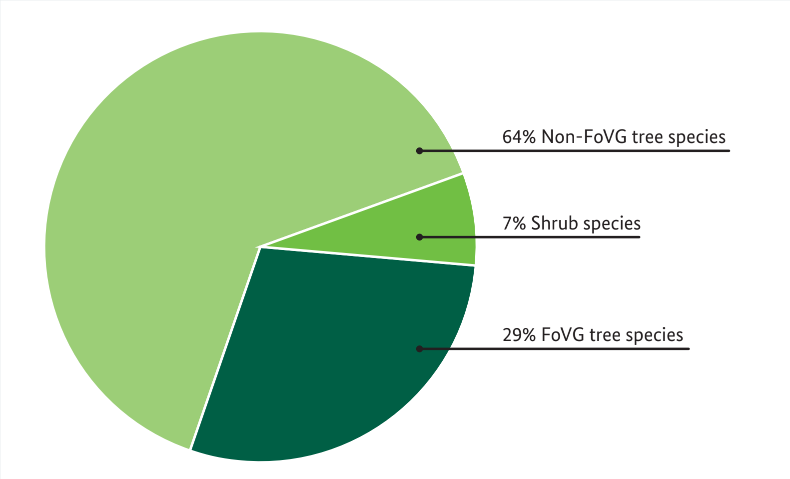

Figure 15: Distribution of designated individual trees among species groups (FoVG tree species and non-FoVG tree species as well as shrub species (2010))
(BLAG-FGR 2011)

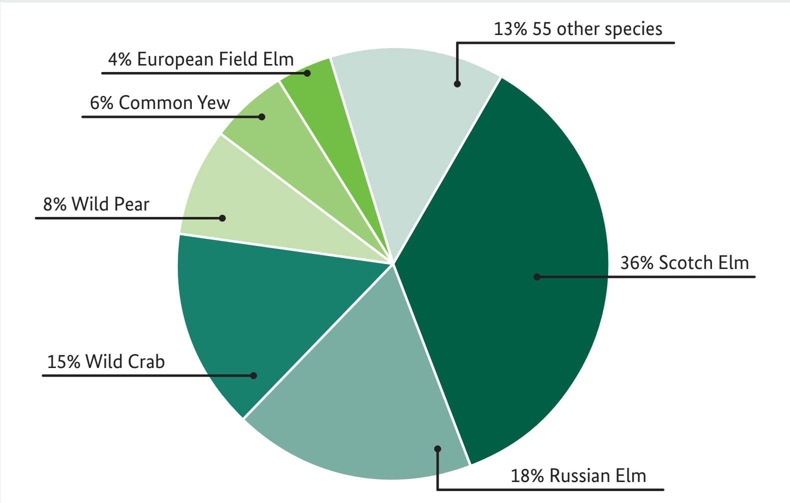

Figure 16: Percentages of designated individual trees in the group of non-FoVG tree species (2010)
(BLAG-FGR 2011)

As the results of the identification of gene conservation objects demonstrate, the focus of *in situ* measures is on the conservation of stands and individual trees. By contrast, due to the scattered distribution and relatively small extent of these populations in many regions of Germany, the designation of gene conservation forests has been rather infrequent to date.

The projects carried out between 2005 and 2007 to identify and characterize the black poplar (BLE 2007a, Figure 17) and native elm species (BLE 2007b) as well as the identification and characterization of rare tree species (Chapter 1.1) underway since 2010, which were funded by the Federal government (BMEL) and the *Länder*, have delivered decisive stimuli for the nationwide identification of forest genetic resources.

The verifiable criteria for the identification of gene conservation objects are the indicators of species, autochthonous or recognizable adaptedness to the site and adaptability. The results of morphological, phenological, eco-physiological and/or genetic studies (if available) can be referred to when assessing adaptability. In addition to these indicators, phenotypic properties such as special morphological attributes or above-average quality can also be used as identification criteria in individual cases.

In order to ensure different selection conditions for the conservation objects and the options for further genetic differentiation, the representative distribution of the conservation objects throughout all forest sites in question for one tree species within a forest region must be investigated. Special and extreme sites should be suitably taken into consideration for this.

As the result of the work conducted, by the end of 2010 approx. 10,000 stands of more than 100 tree and shrub species with a total area of 35,235 hectares and more than 45,000 individuals of 170 tree and shrub species have been identified for *in situ* conservation measures. The FoVG tree species take up the largest area with 85% (or 30,000 hectares).

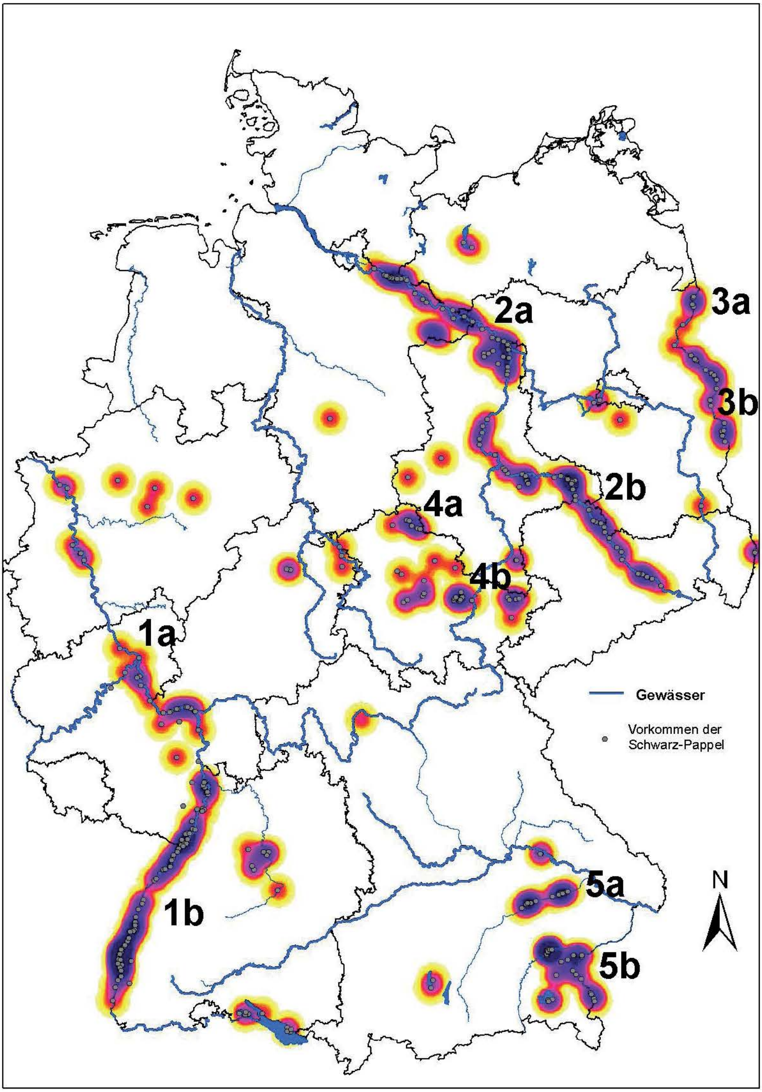

Figure. 17: Coverage and characterization of the black poplar: Kernel density of the populations recorded from 2005 to 2007 not accounting for the number of trees
(BLE 2007a)

Activities for improving the identification and characterization as well as the sustainability of *in situ* conservation measures

With a few exceptions, forest gene conservation objects are designated on the basis of phenotypic attributes. The reasons for this are the as yet extensively unknown genetic constitution of many tree and shrub species and lack of available capacities for conducting genetic studies in many *Länder.* Nonetheless, today nationwide genetic inventories exist (e.g. Konnert and Bergmann 1995; Konnert et al. 2000; BLE 2007a; BLE 2007b) for a number of tree species, such as the common beech, European silver fir as well as black poplar and the native elm species. The results of these studies are increasingly utilized for the evaluation of already or yet to be designated gene conservation objects.

The identification of geographical and chronological changes to the genetic structures of tree and shrub populations is the objective of the concept developed for genetic monitoring (Chapter 1.1.3 and 1.4).

Figure 18: Trunk of black poplar (© ASP)

In order to improve the sustainability of management of *in situ* gene conservation stands, a number of studies have been conducted on the common spruce, Scots pine, European silver fir, common beech and English oak, which record the genetic effects of silvicultural measures (Konnert et al. 2007).

2.3 Activities to promote *in situ* genetic conservation measures

The Federal government and the *Länder* carry out various activities to promote the conservation of forest genetic resources and specific *in situ* measures. Among these are:

- Professional conferences, information and further training events as well as excursions for forestry professionals, forest owners and nature conservation volunteers,
- Courses, seminars and excursions for students and professors of higher educational institutes in forestry,
- Press conferences and articles in popular science print media.

Awareness of the subject matter has increased considerably among the specialized public. One cause of this is the great media interest, which favours the topic of "biological diversity" as a result of the International Year of Biological Diversity and the CBD process. The majority of the regional forestry administrations participated in the biodiversity campaign in 2008 and activities in the year 2010 for the International Year of Biological Diversity. All regional forestry administrations are taking part in the International Year of Forests (2011). In addition, the institutions of the BLAG-FGR have for years taken part in the "Tree of the Year" activities, in which one species is the focus of interest each year. Thanks to the great media interest it is increasingly possible to convey knowledge about the conservation of forest genetic resources and *in situ* conservation.

2.4 Chief requirements for improving *in situ* conservation

Measures for *in situ* conservation of gene conservation objects mainly focus on state-owned forest areas. In privately owned forests, *in situ* measures can only be realized on a voluntary basis. There are not sufficient possibilities to support forest owners in carrying out *in situ* measures, which are often linked to economic losses through waiver of utilization or increased expenses for protection and management measures.

2.4.1 Priorities for future *in situ* conservation activities including research and development

The central focus of measures for the conservation of forest genetic resources continues to be coordinating the identification, conservation and utilization of forest genetic resources. So far, trees or other woody plant species have been processed for which there is a nationwide or Europe-wide need for conservation. In future, the genetic resources of selected tree species will be identified and characterized according to nationally uniform mapping methods on the basis of economic importance, nationwide range, European objectives and the state of knowledge of genetic principles. A need for action, taking into account regional, i.e. *Länder*-specific priorities, is deemed for the tree species English and sessile oak, wild cherry, little leaf linden, black alder, European ash, sycamore, European hornbeam, acacia, European silver fir and Douglas fir. The initiated identification and conservation measures for the black poplar, native elm species and wild fruit species as well as other rare tree species nationwide (e.g. common yew) will be continued with a regional focus.

Furthermore, guidelines should be drawn up for the designation and conservation of gene conservation forests, in which binding terms are defined and the objectives as well as the practical implementation is described. Designated gene conservation forests will then be integrated in a Europe-wide network of gene conservation forests set up by EUFORGEN. The BLAG-FGR institutions will examine for each *Land* the extent to which the objectives of conservation of forest genetic resources (*in situ*) for individual tree species can be intensified in future and also lastingly be implemented in the designated regions of the Habitats Directive.

In future, information from genetic inventories with genetic markers should included to a greater extent in the selection of forest stands for *in situ* gene conservation measures. Presently, much of the information available is based on surveys with only a few isoenzyme gene loci. Newly developed genetic markers will contribute to improve the information value of such surveys. Comparative studies are also urgently needed on the use of a number of categories of genetic markers and work on the optimal sampling strategy. These can be successfully tested and optimized using computer simulations (Cavers et al. 2005).

Similarly to the identification of genetic diversity, previous studies on the effects of forest operations and methods for seed harvesting and plant cultivation are based mainly on genetic surveys with only a few isoenzyme gene loci. Hence new genetic studies with molecular markers will achieve more precise results and could therefore lead to more meaningful conclusions. Simulation models combined with data collection in the forest and the laboratory should be used and further developed in order to gain universally valid results (Degen and Scholz 1996; Degen et al. 2006).

The medium to long-term identification and documentation of spatial and temporal changes of genetic structures based on the concept and the guidelines for the genetic monitoring has become another focus of the conservation of forest genetic resources. Using genetic monitoring a "new" quality in the validity of genetic surveys is attained, since it for the first time expands individual tests to time series. Germany is taking on a pioneering role in Europe.

So far, there are few findings concerning the "natural" variation of genetic processes such as pollen distribution or the percentage of self-fertilization in various years. The anthropogenic influence on "natural" variation must be more precisely examined in future. For this, time series are necessary as those attained by genetic monitoring. Selected tree species from the habitat types included in the "Special Areas of Conservation" designated under the Habitats Directive need to be incorporated in genetic monitoring, since the protective purpose of long-term conservation is already defined there.

Subject to the availability of funds, in coming years the initiated genetic monitoring programmes for the common beech and wild cherry should be continued in order to establish time series of long duration. It would also be advisable to expand genetic monitoring to more tree species selected on the basis of the existing concept and taking into account the above mentioned guidelines as well as previous project experience.

There is more need for action in connection with the efficiency and sustainability of *in situ* conservation measures when assessing the gene flow at the landscape level in the form of pollen and seed distribution between stands as well as the effects of the use of genetically non-adapted reproductive materials in landscaping on the genetic composition of forests. In view of the uncertainties with regard to the extent of future changes to the site conditions, research on the genetic diversity and adaptability of tree species and provenance research are of particularly high importance. Future risks and opportunities for forest management and therefore also for the conservation of forest genetic resources *in situ* must be analyzed early and holistically through interdisciplinary research of the effects of climate change on the forests and the forest trees and on the limits to adaptability of tree species.

2.4.2 Priorities for developing policies to support *in situ* conservation activities

The conservation and sustainable utilization of forest genetic resources is governed by various provisions in the forestry legislation of the Federal government and the *Länder*. In some of the *Länder* forest laws (e.g. Brandenburg, Rhineland-Palatinate) the task is explicitly named. In two *Länder* (Mecklenburg-Western Pomerania, Thuringia) forests can be declared protected forests for the purpose of conservation of forest genetic resources (Table 20). Because of the increasing importance of biological diversity including forest genetic resources, which is reflected in a variety of international provisions, explicit citation of this task in the relevant legal provisions is desirable.

Including the protection purpose "conservation and sustainable utilization of forest genetic resources" in the relevant legal provisions can increase the binding character for carrying out conservation measures following the designation of *in situ* gene conservation objects. On principle, account must be taken of areas and objects that are important for the conservation of forest genetic resources in forest overall planning and in forest function mapping. In this context, the development of funding instruments is advisable to support measures for *in situ* conservation of forest genetic resources in privately owned and communal forests. In most cases, *in situ* measures for forest genetic resource conservation do not conflict with the protective purpose of protected areas of most categories. Measures for the conservation of rare tree species should be taken into consideration in protected area ordinances and management plans for protected areas. If target conflicts should arise in individual cases, the nature conservation authorities should take into account the favourable effect of measures for the conservation of forest genetic resources on biological diversity – as provided for the collecting of regional seed under Article 39 Section 4 (4) of the Federal Nature Conservation Act.

Neither the broader public nor members of the forestry and nature conservation professions are sufficiently aware of the importance of genetic resources for the perpetuation of evolutionary processes, the preservation of biological diversity and the potential uses. In the light of the ever more rapid increase in "genetic expertise" an ever-greater discrepancy is becoming apparent between the amount of knowledge, the practical application of the knowledge and the acceptance of genetic issues. In addition, the controversial public debate on "green genetic engineering" has erroneously led to a growing public resistance to any type of genetic research. It has not yet been possible to convey the required specialist information via the available media in a sufficiently differentiated and detailed way.

Against this background, in addition to technical publications, all possibilities for conveying this information should be employed. Suitable platforms for this include participation in events for the Day of the Forests, the Tree of the Year, presentations at conferences by the BMEL or the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

Additionally, further measures should be designed where possible. In order to create public awareness and intensify public interest, forest genetic resource conservation in the context of biological diversity should continue to be a fixed element in forest public relations. Specific programmes for various target groups, for example for schoolchildren or forest owners without forestry backgrounds, need to be developed. The establishment of relevant, publicly accessible demonstration objects can make a major contribution to these efforts.

3 The State of *ex situ* Genetic Conservation

Ex situ forest genetic resource conservation generally always involves the relocation (evacuation) of genetic resources that are worth preserving from their respective regions of occurrence. Reasons for preservation may be their endangerment, their rarity or the special value of the population. *Ex situ* conservation can be carried out dynamically under natural conditions through sowing or planting or through the establishment of conservation seed orchards or clonal repositories. Statically, conservation can be ensured through the storage of seed, pollen or plant parts in forest gene banks. Another possibility is the conservation of forest genetic resources by means of permanent vegetative propagation, in particular *in vitro* propagation. *Ex situ* conservation provides the opportunity to characterize and document the genetic information before utilizing or otherwise changing the conservation object.

3.1 The state of collections

There are specific *ex situ* conservation programmes for tree and shrub species that are endangered or rare in Germany. In addition, however, *ex situ* conservation measures are also carried out for regionally important populations of tree species, which are regionally threatened or particularly valuable. The *in situ* and *ex situ* conservation work of the BLAG-FGR refers mainly to the tree and shrub species cited in Annex 9. In the scope of these *ex situ* conservation measures to date approx. 95 tree and shrub species occurring in Germany have been processed (Table 9 and Table 10). The conservation measures are distributed relatively evenly among the FoVG tree species (34%), non-FoVG tree species (37%) and shrub species (29%). *Ex situ* conservation is not only conducted by storage of seed and plant material in gene banks. For rare tree species and/or dispersed occurring species and provenances, seed orchards contribute to increasing the genetic diversity and the reproductive capacity of the progeny by bringing isolated genotypes together (Table 9). Seed orchards serve primarily to provide high quality and source-identified seed for multifunctional forestry.

Table 9: Overview of *ex situ* stands (2010) per tree species portrayed (quantity and area)

Tree species		*ex situ* Stands	
Scientific Name	Common Name	Quantity	Area (ha)
Abies alba	European Silver Fir	10	8.70
Abies grandis	Giant Fir, Grand Fir	1	1.50
Abies procera	Noble Fir	5	6.06
Acer campestre	Field Maple, Hedge Maple	9	6.52
Acer platanoides	Norway Maple	1	0.05
Acer pseudoplatanus	Sycamore	32	31.93
Alnus glutinosa	Common Alder, European Alder	1	1.20
Betula pendula	European Birch, Silver Birch	7	12.80
Carpinus betulus	Common Hornbeam, European Hornbeam	13	16.00
Carya ovata	Shagbark Hickory	2	1.00

Tree species		*ex situ* Stands	
Scientific Name	Common Name	Quantity	Area (ha)
Cornus sanguinea	Common Dogwood, Dogberry	3	1.10
Corylus colurna	Turkish Hazel	1	0.05
Crataegus monogyna	Single Seed Hawthorn, Mayhaw	5	10.60
Euonymus europeus	Common Spindle	8	8.18
Fagus sylvatica	Common Beech, European Beech	114	122.30
Frangula alnus	Alder Buckthorn, Common Buckthorn	8	8.80
Fraxinus excelsior	Common Ash, European Ash	11	14.55
Juglans nigra	Black Walnut	4	2.36
Juglans regia	English Walnut, Persian Walnut	4	4.00
Juniperus communis	Common Juniper, Juniper	5	3.00
Larix decidua	European Larch	38	31.92
Larix x eurolepis	Dunkeld Larch	5	5.10
Larix kaempferi	Japanese Larch	1	1.30
Malus sylvestris	Apple, Wild Crab	74	25.25
Mespilus germanica	Medlar	3	2.50
Metasequoia glyptostroboides	Dawn Redwood	2	0.75
Picea abies	Common Spruce, Norway Spruce	120	238.57
Pinus nigra	Austrian Pine, Black Pine	2	1.57

Tree species		ex situ Stands	
Scientific Name	Common Name	Quantity	Area (ha)
Pinus ponderosa	Ponderosa Pine	1	0.40
Pinus x rotundata	Bog Pine	3	1.40
Pinus sylvestris	Scots Pine	38	41.80
Populus canadensis	Canadian Poplar	4	5.00
Populus nigra	Black Poplar	14	9.48
Populus tremula	Aspen	30	21.30
Prunus avium	Gean, Mazzard, Wild Cherry	61	42.21
Prunus padus	European Bird Cherry	34	0.92
Prunus spinosa	Blackthorn, Sloe	12	5.10
Pseudotsuga menziesii	Douglas Fir	153	308.91
Pyrus pyraster	Wild Pear	26	13.09
Quercus petraea	Sessile Oak	9	14.09
Quercus pubescens	Downy Oak	1	0.20
Quercus robur	English Oak, Oak, Pedunculate Oak	45	44.60
Quercus x rosacea		1	0.25
Quercus rubra	American Red Oak	1	2.00
Rhamnus cathartica	Common Buckthorn, European Buckthorn	10	12.70
Sequoiadendron giganteum	Giant Sequoia, Wellingtonia	1	1.40
Sorbus aria	Whitebeam	4	3.80
Sorbus aucuparia	Rowan, Mountain Ash	13	19.30
Sorbus domestica	Service Tree	8	2.10

Tree species		*ex situ* Stands	
Scientific Name	Common Name	Quantity	Area (ha)
Sorbus heilingensis		1	0.50
Sorbus torminalis	Wild Service Tree	24	13.89
Taxus baccata	Common Yew, English Yew	136	84.57
Tilia cordata	Little Leaf Linden	13	7.00
Tilia platyphyllos	Large-Leaved Lime	1	0.80
Ulmus glabra	Elm, Scotch Elm, Wych Elm	70	14.60
Ulmus laevis	Russian Elm	35	13.60
Ulmus minor	European Field Elm	7	1.30
Viburnum opulus	European Cranberry-bush, Guelder Rose	2	0.20

(BLAG-FGR 2011)

The storage of seed, pollen (Table 10) or tissue cultures in gene banks is carried out by the various institutions of the BLAG-FGR as a supplemental measure for *in situ* conservation and as another *ex situ* measure with the objective of conserving forest genetic resources. This material is stored, depending on the tree species, either as a representative entire accession for a population or for individual trees.

Table 10: Overview of *ex situ* conservation measures (2010) for seed (entries and quantity) and pollen (entries and quantity) for the respective tree and shrub species

Tree species		Seeds		Pollen	
Scientific Name	Common Name	Lots	Quantity (kg)	Lots	Quantity (cm^3)
Abies alba	European Silver Fir	214	713.845	7	511.0
Abies firma	Japanese Fir, Momi Fir	1	0.003		
Abies grandis	Giant Fir, Grand Fir	42	577.238		
Abies koreana	Korean Fir	1	0.011		
Abies nordmanniana	Caucasian Fir	1	0.060		
Abies pinsapo	Hedgehog Fir, Spanish Fir	1	0.002		
Abies procera	Noble Fir	20	212.686		
Abies veitchii	Veitch Fir, Veitch's Silver Fir	1	0.592		
Acer campestre	Field Maple, Hedge Maple	3	3.300		
Acer monspessulanum	Montpelier Maple	1	0.700		
Acer platanoides	Norway Maple	9	26.885		
Acer pseudoplatanus	Sycamore	62	226.482		
Alnus glutinosa	Common Alder, European Alder	146	58.077		
Alnus viridis	Green Alder	3	2.800		
Amelanchier ovalis	Snowy Mespilus, European Juneberry	1	0.010		

Tree species		Seeds		Pollen	
Scientific Name	Common Name	Lots	Quantity (kg)	Lots	Quantity (cm³)
Berberis vulgaris	Common Barberry	5	2.500		
Betula pendula	European Birch, Silver Birch	62	77.049		
Betula platyphylla	Asian White Birch	136	3.131		
Betula pubescens	Downy Birch	125	10.846		
Carpinus betulus	Common Horn-beam, European Hornbeam	16	299.745		
Carya ovata	Shagbark Hickory	1	100.000		
Castanea sativa	Spanish Chestnut, Sweet Chestnut	1	200.000		
Cornus mas	Cornelian Cherry	3	3.565		
Cornus sanguinea	Common Dog-wood, Dogberry	18	60.781		
Cotoneaster integerrimus	Cotoneaster	1	0.004		
Crataegus laevigata	English Hawthorn	2	1.460		
Crataegus x media			0.995		
Crataegus monogyna	Single Seed Haw-thorn, Mayhaw	24	57.976		
Cryptomeria japonica	Japanese Cryptomeria	3	0.463		
Daphne laureola	Spurge Laurel	1	1.070		
Euonymus europeus	Common Spindle	26	60.568		
Fagus sylvatica	Common Beech, European Beech	37	15,250.268		

Tree species		Seeds		Pollen	
Scientific Name	Common Name	Lots	Quantity (kg)	Lots	Quantity (cm^3)
Frangula alnus	Alder Buckt-horn, Common Buckthorn	7	0.883		
Fraxinus excelsior	Common Ash, European Ash	140	420.640		
Juniperus communis	Common Juniper, Juniper	3	0.290		
Larix decidua	European Larch	572	136.821	211	821.2
Larix x eurolepis	Dunkeld Larch	74	15.100	16	79.0
Larix kaempferi	Japanese Larch	83	18.544	41	456.4
Ligustrum vulgare	Common Privet	5	3.135		
Lonicera xylosteum	Fly Honysuckle	6	0.740		
Malus sylvestris	Apple, Wild Crab	128	19.014		
Mespilus germanica	Medlar	10	44.168		
Picea abies	Common Spruce, Norway Spruce	2382	1,331.147	2	1217.0
Picea mariana	Black Spruce	1	0.031		
Picea omorika	Serbian Spruce	5	6.859		
Picea orientalis	Caucasian Spruce, Oriental Spruce	1	0.054		
Picea sitchensis	Sitka Spruce	1	0.245		
Picea smithiana	Himalayan Spruce, Morinda Spruce	1	0.001		
Pinus mugo	Dwarf Mountain Pine, Mountain Pine	7	6.100		

Tree species		Seeds		Pollen	
Scientific Name	Common Name	Lots	Quantity (kg)	Lots	Quantity (cm³)
Pinus nigra	Austrian Pine, Black Pine	80	66.757		
Pinus x rotundata	Bog Pine	24	0.300		
Pinus strobus	Eastern White Pine, Weymouth Pine	40	37.887		
Pinus sylvestris	Scots Pine	1472	466.747		
Populus tremula	Aspen	1	0.050		
Prunus avium	Grean, Mazzard, Wild Cherry	96	414.301		
Prunus mahaleb	Mahaleb Cherry, St Lucie Cherry	1	1.890		
Prunus padus	European Bird Cherry	1	0.125		
Prunus spinosa	Blackthorn, Sloe	15	92.590		
Pseudotsuga menziesii	Douglas Fir	2011	712.289	202	1771.9
Pyrus pyraster	Wild Pear	54	22.659		
Quercus petraea	Sessile Oak	2	6.000		
Quercus rubra	American Red Oak		955.000		
Rhamnus cathartica	Common Buckthorn, European Buckthorn	15	10.889		
Ribes nigrum	Blackcurrant	4	0.705		
Robinia pseudoacacia	Acacia, Black Locust, Robinia	99	20.615		

Tree species		Seeds		Pollen	
Scientific Name	Common Name	Lots	Quantity (kg)	Lots	Quantity (cm³)
Rosa canina	Common Briar, Dog Rose	4	34.610		
Rosa corymbifera	Rose	1	2.845		
Sambucus nigra	Common Elder, Elderberry	17	116.446		
Sambucus racemosa	Red Berried Elder, Red Elderberry	22	19.915		
Sciadopitys verticillata	Umbrella Pine	2	0.295		
Sequoiadendron giganteum	Giant Sequoia, Wellingtonia	112	2.434		
Sorbus aria	Whitebeam	15	43.001		
Sorbus aucuparia	Rowan, Mountain Ash	204	64.291		
Sorbus domestica	Service Tree	26	9.111		
Sorbus torminalis	Wild Service Tree	37	29.737		
Taxus baccata	Common Yew, English Yew	185	38.612		
Thuja plicata	Western Red Cedar	2	1.027		
Tilia cordata	Little Leaf Linden	141	113.144		
Tilia platyphyllos	Large-Leaved Lime	1	8.200		
Ulmus glabra	Elm, Scotch Elm, Wych Elm	148	13.474	3	27.0
Ulmus laevis	Russian Elm	42	0.737		
Ulmus minor	European Field Elm	72	11.872		

Tree species		Seeds		Pollen	
Scientific Name	Common Name	Lots	Quantity (kg)	Lots	Quantity (cm³)
Viburnum lantana	Wayfaring Tree	10	7.905		
Viburnum opulus	European Cranberrybush, Guelder Rose	14	14.995		

(BLAG-FGR 2011)

The infrastructure of *ex situ* conservation by the BLAG-FGR institutions is documented in Table 11.

Table 11: Facilities of the BLAG-FGR institutions for *ex situ* conservation (2011)

Institution	Storage of seed	Genetic laboratory	Physiological laboratory	*In vitro*	Nursery
ASP	x	x			x
FAWF	x	x			x
FVA	x	x			x
Landesbetrieb Wald und Holz NW	x				x
Landesforst MV	x				x
LFE	x		x		x
NW-FVA	x			x	x
Sachsenforst	x	x	x		x

Institution	Storage of seed	Genetic laboratory	Physiological laboratory	*In vitro*	Nursery
Thüringer Landesanstalt für Wald, Jagd und Fischerei[4]	x	x			x
Thünen-Institut	x	x	x	x	x

Table 9 shows the *ex situ* stands and areas preserved by the BLAG-FGR institutions. In addition, various institutions conduct genetic analyses (e.g. DNA, isoenzyme; Annex 9.5 and 9.5.1) as well as provenance tests (Table 16). The selection of the forest genetic resources to be preserved is based on their conservation worthiness, which is derived from the adaptability and the adaptedness of the respective species and populations to the ecological conditions of the site. The conservation urgency results from the degree of damages or endangerment.

Additionally, economic aspects and the rarity as well as the ecological, silvicultural or genetic importance of a population or species are taken into consideration. Conservation worthiness and conservation urgency are the basis for designing plans for relevant measures. The plans for future measures for selected species and populations are oriented to such aspects as changed climatic, ecological and commercial conditions.

3.2 Collection activities

Various reproductive materials are collected for the planned *ex situ* measures. Representative collections are made for larger populations of more than 20 individual trees; for smaller populations, all trees are harvested separately.

4 Since 01.01.2012: Service and Competence Center of ThüringenForst – Body governed by public law

3.3 Descriptions of the collections

In addition to the gene banks of the BLAG-FGR institutions, there are also collections in Germany operated by regional and municipal or private institutions, also including the 95 Botanical Gardens and arboretums. The Botanical Gardens cultivate roughly 50,000 species (of the approx. known 280,000 flowering plants) in their scientifically documented collections. However, these collections do not primarily serve the conservation of forest genetic resources.

3.4 Storage facilities

Due to the country's federal structure and as described in Table 11 the facilities for storage of forest genetic resources for conservation are decentralized in Germany. Table 9 and Table 10 provide an overview of the present *ex situ* objects.

Figure 19: Seed storage in a gene bank (© ASP)

3.5 Documentation and characterization

The prerequisites for targeted *ex situ* conservation are the documentation and characterization of the stored material. Characterization of genetic resources provides important information for the conservation of genetic diversity, since this is the most important precondition for the adaptability of forest tree species. The numerous results are published accordingly. A selection of current publications by the *Länder* and the Federal government on forest genetic conservation are contained in the progress reports by the BLAG-FGR.

3.6 Description of present and emerging technologies

The measures of the methods described above (*ex situ* planting, establishment of seed orchards and clonal repositories as well as storage in gene banks) are known and commonly practiced. Other possible conservation measures include *in vitro* conservation and cryo-conservation.

3.7 Transfer of germplasm

Within Germany very valuable populations are doubly safeguarded, i.e. seed is stored in two forest gene banks. Otherwise, forest reproductive material is transferred in the scope of the conservation measures by the BLAG-FGR institutions to, in most cases, governmental or private forestry holdings for the establishment of conservation areas or conservation seed orchards or own areas are established. Control of the areas established with this reproductive material remains in the hands of the respective *Länder* institutions in charge of the conservation of forest genetic resources.

3.8 Chief requirements for *ex situ* conservation

In Germany, according to the Concept for the Conservation and Sustainable Utilization of Forest Genetic Resources in der Federal Republic Germany, priority in the conservation of forest genetic resources is given to *in situ* measures (Chapter 2). *Ex situ* conservation measures are used for such populations where *in situ* measures are not effective or cannot ensure their long-term preservation. The forest ownership structure of Germany is an obstacle, with a large number of small privately owned forests. Necessary measures can only be carried out with the assent and support of the many small forest owners. In future, improved funding provisions are needed for specific conservation measures.

In order to ensure the conservation of forest genetic resources, the ongoing evaluation of genetic resources and *in situ* and *ex situ* measures for the conservation need to be safeguarded. The techniques and facilities for *ex situ* conservation in particular must be continuously developed. In addition, the most suitable conservation method for each tree species should be researched. The development of functioning genetic monitoring for tree and shrub species is necessary and should be equipped with the required financial means.

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

According to the Convention on Biological Diversity (CBD) multifunctional forest management closely combines protection and utilization of genetic resources. In real terms, for Germany this objective involves using close to nature forest management on as large as possible of the managed forest areas. Sustainability is also an important principle for domestic forestry. Sustainability encompasses economical, ecological and social aspects. Sustainable, close to nature forestry equally provides for the concerns of forest utilization, environmental protection (nature, soil and water conservation, etc.) and recreation. State measures (e.g. funding, legislation) make a chief contribution to achieving this sustainable, close to nature and multifunctional forest management. In order to also comply with the objective of protection through utilization of forest genetic resources, the findings by forest genetic research on genetic variation between provenances, stands and within stands must be taken into account in the scope of forest management.

4.1 The importance of sustainable forest management and utilization

The conservation and sustainable utilization of biological diversity, also as the basis for the stability and adaptability of forests, is an important task of forestry. Forestry and the forests play a special role for nature conservation as well as in the National Strategy on Biological Diversity (BMU 2007). The latter is supplemented by the BMEL strategy “Conservation of Agricultural Biodiversity, Development and Sustainable Use of its Potentials in Agriculture, Forestry and Fisheries” (BMELV 2007) and the jointly issued sector strategy by the forest administrations of the Federal government and the *Länder* as well as by non-governmental organizations “Strategy on Forestry and Biological Diversity” of the year 2000 (BMVEL 2001). The central objective is to combine the aspects of protection and conservation of biological diversity with sustainable forest utilization.

A high degree of genetic diversity is important for the tree species because of the individual trees' longevity and immobility in order to adapt to changing environmental influences. The conservation and sustainable utilization of forest genetic resources has therefore been the object of scientific studies and forest action in Germany for many decades.

The German government initiated the programme *Charta für Holz* (Charter for Timber) in 2004 to increase the consumption of sustainably produced timber. The objective of the Charta is to raise domestic consumption by the year 2014 to 1.3 m^3 per capita. This objective was again affirmed in the coalition agreement by the governing parties in October 2009.

Together, the enterprises and institutions in the cluster of forestry and timber employ 1.2 million people. This economic sector generated an annual turnover in 2010 of approx. 170 billion euros, whereby use of timber as energy is only taken into account in part in this figure. According to the results of the Second National Forest Inventory (BWI^2, reference year 2002) with approximately 3.4 billion m^3, a large amount of stocks have become established in Germany. Comparatively speaking, this puts Germany at top place in Europe. The causes of this great build up in stocks are manifold. The average timber increment in Germany according to the 2008 Inventory Study is 11.1 m^3/a* hectares. The point balance of timber stock, timber increment and cuts reveals that 10% more timber has grown back than was eliminated and that timber stock increased by 2% (Polley et al. 2009b).

In the year 2011 the Federal government published the Forest Strategy 2020. As a strategy for forests as a natural and economic resource, it identifies ways of reaching a sound balance between the increasing demands on the forest and its sustainable productivity. The basis for this is the coequal observance of the three dimensions of sustainability (ecological, economic and social dimensions). Sustainable utilization of the forests demand that we combine with equal weight economic productivity, ecological responsibility and social equity. In nine spheres of activity (among them climate protection, ownership, resources, biodiversity, silviculture, hunting, recreation and research) the Strategy cites existing challenges and opportunities, analyzes possible target conflicts and devises resolution approaches. The Forest Strategy addresses all relevant stakeholders at the level of the Federal government and *Länder* while at the same time contributing to promoting the necessary knowledge and understanding in the population for the diverse functions of our domestic forests as well as the benefits and opportunities provided by sustainable forestry for the climate, environment, economy and society.

4.2 The state of utilization and management of forest reproductive material

Under the FoVG 26,407 harvesting units are designated in Germany for the 28 main commercial tree species. The largest of these are stands from the category "selected" with 98% of the units of approval and 99% of area (Table 12).

In order to be approved as a seed crop stand the stands must fulfil specific demands, which are regulated by the Regulation on the Approval of Forest Reproductive Material (FoVZV). The number of trees on which seed are harvested must not fall below a minimum defined in the annex to the regulation (FoVZV, Annex 1). Harvesting may only be done in approved harvest units under the supervision of the owner and may be carried out by any forest seed and forest plant enterprise registered in the EU. In Germany, there are presently 1,662 registered forest seed and forest plant enterprises (Table 13), which can market forest reproductive material under the FoVG. The registered forest seed enterprises are private enterprises, forest owners, state forest offices and state seed extraction plants or kilns. The private enterprises and the state seed extraction plants and nurseries yield the largest share of the harvests. The harvest, processing and longer-term storage of the seed in gene banks is the responsibility of the *Länder.*

Figure 20: European beech seed stand (© ASP)

Table 12: Overview of approved basic material for forest reproductive material (as per 01.05.2008)

Category		Selected		Qualified		Tested	
Type of basic material		Stands		Seed orchards		Stands	
Tree species		number	reduced area [ha]	number	reduced area [ha]	number	reduced area [ha]
Scientific name	Common Name						
Abies alba	European Silver Fir	1,195	7,973	2	8		
Abies grandis	Giant Fir	52	43	2	2		
Acer platanoides	Norway Maple	80	60	1	3		
Acer pseudo-platanus	Sycamore Maple	726	1,083	13	22		
Alnus glutinosa	Common Alder	484	1,400	17	28	5	14
Alnus incana	Grey Alder	6	4	2	1		
Betula pendula	European Birch	96	183	1	0,1		
Betula pubescens	Downy Birch	19	44	1	2		
Carpinus betulus	European Hornbeam	212	508	1	4		
Castanea sativa	Sweet Chestnut	17	33				
Fagus sylvatica	Common Beech	5,643	76,201	4	9	12	134
Fraxinus excelsior	Common Ash	1,162	2,769	9	19		

Tested					Source identified			
Seed orchards		Clones	Clonal mixtures	Parents of Family	Seed sources		Stands	
number	reduced area [ha]	number	number	number	number	reduced area [ha]	number	reduced area [ha]
					5	1	1	1
1	3							
5	15							
					2	2	2	5

Category		Selected		Qualified		Tested	
Type of basic material		Stands		Seed orchards		Stands	
Tree species		number	reduced area [ha]	number	reduced area [ha]	number	reduced area [ha]
Scientific name	Common Name						
Larix decidua	European Larch	1,226	2,378	23	49	8	14
Larix kaempferi	Japanese	344	683	4	7		
Larix x eurolepis	Dunkeld Larch			1	4		
Picea abies	Norway Spruce	3,113	34,154	31	86	19	185
Picea sitchensis	Sitka Spruce	7	28	1	1		
Pinus nigra	Austrian Pine	162	551	4	10		
Pinus sylvestris	Scots Pine	2,629	18,012	44	173	12	92
Populus spec.	Poplars	6	7				
Prunus avium	Wild Cherry	121	131	11	22		
Pseudotsuga menziesii	Douglas Fir	2,293	3,271	9	40	4	15
Quercus petraea	Sessile Oak	3,306	31,890			13	250
Quercus robur	English Oak	2,058	8,854	5	11	5	29

Tested					Source identified			
Seed orchards		Clones	Clonal mixtures	Parents of Family	Seed sources		Stands	
number	reduced area [ha]	number	number	number	number	reduced area [ha]	number	reduced area [ha]
15	17							
2	6							
3	8							
1	10							
10	30							
		58	8	6				
			3		22	21	6	4
1	3			2				
1	1							

Category		Selected		Qualified		Tested	
Type of basic material		Stands		Seed orchards		Stands	
Tree species		number	reduced area [ha]	number	reduced area [ha]	number	reduced area [ha]
Scientific name	Common Name						
Quercus rubra	American Red Oak	443	774				
Robinia pseudoacacia	Black Locust	42	109	1	1		
Tilia cordata	Little Leaf Linden	425	837	14	26		
Tilia platyphyllos	Large-Leaved Lime	18	11	1	2		
Total		**25,885**	**191,989**	**202**	**527**	**78**	**733**

(BLE 2011)

Tested					Source identified			
Seed orchards		Clones	Clonal mixtures	Parents of Family	Seed sources		Stands	
number	reduced area [ha]	number	number	number	number	reduced area [ha]	number	reduced area [ha]
1	2							
					1	0.3		
40	**95**	**58**	**11**	**8**	**30**	**24**	**9**	**10**

Table 13: Overview of the number of forest seed and forest plant enterprises

Land	Number of enterprises								
Year	2001	2002	2003	2004	2005	2006	2007	2009	2010
Baden-Württemberg	68	69	69	111	105	129	131	139	146
Bavaria	154	147	272	269	147	161	185	185	239
Berlin					7				7
Brandenburg	70	63	83	83	146	210	234	229	263
Bremen									
Hamburg					1	1	1	2	2
Hesse	33	27	39	39	53	58	62	62	61
Lower Saxony	5	5	6	9	15	22	22	24	27
Mecklenburg-Western Pomerania	58	61	79	86	92	99	116	126	127
North-Rhine Westphalia	54	53	117	149	162	188	192	209	211
Rhineland-Palatinate	63	62	39	38	42	42	43	48	49
Saarland	6	6	6	6	6	7	7	7	7
Saxony	33	35	51	71	102	148	163	183	193
Saxony-Anhalt	47	58	58	76	84	122	135	140	148
Schleswig-Holstein	141	144	136	139	139	139	142	147	150
Thuringia	18	16	15	15	16	20	26	32	32
Germany	**750**	**746**	**970**	**1,091**	**1,110**	**1,346**	**1,459**	**1,540**	**1,662**

(BLE 2011)

In Germany, there are three *Länder* (Bavaria, Hesse and North-Rhine Westphalia) that have their own state gene bank and store genetically valuable reproductive material for longer periods. Their storage capacity is approx. 150 m³.

Table 14: State seed extraction plants /kilns in Germany

Land	Location
Baden-Württemberg	Nagold
Bavaria	Laufen
Bavaria	Bindlach
Hesse	Hanau-Wolfgang
Lower Saxony	Jatznik
Mecklenburg-Western Pomerania	Oerrel
North-Rhine Westphalia	Arnsberg
Rhineland-Palatinate	Trippstadt
Saxony	Flöha
Saxony-Anhalt	Annaburg
Thuringia	Fischbach

There are 11 state (Table 14) and 2 private seed extraction enterprises for short-term to medium-term storage of reproductive material and for continuous supply of the market in Germany. Presently 3,035 enterprises with a total area of almost 22,600 hectares (Table 15, Figure 21) grow woody plants for forestry and the “open landscape”.

Table 15: Nurseries and nursery areas

Attribute		Unit	Year		
			2000	2004	2008
Enterprises with nursery areas		Quantity	3,779	3,398	3,035
Nursery areas		Hectares	24,690	25,520	22,597
- ornamental shrubs		Hectares	12,341	11,310	12,146
- coniferous trees for Christ-mas tree cultures		Hectares		2,537	1,203
- forest plants		Hectares	3,349	2,519	2,258
of which	Coniferous trees not including Christmas tree cultures	Hectares		1,017	907
	Deciduous trees	Hectares		1,501	1,351
other nursery areas		Hectares	7,642	7,535	5,537

(Federal Statistical Office 2010)

Enterprises that produce forest plants for the forestry sector are subject to state controls and are obliged to prove the movement of goods.

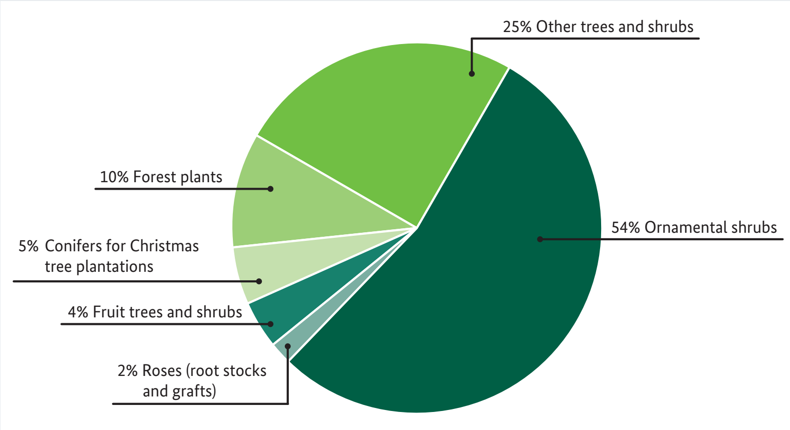

Figure 21: Nursery areas according to use types 2008
(Federal Statistical Office 2008)

Table 16: Provenance tests by the *Länder* or BLAG-FGR institutions (2010)

Scientific Name	Common Name	Provenance tests carried out by
Abies alba	European Silver Fir	BY, BW, SN, RP, NW-FVA
Abies grandis	Giant Fir, Grand Fir	BB, BY, NW-FVA, Thünen-Institut
Abies nordmanniana	Caucasian Fir	RP
Abies procera	Noble Fir	BY, NW-FVA
Acer pseudoplatanus	Sycamore	BB, BY, SN
Alnus glutinosa	Common Alder, European Alder	Thünen-Institut
Betula maximowicziana	Monarch Birch	Thünen-Institut
Betula pendula	European Birch, Silver Birch	BY, Thünen-Institut

Scientific Name	Common Name	Provenance tests carried out by
Betula pubescens	Downy Birch	BY
Castanea sativa	Spanish Chestnut, Sweet Chestnut	RP
Fagus sylvatica	Common Beech, European Beech	BB, BW, BY, SN, RP, MV, NW-FVA, NW, Thünen-Institut
Fraxinus excelsior	Common Ash, European Ash	BB ,BW, BY, NW-FVA
Larix decidua	European Larch	BB, BY, MV, SN, Thünen-Institut
Larix kaempferi	Japanese Larch	Thünen-Institut
Malus sylvestris	Apple, Wild Crab	RP
Picea abies	Common Spruce, Norway Spruce	BW, BY, SN, MV, NW-FVA, TH, Thünen-Institut
Picea sitchensis	Sitka Spruce	NW-FVA, Thünen-Institut
Pinus contorta	Lodgepole Pine, Shore Pine	BY, Thünen-Institut
Pinus nigra	Austrian Pine, Black Pine	BB, BY, Thünen-Institut
Pinus ponderosa	Ponderosa Pine	BY
Pinus strobus	Eastern White Pine, Weymouth Pine	BB
Pinus sylvestris	Scots Pine	BB, BY, RP, MV, NW-FVA, Thünen-Institut
Populus tremula	Aspen	RP
Prunus avium	Gean, Mazzard, Wild Cherry	BW, BY, SN, RP

Scientific Name	Common Name	Provenance tests carried out by
Pseudotsuga menziesii	Douglas Fir	BB, BW, BY, SN, RP, MV, NW-FVA, NW, TH, Thünen-Institut
Pyrus pyraster	Wild Pear	RP
Quercus petraea	Sessile Oak	BB, BY, NW-FVA, RP, Thünen-Institut
Quercus robur	English Oak, Oak, Pedunculate Oak	BW, NW-FVA, RP, NW
Quercus rubra	American Red Oak	Thünen-Institut
Robinia pseudoacacia	Acacia, Black Locust, Robinia	NW-FVA, Thünen-Institut
Sequoiadendron giganteum	Giant Sequoia, Wellingtonia	RP, Thünen-Institut
Sorbus domestica	Service Tree	BY, RP, NW-FVA
Taxus baccata	Common Yew, English Yew	BW, RP
Tilia cordata	Little Leaf Linden	BY, SN, RP, NW-FVA

(BLAG-FGR 2011)

The merely forest tree nurseries (425 enterprises in 2008) annually produce approximately 150 - 185 million plants. At present provenance tests are underway for 33 tree species (Table 16). These experiments test the tree species or provenances for their cultivation worthiness under various site conditions and are the basis for provenance recommendations. Progeny testing serves the approval of the material of the category “tested” under the FoVG and/or are an initial selection stage for further breeding measures (crossbreeding, *in vitro* propagation).

For the production of genetically higher quality reproductive material, following phenotypic selection of the parent trees either seedling or clone seed orchards are established as production seed orchards for the main commercial tree and shrub species or as gene conservation seed orchards for the rare tree and shrub species.

Presently seed orchards for tree and shrub species cover a total area of almost 800 hectares in Germany (Table 17). In addition to seed orchards for tree species (215), shrub seed orchards are gaining importance, as based on the provisions of the Federal Nature Conservation Act (Chapter 5.2) the demand for native shrubs of regional provenance for planting in the "open landscape" will increase.

Table 17: Number and area of seed orchards as well as number of clonal archives per tree and shrub species (2010)

Tree or Shrub Species		Seed Orchards		Clone Archives
Scientific Name	Common Name	Quantity	Area (ha)	Quantity
Abies alba	European Silver Fir	14	29.45	160
Abies grandis	Giant Fir, Grand Fir	2	2.32	
Abies procera	Noble Fir	2	3.00	
Acer campestre	Field Maple, Hedge Maple	2	3.30	
Acer monspessulanum	Montpelier Maple	1	0.05	
Acer platanoides	Norway Maple	5	6.10	12
Acer pseudoplatanus	Sycamore	21	33.20	174
Alnus glutinosa	Common Alder, European Alder	24	38.11	1

Tree or Shrub Species		Seed Orchards		Clone Archives
Scientific Name	Common Name	Quan-tity	Area (ha)	Quantity
Alnus incana	Grey Alder	2	1.00	
Amelanchier ovalis	Snowy Mespilus, European Juneberry	1	0.05	
Berberis vulgaris	Common Barberry	1	0.05	
Betula pendula	European Birch, Silver Birch	7	5.60	325
Betula pubescens	Downy Birch	14	13.50	127
Buxus sempervirens	Boxwood, Com-mon Box	1	0.05	
Carpinus betulus	Common Horn-beam, European Hornbeam	2	4.50	1
Castanea sativa	Spanish Chest-nut, Sweet Chestnut			1
Cornus mas	Cornelian Cherry	1	0.05	
Cornus sanguinea	Common Dog-wood, Dogberry	2	0.65	
Corylus avellana	Cob, Hazel	3	0.45	
Cotoneaster integerrimus	Cotoneaster	1	0.05	
Crataegus x media		1	0.05	
Crataegus monogyna	Single Seed Hawthorn, Mayhaw	3	1.07	

Tree or Shrub Species		Seed Orchards		Clone Archives
Scientific Name	Common Name	Quantity	Area (ha)	Quantity
Daphne laureola	Spurge Laurel	1	0.07	
Euonymus europeus	Common Spindle	6	2.05	
Fagus sylvatica	Common Beech, European Beech	12	17.80	234
Frangula alnus	Alder Buckthorn, Common Buckthorn	1	0.05	
Fraxinus excelsior	Common Ash, European Ash	14	24.00	1
Juglans regia	English Walnut, Persian Walnut	3	3.10	
Juniperus communis	Common Juniper, Juniper	1	0.40	
Larix decidua	European Larch	39	69.12	447
Larix x eurolepis	Dunkeld Larch	6	14.70	83
Larix kaempferi	Japanese Larch	9	18.26	414
Ligustrum vulgare	Common Privet	1	0.05	
Lonicera xylosteum	Fly Honysuckle	1	0.05	
Malus sylvestris	Apple, Wild Crab	14	11.51	42
Mespilus germanica	Medlar	4	0.65	
Picea abies	Common Spruce, Norway Spruce	26	89.60	318
Picea omorika	Serbian Spruce	1	0.80	
Picea sitchensis	Sitka Spruce	1	1.00	

Tree or Shrub Species		Seed Orchards		Clone Archives
Scientific Name	Common Name	Quan-tity	Area (ha)	Quantity
Pinus nigra	Austrian Pine, Black Pine	1	2.00	37
Pinus x rotundata	Bog Pine	1	1.00	40
Pinus strobus	Eastern White Pine, Weymouth Pine	3	2.30	
Pinus sylvestris	Scots Pine	45	83.84	296
Populus alba	White Poplar			3
Populus x canescens	Grey Poplar			43
Populus nigra	Black Poplar	1	1.00	20
Populus tremula	Aspen	2	3.40	312
Populus sp.	Poplar-hybrid,			1
Prunus avium	Gean, Mazzard, Wild Cherry	29	45.10	173
Prunus mahaleb	Mahaleb Cherry, St Lucie Cherry	1	0.05	
Prunus padus	European Bird Cherry	2	0.10	
Prunus spinosa	Blackthorn, Sloe	5	2.05	
Pseudotsuga menziesii	Douglas Fir	31	100.60	4
Pyrus pyraster	Wild Pear	12	10.10	29
Quercus petraea	Sessile Oak	9	8.06	310
Quercus robur	English Oak, Oak, Peduncula-te Oak	12	27.10	2

Tree or Shrub Species		Seed Orchards		Clone Archives
Scientific Name	Common Name	Quantity	Area (ha)	Quantity
Quercus rubra	American Red Oak	1	0.70	
Rhamnus cathartica	Common Buckthorn, European Buckthorn	5	2.35	
Ribes nigrum	Blackcurrant	1	0.05	
Robinia pseudoacacia	Acacia, Black Locust, Robinia	2	0.90	37
Rosa canina	Common Briar, Dog Rose	3	1.28	
Salix alba	White Willow			2
Salix aurita	Eared Willow	1	0.05	2
Salix cinerea	Grey Willow			2
Salix daphnoides	Violet Willow			2
Salix fragilis	Crack Willow			2
Salix pentandra	Bay Willow, Laurel Willow			2
Salix purpurea	Purple Osier, Purple Willow			4
Salix repens	Creeping Willow			2
Salix viminalis	Common Osier, Osier			54
Salix sp.				1
Sequoiadendron giganteum	Giant Sequoia, Wellingtonia	1	0.10	1

Tree or Shrub Species		Seed Orchards		Clone Archives
Scientific Name	Common Name	Quan-tity	Area (ha)	Quantity
Sorbus aria	Whitebeam	5	4.30	
Sorbus aucuparia	Rowan, Moun-tain Ash	7	7.20	
Sorbus domestica	Service Tree	4	3.89	2
Sorbus torminalis	Wild Service Tree	11	12.18	4
Taxus baccata	Common Yew, English Yew	3	1.60	255
Tilia cordata	Little Leaf Linden	25	43.10	219
Tilia platyphyllos	Large-Leaved Lime	7	8.80	2
Ulmus glabra	Elm, Scotch Elm, Wych Elm	9	9.50	317
Ulmus laevis	Russian Elm	4	6.80	3
Ulmus minor	European Field Elm	4	5.50	54
Viburnum lantana	Wayfaring Tree	1	0.05	
Viburnum opulus	European Cranberrybush, Guelder Rose	4	1.07	
Vitis vinifera	Common Grape Vine	1	0.05	

(BLAG-FGR 2011)

4.3 Transfer of germplasm

Under the general declaration of the Third Ministerial Conference on the Protection of Forests in Europe (MCPFE 1998) in Lisbon preference should be given to the use of reproductive material of native species and local provenance well adapted to the site conditions for afforestation and re-afforestation. In Germany, the *Länder* have drawn up provenance recommendations. The provenance recommendations address all forest owners. They are binding for the use of reproductive material in state-owned forests. In municipal and private forests the choice of provenances is controlled via the support guidelines: funding in most *Länder* is only granted on adherence with the respective provenance recommendations of the *Länder*. Within the EU there are basically no restrictions for trade with reproductive material as long as it adheres with the provisions of Directives 1999/105/EC[5] and 2000/29/EC (plant protection)[6].

According to the Council Decision of 16 December 2008 on the equivalence of forest reproductive material produced in third countries (2008/971/EC)[7] (OJ L 345 of 23.12.2008. page 83) it is possible to import reproductive material for all tree species governed by the FoVG from certain third countries that have signed the OECD Scheme. Prior to importing an import notice must be submitted to the responsible office, in Germany the BLE, of the importing Member State.

The FoVG (Article 8) divides forest reproductive material into the following four categories:

Selected:	Stands
Qualified:	Seed orchards
Tested:	Stands, seed orchards, family parents, a clone or a mixture of clones
Source identified:	Seed sources (individual trees, tree groups)

5 OJ L 11 of 15.01.2000, page 17
6 OJ L 169 of 10.07.2000, page 1
7 OJ L 345 of 23.12.2008, page 83

Table 18: Harvest quantities of the years 2000 - 2010 of tree species and categories from the seed qualities governed by the FoVG

Tree species		Quantity harvested per Category (kg)				Total quantity harvested (kg)
Scientific Name	Common Name	Selected	Qualified	Tested	Source identified	
Abies alba	European Silver Fir	44,096	5			44,101
Abies grandis	Giant Fir, Grand Fir	3,179	206			3,385
Acer platanoides	Norway Maple	11,128	234		2,296	13,658
Acer pseudoplatanus	Sycamore	100,054	3,372	261		103,687
Alnus glutinosa	Common Alder, European Alder	4,369	889	70		5,328
Alnus incana	Grey Alder	16	19			35
Betula pendula	European Birch, Silver Birch	2,681	682		8	3,381
Betula pubescens	Downy Birch	249	196	134		579
Carpinus betulus	Common Hornbeam, European Hornbeam	36,011	1,112		4,809	41,932
Castanea sativa	Spanish Chestnut, Sweet Chestnut	39,795			27	39,222
Fagus sylvatica	Common Beech, European Beech	1,221,816		19,398		1,241,214

Tree species		Quantity harvested per Category (kg)				Total quantity harvested (kg)
Scientific Name	Common Name	Selected	Qualified	Tested	Source identified	
Fraxinus excelsior	Common Ash, European Ash	39,147	1,421			40,568
Larix decidua	European Larch	2,918	755	308		3,981
Larix x eurolepis	Dunkeld Larch	125	3	785		913
Larix kaempferi	Japanese Larch	1,747	23			1,770
Picea abies	Common Spruce, Norway Spruce	10,865	299	58		11,222
Picea sitchensis	Sitka Spruce	107	6			113
Pinus nigra	Austrian Pine, Black Pine	280	132			412
Pinus sylvestris	Scots Pine	3,204	1,425	651		5,280
Prunus avium	Gean, Mazzard, Wild Cherry	49,311	34,524		111,732	195,567
Pseudotsuga menziesii	Douglas Fir	10,050	548	446	13	11,057
Quercus petraea	Sessile Oak	2,284,646	192	36,103	6,281	2,327,222
Quercus robur	English Oak, Oak, Pedunculate Oak	1,863,914		8,364	247	1,872,525
Quercus rubra	American Red Oak	648,919			3,312	652,231

Tree species		Quantity harvested per Category (kg)				Total quantity harvest-ed (kg)
Scientific Name	Common Name	Selected	Quali-fied	Tested	Source identified	
Robinia pseudoacacia	Acacia, Black Locust, Robinia	1,938	180			2,118
Tilia cordata	Little Leaf Linden	21,959	463	30		22,452
Tilia platyphyllos	Large-Leaved Lime	741	30		1,003	1,774

(BLE 2011)

Reproductive material with improved cultivation value (categories “qualified” and “tested”) plays a subordinate role in comparison with material from the category “selected” because of the lower number of units of approval on the market. The reason for the low share of the two categories in the units of approval are the high costs of establishing seed orchards and the long testing duration (up to 20 years depending on the tree species) for the approval of material of the category “tested”.

In Germany, the transfer of reproductive material from the category “source identified” to end consumers is only temporarily permitted for non-forestry purposes (FoVG). Until 2012 reproductive material in this category from the tree species European hornbeam, European birch, downy birch (*Betula pubescens*), black locust, Norway maple, large-leaved lime and wild cherry that is not intended for forestry purposes may be harvested and marketed.

Some conclusions on the availability of forest reproductive material can be drawn from the harvest amounts (Table 18). There is however no information available about the quantities of germplasm stored in Germany. Harvesting of pollen is not governed by the FoVG and is therefore not recorded in any statistics. The demand for cones for decorative purposes is negligibly small. The forest nursery sector produces an average of 150 - 187 million plants annually.

4.4 The state of breeding programmes

There are no national breeding programmes in Germany. The individual forest research institutions handle the various stages of forest plant breeding according to their equipment and capacities.

The focus of forest plant breeding is the selection and testing of stands. There are seed stands from the category "tested" (Table 18) of roughly one third of the tree species governed by the FoVG, including all main tree species. At present, breeding of forestry plants for energy timber in short rotation is operated most intensively, in particular with poplars for which various breeding programmes are underway involving crossbreeding, preliminary testing and clonal selection. The attributes used for selection are primarily vigour, resistance and tolerance to abiotic influences. The production of hybrid aspens is the focus for poplars from the section Populus, with the objective of approval for parent trees. At present the poplars are being bred in a project funded by the BMEL through the *Fachagentur Nachwachsende Rohstoffe e.V.* (Agency for Renewable Resources) called FastWOOD (*Züchtung schnellwachsender Baumarten für die Produktion nachwachsender Rohstoffe im Kurzumtrieb* – Breeding of fast growing trees for the production of renewable raw materials in short rotation) in the forest research institutes of the Federal government and the *Länder*. FastWOOD includes the breeding of willows however with less emphasis than the breeding of poplars. Furthermore willows are being bred by the project *Neuzüchtung und Erprobung bisher nicht registrierter Weidenklone und –sorten* (Breeding and testing of new willow clones and varieties which are not yet registered). Breeding of willows will soon be integrated completely in the combined project "FastWOOD II". Besides volume production the focus of wild cherry breeding is high-grade timber production. Plus trees are selected and cloned in progeny tests. A similar procedure applies for the black locust and, to a lesser extent, the European and downy birch, for which the plus trees are selected in stands. Clonal tests were set up for the tree species wild cherry and acacia.

Among coniferous trees, hybrid breeding of the European and Japanese larches (*Larix kaempferi*) has made the most progress. There are two breeding programmes. One conducts controlled crossbreeding of defined selected trees of both species (incomplete diallels), the other only selects the parent trees of the

European larch (top or polycross). In progeny testing the best sires are identified, which are put together in seed orchards. The objective is utilization of the F1 generation, which has distinguished itself through superior growth and great site tolerance. In the case of the Scots pine crossbreeding plus trees of various provenances has led to superior growth. The possibility of improving growth performance and quality through crossbreeding in the Scots pine, but also in many other tree species, is high. However this potential has hardly been taken advantage of in Germany. The next necessary step in the existing progeny testing with Scots pine is to select plus trees with which seed orchards or breeding populations can be established. There was an elaborate selection programme for the common spruce; which was no longer pursued and given up due to changes in the silvicultural provisions. Hence, the parent plants for the production of clones were no longer managed.

Figure 22: Wild cherry silvaSELECT® (© NW-FVA)

In the past, the breeding programmes were designed for increasing growth production and quality as well as resistance to pests. In future, adaptability and stress tolerance or resilience will be important objectives in breeding. A field that has not yet been researched in depth is important ingredients for naturopathy in forest genetic resources.

4.4.1 Information systems on breeding programmes

In recent years forestry research institutes of the Federal government and the *Länder* were involved in two collaborative research projects, which set up information systems on breeding research. A project with 27 partners (TreeBreedex) funded by the EU within the Sixth Framework Programme set up a Europe-wide virtual research and development centre for forest plant breeding. The project compiled the status of activities with regard to forest plant breeding of the tree species common spruce, Sitka spruce (*Picea sitchensis*), Scots pine, Larch, Douglas fir, Poplar, Ash, sycamore and wild cherry. In addition, a website was designed and an information forum and databases were set up. Further results will be published soon.

At the national level the joint project FastWOOD, among others, is setting up an Internet portal (www.fastwood.org) that makes project results accessible.

4.5 Description of present and emerging technologies

Selection and cross breeding are presently the most common methods of forest plant breeding. The selection of seed crop stands according to phenotype is a simple form of selection breeding. The same applies to the selection of plus trees for establishing seed orchards based solely on phenotypes. Cross breeding combines trees (intraspecific, i.e. between provenances of a species or interspecific, i.e. between different species) with very specific (desirable) attributes. Using cross breeding, progenies can be bred that would not occur naturally. Compared with pure selection, cross breeding offers considerably more possibilities for improving the properties of trees.

Tissue culture is established for the conservation of clones and is used by some institutes for series production. Embryo rescue and the use of mentor pollen are increasingly being employed in forest plant breeding. At present the prerequisites for future marker-based selection are being examined (QTL, marker genes).

Figure 23: DNA-Analysis with Polymerase Chain Reaction (PCR; © NW-FVA)

Genetic engineering is not used in forest tree breeding. However it is used for forestry research purposes by two institutions in Germany.

4.6 National seed improvement programme

There is no national seed quality improvement programme. Some of the seed extraction plants/kilns of the *Länder* conduct experiments to improve the storage capacity of heavy-fruited seeds and increase the germination capacity of the seeds with special cleaning techniques.

4.7 Chief requirements for improving the sustainable utilization and management of forest genetic resources

The global increase in demand for raw materials and other exigencies will increase the demands on the forests in future. Climate change might additionally burden them. The forest is already an indispensable supplier of raw material today and, together with the processing industry (forestry and timber cluster), is a nationally important economic factor. It is gaining increasing importance again as a local, sustainably useable energy source due to the use of firewood.

Successful forest plant breeding is based on the retention of broad genetic diversity. The possibilities to develop suitable reproductive material through forest plant breeding in the light of climate change to use these for forest management must be intensified through the provision of financial and human resources. The research institutes need to be enabled to extend their breeding work to more than the tree species they have been working on to date. In view of the limited budgetary means available, priorities need to be set by the institutions involved.

Forest owners who possess suitable seed stands should, in addition to the tenancy revenues, be given incentives via financial assistance to manage the stands so as to ensure the longest possible harvesting capacities. Besides tenancy revenues for seed stands, owners of forest genetic resources are presently not granted any other shared benefits.

One enduring task will be to continuously educate and retrain all forestry personnel in all subject matter relevant to forest management. In addition, the forest practitioners need to be better informed of the improved cultivation value (adaptedness, health and resistance, volume growth, timber quality, form and habitus) of forest reproductive material of the category “tested”. Genetic diversity in the forests is not impaired by utilization of tested reproductive material in the scope of a balanced silvicultural scheme. The topic of forest genetics and forest plant breeding must become and remain a central theme of forest education, further education and training in times of changing environmental conditions and the threat of resource shortages. The forestry professions must be taught that the choice of reproductive material decisively determines the success and therefore the survival of enterprises as well as the adaptability of forests.

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

Under the impression of increasing, novel forest damages in the 1980s and the endangerment to genetic diversity linked to it, in 1987 a Concept for the Conservation of Forest Genetic Resources in the Federal Republic of Germany (BLAG 1989) was produced. This Concept was revised thoroughly in 2000 and adapted to the changed national and international conditions (Paul et al. 2000). In 2010, an updated version was published (Paul et al. 2010) which serves as a National Programme for Forest Genetic Resources.

5.1 National Programme for Forest Genetic Resources

The National Programme identifies measures serving the conservation and sustainable utilization of the forests in future. Based on the importance of genetic diversity and the threats to the genetic constitution of tree and shrub species, it describes the measures and activities necessary for the conservation and sustainable use of forest genetic resources. The objectives are to continue to preserve the inter- and intraspecific diversity of tree and shrub species, to sustainably utilize forest genetic resources, to re-establish viable populations of endangered tree and shrub species and to contribute to the conservation and re-establishment of diverse forest ecosystems.

Implementation of the cited measures is the task of the *Länder* and is administrated by the competent forest institutions of the *Länder*. The BLAG-FGR coordinates the implementation of the measures and research activities for the conservation of forest genetic resources in Germany. The Information and Coordination Centre for Biological Diversity *(Informations- und Koordinationszentrum für Biologische Vielfalt IBV)* at the BLE supports the BLAG-FGR. Reports are made

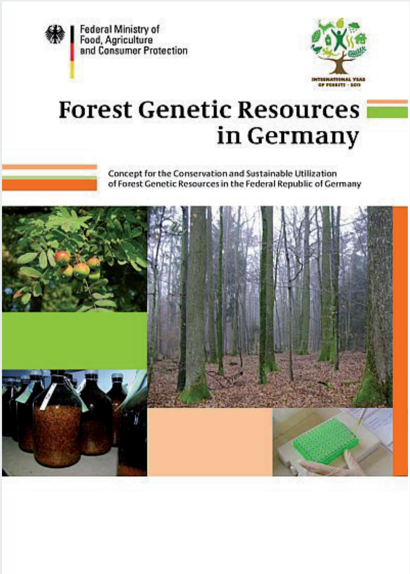

Figure 24: Cover of the National Programme

every four years on the work of the BLAG-FGR and the implementation of the measures.

Because of the distribution of work between the Federal government and *Länder* and the diversity of the stakeholders it is not possible to provide a complete overview of the financial framework. Public funding for measures for the conservation of forest genetic resources comes from the budgets of the Federal government and the 16 *Länder*. Some individual *Länder* have specific programmes with their own budget appropriations for the conservation of forest genetic resources. A large part of the funds used for the conservation of forest genetic resources is, however, tied up in the human resource budgets of the involved institutions. The Federal government supports the conservation of forest genetic resources by research funding (Chapter 5.3) as well as through various support measures. These are augmented by EU programmes and include

- the funding of model and demonstration projects, e.g. for the conservation and innovative utilization of biological diversity as well as the implementation of inventories and surveys of biological diversity by the BMEL;

- the EU Forest Focus Regulation (no longer in force), in the scope of which a method for genetic monitoring was devised;

- the EU LIFE+ Regulation;

- the support guidelines for the Federal Programme on Biological Diversity published on 26 January 2011 by the BMUB, which could open up future perspectives for the conservation of forest genetic resources and

- the funding priority announced on 19 May 2011 by the *Fachagentur Nachwachsende Rohstoffe e. V.* as a project-executing organization of the BMEL on “Present Breeding Strategies for Renewable Resources”, which explicitly contains the breeding of fast-growing tree species for forestry and for short rotation plantations as well as the production of tested forest reproductive material.

Among the chief stakeholders are the institutions cited above collaborating in the BLAG-FGR. Research concerning forest genetic resources is additionally conducted by universities and universities of applied science (Chapter 5.3). The implementation of *in situ* measures for the conservation of forest genetic resources in the scope of forest management is the responsibility of the private, municipal and state forest owners. Private and municipal forest owners are able to take advantage of the forest authorities’ consulting, technical support and training programmes.

Among the non-governmental organizations, the activities of the *Schutzgemeinschaft Deutscher Wald e.V.* (SDW) are specifically aimed at forest conservation. It carries out practical projects as well as public relations and youth work. The *Kuratorium Baum des Jahres* (= Tree of the year, KBJ) presents one specific tree species to the public each year. In addition, organizations such as the *Deutsche Dendrologische Gesellschaft e.V.* (DDG), *Eibenfreunde f.V.*, *Förderkreis Speierling*, the *Interessengemeinschaft Edelkastanie* and the *Interessengemeinschaft Nuss*[8] advocate the conservation of forest genetic resources nationwide. At the regional level nature conservation organizations such as the *GRÜNE LIGA Sachsen e.V.* also work for the conservation of rare tree species. The NABU conducts projects such as those for the conservation of the black poplar.

8 Eibenfreunde etc.: Organisations supporting the conservation of the common yew, the service tree, the sweet chestnut and walnut species respectively.

Figure 25: Common yew in a European beech forest (© K. Kahlert, Ruhla)

Nature conservation organizations are particularly involved in the area of habitat and species protection, also in the forests. The implementation of concrete measures is usually carried out by local nature conservation organizations and their largely voluntary members. The BUND, NABU and WWF are nature conservation associations active nationwide; the DNR acts as the umbrella organization for many groups involved in nature conservation. Trees and shrubs can profit from habitat management measures aimed at specific animal and plant species even when they are not the target species of the projects.

5.1.1 Information systems

a) Information systems providing information about forest genetic resources specifically:

***Informationssystem Genetische Ressourcen* (GENRES)**

GENRES (http://www.genres.de/) is operated by the IBV at the BLE as an information platform on agricultural biodiversity. It supports implementation of the BMEL strategy "Conservation of Agricultural Biodiversity, Development and Sustainable Use of its Potentials in Agriculture, Forestry and Fisheries" as well as that of the National Programmes on plant, animal, forest and aquatic genetic resources.

FGRDEU – *Bestände forstgenetischer Ressourcen in Deutschland*

The FGRDEU database is the national inventory of forest genetic resources in Germany (http://fgrdeu.genres.de/) drawn up jointly by the Federal government and *Länder*. It provides extensive information on genetic conservation measures for tree and shrub species and is operated as a joint project by the BLAG-FGR and by the IBV at the BLE. The data are regularly updated and enhanced.

Progress reports by the Federal government/*Länder* Working Group "Forest Genetic Resources and Legislation on Forest Reproductive Material" (BLAG-FGR)

The progress reports by the BLAG-FGR (http://blag-fgr.genres.de/index.php?id=270) are drawn up at four-year intervals and provide an overview of the work done.

Databases on surveys of rare tree species

To date, nationwide surveys have been completed on the occurrence of black poplar and native elm species. A survey project of ten more tree species is underway. The mapping results are compiled in nationwide databases and provided to the *Länder*.

Crop Authorization Registers of the *Länder*

Under Article 6 of the Act on Forest Reproductive Material, units of approval (seed stands, seed orchards, clones and clonal mixtures) must be kept in registers by the competent *Länder* offices. The registers are accessible to all. In some *Länder* the Crop Authorization Registers (*Erntezulassungsregister*, EZR) can also be accessed and researched on the Internet.

Erhebung zur Versorgungssituation mit forstlichem Vermehrungsgut
(Survey of the forest reproductive material supply situation)

The BLE provides the annual survey of the forest reproductive material supply situation in Germany. The documents can also be downloaded from the Internet.

b) Other national data sources:

Forest-related data are recorded in a number of periodical surveys. Due to the constitutional distribution of competencies, inventories and surveys are chiefly the responsibility of the *Länder*; the Federal government coordinates them and draws up evaluations at the federal level.

***Bundeswaldinventur* (BWI, National Forest Inventory)**

According to its statutory mandate (Article 41a of the Federal Forest Act, BWaldG) every ten years the BWI records the large-scale forest conditions and forest production capabilities in all types of forest ownership according to a uniform procedure. It thereby provides information concerning such aspects as the forest area, the tree species and age composition, increment, fellings, deadwood, carbon stocks, the structure of the forests and changes to these parameters. The sample grid has a width of a maximum of 4 km and the *Länder* densify this as needed; at present 22% are doubled and 32% quadrupled. The first National Forest Inventory was conducted in the reference year 1987, the second in reference year 2002. In 2008 an inventory study was carried out for greenhouse gas reporting. Outdoor surveying for the next National Forest Inventory with reference year 2012 commenced in April 2011 and results will be available at the beginning of 2015. Between the National Forest Inventories the BMEL can survey additional data for greenhouse gas reporting under the FCCC and the Kyoto protocol.

***Forstliches Umweltmonitoring* (Environmental Monitoring of Forest Ecosystems)**

The environmental monitoring of forest ecosystems is a forest-related system of environmental observation. It conducts long-term studies harmonized Europe-wide on the condition of the forests and on impacts on the forests caused by natural and anthropogenic influences. It encompasses periodic surveys over systematic sample grids (annual forest condition survey on a 16 x 16 km grid; to date two forest soil condition surveys 1987 - 1993 as well as 2006 - 2008 on an 8 x 8 km grid) and intensive monitoring on permanent observation plots.

Groundwork has been laid for genetic monitoring, but has not yet been part of regular surveys.

Database Naturwaldreservate in Deutschland
(Natural Forest Reserves in Germany)

The database presently (as of: 28.07.2011) documents 721 natural forest reserves with an area of 31,701 hectares. Each reserve is described via a number of data (administrative information, area size, geographical coordinates, forest communities, tree species, potential natural vegetation, soil characteristics, overlaps with other protection categories, etc.).

Chief requirements for the development and improvement of information systems

The continuous further development of the FGRDEU and implementation of genetic monitoring are deemed urgent.

5.1.2 Networks

The following Table 19 provides an overview of existing networks and their respective main tasks.

Table 19: Networks and their main tasks

Network: *Gütegemeinschaft für forstliches Vermehrungsgut e.V.* (DKV)
Tasks and objectives: The DKV is a private-law association of important forest seed and forest plant enterprises, forest owners and forest administrations. In line with the Agenda 21 resolved by the UNCED Conference in Rio in 1992 it serves sustainable development in forestry and contributes to preserving and improving the productivity and the stability of forests through the use of genetically high quality reproductive material.

The DKV pursues the objective of ensuring the quality of forest reproductive material and promoting the use of suitable, genetically high quality provenances for the conservation and improvement of the productivity and stability of the forests. For this purpose, the DKV has the tasks of:

- selecting particularly high quality materials (usually stands and seed orchards) for production of forest reproductive material (special provenances) and giving them a seal of quality,
- monitoring that users of quality seals adhere to the quality seal bylaws including the implementing rules,
- obligating quality seal users to only label quality-assured products with the quality seal.

Network:
Sektion Forstgenetik und Forstpflanzenzüchtung der DVFFA

Tasks and objectives:
The "Forest Genetics/Forest Plant Breeding" section of the *Deutscher Verband forstlicher Forschungsanstalten* (German Federation of Forest Research Institutes, DVFFA) was founded on 17 September 2009. As the ninth independent section of the DVFFA it was established as a forum for knowledge sharing and transfer between basic and applied research and between science and practice in the areas of forest plant breeding, molecular-genetic basic research, applied population-genetic research, forest genetic conservation, provenance research, seeds etc.
It has set itself the following objectives:

- Exchange of scientific (content, methodology) findings in all areas of forest genetics and forest plant breeding (basic and application-oriented)
- Platform for future collaboration by (young) scientists of all institutions in German-speaking countries
- Joint organization of professional conferences involving forestry practice and neighbouring disciplines/sections
- Development of joint research projects
- Public relations on the subject matter

Network:
Scientific Advisory Board on Biodiversity and Genetic Resources at the BMEL

Tasks and objectives:
The task of the Scientific Advisory Board on Biodiversity and Genetic Resources is to advise the BMEL concerning general and fundamental issues of the conservation and sustainable utilization of biological diversity, in particular the genetic resources for food, agriculture and forests as elements of biological diversity as well as relevant measures at the national, EU and international level.
It focuses in particular on the following issues:

- Biological and ecological basic principles
- Economic, social and ethic evaluation
- Development of science and technology, including genetics and breeding
- Land use, landscaping and rural regions
- Importance for resources, energy, nutrition and health
- Funding strategies and schemes
- Legal issues
- Information and communication, marketing

Network:
Arbeitsgemeinschaft der Länderinstitutionen für Forstpflanzenzüchtung

Tasks and objectives:
The working group's task is to coordinate the experimental work of the *Länder* institutions for forest seed and plant breeding. For this purpose, the following work is done:

- Planning, material procurement and establishment of new joint experiments
- Supervision and joint inventory and evaluation of existing experiments
- Taking up the function of a board of experts for the approval of basic material for "Tested Reproductive Material" in line with paragraphs 2.5.2 and 2.5.9 of the recommendations of the joint expert committee of the *Länder* for implementation of the FoVG

- Collaboration in publications concerning basic principles of forest plant breeding, forest research and test results (e.g. the informative series "Tested Reproductive Material" in *AFZ/Der Wald*, which has issued six articles)
- Drawing up and episodic updating of a manual on "Establishing and supervising field experiments"
- Exchanging information e.g. on mutual support in the updating of provenance recommendations of the represented *Länder* or on the participation of a number of members in projects (e.g. TreeBreedex) or in conjunction with conferences at the national and international level

Network:
Federal government/*Länder* Working Group "Forest Genetic Resources and Legislation on Forest Reproductive Material" (BLAG-FGR)

Tasks and objectives:
In Germany, work on the conservation of forest genetic resources has been coordinated by a Federal government/*Länder* Working Group since 1985. The BLAG-FGR implements the projects set down in the National Programme in coordinating the cooperation between the institutions involved based on four-year measure plans. Some of the main fields of work are

- identification and evaluation of existing forest genetic resources,
- *in situ* measures (natural regeneration. conservation of stands and individual trees, sowing and planting in the forest),
- *ex situ* measures (evacuation, genetic conservation seed orchards, gene banks),
- conservation in the scope of utilization (regeneration, stand management, timber harvesting) and
- drawing up joint research topics.

The objective of this work in forest genetic resources is to continue to conserve the diversity of species and diversity within tree and shrub species, to sustainably use forest genetic resources, to revive viable populations of endangered tree and shrub species as well as to contribute to the conservation and re-establishment of diversified forest ecosystems.

5.2 National legislation

The Basic Law of the Federal Republic of Germany assigns the fulfilment of state tasks to the *Länder* (Article 30) on principle. Under Article 70 the *Länder* have the right of legislation where the Basic Law does not grant the Federal government legislative power. Articles 71 to 74 list the legislative powers of the Federal government. All else is the exclusive responsibility of the *Länder*. The *Länder* have extensive legislative powers in particular in the area of forest conservation and forest management. By contrast the Basic Law grants the Federal government the concurrent legislative powers for marketing of forest seeds and planting materials. Since the Federal government makes use of this power, the *Länder* have no legislative leeway in this area.

Because of its membership in the EU, the Federal Republic of Germany is bound to European law. If European legal acts are not directly enforceable in the Member States, they must be implemented by national law. European law, for example, must be implemented in nature conservation legislation and in the Act on Forest Reproductive Material.

Federal Forest Act

The Federal Act on Forest Conservation and the Promotion of Forestry (*Bundeswaldgesetz*, BWaldG) of 2 May 1975 (Federal Law Gazette I p. 1037), last amended by Article 1 of the Act of 31.7.2010 (Federal Law Gazette I p. 1050), creates a framework at the national level for legislation of the *Länder* concerning forest conservation and forest management. The purpose of the Federal Forest Act under Article 1 is "to preserve the forest given its benefit and importance for the environment, with respect, in particular for maintaining the performance and functioning of the natural balance, the climate, the water balance, the prevention of air pollution, the soil fertility, the landscape features, the agriculture and infrastructure and the recreational function for the people (functions relating to both protection and recreation), if necessary to enlarge it and to ensure its ordered management". The basic policy of the widely accepted and proven act was retained in the latest amendment. The legal definition of forests was rendered more precisely: short rotation plantations and areas of land used for agro-forestry were excluded from the forest definition. The conservation of forest genetic resources is not cited explicitly in the Federal Forest Act, but can be derived from the general requirements of Article 1.

Länder forest laws

Within the framework provided by the Federal Forest Act all of the *Länder* have enacted their own forest laws, most recently the *Land* of Bremen on 31.05.2005. The provisions for forest conservation and forest management in the *Länder* laws are far more detailed than the Federal Forest Act and some also contain explicit provisions concerning the conservation of forest genetic resources. Table 20 offers an overview of these provisions.

Table 20: Provisions in *Länder* laws concerning the conservation of forest genetic resources

Bavaria:
Waldgesetz für Bayern (BayWaldG) in the version promulgated on 22 July 2005 (Gazette of Laws and Ordinances 2005. p. 313) Article 1 (2) This law serves in particular: ... 6. to conserve and where needed increase the biological diversity of the forests.
Brandenburg:
Waldgesetz des Landes Brandenburg (LWaldG) of 20 April 2004 (Gazette of Laws and Ordinances I/04, [No. 06], p. 137), last amended by Article 3 of the law of 27 May 2009 (Gazette of Laws and Ordinances I/09, [No. 08], pp. 175-184)

Article 4 (2) Sustainable management aims to constantly and lastingly ensure the protective, utilization and recreational functions. This includes the pursuit of conserving the forest area, conserving and re-establishing the fertility of forest soils according to best possible stock structure as well as preserving and re-establishing the ecological diversity of the forests, safeguarding the genetic resources and maintaining the habitats of animal and plant species.

Hesse:

Hessisches Forstgesetz as amended on 10 September 2002

Article 4 (3) The State forest enterprise has the following tasks in particular:
No. 6 forest-ecological, forest growth and site-related studies, conservation of forest genetic resources, forest conservation, forest landscape management and environmental monitoring as well as the production of expert opinions in the field of forestry.

Mecklenburg-Western Pomerania:

Waldgesetz für das Land Mecklenburg-Vorpommern (LWaldG) of 8 February 1993

Article 21 (4) Forests, which primarily serve ... the conservation of forest genetic resources can also be declared protected forests.

Rhineland-Palatinate:

Landeswaldgesetz (LWaldG) of 30 November 2000

(1) The purpose of this law is
1. to enduringly preserve, to protect and where necessary increase the forest in the entirety and homogeneity of its effects, as well as to manage and further develop it through forestry measures; the effects of the forest lie in its economic benefits (beneficial effect), its contribution to the environment, in particular to the sustainable productivity of the ecological balance, the climate, the water regime, air pollution control, soil fertility, the conservation of genetic resources and the landscape (protective effect) as well as its contribution to recreation (recreational effect); the guiding principle is close to nature forest management.

Thuringia:

Gesetz zur Erhaltung, zum Schutz und zur Bewirtschaftung des Waldes und zur Förderung der Forstwirtschaft (ThürWaldG)

Article 9 (2) Forests can be declared protected forests through statutory instruments if, for reasons of general welfare, certain actions, in particular forestry measures, must be carried out or desisted in forest areas. Protection purposes include: ...

9. Conservation of forest genetic resources, in particular for safeguarding and procuring genetically valuable seed.

Act on Forest Reproductive Material (FoVG)

The Act on Forest Reproductive Material of 22 May 2002 (Federal Law Gazette I p. 1658), amended by Section 214 of the regulation of 31 October 2006 (Federal Law Gazette I p.2407), replaced the Act on Forest Seed and Planting Stock from the 1970s. The Act implements Council Directive 1999/105/EC of 22 December 1999 on the marketing of forest reproductive material[9].

The purpose of the act is "to maintain and improve the forest with its manifold positive effects and its genetic diversity by providing high-quality forest reproductive material with secured identity as well as to promote the forestry and its performance".

The act regulates the commercial production, marketing as well as imports and exports of forest reproductive material. Reproductive material includes seeds, plant parts (intended for vegetative or micro-vegetative propagation) and planting stock (plants raised from seeds, from parts of plants, or from plants from natural regeneration). Under Article 7 of the FoVG forest reproductive material intended for marketing may only be produced by registered forest seed or forest plant enterprises and the basic material must be approved pursuant to Article 4. Under Article 21 the BLE may permit exceptions for the purpose of testing, scientific purposes, selection work or genetic conservation purposes. Furthermore, every forest owner may harvest and use reproductive material in their own forest without restrictions. Only a transfer to third parties is governed by the FoVG.

Detailed implementing rules are contained in the following three ordinances:

- the Implementing Regulation on Forest Reproductive Material (FoVDV) of 20 December 2002 (Federal Law Gazette I p. 4711 (2003. 61)),
- the Regulation on the Approval of Forest Reproductive Material (FoVZV) of 20 December 2002 (Federal Law Gazette I p. 4721 (2003. 50)) as well as
- the Regulation on Regions of Provenance of Forest Reproductive Material (FoVHgV) of 7 October 1994 (Federal Law Gazette I p. 3578), amended by the regulation of 15 January 2003 (Federal Law Gazette I p. 238).

9 OJ L 11 of 15.01.2000, page 17

Nature conservation legislation

The Act amending the Act on Nature Conservation and Landscape Management of 29 July 2009 (Federal Law Gazette I p. 2542) revised the Federal Nature Conservation Act. In Article 1 of the Federal Nature Conservation Act, the sustainable conservation of biological diversity was anchored as one of three primary objectives of nature conservation and landscape management. The two other objectives, to safeguard the functioning of the ecosystem including the regenerative capacity of the natural resources and their sustained availability for human use, as well as conservation of the diversity, characteristic features and beauty of nature and landscapes, were already contained in the previous versions. This act also implements provisions of European laws such as the European Bird Protection Directive and the Habitats Directive as well as international obligations that Germany has to assume as party to the Convention on Biological Diversity.

These objectives are achieved in particular by means of area and biotope protection (Chapter 4, Articles 20 - 36) as well as species protection (Chapter 5, Articles 37 - 55), hence *in situ*. In addition to static protection, the act also encompasses dynamic elements. Hence, under Article 1 “protection” expressly includes the management, development and restoration of nature and landscape. Chapter 4 of the act gives high priority to the linking of biotopes, by which interaction between populations, movement and resettlement are enabled. Article 40 (4) is important for the conservation of forest genetic resources. It requires a permit for the planting of alien species of plants in natural surroundings. During a transitional phase until 1 March 2020 preference should be given to planting woody plants and seeds in natural surroundings only within their natural ranges. However, this provision does not apply for agriculture and forestry.

The Ordinance on the Conservation of Wild Species of Fauna and Flora (Federal Species Protection Ordinance) of 16 February 2005 (Federal Law Gazette I p. 258 (896)), last amended by Article 22 of the Act amending the Act on Nature Conservation and Landscape Management of 29 July 2009 (Federal Law Gazette I p. 2542) contains specific provisions on species protection. The annex of the ordinance lists the protected and strictly protected fauna and flora species. Among the protected species are some woody plant species, such as the common holly (*Ilex aquifolium*) and the common yew (*Taxus baccata*).

Länder nature conservation legislation

There are other nature conservation laws and ordinances at the level of the *Länder*. The Basic Law gives the *Länder* the right to deviate in their nature conservation legislation from Federal law. This does not apply, however, for the general principles of nature conservation and the provisions on species and marine nature conservation.

5.3 Research activities

The nine *Länder* institutions represented in the BLAG-FGR (Annex 9.1) primarily do practical research directly linked with the characterization, identification, conservation and documentation of forest genetic resources.

Johann Heinrich von Thünen Institute – Federal Research Institute for Rural Areas, Forestry and Fisheries *(Thünen-Institut)* draws up scientific bases as decision-making aids for Federal government policies. It is one of four federal research institutes within the area of operations of the BMEL and consists of 15 institutes, one of which is an institute of forest genetics.

Research on forest genetic resources is also done by the universities funded by the *Länder*, in particular those with forestry faculties. These are the *Technische Universität Dresden* (Tharandt), the University of Freiburg, the University of Göttingen and the *Technische Universität München* (Freising) as well as the Eberswalde University for Sustainable Development (FH), the Erfurt University of Applied Science, the Göttingen University of Applied Sciences and Arts, the Rottenburg University of Applied Forest Sciences and the Weihenstephan-Triesdorf University of Applied Sciences. However, research subjects linked to forest genetic resources are also the focus of related areas of study (e.g. botany, biogeography, agriculture, horticulture) of other universities.

The BMEL Renewable Resources Funding Programme is coordinated by the *Fachagentur Nachwachsende Rohstoffe e.V.* (FNR) created in 1993. The programme funds projects, *inter alia*, on use of timber and timber products as raw material and fuel, including genetic and breeding matters.

The Federal Ministry of Education and Research (BMBF) is responsible for research within the Federal government. In an international context the BMBF funds scientific and technological cooperation between German research institutes and institutions in foreign countries. Targeted funding of young people by the BMBF in cooperation with the German Academic Exchange Service (DAAD) in the DAAD programme "Studying and research for sustainability" contains, for example, scholarships and summer schools for forest and timber research with young academics from Brazil, Russia, India, South Africa, the People's Republic of China and Mongolia.

In 2004 the BMBF launched the funding programme for sustainable forestry. For five years, until the end of 2009, 25 research groups participated in a diverse variety of studies along the forest-timber chain with 96 individual projects and 380 stakeholders. The aim was further development of sustainable forestry based on five guiding themes:

1. Mobilization and provision of timber
2. Woody biomass as energy supplier
3. Utilization and competing uses in forested landscapes
4. Markets for and products of timber
5. Sustainable perspectives for forestry and timber

The annual budget for forest genetic research cannot be precisely calculated. A rough estimate of expenses by the chairs of forestry genetics at the universities in Göttingen and Munich as well as the forest genetic institutes and departments of the Federal and regional research institutes comes to approx. 20 million euros per year.

We cannot provide information concerning patents in the area of forest genetic resources in Germany. There are also problems in their demarcation. If we interpret them narrowly, these could include IPC-class patents like A01H "new plants or processes for obtaining them" if they refer to forestry plants. Interpreted in a broader sense, we would have to include patents in the areas of the utilization and exploitation of forest genetic resources including the manufacturing industry (timber-based materials, fibres, paper, substances for diverse applications in the chemical and pharmaceutical industries, etc.). For example, a method for the extraction of taxanes was patented; these are substances impeding cell growth from the common yew that can be used in cancer treatment (Derdulla et al. 1997).

All in all, patents play only a minor role in the field of forest genetic resources.

5.4 Education and training

One notable feature of vocational training in Germany is the "dual system" that is used. It is called "dual system" because vocational training is done at two places of learning: in the training enterprise and at vocational school. The apprentices are involved in the enterprise routine at the training enterprises from the beginning and thus gain practical vocational experience during training. For one to two days a week they attend vocational school where the theoretical knowledge and practical skills they acquire in the enterprise are given a solid foundation in courses and classes.

The 3-year vocational training course to become a forest worker prepares trainees for work in forest holdings. The educational content includes knowledge of tree species and their site requirements, forest reproductive material, silviculture as well as nature conservation and environmental protection. Forest workers can further train to become master foresters or at technical schools to become forest technicians.

University studies prepare students for management tasks in forestry holdings and related areas, for work with authorities and in academia as well as for selfemployed work (services). Both universities and universities of applied science have adopted the Bologna system with Bachelor's and Master's degrees, whereby the universities of applied science are somewhat more aligned to practical work and their research focuses on applied research. The Bachelor courses of study incorporate forest genetics and the conservation of forest genetic resources either in the form of self-contained subjects or convey relevant knowledge in the scope of the subjects of biology, forest botany, forest ecology and silviculture. The Master courses of study offer more in-depth modules for this. University graduates aiming for positions with the public administrations usually go through a preparatory period of service with a public forestry administration.

In recent years, knowledge transfer in practice has improved considerably. By means of training courses and advanced training measures, bulletins, lectures and also online forums, the importance of genetic diversity and knowledge about the importance of forest genetic resources is conveyed to the forestry professionals.

Chief requirements for supporting education in sustainable utilization, development and conservation

The status of forest genetics as a self-contained field of study needs to be intensified in the courses of study. Additionally, the educational and in particular the advanced training programmes in the field of forest genetics should be expanded, also using new forms of learning (e.g. e-learning).

5.5 Public awareness/public relations

The general population is hardly aware of the function and importance of forest genetic resources. In a representative survey 58% of those questioned agreed to the statement "Biological diversity should be preserved and passed on to our children and future generations". Yet only half of those surveyed could explain what the term "biological diversity" means and only 12% were aware that this also involves genetic diversity within the species (BMU 2010). Nevertheless, in 2007 only one fourth of the people surveyed were familiar with the term "biological diversity" (http://www.biofrankfurt.de/fileadmin/website/download/biozahl/Biozahl-2007.pdf). The numerous activities carried out in the 2010 Year of Biological Diversity probably contributed to the increase in awareness of the term "biological diversity" among the population.

There are no programmes in Germany aimed specifically at creating awareness of forest genetic resources. However, there are many opportunities for the public to learn about the forests.

For the International Year of the Forests (2011) the National Programme "Forest Genetic Resources in Germany - Concept for the Conservation and Sustainable Utilization of Forest Genetic Resources in the Federal Republic of Germany" was reissued as a brochure (PAUL et al. 2010) and published on the website of the BMEL. GENRES and FGRDEU (Chapter 5.1.1) are not only information systems for experts, but also address the general public with brief, informative texts.

Public relations about the forests are operated at the Federal level by the BMEL, the BMUB, the *Thünen-Institut*, the aid and by the Federal Agency for Nature Conservation (BfN), by nationally active associations such as the SDW, the *Deutscher Forstverein*, the *Deutscher Forstwirtschaftsrat*, the *Arbeitsgemeinschaft deutscher Waldbesitzerverbände* (AGDW) and nature conservation associations such as the BUND, NABU and WWF. The aid *(aid infodienst Ernährung Landwirtschaft Verbraucherschutz e.V.)*, an organization funded by the BMEL, has been working in education and public relations in the agricultural sector for 60 years and also conveys knowledge about forestry.

These nationwide services are supplemented by regional information and educational programmes offered in particular by forest administrations, some of them also in cooperation with local tourism organizations, associations or with educational institutions such as the adult education centres. These include guided hikes, nature trails or forest information centres. The environmental education programmes of the national parks are also of note here.

The importance of forest genetic resources also is incorporated in forest education programmes, which have been intensified and expanded over the past ten years. For instance, in Bavaria the first educational nature trail to also integrate forest genetics was opened. Under the motto “The Transforming Forest” visitors are introduced not only to different tree species, but also different provenances of the same tree species and knowledge of genetics.

In addition to the information and educational programmes for the general public, there are also those for specific target groups. These include forest education programmes for children and young people offered by regional forest administrations, national parks, the SDW and a number of municipal institutions and associations. They aim at awakening an interest in forests, conveying basic knowledge about the forests and their importance for humanity and the significance of forest conservation, as well as intensifying the environmental awareness of children and young people and their willingness to develop environmental sound behaviours. The importance of forest genetic resources is also increasingly conveyed.

Target group-specific programmes include consulting services and training for forest owners offered by the forest authorities of the *Länder*. The aid offers informative materials to forest owners, for example about site-suitable provenance selection and suitable forest reproductive material.

The lack of knowledge about nature in general and the increasing urbanization of the population are impediments. There is a lack of reference to the subject matter of “forest genetic resources” in people’s private lives. The forests are the workplace and source of income of only a small fraction of the population. Because of this, understanding for forest management is dropping; the forests are perceived more as natural assets for protection or as the green backdrop of recreational activities. The lack of understanding of their management is accompanied by the lack of understanding about planting productive provenances and of forest plant breeding. Information about the importance of forest genetic resources is not one of the chief priorities of institutions conducting public relations about forests, forestry and nature conservation. In our information-flooded society the "forests" in general and forest genetic resources in particular compete for public attention with many other subjects. Even for those people who are interested in and seek information about the forests the large number of stakeholders with their respective own interests create a rather confusing picture.

The German public is sceptical of genetic engineering. Genetic engineering and genetics are often considered one and the same. Genetics and all related terms are therefore mainly given negative connotations. This greatly hinders conveying knowledge of the importance of forest genetic resources.

5.6 Coordination of public relations

The *Informations- und Koordinationszentrum für Biologische Vielfalt* (IBV) was set up at the BLE to coordinate public relations concerning biological diversity. GENRES and FGRDEU are part of the information provided there. IBV played a central role in the campaign for the Year of Biological Diversity in 2010.

In Germany, the various activities for the 2011 International Year of the Forests initiated by the United Nations are coordinated by the BMEL. A number of partners – institutions of the Federal government, the *Länder*, local authorities and more than 60 umbrella organizations, associations and enterprises – are supporting the campaign and holding their own events.

Forest public relations and forest education are among the tasks of the forest administrations of the *Länder* in Germany. A few years ago, the *Länder* forest administrations created a joint Internet platform for their public relations at http://www.treffpunktwald.de/wald-online/. In 2009, the *Deutsche Forstwirtschaftsrat* (DFWR) set up its committee for public relations. Its objective is to intensify and improve collaboration within German forestry in communications. In addition, the SDW and the *Bund Deutscher Forstleute* (BDF) initiated the establishment of a National Forest Education Forum. Crossing borders, forestry research facilities of Austria, Germany and Switzerland have combined their information for the public on the platform www.waldwissen.net/.

6 The State of Regional and International Collaboration

Against the background of the continued advancing destruction of forests worldwide, it is the paramount objective of international forest policy to halt deforestation and further degradation of the forests. This is also an important contribution to the internationally agreed millennium development objectives and to protection of the climate, conservation of biological diversity and to combat desertification but also to the objective of poverty alleviation, in particular in rural regions.

6.1 Regional and sub-regional networks, programmes and cooperation for the conservation of *ex situ* and *in situ* collections

With regard to regional and national cooperation in forest genetic resources, the following networks and programmes are of particular importance:

European Forest Genetic Resources Programme (EUFORGEN)

Germany has been involved in the European Forest Genetic Resources Programme (EUFORGEN) from the beginning. The objective of EUFORGEN is to promote the conservation and sustainable utilization of forest genetic resources for the welfare of present and future generations. It was set up in October 1994 for the purpose of implementing Resolution No. 2 (conservation of forest genetic resources) of the First Ministerial Conference on the Protection of Forests in Europe (MCPFE), which was held in Strasbourg in 1990. The Member States voluntarily cooperate in it to promote *in situ* and *ex situ* conservation of forest genetic resources, to coordinate measures, exchange ideas and disseminate information.

EUFORGEN is funded by the Member States and coordinated by the institute Bioversity International in cooperation with the Forestry Department of the United Nations Food and Agriculture Organization (FAO). International activities are harmonized between the individual states. A steering committee made up of the national coordinators carries out the supervisory function. The Forest Genetics Institute of the *Thünen-Institut* is Germany's national coordinator. Various members of the BLAG-FGR are taking part in current work of Phase IV (2010 - 2013) as experts. The work of EUFORGEN is reported regularly at the meetings of the BLAG-FGR.

6.2 International programmes and projects

Issues at the level of international forest policy in particular are treated by the FAO. Along with the BMEL, other Federal ministries, in particular the BMUB and BMZ, are involved in the international forest policy of Germany in order to counter progressive deforestation and to promote sustainable forest management. In this context, Germany supports the following international programmes and organizations that focus on genetic resources:

Concrete work on the identification, genetic characterization and conservation of forest genetic resources with the involvement of German partners has been done in the scope of diverse EU research projects. The most significant among these are the activities by the projects EVOLTREE (http://www.evoltree.eu), TreeBreedex (http://treebreedex.eu/) and various EU Cost projects such as that for the common beech (Cost E52). In addition, various German institutions have been involved for many years in international IUFRO provenance tests (e.g. common spruce, Scots pine, oaks, European silver fir). Numerous scientists from Germany contribute to IUFRO working groups dealing with forest genetic research topics (http://www.iufro.org/).

6.3 International agreements and initiatives

Germany is a contracting party of the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change and signed the International Tropical Timber Agreement (ITTA) as well as the United Nations Non-Legally Binding Instrument on all types of Forests.

In the scope of the **Convention on Biological Diversity** a number of decisions were made over the past ten years, which are significant for the conservation and sustainable utilization of forest genetic resources, such as the expanded programme of work on forest biological diversity (COP 6 Decision VI/22) in 2002 at the sixth Conference of the Parties and decisions made in this regard by the ninth Conference of the Parties (COP 9 Decision IX/5) in 2008.

Information on the Nagoya Protocol on access to genetic resources and benefit sharing adopted in 2010 is given in Chapter 7.

The **United Nations Framework Convention on Climate Change** and the **Kyoto Protocol** are relevant in the conservation of forest genetic resources because they have sharpened awareness of the role of forests in the global carbon balance and for the importance of genetic diversity for adapting to climate change. In addition, safeguarding forest genetic resources is important because Germany opted for the accounting of forest management under Article 3.4 of the Kyoto Protocol.

International Tropical Timber Agreement (ITTA)

This agreement promotes the expansion of international trade in tropical timber from sustainably managed forests and the sustainable management of tropical forests. The ITTA (2006) is available for signing by the members of the International Tropical Timber Organization (ITTO) and others states. If possible, all EU Member States should ratify it simultaneously. The ITTA should preferably come into force in 2011 or be preliminarily applied.

United Nations Non-Legally Binding Instrument on all Types of Forests

In April 2007, agreement on the "Non-Legally Binding Instrument on all Types of Forests" (NLBI) signified a breakthrough in the international negotiations at the United Nations Forum on Forests (UNFF). The new international instrument is the first to define a globally valid definition of sustainable forest management, which goes far beyond mere use of timber and incorporates aspects of sustainability. Germany supports the policies and measures anchored in the instrument, which have long been fixed elements of German development cooperation.

Moreover, the worldwide preservation and sustainable utilization of the forests are important concerns for German development policy. Germany is a committed partner in international forest-related cooperation and supports public authorities, civil society groups and private entrepreneurs in the development and implementation of sustainable protection and utilization schemes for their natural resources.

6.4 Regional agreements and initiatives

In addition to the above international agreements, Germany is also a contracting party in some regional agreements related to forests, such as the Convention on the Conservation of European Wildlife and Natural Habitats of 19 September 1979 (Bern Convention), the Convention on the Protection of the Alps (Alpine Convention) and the Mountain Forests Protocol.

Furthermore, Germany is committed to sustainable forest management in Forest Europe.

The objective of the **Bern Convention** is the conservation of wildlife, plants and their habitats as well as collaboration of the European states in nature conservation. The Convention regulates the protection of species, for example through removal and utilization restrictions as well as the obligation of protecting habitats. Genetic aspects play a minor role, but are implicitly of importance for the conservation of viable populations. Endangered species are cited in the annexes. Annex I covers strictly protected plant species that may not be damaged or removed from their natural habitats, including some woody plants.

Germany ratified the protocols of the **Alpine Convention** in 2002. In the **Mountain Forests Protocol** of the Alpine Convention the contracting states pledge to sustainably manage the forests of the Alpine region. For the regeneration of mountain forests preference shall be given to autochthonic reproductive material.

Measures combating illegal logging

Illegal timber cuts in affected countries lead to the loss of biological diversity and therefore also of forest genetic resources. As a major demand market for timber products, the Member States of the EU can contribute to improving the situation.

On 15 July 2011, the German Act Combating Trade in Illegally-harvested Timber (Timber Trade Safety Act, HolzSiG) came into force. The **Timber Trade Safety Act** regulates the national control of timber imports from states that have concluded partnership agreements with the EU against illegal timber cutting (EU Regulation 2173/2005[10] is the legal basis).

Corresponding agreements have been negotiated so far with six tropical nations (Ghana, Republic of the Congo, the Republic of Cameroon, the Central African Republic, Indonesia and Liberia). The EU Commission is presently negotiating with other states such as Malaysia. In the scope of this agreement, the partner countries establish an approval and licensing system to ensure that only legally harvested timber is exported to the EU.

The voluntary partnership agreements are applicable in the timber producing countries themselves and are therefore an especially promising measure for combating illegal logging. Since, however, relevant agreements cannot be concluded with all important timber producing countries in the foreseeable future,

10 OJ L 247 of 30.12.2005, page 1

an effective supplement at EU level was enacted on 2 December 2010 with the **Timber Trade Regulation** (EU Regulation No. 995/2010 of 20 October 2010[11]). It prohibits the marketing of illegally harvested timber and obligates all market participants who put timber or timber products on the market for the first time within the EU to adhere with specific due diligence. This includes, for example, information obligations with regard to the species and provenance of the timber as well as methods for estimating and reducing the risk that the timber might originate from illegal harvesting. The Timber Trade Regulation will be applied in its entirety from 3 March 2013. In Germany, the Timber Trade Safety Act will be accordingly amended before March 2013.

In order to also be able to control that the provisions can be observed in practice, additional important research projects are being conducted. For example, the *Thünen-Institut*, the research institute of the BMEL competent for forests, is presently developing methods for "genetic fingerprinting for timber" and bringing these into practice in an international collaboration. In this way, in future the provenance labelling of timber will be able to be tested without a doubt.

Forest Europe

In June 2011, at the sixth Ministerial Conference on the Protection of Forests in Europe in Oslo Europe's forestry ministers cleared the way for negotiations on a legally binding forest instrument. This will strengthen the framework conditions for integrative, sustainable forestry in the whole of Europe.

Sustainable forest management – the chief goal of the pan-European forestry minister process of Forest Europe – not only conserves the climate and environment and preserved species diversity, but also creates regional income benefits.

The targeted forest convention will set down joint objectives and a binding framework for forest management as well as for an improved balance of interests in forest policy. At the same time, it will send out a positive signal to the remaining community of states and encourage discussion of a global forestry instrument.

11 OJ L 295 of 12.11.2010, page 23

Forest Europe (previously MCPFE - Ministerial Conference on the Protection of Forests in Europe) coordinates cooperation by 46 signatory states, including Russia, in the area of forest policy. Germany presently has a seat in the five-state General Coordinating Committee and helped to prepare the resolutions. The negotiations should be completed by 2013.

6.5 Needs and priorities for improving international collaboration

The majority of genetic studies conducted to date using genetic markers have focused on “neutral genetic variation.” In this way, the huge impact of post-Ice Age remigration on today’s genetic composition of tree populations in Europe could be ascertained for the main tree species in Europe. It is essential that future international research projects also provide more information about the genetic variation to adaptation-relevant gene loci. This would provide important information on the adaptation potentials of tree populations. Methods needed for this are partly already available. In order to be able to assess the impacts of environmental changes on the genetic diversity of tree populations, a European genetic monitoring system in the forests is very important. Some very successful pilot studies have already been conducted in some EU countries. However, there is no combined forest genetic monitoring at the European level. In the various European countries there are very different approaches to demarcating forest regions of provenance. Consolidating and harmonizing these approaches in future would be very desirable, in particular as most tree species distribution ranges often reach far beyond national borders.

Controlled transfer of forest reproductive material across national borders is being discussed as one measure for adapting forests to climate change. For this purpose, recommendations should be drawn up at the European level in particular using data from provenance tests. New provenance tests should be established at the European level and genetic inventories conducted with genetic markers for rarer tree species.

Figure 26: Forest in autumn (© BLE/IBV)

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

Access to and equitable sharing of benefits in the utilization of genetic resources are elements of the Convention on Biological Diversity (CBD). The CBD emphasizes the national sovereignty of states over their genetic resources. The prerequisite for utilization is on principle the prior informed consent (PIC) by the contracting party providing the resource. In addition, access and therefore also the benefit sharing are based on mutually agreed terms (MAT).

Germany, as most EU states, has not yet introduced new regulations following the ratification of the CBD to further regulate access to genetic resources or issues concerning the sharing of benefits.

At present no PIC is required for access to genetic resources in Germany. Access to genetic resources is basically free within the framework set by public and private law (German Civil Code). Forest, nature conservation and species protection law (Chapter 5.2), the rights of owners and intellectual property rights (i.e. from patent, variety and seed rights) in particular must be observed.

In 2004, the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGR) came into force. The ITPGR is a legally binding implementation of the CBD for plant genetic resources for food and agriculture under sector and international law and is in agreement with the CBD. One central element of the ITPGR is a multilateral system (MLS) of access and benefit sharing, which covers the genetic resources of approx. 60 crops (Annex 1 of the ITPGR), including fruit tree species such as apples. The European member states of the ITPGR alone have already included over 24,000 provenances of the *Malus* genus in the MLS. Facilitated access to these resources in the MLS is then granted by using a Standard Material Transfer Agreement (SMTA) for the purpose of utilization and conservation for research, breeding and training for food and agriculture. Via this SMTA under the respective conditions of the ITPGR either obligatory or voluntary payments into the so-called Benefit Sharing Fund (BSF) of the ITPGR are collected and used for projects in developing countries and countries with transitional economies.

Another system regulating access to genetic resources and benefit sharing was initiated by the *Verband Botanischer Gärten*. The International Plant Exchange Network (IPEN) enables its member gardens simplified non-commercial exchange of living plant material based on the CBD. A Code of Conduct was drawn up for this purpose, which obligates the members to use the plant material exclusively for non-commercial purposes. Material is only granted for commercial utilization if the potential user previously has obtained the authorization of the country of origin and can credibly prove this. By introducing IPEN numbers (Annex 3 of the Code of Conduct), which accompany the plant material circulated within the IPEN and are stored in the databases of the participating gardens, the country of origin of the plant remains traceable. In this way, benefit compensation can always be made to the country of origin based on the commercial utilization of the genetic resource. IPEN is also CBD-compliant and offers simplified access to plant material for the important conservation work of botanical gardens. Today over 60 botanical gardens in Germany, Austria, Luxembourg, the Netherlands and Switzerland belong to the International Plant Exchange Network.

The transfer of forest genetic resources in the scope of forest plant breeding inside of Germany is conducted chiefly on an exchange basis, so that both partners reap a certain benefit. The future benefit sharing in the scope of the CBD will support the conservation and sustainable utilization of biological diversity. The shared benefits resulting from the utilization of forest genetic resources can be both of a financial (e.g. profit sharing) or non-monetary nature in the form of technology transfer, technology access and research participation.

At the tenth Conference of the Parties of the CBD in October 2010, the parties passed the so-called Nagoya Protocol (Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization). The protocol will enter into force as soon as at least 50 states have ratified it (the date of coming into force is 90 days following the fiftieth ratification).

Germany signed the Nagoya Protocol in June 2011 along with other EU Member States. At EU level, the EU Commission is carrying out an impact assessment with the objective of proposing provisions on the implementation of the Nagoya Protocol concerning access to genetic resources and equitable sharing of benefits from its utilization in the EU. Results are anticipated in early 2012. The CBD acknowledges the sovereign right of the states to regulate access to genetic resources in the scope of their national legislation. In Germany, the national need for action is under investigation so that the EU or Germany respectively can ratify the protocol according to the global objective as soon as possible, but by 2015 at the latest.

8 The Contribution of Forest Genetic Resources to Sustainable Development, Food Security, Poverty Alleviation and to Climate Protection

The conservation of biodiversity and in particular of forest genetic resources is a prerequisite for future utilization purposes, innovation and further development in breeding. It therefore contributes to food security, poverty alleviation, sustainable development and climate protection.

8.1 Contribution to sustainability in forestry and agriculture

In German forestry, the principle of sustainability was developed over a period of approximately 300 years. It was originally aimed at the sustainable supply of timber for future generations. Soon further economic and, since the middle of the last century, increasingly also ecological and social aspects of sustainability were included. Germany acted on the international agreements on sustainable development in 2002 with a National Sustainability Strategy and in 2007 with the National Strategy for Biological Diversity. In 2011 it published the Forest Strategy 2020.

At the international level, Germany also supports strengthening cooperation to achieve the equitable and sustainable management of forest ecosystems worldwide.

The importance of forests for climate protection, for biodiversity and for preserving our cultural heritage are taken into consideration in the scope of multifunctional forestry, which produces and utilizes the renewable and carbon-neutral resource of timber in an ecologically sound and sustainable way, ensures environmentally-compatible recreation and creates and preserves environmentally sound and long-lasting jobs.

Sustainability in forestry is also an important objective at the international level. That is why sustainable utilization of forests, including the conservation of soil fertility and species diversity, is of great significance. Within various action fields of the FAO, such as national forest programmes and worldwide forest surveys, Germany supports strengthening cooperation in sustainable forestry.

8.2 Contribution to Food Security and Poverty Alleviation

The cluster of forestry and timber is of great importance for Germany both with regard to labour market policy and economically. However, rural development encompasses economical, social and ecological aspects. Therefore, for sustainable development and for longer-term improvement of the regional economic structure in structurally weak rural regions, the natural capital of rural regions must be better used to establish a tourism added value, to generate additional income, for example, for the hotel and restaurant industry, the trades, the retail trade as well as for agriculture and forestry. In addition, it is essential to optimize and further develop the quality of life for people in rural regions through employment.

Altogether, area utilization in rural regions needs to be better aligned to the principle of sustainability. Biomass production both for food and for use as fuel and raw material must be increased. In this way, with regional energy production and supply, for example, from the renewable resource of wood, even rural regions can contribute to climate protection. Competing area use in rural regions for energy purposes to the disadvantage of food production must be avoided.

At the international level the importance of the forests for safeguarding the food supply and for combating poverty has been acted on in international agreements and is actively supported by Germany.

8.3 Contribution to climate protection

By storing carbon, building up stocks in the forests and avoiding emissions through the use of timber as fuel and as a raw material, the forests, forestry and timber in Germany make an important contribution to the protection of our climate. They relieve the atmosphere of approx. 125 million tonnes of CO_2 annually. The conservation of forest genetic resources is an essential prerequisite so that this important contribution to achieving the climate objectives of the Federal government can be assured and further enhanced.

9 Annex

9.1 List of institutions in the BLAG-FGR

Name	Address
Bayerisches Amt für forstliche Saat- und Pflanzenzucht (ASP) (Bavarian Office for Forest Seeding and Planting)	Forstamtsplatz 1 83317 Teisendorf Tel.: 08666 9883 22, Fax: 08666 9883 30 www.asp.bayern.de
Bundesanstalt für Landwirtschaft und Ernährung (BLE) (Federal Office for Agriculture and Food)	Referat 321 - Informations- und Koordinationszentrum für Biologische Vielfalt (IBV) Deichmanns Aue 29 53179 Bonn Tel.: 0228 996845 3237, Fax: 0228 6845 3105 www.ble.de
Bundesministerium für Ernährung und Landwirtschaft (BMEL) (Federal Ministry of Food and Agriculture)	Referat 535 – Nachhaltige Waldbewirtschaftung, Holzmarkt Postfach 14 02 70 53123 Bonn Tel.: 0228 529 4334, Fax: 0228 529 4262 www.bmel.de
Forschungsanstalt für Waldökologie und Forstwirtschaft Rheinland-Pfalz (FAWF) (Research Institute for Forest Ecology and Forestry Rhineland-Palatinate)	Referat 6.1 - Forschungsbereich nachhaltige Waldbewirtschaftung Schloss 67705 Trippstadt Tel.: 06306 911 117, Fax: 06306 911 200 www.fawf.wald-rlp.de

Name	Address
Forstliche Versuchs- und Forschungsanstalt Baden-Württemberg (FVA) (Forest Research Institute Baden-Württemberg)	Abt. Waldökologie Wonnhaldestr. 4 79100 Freiburg Tel.: 0761 4018 183, Fax: 0761 4018 333 www.fva-bw.de
Johann Heinrich von Thünen-Institut (Thünen-Institut) (Johann Heinrich von Thünen Institute)	Institut für Forstgenetik Sieker Landstraße 2 22927 Großhansdorf Tel.: 04102 696 0, Fax: 04102 696 200 www.ti.bund.de/de/fg/
Landesbetrieb Wald und Holz Nordrhein-Westfalen (State Enterprise for Forestry and Timber North Rhine-Westphalia)	Lehr- und Versuchsforstamt Arnsberger Wald Schwerpunktaufgabe Waldbau, Beratungsstelle für Forstvermehrungsgut Obereimer 13 59821 Arnsberg Tel.: 02931 7866 0, Fax: 02931 7866 422 www.wald-und-holz.nrw.de
Landesforst Mecklenburg-Vorpommern (State Forest Mecklenburg-Western Pomerania)	Anstalt des öffentlichen Rechts Betriebsteil Forstplanung, Versuchswesen, Informationssysteme (FVI) Fachgebiet Forstliches Versuchswesen Zeppelinstr. 3 19061 Schwerin Tel.: 0385 6700 112, Fax: 0385 6700 102 www.wald-mv.de
Landeskompetenzzentrum Forst Eberswalde (LFE) (Eberswalde forestry state centre of excellence)	FB Waldentwicklung / Monitoring Alfred-Möller-Str. 1 16225 Eberswalde Tel.: 03334 65230, Fax: 03334 65239 www.lfe.brandenburg.de/cms/detail.php/lbm1.c.358376.de

Name	Address
Nordwestdeutsche Forstliche Versuchsanstalt (NW-FVA) (Northwest German Forest Research Institute)	Abt. C - Waldgenressourcen Prof.-Oelkers-Str. 6 34346 Hann. Münden Tel.: 05541 7004 31, Fax: 05541 7004 73 www.nw-fva.de
Staatsbetrieb Sachsenforst (Public Enterprise Sachsenforst)	Kompetenzzentrum Wald und Forstwirtschaft Bonnewitzer Strasse 34 01796 Pirna Tel.: 03501 542 220, Fax: 03501 542 213 www.sachsenforst.de
ThüringenForst – Body governed by public law	Service- und Kompetenzzentrum Jägerstr. 1 99687 Gotha Tel.: 03621 225 0, Fax: 03621 225 222 www.thueringen.de/de/forst/

9.2 List of the tree and shrub species and other woody plants cited in the report with scientific names

Scientific name	German name[12]	English name
Abies alba	Weiß-Tanne	European Silver Fir
Abies firma	Momi-Tanne	Japanese Fir, Momi Fir
Abies grandis	Küsten-Tanne	Giant Fir, Grand Fir
Abies koreana	Korea-Tanne	Korean Fir
Abies nordmanniana	Nordmanns-Tanne	Caucasian Fir
Abies pinsapo	Spanische Tanne	Hedgehog Fir, Spanish Fir
Abies procera	Edel-Tanne	Noble Fir
Abies veitchii	Veitchs Tanne	Veitch Fir, Veitch's Silver Fir
Acer campestre	Feld-Ahorn	Field Maple, Hedge Maple
Acer monspessulanum	Felsen-Ahorn, Franz. Ahorn	Montpelier Maple
Acer negundo	Eschen-Ahorn	Ash Leafed Maple
Acer platanoides	Spitz-Ahorn	Norway Maple
Acer pseudoplatanus	Berg-Ahorn	Sycamore

12 Most of the German and English names of the tree and shrub species and other woody plants were taken from ERHARDT, W., GÖTZ, E., BÖDEKER, N. and SEYBOLD S. (2008): *Der große Zander – Enzyklopädie der Pflanzennamen. Band 2: Arten und Sorten*. Eugen Ulmer Verlag, or were slightly modified.

Scientific name	German name[12]	English name
Acer saccharinum	Silber-Ahorn	Silver Maple
Aesculus hippocastanum	Gewöhnliche Rosskastanie	Horse Chestnut
Alnus glutinosa	Schwarz-Erle	Common Alder, European Alder
Alnus incana	Grau-Erle	Grey Alder
Alnus viridis	Grün-Erle	Green Alder
Amelanchier ovalis	Gewöhnliche Felsenbirne	Snowy mespilus, European Juneberry
Berberis vulgaris	Gewöhnliche Berberitze	Common Barberry
Betula humilis	Strauch-Birke	Shrub Birch
Betula pendula	Hänge-Birke, Sand-Birke	European Birch, Silver Birch
Betula platyphylla	Mandschurische Birke	Asian White Birch
Betula pubescens	Moor-Birke	Downy Birch
Buxus sempervirens	Europäischer Buchsbaum	Boxwood, Common Box
Carpinus betulus	Hainbuche, Gewöhnliche Hainbuche	Common Hornbeam, European Hornbeam
Carya ovata	Schuppenrinden-Hickorynuss	Shagbark Hickory
Castanea sativa	Edel-Kastanie	Spanish Chestnut, Sweet Chestnut
Chamaecyparis lawsoniana	Lawsons Scheinzypresse	Lawson's Cypress, Oregon Cedar
Clematis vitalba	Gewöhnliche Waldrebe	Old Man's Beard, Traveller's Joy

Scientific name	German name[12]	English name
Colutea arborescens	Gewöhnlicher Blasenstrauch	Bladder Senna
Cornus mas	Kornelkirsche	Cornelian Cherry
Cornus sanguinea	Blutroter Hartriegel	Common Dogwood, Dogberry
Corylus avellana	Gewöhnliche Hasel	Cob, Hazel
Corylus colurna	Baum-Hasel	Turkish Hazel
Cotoneaster integerrimus	Gewöhnliche Zwergmispel	Cotoneaster
Crataegus laevigata	Zweigriffliger Weißdorn	English Hawthorn
Crataegus x macrocarpa	Großfrüchtiger Weißdorn	
Crataegus x media	Bastard-Weißdorn	
Crataegus monogyna	Eingriffliger Weißdorn	Single seed hawthorn, Mayhaw
Crataegus rhipidophylla	Großkelchiger Weißdorn	
Crataegus x subsphaericea	Verschiedenzähniger Weißdorn	
Cryptomeria japonica	Japanische Sicheltanne	Japanese cryptomeria
Cytisus scoparius	Besenginster	Broom, Scotch Broom
Daphne laureola	Lorbeer-Seidelbast	Spurge Laurel
Daphne mezereum	Gewöhnlicher Seidelbast	February Daphne, Mezereon
Euonymus europeus	Pfaffenhütchen	Common Spindle
Fagus sylvatica	Rot-Buche	Common Beech, European Beech

Scientific name	German name[12]	English name
Frangula alnus	Gewöhnlicher Faulbaum	Alder Buckthorn, Common Buckthorn
Fraxinus excelsior	Esche, Gewöhnliche Esche	Common Ash, European Ash
Fraxinus pennsylvanica	Pennsylvanische Esche	Red Ash
Genista germanica	Deutscher Ginster	German Greenweed
Hedera helix	Gewöhnlicher Efeu	Common Ivy, English Ivy
Hippophae rhamnoides	Sanddorn	Sea Buckthorn
Humulus lupulus	Gewöhnlicher Hopfen	Common Hop
Ilex aquifolium	Gewöhnliche Stechpalme	Common Holly, English Holly
Juglans nigra	Schwarze Walnuss	Black Walnut
Juglans regia	Echte Walnuss	English Walnut, Persian Walnut
Juniperus communis	Heide-Wachholder	Common Juniper, Juniper
Larix decidua	Europäische Lärche	European Larch
Larix x eurolepis	Schottische Hybrid-Lärche	Dunkeld Larch
Larix kaempferi	Japanische Lärche	Japanese Larch
Ledum palustre	Sumpf-Porst	Wild Rosemary
Ligustrum vulgare	Gewöhnlicher Liguster	Common Privet
Liriodendron tulipifera	Amerikanischer Tulpenbaum	Canary Whitewood, Tulip Polar
Lonicera xylosteum	Rote Heckenkirsche	Fly Honeysuckle

Scientific name	German name[12]	English name
Malus sylvestris	Holz-Apfel	Apple, Wild Crab
Mespilus germanica	Echte Mispel	Medlar
Metasequoia glyptostroboides	Urweltmammutbaum	Dawn Redwood
Morus alba	Weißer Maulbeerbaum	White Mulberry
Myrica gale	Moor-Gagelstrauch	Bog Myrtle, Sweet Gale
Picea abies	Fichte, Gewöhnliche Fichte	Common Spruce, Norway Spruce
Picea glauca	Kanadische Fichte	White Spruce
Picea mariana	Schwarz-Fichte	Black Spruce
Picea omorika	Omorika-Fichte	Serbian Spruce
Picea orientalis	Kaukasus-Fichte	Caucasian Spruce, Oriental Spruce
Picea pungens	Blau-Fichte	Blue Spruce, Colorado Spruce
Picea sitchensis	Sitka-Fichte	Sitka Spruce
Picea smithiana	Himalaya-Fichte	Himalayan Spruce, Morinda Spruce
Pinus cembra	Zirbel-Kiefer	Arolla Pine, Swiss Stone Pine
Pinus contorta	Dreh-Kiefer, Küsten-Kiefer	Lodgepole Pine, Shore Pine
Pinus mugo	Berg-Kiefer	Dwarf Mountain Pine, Mountain Pine
Pinus nigra	Schwarz-Kiefer	Austrian Pine, Black Pine
Pinus ponderosa	Gelb-Kiefer	Ponderosa Pine

Scientific name	German name[12]	English name
Pinus x rotundata	Moor-Kiefer	Bog Pine
Pinus strobus	Strobe, Weymouths-Kiefer	Eastern White Pine, Weymouth Pine
Pinus sylvestris	Wald-Kiefer, Föhre	Scots Pine
Platanus hispanica	Bastard-Plantane	London Plane, Plane
Populus alba	Silber-Pappel	White Poplar
Populus canadensis	Bastard-Schwarz-Pappel	Canadian Poplar
Populus x canescens	Grau-Pappel	Grey Poplar
Populus jackii	Ontario-Pappel	Balm of Gilead
Populus nigra	Schwarz-Pappel	Black Poplar
Populus tremula	Zitter-Pappel	Aspen
Populus trichocarpa x maximowiczii	Balsam-Pappelhybride	Black Cottonwood, Western Balsam Poplar
Populus (*Kultivare*)	Pappelhybride	Poplar hybrids
Prunus avium	Vogel-Kirsche	Gean, Mazzard, Wild Cherry
Prunus mahaleb	Felsen-Kirsche	Mahaleb Cherry, St. Lucie Cherry
Prunus padus	Traubenkirsche	European Bird Cherry
Prunus serotina	Späte Traubenkirsche	American Bird Cherry, Black Cherry
Prunus spinosa	Gewöhnliche Schlehe	Blackthorn, Sloe
Pseudotsuga menziesii	Douglasie	Douglas Fir
Pyrus pyraster	Wild-Birne	Wild Pear

Scientific name	German name[12]	English name
Quercus cerris	Zerr-Eiche	Turkey Oak
Quercus petraea	Trauben-Eiche	Sessile Oak
Quercus pubescens	Flaum-Eiche	Downy Oak
Quercus robur	Stiel-Eiche	English Oak, Oak, Pedunculate
Quercus x rosacea (*petraea x robur*)	Gewöhnliche Bastard-Eiche	
Quercus rubra	Rot-Eiche	American Red Oak
Rhamnus cathartica	Echter Kreuzdorn	Common Buckthorn, European Buckthorn
Ribes alpinum	Alpen-Johannisbeere	Alpine Currant, Moun-tain Currant
Ribes nigrum	Schwarze Johannisbeere	Blackcurrant
Ribes rubrum	Rote Johannisbeere	Currant
Ribes uva-crispa	Stachelbeere	Gooseberry
Robinia pseudoacacia	Robinie, Gewöhnliche Scheinakazie	Acacia, Black Locust, Robinia
Rosa canina	Hunds-Rose	Common Briar, Dog Rose
Rosa corymbifera	Hecken-Rose	Rose
Rosa elliptica	Keilblättrige Rose	
Rosa rubiginosa	Wein-Rose	Eglantine, Sweet Briar
Rosa tomentosa	Filz-Rose	Downy Rose
Salix alba	Silber-Weide	White Willow
Salix aurita	Ohr-Weide	Eared Willow

Scientific name	German name[12]	English name
Salix bicolor	Zweifarbige Weide	
Salix caprea	Sal-Weide	Goat Willow, Pussy Willow
Salix cinerea	Grau-Weide	Grey Willow
Salix daphnoides	Reif-Weide	Violet Willow
Salix fragilis	Bruch-Weide	Crack Willow
Salix helvetica	Schweizer Weide	Swiss Sallow
Salix myrsinifolia	Schwarzwerdende Weide	Dark Leaved Willow
Salix pentandra	Lorbeer-Weide	Bay Willow, Laurel Willow
Salix phylicifolia	Teeblättrige Weide	Tea Leaf Willow
Salix purpurea	Purpur-Weide	Purple Osier, Purple Willow
Salix repens	Kriech-Weide	Creeping Willow
Salix x rubens	Fahl-Weide	Hybrid Crack Willow
Salix schraderiana	Zweifarbige Weide	
Salix triandra	Mandel-Weide	Almond Leaved Willow
Salix viminalis	Hanf-Weide, Korb-Weide	Common Osier, Osier
Sambucus nigra	Schwarzer Holunder	Common Elder, Elderberry
Sambucus racemosa	Roter Holunder	Red Berried Elder, Red Elderberry
Sciadopitys verticillata	Japanische Schirmtanne	Umbrella Pine

Scientific name	German name[12]	English name
Sequoiadendron giganteum	Bergmammutbaum	Giant Sequoia, Wellingtonia
Sorbus acutisecta	Spitzwinklige Bastard-Mehlbeere	
Sorbus aria	Gewöhnliche Mehlbeere	Whitebeam
Sorbus aucuparia	Vogelbeere	Rowan, Mountain Ash
Sorbus decipiens	Täuschende Bastard-Mehlbeere	
Sorbus domestica	Speierling	Service Tree
Sorbus heilingensis	Heilinger Bastard-Mehlbeere	
Sorbus intermedia	Schwedische Mehlbeere	Swedish Whitebeam
Sorbus isenacensis	Eisenacher Mehlbeere	
Sorbus latifolia agg.	Breitblättrige Mehlbeere	Service Tree of Fontainebleau
Sorbus multicrenata	Vielkerbige Bastard-Mehlbeere	
Sorbus parumlobata	Schwachgelappte Bastard-Mehlbeere	
Sorbus pinnatifida	Bastard-Eberesche	
Sorbus subcordata	Arnstädter Bastard-Mehlbeere	
Sorbus torminalis	Elsbeere	Wild Service Tree
Spartium junceum	Binsenginster	Spanish Broom
Symphoricarpos albus	Gewöhnliche Schneebeere	Snowberry, Waxberry

Scientific name	German name[12]	English name
Taxodiaceae	Sumpfzypressengewächse	
Taxodium distichum	Sumpfzypresse	Swamp Cypress
Taxus baccata	Eibe, Europäische Eibe	Common Yew, English Yew
Thuja occidentalis	Abendländ. Lebensbaum	Arborvitae, Red Cedar
Thuja orientalis	Morgenländ. Lebensbaum	Oriental Arborvitae
Thuja plicata	Riesen-Lebensbaum	Western Red Cedar
Tilia cordata	Winter-Linde	Little Leaf Linden
Tilia platyphyllos	Sommer-Linde	Large Leaved Lime
Tsuga canadensis	Kanadische Hemlocktanne	Eastern Hemlock
Tsuga heterophylla	Westamerikanische Hemlocktanne	Western Hemlock
Ulex europaeus	Gewöhnlicher Stechginster	Furze, Gorse
Ulmus glabra	Berg-Ulme	Elm, Scotch Elm, Wych Elm
Ulmus x hollandica (*minor x glabra*)	Bastard-Ulme	Dutch Elm
Ulmus laevis	Flatter-Ulme	Russian Elm
Ulmus minor	Feld-Ulme	European Field Elm
Viburnum lantana	Wolliger Schneeball	Wayfaring Tree
Viburnum opulus	Gewöhnlicher Schneeball	European Cranberry-bush, Guelder Rose
Vitis vinifera	Weinrebe	Common Grape Vine

9.3 Forest area by tree species

only accessible forest/stocked timberland/without gaps in the main stand or plenter forest. Source: BWI²

Tree species	Area (ha)	Area of the species group (ha)	Percentage of stocked timber-land (%)
English Oak (*Quercus robur*)	456,827		4.4%
Sessile Oak (*Quercus petraea*)	509,748		4.9%
American Red Oak (*Quercus rubra*)	43,960		0.4%
Turkey Oak (*Quercus cerris*)			
Oak species		**1,010,535**	**9.8%**
Common Beech (*Fagus sylvatica*)	1,564,806		15.2%
Beech		**1,564,806**	**15.2%**
Common Ash (*Fraxinus excelsior*)	209,358		2.0%
Common Hornbeam (*Carpinus betulus*)	112,885		1.1%
Sycamore (*Acer pseudoplatanus*)	161,136		1.6%
Norway Maple (*Acer platanoides*)	13,767		0.1%
Field Maple (*Acer campestre*)	15,579		0.2%
Lime (*Tilia Spec.*)	45,268		0.4%
Black Locust (*Robinia pseudacacia*)	33,778		0.3%
Elm species (*Ulmus spec.*)	11,729		0.1%
Horse Chestnut (*Aesculus hippocastanum*)	2,539		0.0%

Tree species	Area (ha)	Area of the species group (ha)	Percentage of stocked timber-land (%)
Sweet Chestnut (*Castanea sativa*)	7,445		0.1%
Service Tree (*Sorbus domestica*)	160		0.0%
White Mulberry (*Morus alba*)	n.o.		
Whitebeam (*Sorbus aria*)	3,556		0.0%
Walnuts (*Juglans spec.*)	1,117		0.0%
Common Holly (*Ilex aquifolium*)	1,582		0.0%
further deciduous trees with a long life expectancy	1,830		0.0%
other deciduous trees with a long life expectancy		**621,728**	**6.0%**
European Birch (*Betula pendula*)	459,262		4.4%
Downy Birch (*Betula pubescens*)	37,114		0.4%
Alder species (*Alnus spec.*)	216,034		2.1%
Aspen (*Populus tremula*)	68,899		0.7%
Black Poplar (*Populus nigra*) (+ hybrids)	39,049		0.4%
Grey Poplar (*Populus x canescens*) (+ hybrids)	5,028		0.0%
White Poplar (*Populus alba*)	3,171		0.0%
Western Balsam Poplar (*Populus trichocarpa x maximowicii*)	24,838		0.2%
Rowan (*Sorbus aucuparia*)	46,715		0.5%
Willows (*Salix spec.*)	57,716		0.6%
European Bird Cherry (*Prunus padus*)	4,976		0.0%

Tree species	Area (ha)	Area of the species group (ha)	Percentage of stocked timber-land (%)
Wild Cherry (*Prunus avium*)	38,002		0.4%
Common Buckthorn (*Frangula alnus*)	23,126		0.2%
Wild Crab (*Malus sylvestris*)	1,745		0.0%
Wild Pear (*Pyrus pyraster*)	1,581		0.0%
Turkish Hazel (*Corylus colurna*)	674		0.0%
Wild Service Tree (*Sorbus torminalis*)	1,926		0.0%
further deciduous trees with a short life expectancy	9,267		0.1%
other deciduous trees with a short life		**1,039,122**	**10.1%**
All deciduous tree species		**4,236,190**	**41.0%**
Common Spruce (*Picea abies*)	2,948,965		28.6%
Serbian Spruce (*Picea omorika*)	4,169		0.0%
Other Spruce species (*Picea spec.*)	23,454		0.2%
Common Yew (*Taxus baccata*)	272		0.0%
other conifers	1,344		0.0%
Spruce		**2,978,203**	**28.9%**
European Silver Fir (*Abies alba*)	152,793		1.5%
Other Firs (*Abies spec.*)	9,223		0.1%
Fir		**162,016**	**1.6%**
Douglas Fir (*Pseudotsuga menziesii*)	179,607		1.7%
Douglas Fir		**179,607**	**1.7%**

Tree species	Area (ha)	Area of the species group (ha)	Percentage of stocked timber-land (%)
Scots Pine (*Pinus sylvestris*)	2,430,113		23.5%
Dwarf Mountain Pine (*Pinus mugo*)	2,832		0.0%
Black Pine (*Pinus nigra*)	13,902		0.1%
Balkan Pine (*Pinus peuce*)	35		0.0%
Arolla Pine (*Pinus cembra*)	55		0.0%
Other Pines (*Pinus spec.*)	19,859		0.2%
Pine		**2,466,797**	**23.9%**
European Larch (*Larix decidua*)	224,170		2.2%
Japanese Larch (*Larix kaempferi*) (+hybrids)	73,618		0.7%
Larch	**297,787**	**297,787**	**2.9%**
All conifers		**6,084,411**	**59.0%**
All tree species	**10,320,601**	**10,320,601**	**100.0%**

n.o.= not occuring

9.4 Red List of tree and shrub species and other woody plants in Germany

This list is an excerpt from the *Rote Liste gefährdeter Pflanzen in Deutschland* (BfN, 1996) and from the Red Lists of the *Länder*. The Red Lists of the *Länder* refer to different time periods and the dates of publication vary accordingly.

Brandenburg:	Rote Liste Gefäßpflanzen. Naturschutz und Landschaftpflege in Brandenburg 15 (4) 2006
Baden-Würtemberg:	Rote Liste der Farn- und Samenpflanzen Baden-Württembergs, 3rd edition. Landesanstalt für Umweltschutz Baden-Württemberg (Hrsg.), 1999
Bavaria:	Scheuerer, M. & W. Ahlmer (2003): Rote Liste gefährdeter Gefäßpflanzen Bayerns mit regionalisierter Florenliste. Schriftenreihe Bayerisches Landesamt für Umweltschutz 165
Hesse:	Rote Liste der Farn- und Samenpflanzen Hessens, 4th edition. Hessisches Ministerium für Umwelt, ländlichen Raum und Verbraucherschutz (HMULV) (Hrsg.), 2008
Lower Saxony and Bremen:	Rote Liste der Farn- und Blütenpflanzen Mecklenburg-Vorpommerns, 5. Fassung. Umweltministerium Mecklenburg-Vorpommern (Hrsg.), 2005
Niedersachen und Bremen:	Rote Liste gefährdeter Farn- und Blütenpflanzen in Niedersachsen und Bremen, 5th edition. Informationsdienst Naturschutz Niedersachsen 1/04

Mecklenburg-Western Pomerania:	Rote Liste der Farn- und Blütenpflanzen Mecklenburg-Vorpommerns, 5th edition. Umweltministerium Mecklenburg-Vorpommern (ed.), 2005
North Rhine-Westphalia:	Rote Liste und Artenverzeichnis der Farn- und Blütenpflanzen - Pteridophyta et Spermatophyta - in Nordrhein-Westfalen, 4th edition. Landesamt für Natur, Umwelt und Verbraucherschutz Nordrhein-Westfalen (ed.), 2010
Rhineland-Palatinate:	Naturschutz und Landschaftspflege, Rote Listen von Rheinland-Pfalz. Landesamt für Umwelt, Wasserwirtschaft und Gewerbeaufsicht Rheinland-Pfalz (ed.), 2007
Saarland:	Rote Liste der Farn- und Blütenpflanzen des Saarlandes (2007). In: Rote Liste gefährdeter Pflanzen und Tiere des Saarlandes - Atlantenreihe Band 4. Ministerium für Umwelt und DELATTINA (ed.), 2008
Saxony:	Materialien zu Naturschutz und Landschaftspflege 1999, Rote Liste Farn- und Samenpflanzen. Sächsisches Landesamt für Umwelt und Geologie (ed.), 1999
Saxony-Anhalt:	Rote Liste der Farn- und Blütenpflanzen (Pteridophyta et Spermatophyta) des Landes Sachsen-Anhalt, 3rd edition. In: Rote Listen Sachsen-Anhalt. Berichte des Landesamtes für Umweltschutz Sachsen-Anhalt, Halle, 39 (2004). ISSN 0941-7281

Schleswig-Holstein:	Die Farn- und Blütenpflanzen Schleswig-Holsteins. Rote Liste Band 1, 4th edition. Landesamt für Natur und Umwelt des Landes Schleswig-Holstein (ed.), 2006 Die Farn- und Blütenpflanzen Schleswig-Holsteins. Rote Liste Band 2 – Brombeeren, 3rd edition. Landesamt für Natur und Umwelt des Landes Schleswig-Holstein (ed.), 2006
Thuringia:	Korsch, H. & Westhus, W.: *Rote Liste der Farn- und* Blütenpflanzen (Pteridophyta et Spermatophyta) Thüringens, 4th edition. Naturschutzreport 18 (2001) 273-296

The nomenclature in the following list generally uses that of the *Rote Liste gefährdeter Pflanzen in Deutschland* (BfN, 1996). If taxa are differently categorized or named in the Red Lists of the Länder, this is noted in a footnote. The endangerment categories and other status information from the BfN (1996) have been supplemented with further categories used in the *Länder*.

Red List	**(Endangerment)**
*	Occurring (not considered endangered)
0	Extinct or missing
0a	Missing (suspected); in BW for taxon that have not yet re-established themselves following resettlement measures
1	Critically endangered
2	Endangered
3	Vulnerable
4	Potentially endangered
G	Endangerment assumed
R	Extremely rare
R*	Quite rare (potentially very endangered)

V	Declining, near threatened list
+	Regionally more endangered
-	Regionally less endangered
D	Data insufficient
S	Due to protective measures in NW equally, lesser or no longer endangered (as addendum to *, V, 3, 2,1 or R)
#	Due to the differing taxonomical references, a few of the taxa evaluated in the *Rote Liste gefährdeter Pflanzen in Deutschland* are not categorized at the subspecies level
♦	Not assessed; species excluded from assessment for certain reasons

Responsibility

!	Highly responsible
!!	Notably responsible
!! a	Sole responsibility of Bavaria within Germany

Endemism

E	Endemic within the political borders of Germany or a Land
E‘	Endemic in a small geographic region part of which belongs to Germany

Status information

N	Firmly established neophyte at all locations in German
En	Established neophyte
neo	Neobiota species with establishment tendency, i.e. the species does not yet fulfil the establishment criteria, but shows a tendency towards firm establishment
T	Taxon with establishment tendency
u	Erratic taxon

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Abies alba	Weiß-Tanne	3	1	*		u									1	1	3
Acer campestre[13]	Feld-Ahorn	*	G	*		*					*		*				
Acer monspessulanum	Felsen-Ahorn, Franz. Ahorn	*			3	*											
Acer negundo	Eschen-Ahorn	N		*		En					*						
Acer opalus	Frühlings-Ahorn	R		R													
Acer platanoides	Spitz-Ahorn	*		*		*					*		*				
Acer pseudoplatanus	Berg-Ahorn	*		*		*					*		*				
Ailanthus altissima	Götterbaum	N		*		En					*						
Alnus glutinosa	Schwarz-Erle	*		*		*					*		*				
Alnus incana	Grau-Erle	*		*		T					neo		*				
Alnus viridis	Grün-Erle	*															
Amelanchier lamarckii	Kupfer-Felsenbirne					T					*						
Amelanchier ovalis[14]	Gewöhnliche Felsenbirne	*		*		*		0						3			
Andromeda polifolia	Kahle Rosmarinheide	3		3	3	2	2	3	3	3	2 S	2	3	0	2	2	1
Arctostaphylos uva-ursi	Echte Bärentraube	2		1	2	0	0	0	0	2	0	0	1		1	R	1
Artemisia absinthium	Echter Wermut	*		*		En					3		3				
Berberis julianae	Julianes Berberitze					u					neo						
Berberis vulgaris	Gewöhnliche Berberitze	*	D	*		*	G	3		2	3			0			
Betula humilis	Strauch-Birke	2	0	2	2		1						1				
Betula nana	Zwerg-Birke	2 !	R	1	2		0	R		1						D	
Betula pendula	Hänge-Birke, Sand-Birke	*		*		*					*		*				
Betula pubescens ssp. carpatica	Karpaten-Birke	*				*					*		*		D		
Betula pubescens. ssp. pubescens	Moor-Birke	*				*					*		*				
Buddleja davidii	Sommerflieder	N		*		En					*		*				
Calluna vulgaris	Besenheide, Heidekraut	*		*	*	*	V				*		V				
Carpinus betulus	Hainbuche	*		*		*					*		*				
Castanea sativa	Edel-Kastanie	*		*		*					*						

13 SH: Acer campestre ssp. leiocarpum
14 BW und HE: Amelanchier ovalis ssp. embergeri

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Chamaespartium sagittale (= Genista sagittalis)	Flügelginster	*		*	3	V					* S				1	1	
Clematis vitalba	Gewöhnliche Waldrebe	*		*		*					*		*				
Colutea arborescens	Gewöhnlicher Blasenstrauch	3		2		T											
Cornus mas	Kornelkirsche	*			3			3			R						
Cornus sanguinea[15]	Blutroter Hartriegel	*	D	*		*					*		*				
Cornus sericea	Weißer Hartriegel	N				T					neo		D				
Corylus avellana	Gewönliche Hasel	*		*		*					*		*				
Cotoneaster bullatus	Blasen-Zwergmispel										neo						
Cotoneaster dielsianus	Diel's Zwergmispel					u					neo						
Cotoneaster divaricatus	Sparrige Zwergmispel					T					neo						
Cotoneaster horizontalis	Fächer-Zwergmispel					T					neo						
Cotoneaster integerrimus	Gewöhnliche Zwergmispel	*		*	3	*		R			*			R	3		
Cotoneaster tomentosus	Filzige Zwergmispel	*		3		u											
Crataegus laevigata	Zweigriffliger Weißdorn	*	2			*					*		*				
Crataegus monogyna	Eingriffliger Weißdorn	*		*		*					*		*				
Crataegus rhipidophylla			1			G							D				2
Crataegus rhipidophylla var. rhipido-phylla[16]	Großkelchiger Weißdorn	*			*						G						
Crataegus rhipidophylla var. lindmanii	Lindmans Weißdorn	*		*	*						G				G		
Crataegus x macrocarpa	Großfrüchtiger Weißdorn	*	3	*							*		*				
Crataegus x media	Bastard-Weißdorn	*	3	D									D				
Cytisus multiflorus	Vielblütiger Weißklee										neo						
Cytisus nigricans	Schwarzwerdender Geißklee			V		D									3		
Cytisus scoparius	Besenginster	*		*		*					*		*				
Cytisus striatus	Gestreifter Geißklee	N				u											
Daphne cneorum	Heideröschen, Rosmarin-Seidelbast	2		2	2	0						1					
Daphne laureola	Lorbeer-Seidelbast	3		R								4					
Daphne mezereum	Gewöhnlicher Seidelbast	*	0	*		*	R			2	*		3		3		

15 HE: Cornus sanguinea ssp. sanguinea
16 NW: included in the Red list as Crataegus rhipidophylla and Cr. lindmanii

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Empetrum hermaphroditum	Zwittrige Krähenbeere	*		2													
Empetrum nigrum	Schwarze Krähenbeere	3	1	2	2	2	V				2		*		3	R	R
Erica cinerea	Graue Heide	1									2 S						
Erica tetralix	Glockenheide	*	2	*	3	3	2	3			* S	3	V	1	3	2	1
Euonymus europaeus	Pfaffenhütchen	*		*		*					*		*				
Euonymus latifolia	Breitblättriges Pfaffenhütchen	*		V		T											
Fagus sylvatica	Rot-Buche	*		*		*					*		*				
Frangula alnus	Gewöhnlicher Faulbaum	*		*		*					*		*				
Fraxinus excelsior	Esche, Gewöhnliche Esche	*		*		*					*		*				
Fraxinus ornus	Blumen-Esche	N				u											
Fumana procumbens	Gewöhnliches Nadelröschen	3 + !		2	2	2					1	2				2	3
Genista anglica	Englischer Ginster	3	1	*			1	2	0	3	3 S	3	3			3	
Genista germanica	Deutscher Ginster	*	2	3		3	1	2		1	2		1	1	3	3	3
Genista pilosa	Behaarter Ginster	*	V	V	3	*	2	3		3	3		2		3	3	1
Genista tinctoria ssp. littoralis	Küsten-Färberginster	*															
Genista tinctoria ssp. tinctoria	Färber-Ginster	*	3	*		*	2		1	2	3 S		1		V		
Globularia cordifolia	Herzblättrige Kugelblume	*															
Globularia punctata	Gewöhnliche Kugelblume	3 +		3	3	0					*	2		0		3	
Hedera helix	Gewöhnlicher Efeu	*		*		*					*		*				
Hippophae rhamnoides	Sandorn					T					neo						
Hippophae rhamnoides ssp. carpatica	Karpaten-Sanddorn	*															
Hippophae rhamnoides ssp. fluviatilis	Gebirgs-Sandorn	*		3	3												
Hippophae rhamnoides ssp. rhamnoides	Küsten-Sandorn	*											*				
Hyssopus officinalis	Ysop	N		R		u					0					3	
Ilex aquifolium	Gewöhnliche Stechpalme	*	2	*	3	*					*		*				
Juglans regia	Echte Walnuss	*		*		*					neo		D				
Juniperus communis				*		V								0	2	3	

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Juniperus communis ssp. alpina	Zwerg-Wacholder	*															
Juniperus communis ssp. communis	Heide-Wacholder	*						3		3	3		2				
Juniperus sabina	Gewöhnlicher Stink-Wacholder	3			R*												
Kalmia angustifolia	Schmalblättrige Lorbeerrose	N									neo						
Laburnum anagyroides	Gewöhnlicher Goldregen	N		*		T					*						
Larix decidua	Europäische Lärche	*				En							*				
Ledum palustre	Sumpf-Porst	3 +	2	0 a	1		3			2			1		3	2	0
Ligustrum vulgare	Gewöhnlicher Liguster	*	D	*		*					*						
Lonicera caerulea	Blaue Heckenkirsche	*		3		u											
Lonicera caprifolium	Wohlriechendes Geißblatt	*		*		T											
Lonicera henryi	Henrys Geißblatt										neo						
Lonicera periclymenum	Wald-Geißblatt	*	V	*		*					*		*				
Lonicera pileata	Immergrüne Kriech-Heckenkirsche					u					neo						
Lonicera xylosteum	Rote Heckenkirsche	*	G	*		*					*		*				
Loranthus europaeus	Eichen-Mistel	G															
Lycium barbarum	Gewöhnlicher Bocksdorn	N				T					*						
Mahonia aquifolium	Gewöhnliche Mahonie	N		*		En					*						
Malus domestica	Kultur-Apfel	*		*		u							*				
Malus sylvestris	Holz-Apfel	*	G	3	3	V	3	3		3	3		3		3		3
Mespilus germanica	Echte Mispel	*		3		T					*						
Myrica gale	Moor-Gagelstrauch	3	1				3	2	3	3	3		3			R	
Myricaria germanica	Deutsche Tamariske	1		1	1							0					
Orthilia secunda	Birngrün, Nickendes Wintergrün	*		V		3	3	3		2	2	0	0		V	3	
Parthenocissus inserta	Fünfblättrige Jungfernrebe	N		*		En					*		*				
Physocarpus opulifolius	Virginische Blasenspiere	N				T											
Picea abies	Fichte, Gewöhnliche Fichte	*	2	*		En					*		*			2	
Picea sitchensis	Sitka-Fichte												*				

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Pinus mugo[17]	Berg-Kiefer	*		R													
Pinus rotundata[18]	Moor-Kiefer	*		3	3										3		0
Pinus strobus	Strobe, Weymouths-Kiefer					T					neo						
Pinus sylvestris	Wald-Kiefer, Föhre	*		*		*					*		*	2			
Populus alba	Silber-Pappel	*		*	3	*					*						
Populus nigra		3		2		3	1						*		1	2	1
Populus nigra ssp. nigra	Schwarz-Pappel		2		2				3	3	2	3					
Populus tremula	Zitter-Pappel	*		*		*					*		*				
Populus x canescens	Grau-Pappel	*		*	3	*											
Prunus avium				*		*					*						
Prunus avium ssp. avium	Vogel-Kirsche	*	2										*				
Prunus cerasifera	Kirschpflaume			*		En					neo						
Prunus domestica																	
Prunus domestica ssp. domestica	Zwetschge	*		*		T											
Prunus domestica ssp. insititia	Pflaume	*	G	*		T					*						
Prunus fruticosa	Steppen-Kirsche, Zwerg-Kirsche	2 !!										2				2	
Prunus mahaleb	Felsen-Kirsche	*		*	3	*					R		*	R			
Prunus padus ssp. padus	Traubenkirsche	*		*		*					*		*				
Prunus padus ssp. petraea	Gebirgs-Traubenkirsche	*		*		R											
Prunus serotina	Späte Traubenkirsche	N		*		En					*		*				
Prunus x fruticans	Hafer-Schlehe		D	*		D					*						
Prunus spinosa	Gewöhnliche Schlehe	#		*		*					*		*				
Pseudotsuga menziesii	Douglasie					T					neo						
Pyrus communis	Kultur-Birne	*				u											
Pyrus pyraster	Wild-Birne	*		V		V	3	3			2		G				3
Quercus cerris	Zerr-Eiche					T					neo						

17 BW: Pinus mugo ssp. mugo

18 BW: Pinus mugo ssp. rotundata; TH: Pinus x rotundata (P. mugo) "Bergkiefer"; SN Pinus uncinata auct. is assigned to endangerment class = 1

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Quercus petraea	Trauben-Eiche	*		*		*					*		*				
Quercus pubescens	Flaum-Eiche	3	G	V													2
Quercus robur	Stiel-Eiche	*		*		*					*		*				
Quercus rubra	Rot-Eiche					T					neo						
Quercus x calvescens	Flaumblättrige Bastard-Eiche			V	R*	R						1		0			
Rhamnus cathartica	Echter Kreuzdorn	*		*		*				3	*				V		
Rhamnus saxatilis[19]	Felsen-Kreuzdorn	*		2	3												
Rhododendron ferrugineum	Rostblättrige Alpenrose	*		0													
Ribes alpinum	Alpen-Johannisbeere	*	D			*					*		D		V		
Ribes nigrum	Schwarze Johannisbeere	*	V	D	3	*					*	2	*				
Ribes petraeum	Felsen-Johannisbeere	R		V	R*												
Ribes rubrum[20]	Rote Johannisbeere	*	D	*	3	*					*		*				
Ribes spicatum	Ährige Johannnisbeere	*	G		R		R						*	R	2		
Ribes uva-crispa	Stachelbeere	*		*		*					*		*				
Robinia pseudoacacia	Robinie, Gewöhnliche Scheinakazie	N		*		En					*		*				
Rosa abietina	Nadel-Rose	0			0*												
Rosa agrestis	Feld-Rose	*	1	3	3	3		2		1	3		1		1		
Rosa arvensis	Kriechende Rose	*		*		*		2		R	*					0	2
Rosa caesia (= *Rosa coriifolia*)	Lederblättrige Rose	*	2	3	3	3	3	2		2	G	4	R		3		
Rosa canina				*		*					*		*				
Rosa canina var. andegavensis		*															
Rosa canina var. blondaeana (= *R. nitidula*)	Glänzende Hunds-Rose	*			G												
Rosa canina var. canina	Hunds-Rose	*															
Rosa canina var. dumalis		*															
Rosa canina var. scabrata	Sparrige Hunds-Rose	*			G												
Rosa corymbifera				*		*					*		*				
Rosa corymbifera ssp. corymbifera	Hecken-Rose	*															

19 BY: Rhamnus saxatilis ssp. saxatilis
20 BY: Ribes rubrum ssp. rubrum

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Rosa corymbifera ssp. deseglisei	Deseglises Hecken-Rose	*			G												
Rosa dumalis	Graugrüne Rose	*	2			*		3		3	*		3		V		
Rosa elliptica	Keilblättrige Rose	3	1	2	2	3	2	3			3	4	1	R	1		
Rosa gallica	Essig-Rose	3 +	G	3	3	2						0			1	2	2
Rosa glauca	Rotlättrige Rose, Bereifte Rose	3		3	3	T											
Rosa inodora	Geruchlose Rose	*	2	D	3	3	3	G		G	0		R		1		
Rosa jundzillii	Raublättrige Rose		1	3	2	2						4		R	1	2	3
Rosa majalis	Mai-Rose, Zimt-Rose	*	G	2		T										3	R
Rosa micrantha	Kleinblütige Rose	3	1	3	3	3	2	3		0	3	4	R		0		
Rosa mollis	Weiche Rose	*					R						R				
Rosa pendulina	Alpen-Rose	*		V		u									1		
Rosa spinosissima (= *R. pimpinellifolia*)	Bibernell-Rose (Pimpinell-Rose)	*		V		*	R		3		R		1	R			2
Rosa rubiginosa	Wein-Rose	*	G	*		*					*		*		3		
Rosa rugosa	Kartoffel-Rose	N				T							*				
Rosa sherardii	Samt-Rose	*	V	D	3	R		2	R	3	2		*		2		
Rosa stylosa	Griffel-Rose	3		V							1						
Rosa subcanina	Falsche Hunds-Rose	*	V	*		*					*		*				
Rosa subcollina	Falsche Hecken-Rose	*	V	D	3	*		3	R	3	*		*				
Rosa tomentella	Stumpfblättrige Rose	3	1	V	3		3	3	R	3			*		2		
Rosa tomentosa	Filz-Rose	#	2	*	3	*		3		2	*		*		3	3	
Rosa pseudoscabriuscula	Falsche Filz-Rose, Kratz-Rose	*	3		G		3	3		2	*	4	*		G		
Rosa villosa	Apfel-Rose	*	G	2	R*	En		3		3	3		R	R			
Rubus acanthodes	Hofmanns Brombeere	*			1 !										V		
Rubus adornatoides	Schmuckartige Brombeere										*						
Rubus adornatus	Geschmückte Brombeere	!! E				♦					* !!						
Rubus adspersus	Hainbuchenblättrige Brombeere	*	R		R*						*						0
Rubus albiflorus	Weißblütige Brombeere	*		D		♦											
Rubus allegheniensis	Allegheny-Brombeere	N				♦					*		*				

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Rubus amiantinus	Asbestschimmernde Brombeere	*		D	R	♦				3	*						
Rubus amisiensis	Ems-Brombeere	!! E’									2 !!						
Rubus ammobius	Sandbewohnende Brombeere	*									*						
Rubus amphimalacus	Samtblättrige Haselblattbrombeere	!! E				♦											
Rubus anisacanthiopsis	Hakenstachelige Brombeere	!! E‘									*						
Rubus anisacanthos	Verschiedenbestachelte Brombeere	*						1					2				
Rubus apricus	Besonnte Brombeere	*		D		♦		R			R				0		
Rubus arduennensis	Ardennen-Brombeere	*			R*	♦					*						
Rubus armeniacus	Armenische Brombeere	N		*		♦					*		*				
Rubus arrhenii	Arrhenius’ Brombeere	*						3			*		*			2	
Rubus arrheniiformis	Reichswaldbrombeere										R						
Rubus asperidens	Rauzähnige Brombeere										*						
Rubus atrichantherus	Kahlmännige Brombeere	*								R	*		*			2	
Rubus atrovinosus	Schwarzrotdrüsige Brombeere	!! E		*							*						
Rubus axillaris	Achselblütige Brombeere	R									R						
Rubus balticus	Baltische Brombeere	!! E	R														
Rubus barberi	Barbers Brombeere	0 !! E’													0		
Rubus baruthicus	Bayreuther Haselblattbrombeere					♦					*						
Rubus batos-weberi	Webers Haselblattbrombeere										*						
Rubus bertramii	Bertrams Brombeere	*						R			*		V		1	1	
Rubus bifrons	Zweifarbige Brombeere	*		*		♦	R				*				V		1
Rubus braeuckeri	Braeuckers Brombeere	*									*						
Rubus braeuckeriformis	Schein-Braeucker-Brombeere	!! E‘									*						
Rubus bregutiensis	Bregenzer Brombeere	G		*	G												
Rubus buhnensis	Buhn-Brombeere	*						R			*						
Rubus caesius	Acker-Brombeere	*		*		*					*		*				
Rubus calvus	Kahlköpfige Haselblattbrombeere	*				♦					*		R				
Rubus calothyrsus	Schönsträußige Brombeere										R						

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Rubus calyculatus	Langkelchige Brombeere	!! E’									R						
Rubus camptostachys	Bewimperte Haselblattbrombeere	*			2	♦					*		*		2		
Rubus canadensis	Kanadische Brombeere	N															
Rubus canaliculatus	Rinnige Brombeere	!! E’				♦											
Rubus canescens	Filz-Brombeere	*		D	3	♦					R					1	3
Rubus chaerophyllus	Frischgrüne Brombeere	*			2												3
Rubus chamaemorus	Moltebeere	1		0		0			1	2			1				
Rubus chloocladus	Grünästige Brombeere	*					R				3					2	
Rubus chlorothyrsos	Grünsträußige Brombeere	*						R			3		3			1	
Rubus cinerascens	Aschgraue Brombeere	!! E’									*						
Rubus circipanicus	Circipanier-Brombeere	*	R		R*					2			2				R
Rubus cochlearis	Löffelblättrige Brombeere										*						
Rubus condensatus	Gedrängtblütige Brombeere	*		D	R	♦					*					G	
Rubus confusidens	Wirrzähnige Brombeere	!! E’									3						
Rubus conothyrsoides	Kegelstraußartige Brombeere	!! E’									*						
Rubus conspicuus	Ansehnliche Brombeere	*		D	R	♦					*						
Rubus constrictus	Zusammengezogene Brombeere	*			2	♦		1			2				0	G	2
Rubus contractipes	Kurzfüßige Haselblattbrombeere	*E									* E !!						
Rubus correctispinosus	Geradstachelige Brombeere	2 !!											2				
Rubus crassidens	Dickzähnige Brombeere	!! E									*						
Rubus curvaciculatus	Krummnadelige H‘brombeere			D							R		*				
Rubus cuspidatus	Zugespitzte Haselblattbrombeere	*		D	3	♦					R						
Rubus dasyphyllus	Dickblättrige Brombeere	*			R*						*		1				
Rubus decurrentispinus	Herablaufendstachelige H’brombeere	*	R										*				1
Rubus delectus	Auserlesene Haselblattbrombeere										*						
Rubus dethardingii	Dethardings Haselblattbrombeere	*				♦							3			1	
Rubus deweveri	DeWevers Haselblattbrombeere										R						
Rubus discors	Zwieträchtige Brombeere	2 !! E’								2	R						

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Rubus dissimulans	Unähnliche Haselblattbrombeere	*						1			1		*		1		
Rubus distractus	Spreizrispige Brombeere	*		*		♦					*						
Rubus divaricatus	Sparrige Brombeere	*		D		♦					*						
Rubus drejeri	Drejers Brombeere	*						1					*				
Rubus echinosepalus	Igelkelchige Haselblattbrombeere	!! E’									1						
Rubus ehrnsbergeri	Ehrnsbergers Haselblattbrombeere							2			*						
Rubus egregius	Ausgezeichnete Brombeere	*		D			R				2		V				
Rubus egregiusculus	Ausgezeichnete H’brombeere	2 !! E’					1						2				
Rubus eideranus	Eider-Brombeere	3 !! E											3				
Rubus eifeliensis	Eifel-Brombeere	*			R* !!	♦					*						
Rubus elatior	Höhere Brombeere	*		D													
Rubus elegantispinosus	Schlankstachelige Brombeere	*				♦				R	*					1	
Rubus erubescens	Errötende Brombeere	!! E									*						
Rubus euryanthemus	Weitblütige Brombeere	*								R	R		*				
Rubus fabrimontanus	Schmiedeberger H’brombeere	*				♦					*		*				
Rubus fasciculatiformis	Falsche Büschelblütige H’brombeere	!! E				♦					D E !!						
Rubus fasciculatus	Büschelblütige Haselblattbrombeere	*		D	3	♦					3		*				
Rubus ferocior	Wildere Haselblattbrombeere	*									*		R			G	
Rubus fioniae	Fünensche Haselblattbrombeere	*											*			2	
Rubus firmus	Violettdrüsige Haselblattbrombeere	2 !! E’											2				
Rubus flaccidus	Schlaffblättrige Brombeere	*		D		♦		2			D						
Rubus flexuosus	Zickzackachsige Brombeere	*		D		♦	1				R		2				
Rubus foersteri	Foersters Haselblattbrombeere										*						
Rubus foliosus[21]	Blattreiche Brombeere	*		*	R*	♦					*						
Rubus franconicus	Fränkische Haselblattbrombeere	*				♦											
Rubus frederici	Frits´ Brombeere	2									*						
Rubus frisicus	Friesische Haselblattbrombeere	!! E											V				

21 BY: Rubus foliosus ssp. foliosus

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Rubus fuscus	Braune Brombeere	*				♦					*		D				
Rubus galeatus	Helm-Brombeere	!! E									*						
Rubus gelertii	Gelerts Brombeere	*									R		3				
Rubus geminatus	Zwillings-Brombeere	G !! E’			0 !!										V		
Rubus geniculatus	Gekniete Brombeere	*			R*	♦		R		R	*						
Rubus glandisepalus	Drüsenkelchige Brombeere	R !! E				♦		2			* E !!						
Rubus glandithyrsos	Drüsensträußige Brombeere	*									*		*				
Rubus glauciformis	Blaugrüne Haselblattbrombeere	1					1										
Rubus glaucovirens	Blaugrüne Brombeere	!! E	R					0									R
Rubus godronii	Godrons Brombeere	G !! E’		D													
Rubus goniophorus	Winkel-Brombeere	*			R*	♦		1		1	*					2	
Rubus gothicus	Gotische Haselblattbrombeere	*		D	3	♦					2		*				
Rubus grabowskii	Grabowskis Brombeere	*		*		♦			1		*		2				
Rubus gracilis	Haarstängelige Brombeere			D							*		*				
Rubus gracilis ssp. gracilis	Südöstliche Haarstängelige Brombeere	*				♦											
Rubus gracilis ssp. insularis (= *R. insularis*)	Nordische Haarstängelige Brombeere, (Insel-Brombeere)	*				♦					2		*				
Rubus gratus	Angenehme Brombeere	*				♦					*		*		R		
Rubus gremlii	Gremlis Brombeere	*		*		♦											1
Rubus griesiae	Gries’sche Haselblattbrombeere										*						
Rubus grossus	Grobe Haselblattbrombeere	*		D		♦		R							3		
Rubus guentheri	Günthers Brombeere	*			R												
Rubus guestphalicoides	Weißblütige Westfälische Brombeere	R !! E									3E !!						
Rubus guestphalicus	Westfälische Brombeere	!! E									R E !!						
Rubus hadracanthos	Dickstachelige Haselblattbrombeere	*		D	3	♦					*		*				
Rubus haesitans	Unentschlossene H’brombeere	*	R								R		*				
Rubus hallandicus	Halland-Haselblattbrombeere	*					R						1			1	
Rubus hastiferus	Spieß-Brombeere	!! E’									R !!						

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Rubus hercynicus[22]	Harzer Brombeere	*		D	R	♦				0							
Rubus hevellicus	Heveller-Haselblattbrombeere	*				♦				1					2		
Rubus hirtifolius	Haarblättrige Brombeere	!! E															
Rubus hirtus	Dunkeldrüsige Brombeeren	*		D		♦					*						
Rubus hostilis	Rotmännige Brombeere	!! E		D		♦											
Rubus hypomalacus	Samtblättrige Brombeere	*			R*	♦					*		*				
Rubus hystricopsis	Stachelschwein-H'brombeere	*									2		*				
Rubus idaeus	Himbeere	*		*		*					*		*				
Rubus ignoratus	Unerkannte Brombeere	*				♦					*						
Rubus imbricatus	Dachziegelblättrige Brombeere	G									3						
Rubus imitans	Nachahmende Brombeere	!! E									*						
Rubus immodicus	Maßlose Brombeere	!!									*						
Rubus incarnatus	Inkarnat-Brombeere							1			2						
Rubus incisior	Eingeschnittene H'brombeere	!! E								2	* E !!						
Rubus infestus	Feindliche Brombeere	*				♦					*						
Rubus inhorrens	Ungleichstacheligere H'brombeere	!! E							1								
Rubus insulariopsis	Inselbrombeerähnliche Brombeere	!! E								R			*				
Rubus integribasis	Große Sparrige Brombeere	*		*						R	*		0			G	
Rubus josefianus	Josefs Haselblattbrombeere	G		D												2	
Rubus koehleri	Köhlers Brombeere	*			3 !	♦	R			1	R		R				
Rubus laciniatus	Schlitzblättrige Brombeere	N		*		♦					*		*				
Rubus laevicaulis	Glattstengelige Brombeere	*						2			*						
Rubus lamprocaulos	Feingesägte Haselblattbrombeere	*									*		*				
Rubus langei	Langes Brombeere	*			R* !	♦			1		*		*				
Rubus lasiandrus	Wollmännige Brombeere	*								1	*						
Rubus latiarcuatus	Breitbogige Brombeere	!! E						1		1	* E !!						
Rubus leptothyrsos	Dünnrispige Brombeere	*											*				1

22 BY; NI HB Lowland: R. h. ssp. hercynicus

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Rubus leucandrus[23]	Weißmännige Brombeere	*						1			2						
Rubus leuciscanus	Plötzensee-Haselblattbrombeere	!! E				♦							2		R		1
Rubus libertianus	Liberts Brombeere	R !! E'									1						
Rubus lidforssii	Lidforss' Haselblattbrombeere	*								1							
Rubus lignicensis	Liegnitzer Brombeere	0 E'													0		
Rubus lindebergii	Lindebergs Brombeere	*									R		2				
Rubus lindleianus	Lindleys Brombeere	*							2		*						
Rubus lividus	Bleigraue Brombeere	*			R	♦		1							0	G	
Rubus lobatidens	Lappenzähnige Haselblattbrombeere	*			R* !!		R	1			*						
Rubus loehrii	Löhrs Brombeere	*			G	♦					*						
Rubus longior	Längere Brombeere	R !! E									R						
Rubus loosii	Loos' Haselblattbrombeere										*						
Rubus luminosus	Lichtgrüne Haselblattbrombeere	*					R			1			*				
Rubus lusaticus	Lausitzer Brombeere	G !! E'													3		
Rubus maassii	Maaßens Brombeere	*				♦					R		1				
Rubus macer	Magere Brombeere	!! E									* E !!						
Rubus macrophyllus	Großblättrige Brombeere	*		*		♦	1				*		*				3
Rubus macrothyrsus	Schmalsträußige Brombeere	*					R	R		R			*			2	
Rubus marianus	Marienwald-Brombeere	!! E'								0			*				
Rubus maximiformis	Violettstachelige H'brombeere	*								R			*				
Rubus maximus	Riesen-Haselblattbrombeere	1 !! E					1										
Rubus meierottii	Meierotts Brombeere					♦					*					1	
Rubus melanoxylon	Schwarzholzige Brombeere	G				♦		1			* !!						
Rubus micans	Schimmernde Brombeere	G								1			3				
Rubus mollis	Weiche Haselblattbrombeere	*		D		♦										0	
Rubus montanus	Mittelgebirgs-Brombeere	*	R	D		♦					*		1				
Rubus mortensenii	Mortensens Haselblattbrombeere	1											1				

23 NI & HB Highland: R.l. ssp. leucandrus

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Rubus mucronulatus	Pickelhauben-Brombeere	*	R			♦					*		*				
Rubus muenteri	Münters Brombeere	*									2						
Rubus murrayi	Murrays Brombeere										*						
Rubus nemoralis	Hain-Brombeere	*	R	D	1						2		*		R		
Rubus nemorosoides	Falsche Hain-Haselblattbrombeere	*E									* E !!						
Rubus nemorosus	Hain-Haselblattbrombeere	*			R	♦					*		*		R		
Rubus nessensis	Halbaufrechte Brombeere			*		♦											
Rubus nessensis ssp. nessensis	Gewöhnliche Halbaufrechte Brombeere	*									*		*				
Rubus nessensis ssp. scissoides	Eingeschnittene Halbaufrechte Brombeere	*			2								*				1
Rubus neumannianus	Neumanns Brombeere	*		D	R* !!	♦		1			*						
Rubus nuptialis	Hochzeits-Brombeere	!!									* E !!		V				
Rubus obtusangulus	Stumpfkantige Brombeere	G		D													
Rubus ochracanthus	Gelbstachelige Brombeere										*						
Rubus odoratus	Zimt-Himbeere	*				T	R				*						
Rubus omalodontos	Flachzähnige Brombeere	!! E’									R !!						
Rubus opacus	Dunkle Brombeere	*			R*		R				*				3		1
Rubus oreades	Bergnymphen-Brombeere	*			1						*						
Rubus orthostachyoides	Geradachsenförmige H’brombeere	*		D		♦		2			*		1				
Rubus orthostachys	Geradachsige Haselblattbrombeere	*		D		♦	R			1	*						
Rubus palaefolius	Spatenblättrige Brombeere										3						
Rubus pallidifolius	Blaßblättrige Brombeere	3 !! E’											2				
Rubus pallidus	Bleiche Brombeere	*		D	2	♦					*		*		2		
Rubus pannosus	Dickfilzige Brombeere	*				♦					*						
Rubus parahebecarpus	Rheinländische Haselblattbrombeere	*								1	*						
Rubus pedemontanus	Träufelspitzen-Brombeere	*		*		♦					*		*				
Rubus pedica	Fußangelbrombeere					♦					R						
Rubus perdemissus	Bescheidene Haselblattbrombeere										2						
Rubus perperus	Lügen-Brombeere					♦											3

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Rubus pervirescens	Grünliche Brombeere	!! E					R			1	*						
Rubus phoenicacanthus	Purpurstachelige H'brombeere	1								1							
Rubus phoenicolasius	Rotborstige Himbeere					T					neo						
Rubus phyllostachys	Blattrispige Brombeere	*		D	R	♦					*						
Rubus phyllothyrsos	Blattsträußige Brombeere	2 !! E'											1				
Rubus picearum	Fichtenliebende Brombeere	!! E'									* !!						
Rubus picticaulis	Buntstengelige Haselblattbrombeere	!! E									R E !!						
Rubus placidus	Friedliche Haselblattbrombeere	*			R	♦					*		*				R
Rubus platyacanthus	Breitstachelige Brombeere	*				♦	R				*		R				
Rubus plicatus	Falten-Brombeere	*		*		♦					*		*				
Rubus polyothyrsus	Graurispige Brombeere										R						
Rubus polyanthemus	Vielbllütige Brombeere	*						3			*		3				
Rubus praecox	Frühe Brombeere	*		D	G	♦		1			*						0
Rubus praticolor	Wiesenfarbige Brombeere										R						
Rubus pruinosus	Bereifte Haselblattbrombeere	*			3	♦					D		*				
Rubus pseudargenteus	Falsche Silber-Brombeere	!! E				♦					* E !!						
Rubus pseudoincisior	Falsche eingeschnittene H'brombeere										R						
Rubus pseudinfestus	Falsche Feindliche Brombeere	E		*		♦											
Rubus pseudothyrsanthus	Falsche Straußblüten-Brombeere	*								R							
Rubus pugiunculosus	Achener Haselblattbrombeere										*						
Rubus pyramidalis	Pyramiden-Brombeere	*			3 !	♦					*		*				
Rubus radula	Raspel-Brombeere	*		D		♦					*		*		V		
Rubus raduloides	Raspelartige Brombeere	*			1	♦					*						
Rubus ranftii	Ranfts Haselblattbrombeere	!! E	R														R
Rubus raunkiaeri	Raunkiaers Haselblattbrombeere	*															
Rubus rhamnifolius	Faulbaumblättrige Brombeere	R !! E						1		1	2 E !!						
Rubus rhombicus	Rhombische Haselblatt-Brombeere			D		♦											R
Rubus rhombifolius	Rautenblättrige Brombeere	R !! E						1			R E !!						

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Rubus rhytidophyllus	Runzelblättrige Haselblattbrombeere	!! E															
Rubus ripuaricus	Ripuarier-Brombeere										*						
Rubus rosaceus	Rosarote Brombeere	*									*						
Rubus rudis	Rauhe Brombeere	*	R	*		♦					*		*				
Rubus rufescens	Rötliche Brombeere	R									R						
Rubus rugosifolius	Mittelwestfälische H‘brombeere										*						
Rubus rurae	Ruhr-Haselblattbrombeere										*						
Rubus saxatilis	Steinbeere, Felsen-Himbeere	*	3	*		*	V	2		2	3		*	R	1	3	3
Rubus saxicola	Felsenbewohnende Brombeere	!! E				♦					R E !!						
Rubus scaber	Scharfe Brombeere	1									1 !				1		0
Rubus scabrosus	Kratzige Haselblattbrombeere					♦					*						
Rubus schlechtendalii	Schlechtendals Brombeere	*				♦	R	R		R	*						
Rubus schlechtendaliiformis	Mittelholsteinische Brombeere	3 !! E											*				
Rubus schleicheri	Schleichers Brombeere	*		D		♦					*		*				
Rubus schnedleri	Schnedlers Brombeere	*		*		♦											1
Rubus sciocharis	Schattenliebende Brombeere	*				♦					*		*				
Rubus scissus	Eingeschnittene Brombeere	*	R								*		V				
Rubus senticosus	Dornige Brombeere	*		D	2	♦					*		2				
Rubus siekensis	Kegelstrauß-Brombeere	*					R			R	*		3				
Rubus silvaticus	Wald-Brombeere	*			R*						*		*				R
Rubus sorbicus	Sorbische Brombeere	G !! E													3	G	1
Rubus speculatus	Spiegel-Brombeere										*						
Rubus spinacurva	Kreidige Brombeere										*						
Rubus sprengelii	Sprengels Brombeere	*				♦					*		*				
Rubus sprengeliusculus	Breitrispige Haselblattbrombeere	2											2				
Rubus steracanthos	Hartstachelige Brombeere	*									*		R				1
Rubus stohrii	Stohrs Brombeere				2												R
Rubus stormanicus	Stormaner Brombeere	3 !! E					1			0			3				

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Rubus subcordatus	Herzähnliche Brombeere	*		*	3 !!	♦					R						
Rubus sulcatus	Gefurchte Brombeere	*	R	*		♦					*		V		1		
Rubus tenuihabitus	Zierliche Haselblattbrombeere										*						
Rubus tereticaulis	Rundstengelige Brombeere	*		*		♦											
Rubus tiliaster	Lindenblättrige Haselblattbrombeere	*				♦	1						2				
Rubus transvestitus	Falsche Samt-Brombeere			D	R* !!	♦					R						
Rubus trichanthus	Haarblütige Brombeere										R						
Rubus tuberculatus	Höckerige Haselblattbrombeere	*			R*	♦				R	*				R		R
Rubus ubericus	Ubier-Haselblattbrombeere										*						
Rubus ulmifolius	Ulmenblättrige Brombeere	*				♦					*		R				
Rubus vaniloquus	Angeber-Haselblattbrombeere	!! E						R		1	* E !!						
Rubus vestitus	Samt-Brombeere	*		D	3	♦					*		*				R
Rubus vigorosus	Üppige Brombeere	*	R		R	♦	R				*		0			2	
Rubus villarsianus	Villars' Haselblattbrombeere	G			R												
Rubus viscosus	Klebrige Brombeere	!! E'									*						
Rubus vulgaris	Gewöhnliche Brombeere	*				♦	R				*		2		0		
Rubus wahlbergii	Wahlbergs Haselblattbrombeere	*			R			1		R			*		R	2	
Rubus walsemannii	Walsemans Haselblattbrombeere	*	R					2					*				
Rubus wessbergii	Wessbergs Haselblattbrombeere	*			R* !					R			D		G		
Rubus winteri	Winters Brombeere	*				♦		2			*						
Rubus xiphophorus	Schwerttragende H'brombeere	!! E														1	
Ruta graveolens	Wein-Raute	N		3		T											3
Salix acutifolia	Spitzblättrige Weide	N				T											
Salix alba	Silber-Weide	*	V	*		*					*		*				
Salix alpina	Alpen-Weide	0			0*												
Salix aurita	Ohr-Weide	*	3	*		*					*		*				
Salix bicolor	Zweifarbige Weide	0						0								D	
Salix caesia	Blaugrüne Weide				R*												

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Salix caprea	Sal-Weide	*		*		*					*		*				
Salix cinerea	Grau-Weide	*		*		*					*		*				
Salix daphnoides	Reif-Weide	2		2	3		R					0	R				
Salix eleagnos	Lavendel-Weide	*		V													
Salix fragilis	Bruch-Weide	*	G	*		*					*		D			1	
Salix hastata	Spieß-Weide	*			R								R				0
Salix herbacea	Kraut-Weide	*			R												
Salix myrsinifolia (= *Salix nigricans*)	Schwarzwerdende Weide	3 -	3	*			0	0		0		0	R		1	R	
Salix myrtilloides	Heidelbeer-Weide	1 !			1												
Salix pentandra	Lorbeer-Weide	*	V	3	2	*		3	3	3	3		*		V	3	
Salix purpurea[24]	Purpur-Weide	*		*		*	3				*		*				
Salix repens						2						3		1	3	3	2
Salix repens ssp. argentea (= *Salix repens ssp. dunensis*)	Dünen-Weide	*					3						3				
Salix repens ssp. repens	Kriech-Weide	*	3	3	3		3	3			3		3				2
Salix repens ssp. rosmarimifolia (= *Salix rosmarinifolia*)	Rosmarinblättrige Weide	*	2	G	3		2						1		0a		0
Salix reticulata	Netz-Weide	*			R												
Salix serpyllifolia	Quendelblättrige Weide	*			R												
Salix starkeana	Bleiche Weide	2 !!	0	2	1												
Salix triandra				*		*					*		*		G		
Salix triandra ssp. amygdalina	Bereifte Mandel-Weide	*			G												
Salix triandra ssp. triandra	Mandel-Weide	*															
Salix viminalis	Hanf-Weide	*		*		*					*		*				
Salix x multinervis	Vielnervige Weide	*				*					*		*				
Salix x rubens	Fahl-Weide	*		*		*							*				
Salvia officinalis	Echter Salbei	N				u											
Sambucus ebulus	Zwerg-Holunder	*	R	*		*	R				*		*				
Sambucus nigra	Schwarzer Holunder	*		*		*					*		*				

24 BW: Salix purpurea ssp. purpurea

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Sambucus racemosa	Roter Holunder	*		*		*					*		*				
Solanum dulcamara	Bittersüßer Nachtschatten	*		*		*					*		*				
Sorbus acutisecta	Spitzwinklige Bastard-Mehlbeere	*				R											R
Sorbus adeana	Ades Mehlbeere				R E !! a												
Sorbus algoviensis	Allgäuer Zwerg-Mehlbeere				R* E !! a												
Sorbus aria	Gewöhnliche Mehlbeere	*		*		*					*						
Sorbus aucuparia ssp. aucuparia	Vogelbeere	*		*		*					*		*				
Sorbus aucuparia ssp. glabrata		*		D	R	D									R		
Sorbus badensis	Badische Mehlbeere	!! E		D	3 !!									G			
Sorbus chamaemespilus	Zwerg-Mehlbeere	*		R													
Sorbus cordigastensis	Kordigast-Mehlbeere				R* E !! a												
Sorbus cochleariformis	Löffelblättrige Mehlbeere				R* E !! a												
Sorbus decipiens	Täuschende Bastard-Mehlbeere	!! E												G			R
Sorbus doerriana	Doerrs Zwerg-Mehlbeere				R E !! a												
Sorbus domestica	Speierling	*		V	3	3					3S					3	3
Sorbus eystettensis	Eichstätter Mehlbeere				2 E !! a												
Sorbus franconica	Fränkische Mehlbeere	!! E			3 E !! a									G			
Sorbus gauckleri	Gaucklers Mehlbeere				2 E !! a												
Sorbus harziana	Harz´ Mehlbeere				2 E !! a												
Sorbus heilingensis	Heilinger Bastard-Mehlbeere	!! E												G			R
Sorbus herbipolitana	Würzburger Mehlbeere				3 E !! a												
Sorbus hohenesteri	Hohensters Mehlbeere				1 E !! a												
Sorbus hoppeana	Hoppes Mehlbeere				3 E !! a												
Sorbus intermedia	Schwedische Mehlbeere	N											*				
Sorbus isenacensis	Eisenacher Mehlbeere																R
Sorbus latifolia	Breitblättrige Mehlbeere	*		*		R								G			
Sorbus mergenthaleriana	Mergenthalers Mehlbeere				R E !! a												
Sorbus meirottii	Meierotts Mehlbeere				3 E !! a												

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Sorbus mougeotii	Mougeots Mehlbeere, Berg-Mehlbeere	*		D	R*												
Sorbus multicrenata	Vielkerbige Bastard-Mehlbeere	!! E												G			R
Sorbus pannonica	Ungarische Mehlbeere	*		D													
Sorbus parumlobata	Schwachgelappte Bastard-Mehlbeere																R
Sorbus perlonga	Langblättrige Mehlbeere				R* E !! a												
Sorbus pseudothuringiaca	Thüringische Eberesche	*			3 E !! a												
Sorbus puellarum	Mädchen-Mehlbeere				R* E !! a												
Sorbus pulchra	Gößweinsteiner Mehlbeere				3 E !! a												
Sorbus ratisbonensis	Regensburger Mehlbeere				3 E !! a												
Sorbus schnizleiniana	Schnizleins Mehlbeere				R* E !! a												
Sorbus schuwerkiorum	Schuwerks Mehlbeere				2 E !! a												
Sorbus schwarziana	Schwarz´ Mehlbeere				1 E !! a												
Sorbus subcordata	Arnstädtere Bastard-Mehlbeere	!! E												G			R
Sorbus torminalis	Elsbeere	*	2	*		*	2				3S		0		2		
Sorbus x rotundifolia	Rundblättrige Bastard-Elsbeere				3												
Sorbus x schinzii	Schinz' Mehlbeere	*			R*												
Spiraea alba	Weißer Spierstrauch	N				T					*		*				
Spiraea x billardii	Billards Spierstrauch					T					*		*				
Spiraea douglasii	Douglas Spierstrauch										*		*				
Staphylea pinnata	Gewöhnliche Pimpernuss	3		*	2	T					*						
Symphoricarpos albus	Gewöhnliche Schneebeere	N				T					*		*				
Syringa vulgaris	Gewöhnlicher Flieder	N				T					*		*				
Taxus baccata	Eibe, Europäische Eibe	3	0	3	3	*	R	3			3	3			R	R	
Teucrium chamaedrys				*							* S			3			
Teucrium chamaedrys ssp. chamaedrys	Edel-Gamander	*				*											
Teucrium chamaedrys ssp. germanicum		*															
Teucrium montanum	Berg-Gamander	*		3		R					3 S	3		2			

Scientific Name	German Name	DE	BB	BW	BY	HE	MV	NI & HB			NW	RP	SH	SL	SN	ST	TH
								High-land	Coastal regions	Low-lands							
Thymus serpyllum[25]	Sand-Thymian	*		2		3	3	1			2	2	3			0	
Tilia cordata	Winter-Linde	*	D	*		*					*		*	R			
Tilia platyphyllos	Sommer-Linde	*	D	*		*	G				*		*				
Ulex europaeus	Gewöhnlicher Stechginster	N				T	1	2	3	3	2		2			3	
Ulmus glabra	Berg-Ulme	*	3	*		V					3		V	2	V		
Ulmus laevis	Flatter-Ulme	*	V	V	3	*	3	3		3	2		3	1			
Ulmus minor	Feld-Ulme	3	3	*	3	3	2	3		3	3	2	*		3		
Vaccinium myrtillus	Heidelbeere	*		*		*					*		*				
Vaccinium oxycoccos	Gewöhnliche Moosbeere	3		3	3	3	V	3	3	3	3S	3	3	0		2	
Vaccinium uliginosum[26]	Moorbeere	*	2	V		R		3	3	3	2	3	3	1	3	3	3
Vaccinium vitis-idaea	Preiselbeere	*		3		3			2		3	3	1	0			
Viburnum lantana	Wolliger Schneeball	*		*		*					*						
Viburnum opulus	Gewöhnlicher Schneeball	*	V	*		*					*		*				
Viscum abietis			1														
Viscum album ssp. abietis	Tannenholz-Mistel	*		*	3										1		3
Viscum album ssp. album	Laubholz-Mistel	*		*		*					*		0				
Viscum album ssp. austriacum	Kiefern-Mistel	*		*		*											
Vitis vinifera ssp. sylvestris	Wilde Weinrebe	1		1		0						1					
Vitis vinifera ssp. vinifera	Weinrebe	N				u						*					

25 NI & HB Highland: Thymus serpyllum ssp. serpyllum
26 BB; NI & HB Highland/costal regions/lowland: Vaccinium uliginosum ssp. uliginosum

9.5 Overview of the genetic testing conducted in the *Länder* (isoenzyme and DNA analysis)

Tree species		Genetic analysis	
Scientific Name	**Common Name**	**Isoenzyme Analysis**	**DNA Analysis**
Abies alba	European Silver Fir	BY, RP, SN, BB, TH	BY, Thünen-Institut
Abies grandis	Giant Fir, Grand Fir	BY, RP, NW-FVA	
Abies procera	Noble Fir	BY	
Acer campestre	Field Maple, Hedge Maple	BY	
Acer platanoides	Norway Maple	BY, NW-FVA	BY
Acer pseudoplatanus	Sycamore	BY, NW-FVA, BB	BY
Alnus glutinosa	Common Alder, European Alder	BY, NW-FVA, BB, RP	
Alnus incana	Grey Alder	BY	
Alnus viridis	Green Alder	BY	
Betula pendula	European Birch, Silver Birch	NW-FVA, Thünen-Institut	RP
Betula pubescens	Downy Birch	NW-FVA, Thünen-Institut	
Carpinus betulus	Common Hornbeam, European Hornbeam	NW-FVA	BY
Cornus sanguinea	Common Dogwood, Dogberry		Thünen-Institut
Corylus avellana	Cob, Hazel	NW-FVA	NW-FVA

Tree species		Genetic analysis	
Scientific Name	**Common Name**	**Isoenzyme Analysis**	**DNA Analysis**
Crataegus monogyna	Single Seed Hawthorn, Mayhaw	NW-FVA	
Fagus sylvatica	Common Beech, European Beech	BY, SN, NW-FVA, BB, NW, Thünen-Institut	BY, RP, Thünen-Institut
Fraxinus excelsior	Common Ash, European Ash	RP	BY, Thünen-Institut
Juglans nigra	Black Walnut	NW-FVA	NW-FVA
Juglans regia	English Walnut, Persian Walnut	NW-FVA	NW-FVA
Larix decidua	European Larch	BY, NW-FVA, RP, Thünen-Institut	Thünen-Institut
Larix kaempferi	Dunkeld Larch	BY, NW-FVA, Thünen-Institut	
Larix x eurolepis	Japanese Larch	BY, NW-FVA, Thünen-Institut	
Malus sylvestris	Apple, Wild Crab	NW-FVA, RP, BB	NW-FVA, BB
Picea abies	Common Spruce, Norway Spruce	BY, SN, NW-FVA, NW, Thünen-Institut	BY, SN, NW-FVA, TH, Thünen-Institut
Pinus cembra	Arolla Pine, Swiss Stone Pine		BY
Pinus mugo	Dwarf Mountain Pine, Mountain Pine		BY
Pinus nigra	Austrian Pine, Black Pine	BY	BY
Pinus strobus	Eastern White Pine, Weymouth Pine		BY
Pinus sylvestris	Scots Pine	BY, NW-FVA, RP, BB, Thünen-Institut	BY

Tree species		Genetic analysis	
Scientific Name	**Common Name**	**Isoenzyme Analysis**	**DNA Analysis**
Populus canadensis	Canadian Poplar	BY, RP, NW-FVA, Thünen-Institut	BY, NW-FVA, Thünen-Institut
Populus x canescens	Grey Poplar	NW-FVA, Thünen-Institut	NW-FVA, Thünen-Institut
Populus nigra	Black Poplar	Thünen-Institut	Thünen-Institut
Populus tremula	Aspen	NW-FVA, Thünen-Institut	NW-FVA, Thünen-Institut
Populus trichocarpa x maximowiczii	Black Cottonwood, Western Balsam Poplar	NW-FVA, Thünen-Institut	Thünen-Institut
Prunus avium	Gean, Mazzard, Wild Cherry	SN, NW-FVA, TH	BY, SN, NW- FVA, BB, Thünen-Institut
Prunus spinosa	Blackthorn, Sloe		BY
Pseudotsuga menziesii	Douglas Fir	BY, RP, NW-FVA, NW, TH, Thünen-Institut	BY
Pyrus pyraster	Wild Pear	NW-FVA, RP	NW-FVA
Quercus petraea	Sessile Oak	BY, SN, NW-FVA, BB, Thünen-Institut	BY, RP, SN, Thünen-Institut
Quercus pubescens	Downy Oak	BY	BY, Thünen-Institut
Quercus robur	English Oak, Oak, Pedunculate Oak	BY, SN, NW-FVA, Thünen-Institut	BY, RP, SN, NW, Thünen-Institut
Quercus x rosacea		NW-FVA, Thünen-Institut	Thünen-Institut
Quercus rubra	American Red Oak	BY, NW-FVA	BY
Ribes nigrum	Blackcurrant		RP
Ribes rubrum	Currant	BY	

Tree species		Genetic analysis	
Scientific Name	**Common Name**	**Isoenzyme Analysis**	**DNA Analysis**
Robinia pseudoacacia	Acacia, Black Locust, Robinia	NW-FVA, Thünen-Institut	RP, Thünen-Institut
Rosa canina	Common Briar, Dog Rose	BY	
Salix alba	White Willow		NW-FVA
Salix aurita	Eared Willow		NW-FVA
Salix caprea	Goat Willow, Pussy Willow	NW-FVA	NW-FVA
Salix cinerea	Grey Willow	NW-FVA	NW-FVA
Salix daphnoides	Violet Willow	NW-FVA	NW-FVA
Salix fragilis	Crack Willow	NW-FVA	NW-FVA
Salix pentandra	Bay Willow, Laurel Willow		NW-FVA
Salix phylicifolia	Tea Leaf Willow		NW-FVA
Salix purpurea	Purple Osier, Purple Willow		NW-FVA
Salix repens	Creeping Willow	Thünen-Institut	NW-FVA
Salix x rubens	Hybrid Crack Willow		NW-FVA
Salix schraderiana			NW-FVA
Salix triandra	Almond Leaved Willow	NW-FVA	NW-FVA
Salix viminalis	Common Osier, Osier	NW-FVA	NW-FVA
Sambucus nigra	Common Elder, Elderberry	NW-FVA	

Tree species		Genetic analysis	
Scientific Name	**Common Name**	**Isoenzyme Analysis**	**DNA Analysis**
Sambucus racemosa	Red Berried Elder, Red Elderberry	NW-FVA	
Sorbus acutisecta			TH
Sorbus aria	Whitebeam		TH
Sorbus aucuparia	Rowan, Mountain Ash	NW-FVA	
Sorbus decipiens			TH
Sorbus domestica	Service Tree	BY, NW-FVA, RP	NW-FVA
Sorbus heilingensis		TH	TH
Sorbus intermedia	Swedish Whitebeam		TH
Sorbus isenacensis			TH
Sorbus latifolia agg.	Service Tree of Fontainebleau		TH
Sorbus parumlobata			TH
Sorbus pinnatifida			TH
Sorbus torminalis	Wild Service Tree	RP, NW-FVA, Thünen-Institut	NW-FVA, TH
Symphoricarpos albus	Snowberry, Waxberry	BY	
Taxus baccata	Common Yew, English Yew	BY, NW-FVA, TH	RP
Tilia cordata	Little Leaf Linden	BY, RP, Thünen-Institut	Thünen-Institut
Tilia platyphyllos	Large-Leaved Lime	BY, NW-FVA, RP, Thünen-Institut	Thünen-Institut

Tree species		Genetic analysis	
Scientific Name	**Common Name**	**Isoenzyme Analysis**	**DNA Analysis**
Ulmus glabra	Elm, Scotch Elm, Wych Elm	NW-FVA	
Ulmus laevis	Russian Elm	NW-FVA	
Ulmus minor	European Field Elm	NW-FVA, Thünen-Institut	
Viburnum opulus	European Cranber-rybush, Guelder Rose	NW-FVA	

(BLAG-FGR 2011)

9.5.1 Overview of further genetic testing conducted in the *Länder*

Tree species		Genetic analysis	Conducted by Federal State or Institution
Scientific Name	**Common Name**		
Salix daphnoides	Violet Willow	Salicin content	BB
Salix pentandra	Bay Willow, Laurel Willow	Salicin content	BB
Salix purpurea	Purple Osier, Purple Willow	Salicin content	BB
Quercus pubescens	Downy Oak	Species identification	BB

(BLAG-FGR 2011)

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