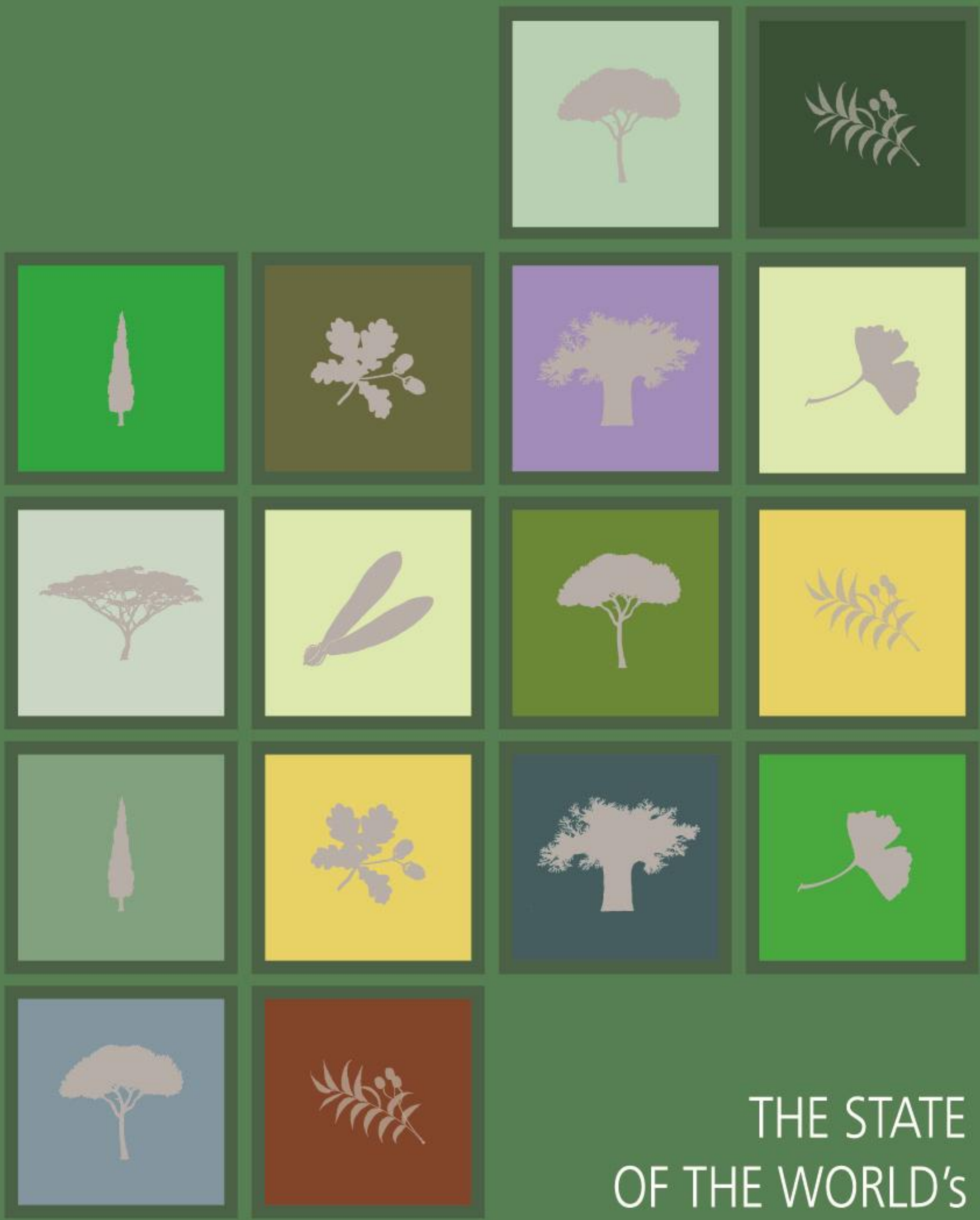


THE STATE
OF THE WORLD's
FOREST GENETIC RESOURCES

COUNTRY REPORT

THE RUSSIAN FEDERATION

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

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

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

Section I. **EXECUTIVE SUMMARY**

The forest area of the Russian Federation is 809,090 ha or 20.1% of the total forest area of the world (Global Forest Resources Assessment 2010). The country's forests are mostly natural. Annually artificial reforestation (planting or seeding of native species) is carried out on an area of about 200 hectares, and reforestation by means of promoting natural regeneration (creating conditions for rapid stocking of valuable native tree species) is carried out on an area of over 600 hectares, which is very important to preserving/maintaining the genetic structure of natural forests.

Forest ecosystems of the Russian Federation, spread over a huge territory, make a significant contribution to the regional and global stability of the biosphere, conservation of forest genetic diversity, maintenance of global carbon balance, and perform global ecosystem functions such as climate- and water-regulating, soil conservation, etc.

Russia's forests play a vital role in conserving the biodiversity of the temperate and boreal regions of Eurasia. The general state of the species diversity in Russia is quite good. In general, it corresponds to the level of biodiversity typical for the 8 natural areas of the country, as all of them have preserved the major floristic complexes. The main tree species of Russia are larch, pine, spruce, cedar, fir, oak, birch. Particularly high level of species diversity and dendroflora endemism are characteristic for Caucasus, Southern Siberia and the Far East. Being relatively few in number the main forest forming species in Russia have extensive and varied growing sites. In the vast areas of woody plants of the Russian Federation a special role in the biology of species belongs to genetic diversity within species, which provides populations of woody plants to adapt to specific habitats by natural selection.

Russia holds about 25% of old-growth forests in the world. These vast arrays characterized by the natural composition, structure and dynamics of population and coenotical mosaics, ensure the spontaneous development of tree populations. Old-growth forests have a natural (background) level of biodiversity and are a kind of sample area for the genetic, species and ecosystem diversity. These forests are important for the knowledge about the natural genetic structure of populations and the dynamics of population genetic processes.

Despite the good integrity of natural ecosystems in Russia and the prevalence of the landscapes undisturbed and low-disturbed by economic activity in general, over the recent centuries the gene pool of individual edificatory tree species in the European part of the country has undergone transformation and erosion as a result of continuous selective and mining logging and periodic catastrophic fires. Since the 1950s, a series of forest regions of Russia is experiencing the impact of toxic industrial waste and contamination.

The study of the flora of the country that started in XVIII century continues at the present time and involves the stuff of industry and academic research institutions, universities and botanical gardens. Detailed information about the vascular plants of Russia is presented by S.K.Cherepanov in the Summary Report "Vascular Plants of Russia and the Neighboring Countries" (1995) as well as in the 30-volume (with additions) publication "Flora of the USSR"(1934-1964). Despite the fact that in the country there are teams of qualified professionals the inventory of the plant species diversity of forest ecosystems has not been completed yet and there is no uniform list of species for the country. The study of the ecosystem, species and genetic diversity in the country has been uneven.

Russian scientists have analyzed (using morphological, karyological and molecular methods) the phylogenetic relationships of species and supraspecific taxa of trees, and have received the quantitative assessment of the genetic structure of populations of some certain species and species complexes. It has been found that the main forest forming species of Russia are characterized by high levels of genetic diversity within the populations, especially in the central part of their areas, local areas close to the ancient refugia and the areas of introgressive hybridization. Most species have a relatively poor spatial intraspecific genetic differentiation in the central part of their areas: 2-6% of the total variability accounted for the interpopulation component. In the outskirts of the areas the degree of differentiation increases. It has been found that, as a rule, sympatrical pairs of the same species are characterized by the interspecific introgression of genes. Genetic differences in the majority of the studied species are correlated with the geographic distances between populations.

The results of the study of the genetic diversity between and within tree populations in Russia are published mostly in the Russian language and are often presented in the publications which are difficult to reach by international scientific readership. In this regard, a special desk review of the data on the genetic diversity between and within species of woody plants in Russia presented in hundreds of Russian scientific sources was conducted especially for this Report. In cases when the genetic diversity values of the selected indicators were absent, they were calculated based on the available descriptions of allelic variation. The results of this large analysis are summarized in Tables IV.3d and IV.3e of this Report, which for the first time summarizes the main parameters of the genetic diversity between and within the populations of woody plants in Russia. Studies have found that conifer plantations represent a hierarchical structure of interconnected subdivided populations, and are not, as is so often appear, panmictic community where all differences are leveled by an unrestricted gene flow. Such hierarchical subdivided structures differ in sizes of the occupied territories and the number of individuals, the types of growing conditions and their proximity to the species optimum, degree of spatial subdivision, levels of intra-population diversity and inbreeding. Parameters and modes of the functioning of these population systems are determined by the following: the total effective size and the number of individual subpopulations, migration (through open pollination with different ways of pollen, seeds and fruit dispersal) and its limitations (different forms of insulation), crossing system (frequency of outcrossing, inbreeding and close crossing, and assortative crossing), Pleistocene and Holocene history, and introgressive hybridization with closely related species.

Knowledge received by the Russian science is unique and extremely important for strengthening the understanding and expanding the knowledge about the forest genetic resources of the world, they will contribute to the development of the international standards and protocols of inventory and monitoring of forest genetic resources.

The priority areas in the field of forest genetic resources in Russia should be:

- ✓ a large-scale inventory of forest genetic resources with the use of traditional and modern molecular methods, the integration of the genetic diversity assessment elements in the state forest inventory;
- ✓ study of the native genetic structure of tree species in old-growth forests and its response to climate change;
- ✓ study of the transformed genetic structure of species and its adaptation mechanisms in forests suffered from anthropogenic/radiation damage;
- ✓ study of the genetic structure of the populations of endemic, rare and endangered species, the marginal and small local mountain populations, "ancestral" populations in refugia, and the genome of hybrids with a significant heterosis effect;
- ✓ development of theoretical frameworks, methodologies and practical activity plans of the conservation and management of forest genetic resources at the federal level and the level of the federal subjects of the Russian Federation.

Russia has paid great attention to the system of specially protected areas (SPA) which is important for the conservation of forest genetic resources. In the botanical gardens and arboreta of Russia with the total area of more than 7.7 hectares, more than 17,000 species of vascular plants and more than 20,000 varieties and clones are cultivated. Different types of protected areas in the forest zone and mountain forest zone cover more than 120 million hectares (about 7% of the country). Forest vegetation of the country represented in the SPA system well enough, but the genetic diversity conservation goals are not integrated into the strategy of operation and development of this system.

Conservation of forest genetic resources in Russia is carried out not only in the specially protected areas, but also beyond – in the reserved and protective forests, and to some extent, in the commercial forests of the country. [1]In the 1960's the Federal Forestry Agency undertook measures for the *in situ* and *ex situ* conservation of the gene pool of forest forming tree species in the framework of programs on designating forest genetic reserves, plus trees and plantations, as well as a provenance trial plantations, clone banks, seed orchards, etc. Due to the economic and organizational problems over the last decade, these works have practically been suspended in the country.

The most important forest genetic resource conservation activity is creation of forest genetic reserves. Systematic work in this area in Russia began in 1982. Nowadays the country has 205,501 hectares of genetic reserves of 21 tree species. Besides, 15,205.5 hectares of plus 32 species plantations and 35,065 plus trees of 62 species have been isolated. In many federal subjects of the Russian Federation genetic reserves, plus-trees and plantations of many species have not been designated or sufficiently designated yet, which brings about an urgent need to continue this work and to improve their methodological framework.

For the forest seed production based on genetics and breeding and the *ex situ* conservation of forest genetic resources the following objects were created in the Russian Federation: clone banks and mother-tree plantations, provenance trial plantations, population cultures, seed orchards (SO)

[1] Protective forests (276.1 million hectares or 24% of forest land) and reserve forests (271.5 million hectares or 24% of forest land) have been identified for specific purposes. In addition, according to preliminary estimates of experts, the area of specially protected sites for different purposes is 12-15% of the total forest area of forest fund of the country.

and forest seed plantation. The above-mentioned sites together with the identified forest genetic reserves, plus trees and stands they form the single genetics and breeding system (SGBS).

In the current context of climate change the analysis of the adaptive and selective processes in the established provenance trial plantations in Russia is apparently interesting. Provenance trial plantations are recognized in the world as the valuable objects of the genetic diversity conservation, the study of its differentiation and adaptation of forest tree species populations to new environmental conditions and global climate change. The first provenance plantations were established in Russia in the late XIX - early XX centuries. Russian experience of the establishment of the network of main forest forming species provenance plantation in 1970-1980-s based on a unified program and methodology is a unique and one of the most ambitious experiments on the geographic variation of forest species in the world. At present, there are 872.1 hectares of provenance plantations in the country. The publication "Forest seed zoning of the main forest forming species in the USSR" (1982) was developed on the basis of the variation in natural populations and provenance plantations, as well as the natural and geographical regionalization of the country. It is planned to prepare a new seed zoning of the main forest forming species of the Russian Federation in 2013, which will be based on the assessment of the genetic differentiation degree of forest forming species populations. The work on the provenance trials is far from being complete, as Russia still lacks a summary analysis of the results of their long-term study. Due to the unprecedented scale of the created plantations their study is potentially productive for international cooperation.

When creating forest seed plantations in Russia the methods of forest selection based on the group (population) and individual selection are used. Individual selection is based on the selection and genetic studies of plus and elite trees, aimed at increasing the overall productivity and quality of the wood. Seed orchards (SOs) are one of the main objects of forest seed production. Nowadays the country has 6238.8 ha of seed orchards, 821.3 hectares of trial plantations, 588.9 hectares of clone banks. A considerable part of the SOs in Russia was established on the phenotype of the selected plus trees that were not progeny-tested. Great resources available in the Russian Federation for the development of positive selection are unevenly distributed between the SO establishment and programs of gene conservation and study, research-oriented and other breeding and genetic programs. Neither any economic analysis has been conducted in relation to this work in the country, nor the compilation and analysis of all rather contradictory results of surveys and studies of the SOs and trial plantations. However, as in other countries plus selection based on economically valuable characteristics has proven high efficiency, it is necessary to develop the scientific support of the work in this direction, especially in terms of the trial plus trees plantations (seed and vegetative origin), identifying elite trees, and establishing seed orchards of the II order based on the elite parent material. The primary need is to develop and implement programs to improve the selection and conservation of the gene pool for each forest forming species.

The share of different categories of SGBS objects of different tree species and their distribution in the regions vary considerably. The perspective of using them for the improved seed production is unclear. Creation of a complete reliable database on these sites and the results of their surveys open to study and scientific analysis is required. The extent of the discrepancy of the plus trees identified in the country and the volume of the trial plantations and clone banks to study them is a particularly relevant issue.

At present in the country only a few activities are carried out in relation to the establishment of hybrid and seed orchards with the interpopulation and interspecies crossing types that are capable of the heterosis effect of seed progeny. Over the last decades the underestimation of individual selection of various natural forms of forest woody species (primarily, decorative), their genetic research, breeding and introduction led to the fact that Russia is currently in the position of an outsider in the market of ornamental woody plants cultivators.

Forest exploitation and forest restoration measures, including those through improved plantations, should not lead to a breach of the naturally and historically formed population structure of forest tree species in Russia, and reduce the genetic potential of their populations. In this regard in the Russian context it is very promising to use a "group" selection of the best ("plus") trees within the seed production areas. In order to maintain genetic diversity during the development of the strategy and tactics of the genetics and breeding in the country it would be wise not to contradistinguish the group (population) and individual methods, but, evaluate their contributions and pursue the policy of optimization different breeding programs for some certain subjects of the Russian Federation with due attention to the genetic reserves and natural forests as well as population selection and individual selection on the basis of plus trees to create the appropriate categories of forests and plantations. It also requires the development of optimal technologies of various cutting types that will ensure the conservation of the genetic diversity of woody species populations, hence their stability and ability to adapt.

A very important issue is the improvement of the legislation of the Russian Federation on the of forest genetic conservation, in terms of specificity of the direct rules obliging members of forest relations implement the *in situ* and *ex situ* forest genetic resource conservation activities. It is crucial for the forestry authorities, botanical gardens and arboreta to seed banks, live collections, etc. After the forestry reform, linked to the introduction of the Forest Code (2006), in the Russian Federation there is no legally established system of accounting/control of the sources of reproductive material of forest plants (seeds, seedlings, transplants, cuttings, etc.) and its turnover (storage, sale, transportation, etc.). Currently, the country is drafting new legislative instruments in this area.

Actual development of the system of the federal forest seed funds and reserves is essential. In this case we need to use the experience of Russian scientists in creating cryobanks of seeds and backup storage in areas of permafrost, and develop a method for selection of seed/vegetative material to be deposited in the seed banks, seed collections and reserve funds based on data analysis of intraspecific genetic variation and their spatial organization in the areas of species.

The peculiarity of our country is that the forest genetic resources conserved *in situ* and *ex situ* are located on the territory of 83 subjects of the Russian Federation, each of which is governed by the federal law and also has its own legislation on the protection and use of wildlife, its forestry and conservation management bodies, its systems of protected areas, the Red Book of the subjects of the Russian Federation, forestry plans, targeted programs for the biodiversity conservation, etc. In addition, forest genetic resource conservation and management measures are implemented by the organizations of different ministries and departments whose uncoordinated actions often impede effective conservation and are fraught with irreparable losses in the absence of a coherent strategy and a common information system. Disunity and duplication of information about living botanical gardens, arboreta, institutions, etc., almost no uniform information about the *in vitro* collections of live cultures, fragmentation of the approaches to documenting and describing forest genetic resources preserved *ex situ* necessitate the development of a well-tuned coordination mechanism, a common information space and integration of academic and industrial research. It is required to create a unified scientific, methodological and information support for the conservation and utilization of forest genetic resources.

In order to ensure conservation of forest genetic resources, their effective and safe use in biological research and commercial purposes beneficial for the country it is necessary to create a common information policy. This is all the more urgent in the light of the world rapidly developing issues of access to genetic resources and sharing of benefits from their use (the Bonn Guidelines, the CBD and the Nagoya Protocol, etc.). The national pool of forest genetic resources in Russia is priceless, but is also an unpriced treasure. Russia has no clear rules on access to genetic resources and benefit-sharing issues especially from such use.

The problem of stable and adequate funding is rather acute in relation to research and coordination, as well as work on the design, organization, operation, protection, monitoring and inventory of forest genetic resources conservation. The lack of resources allocated by the state in the last decade to the study, conservation and management of forest genetic resources in the country, resulting in the loss of priceless objects and field experiments laid by previous generations of forest breeders and geneticists, loss and/or non-use of the results of their study, disruption of the continuity of scientific schools and research. The number of researchers, protection and control service experts, scientific research institutions, hospitals and missions do not match the scale of the country, the diversity of forest ecosystems and the value of forest genetic resources of the Russian Federation.

There is a need to disseminate scientific knowledge on the basics and achievements of the forest population genetics and breeding of the Russian population, and particularly among professionals working in the field of nature conservation and forest management. It is necessary to help increase the understanding of how the general public and business entities, and the true significance of genetic resources.

Forest genetic resources conservation and management of is a priority for the state, a national objective that is to integrate all of the current trends. However, the national programme of the forest genetic resources conservation and management has not been established in the country yet, and needs to be developed. In the conditions of the federal structure of Russia and decentralized management of its forests in this area it is necessary to develop a hierarchy of strategic planning with regional/sectoral objectives that are subordinate to the objectives of the national programmes, as the optimal decision making is only possible at the federal level with the participation of specialized expert scientific bodies. In addition it should be noted that the timber industry, which is represented by private business in Russia, is insufficiently involved in the issues of the conservation and management of forest genetic resources. Engagement of private sector into this kind of activities could provide the emergence of additional financial resources as well as the involvement of the existing private-owned infrastructure for the benefit of forest genetic resources conservation and management.

Russia has a considerable capacity of highly qualified specialists in the field of forest genetics and breeding. However, their communication with the international scientific community is limited only to small-scale international projects. No decision has been taken in relation to the Russian Federation joining to the EUFORGEN programme. As a result, Russia could not fully participate in the more specialized programmes developed by the European Union in the framework of EUFORGEN.

The international cooperation of the Russian Federation on the issues of conservation, research and management of forest genetic resources is of high importance. The national programme of the forest genetic resources conservation and management of the Russian Federation will benefit greatly from cooperation at the European, Asian, circumboreal and global levels.

Section II: **INTRODUCTION TO THE COUNTRY AND FOREST SECTOR**

Russia is located in the Northern Hemisphere, in the north of Eurasia. Ural Mountains and the Kuma-Manych depression divide Russia into the European and Asian parts, the latter includes the North Caucasus, Siberia and the Russian Far East. The country is bordered by the Pacific and Arctic oceans, as well as the Baltic, Black, Azov seas of the Atlantic Ocean and the Caspian Sea, having the longest coastline (37,653 km).

More than 70% of the Russian territory is occupied by plains and lowlands. The western part of the country lies within the vast East European Plain, which is characterized by alternating lowlands (Caspian, etc.) and elevation (Valdai, The Middle, etc.). Meridionally elongated Ural mountain range separates the East European Plain and the West Siberian Plain. To the east there is the Central Siberian Plateau with the isolated mountains which smoothly turn into the Central Yakut Lowland.

The southern and eastern parts of the country are mainly mountainous. The northern ranges of the Great Caucasus mountain stretch in the far south of the European part (here is the highest peak in Russia - Elbrus, 5642 m), Altai, Western and Eastern Sayan, the Stanovoi Range and other mountain ranges are located in southern Siberia. The North-East of Siberia and the Far East are the regions with prevailing medium-mountain ranges, such as Sikhote-Alin, Verkhoyansk, Cherskii etc. The Kamchatka Peninsula (here is the highest volcano in Eurasia - Klyuchevskaya Sopka, 4750 m) and the Kuril Islands in the Far East are the territory of more than 200 volcanoes, about 50 of them are acting.

The climate of the whole of Russia is characterized by a clear division of the year into the cold and warm seasons. Due to Russia's position in northern Eurasia (the country's territory lies mostly north of 50 ° N lat. Lat.) it is located in the arctic, subarctic, temperate and partly in subtropical climates. The largest part of the territory is located in the temperate zone. Diversity climate of the country also depends on the topography and the proximity or remoteness of the ocean.

Latitudinal zoning is most pronounced in the plains. The most complete range of natural areas is in the European part of the country, where the territory is covered from the north to the south by arctic deserts, tundra, forest tundra, taiga, mixed forests, forest-steppe, steppe, and semi-desert. Further to the east the climate becomes more continental; the number of natural areas in the same latitude range is greatly reduced.

Average temperatures in January, depending on the region, range from 6 to -50 ° C; in July from 1 to 25 ° C; maximum temperature difference is 116.6 ° C; according to this indicator, Russia ranks first in the world. Precipitation ranges from 150 to 2000 mm per year. Permafrost (the areas of Siberia and the Far East) is 65% in Russia.

The total area of the Russian Federation is 1,709,824 hectares, including inland waters - 71,685 hectares, the area of land - 1,638,139 hectares (FAOSTAT). According to the Global Forest Resources Assessment, FAO UN, in 2010 (FRA 2010) the forest area of Russia is 809,090 ha or 20.1% of the total forest area in the world.

According to the State Forest Register (SFR) for 01.01.2011, the total area of the Russian Federation covered with forests[2], is 1 183.3 million hectares, including the area of forest fund that is 1 144.1 million hectares (96.7%).

All forest land in the forest fund is under the federal ownership (Article 8 of the Forest Code).

In accordance with the Russian legislation the lands of the forest fund include forest land and non-forest land. Forest land is the areas covered with forest vegetation and areas not covered with forest vegetation but preserved for its recovery (logging, burning, land occupied with seed orchards, etc.). Non-forest land is the land designated for forest management (clearing, roads, etc.). Forest land covers 75.4% of the total forest area 67.4% of which is covered with forest vegetation, 8.0% is not covered with forest vegetation, 24.6% is the non-forest land.

In the territory of the Russian Federation in addition to the forest land there are a lot of specially protected areas (SPAs) - 26.2 million hectares, 1.4 million hectares of settlements, covered with forest, and 11.6 million hectares of land of other categories (Table II.1).

According to Article 10 of the Forest Code all forests located in the territory of the forest fund of the Russian Federation are classified according to the purpose into protective (26%), commercial (51%) and reserve (23%) forests. For each group there are certain rules of forest management, forest management planning, and management activities.

Forests in the Russian Federation are mainly natural. The share of forestry artificial stands and plantations makes only 2.3%. The most important feature of the Russian forests is the conservation of natural forest ecosystems that are not subject to human impact on large areas. Russia holds about 25% of the world natural old-growth forests.

Table II.1. **Information on forest fund land and forests located on the land of other categories as of 01.01.2011**

[2] Russian statistical data on forest resources is different from the data FAO used in FRA: according to the method of the State forest register the term "forest land" includes shrubs, covering the area of more than 75 million hectares, and urban forests with the area of 1.4 million hectares. According to the FAO methodology these categories of forest land are excluded from the concept of "Forest" and are included in the category of "Other wooded land» (OWL).

Land with forests	Area of land with forests, thousand ha					
	Total	according to the purpose			Forest land	Including land covered with forest vegetation
		protective	commercial	reserve		
Forest fund lands	1 144 115.7	276 067.9	596 509.0	271 538.8	863 086.1	770 621.2
Land of specially protected areas of federal significance	26 198.8	26 198.8	0.0	0.0	17 422.6	16 477.9
Land of settlements covered with forest	1 363.5	1 363.5	0.0	0.0	1 125.2	1 021.7
Land of other categories	11578.8	4281.6	6307.7	989.5	10126.7	9016
Total	**1 183 256.8**	**307 911.8**	**602 816.7**	**272 528.3**	**891 760.6**	**797 136.8**

The forest cover of the Russian Federation, i.e. the ratio of wooded land area to the total land area of the country is 46.6%. The forests are unevenly distributed across the country depending on the climatic and anthropogenic factors (Figure II.1). The greatest values of forest cover (80%) were observed in the Perm region, Komi Republic and Central Siberia. The sparsely forested areas (forest cover less than 1%) are the arid zone of the Republic of Kalmykia, parts of the Stavropol Krai, Astrakhan, Rostov and Volgograd regions. A significant increase in forest cover in Russia in recent years takes place due to the forested agricultural land.

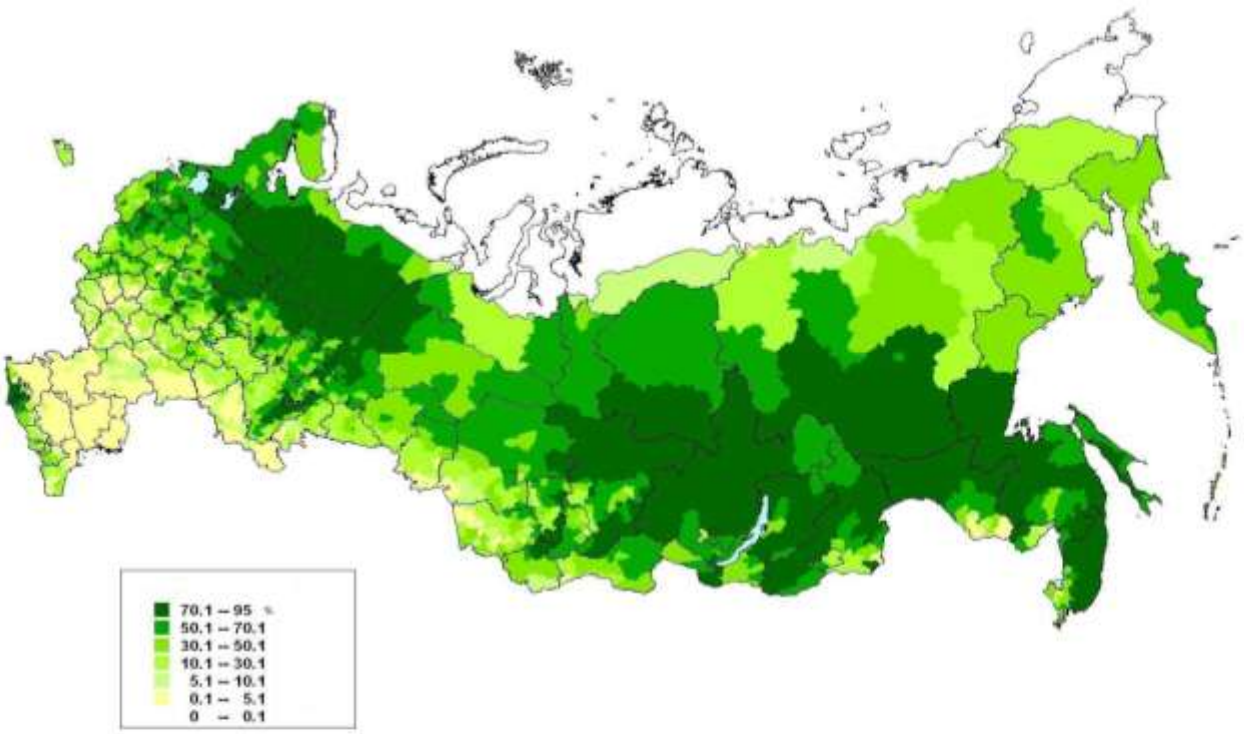


Figure II.1. **Forest cover of the Russian Federation, %**

Russian forests are mainly boreal: their area is 88% of wooded land. The main tree species are larch, pine, spruce, Siberian cedar, oak, beech, birch, aspen (Figure II.2). Areas with a predominance of these species occupy about 90% of the land area covered by forest vegetation, including plantations formed by coniferous tree species - 68.4%; hardwood - 2.4%; softwood - 19.4%. Other areas with a predominance of woody species (pear, chestnut, walnut, Manchurian walnut, etc.) are less than 1% of the land, the remaining area is covered with shrubs (dwarf Siberian pine, dwarf birch, etc.). The composition of the plantations formed with coniferous tree species has a significant proportion of mixed stands, where farming is aimed at forming plantations dominated by conifers.

The forest fund land is dominated by mature and old growth stands which account for 43.8% of the area, while 17.1% is occupied by saplings, 28.4 – by middle-aged forest, 10.7% - by the ripening forest. About 50% of the coniferous species are presented by mature and overmature stands. Plantations of different age groups are unevenly distributed across the country. Most of the area of mature and overmature stands is presented by of larch-dominated forests, which are located in Siberia and hardly exploited.

Figure II.2. **Distribution of the dominating species across the territory of the Russian federation**

Преобладающая порода – Dominating species
Сосна – Pine
Ель - Spruce
Пихта – Fir
Лиственница – Larch
Кедр – Stone pine
Дуб – Oak
Бук – Beech
Ясень – Ash
Вяз – Elm
Береза – Birch
Береза каменная – Stone birch
Осина - Asp
Липа – Lime
Ива – Willow
Кедровый стланик – Dwarf pine
Прочие породы – Other species
Безлесные территории – Unforested territories

According to SFR in 2011 the total timber volume in Russia is 83.4 billion m3, including 79.9 billion m3 of the forests located in the territory of the forest fund. In general, the average timber volume per 1 ha of mature and overmature stands (without shrubs) makes 132 m3, and in the woods available for timber harvesting it makes 165 m3. Annual average growing stock increment of forests in Russia is rather low and does not exceed 1.3 m3 per 1 ha of land covered with forest vegetation.

Since 1990 the forest land of the country has seen some positive changes in terms of the gross stand volume and timber increment. However, the stock increases mainly due to the increase in the area of low-value stands of small-leaved deciduous species. Besides, a significant accumulation of unproductive coniferous stands has been observed as well (V- Vb productivity class).

The overall average increase in the stands of the forest fund is 1017.4 million m3 per year, including 660 million m3 per year of commercial forests, and 853 million m3 per year of the forests where industrial logging is legally permitted.[3]

In addition to the considerable size (Russia is the largest country in the world in terms of area) and good conservation of natural ecosystems (about 65% of the country are landscapes undisturbed or low-disturbed by economic activity) the specificity of the Russian Federation is its federal structure. In accordance with Article 5 of the Constitution of the Russian Federation (1993) the Russian Federation consists of the equal subjects of the Russian Federation (Figure II.3) effecting independent decision making in relation to many issues of reforestation, management and conservation of forest genetic resources.

Figure II.3. **Distribution of the territory of the Russian Federation in seven federal districts, and 83 subjects (numbers in the figure show forest ranges created in accordance with the requirements of the forest legislation in order to create a regulatory framework for forest management taking into account the differences in the rules of use, reproduction, and protection of forests)**

Федеральные округа - Federal Districts
Северо-Западный – Northwestern
Центральный – Central
Уральский – Urals

[3] According to the silvicultural rules, the permissible wood removals should not exceed the average annual growth rate of the stand in the woods that are allowed to be used for timber production, and must take into account the losses caused by forest fires, windfall, outbreaks of pests and diseases.

Сибирский – Siberian
Приволжский – Volga
Южный – Southern
Дальневосточный – Far Eastern
Субъекты РФ – Subjects of the Russian Federation
Лесные районы – Forest areas

Public administration of the use, protection, conservation and rehabilitation of forests in the Russian Federation is exercised by the Government of the Russian Federation, the executive authorities of the Russian Federation, as well as the specially authorized state bodies for forest management, i.e. the Federal Forestry Agency (FFA) and territorial authorities in the federal districts. In addition to FFA; the Federal Service for Supervision of Natural Resources (RosPrirodNadzor) is responsible for the state forest management in relation to forests located on the land of the specially protected natural areas of federal significance; the Federal agencies of executive authority in charge of defense and security are responsible for the forests located on the land of defense and security in federal ownership (Figure II.4).

Federal Forestry Agency operates directly through its regional offices and subsidiary organizations in coordination with the other federal executive bodies, executive bodies of the subjects of the Russian Federation, local government bodies, public associations and other organizations. Forest districts and municipal forests are the basic territorial units of the country's forest management in terms of conservation, protection and reproduction.

Figure II.4. **Structure of forest management in the territory of the Russian Federation**

Леса Российской Федерации – Forests of the Russian Federation
Категории земель – Land Categories
Земли лесного фонда – Forest fund land
Земли обороны и безопасности – Land of defense and security
Земли ООПТ – Land of specially protected territories
Земли населенных пунктов – Land of settlements

Ведомственная принадлежность - Subordination
Рослесхоз - FFA
Минобороны – Ministry of Defense
Минприроды – Ministry of Natural Resources
Органы местного самоуправления – Local government bodies
Органы управления – Administrative bodies
Органы исполнительной власти объектов РФ – Executive authorities of the subjects of the Russian Federation
Квартирно-эксплуатационное управление – Housing and property management directorate
Росприроднадзор - Federal Service for Supervision of Natural Resources (RosPrirodNadzor)
Органы местного самоуправления – Local government bodies
Территориальные единицы управления – Territorial authorities
Лесничества, лесопарки – Forest districts, municipal forests

The types of permitted use of forest lands and lands of other categories are defined in forest regulations. Forests can be used for one or more purposes. The use of forests is a business carried on forest land by persons registered in the Russian Federation in accordance with the Federal Law of 08.08.2001 № 129-FZ "On state registration of legal entities and individual entrepreneurs."

According to the Federal Agency Forestry the authority of the Russian Federation includes:

- ✓ development and implementation of public policy and legal regulation of forest relations (with the exception of forests located in protected natural areas);
- ✓ control and supervision of forest relations (with the exception of forests, arrangement of the specially protected natural areas);
- ✓ provision of public services and the management of state property in the sphere of forest relations;

Federal Forestry Agency provides public services in the following areas:

- ✓ state forest inventory, forest management;
- ✓ forest pest monitoring;
- ✓ seed production;
- ✓ conduct of air operations for the protection of forests against fires;
- ✓ research;
- ✓ additional professional education.

The above services are provided by institutions and enterprises which are subordinate to the Federal Forestry Agency, or on the basis of public procurement through tenders.

Federal authority in the area of forest at the regional level are implemented through the Department of Forestry in the federal districts, which are the territorial unification of the subjects of the Russian Federation created according to the geographical distribution (Figure II.3). Federal Districts created in 2000 are the tools of the federal policy in all spheres of governmental administration in the federal political system.

The Russian Federation controls the exercise of authority in the sphere of forest relations delegated to the regions by means of analysis provided by the forestry bodies of the Russian Federation, forest plans of the subjects of the RF, forestry regulations, and other relevant reporting documents, as well as audits.

In 2011, 196.7 million m3 of timber was harvested on the territory of the forest fund, which is 21 million m3, or 13% more than in 2010 (Figure II.5). Just like in previous years, mainly coniferous wood (67%) was harvested, which inevitably leads to species replacement and depletion of coniferous stands. The allowable cut in 2011 was 666 million m3, including 67 million m3 in protective forests and 599 million m3 in commercial forests. The largest volume of the allowable cut - 144 million m3 - was defined for the pine block. The share of the allowable cut use in 2011 remained at the level of 2010 - about 21%.

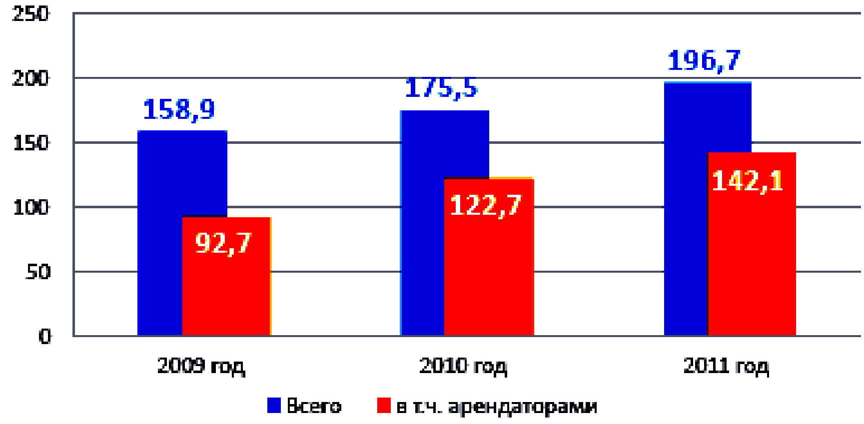


Figure II.5. **Dynamics of the cut timber volume, million m3**
Всего – Total
В т.ч. арендаторами – By tenants

Dynamics of the production volume of the main types of timber for the period from 1980 to 2010 is shown in Table II.2. 61% of the products (in cost measurement) produced in 2010 were consumed in the domestic market and the rest (39%) was exported.

Таблица II.2. **Dynamics of the production volume of the main types of timber in the Russian Federation for 1980-2010**

Main types of timber	1980	1990	1995	2000	2005	2008	2009	2010	2010/ 1980, %
Wood production, million m3	328.0	303.8	116.2	167.9	185.0	181.4	161.2	175.0	53.3
Lumber, million m3	80.0	75.0	26.5	20.2	22.0	21.6	19.0	19.0	23.7
Plywood, million m3	1.5	1.6	0.9	1.5	2.6	2.6	2.1	2.7	180.0
Chipboard, million m3	3.5	5.6	2.2	2.3	3.9	5.8	4.6	5.5	157.1
Fibreboard, million m3	1.5	1.5	0.8	0.9	1.3	1.6	1.3	1.4	93.3
Pulp production, th. tonnes	2405	2770	1801	2037	2429	2286	2014	2100	87.3
Paper and paperboard, th. tonnes	6998	8325	4070	5140	7126	7700	7373	7590	108.4

Despite the "modernization" of the lease (modification of the procedures for the access to forest management, timing of contracts, rights and obligations of the parties, etc.) introduced through the federal laws and regulations adopted in 2006-2012, the forest lease in Russia represents a unique form of cooperation between the state - forest owners - and private sector, which has no parallel in the international practice in terms of the organization of forest use.

The tenants of the sites are responsible for the forest management (reforestation, forest care, provision of sanitary and fire safety in forests) on the forest fund land leased for timber production. Forest management of the unleased forest land is performed by the organizations like unitary enterprises and autonomous institutions.

In 2011 the total area of the leased land was 212.0 million hectares, nearly 76.7% of the timberland holding is in the Northwestern, Siberian and Far Eastern Federal Districts. 142 million m3 (72% of the total harvested wood) was harvested on the leased forest areas. Over the whole period of the lease more than half a billion cubic meters of wood were logged, whereby the wood has been harvested in the regions well-developed in terms of transportation without making a significant investment in the development of transport and social infrastructure.

The reforms in recent years have led to the reduction in the number of employees of the forest-related industry in general and logging in particular (Figure II.6.).

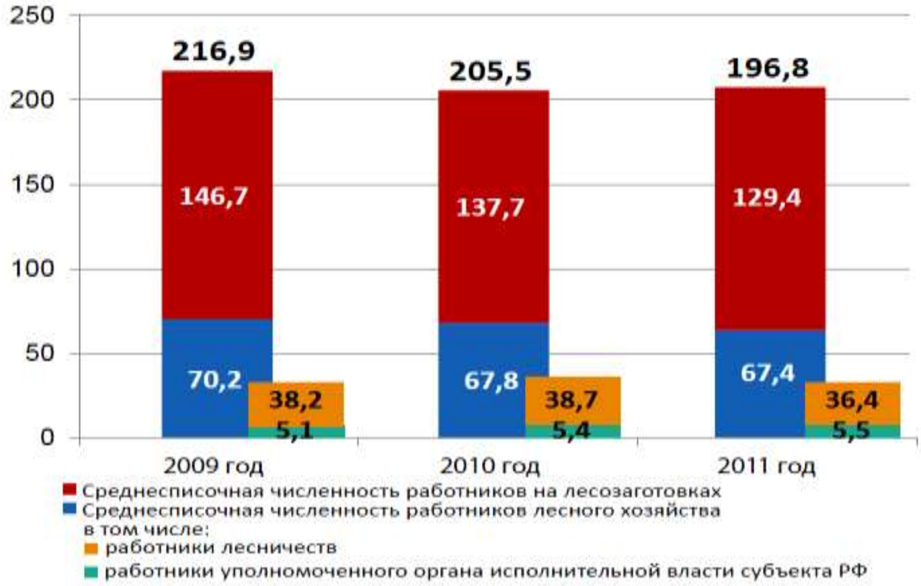


Figure II.6. **Dynamics of the number of forestry sector employees, in thousands.**

Среднесписочная численность работников на лесозаготовках – The average number of employees in logging

Среднесписочная численность работников лесного хозяйства – The average number of the forestry employees

В том числе: - Including:

Работники лесничества – Employees of forest districts

Работники уполномоченного органа исполнительной власти субъекта РФ – Employees of the authorized bodies of executive authorities of the Russian Federation

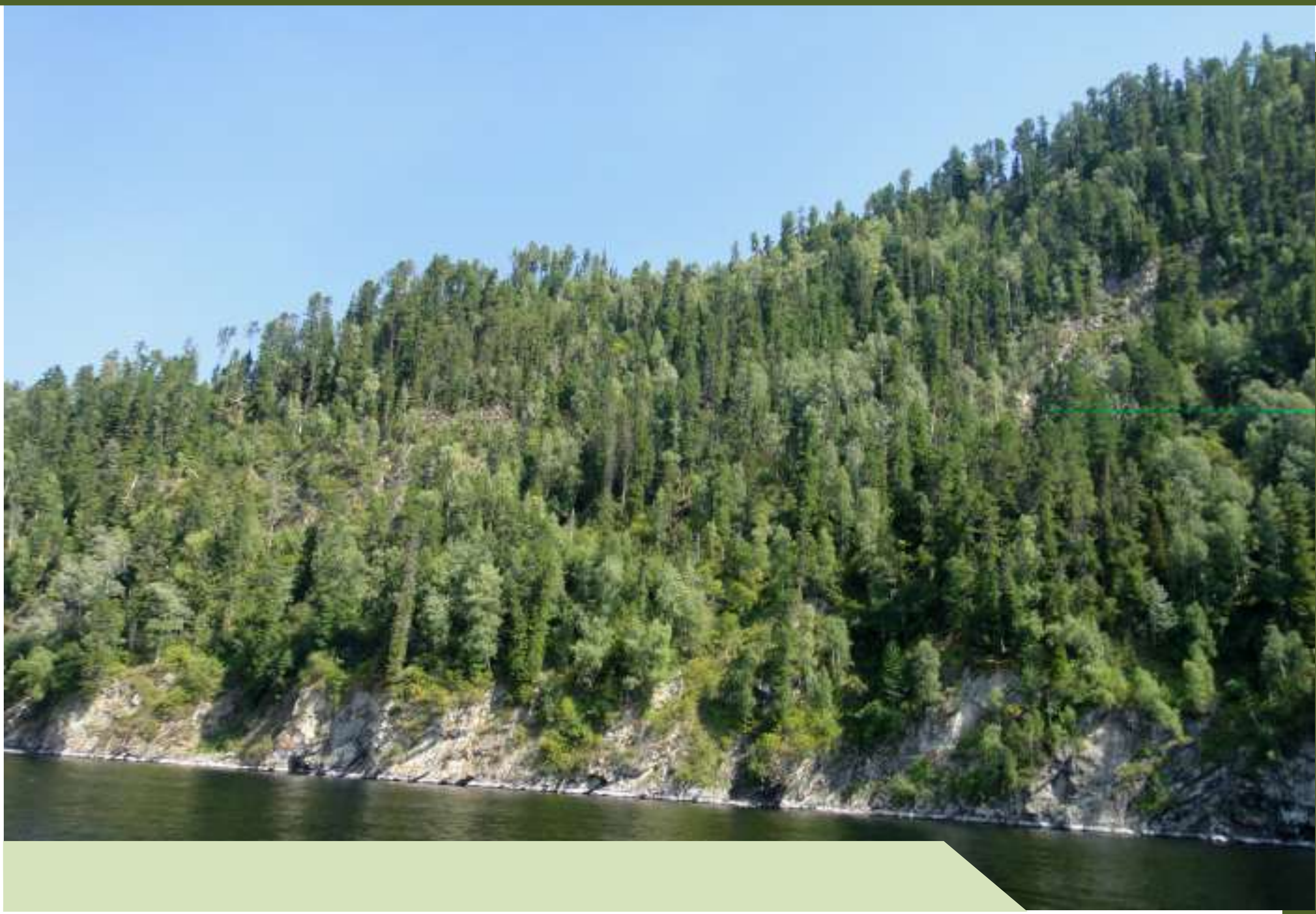
Under the procedures of access by the private sector to forest use that are established by the Forest Code of the Russian Federation there are great risks of corruption creating conditions for illegal logging and illegal timber trade. The consequence of the above-mentioned is the extensive forest management, low use of the forest resource capacity, low volume of forest industry output. Table II.3 contains indicators that characterize the place of the forest sector in the economy.

Table II.3. **Place of the forest sector in the economy of the Russian Federation (Rosstat, 2010)**

Indicators	The share of the forest sector, %
Gross domestic product	1.3
Industrial output	3.7
Foreign exchange earnings	2.4
Fixed investment	0.9
Employment (number of employees)	1.0
Flow of revenues to the budget system	0.2
Budget funding for research	0.01
Electricity consumption	2.0

The forest sector of the Russian economy, including forestry and all branches of the forest industry has been having a very long and hard time adapting to the market economy and providing for sustainable forest management. One reason for this situation is the fact that the forest sector is not a priority for the national economy development in terms of its contribution to gross income, value added, profits and revenue in the budget system; the priority in the country is still given to the fuel and energy sector.

The use of forest resources of the Russian Federation in the future should strive to the conservation and enhancement of social and environmental importance of forests while meeting the public needs for forest resources. The challenges that the forest sector faces create new opportunities to address them. Global ecological value, the enormous economic and social potential of the Russian forests oblige the Russian Federation to have a long-term state forest policy which determines the basic principles and direction of the development of the Russian forest sector in the twenty-first century.



Section III. **MAIN BODY OF THE COUNTRY REPORT**

Chapter 1
The state of the forest genetic resources

The natural level and structure of genetic diversity in forest ecosystems are determined by several existing evolutionary factors that are aggravated by anthropogenic impacts. The diversity of species and within species of woody plants in Russia is determined by paleoclimatic processes, especially by the events of the Ice Age, the reduction of areas, paths, and temporal dynamics of the subsequent dispersal of tree species of Pleistocene refugia, etc. The formation of the natural level of genetic diversity of forest ecosystems existing in Russia depends greatly on a variety of growth conditions (see Section II), competitive interactions between species, the impact on coenopopulations trees associated with forest ecosystems organisms (including insect herbivores and pollinators symbiotic mycorrhizal fungi and fungal diseases, zoocoric species - animals agents of seed dispersal). Fires and other occasional and often disastrous exposures have very strong impact as well.

The territory of Russia is unique in terms of the manifestation of the planetary latitudinal zonal patterns of genetic diversity, as it has a clear change of the zonal natural ecosystems. The specificity of forest ecosystems in Russia is the spread over the vast territory, respectively, many types of woody species are characterized by the formation of large area habitats. These vast areas see the gradual clinal change of climate, whereas in a number of areas - particularly in the mountains or ecotones - sharply contrasting changes of growing conditions are observed.

A unique feature of the Russian forests is the preservation of the vast territories of natural ecosystems, minimally affected by the economic activity. Russia holds about 25% of old-growth forests in the world. These vast area arrays characterized by the natural composition, structure and dynamics of population-coenotical mosaics (Eastern European forests ..., 2004), ensure the spontaneous development of tree populations. Old-growth forests have a natural (background) level of biodiversity and are a kind of sample area for the genetic, species and ecosystem diversity.

The general state of the species diversity of flora and fauna in Russia is quite satisfactory. The main faunal and floral complexes of all landscape areas of the country have been preserved. The main diversity of Northern Eurasia - the largest region of the planet – is concentrated in the territory of Russian. 14 out of 200 world’s ecological regions crucial in terms of maintaining the diversity of wildlife on Earth (Global 200) are located in Russia; they are located mainly in the mountainous regions of the Far East and Southern Siberia (Altai-Sayan ecoregion), the Caucasus, etc. In these areas there is a high level of endemism of plants and animals. According to preliminary estimates, about 20% of the flora and fauna of Russia consists of endemic species, many of which live in the forest ecosystem.

The main tree species in Russia are larch, pine, spruce, stone pine, fir, oak, birch (see Figure II.2). The largest share of the forest area is covered by forests dominated by different species of larch: Siberian (*Larix sibirica)*, Dahurian *(L. gmelinii)*, *L. cajanderi*, *L. czekanowskii*. Being undeveloped, most of this territory (particularly in Siberia and the Far East) is characterized by the old-growth structure of forests. Second large area is covered by the forests dominated by pine - *Pinus sylvestris*. Coniferous spruce and fir forests cover about 11.9% of the total forest area, just over half of them native to the European-Ural part of the country. In this group the largest area belongs to the forests dominated by spruce (*Picea abies*), Siberian spruce (*P. obovata*) and *P. ajanensis*, and hybrid forms of this spruce prevailing in the border of the areas (*P. abies* - *P. obovata* and *P. obovata* - *P. koraiensis*). Forests dominated by fir occur in a limited area - primarily in the Urals, the south and west of Siberia, the Far East. Pure stands in small areas can be formed by the following fir species: Siberian fir (*Abies sibirica*), Caucasian fir (*A. nordmanniana*), East Siberian fir (*A. nephrolepis*), Sakhalin fir (*A. sachalinensis*). The area of cedar forests growing mainly in Siberia (with a predominance of Siberian stone pine - *Pinus sibirica*) and in the Far East (with a predominance of Korean pine - *P. koraiensis*), is about 38.9 million hectares. In Siberia and the Far East there are formations dominated by dwarf-pine (*Pinus pumila*).

Most of the forest area occupied by Russian birch forests is dominated by silver birch (*Betula pendula*) and *B. pubescens*, as well as the forests dominated by aspen (*Populus tremula*). Birch and aspen forests are formed in clearings, burned areas, and abandoned farmland. Areas with a predominance of alder – speckled alder (*Alnus incana*), common alder (*A. glutinosa*) and *A. hirsuta*; poplars – black poplar (*Populus nigra*), *P. suaveolens*, Maksimovich poplar (*P. maximoviczii*); willow tree - *Salix alba* and *S. fragilis* which are usually located close to the river valleys. The largest areas of forest dominated by lime are concentrated in the European Russia and the Urals, where the species is represented by *Tilia cordata*; a smaller area is occupied by linden forests in the Far East with Amur linden (*T. amurensis*), Manchurian linden (*T. mandshurica*) and *T. taquetii*. In the Far East there are extensive forests dominated by stone birch. In these forests, there are several species of birch: Siberian yellow birch (*Betula costata*), *B. davurica*, stone birch (*B. ermanii*), *B. lanata*, iron birch (*B. schmidtii*).

About 55% of the oak plantations are concentrated in the European part of Russia, which is dominated by English oak (*Quercus robur*). In the Far East, oak forests are formed by the Mongolian oak (*Q. mongolica*). Forests dominated by saxaul (*Haloxylon aphyllum*) are a very rare type of plant communities typical of the Caspian Sea region. Forests dominated by other tree species:

chestnut (*Castanea sp.*), pear (*Pyrus sp.*), honey locust (*Gleditsia sp.*), walnut (*Juglans regia*), Manchurian walnut (*J. mandshurica*) occupy small areas. Plant communities that grow in adverse site conditions are made up mainly of dwarf birch species (*Betula ovalifolia*, *B. fruticosa*, etc.).

The forest area of the country is occupied by the vegetation dominated by the major groups of forest tree species, practically unchanged over the last decades, which indicates the stability of the ecosystem diversity. The summary of the major forest species in the categories of FRA 2000 is presented in Table IV.3.

The total system inventory of forest genetic resources has not been performed in the Russian Federation. FFA is planning to develop a methodology for assessing the genetic diversity parameters which will be included in the state forest inventory.

1.1. The state of diversity between and within species

The first review of the botanical vegetation of Russia was prepared by P.S. Pallas (1784). The first "Flora" of Russia was prepared by K. Ledeburom and published in Germany in the middle of XIX century. The studies of the country's flora are under way at the present time, the employees of the RAS institutes, universities and botanical gardens are involved in this work. Detailed information about the vascular plants of Russia is presented by S.K.Cherepanov in the Summary Report "Vascular Plants of Russia and the Neighboring Countries" (1995) as well as in the 30-volume (with additions) publication "Flora of the USSR"(1934-1964).

Russian forests have been studied and described thanks to the forest management fieldwork conducted over a long period. Currently, statistics on the state of forests, their quantity and quality is collected, analyzed and summarized in the process of the state forest inventory (SFI), state forest registry, formulating forestry regulations, forest development plans, materials, monitoring of forest fires and forest pathology, as well as the results of the forest order and organization monitoring assessment. The methodology of the SFI includes the records of rare and endangered species of trees, shrubs, vines and other forest plants, but does not assess the genetic diversity, although FFA is planning to develop such a methodology and include it into the SFI.

The annual reports issued in the country are the Report on the Status and Use of the Forest Resources of the Russian Federation (FFA) and the State Report on the Environmental Status and Protection of the Russian Federation (Ministry of Natural Resources of Russia) with the sections on the state of the animal and vegetal life, protected species, specially protected areas, etc.

The analysis of the sectoral information on the species composition of woody plants has identified several weaknesses in terms of data registration and aggregation (Alekseev, Zimnitsky, 2006). Information on the composition of forests of the Russian Federation and their profile is presented by the FFA mainly at the level of general species rather than individual species. Some of the materials in this Report will be presented accordingly.[4] In Table IV.3a the relevant categories of species mentioned in the report can be found.

Methods of analysis and evaluation of genetic variation. Quantitative assessment and monitoring of levels and patterns of genetic diversity of populations and species is the basis of the forest genetic diversity conservation and management, the basis of the assessment of the forest ecosystems breeding potential (including production potential).

The work on assessing the genetic variability of woody plants started with the analysis of the existing diversity form of the main forest forming species, including pine (Pravdin, 1964, 1975, Tcherepnin, 1982 Shutyaev, 2003), Siberian stone pine (Polikarpov et al), spruce (Morozov, 1976, Popov, 1999; Pravdin, 1964, 1975), larch (Dylis, 1947, 1961, 1981, Milutin, Kravtsov, 1984; Irosh-

[4] Latin names of trees and shrubs are provided in the text and tables of this Report in accordance with the book by S.K. Cherepanov "Vascular plants of Russia and the neighbouring countries" (the former USSR) / S.K. Cherepanov. - St. Petersburg: Mir i semya, 1995. 992 p.

nikov, 2004) and Siberian fir (Kokorin and Milutin, 2003), oak (Semerikov, 1986 Shutyaev, 2001, 2003, 2007), birch (Kudryashov, 1972 Makhnev, 1975 Rusanovich 1982, Danchenko, 1990), including Karelian (Liubavskii, 1966) and other (Romanovsky, 1982) aspen (Pchelin, 2000), etc.

Some species required the development of phenetic approaches using vegetative and volatility characteristics, such as the morphology of cones and coloration phenes of cones and seeds, crown shape, cortex coloration and character, the average weight of 1000 seeds, etc. (Danchenko, 1975, Mamaev, Makhnev, 1980, Milutin, 1982, Popov, 1999; Vidyakin, 2001, 2003, etc.). The main disadvantages of the phenetic approach is the small amount of phenes available for the analysis and the unknown mechanisms of inheritance. Phenetic analysis of seed coloration has been proposed to identify the pine clones in seed orchards (Vidyakin, Cockroaches, 2009) and is recommended by the authors for practical use (Kalchenko Cockroaches, 2010) as an inexpensive method to obtain relatively reliable identification parameters, preceded by molecular genetic certification and monitoring.

Russian phytocenology has developed unique methods to study plant populations which combine a profound study of the morphology, biology and ecology of populations, elaboration of the universal methods of developmental assessment and the spatial structure of populations, and the construction of the hierarchy of population units (Gatzuk et al., 1980; Shorina, Smirnova, 1985, Smirnov, 1987; Zaugolnova, 1994). The concept of discrete ontogeny description was developed to describe the structure of the population and especially its development in specific environmental and coenotical conditions and the tracking of various manifestations of differentiation in plant populations, (Rabotnov, 1950, 1975, Uranus, 1975; Cenopopulations ..., 1976, 1977, 1988; Population dynamics, 1975) and the idea of the polyvariant character of ontogenesis (Zhukov, 1995).

Karyology of woody plants. Woody plants, especially conifers are characterized in general by a very stable organization of genome in which significant deletions, translocations and inversions are very rare and do not show the required level of variability for the use in population studies. The number and aggregate morphology of chromosomes are stable within a species, but the use of differential staining of chromosomes in coniferous and deciduous forest formers are difficult due to the methodological problems. FISH (Fluorescent In Situ Hybridization) has recently been recognized as one of the most promising methods for karyological analysis which allows the physical mapping of the genes. However, the experiments on the localization ribosomal types of genes in the chromosomes on the Russian species of conifers, conducted by IOGen RAS with the participation of the experts from the Institute of Forest, SB RAS, are still in the pilot phase (Kvitko et al, 2011).

Molecular-based methods. Modern molecular-based technologies (allozyme and DNA markers) allow quantifying the level of genetic diversity in specific plantations. Evaluation of the genetic differentiation of populations can provide information about the degree of difference between the compared populations, groups of individuals, selected according to a particular feature, or individuals.

The bulk of the data on the genetic diversity and genetic processes in populations of woody plants in Russia was received by means of electrophoresis of isoenzymes. In the 1980-2000's for the first time Russian scientists received the quantitative assessment of the levels of genetic diversity (percentage of polymorphic loci, allelic diversity, heterozygosity) and its structure, namely the spatial and temporal distribution of parameters, such as estimates of the inbreeding levels (F_{IS}) at different stages of ontogeny, the proportion of the variation between populations in the total variability of the species (F_{ST}) etc. The relatively low level of volatility and limited number of the msot available markers (allozymes) in conifers is generally compensated by the high degree of polymorphism (from 50% to 90% of variable loci).

Starting from 1990 the methods of DNA polymorphism analysis of as the genetic information carrier have also been developed in the country: RAPD (PCR with random primers), ISSR (PCR analysis of inter-microsatellite sequence repeat of DNA), restriction analysis and sequencing of mitochondrial and chloroplast DNA, microsatellite loci of chloroplast and nuclear localization, AFLP (amplified fragment length polymorphism), etc. The main disadvantages of the so-called non-specific markers are anonymousness and dominance (RAPD, ISSR, AFLP), as well as low reproducibility (RAPD, less ISSR).

Despite the widespread practice of the microsatellite analysis, its application in forest genetics in Russia was hampered because of the absence of specific primers and methodological problems associated with the use of heterologous (developed for other species) primers. In addition, too high variability of microsatellite caused by the high evolution rate and the associated mutational "saturation" (microsatellites) make it difficult difficult to obtain estimates of diversity within populations, and differentiation in the analysis of large tree habitat areas. However, the work on the adaptation and use of microsatellite primers developed on other species or on the European populations of such species as pine, spruce and stone pine, has already started (Belokon et al, 2008; Mudrik et al, 2010).

Automatic sequencing of specific coding and noncoding genome zones actually has no methodological flaws, as this is a reading of the primary structure of DNA. However, for many organisms, including trees and shrubs native to Russia, there is a shortage of the developed PCR primers. In addition, all objects that are beyond the commercialized areas of scientific activity (forensic examination, intensive agriculture, certain branches of forestry and fisheries in the developed western countries), the use of this approach on the mass material in Russia is still not readily available. Automatic sequencing of samples for mass is only available in a few laboratories in the country mainly in the fundamental areas of population genetics.

A new generation sequencers that have appeared in the most recent years are capable of producing millions of DNA sequences of any organism in a short period of time and at a low labour cost. A whole genome species can be “collected” of these short sequences using the methods of bioinformatics. In addition to the difficulties that come up on the bioinformatics stage of such genomic work, there is a problem the forest tree genome complexity (for example, the average genome of a coniferous plant is approximately 6 times bigger than the human genome), and the problem of the high cost of equipment for the genome-wide sequencing, its maintenance, and the necessary reagents and consumables. In Russia the above methodological problems that affect not only the next generation sequencing but also other molecular methods are aggravated by high customs duties on the «hi-tech» products, as well as the weak linkages between the forest complex, which could be a potential customer of such work, and basic academic and university science, employing a few experts in the field. For many years the departmental research institutes and the FFA services did not consider neither modern nor traditional molecular markers as tools for learning, protection and management of forest genetic resources. However, in 2012 the Research and Education Center for Genomic Research, Siberian Federal University, started working on the genome sequencing of Siberian larch and cedar (Krutovsky et al. 2012).

1.1.1. Diversity between species

Russia occupies one eighth of the land mass of the planet - the major part of the extratropical Eurasia. Its territory represents a significant part of the ecosystem (biome) and natural landscape diversity of the temperate zone of the Earth, which is conserved due a relatively weak disturbance in Russia: up to 65% of the country, mainly in the Arctic, Siberia and the Far East preserves the natural mode of existing. Despite the high landscape diversity, the species diversity is relatively low compared to the more southern regions of the planet. General diversity state of the flora species in Russia is quite good. Save The main floristic complexes of 8 natural areas of the country have been preserved.

The native flora of the Russian Federation includes more than 12 500 species wild vascular plants belonging to 1488 genera and 197 families. The highest levels of flora are typical for Caucasus, mountains of southern Siberia and the Far East. The relatively high level of local biodiversity on the plains is characteristic for the zonal ecotones. Flora and fauna of the forest areas in the country has been studied unevenly. The exact number of native species on the whole of the territory of Russia is difficult to establish due to the insufficient knowledge of the indicator in some areas and the lack of aggregate data. According to preliminary estimates, about 30% of the species of vascular plants in Russia (about 3.5 thousand species) are associated with forest ecosystems. The flora composition of forests in Russia includes more than 1,000 species of wild trees, bushes, shrubs and vines, while about 180 native species of trees and shrubs are dominant or subdominant in forest ecosystems. The list of endemic and hemiendemic species of the Russian Federation together with the indication of their geographical area is given in Table IV.3b.

Karyology of woody plants. A great load of work has been done in Russia in order to clarify the taxonomic status of the species of woody plants. To date the chromosome numbers of almost all coniferous species (Kozubov, Muratov, 1986 Muratov Kruklis, 1988) and deciduous species are known. The database on the chromosome numbers of gymnosperms was created (Muratov, Knyazev, 2008). Many researchers was repeatedly recognized the conservatism of the basic chromosome numbers and the stability of the diploid genome of almost all gymnosperms (Muratov Kruklis, 1988). Russian conifers are mainly represented by pine (genera - *Pinus. Picea*, *Abies, Larix*) and cypress (*Juniperus, Cupressus, Microbiota*). Most conifers have a constant chromosome number within families (Muratov Kruklis, 1988). Pinaceous is one of the oldest families, and their basic chromosome number (x = 12) is the source for the majority of the related conifer families, as it is observed, for example, in the yew genus, *Taxus* family (Taxaceae). The basic chromosome number of cypress has decreased down to 11. A surprising conservatism is observed between species within genera of the pinaceous –all genera have x = 12 -, just like in most families.

Variability of chromosome numbers within species and even within genera of conifers is a rare phenomenon (e.g., in case of juniper, *Juniperus*, the variation of chromosome numbers is described as 2n=22 or 24). In the same way, the triploidy and tetraploidy of such genera as *Larix, Pinus, Picea* and *Abies* can be called a rare phenomenon. However, polyploid forms of pine usually have strongly marked morphological disorders and rarely survive to adulthood.

In terms of the differences in the morphology of the basic chromosomes the analysis of the variation within species of conifers is even more difficult than that on the superspecies level. However, in case of pinaceous the presence of supernumerary chromosomes (B-chromosomes) is common which is described, for example, in several species of spruce and common pine (Muratov Kruklis, 1988). Intraspecific differences in the total length of the chromosomes, the size of the individual homologues, and their morphology in terms of the chromosome number with secondary constrictions, the number of such constrictions in a genome, etc. are described as well. Among the pinaceous in Russia the following widespread species have been studies: common pine (Budaragin, 1973, Butorina et al, 1975, Butorina, Muraya, 1976, Butorina et al, 1979a, Butorina et al, 1979b), European and Siberian spruce (Skupchenko, 1975, Muratov Kruklis, 1988) and Ajan spruce (Shershukova, 1976, 1978). When comparing the marsh and upland populations of common pine it was shown that the variability of morphological parameters of the generative organs and sowing qualities of seeds, polymorphism of chromosome nuclear loci, the level and spectrum of chromosomal mutations characterize the adaptive response of plants and are the main criteria of differentiation of the marsh and upland populations of conifers (Sedelnikova, Pimenov , 2003, 2005; Sedelnikova et al, 2001, 2004, 2007). When analyzing the karyotypes of the weeping birch and the pubescent birch it was found that the latter is a tetraploid, while the yellow birch is a hexaploid. Karyological and molecular analysis has also revealed triploid individuals of aspen (Sivolapov et al, 2011).

Phylogenetic studies using molecular genetic markers. Against the background of generally low (compared to the subtropical and tropical forests) tree species diversity in Russia and its regions, we can often observe a co-existence of two or more species of the same genus (spruce, Siberian and Korean pine, Far Eastern pine, Siberian stone pine and dwarf pine, larch, birch and alder species, white poplar - aspen) that creates the prerequisites for specific hybridization in the condition of the overlapping of flowering periods, genetic, physiological and biochemical compatibility (Koropachinsky, Milutin, 2004). The emergence of hybrid zones, the lack of clear boundaries of areas within the species complexes leads to taxonomic problems and complicates the species biodiversity inventory. The list of the hybridized species pairs of woody plants in Russia, and test cases based on the morphology of the proposed hybrid molecular genetic methods is given in Table IV.3c. Wide spreading of hybrids indicates the immaturity of prezygotic isolation mechanisms in woody plants. Perhaps the ability to hybridize allows trees and shrubs to maintain and improve the levels of adaptively important variation in the sub-Arctic and boreal zones, especially at the edges of areas due to genes of closely related species.

Pine - genus *Pinus* L. Because of the presence of one or two vascular bundles in the needles, and other morphoanatomic signs, there are two recognized subgenera of pines: pitch pines (subgenus *Pinus*) and soft pines (subgenus *Strobus*, or *Haploxylon*). Genetic data fully confirm this division (Shurhal et al, 1991, Podogas et al, 1991). Such representatives of *Pinus* subgenus in Russia like *Pinus sylvestris* L., and the Far Eastern pine species *P. densiflora* Siebold. et Zucc. and *P. funebris* are spread throughout Eurasia. The allozyme analysis (Potenko, 2003; Potenko, Popkov, 2003) has revealed a significant genetic differentiation between omatsu (*P. densiflora*) and common pine, which, therefore, are "good" species. At the same time, *P. funebris*, according to the authors, belongs to the northern omatsu pine populations and has a hybrid origin as a result of crossing with *Pinus sylvestris*, which, thus, confirms its status (*P. x funebris Kom*.) proposed by V.L. Komarov and V. E. Bobrov (cited in Bobrov, 1978). *Pinus kochiana* Klotzsch ex. C. Koch which grows in Caucasus and is recognized as a species “Koch's pine” by some authors (Bobrov, 1978) is, according to L.F. Pravdin (1964) and some others, a subspecies of pine *P. sylvestris var. hamata Stev*. Allozyme analysis showed its proximity to the common pine and a just cause to keep it within *P. sylvestris*, however, and its differentiation is more pronounced compared to the subspecies within the species (races, varieties) as *sibirica, lapponica, cretacea, carpatica, rigensis* (Goncharenko, 1999).

As for the *Strobus* subgenus only the so-called stone pines grow in Russia in nature, and have the characteristic features, namely indehiscent ripe cones and large wingless seeds, which is an adaptation to the seed dispersal by corvids - nutcrackers. Stone pines are represented in Russia by three species: Siberian stone pine - *Pinus sibirica* Du Tour - widespread from the Urals to the southern Yakutia, Korean pine - *P. koraiensis Sieb.* et Zucc. - in Primorye and Khabarovsk, and dwarf pine - *P. pumila* (Pall.) Regel, - which has a unique shrublike or creeping form if life and grows from Baikal to the Pacific coast, Kamchatka, Sakhalin and the Kuril Islands. Genetic studies using allozyme analysis showed a close relationship of dwarf pine with Korean pine (Krutovsky et al, 1990; Politov et al, 1992; Belokon et al, 1998; Krutovskii et al., 1994, 1995, Politov, Krutovskii, 2004; Goncharenko et al, 1991; Goncharenko, Silin, 1997; Goncharenko, 1999; Shurhal et al, 1991; Podogas, 1992; Shurkhal et al., 1992), while the Siberian stone pine has the only close relative, the European stone pine - *P. cembra* L. from the Alps and Carpathians. The validity the Cembrae subsection in terms of the monophyletic origin of its constituent species has long been questioned. Obviously, their distinctive features such as large size and wingless seeds, and most importantly, unopened cones arose in evolution as an adaptation to the seed dispersal by Corvidae (nutcracker belonging to the Nucifraga genus) (Tomback, 1982, Tomback, 1983, Lanner, 1990, Tomback et al., 1990, Tomback, Linhart, 1990, Lanner, 1996) and can be rigidly determined by selection. In terms of the needle anatomy this group is heterogeneous (de Ferré, 1966); molecular data does not allow us to distinguish these five species in a monophyletic group, while various DNA markers have not provided any consistent phylogenetic reconstruction, or even any general pronounced differentiation within the *Strobus* section (Liston et al., 1999, Wang et al., 1999, Wang et al., 2000). The pattern observed in allozymes does not contradict to the polyphyletic origin of stone pine (Belokon et al, 1998; Politov, Krutovskii, 2004; Politov 2007). In the zone of the overlapping areas in the Baikal, Transbaikal and Yakutia there are forms intermediate between *P. sibirica* and *P. pumila* in terms of the morphology and anatomy, which have been identified as interspecific hybrids by means of molecular markers (Politov et al., 1999); moreover, the hybridization goes further than the first generation hybrids producing F2 hybrids and backcrosses (as a result of backcrossing to one or both parents (Goroshkevich et al, 2007, 2010, Petrova et al, 2007, 2010).

Spruce - genus *Picea* Dietr. The most common species of the spruce complex on the territory of Russia is the spruce *Picea abies* (L.) Karst., Siberian spruce *P. obovata* Ledeb., and Korean spruce *P. koraiensis*. Numerous genetic studies, based on the polymorphic allozyme loci data (Goncharenko et al, 1990; Goncharenko, 1999; Goncharenko, and fall 2001, Goncharenko, Potenko, 1991; Krutovskii, Bergmann, 1995) confirmed the existence of a broad zone of introgressive hybridization between *Picea abies* and *P. obovata*, originally described by the morphological data (Popov, 2005) - seed size, size and shape of female cones, and a diagnostic feature - the shape of seed scales which is rounded and smooth in the Siberian spruce, and is pointed and jagged in the Norway spruce.

Allozyme data showed that the zone of hybridization is even greater than previously thought (Politov, Krutovsky, 1998; Politov and others, 2011), and covers a huge area from the western borders of Russia to western Siberia, inclusive, where allele frequencies of allozyme loci vary clinally. In this case, however, it was assumed that a number of rare alleles in the middle of the hybrid zone, significantly different from the frequencies of other alleles between Siberian and Norway spruce, originate as a result of the intragenic recombination of these alleles in heterozygous hybrids, which is also one of the signs of introgressive hybridization (Krutovskii, Bergmann, 1995). In the east, from the Lake Baikal to Yakutia and on to the Khabarovsk Territory and Primorye (Potenko, 2007), we observe the influence of the Korean spruce genes (Politov et al, 2011), which also forms a zone of the introgressive hybridization with Siberian spruce.

In Eastern Siberia and the Far East there are several more spruce species, *P. glehnii, P. jezoensis, P. microsperma, P. komarovii, P. kamchatkensis.* Their research with the help of allozyme loci (Potenko, 2007) has revealed the genetic proximity of the continental populations of *P. Microsperma* and *P. komarovii* to *P. jezoensis*, and the potential conspecificity of these nominative taxa, while *P. kamchatkensis* and *Picea glehnii*, deserve a species status.

Fir - genus *Abies* Hill. Several species of fir grows in Russia with the most extensive area belonging to the Siberian fir, *Abies sibirica* Ledeb. *A. nephrolepis* and *A. sashalinensis* – the species close to the Siberian fir grow in the Far East. The observed clinal variation allowed the authors of studies (Semerikova, Semerikov, 2006a, b, 2008, 2011) conclude that there are areas of introgressive hybridization between them in Sakhalin. Studies using allozymes showed the independence of the Kamchatka species - *A. gracilis*, which also refers to the Siberian fir complex, but is more diverged from it than the Sakhalin and Khingam fir.

Larch - *Larix* genus. Broad hybrid zones are observed between the larch species in Russia in areas where their ranges contact (Koropachinsky, Milutin, 2006) which was confirmed by the genetic data with the use of different classes of nuclear and cytoplasmic molecular markers (Semerikov, 2007; Semerikov and others 2007; Semerikov, Polezhayev, 2007 ; Polezhayev, Semerikov, 2009, Polezhayev, 2010). Siberian larch - *Larix sibirica* - has an area of intergradation with Sukachev's larch (*L. sukaczewii)* in the west, and with Dahurian larch (*L. gmelinii*) in the east (Czekanow's larch hybrid populations - *L. czekanowskii*). The introgressive hybridization of *L. cajanderi* and *Olga L. olgensis* were detected in the Far East. The Kamchatka larch *kamtschatica* has diverged the most. The genetic data also speak in favour of the independence of larch populations *L. ochotensis* in the Magadan area.

1.1.2. Diversity within species

Russian scientists have studied in detail the existing form diversity of the main forest species, including pine (Pravdin, 1964), Siberian stone pine (Polikarpov, etc.), spruce (Morozov, 1976; Pravdin, 1964, 1975), larch (Dylis, 1947 1961, 1981, Milutin, Kravtsov, 1984; Iroshnikov, 2004), oak (Semerikov, 1986), birch (Kudryashov, 1972 Makhnev, 1975 Rusanovich 1982, Danchenko, 1990), including downy birch (Romanovsky, 1982) and Karelian birch (Liubavskii, 1966), aspen (Pchelin, 2000), etc. For a number of species variability of the generative characteristics, such as the morphology of cones and seed coloring phenes, the average weight of 1000 seeds, crown shape, color and character of the cortex, the timing of flowering, etc. was studied (Danchenko, 1975, Mamaev, Makhnev, 1980, Milutin, 1982 Vidyakin, 2001, 2003; Shutyaev, 2011, etc.).

Russian researcher' works (Smirnova et al, 1991; Popadyouk et al., 1995; Smirnova et al., 1995) showed the need for the concepts of the biocenotic cover population organization (Eastern forests ..., 1994, 2004) in the intraspecific diversity studies.

In the vast areas of woody plants in Russia a special role in the biology of species belongs to the genetic diversity within species, which provides populations of woody plants to adapt by means of natural selection to specific habitats, despite the fact that the potential integration processes in their gene pool (the exchange of genes through seed and pollen dispersal) should dominate the differentiation.

Common pine - *Pinus sylvestris* L. Common pine has one of the most extensive areas among all conifers of the world and grows in a wide range of environmental conditions. Studies of this species in Russia include mainly allozyme polymorphism loci (Goncharenko et al, 1991, 1993, 2002; Goncharenko, Silin, 1997; Semerikov et al, 1993; Petrov, Sannikov, 1996, Sannikov, Petrov, 2003; Sannikov et al, 1997, 2002; Shigapov et al, 1995; Yanbaev, 1989, Larionov, 2002), and found no pronounced spatial genetic differentiation or clear correlation of the variability of allozyme loci with the geographical distances between populations. Obviously, the ecological mechanisms of differentiation by partially adaptively loaded allozyme loci are prevalent in this species over the isolation by distance (Belokon et al, 1998; Petrov, Sannikov, 1996, Petrova et al, 1989; Sannikov, Petrov, 2003, Sannikov et al, 2010, 2011, Larionov, Eckart, 2010), resulting in changes in gradients of the genetic distances at a fairly short distance, marking the change of the growth conditions (Petrova et al, 2000; Sannikov, Petrov, 2003). Probably similar selection vectors in mosaic environments lead to similar frequency profiles by partially adaptively loaded allozyme loci in different parts of the species' area, so that in case of pine the local adaptation is prevalent over the geographical zonal and clinal patterns.

Siberian stone pine *Pinus sibirica* has been studied by several groups of researchers. The use of allozyme polymorphism revealed its weak spatial differentiation in the Urals and Western Siberia (Podogas et al, 1991, Podogas, 1993), in the populations located in the south of the Middle Siberia and Transbaikalia (Goncharenko et al, 1987, Goncharenko et al, 1992b , Goncharenko, Silin, 1997). In the central part of the species' area where the growth conditions are optimal low differentiation (2.5%) was observed in allozymes (Krutovskii et al, 1989; Krutovskii et al., 1994, 1995: Politov et al, 1992; Politov, Krutovskii, 2004), but the examination of the Baikal and Trans-Baikal populations has revealed a higher F_{ST} index (4.4%); besides, after the expansion of the research area the genetic subdivision turned out to be quite pronounced (5.9%) and comparable to the differentiation between *P. sibirica* and the Alpine-Carpathian species - *P. cembra* (8.9% according to the combined data (Politov, 2007).

Korean pine *Pinus koraiensis* was the only stone pine species with the genetic differentiation obviously not associated with the geographical location (Potenko, great, 1999, 2002; Velikov, Potenko, 2006; Belokon et al., 2008, Belokon, 2007; Politov, 2007).

Dwarf pine *Pinus pumila*, which is akin to the Korean pine, is a species well differentiated by the habitat (F_{ST} = 12%). Thus, only in the Pacific interpopulation variability component (F_{ST}) was 10.9%. The groups well-defined in terms of allozymes are the Baikal populations, the transition cluster population of the Stanovoi Range and the Stanovoi plateau (the Baikal-Amur Mainline area), and Pacific populations, with the most pronounced differentiation found in the sample of southern Kamchatka, Sakhalin and the Kuril Islands, where the genetic isolation has long been established (Belokon et al, 2009, Politov et al, 2009). It is noteworthy that other authors' studies of the same species (Goncharenko et al, 1992, Goncharenko, Silin, 1997) had an attempt to ascertain the average degree of subdivision (4.9%) and the absence of connection between the allozyme variation and the geographical location, which probably was caused by the lack of representativeness of the material, in particular, the small sample size used for the analysis. Diversity within the species of dwarf pine turned out to be the highest among all studied species of pine in the world. Thus, this species has more than 90% of the variable allozyme loci, allelic diversity of A = 2.17, and the average expected heterozygosity of 0.249 (Krutovsky et al, 1990; Politov et al, 1992), 0.231 (Politov, 2007; Belokon et al, 2009), 0.271 (Goncharenko, Silin, 1997), which probably helps this species to adapt to the harsh growing conditions.

Norway and Siberian spruce. As noted in the section "Genetic diversity between species", the Norway and Siberian spruce complex is characterized by the clinal variation caused by the introgression of genes between *Picea abies* and *P. obovata* in the west, and between *P. obovata* and *P. koraiensis* in the east (Krutovskii, Bergmann, 1995; Goncharenko Potenko, 1991; Goncharenko, and Padutov, 2001). Within the "pure" populations of Siberian spruce unaffected by hybridization the subdivision over large areas is weak - 2.83% (Kravchenko et al, 2004; Larionov et al, 2007, Politov et al, 2011). Maximum values of genetic diversity within populations are observed in the Urals and the adjacent areas of the north-east of the European part of Russia and in Western Siberia (Krutovskii, Bergmann, 1995; Politov et al, 1998; Politov, 2007), that is the assumed secondary center of diversity, where the dispersing Norway and Ural-Siberian spruce refugia gene pools met during the latest interglacial period and then in the Holocene age.

The continental populations of **Ajan spruce** - *Picea jezoensis* - have a low level - 2.4% - of intraspecific allozyme genetic differentiation (Potenko, Knysh 2003).

As for the diversity within the fir species - ***Abies* Hill genus** - the highest levels of genetic diversity within populations by allozymes and chloroplast microsatellite is observed in Sakhalin fir (*Abies sachalinensis)*, whereas other species are less variable (Semerikova, Semerikov, 2006). The intraspecific differentiation was relatively high in *A. sachalinensis* F_{ST} = 8.3%, quite low in *A. nephrolepis* - 4.4% (Semerikova, Semerikov, 2006) and Siberian fir (*A. sibirica)* in the central part of the area even taking into account the heterogeneity of the samples by growth areas altitude - 4.3% (Eckart, 2004, 2006). However, the study of a broader area of *Abies sibirica* could identify a significant differentiation in allozymes (F_{ST} = 9.3%) (Ce merikova, Semerikov, 2006; Semerikova, 2008), as well as in AFLP-markers (14.1%) (Semerikova, Semerikov, 2011).

Larch - *Larix* genus. In general, most larch species in Russia (*Larix sibirica, L. gmelinii, L. kamtschatica*) are characterized by high levels of genetic variation in molecular markers of genes. Variability levels are reduced in cytoplasmic markers of the populations of *L. cajanderi* and *L. kurilensis*. In terms of allozyme loci *L. olgensis* also has a reduced of genetic diversity within populations, but it does not affect the high level of variability in the mitochondrial and chloroplast markers. Taking into account the complex taxonomic structure of larch with no clear species boundaries, it is difficult to interpret the estimates within population differentiation. According to the allozyme data, the share of the interpopulation variation (F_{ST}) of *L. sibirica* within species was 0.079, while *L. gmelinii* had the share of 0.021.

Hardwood. Unlike conifers, genetic studies of diversity levels between and within hardwood species in Russia are very few. The genetic diversity levels and differentiation of a number of *Quercus* genus species were examined: *Q. robur* has an average level of differentiation and turned out to be close to the estimates derived for conifers (Gabitova, 2012; Gabitova et al, 2012; Bushby et al, 2012). The Far Eastern oaks *Q. dentata* and *Q. mongolica* are characterized by a high level (0.199 and 0.165, respectively) of the intrapopulation genetic diversity in allozymes (Potenko et al, 2007). High values of heterozygosity (0.205) were obtained for weeping birch (Konovalov et al, 2001, 2003, Yanbaev et al, 2009) and aspen (Yanbaev, 2002). At the same time, the black poplar and maple (Yanbaev, 2002) are characterized by the decreased genetic diversity (0.077).

The results of the study of genetic diversity of between and within tree populations in Russia are published mostly in the Russian language and are often presented in the publications which are difficult to reach by the international scientific readership. In this regard, a special desk review of the data on the genetic diversity between and within species of woody plants in Russia presented in hundreds of Russian scientific sources was conducted especially for this Report. In cases when the genetic diversity values of selected indicators were absent, they were calculated based on the available descriptions of allelic variation. The results of this large analysis are summarized in Tables IV.3d and IV.3e of this Report, which for the first time summarizes the main parameters of the genetic diversity between and within populations of woody plants in Russia.

The application of the molecular markers of different classes (allozymes, PCR-RFLP fragments of mitochondrial DNA, chloroplast and nuclear microsatellites) have refined the phylogenetic relationships and the status of the species to obtain the quantitative estimates of the genetic processes parameters of coniferous populations in Russia. The combination of markers with the different mode of inheritance allowed receiving additional information about the features of the gene flow of seeds and pollen.

The studied coniferous species in Russia in general are characterized by a high level of intra-allelic and gene diversity. The highest levels of variability observed in common pine and dwarf pine, spruces (the *P. abies - P. obovata* complex), firs - *A. sachalinensis*, larches - *L. kamtschatica* and *L. gmelinii*. For the most species a relatively weak spatial genetic differentiation was revealed in the central part of the area, 2-6% of the total variability accounted for the interpopulation component. The degree of differentiation increases on the outskirts of the areas. In the sympatric pairs of the same species, as a rule, the introgression of genes between species is observed.

The analysis of the gene geography of the most species shows a significant dependence of the genetic distances to the geographic origin of samples. The exceptions are pine and fir (in the central part of the area) where the local differentiation linked to the contrasting environmental conditions is likely to prevail over the geographic structuring by the mechanism of isolation by means of distance. The Korean pine has weak differentiation with no link to the geographical location.

The analysis of the mating system and the genotypes distribution balance showed that conifers are usually have deficient heterozygotes of the fetus, which results from the inbreeding due to self-pollenating (0-15 % in the majority of species) and inbreeding. The frequency of self-pollination increases with the decrease of the effective size and population density.

During the formation of the mature conifer plantations the less adapted inbred offspring is eliminated from the pool of embryos; as a result the distribution of genotypes in the adult plant samples is usually close to equilibrium. In some cases there is slight excess of heterozygotes due to balancing selection. The use of mass selection and inbreeding control by means of molecular genetic markers at the early stages of the artificial reproduction can improve the quality of seed progeny of conifers.

Studies have found that conifer plantations are not the panmictic communities where all differences are leveled by the gene flow, but the hierarchical structure of interconnected subdivided populations. The parameters of these population systems are determined by the effective size of populations, migration (including cross wind-pollination and various ways of seed dispersal) and its limitations, mating system, Pleistocene and Holocene history, and introgressive hybridization with a closely related species.

It is characteristic that the endemic species of coniferous and marginal populations are often, but not always, genetically depleted, which underlines the role of natural selection in shaping the genetic structure of populations. It is necessary to distinguish between geographically marginal populations that still grow in the conditions close to the optimum, and ecologically marginal populations, where the selection intensity and vectors are different from that in the central part of the area.

The vastness of the territories covered by many tree species in the Russian part of their areas make it difficult to analyze the spatial distribution of genetic diversity, as the field genetic data are usually obtained for a small number of samples: from 3-5 up to 2-3 dozens. The method of transects or profiles (Sannikov, Petrov, 2003) specifically incorporated taking into account the geographical coordinates, altitude, environmental conditions, etc., is used extremely rarely to collect material. Most commonly the population and genetic material of woody plants has to be collected along the existing lines of communication.

The above mentioned methodological problem can be solved by creating an integrated geographic gene pattern by means of building digital maps. MDStudio2 is the programme designed in the Vavilov Institute of General Genetics, RAS, for the cartographic analysis of population and genetic data distributed in a geographic area (http://humgenlab.vigg.ru/Programs/programs.htm). The analysis is based on the methods of constructing continuous geographic fields using interpolation, as well as the methods of mathematical transformations, and statistical analysis of geographical distributions (Gene pool and gene geography of population, 2003).

The examples constructed in this mapping programme give an idea of the spatial distribution of genetic parameters in the area of the woody plants. This paper presents two examples of prepared geographic gene maps. The regular change in the average expected heterozygosity of the common pine area: from north to south in the European part of Russia, and from east to west in the Asian part of the country is shown in Figure III.1.1. Another example (Figure III.1.2) illustrates the change in the frequency of mitochondrial gene haplotypes *nad1* depending on the geographic coordinates: the uniformity by this criteria in most of the area and Siberian and Norway spruce is graphically represented.

Inbreeding and selection against inbred offspring. Lack of inbreeding and other disturbances in the "ideal" population is characterized by the so-called Hardy - Weinberg equilibrium when the frequency distribution of genotypes in a freely interbreeding (panmictic) population is linked according to the following formula: *p2 2pq q2 = 1*, where *p* and *q* are the allele frequencies. The relative number of homo-and heterozygotes are the members of the binomial equation.

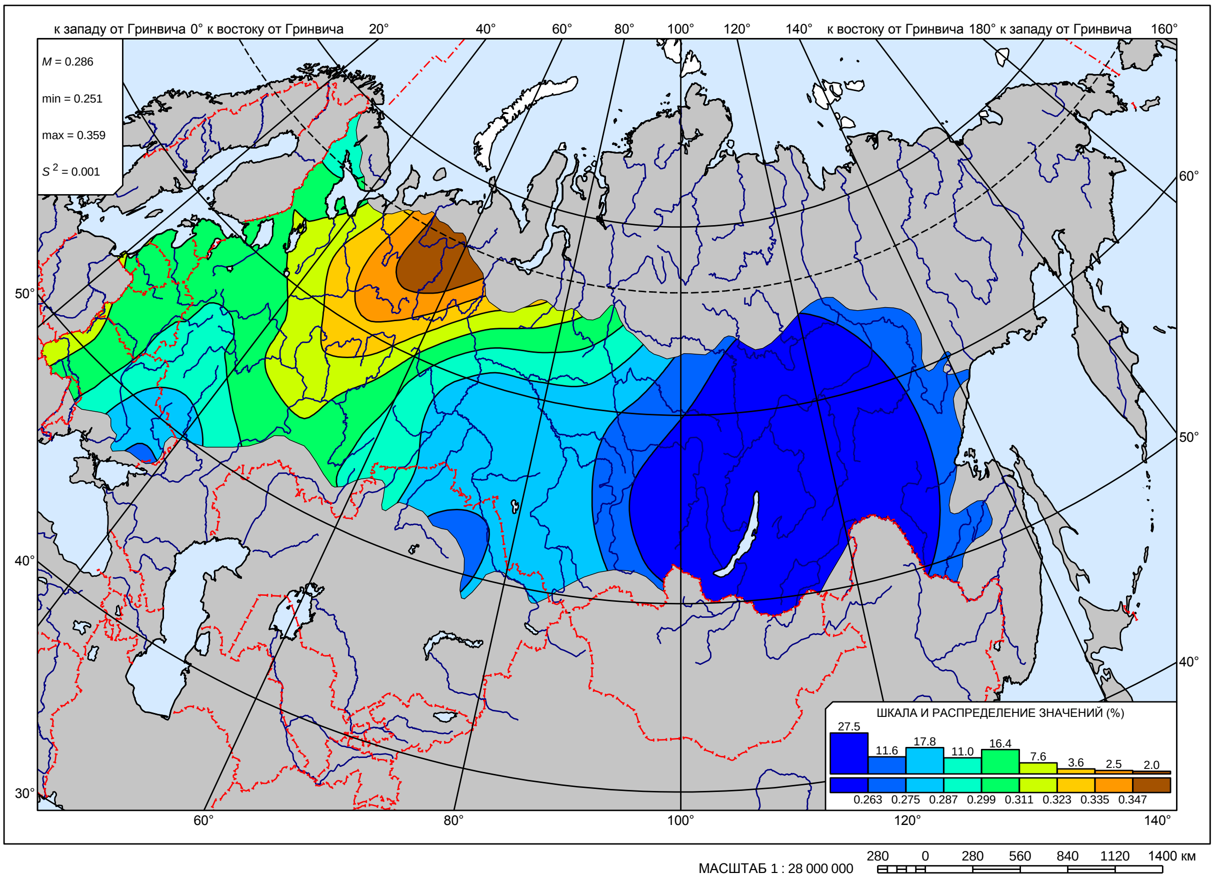


Figure III.1.1. **Distribution of the average expected heterozygosity over the area of common pine**

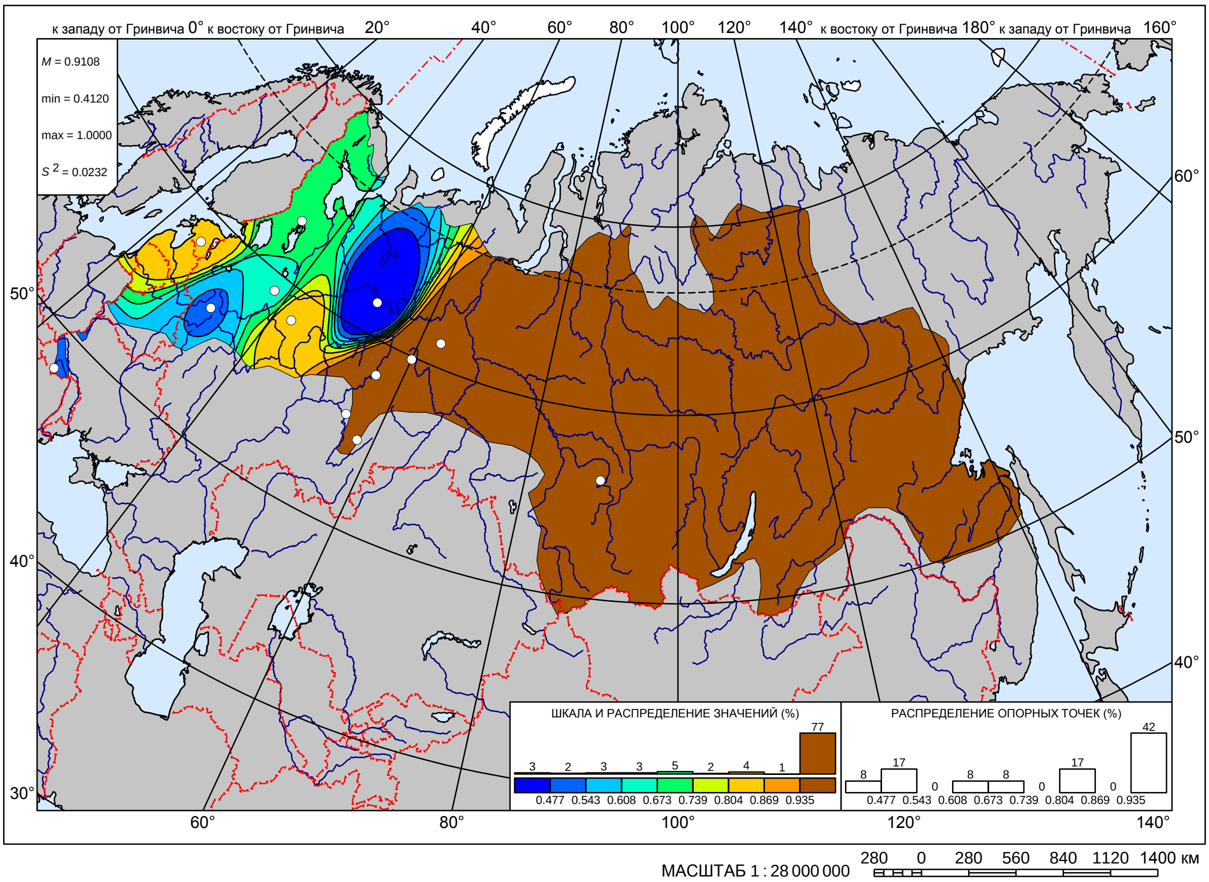


Figure III.1.2. **Haplotype frequency distribution by *nad1* mtDNA locus of Norway and Siberian spruce**

In analyzing the distribution of genotypes by allozyme loci in the embryos of dormant seeds of most coniferous in Russia (Table IV.3f), as a rule, there is a weak to moderate deficiency of heterozygotes compared to the Hardy - Weinberg equilibrium values (Politov, Krutovsky, 1990; Politov, Krutovskii, 1994, 2004; Krutovskii et al., 1995, Politov, 2004, 2007, Politov et al, 2006; Potenko, Velikov, 2002).

Heterozygote deficiency in the embryos of dormant seeds is caused, as is commonly believed, by a certain degree of self-pollination, usually in conifers, and, in case of family structure stands and inbreeding. Moreover, the adult population (of mother trees) is characterized by either an equilibrium state, or even a surplus (excess) of heterozygotes, and even if a mild deficiency of heterozygotes remains it is almost always less than that of the embryos. All this indicates the occurrence of selection against inbred offspring in favor of heterozygotes, which takes place at the early and the following stages of the plantation.

Individuals of woody plant populations being unable to move in space throughout their life, adapt by selection of highly heterozygous individuals. The presence of different alleles in the genotypes of these individuals allows them to adapt to the changing environment and to the influence of various, often adverse conditions whose nature and intensity often change throughout their lives. When planning any breeding activities one should be aware of this pattern, since it means that the effective pool of zygotes (genotype individuals of the next generation) during the "maturing" of the plantations is shaped not only by mating and recombination of the parental gene variants (alleles), but also as a result of selecting the most adapted individuals. Simulation of the process in forest breeding and tree seedlings and saplings for reforestation, namely the provision of natural selection of better genotypes for the population at the early stages, will provide a better adapted offspring.

1.2. The main value of the forest genetic resources

In Russia, where most of the area is occupied by forest ecosystems, forest has played an important role in human life from prehistoric times to the present day. Forest, wooden construction, forest fish ponds, food and medicinal plants, game animals and other living resources play a significant role in the economy in general, and the leading role in the economy of certain regions.

Forest ecosystems of the country are a renewable natural resource that meets the multiple needs of its population and industry, and has social and cultural importance. Forest ecosystems provide important habitat-forming and environment protection functions. Despite the fact that many people still perceive forest as a "wood factory", nowadays there is a growing recognition of the other important functions of forests, such as the different ecosystem related services, as well as the intangible benefits that have a direct impact on people: spiritual and religious values, recreation and ecotourism, aesthetic values. Forest biodiversity is of great social and cultural significance to indigenous peoples and local communities.

In Russia there is no official list of priority species of woody plants. The economic importance has always been determined by the needs of the internal and external markets. Besides, due to the vastness of the Russian territory and the variety of the species composition of forests in different areas, the set of important species has always had a regional character. The following official list of priority species may be mentioned:

1) Order of MNR of Russia "On the approval of lists (lists) of flora listed in the Red Book of the Russian Federation and excluded from the Red Book of the Russian Federation" (2005);

2) Updated (2011) list of species of trees and shrubs not allowed for timber (Order № 515 of 05.12.2011, FFA);

3) classification of woody plants of the former Soviet Union in accordance with their need in protection and the recommended protection measures, developed in the Main Botanical Garden of the Russian Academy of Sciences, which is based on a set of attributes taking into account the area and the nature of the species range, dynamics of the area, environmental attributes of species habitat, its taxonomic significance, sustainability in nature, direct and indirect human impact, etc.;

4) agro-ecological atlas of Russia and the neighboring countries which provides the distribution profile of more or less important crops (including trees and shrubs) grown in the former Soviet Union, and their diseased, damage by pests (www.agroatlas.ru).

Table IV.4 presents the priority species of the dendroflora of the Russian Federation revealed during the study of literature and extensive consultation

Economic importance. Russian timber is used in the form of round and sawn material for the manufacture of plywood, wood fiber and particle board, fiberboard, etc.), and also as the raw material for the production of cellulose and wood pulp, synthetic fiber, alcohol, vinegar, yeast, etc. It is still important in Russia as fuel/biofuel. The forestry sector plays an important role in the economy and is essential to the economic and social development of more than 40 subjects of the Russian Federation where the forest products ranges from 10 to 50% of the total industrial output of the region. Nationwide, the figure is around 4%. In terms of the volume of timber Russia is the 4th in the world (FRA 2010). The main harvested timber objects are common pine and Siberian stone pine, Norway and Siberian spruce, Sukachev's, Siberian and Dahurian larch, Siberian fir, oak, white and weeping birch, aspen. The total volume of harvested wood in 2011 was about 38.6 million m3. In 2010 61% of the volume of the produced wood products was consumed in the domestic market and the rest (39%) was exported.

Forests in the Russian Federation have a large resource potential for the development of different types of non-timber forest use. The most common of these are the ones mentioned in the Forest Code: harvesting and collection of non-timber forest resources (stumps, birch bark, bark of trees and shrubs, brush, twig food, spruce, fir and pine boughs, spruce or other coniferous trees for the New Year holidays, moss, ground litter, reed, cane, and similar forest resources); harvesting food forest resources and collection of medicinal plants, the implementation of activities in the sphere of hunting, agriculture (mowing, grazing livestock, beekeeping, reindeer breeding, cultivation of crops and other agricultural activities), etc.

Hundreds of forest food species and medicinal plants grow in Russian forests. Being widely used by the population they have great social and economic importance, and are in demand in both the domestic and international markets (see Section III.8). Almost all berries and fruit trees and shrubs (Actinidia, Amur grape, apricot, Ussurian pear, etc.) of the Far East have a considerable value as a source material for breeding, which is essential because of its winter hardiness.

Tables IV.5 and IV.22 present the lists of the forest species widely used by the Russian population, clarifying the common use, as well as the areas of forest ecosystems dominated by these species and regulated/available for use (Table IV.5).

Social and cultural importance. In many regions of Russia hunting in the forests, harvesting of forest food resources (fruit, berries, nuts and mushrooms), collecting medicinal plants and their further use in private households or sale to loggers are the main source of livelihood for the rural population. The forest is the basis of life for the indigenous peoples and some ethnic groups of the Russian Federation. Many species of trees and shrubs are used in landscaping of cities and towns.

The culture of the peoples of Russia is inextricably connected with forests:

• (sacred/religious groves, etc.) in 2011 7.73 hectares of forest areas was leased to carry out religious activities,
• more than 3,000 plant species are used in folk medicine,
• use of birch twigs for the religious festival of the Trinity,
• spruces, firs and pines used as the New Year trees
• hunting,
• mushrooms, berries and other food plants
• traditional leisure areas
• forest characters from legends and fairy tales.

All these relations between the forest and the man in the Russian Federation had a strong effect on the formation of the national character. Tables IV.5 and IV.6 list some species of trees and other forest woody plants that have a social and/or cultural value.

Environmental functions. Russia's forests play a vital role in conserving the biodiversity of the temperate and boreal regions of Eurasia at the ecosystem, species and genetic levels. Russian forests perform environmental, water protection, conservation, sanitation, health, etc., functions.

The boreal forests of Russia have got almost no analogues in the world by in terms of the length of forest ecosystems by the same dominating species over millions of square kilometers. It is difficult to overestimate the importance of the Russian forests for the genetic diversity conservation because here there are vast areas of forests of various types with native or low-disturbed genetic structure. They can serve as test sites for the study and subsequent reconstruction of native and quasi-native forest structure in the areas with highly disturbed forests.

The share of protected forests is 24% of the total area of the country’s forest fund (Table II.1). Protection forests are essential to provide a healthy environment for the people, so they are located mainly around the cities, recreational places, rivers, and other valuable natural sites.

Russia is one of the first countries where field-protective afforestation appeared. The country has a long-standing practice of protecting agricultural land from soil erosion and protecting crops from droughts and dry winds by means of forest plantations. 5.2 million hectares of protective forest plantations have been planted on the agricultural land since the protective afforestation appeared in Russia. To date, this area is 2.74 million hectares.

Russian forest ecosystems play an important role in the global carbon cycle. According to the 2010 FAO FRA estimates, the carbon stocks/pools in living and dead phytomass of the world's forests are about 360 billion tons of C, with 49.4 billion tons of C concentrated in the forests of the Russian Federation.

Taking into account the real contribution of the forest ecosystems of the Russian Federation in the regional and global biosphere stability, performing such global ecosystem functions as climate control, water control, conservation of genetic diversity, preserving the global carbon balance, etc., it can be argued that this contribution is significantly higher than the share of Russia in the area of the planet.

Plantations formed by the species listed in Table IV.6 have great significance for the environmental functions of forest ecosystems.

1.3. Threatened species and genetic resources, the main factors influencing the state of forest genetic diversity

Rare and threatened species of woody plants are the most fragile, but a very important part of forest genetic diversity. The priority of protecting these species is defined by the UN Convention on Biological Diversity and by the Russian environmental legislation, in particular by the Federal Law

"On Environmental Protection" (2002), the strategy for conservation of rare and endangered species of animals, plants and fungi (2004).

According to the Red Book of the Russian Federation, in the forests of Russia one species - *Daphne altaica* Pall. (incl. *D. sophia* Kalen., *D. taurica* Kotov) - is classified as "possibly extinct", 14 woody plant species are endangered, 19 species are recorded as vulnerable and 30 species are rare (Table IV.4). Table IV.7 presents more detailed information on the status of species of trees and other woody plants, which are endangered in whole or in part in the country in terms of genetic resources conservation.

A large area of Russia and a variety of growth conditions, trends of impact on forest ecosystems and populations of individual species, the particular situation of the species in the space of the area lead to the fact that some species can be common in one region of the country but rare in another region. This determines the need to keep the country's Red Book on two levels - federal (the Red Book of the Russian Federation) and regional (territorial lists of protected species and the Red Books of the subjects of the Russian Federation). Federal and regional Red books complement each other and are created according to the same methodology. This practice contributes to the conservation of genetic diversity: the types of trees and shrubs that are not endangered and are not even rare for the Russian Federation as a whole, may have vulnerable population, for example, on the borders of its range. In this case they are added to the Red Books of relevant subjects of the Russian Federation. A good example of such "regionally rare" species is Siberian larch (*Larix sibirica* Ledeb.), which is being one of the main forest forming species in Siberia, is in the Red Book of the Republic of Karelia, Republic of Udmurtia, and Vologda and Novgorod regions. Another example is the typical Russian taiga species marsh rosemary (*Ledum palustre* L.) which is included in the Red Books of Bashkortostan, Tatarstan, Chuvashia, Belgorod, Lipetsk and Penza.

In Russia the maximum number of rare species with limited distribution or reducing area is concentrated in the deciduous, coniferous and broad-leaved and coniferous forests of the Caucasus and southern Siberia and the Far East. A significant number of rare species is located in the distribution area of the deciduous forests of European Russia and the Urals. Below there is a brief description of the negative trends in the forest ecosystems of the Russian Federation, which are the result of the expansion of economic activity and increase of the load on forest biodiversity and biological resources in different regions of Russia.

In the *European North* along the northern boundary of the forest in the Nenets Autonomous District in recent years a number of forest islands were lost in some areas, the eroded areas of forest-tundra and northern taiga have been growing bigger. In the European part of the Russian Federation there is a reduction of old growth native forests within the taiga zone and in the zone of coniferous-deciduous and deciduous forests, and there is an increase of the secondary forest share (birch and aspen) in the structure of the forest fund; besides, the deciduous forest biomes have almost disappeared and are now represented by small fragments of the ecosystems of the specially protected areas and closed military sites.

The forests *of the central part of European Russia* have reached maximum level of fragmentation, when the forest area is not sufficient to maintain the diversity of biota at the level close to the original. The existing network of the specially protected areas is unable to perform effectively territorial protection of biodiversity.

In the north of Western Siberia and the south of the Yamal-Nenets Autonomous District, the site of major oil and gas center of the country, almost all the extant forest areas along the northern border, the unique lowland forests, and forest-bog complexes rich in biodiversity has become available nowadays. Many of the areas are polluted with oil.

The forests of the North Caucasus including the areas of the preserved xerophytic Mediterranean-type forests on the northern border are experiencing high loads now. These ecosystems play a crucial role in preserving populations of rare trees and shrubs (over 10 types): Pitsunda pine (*Pinus brutia subsp. Pithyusa, P. pithyusa* strangw.), yew (*Taxus baccata*), juniper (*Juniperus excelsa*), birch (*Betula raddeana*), Caucasian persimmon (*Diospyros lotus*), common fig (*Ficus carica*), wing-nut (*Pterocarya pterocarpa*), boxwood (*Buxus colchica*), honeysuckle (*Lonicera etrusca*), spindle tree (*Euonymus nana*).

Forests of the Far East, especially its southern part are characterized by a high level of biodiversity. Here the boreal and subtropical flora and fauna come in to contact. A unique forest formations – stone pine and broadleaf forests occupies less than 3% of wooded land area of the region, but there is a high concentration of rare and endangered trees, shrubs and woody vines: Manchurian apricot (*Armeniaca mandshurica*), prickly castor-oil tree (*Kalopanax septemlobus*), Schmidt birch (*Betula schmidtii*), pearlbush (*Exochorda serratifolia*), *Prinsepia sinensis*, yew (*Taxus cuspidata*), lespedeza (*Lespedeza cyrtobotrya*), devil's-club (*Oplopanax elatus*) and others. The trees and shrubs with limited ranges in the south of Primorsky Krai also include microbiota (*Microbiota decussata*), oak (*Quercus dentata*), larch (*Larix olgensis*), omatsu (*Pinus densiflora*), juniper (*Juniperus rigida*), Manchurian fir (*Abies holophylla*), rhododendrons (*Rhododendron fauriei, R. schlippenbachii*) and others. High levels of biodiversity is characteristic of southern Sakhalin and the Kuril Islands. In the Far East there are 42 species of trees and shrubs included in the Red Book of Russia, about 50 species are endemic and hemiendemic. The main factor adversely affecting the diversity of forest genetic resources of the Far East is human activities, primarily mining, construction of roads, pipelines and other facilities, timber, unregulated collection of medicinal and food plants. Forests adjacent to settlements and places of public entertainment, suffer from occasional fires.

Threats to individual species and forest ecosystems are obvious and are often at the center of attention unlike the genetic erosion at the intraspecific level. This is largely due to the peculiarities of the life cycle of trees, which complicates the analysis of the genetic processes within populations: because of the great length of life of the woody plant populations and the difficulties related to the monitoring of the genetic diversity evolution, the "real-time" assessment of potential genetic erosion in Russia is conducted mostly indirectly - by comparing trees of different ages, affected by different types of intervention, based on their vector and intensity. Reduction of genetic diversity of populations occurs for different reasons. Partly, is happens as a result of natural disasters - fires, windfalls, proliferation of pests, etc. But the human business activities (industrial pollution, logging, improper reforestation and breeding, etc.) have the most profound negative impact on the gene pool of the main forest forming species populations.

Disappearance, reduction of the area, change in the structure of forests as a result of the regulatory and/or scientifically invalid logging, including illegal logging, fires and the related pyrogenic successions, other undesirable succession, including anthropogenic, pathogen and pest impact and the impact of chemical and radionuclide contaminants reduce the overall effective population size of woody species, which leads to the extinction of alleles and genotypes and results in reducing both the overall adaptability of the population, and especially their adaptability to the fast changing conditions . Area fragmentation causes dissociation of gene pools, reducing the recombinative variability component, increasing the likelihood of inbreeding, leading to the destruction of the existing level of the intensity of natural gene exchange between subpopulations and the degree of natural spatial genetic subdivision of populations. Reduction of population density and seed and pollen production can also lead to a decrease in the natural selection intensity in the next generation of trees, resulting in the reduced adaptability of forest populations. Global climate change, the effect of air, water and soil pollution, pathogens and pests, and the combination of these factors lead to the selection of species resistant to these types of stressful influences, and as a result, not only reduces the overall level of genetic diversity, but also significantly vary the allele frequencies and genotype distribution as a result of mutagenesis and specific directional selection profiles. The process of the above changes in the forest populations is much faster than the evolutionary rate. As a result we observe genetic erosion which leads to a drastic reduction of adaptive capacity of individual trees, populations and species in general.

The main threats to the genetic diversity conservation are as follows:

- ✓ global climate change leading to a selective change in the species and genotypic composition of populations, to a shift in the boundaries of the forest-tundra ecotones tundra, taiga-steppe and in the mountains. Climatogenic successional forest vegetation can lead to the changes in the species composition of forest ecosystems, reduce the size and stability of populations of some species;
- ✓ transformation of forest ecosystems in the areas of the forecasted increase in seasonal (25-50%) permafrost thawing;
- ✓ expansion of the area and frequency of fires due to the synergistic effects of climate change and economic activity expansion, which leads to the substitution of considerable areas of forest ecosystems with pyrogenic vegetation options characterized by the poor biota diversity, reducing genetic diversity developed from single trees and low-value tree clumps at the large fire sites;
- ✓ biologically and genetically unjustified system of logging and harvesting of non-timber forest resources:

  - o in concentrated clearings, often without meeting deadlines for the cutting areas contiguity; creating of barrens where the restoration with full genetic material is extremely difficult (Mamaev et al, 1988). Even leaving seed trees on the clear-cutting grounds prescribed by the rules cannot compensate for removing most of the trees / population's gene pool;
  - o selective and conditional clear felling leads to the formation of stands with the damaged gene pool as a result of negative selection;
  - o destruction of local populations (trees with a specific, evolutionarily shaped genetic structure), which leads to the loss of a number of alleles, and to the reduction of the total variability; marginalized populations growing in the sub-optimal conditions are especially threatened ;

- ✓ technogenic forest degradation caused by discharges of metallurgical, chemical, energy and transport sectors:

  - o environmental pollution has a negative impact on the reproductive organs of woody plants, especially on the viability of the pollen;
  - o individual pollutants and their combined action can shift allelic and genotypic frequencies due to different ratios of adaptability of the relevant alleles and genotypes in the absence and presence (in different concentrations) of specific pollutants;

- ✓ mutagenesis, forest mortality and transformation of forest communities in the areas of acute and chronic radionuclide pollution;
- ✓ illegal logging, poaching and other unauthorized use of the forest, leading to a) removal of vulnerable and protected species populations from the forest communities or b) the selective removal of the populations of the best genotypes. The forest areas remaining after such logging can be so small that the surviving number of plants of a species will be insufficient to maintain the original genetic structure and levels of genetic diversity;

- ✓ the destruction of the native population genetic structure as a result of habitat fragmentation and habitat loss, which occur due to a) the exclusion of forest lands for non-forestry (agricultural land, industrial, road and urban construction, mining, linear structures), b) unregulated recreation/activation of recreational impact on forest ecosystems in areas of tourists and vacationers in the absence of environmental infrastructure. In a highly fragmented forests the generations that appear as a result of the natural regeneration of a limited number of trees will be less genetically diverse, therefore, less productive, less resilient to adverse environmental factors. Young growth that appears as a result of such resumption in fragmented stands is composed mainly of related trees, and their further cross-pollination between each other further increases the effect of inbreeding, which leads to offspring weakening. Reducing the size of plantations also creates a barrier to the exchange of genes, and the gene exchange is a major factor of preserving the genetic stability of the population system (Altukhov P., 2003). In small-sized plantations due to genetic drift the genotypic composition of the offspring in the first generation will be very different from the original population, both in frequency and allelic variant composition of genes (Mamaev et al, 1984);

- ✓ transformation of some forest ecosystems at the local level that happen due to invasive alien species and spread of quarantine pests and agents of forest diseases. In Russia the study of the fundamental and practical importance of the invasive plant species has started only recently. At the same time, the geographical position of the country, the relatively high human pressure, poor legislation on the conduct of introductions and accidental introduction of organisms from other countries and a number of other factors contribute to the invasion process. Currently, the natural plant communities (including forests) are the most susceptible to invasion process in the European part of Russia, close to major cities and industrial centers. In Russia there are over a thousand alien species (Vinogradov et al, 2010). The Black Book of the flora of Central Russia (2010) gives the profile of 52 most aggressive and most common alien species: nine of them are trees and shrubs. The invasive species do not represent a big threat to the integrity of the forest ecosystems of the country so far. These are: the box elder (*Acer negundo*), oleaster (*Elaeagnus angustifolia*), sea buckthorn (*Hippophae rhamnoides*), black ash (*Fraxinus pennsylvanica*), June berry (*Amelanchier spicata*), saskatoon berry (*Amelanchier alnifolia*), hawthorn (*Crataegus monogyna*), fieldfare (*Sorbaria sorbifolia*) and white poplar (*Populus alba*). *Agrilus planipennis* has invaded the European part of the country due to the wide spread of black ash, and has quickly and successfully acclimatized here and is now killing both the black ash and the native ash species.

It should also be noted that poorly organized forestry and seed breeding and reforestation that have no scientific justification or violate the recommendations is a particular threat to the genetic diversity. Lack of thinking in the terms of population genetics leads to the use of technologies that are ineffective in the context of conserving and recreating the population genetic structure. The negative impact of such factors is as follows:

- cultivated coeval plantings and pure forest plantations are characterized by poor resistance to pathogens, pests and adverse environmental factors, therefore, it may lead to the change of natural selection vectors and destruction of the natural genetic structure of plants;
- plantations obtained as a result of artificial regeneration from a limited number of individuals usually have low genetic diversity and, therefore, are less resistant to adverse environmental factors. Even under the condition of selecting the "best" of elite genotypes for mass (e.g. plantation) growing, high growth rates in the early stages of ontogeny may not prevent the loss of some individuals or destruction of all plantings until the age of cutting or using for other benefits;

- genetic diversity of plants in forest reserves is generally lower than that in natural populations and plantations formed as a result of natural regeneration (Padutov et al, 2008, Ilyin et al, 2011).
- genetic erosion and loss of local evolutionary population gene pools, destruction of adapted gene complexes, emerging of non-adaptive genotypes and, consequently, reduced productivity and sustainability of plantations can take place because of the unnecessary seed movement within and outside of formally approved seed zones and/or due to the imperfect seed zoning schemes (Mamaev et al, 1988, Politov, 2004);
- at all stages of breeding and artificial regeneration (seedlings, propagula and saplings), even without a special human intervention the process of selection is fundamentally different from the natural, as in conditions very different from the natural ones the stabilizing selection is not guarding the norm, which can lead to the emerging of the reproductive part of the genotype population that die at the early stages of ontogeny in the wild (Mamaev et al, 1988). Thus, the absence of the stage simulating natural selection in the breeding and artificial afforestation can lead to the formation of plantations with low resistance, and ultimately, in the long run, - to their low productivity;
- selection and vegetative propagation of only a few high-plus trees, families, hybrids of different origin can lead to substantial restrictions of the genetic variability of forests (Mamaev et al, 1988).

Federal legislation does not set specific requirements for the documentation of a seedling or sapling lot. Reforestation regulations in the Russian Federation determine only the general requirements for the planting materials (see III.4.2.3 for the record system of the sources of forest reproductive material of plants). The volume of seed harvesting in specific regions and years in Russia depends on 1) the presence of seed yield, 2) the availability of funds for its harvest, 3) the availability of special technical devices for harvesting forest seed material, and 4) the volume of clear-cutting when seeds can be harvested at the least costs. The scope of FFA work on forest seed production is presented in Table IV.8. Official FFA statistics does not provide any data on the number of planted seedlings/saplings. Forest reproductive material of the vegetatively propagated plants has very limited use in Russia. The reason for this is that such forest management activity as creating target timber resource plantations has not yet been widely known in the country. Article 42 of the Forest Code of the Russian Federation provides for the establishment of forest plantations, but defines it as entrepreneurial activity. Vegetative reproductive material of forest plants is used mainly to create seed orchards and clone banks, as well as for the cultivation of ornamental species for landscaping settlements or private estates. In the first case the propagula of plus trees grafted on the seedlings of the same species. In the second case the propagula rooted under the special conditions of the greenhouses. Thus, the scales of the movement of reproductive materials in the country show that the mismanagement of reproductive material can cause genetic erosion.

1.4. Needs and priorities for improving understanding of the state of forest genetic diversity

The task of conserving the genetic diversity can be successfully achieved only if the population and chorological structure of species has been studied properly, which gives a clear picture of the spatial position of populations and superspecies divisions. It is necessary to preserve the gene pool of each population as the basic structural and elementary evolutionary unit of species. Russia is continuing to study the quantitative profile of gene pools of forest trees (see Tables IV.3c, IV.3d, IV.3e, IV.3f and IV.9): we have received the data on the levels of morphological and genetic diversity (percentage of polymorphic loci, allelic diversity, heterozygosity) and its structure, namely the spatio-temporal distribution of the parameters, the evaluation of inbreeding levels at different stages of ontogeny of woody plants, evaluation of the variation between populations in the proportion of the total variation of the species, etc. The development of molecular genetics has opened up new possibilities for studying the genetic structure of natural populations, development of recommendations and highlighting the most valuable individual genotypes and trees in their further selection for the use in plantation forestry. The main constraints for the development of a more complete understanding of the genetic diversity in the country are:

- ✓ inadequate planning and administrative support of scientific research; it is necessary to create long-term government programmes and the coordination of research conducted in the sectoral research institutes, institutes of Russian Academy of Sciences, universities, botanical gardens, nature reserves and other specially protected areas, aimed at the study and systematization of the data on species and genetic diversity of trees and shrubs;
- ✓ lack of funds allocated by the state and international community to study the forest genetic resources in the Russian Federation; to the monitoring and inventory of genetic diversity, genetic erosion monitoring, and information support to the researches and inventory of biodiversity. The laboratory facilities of the research institutions do not always conform to international standards. In Russia the network of scientific institutions, forest management stations and boards and the level of funding are insufficient for the work scale and diversity of forest areas, species and genetic diversity of the country's forests.

There are a number of priorities in the research of forest genetic resources diversity of the Russian Federation:

- ✓ scientific basis of the systematics for the flora of trees and shrubs of the Russian Federation with the help of molecular genetic markers;
- ✓ large-scale inventory of the forest genetic resources with the use of traditional and modern molecular methods, the inclusion of elements of the genetic diversity assessment into the state forest inventory: development of methodology for assessing forest genetic resources of the state forest inventory. In this regard, the most important task is to develop the techniques of using molecular markers most appropriate to identify the origin of the softwood genetic material, i.e. to fully reflect the spatial organization of the genetic variability of species. Pilot projects are necessary to establish a set of isozyme loci and DNA data for each forest forming woody plant/species. National and international efforts are needed for large-scale inventory of forest genetic resources of the Russian Federation with the use of modern molecular techniques;
- ✓ study of the genetic structure of populations of economically important (resource) tree species, finding patterns with hierarchical structure of natural populations, clarifying their boundaries, assessment of the relative roles of the various factors that influence the levels of genetic diversity between and within populations;
- ✓ study the genetic structure of populations of endemic, rare and endangered tree species (especially those included in the Red Book), marginal and small local mountain populations, "ancestral" populations in refugia, and the genome of hybrids with significant heterosis effect, and further application of knowledge on forest genetic resources in the development of practical measures to preserve the gene pool of species;

- ✓ study of the native genetic structure of the populations of Eurasian woody plants on old growth territories and its response to climate change. The destruction of the last natural populations of boreal forest woody plant species before they are studied in sufficient detail will lead to the fact that humanity will never be able to get information about their natural genetic structure and genetic diversity normal for these species which is necessary to develop appropriate measures to restore the species undergoing genetic depauperization;
- ✓ study of the transformed genetic structure of species and its adaptation mechanisms in forests with technological/radiation damage, organizing research and monitoring of the changes in the genetic structure of forests in areas polluted with radionuclides;
- ✓ study of the adaptation mechanisms of forest woody plant species populations to new environmental conditions and global climate change;
- ✓ development of theoretical frameworks, methodologies and programmes of practical activities aimed at studying forest genetic resources at the federal level and the level of the subjects of the Russian Federation with regard to intersectoral collaboration.

When applied properly the inventory of forest genetic resources may become the basis for obtaining and practical application of quantitative estimates of gene diversity, refinement of seed zoning schemes, development of genetic profiles and passports of plus trees and plantings, clones, certification and restoration of breeding sites schemes, profiles of local and regional populations and their groups, allocation of genetic reserves, etc. The promising application areas are:

- ✓ scientific basis of the principles of seed selection to be deposited in seed banks and seed reserve funds based on the analysis of genetic variability within species, their spatial organization in the range;
- ✓ certification of the objects of the single genetic breeding system using molecular markers. Organization of the control system over the circulation of forest plant reproductive material is planned for the future;
- ✓ study of the form diversity of main forest forming species, the assessment of morphological, geographical, ecological forms and genotypes with economically valuable characteristics (rate of growth, quality and texture of wood, productivity in terms of nuts, etc.);
- ✓ development of measures to address the threats of genetic erosion, disruption of stable reproduction of populations in time and space;
- ✓ development of modern sustainable way of harvesting and reforestation projects that do not lead to a sharp depletion of the gene pool of forest plantations.

In the light of the global natural and man-made changes in the environment a special emphasis should be made the genetic monitoring organization which is as a long-term monitoring of the population gene pool status, evaluation and prediction of the changes over time and space, determining the limits of acceptable change. The scope of the genetic monitoring of the forest woody species characterized by high polymorphism and long ontogenesis includes the following:

- ✓ study of the subdivision of within woody species in the area and its dynamics in relation to adaptation to specific environmental conditions, specific settlement, levels of isolation and introgression;
- ✓ establishment of centers of genotypic and phenotypic polymorphism and geomorphological and floristic provinces with an increased frequency of mutant representative, polyploid and hybrid genotypes (including the effect of heterosis and various abnormalities of growth and development);

- ✓ assessment of specific reactions of the woody plant genotype and phenotype to various natural and man-made impacts on different stages of ontogeny;
- ✓ clarification of the genetic basis of phenotypic variation, especially the adaptive and economically valuable ones;
- ✓ evaluation of the "purity" of seed selection and breeding objects and high-quality material, and the level of elimination of genotypes in gene banks;
- ✓ impact assessment of natural and man-made factors (like logging, fires, pathogens, toxins, radionuclides, extreme atmospheric phenomena, invasive species) on the population's gene pool
- ✓ assessing how the gene pools are affected by the use of azonal seeds of exotic species, hybrids and varieties that are created in a narrow genetic base and genetically modified plants during forest restoration;
- ✓ control over the effectiveness of measures for the rehabilitation of areas with depleted gene pool of indigenous forest formers.
- ✓ development of immediate scientifically based actions to prevent genetic erosion, their implementation in the whole territory of Russia, and in every region of the Russian Federation, taking into account the specific local conditions, and monitoring of the implementation of these measures.

The scale, complexity and diversity of the research on the genetic diversity of forest woody plant populations, high cost of equipment and reagents, requirements for qualification require adequate methodological support:

- ✓ organization of a well-tuned system of establishing monitoring stations/sites (baseline - stationary, subsidiary - short-term and one-time); assessment and collection of samples in the years of abundant and good seed production, in case of activated solar-cosmic processes, accidental releases of toxins and mutagens, pests and diseases, extreme weather phenomena, etc.;
- ✓ development of objective criteria to select from a population the optimal number of indicator species that represent different generations and differ in contrast attributes and properties (reproductive activity, tolerance to mutagens, toxicants, low and warm temperatures, pests, fungal, bacterial and viral diseases, growth intensity, heterozygosity level, etc.), methods for their experimental testing, and identification of the connections of the indicator species to various genetically determined marker signs;
- ✓ selecting a limited number of morphological, anatomical, cytological, karyological, physiological, biochemical and molecular genetic markers, which give full accurate (objective) profile of phene pools and gene pools, as well as the level of mutation and genetic load in the studied populations and their progeny;
- ✓ development of migrant registration methods (the contribution of background dynamics of pollen, exotic seeds, alien invasive species) and their survival (both in field studies and analysis of marker traits in representative sampling);
- ✓ development of effective methods to identify new genotypes in the population (evolutionarily promising and the ones reducing their competitiveness or economic value), as well as individuals with heterosis (in terms of growth intensity, tolerance, adaptability, reproductive activity, etc.);
- ✓ formation of a unified database system for monitoring the genetic diversity, as well as the integral estimates.

Chapter 2
The State of *in situ* Genetic Conservation

The National Biodiversity Strategy of Russia (2001) identifies the following ways of *in situ* forest genetic resources conservation in natural habitats:

- ✓ protection of species and ecosystems in specially protected areas;
- ✓ conservation of rare and endangered species included in the Red Book of the Russian Federation;
- ✓ regulation of capture fisheries species, including measures against illegal exploitation, regulation of their legal use in different purposes, environmental impact assessments of business projects involving biodiversity and other objects;
- ✓ monitoring, control and regulation of the unexploited species populations, including measures against illegal exploitation, regulation of their legal use in different purposes (recreational, scientific, cultural, etc.), environmental impact assessments of economic projects affecting wetlands and their biodiversity etc.;
- ✓ conservation and restoration of habitats of species, reconstruction of habitats;
- ✓ reintroduction (reacclimatization) of the extinct populations in their natural habitats, restoration and/or genetic "recovery" of small populations.

2.1. Conservation of forest genetic resources within and outside protected areas

Russia pays great attention to the system of specially protected natural territories (SPAs), which is important for the conservation of forest genetic resources. Forest vegetation of the country is represented in the SPA system well enough, but the genetic diversity conservation objectives are not integrated into the strategy of the operation and development of this system. Forest genetic resource conservation in Russia is carried out not only within but also outside the protected areas, - in the reserve, security, and, to some extent, commercial forests of the country.

2.1.1. The system of the specially protected natural reservations

The system of specially protected natural territories of the Russian Federation plays a big role in keeping the typical and unique natural forest landscape, diversity of flora and fauna, including forest genetic resources. In Russia, in accordance with the law "on Specially Protected Natural Territories" (1995) there are the following categories of protected areas: state nature reserves, including biosphere reserves, national parks, nature parks, state natural sanctuaries, natural monuments, arboretums and botanical gardens , health areas and resorts. Russian SPAs have federal, regional or local significance. Reserves and national parks are protected at the federal level, and the natural parks are the regional SPAs as they are managed by the subjects of the Russian Federation. Other categories of protected areas (nature reserves, natural monuments, etc.) can have both federal and regional status. The Government of the Russian Federation, the relevant executive authorities of the subjects of the Russian Federation, local authorities may establish other categories of protected areas. By 2011, 23 regions of Russia established 29 different categories of protected areas of regional significance; in addition, 28 subjects of the Russian Federation established 49 different categories of protected areas of local significance.

By now the Russian Federation has established about 12 thousand SPAs of different levels and categories, covering an area of 207.3 million hectares. This system comprises 204 federal protected areas (www.zapoved.ru; oopt.info), including 102 State Nature Reserves (hereinafter - Reserves), 42 national parks and 70 state natural sanctuaries of federal importance (hereinafter - Federal natural sanctuaries) which cover the total area of about 580 thousand km2 (2.7% of the total territory of the Russian Federation). Specially protected areas at all levels cover up to 10% of the country.
The major part of the SPA structure in Russian constitutes of the regional PAs, which account for 84% of the total number of protected areas, and 58% of the total area. The protected areas of local importance cover 13 and 14% relatively. Despite the fact that the federal protected areas make up less than 3% of the total number of protected areas, they account for over a quarter of the total protected area (Figure III.2.1).

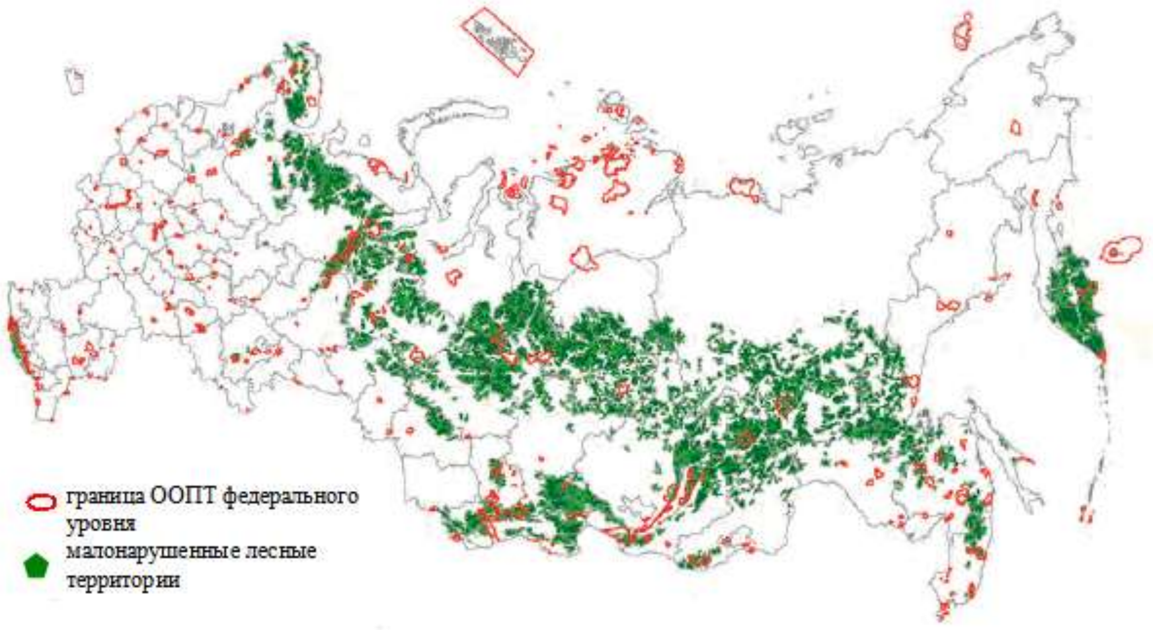


Figure III.2.1. Old growth forest territories and federal SPAs of Russia (from "Specially Protected Natural Territories of Russia: current status and development prospects…, 2009)

граница ООПТ федерального уровня – the borders of the federal SPAs
малонарушенные лесные территории – old growth forest territories

Specially protected areas are found in all the subjects of the Russian Federation, but their distribution in Federal Districts is quite uneven (Specially protected..., 2009): two-thirds of SPAs are located in the European part of Russia. 65% of all Russian SPAs are distributed in three Federal Districts (Northwestern, Central and Volga). However, the maximum total area of SPAs is registered in the Far Eastern Federal District (60.3%).

Different types of SPAs within the forest zone and forest mountain belts cover more than 120 million hectares (about 7% of the country). The information on the species composition of fauna and flora which is protected in the reserves of Russia can be found in Information Retrieval System for Fauna and Flora in Protected Natural Areas of the Russian Federation (www.sevin.ru/natreserves/).

8130 species and sub-species of vascular plants from 210 families, 9 classes and 6 divisions grow in the reserves of Russia as of 2008 (Specially protected..., 2009). It makes about 64.5% of all Russian natural flora rich in 12,500 species and subspecies. Floral representativeness of some specific reserves ranges from an average of 30 to 70% of the number of species in floristic regions identified in the "Flora of the USSR" (Nuhimovskaya, 1994). The most significant are the reserves covering the flora of the European and Siberian taiga (over 95%), deciduous forests and tundra. On the whole, the forest vegetation of the country is presented in the SPA system well enough. However, as for the rare and endangered plant species listed in the Red Book of the Russian Federation, the existing federal protected areas can provide sufficient protection only to approximately half of these high-value species. 58% of the species listed in the Red Book of the Russian Federation on the territory of the reserves are vascular plants.

23 species (32.9%) out of the 70 species of trees, shrubs and woody vines listed in the Red Book of the Russian Federation are not recorded within state nature reserves (Table IV.4a). Most of them are the rare protected species of the Caucasus, Eastern Siberia and the Far East.

2.1.2. Other categories of the forest genetic resources conservation

Forests within SPAs make up a relatively small part of the country's forests. There are other categories of land in Russia where forest genetic resources are conserved to a greater or lesser extent. First of all, these are the protection forests designated for the intended purpose (Table II.1) (276.1 million hectares, or 24% of lands of the forest fund) and forest reserves (271.5 million hectares, or 24%).

Reserve forests are the forests located away from the transport ways with no forestry or forest use carried out or planned for the near future. Such forests are located mainly in the northern parts of Siberia and the Far East. Reserve forests areas are characterized by harsh soil and climatic conditions. This category of forest ecosystems is characterized by natural dynamics which makes the forest genetic resources conservation possible in these areas. Reserve forests are mostly formed by mature and overmature (80% on a stock of wood) stands dominated by conifers (larch, spruce and pine). The average age of these plants is more than 150 years.

Protection forests are forests designated for the conservation of habitat forming, water-protection, safety, hygiene, health and other beneficial functions of forest ecosystems (Table II.1). Besides, protection forests have the function of forest genetic resource conservation since logging there is significantly limited.

To maintain safety and other environmental services, in particular, forest genetic resources in the forests for various purposes (including logging) in the Russian Federation in accordance with Art. 107 of the Forest Code small **designated sites** (DS) are allocated, where the appropriate mode of forest management and use of forests is established. The inventory of DS in Russia has just begun and the data on the DS is included in the composition of the state forest registry. According to the preliminary estimates of experts the area of DS is 12-15% of the total area of forest fund of the Russian Federation.

Voluntary forest certification is one of the most important mechanisms of preserving forests on the planet, including the conservation of forest genetic resources. The two basic schemes of voluntary forest certification by the initiatives and organizations that emerged in Russia over the period of 1990 – 2000 are the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification schemes (PEFC). Currently in Russia more than 30 million hectares of forests were certified and more than 150 certificates for the supply chain were issued (www.fsc.ru) in the PEFC-FCR system for the area of over 320 hectares (www.pefc . ru).

As the list of the protected forests and DS provided by the Forest Code of the Russian Federation does not include many types of biologically and socially valuable forests in the country, the national concept of "high conservation value forests" (HCVF) was developed as a part of FSC certification. Wide experience has been gained in terms of definition, designation and mapping of these forests. Attention to HCVF contributes to the conservation of forest genetic resources. One of the

HCVF categories is the old growth forests. The area of the old-growth forests in Russia is 26% of the world's old growth forests (Figure III.2.1). These large (at least 50 ha) forest areas with no or mild economic activity (no logging trace, weak or non-existent road network and extremely low population) are particularly valuable unique wood objects, which have preserved native genetic structure of the forest forming populations of woody plants. The estimated area covered by old-growth forests in the Russian Federation is 288.5 million hectares, with 153.9 million hectares located in Eastern Siberia, 58.4 million hectares - in Western Siberia, 44.4 million hectares - in the Far East, 31.8 million hectares – in the North of the European Russia (www.wwf.ru). In total, 216.4 million hectares of old-growth forests are located in these old-growth forest areas.

Reserve forests, protective forests, DS and HCVF in the territory of the Russian Federation have great environmental and ecological value and are highly significant for forest genetic resource conservation. These categories are reserved to be included in the network of the specially protected areas. They have already been identified in nature and described in one way or another; some of them have a similar order of forest protection and management.

2.2. Sustainable forest management or ecosystem management for forest genetic resources conservation within and outside protected areas

The Russian SPA system is considered one of the best in the world: not many countries have SPAs with a strict limitation of economic use - such as, for example, the Russian reserves – that occupy a rather large proportion of the country. SPAs include land, water surface and the air space above them, where the natural complexes and objects of special environmental, scientific, cultural, aesthetic, recreational and health value are located. These territories are wholly or partially withdrawn from economic use by the decisions of public authorities. The special protection order is established for them.

The most traditional form of the SPA with high priority for the conservation of biological diversity is the state **nature reserve**. The system of national parks as the standards of undisturbed natural areas is the subject of well-deserved pride of Russia. According to the legislation, state nature reserves have the status of conservation, research and environmental education institutions. Any kind of economic activity and recreational interference is forbidden in the territories of the nature reserves. State natural reserves are located in the territory of 19 republics, 8 territories (krai), 32 regions, 1 autonomous region and 4 autonomous districts. In accordance with the Federal Law "On Specially Protected Natural Territories" the inspection service of the Russian state natural reserves work to ensure the security arrangement of the protected areas and conservation areas through, and are in charge of the state natural reserves of federal significance.

The territories of the Russian Federation which include natural complexes and objects of special ecological, historical and aesthetic value and are intended for the use in environmental, educational, scientific, cultural purposes and controlled tourism are declared **national parks**. The basis for forest related economic activities in the national parks is the formation of the target landscape structure of the forest fund, taking into account the established order of maintenance, protection and management of forests in the functional areas. Forest use provisions and forestry related activities in the conservation area are fully correspondent with to the provisions of the state nature reserves. Activities implemented in the recreational areas create favorable conditions for recreational forest use and provide the best possible safety of natural forest complexes. Fire-safety measures and forest sanitation activities are developed for all functional areas of national parks. National parks and adjacent territories establish a proper order to meet the needs of the local population in wood and non-timber forest products, and identify the opportunities to preserve traditional forest uses. National parks are located in the 12 republics, 5 territories (krai), 19 regions, 1 city of federal significance.

State nature sanctuaries are the areas of special significance in terms of the conservation or restoration of natural systems or their components and the ecological balance maintenance. State sanctuaries serve as the territorial nature protection with the restriction of certain types of economic activity and natural resource use. State nature sanctuaries are located in the federal territories of 8 republics, 6 territories (krai), 23 provinces and 4 autonomous regions.

Natural parks of regional significance are the environmental recreational facilities under the jurisdiction of the subjects of the Russian Federation. Natural complexes and objects of great ecological and aesthetic value are located on their territory and are intended for use in nature protection, educational and recreational purposes. At present the network of the natural parks of the Russian Federation consists of 59 natural parks with the total area of forest fund amounting to 32.1 ha. Natural parks are located in the territory of 9 republics, 3 territories, 11 provinces, 2 autonomous regions and 1 city of federal significance.

Natural monuments (geologic, water, botanical, zoological and complex) are the largest category of SPAs. These are unique and irreplaceable ecological, scientific, cultural and aesthetic nature complexes and objects of natural and artificial origin. Like the sanctuaries this category of SPAs is the most common category at the regional level. An area of 36.6 hectares is occupied by 31 natural monuments of federal significance as of December 31, 2010. Natural monuments of federal significance are located in the territories of 1 republic, 1 territory (krai) and 10 regions.

The most effective protection of the genetic structure of woody plants (characterized by large areas of viable populations) is implemented by the SPA network by means of applying different levels of protection connected by "ecological corridors". When creating a network the spatial and temporal structure of protected species populations is taken into account. The legal framework for the formation of ecological networks in Russia include the Ecological Doctrine of the Russian Federation, Federal Laws "On Environmental Protection", "On Specially Protected Natural Territories", "Animal World", Codes of the Russian Federation of land, forest, water, urban development, natural resources, a number of other federal regulations and many regional legislative and other legal acts which shall govern the establishment and preserving of protected areas, as well as the maintenance of natural processes on the other (non-protected) areas. The process of establishing a regional ecological network of protected natural areas is under way at present in some forest regions of Russia with the objective of its gradual integration into the Pan-European Ecological Network. In 2011 the Russian Federation adopted the Concept of development of specially protected natural territories of federal significance for the period up to 2020.

We have to admit that only a few Russian SPAs are aimed at the conservation of forest genetic resources. However, because of the reserve and/or protection regime organized in the territories of all protected areas, they are indirectly involved in the process of sustainable forest management/ecosystem management for the benefit of the species and genetic diversity conservation.

Protection of the populations of animal, plant and fungi species on protected areas is one of the most effective methods of the conservation of rare and endangered species: many protected areas in Russia were created specifically for the conservation of such species. Six categories[5] of the status of all taxa and populations according to the risk of extinction were established in the Russian Federation for the protection of rare and endangered species. Identification of rare and endangered species of animals, plants and fungi, their assessment, development of monitoring parameters and setting priorities for their protection in Russia is performed on the basis of the developed system of categories and criteria (see Frame 1).

Currently, 533 taxa of flora of the Russian Federation need protection (5% of the total number of plants described in Russia), 440 of them are angiosperms (flowering), 11 are gymnosperms

[5] Categories of the rarity status of taxa and populations by risk of extinction: 0 - probably extinct, 1 - endangered, 2 - dwindling in number, 3 - rare, 4 - indeterminate status, 5 - recovering and restored

(Conservation Strategy ..., 2003). Forest depending plants make up a large proportion (over 40%) of the total number of species included in the Red Book of the Russian Federation.

The conservation of biological (including genetic) diversity in forest ecosystems is one of the elements of sustainable forest management. Biological diversity conservation is defined as one of the basic principles of the forest legislation of the Russian Federation (Article 1 of the Forest Code of the Russian Federation). Forestry Development Strategy of the complex of the Russian Federation until 2020 (2008) places high emphasis on the biological diversity conservation. Thus, efforts are applied to conserve forest genetic resources not only in protected areas, but also outside – i.e. in the reserve, protective and even commercial forests.

The FFA has established the optimal indicators of the forest cover and the area of protective forests for the subjects of the Russian Federation; the regional indicators for the assessment of the forest biodiversity in the territory of the forest fund are being developed. In accordance with the requirements of the Forest Code (2006), the Decree № 515 of the Government of the Russian Federation of 05.12.2011 approved the updated list of the species of trees and shrubs that are not allowed for timber harvesting in the territory of the Russian Federation.

Frame 1

Rare and endangered plant species inventory of is a part of the state inventory of flora and fauna of Russia.

Inventory of rare and endangered species of animals, plants and fungi is an official document containing a set of data on rare and endangered species (subspecies, populations, species groups) of animals, plants and fungi, comprehensive description of these objects, and an assessment of the full ecological, economic and social value of the objects. The information contained in the inventory includes: information about the system and conservation status, distribution in the country/region, the profile of the main habitats, information on the size and performance of its annual dynamics, information on the biology and ecology, resource value, protection measures, their effectiveness and sufficiency. Inventory of rare and endangered species is kept in the form of a computer database, some of its elements are published as texts, tables and maps/charts.

Monitoring of rare and endangered species is conducted on the basis of accounting and inventory of these species. The monitoring parameters include: the fact of the presence (or absence) of the species and its population, the primary and most important parameters, and the parameters associated with the biological criteria for evaluating the state of rare species. Monitoring is part of the state monitoring of flora and fauna and is included in the unified state system of environmental monitoring of Russia.

The monitoring system combines a variety of structures conducting the monitoring of biodiversity in general on the territory of the whole country. It includes all types of potential performers actually related to the study and conservation of rare species, and other objects of biodiversity, as well as assessing the state of the environment: nature reserves and other protected areas, biological stations, specialized research institutions and universities, governmental conservation organizations, correspondents among the population, zoos, botanical gardens and nurseries; industry accounting systems of biological resources.

The analysis of the rare and endangered species, obtained as a result of record, inventory and monitoring of these objects, results in the preparation of recommendations for inclusion of individual species, subspecies or populations of animals, plants and fungi in the Red Book, or the exclusion from it. The Red Book of the Russian Federation includes the rare and endangered species of animals, plants and fungi, permanently or temporarily living in a state of natural free-ranging, or growing in the wild in Russia, the continental shelf and maritime economic zone of the Russian Federation, that are in need of state and legal acts, within the jurisdiction of the Government of the Russian Federation, the Ministry of Natural Resources of the Russian Federation and other federal executive bodies. These actions should provide, inter alia, the fulfillment of the international obligations of Russia to protect such sites, coordination of government activities between federal entities and state control over the conservation of the object living within only one subject of the Russian Federation if its disappearance from the area entails the loss the object from the composition of the fauna and flora of Russia. The Red Book of the Russian Federation indicates the spread of the species in the past and at present, especially reproduction, and the measures that has already been taken or are necessary to protect the species, subspecies and local populations.

The Red Book of the Russian Federation (www.biodat.ru) is the official document that contains a collection of information about rare and endangered species (subspecies, populations) of wild animals, wild plants and fungi, as well as the necessary measures for their protection and restoration. The Red Book of the Russian Federation is kept by a federal executive authority responsible for the environmental management and protection, based on the data being updated reg-

ularly. Inclusion in the Red Book of the Russian Federation is a legally significant act and a formal sign, which distinguishes certain objects as the objects of legal protection from other members of the animal and plant world. In accordance with Article 60 of the Federal Law "On Environmental Protection" (2002) animals and plants listed in the Red Book of the Russian Federation and the subjects of the Russian Federation, are set aside and restricted for economic use.

The Red Book in Russia is kept at two levels - federal (the Red Book of the Russian Federation) and the regional (territorial lists of the protected species and the Red Books of the subjects of the Russian Federation)-, which complement each other and create a unified methodology. In 2006 the Ministry of Natural Resources of the Russian Federation developed and submitted to the government authorities of the Federation subjects the "Guidelines for the Red Book of the Russian Federation" in order to implement the state policy in the area of biodiversity conservation. This Recommendation defines the framework requirements for the maintenance and publication of the Red Book of the Russian Federation. Keeping the Red Books in accordance with the current legislation is included in the administrative duties of the subjects of the Russian Federation.

In accordance with the current legislation the Red Book of the Russian Federation shall be published at least once in 10 years, which allows us to generalize the monitoring data accumulated over the period of time between editions. Plants listed in the Red Book of the IUCN, living (growing) permanently or temporarily in the territory of Russia, are included in the Red Book of the Russian Federation in cases where this is required by their state, their number or conditions of existence in the country. The same applies to the plants protected by the international conventions.

In the USSR the Red Book was established in 1974 and its first edition appeared in 1978. The Red Book of the RSFSR (plants) was published in 1988, the Red Book of the Russian Federation (plants) - in 2008. A public information system on rare and endangered species of the Russian Federation has been developed (www.sevin.ru/redbooksevin/).

In 2007 the Red Book laboratory of the Russian Research Institute of Nature completed the formation of the first consolidated inventory list of natural objects of the Russian Federation that had been taken under special protection - the Red List of Russia. According to the updated information, 6668 species, including 4,452 species of plants and fungi (66.8%) within the country has been taken under the legal protection. A comparison of the composition and structure of the Red List of Russia and the Red Book of the Russian Federation has shown that the number of species in the Red List of Russia is 6.5 times (from 2 to 14 in different regions) bigger than the number of species in the Red Book of the Russian Federation in terms of the flora objects with a slight difference in the structure of the main macrotaxa. The order of distribution of the protected species by macrotaxa is more natural in the Red List of Russia. In 2007 we completed the publication of the Red List of the protected rare and endangered animals and plants of Russia in 5 volumes based on the Red Books of the Russian Federation.

The use of protective forests in the Russian Federation is only possible if it is compatible with the purpose and functions of these forests. These forests have a special regulated forestry order. The Forest Code determines 4 categories of protective forests, each having its own sub-categories:

1. Forests within specially protected natural areas,
2. Forests located in water conservation zones,
3. Forests with the function of protection of natural and other objects,
4. Valuable forests (anti-erosion forests, forests with scientific or historical value, pine nut-harvesting zones, forest fruit plantations, forest belts, etc.).

Not all of these categories of protected forests are directly related to the objects of the conservation of genetic diversity. However, we can state that the Russian system of protective forests in general contributes to the conservation of the forest genetic resources.

In the forests of the Russian Federation there are SPAs (see frame 2) where the appropriate order of forest management and use of forest is implemented according to the Forest Code: industrial harvesting of wood is prohibited; clear-cutting of forest stands (except for the bathrooms) are restricted to the selective logging; farming is prohibited, except for mowing and bee-keeping; permanent buildings and facilities construction is not allowed; use of toxic chemicals, mining, etc. is forbidden. According to the Forest Code amendment made in December 2010, seed orchards, plus stands and other objects of forest seed breeding became one of the categories of SPA (in 2006, this category included only permanent seed plantations). The above mentioned amendment to the Forest Code is very important for the conservation of these precious objects, that is, for the *ex situ* conservation of forest genetic resources.

The methods of dividing SPAs into different categories (in areas of potential habitat and distribution of rare and endangered plant species for forests in different regions - the North European part of Russia, south of the Far East, etc.) have been developed. At present, proposals to change to the Forest Code are prepared. They are aimed at transferring the authority to establish SPAs to the

Frame 2

The Forest Code of the Russian Federation (Article 102) determines the following as specially protected areas (SPAs):

- *bank protecting, soil protecting forest areas along water bodies, slopes of ravines;*
- *edge of the forests bordering the treeless spaces;*
- *reserved forest areas;*
- *forest areas with relict and endemic plants;*
- *habitats of rare and endangered wild animals;*
- *other special protection areas of forest (small patches of forest, set among treeless spaces, special protection of the state nature reserves, forest areas around the capercaillie displays; forest belts along the banks of rivers or other water bodies inhabited by beavers; honey tracts of forests; permanent inventory plots; forest belts along the permanent, duly approved tourist tracking and hiking trails of the federal or regional significance; forest on the rock streams; forest areas on easily washed soils; forests on reclaimed quarries and dumps, etc.)*
- *seed orchards, permanent seed lots and other facilities of forest seed breeding.*

subjects of the Russian Federation, while reserving the authority to determine the list and order of SPAs in the Russian Federation.

Conservation of forest ecosystem biodiversity is a prerequisite of the certification of Russian forests that is implemented in the certified forests of Russian by the efforts of timber industrialists. The forest certification standards do not yet include the immediate demands of conservation of forest genetic resources; however, the existing requirements include the establishment of a protection system of rare species and their habitats, leaving the key elements of forest (trees and their groups), etc. while logging. FSC certification is widely developed in Russia. Great practical experience have been gained during many years of its implementation, and procedures have been set up for the identification of HCVF in the Komi Republic and Arkhangelsk region, the HCVF atlas has been compiled for Primorsky Krai, southern Khabarovsk Krai and the Jewish Autonomous Region, HCVFs have been identified in Angara region (part of the Krasnoyarsk Territory and the Irkutsk Region), etc. In 2008 the country developed a practical guidance for HCVF identification in Russia, which describes the experience of HCVF identification and protection. In 2011 this guidance was amended (www.wwf.ru).

2.3. Activities on *in situ* genetic conservation

Targeted measures for the conservation of the gene pool of forest forming woody plants in their natural habitats are implemented in Russia as a part of the FFA practical actions. The existing regulations establishing the procedure for the organization of such works are the "Regulations on the identification and conservation of the gene pool of woody species in the forests of the USSR", approved by the Order № 112 of the State Forest Committee of the USSR on 13.08.1982, and the "Guidelines for Forest Seed Breeding in the Russian Federation" approved by the FFA in 2000.

Conservation of forest genetic resources and, above all, conservation of plants characterized by significant genotypic diversity is essential to the sustainability of forests and makes the breeding work possible. In the Russian Federation, the following objects of the *in-situ* genetic diversity conservation have been identified: plus stands (PS), plus trees (PT), forest genetic reserves (the reserves), permanent seed orchards (PSO)[6].

The designation and registration of the **Reserves** is carried out on the basis of the existing legal and methodological documents. When identifying the forest reserves the representation of the respective populations of the species in the protected areas of the region are taken into account. When identifying location areas for the Reserves the highest priority is given to the territories with a greater natural diversity, less disturbed forest composition and structure, and the gene pool of their populations. When selecting sites for the Reserves the preference is given to the native forests, old-growth forest areas, climax forests, unique forest stands and relict dendroflora refugia. The Russian Federation has drafted standards to determine the area of the Reserves, the basics of the Reserve management, establishment order, registration and inventory.

[6] Most of the permanent seed orchards in Russia have been established by designation of highly productive wild stand areas. PSOs are covered in Chapter 2 of this Report, because so far there has been no oppotunity to collect statistics on PSO created by planting.

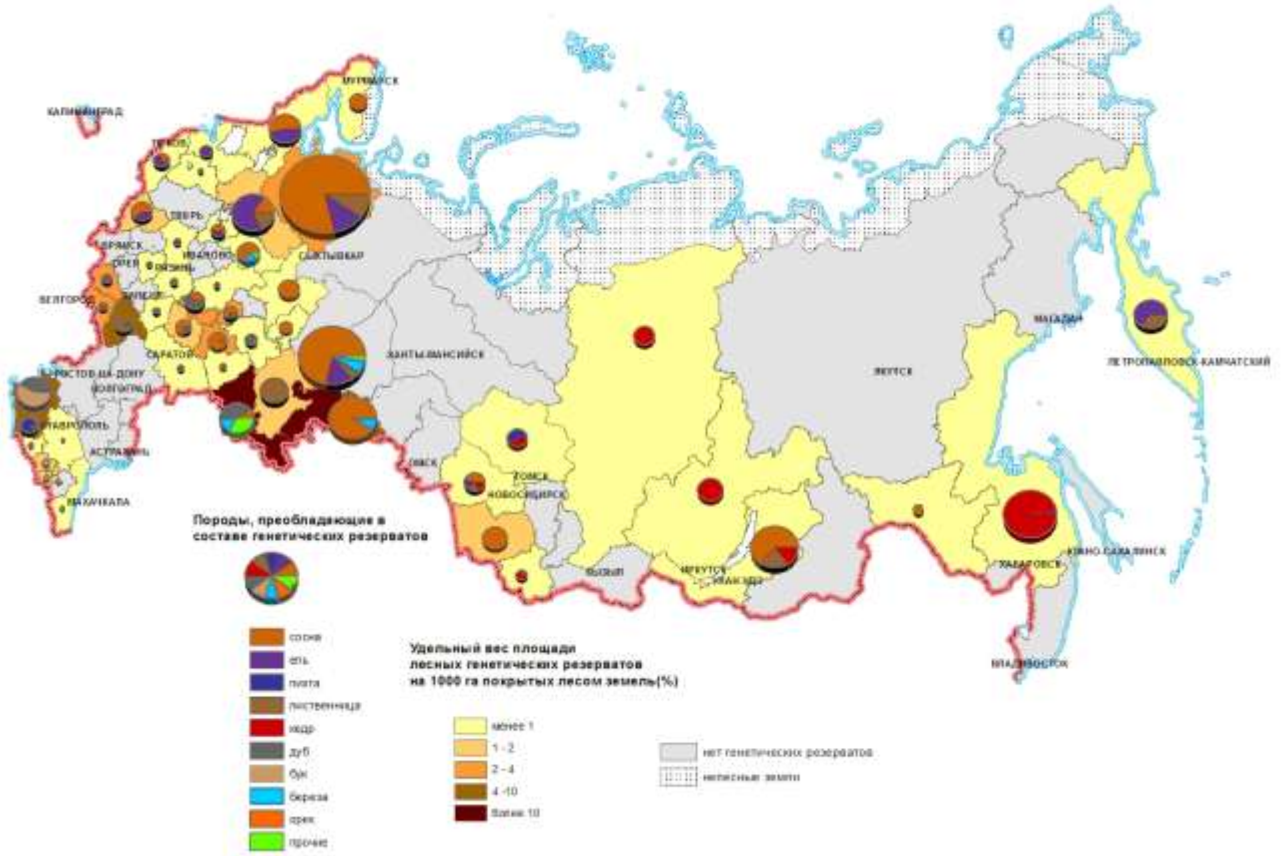


Figure III.2.2. **Forest genetic reserves in the Russian Federation (as of 01.01.2012)**
Породы, преобладающие в составе лесных резерватов – Species dominating in the composition of the forest reserves
Сосна- Pine
Ель – Spruce
Пихта – Fir
Лиственница – Larch
Кедр – Stone pine
Дуб – Oak
Бук – Beech
Береза – Birch
Орех – Walnut
Прочие – Others

Удельные вес и площади лесных генетических резерватов на 1000 га покрытых лесом земель (%) - Ratio and area of the forest genetic reserves on 1,000 hectares of forested land
Менее 1 – Less than 1
Более 10 – More than 10

Нет генетических резерватов – No genetic reserves
Нелесные земли – Non-forest land

Establishment of the forest genetic reserves of the major forest forming species is, by far, the main and most important measure of the forest genetic resources conservation in Russia. Systematic work in this area started in late 1982, however, due to economic and organizational problems, the work was suspended. Over the last 10 years the area of the reserve has been reduced only as a result of writing-off (destruction by fire, damage by insects, forest drying, illegal logging, etc.). At present, 205,501 hectares of genetic reserves of 21 tree species are designated in the country (Figure III.2.2, Table IV.10).

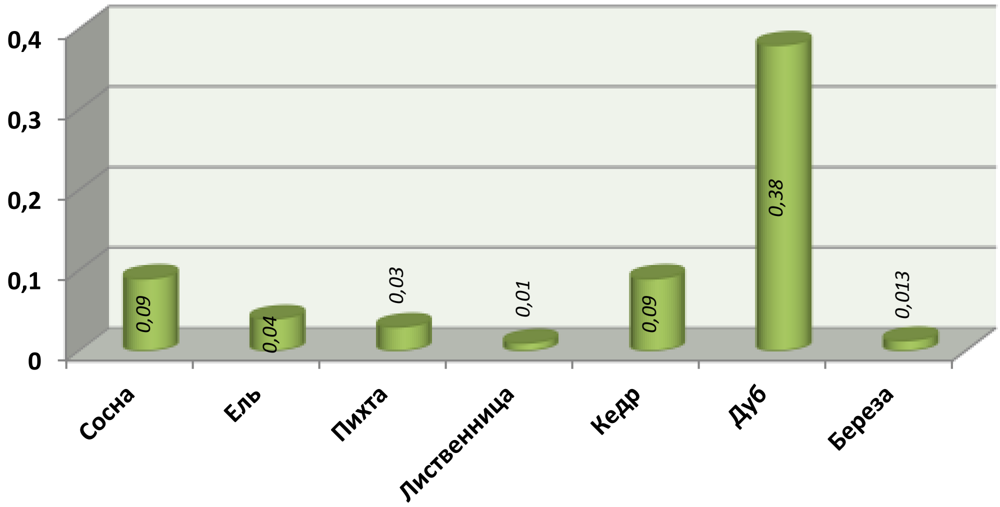


Figure III.2.3. **The share of forest genetic reserves in relation to the area of forests dominated by the respective forest forming species (%)**

Сосна- Pine
Ель – Spruce
Пихта – Fir
Лиственница – Larch
Кедр – Stone pine
Дуб – Oak
Бук – Beech
Береза – Birch
Орех – Walnut
Прочие – Others

In terms of the species representation, about 50% of the total area consists of the common pine Reserves, which clearly does not reflect the needs of the country in preserving the genetic diversity of different species of woody plants. Currently in the majority of the subjects of the Russian Federation an area of the Reserves is less than 1 thousand ha.

A more objective assessment of the state of work on the designation of the Reserves presents the calculation of the reserve area ratio of a particular species in relation to the forest area occupied by vegetation with a predominance of this species. The analysis has revealed that in Russia the biggest are the reserves of oak (0.36% of forests dominated by oak), common pine and Siberian stone pine (0.09%). Significantly smaller share of stands with a predominance of the respective species belongs to the reserves of spruce, fir, birch and larch (Figure III.2.3).

Reserves can be used to designate the plus trees and plus stands. A complete enumeration breeding inventory and plus tree identification is carried out in the plus stands.

Since the selection of **plus trees** (Figure III.2.4) in Russia was conducted in 70-90s of the last century in mature and maturing plantations, the age of these trees at present is often more than 130-150 years. Due to this, according to the inventory results in 2007, 6,400 PTs had been written off in the country as dead and damaged. As of 01.01.2012, the database of FSFI “Roslesozashchita” includes 35065 plus trees of 62 species: 16062 PTs of common pine, 4712 of Norway spruce, 2850 of English Oak, 2093 of Siberian stone pine, more than 1000 PTs each of Siberian larch and Sukachev’s larch. For the remaining 56 species from a hundred to less than a dozen of PTs were selected (Figure III.2.5, Table IV.14).

Figure III.2.4. **Common pine plus tree**

Plus stands (Figures III.2.6 and III.2.7) are the most highly productive and high-quality stands in the given forest site conditions. Plus stands, along with PSO represent a population line of forest seed breeding.

The PS areas have remained relatively stable in the country over the last 10 years. The main reason for PS writing off has been their distraction due to windstorms and fires. As of 01.01.2012, the FSFI "Roslesozashchita" database includes 15205.5 hectares of plus stands of 32 woody species (Figure III.2.8, Table IV.10). More than 50% of the total area of the plus stands is the common pine plus stands (Figures III.2.6 and III.2.8).

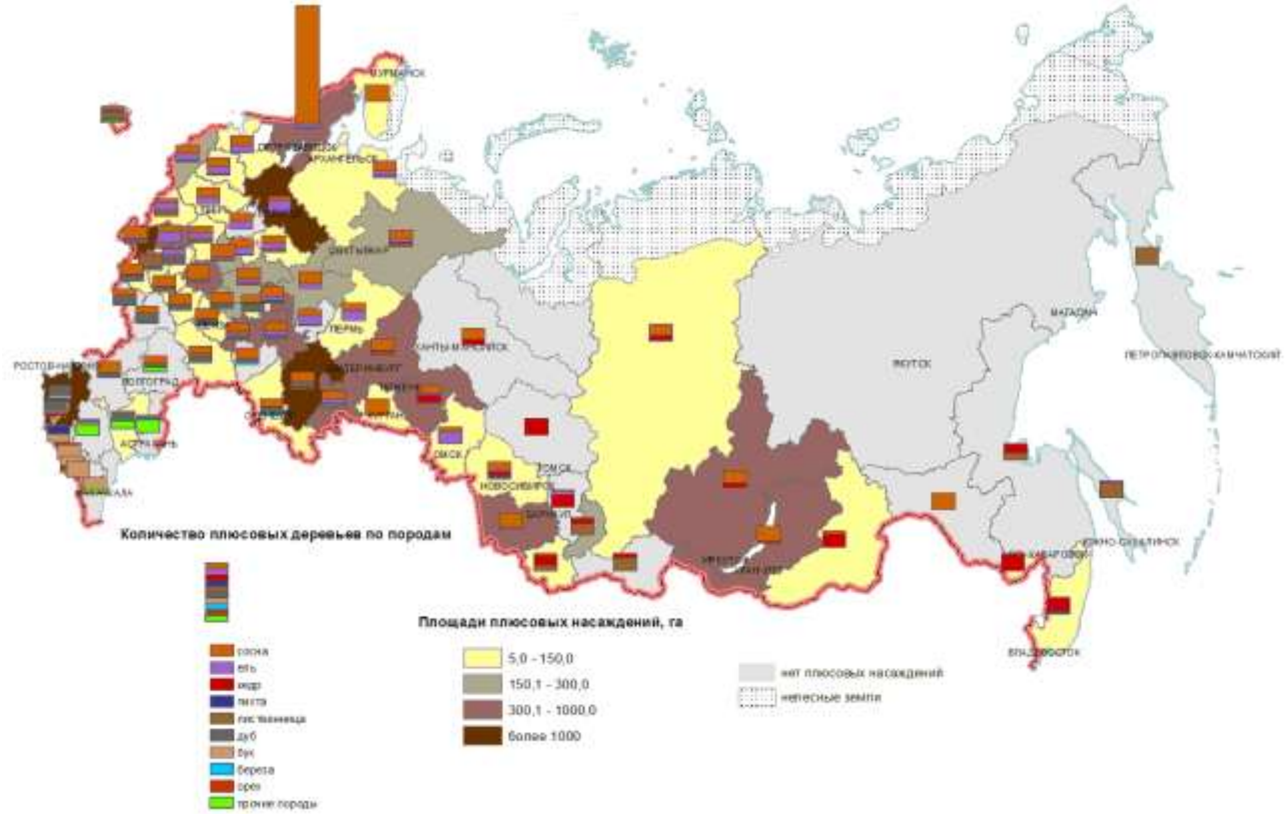


Рисунок III.2.5. **Plus trees and plus stands in the Russian Federation (as of 01.01.2012)**

Количество плюсовых деревьев по породам – Number of plus trees by species
Сосна- Pine
Ель – Spruce
Пихта – Fir
Лиственница – Larch
Кедр – Stone pine
Дуб – Oak
Бук – Beech
Береза – Birch
Орех – Walnut
Прочие – Others

Площади плюсовых насаждений, га – Area of plus stands, ha
Более 1000 – More than 1000

Нет генетических резерватов – No genetic reserves
Нелесные земли – Non-forest land

Permanent seed orchards (PSO) are designated in highly productive and high-quality natural stands/forest plantations of a known origin and are formed especially for a long-term seed production. PSO are established according to the FFA regulatory documents in the following ways:

1) establishment – thin primary planting of standard planlets (seedling) and grown from the seeds harvested on seed plantations, plus trees from the plus stands; and sowing seeds (oak, beech) collected at these sites. Thus, a mixture of seeds from not less than 50 trees is used.

2) formation - thinning of the suitable highly productive and high-quality natural stand areas of seed origin or forest plantations of a known origin. To form oak and beech PSOs the first generation natural stands of vegetative origin can be used.

Most of the permanent seed orchards in Russia have been created by designating highly productive sites of natural stands.

Figure III.2.6. **Common pine plus stand**

Figure III.2.7. **Norway spruce plus stand**

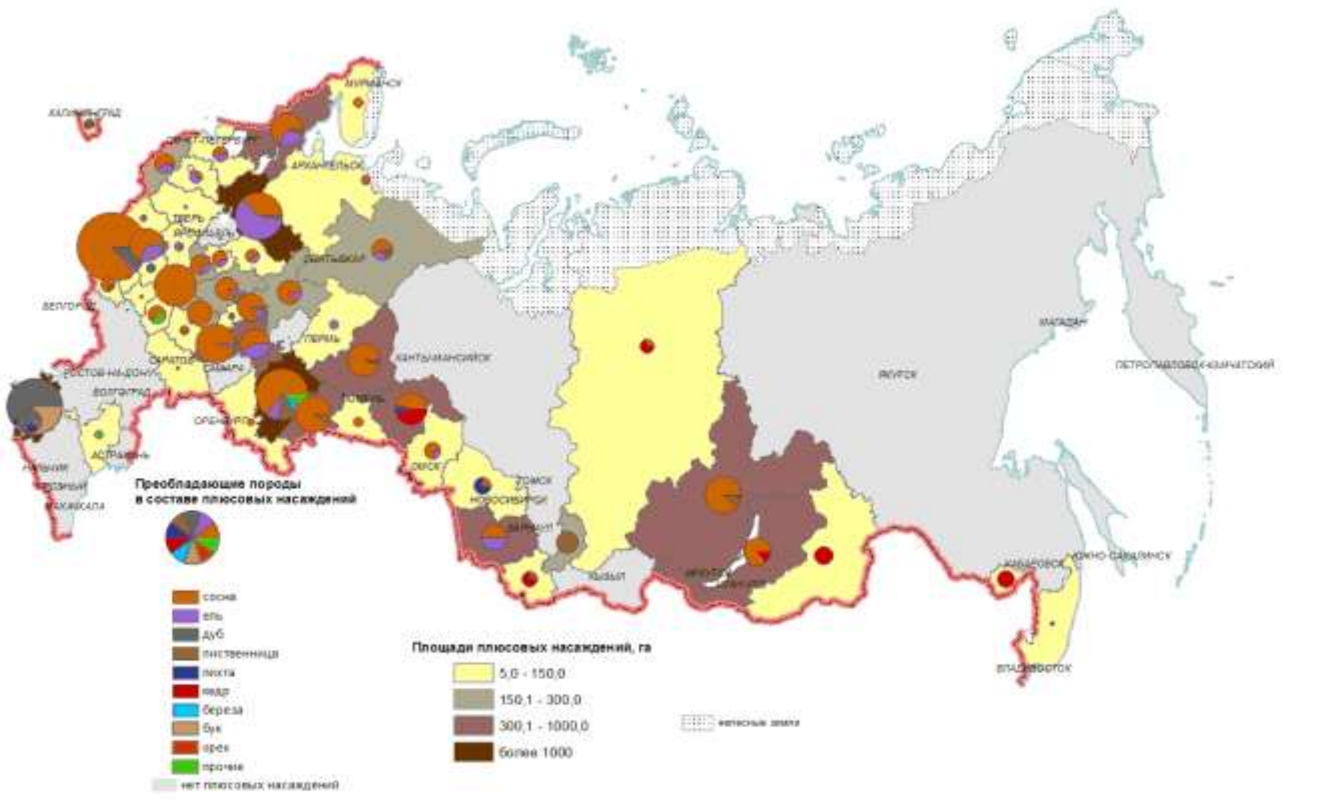


Figure III.2.8. **Plus stands of different target species in the Russian Federation (as of 01.01.2012)**

Преобладающие породы в составе плюсовых насаждений – Species dominating in the composition of plus stands
Сосна - Pine
Ель – Spruce
Пихта – Fir
Лиственница – Larch
Кедр – Stone pine
Дуб – Oak
Бук – Beech
Береза – Birch
Орех – Walnut
Прочие – Others

Площади плюсовых насаждений, га – Area of plus stands, ha
Более 1000 – More than 1000

Нелесные земли – Non-forest land

According to the specifications, the PSO area should not be less than 5 hectares. Improving the qualitative composition of stands, ensuring the development of seed tree crowns, early sustainable and abundant fruiting, and creating favorable conditions for cone (fruit, seed) harvesting on PSOs is achieved by space or corridor thinning in several stages (3-5).

PSOs, in fact, refer to the objects of *in situ* forest genetic resources conservation, as the best trees and stands are preserved in their natural habitats. This object of forest seed breeding is all the more important for the *in situ* conservation because the designated and appropriately protected PSO area in Russia is 20579.6 hectares. They are an essential complement to the forest genetic resources conservation in the genetic reserves and plus stands, as at present the country has the PSOs of 53 woody plant species (Figure III.2.9, Table IV.10).

The designation and registration of reserves, PS, PT, PSO as well as using them for economic activity in Russian is carried out on the basis of the existing legal and methodological documents. The designation of these objects presupposes preparation and legalization of necessary documentation, passport forms and related consolidated lists/registries, recording system.

Systematic work on the *in situ* forest genetic resources conservation was started by FFA at the end of the last century. However, in many regions of Russia a number of species, as well as genetic reserves, plus trees and plus stands have not been identified yet, are insufficient and/or have been partly lost in the years of inadequate funding and lack of attention to this problem. A disadvantage of the previous designation of the genetic reserves was the fact that most of the Reserves were designated according to the geographical landscape, but not to their population and genetic basis. Altogether these factors provide for an urgent need in further research and practical work on conserving the gene pool of forest woody plants and improving its methodological basis.

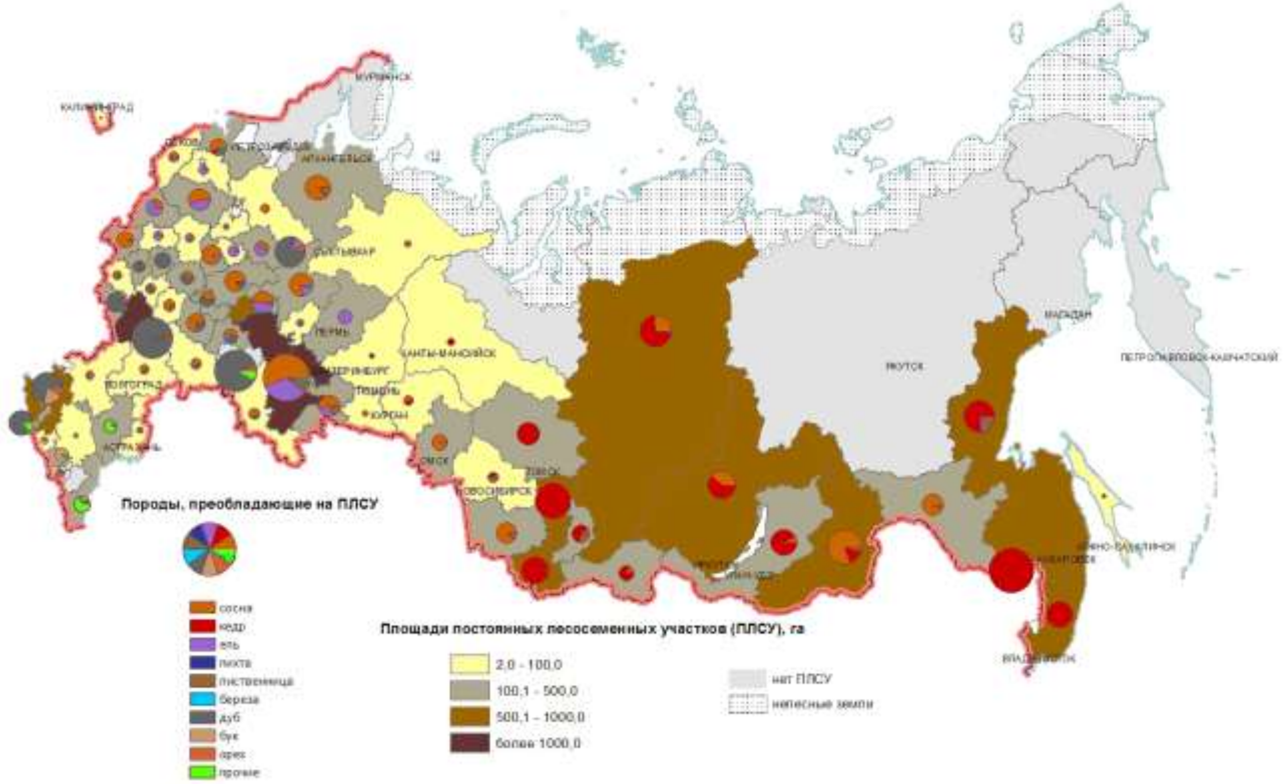


Figure III.2.9. **Permanent seed orchards in the Russian Federation (as of 01.01.2012)**
Породы, преобладающие на ПЛСУ – Species dominating in PSOs
Сосна - Pine
Ель – Spruce
Пихта – Fir
Лиственница – Larch
Кедр – Stone pine
Дуб – Oak
Бук – Beech
Береза – Birch
Орех – Walnut
Прочие – Others

Площади постоянных лесосеменных участков (ПЛСУ), га – Area of permanent seed orchards (PSO), ha
Более 1000,0 – More than 1000,0

Нет ПЛСУ- no PSO

Нелесные земли – Non-forest land

2.4. Criteria for *in situ* genetic conservation unit identification

Russian scientists have formulated the principle of plant organization of the community as a system of interacting populations (Rabotnov, 1950, Uranov, 1973, 1975). The principle of the population-based vision of a plant community was proposed and developed by T.A. Rabotnov and A.A.Uranov and transformed into the concept of population structure of species biocoenosis and biocenotic cover as a whole. Researches of the generation flows in the populations' edificatory species allow us to understand the mechanisms of the formation of heterogeneous biogeocenosis environment and sustain it in a permanently dynamic state. The basis of these ideas lies in two concepts, i.e. «gap mosaic concept» and «mosaic cycle concept» (The mosaic cycle ..., 1991; Smirnov, 1998). Within these concepts there are substantiated ways of calculating the minimum area of climax forest community on the basis of the determination of areas needed to sustain the generation flow of plant and animal edificator species (Eastern forests ..., 2004). Generation flows in the elementary populations of different species are presented at each time as population mosaics of different spatial structures.

Accordingly, when determining the size and location of the reserve in a species area it is important to take into account the evolutionary and genetic factors responsible for the specificity of the ecological and geographical differentiation of gene pools of the populations of each species. In the majority of woody plants sampled in terms of their intraspecific genetic differentiation (Table IV.9) the molecular markers often identify geographic groupings whose genetic differentiation levels exceed the morphological specificity of the species (for example, northern populations of *Pinus sibirica*, different groups of larch populations, etc.). Population and chorologic structure of many woody plants is a three-level hierarchical system comprising populations, groups of populations, migration systems (Vidyakin, 2007). Populations are formed within physiographic regions; groups of populations occupy large landforms - hills, lowlands, plains, river terraces of large rivers. Migration complexes comprising several groups of populations have very large area and tend to spread across several natural zones.

Besides, particular attention needs to be paid to the environmental aspects of the differentiation of sympatric populations when upland and wetland populations of many conifers (common pine, fir), their forms or ecotypes typical and adapted to the specific conditions (*Pinus sylvestris* L. var. cretacea Kalenicz. ex Kom., etc.), exist in the same region. S.N.Sannikov proposed a method of objective selection of populations with gradients of genetic distances on the example of common pine (Sannikov, 1993, Sannikov, Petrova, 2003, 2007). The sharp increase in genetic differentiation in the small physical distances can serve as a criterion for distinguishing the population, i.e. a unit of genetic resources within a species. Genetic diversity of forests is possible under the condition of conservation the gene pool of each population as the main structural and basic evolutionary species unit (Altukhov 2003, Population gene pool dynamics ..., 2004; Vidyakin 2007). Thus, the problem of the species genetic diversity conservation can be successfully solved provided that its population-chronologic structure is previously properly studied, which gives a clear picture of the spatial position of each population and each superpopulation unit. At present, the insufficient study of the genetic structure of most woody plat species makes us use forest growth schemes or seed zoning in determining the degree of environmental and geographical subdivision of the gene pool, based on an analysis of the growth rate of plants in provenance, and which relatively reflects the influence of natural selection on the genotypic composition and the structure of its populations.

In situ conservation of the gene pool of forest forming species populations can be ensured at the stage of designating a representative reserve aggregate (2-3 to 5-7) in a forest (seed production) area. When the location of forest ecosystems representing the main micropopulation and cenopopulations diversity is space effective within the same array, the amount of reserves in the relevant area is minimal (i.e. 2-3). It is recommended to increase the number of reserves up to 5-7 in the areas of significantly disturbed and fragmented natural forest stands or areas represented by isolated populations.

In accordance with the Regulation on the designation and conservation of woody species genetic fund of in the forests of the USSR (1982), a forest genetic reserve is a forest site with the phitocenotic, silvicultural and forest growth indicators typical for the given natural and climatic (seed production) area where the valuable genetic and breeding part of the population of species, subspecies, ecotypes is concentrated. Genetic reserves are designated primarily in the protective forests in order to avoid unnecessary removal of forest resources from industrial use. If there is no possibility to provide the required number of genetic reserves in protective forests, they are designated in commercial forests. Special protective forest sites where logging is not allowed can be used for this purpose.

After a decade of studying the Korean pine populations within the five seed production areas of the Far Eastern Federal District (FEFD) the parameters of genetic variability (effective number of alleles, polymorphism, average expected heterozygosity) have been defined for 25 populations of the species and as well as their average values in seed production areas (Velikov, Potenko, 2004). Taking into consideration the peculiarities of the Korean pine genetic structure it was concluded that in the process of developing the strategies for the species genetic diversity conservation in FEFD the preference should be given to conserving the plantations of species with the typical level of expected heterozygosity as this parameter is responsible for increasing the number of heterozygous individuals in the population, and is, therefore, characteristic of more stable populations.

Table III.2.1. **Calculation of the *Pinus koraiensis* genetic reserve area taking into account the cedar tree share in the forest stand composition of the prevailing forest types by seed production areas (Velikov, Potenko, 2004). (Velikov, Potenko, 2004).**

Seed production are (number)	Prevailing forest types	Cedar tree share in composition	Number of individuals per 1 ha	Effective population size, individuals	Reserve size, ha
Khingan-Amur (42)	Cedar tree - spruce	4	62	502100	8098
Middle Amur (43)	Elfinwood and spruce	2	44	533245	12119
Amur - Ussuriisk (44)	Cedar forest with Corylaceae, linden and oak	3	154	577153	3748
South Primorye (45)	Cedar forest with maple, Corylaceae, hornbeam	3	142	548038	3859
Coastal (46)	Cedar tree - spruce	4	80	532143	6652
Total in the area					34477

According to the calculation the effective population size for various seed production areas ranged from 502.1 to 548 thousand individuals (Table III.2.1). Given the average number of individuals per 1 ha in the prevailing forest types, the minimum total area of genetic reserves in the Russian part of the *Pinus koraiensis* area should be 34.5 thousand hectares. Each seed production area must have at least 3 reserves; they must be surrounded by a buffer zone with the area at least twofold of the reserve size to avoid negative impact. The calculation must also take into account the contribution of the parental individuals in the gene pool of the next generation, which is not tantamount. It includes such biological characteristics of species as seed production periodicity, degree of sexual specialization of individuals and the sex ratio in the panmictic population, age composition and other factors.

Calculations of the minimum total area of the reserves for other woody species have not been made; however, it can be done by using the proposed method under the condition of continuing the research on defining the genetic variability of species and silvicultural characteristics of modern forests.

2.5. Major needs for *in situ* forest genetic resources conservation

The *in-situ* conservation methods play a priority role in the conservation of forest genetic resources, since full and long-term conservation of species genetic diversity and their natural evolution is only possible in the natural environment. It is worth mentioning the following needs in term of the *in situ* conservation of forest genetic resources in the Russian Federation:

1. Expansion of research and practical work. Lack of integration between academic, university and industry researches results in non-use of the existing knowledge in genetic diversity, the scientific potential of universities and academic institutions, modern advances of the Russian forest population genetics, genogeography and phylogenetics are not applied in practice when developing systems, programmes and procedures of forest genetic resources conservation. Some of the up-to-date trends in joint scientific and practical work can be listed:
   - ✓ improvement of work on the inventory of dendroflora species diversity as the nature of the federal protected areas are still poorly studied: the full inventory of the flora of the higher plants have been made only in relatively "old" reserves, the data on the flora and fauna of the national park is incomplete, and the data on the interstate sanctuaries is simply unavailable;
   - ✓ development of the theoretical framework, methodology and programme of practical activities for the conservation of forest genetic resources: justification of the optimal sizes of reserves and PS, the rationale for the spatial distribution of reserves and plus stands, etc.;
   - ✓ study of the genetic diversity of old-growth forests as unique sites for the study and conservation of the woody plant populations with native genetic structure, i.e. reference samples that can be used to restore the genetic diversity of species or their regional groupings in case of catastrophic situations. The study of these forests is important to build knowledge about the genetic structure of natural populations and the dynamics of population and genetic processes that provides high levels of population stability and adaptability to environmental changes;
   - ✓ study of the genetic diversity and genetic structure of endemic, rare and endangered species populations, and small, local, marginal and high-mountain populations of tree and shrub species.

2. The need for interagency cooperation. Forest genetic resources conserved *in situ* are located in the different subjects of the Russian Federation, and are conserved/managed by organizations of various ministries and departments lacking coordination in the absence of a single unified strategy which often impedes effective conservation and can cause irreparable loss of genetic diversity. It is necessary to establish and define the status of the chief coordination center/council for science and methodology and regional institutions supervising various aspects of the conservation of forest genetic resources. The responsibilities of such center should include the training and education of stuff.

First of all, FFA and the Ministry of Natural Resources need to cooperate on coordination/co-funding of activities on the conservation of forest genetic resources, since this problem in Russia is not integrated into the framework of programmes and activities for the biological diversity conservation. There is no federal SPA that was designated especially for the purpose of conservation the genetic diversity of woody plants. The work carried out to assess the prospects for the development of SPAs in Russia does not aim to conserve genetic diversity in the specially protected areas (Specially protected..., 2009). It is necessary to take into account that the SPA network in Russia has been created for many decades, and the system of priorities for the selection of territories for special protection has changed repeatedly. The boundaries of many SPAs are the result of compromise with different economic interests rather than the reflection of the environmental protection idea. In this regard it is necessary to objectively identify the regions and types of plant communities/forest conditions most in need of urgent establishment of specially protected areas for the conservation of forest genetic resources. Russian federal SPA network should be significantly enriched by including the old-growth forest areas[7]. Some of the federal sanctuaries and federal natural monuments should upgrade their conservation status.

SPA system is able to ensure genetic diversity conservation only when all its components are interrelated, and the SPAs are converted in a network of protected areas providing landscape permeability. Despite the developed theoretical justification, available methods and specific research results, so far the achievements of the Russian population genetics are not highly demanded in the designation of protected areas and formation of such a network. It is necessary to consider the establishment of forest genetic reserves at the territory of state natural reserves and national parks.

3. Improving public information policy. In the Russian Federation there is no common research guidance and information center where the information on the *in situ* conservation of forest genetic resources is collected, and the information on all types, objects of conservation, etc. is stored (See also section III.3.7).

4. Improvement of the legislation on the *in situ* conservation of forest genetic resources. Federal law contains no direct provision obliging forestry stakeholders to implement activities on the *in situ* conservation of forest genetic resources. Improvement of the legislative framework is required, as currently in Russia there is no regulatory document that directly defines the procedure of the conservation of forest genetic resources. The "Regulations on the designation and conservation of the gene pool of tree species in the forests of the USSR" confirmed by the order of the USSR State Committee for Forestry in 1982 is not legitimate under the new forestry legislation, and contains only the most common approaches to the conservation of forest gene pool. Moreover, the federal legislation does not state a need to create such a legal instrument which, in principle, does not allow adopting it on the federal level. As a consequence, no guidance document was developed to determine the order of selection of the objects of forest genetic resources conservation by major forest forming species and regions of the country, even though there are such recommendations prepared following the implementation of the EUFORGEN Programme related to some certain Eurasian woody species. It is necessary to develop new regulations for the conservation of forest genetic resources in Russia and use it a basis to continue the designation of reserves and plus stands, development and adoption of regulatory and technical documents related to the economic activities in their territories. It is necessary to determine the order and legal status of the conservation of natural old-growth (virgin) forest ecosystems. Accomplishing these tasks will help create a legal framework for the *in situ* conservation of forest genetic resources.

5. It is necessary to ensure stable and adequate funding of scientific researches and works on development, organization, economic management, protection, monitoring and inventory of the *in situ* conservation of forest genetic resources. Lack of timely financing brings to nought the efforts of hundreds of people, and the money spent on activities turns out to be wasted. Just like this, according to the one-time inventory of the objects of conservation of forest genetic resources established in Russia in the last century, which was held by FFA in 2007, 6400 destroyed and damaged plus trees(15% of the inventoried trees) and 10% of the designated and registered plus stands (1625,9 hectares) were written off; 16.7 thousand hectares were written off as the forest genetic reserves that had lost their intended purpose of use.

6. Methods of *in situ* conservation of forest genetic resources should be smoothly integrated in the practice of forest use and reforestation. Conservation of forest genetic resources with the use/exploitation of forests is only possible when management activities are based on the knowledge about the population and genetic structure of species.

[7] Only 4.8% of the area of old-growth forests (13.3 million hectares) is currently within the federal nature reserves, national parks, sanctuaries and natural monuments (Figure III.2.1).

7. To improve the conservation of forest genetic resources is also required to increase the objectivity and accuracy of the inventory of forest genetic diversity, including the implementation of GIL.

8. Conservation of forest genetic resources would allow the dissemination of scientific knowledge in forest genetics among the Russian population, and particularly among professionals working in the field of nature conservation and forest management. In this direction there is a need to:

- ✓ organize publication of popular scientific literature on forest genetic diversity, evaluation, monitoring and protection, as well as visual information for exhibition stands and booklets
- ✓ advocate for annual activities and events for the conservation of forest genetic resources.

9. There is no federal (national) programme of conservation of forest genetic resources. It is necessary to develop such a programme, as this national goal is supposed to integrate the above mentioned areas of work.

Chapter 3
The State of *ex situ* Genetic Conservation

Ex-situ[8] conservation of forest genetic resources in the Russian Federation is carried out using different methods:

- ✓ establishment and maintenance of collections of living organisms,
- ✓ propagation of plants for their subsequent reintroduction into nature (creation of special nurseries, arboreta, farms, etc.)
- ✓ establishment and maintenance of plant tissue culture collections
- ✓ establishment and maintenance of gene banks (including cryobanks), seed banks.

Ex situ conservation is considered an extremely important component of the overall strategy of enhancing the conservation and sustainable use of biological diversity. *Ex situ* conservation is particularly important for the rare and endangered species: it allows saving their gene pool from destruction, to organize their artificial propagation and reintroduction into the natural habitat to create larger populations and restore damaged ecosystems. An important function of conservation of forest genetic resources outside of their natural habitats in Russia belongs to botanical gardens and arboreta. Besides, the following objects of *ex situ* conservation of forest genetic resources have been created in the country in order to carry out genetics based forest seed breeding: clone banks and mother plantations, trial plantations, provenance plantations, population and environmental plantations, seed orchards (SOs), permanent seed orchards (PSOs), collection nurseries, and genetic seed, pollen grain and forest plant meristem banks. All the above mentioned breeding and seed production facilities as well as objects designated in the natural environment for conservation and study of forest genetic resources, forest genetic reserves, plus trees and stands (see Section III.2) constitute a single genetic breeding system (SGBS).

3.1. Collections

3.1.1. Living collections of arboreta and botanical gardens

The National living collection of vascular plants is concentrated in botanical gardens (BGs) and arboreta. In Russia the BGs and arboreta are the autonomous category of protected areas. According to the Federal Law “On Specially Protected Natural Territories” its objectives include *ex situ* conservation of biodiversity of the Russian flora, establishing special collections of plants in order to preserve and enrich the biodiversity of flora, and implementation of scientific, educational and outreach activities.

More than 17,000 species of vascular plants and more than 20,000 varieties and clones are cultivated in the Russian BG and arboreta. The total area occupied by the BGs and arboreta in Russia is more than 7.7 hectares. (Www.sevin.ru / rusgenres / collections / gardens.html). BD develops scientific methods of conservation, rational use and reproduction of useful, as well as rare and endangered plant species. Data base on the plant species of the Red Book of the Russian Federation grown in BC provides information for assessment of the overall status of *ex situ* conservation of rare plant species in Russia

[8] Conservation of population's gene pool, or certain sets of genotypes of forest woody plants outside their natural ranges in artificially created facilities and in gene banks (germoplasm).

and the reliability of this protection. It also helps outline a specific action plan of the implementation of the National and Global Strategies for Plant Conservation and activities on saving the species not conserved *in situ*. Analysis of the information collected in the database showed that the Russian BGs and arboreta grow about 60% of the species of the Red Book of the Russian Federation, including all tree species from the Red Book of the Russian Federation. The BG and arboreta collections are also used to produce genetic resources of introduced valuable woody species adapted to new environmental conditions by seed or vegetative reproduction.

The BG and arboreta activities are coordinated by the Council of Botanical Gardens of Russia (http://hortusbotanicus.ru/), which is a division of the International Union of Botanical Gardens. It brings together more than 100 BGs and arboreta of different subordination (Russian Academy of Sciences, Russian Academy of Agricultural Sciences, Ministry of Agriculture, Ministry of Education and Science, etc.). The Information Analytical Center of the Council of Botanical Gardens of Russia has been collecting information on the taxonomic composition of the BG and arboreta collection funds. The data obtained are placed in a retrieval system "Botanical collections of Russia and neighboring countries» (www.garden.karelia.ru). At the moment, it includes information about 25855 species (including intraspecific taxa) and 29394 varieties of vascular plants.

The FFA academic institutions have special dendroflora collections, such as the CRIFGS collection, which includes heteroploid hybrid poplars, poplar regenerants obtained by another culture, etc. (Development and production ..., 2004).

In addition to the state BGs and arboreta in Russia there is a number of private collections, for example, the collection of A. Vereshchak (Kaluga region) with more than 1,800 cultivars and 90 conifer species; there are varieties of self-selected conifers recognized by world experts (Figure III.3.1), or S. Goroshkevich's collection with more than 1,500 ornamental cultivars (see Frame 3 in Chapter 5.)

Figure III.3.1. ***Larix gmelinii var. principis-rupprechtii***
"AV Variegata" – selected out of 10000 seedling

3.1.2. Field gene banks[9]

Plant gene banks are also created for the *ex situ* conservation the plant gene pool. This type of forest woody species gene pool collections may include some SGBS objects - plus tree clone banks (CBs) and mother plantations (MPs).

[9] Field gene banks are special, usually clonal plantations of fruit and forest species, root and tuber crops.

Clone banks are plantations created by using vegetative progeny of plus trees in order to conserve their gene pool and the study of the genetic properties (Figures III.3.2, III.3.3). In Russia CBs are created in minimum two points of the region in order to ensure the conservation of PT genotypes in natural disasters. The genotypes of other, non-plus trees are introduced in the CBs in case when the species diversity is not covered by the selected plus trees. CBs also preserve high-value mutants and interspecies forest woody plant hybrids. As of 01.01.2012, the Roslesozashchita database lists 588.9 hectares of CBs (Figure III.3.4). The CB ratio established in the country currently does not present all of the selected plus trees in the country (Table IV.14).

Figure III.3.2. **Common pine clone bank**

Figure III.3.3. **English oak clone banks**

Mother plantations are plantations created with the use of vegetative progeny of plus trees for mass reproduction and for the preparation of cuttings for subsequent grafting rootstock. As of 01.01.2012, the Roslesozashchita database lists 226.6 hectares of MPs (Figure III.3.4). The species diversity of the existing MPs is lower than that of CBs. The ratio of the MP area for different species depends on the country’s needs in seed orchard establishment (Table IV.14).

Some academic institutions have field gene banks. For example, the scientific station “Kedr”, IMCES RAS, has a unique collection of five-needle pines including more than 700 clones of 18 species. Siberian stone pine is the most widely represented in the clone bank (Figures III.3.5, III.3.6). More than 30 ecotypes of Siberian stone pine are organized into several logical sets: latitudinal profile, longitudinal profile, several altitudinal and environmental (forest-marsh) profiles. This allows exploring the species structure in relation to the eco-geographic reference system and to characterize different aspects of diversity within species.

Figure III.3.4. **Clone banks and mother plantations (as of 01.12.2012)**
Площади маточных плантаций, га – Area of mother plantations, ha
Площади архивов клонов, га – Area of clone banks, ha
Более 30 – More than 30
Нет маточных плантаций – No mother plantations
Нелесные земли – Non-forest land

Figure III.3.5. **Trial graft plantation of Siberian stone pine: on the right – ordinary, on the left – a better clone in terms of growth rate**

Figure III.3.6. **A collection of forest woody species mutations in the scientific station "Kedr", IMCES RAS**

3.1.3. Plant material banks, conserved in vitro (meristem cultures, tissues under slow-growth conditions)

In vitro storage and reproduction of forest genetic resources is an additional opportunity to conserve them. These banks are organized in BGs and arboreta, and in organizations of various agencies (Russian Academy of Sciences, Russian Academy of Agricultural Sciences, Ministry of Agriculture, Ministry of Health and others) conducting research in medicine, genetics and tree selection, etc. Information portal of genetic resources that is intended, in particular, for inventory and documentation of such banks are under development in Russia (www.sevin.ru/rusgenres/), so the following list of organizations engaged in such collection is incomplete.

- ✓ All-Union (Russian) Collection of Cell Cultures was established in 1978 (www.sevin.ru / collections / cells.html). It includes 9 collections; two of them are plant collections:

• National collection of cells of higher plants (Timiryazev Institute of Plant Physiology, Russian Academy of Sciences)
• Collection of genetically transformed rRi roots of higher plants (Timiryazev Institute of Plant Physiology, Russian Academy of Sciences).

- ✓ *In vitro* collection of rare and endangered plant species of MBG RAS includes 47 species of 14 families.
- ✓ *In vitro* collection of the biotechnology laboratory of the Central Siberian Botanical Garden SB RAS preserves 16 microclones of rare and endemic species of 6 families and 185 microclones of useful species, varieties, and hybrid forms of 11 families.
- ✓ A flora species collection of the Volgograd BG includes 28 species.
- ✓ SPFRI has a collection of the best genotypes of aspen, birch, etc.
- ✓ NIILGIS has been keeping a collection of genotypes of deciduous trees for 19 years.
- ✓ IBCh RAS has a collection of genotypes of aspen, birch, ash and willow.
- ✓ Sukachev Institute of Forest Sciences has a collection of larch genotypes.
- ✓ Institute of Biology and Soil Science, FEB RAS, has a collection of cell cultures of 17 families of the Far Eastern flora, as well as transformed and transgenic lines of ginseng, Rubya, yew, etc.

3.1.4. Seed gene banks

The most accessible and cheapest way to conserve plant genetic resources *ex situ* is a collection of seeds or seed banks for long-term storage at low positive temperatures (+5 ° C) and shallow freezing (up to -20 ° -25 ° C). Establishment of seed banks of rare and endangered plants is carried out in most BGs and arboreta of Russia, as well as in a number of Russian scientific institutions (VIR, MBG, Institute of Plant Physiology of RAS, etc.).

N.I. Vavilov Research Institute of Plant Industry (www.vir.nw.ru) is one of the world's crop gene banks, a national research center of the world's genetic resources of cultivated plants and their wild relatives. The total collection of the world's plant genetic resources of the Institute has more than 323 thousand samples that are representative of 64 botanical families, 376 genera and 2169 species. More than 270 thousand samples are kept at low temperatures in long-term storage in the cryobank of the Institute.

In MBG there are seeds of 210 wild species in long-term storage, and 160 species of protected and medical plants stored in the deep freeze since 1986. Seed storage in the refrigerator at +5 ° C is carried out since 1982 in a sealed glass container (994 samples, 201 species). Low positive temperature increases seed longevity, but cannot provide reliable storage since the metabolism of seeds of many species does not stop in this mode, and they get older and die. Certain species are monitored for germination of seeds. Permanent storage of seeds of 50 species in shallow freezing up to -20 ° C is carried out in MBG since 1998. In the coming years a comparative study will be conducted on seed viability conservation in +5 ° C and -20 ° C storage temperature. Permanent seed storage at -196 ° C is carried out since 1986 in cooperation with the Institute of Plant Physiology. On the 1320 tubes with seeds are stored at present (156 species, 188 samples).

The Research Institute of Nature has created a seed bank of wild plants kept in positive low temperature (150 species). The Institute of Plant Physiology, RAS, has been keeping a seed cryobank (120 species) since 1986. The cryostorage of the Institute for Biological Problems of Cryolithozone (IBPC), Yakut Scientific Center, Russian Academy of Sciences, contains about 11,000 of the seed samples of cultivated plants.

As this review shows, there is no specialized dendritic seed bank. Only recently the creation of the genetic cryobank of seed, pollen and tissue cultures of the main forest forming species in Russia has started in Krasnoyarsk on the initiative of scientists.

3.2. Objects of the unified genetics and breeding complex

The first phase of tree selection which includes the creation of plus tree clone banks, trial and provenance plantations, seed orchards contributes to the conservation of the gene pool of valuable tree species.

3.2.1. Trial plantations and population ecology plantations

Trial plantations (TPs) are forest plantations established by using special methods from the seed offspring of PTs, PSs, the primary SPs and PSOs to conduct genetic evaluation of the adaptive capacity of their seed progenies and identify prospects for use in silvicultural practice.

As of 01.01.2012 the Roslesozashchita database lists 821.3 hectares of TPs (Figure III.3.7, Table IV.14) that are predominantly TPs of common pine and Norway spruce.

Figure III.3.7. **Trial plantations and population and environmental plantations (as of 01.01.2012)**

Породы, преобладающие в составе испытательных культур – Species dominating in the composition of trial plantations
Сосна- Pine
Ель – Spruce
Пихта – Fir
Лиственница – Larch
Кедр – Stone pine
Дуб – Oak
Бук – Beech
Береза – Birch
Орех – Walnut
Прочие – Others

Площадь испытательных культур, га – Area of trial plantations, ha

Площадь популяционно-экологических культур и преобладающие в их составе породы – Are of population and environmental plantations and species dominating in their composition
Сосна – Pine
Дуб – Oak

Нелесные земли – Non-forest land
Нет испытательных культур – No trial plantations

Population and environmental (forest typological) plantations are trial plantations that create progenies of several edaphotypes of the climatic types best for a particular region, in the most common forest conditions for their further trials in this region and determining varieties of populations. Establishment of population and environmental plantations requires three trial replications, and the size of each edaphotype site should provide at least 100 trees growing to maturity age. As of 01.01.2012, the Roslesozashchita database lists 31.3 hectares of forest typological plantations, with 18.3 hectares of common pine and 13 hectares of English oak (Figure III.3.7, Table IV.14).

3.2.2. Provenance trial plantations

Provenance trial plantations (PTPs) are trial plantations that are created with the seed progeny of the most characteristic populations of several ecotypes (climatic types) for the purpose of further trials in new conditions, determination of population varieties, and development of seed zoning. According to the FFA regulations when establishing PTPs, the seed harvesting sites should reflect the variability of silvicultural and biological properties of the species across its entire natural range or its part; and the plantation establishment sites should reflect the variability of forest conditions in the areas under cultivation. The seeds for the PTP establishment are harvested in the mature stands of the most common forest type of each climatic type. Seeds of the local climatic type are used for control. PTP establishment requires tree trial replications, and the size of each climatype site should provide at least 100 trees growing to maturity age.

In Russia the first provenance trial plantations of spruce, larch and pine trees were established in the late XIX century by M.K.Turskiy. Some of them have survived to this day. During the XX century in the framework of initiative experiments and various programmes a number of unique plantations of oak, pine, spruce, larch, etc. were established (Shutyaev, 2011). Unfortunately, there is no integrated data neither on the safety of these plantations, nor on the results of the survey of these trials.

Thanks to the efforts of a large team of scientists of many research institutes, universities and other scientific organizations in collaboration with the production teams in 1975-1978 in the country in accordance with the state programmes of the USSR State Forest Enterprise (Gosleskhoz) (1973) a network of provenance plantations were established on 1,236 hectares (111 sites), including: pine - 626 ha/37 sites, spruce - 256 ha/21 sites, oak - 21 ha/21 sites, larch - 80 ha/23 sites, fir -

51 ha/7 sites, stone pine - 6 ha/2 sites. The seeds from 50-120 sites in the country (depending on the size range of species) were used. All trials were certified (CSRIFGS, A.M.Shutyaev). The methods of work included the establishment of objects in two or three replications, with obligatory control (local climatype). Currently these plantations are about 35 years of age. The Russian experience of establishment of the provenance plantation network of the main forest forming species in accordance with a uniform programmes and methodology still remains the world's most ambitious experiment in the study of geographic variation in forest species, and is unprecedented in the world.

In 2011-2012 VNIILM in cooperation with Roslesozashchita conducted the PTP survey in the country. Detailed data about their growth, conservation and state has been obtained. As of 01.01.2012, 872.11 hectares of provenance trial plantations are registered in the country (Figure III.3.8, Table IV.14) and includes: pine - 427.7 ha (*Pinus sylvestris* - 187 ha); spruce - 227.4 ha (Norway spruce - 81 ha); larch - 117.11 ha (Siberian larch - 6.3 ha, Larix sukaczewii - 20.2 ha); stone pine - 14.1 ha; oak - 85.8 ha (English oak - 76.7 ha).

Figure III.3.8. **Provenance trial plantations of the main forest forming species (as of 01.01.2012)**

Породы, преобладающие в составе географических культур – Species dominating in the composition of provenance trial plantations

Сосна- Pine
Ель – Spruce
Пихта – Fir
Лиственница – Larch
Кедр – Stone pine
Дуб – Oak
Бук – Beech
Береза – Birch
Орех – Walnut
Прочие – Others

Площадь географических культур, га – Area of provenance trial plantations, ha

Более 50 – More than 50

Нелесные земли – Non-forest land
Нет географических культур – No provenance trial plantations

At present, a limited number of publications summarizing the results of the study of the Russian unique provenance trial plantation network have been produced (Prokazin, 1972 Ioshnikov, 1997; Shutyaev & Giertych, 1997, 2000, 2003; Shutyaev, 2011, and others).

3.2.3. Seed plantations

Seed plantations (SPs) are plantations specially created for the long-term large-scale production of forest seed with valuable hereditary properties. They are created by both seed and vegetative progeny of specially selected plus trees best in terms of productivity and quality (and other characteristics depending on the purpose of their designation) (Figures III.3.9, III.3.10, III.3.11, III.3.12).

There are the following categories of SPs: SPs of vegetative origin or clone SPs, including graft, and SPs of seed origin.

SP establishment method is defined by the biological characteristics of species, growing conditions and intensity of forest management in the region. In the Russian Federation the main SP establishment method is using ball-rooted saplings with grafted plus trees cuttings. This method allows obtaining seed yield faster than from SPs of seed origin.

Figure III.3.9. **Seed plantations of Siberian stone pine**

Figure III.3.10. **Seed plantations of English oak**

Figure III.3.11. **Seed plantations of Siberian larch**

Figure III.3.12. **Seed plantations of Norway spruce**

In Russia, the SP is one of the main objects of forest seed production,- as of 01.01.2012 in the Roslesozashchita database lists 6238.8 hectares of SPs of 22 species (Figure III.3.13 and Table IV.15). The area ratio of the SPs of different tree species reflects the need for certain species seeds for reforestation.

Each of the primary SPs has progeny of plus trees of one or more populations of the given forest seed area.

In Russia there are also SPs of high genetic value – the plantations created with vegetative progeny of plus trees selected on the results of the preliminary genetic evaluation. They are created as an intermediate stage between the primary and secondary SPs in order to maintain a continuous breeding process and the practical use of the primary breeding effect. PDs which based on the results of the final evaluation have significantly better seed progeny in terms of selectable attributes and properties are determined as elite. Elite trees are used to create secondary SPs. Selection of trees for the SPs of the given types is carried out based on the results of a comprehensive evaluation of seed and vegetative progeny.

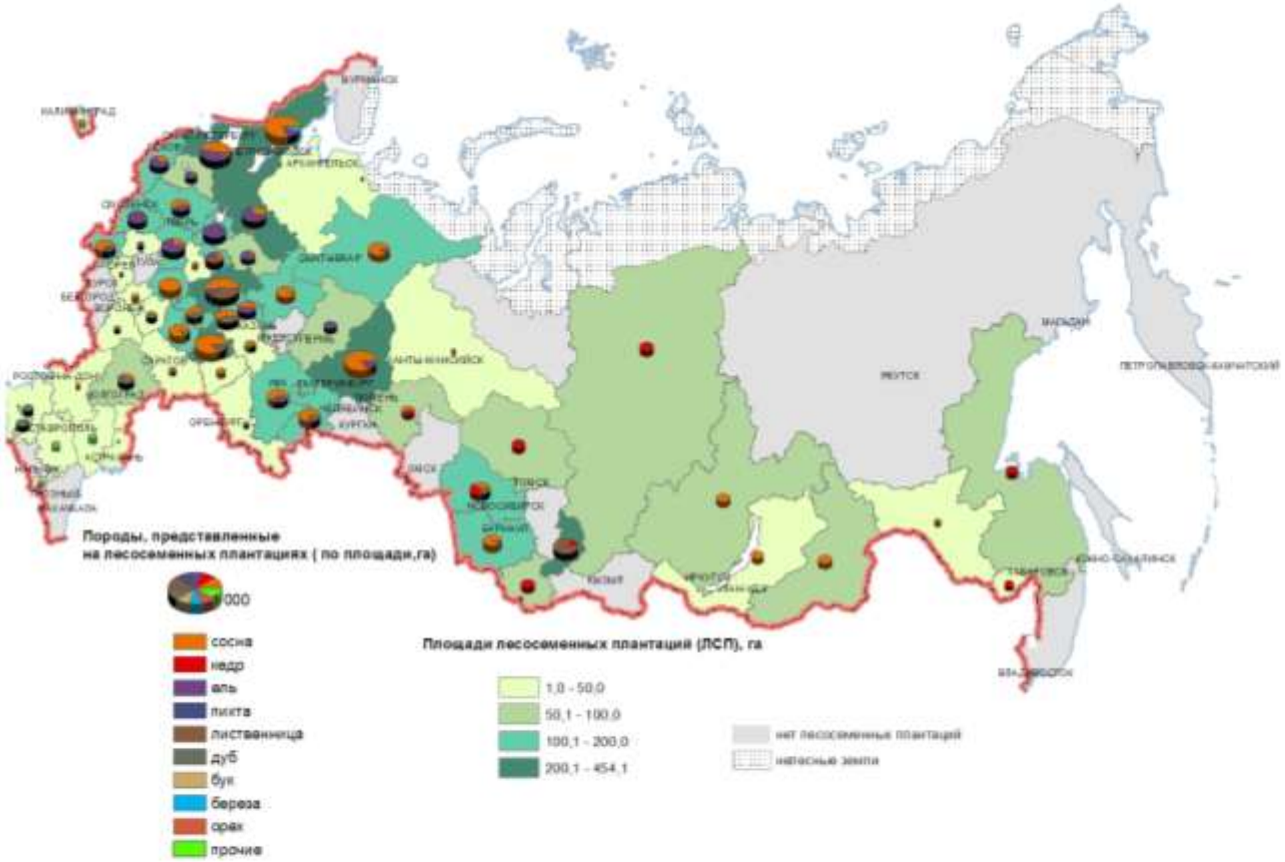


Figure III.3.13. **Seed plantations of different forest forming species (as of 01.01.2012)**
Породы, представленные на лесосеменных плантациях (по площади, га) – Species represented in seed plantations (by area, ha)
Сосна- Pine
Ель – Spruce
Пихта – Fir
Лиственница – Larch
Кедр – Stone pine
Дуб – Oak
Бук – Beech
Береза – Birch
Орех – Walnut
Прочие – Others

Площади лесосеменных плантаций, га – Area of seed plantations, ha

Нелесные земли – Non-forest land
Нет лесосеменных плантаций – No seed plantations

The activities on creation/maintenance/operation of the SGBS objects are carries out by FFA through a system of targeted funding. The regulations of the FFA subordinate FSFI "Roslesozashchita" provides for implementation of the activities on creation/maintenance of SGBS objects and sites across the country. These works are fulfilled through targeted funding from the federal budget in the amount of 100 million rubles annually. In accordance with federal legislation on public procurement, the contractors to do the work are selected based on the results of tenders and auctions arranged by FSFI "Roslesozashchita".

3.3. Documentation and characterization

In the Russian Federation there is no single standard documentation and profile description of the objects of forest genetic resources conserved *ex situ*. Botanical gardens and arboreta, VIR and other institutions use international standards or apply their own. Documentation of seed storage is developed better both in the botanical gardens and arboreta, and in forestry.

To assess the progeny quality of different species forest seeds a long list of national Russian standards has been developed and used to set the methods for determining indicators such as weight, purity, germination energy, germination capacity, seed viability. Methods used in Russia are almost identical to the methods of the International Seed Testing Association. Seed certification in the Russian Federation is carried out by the network of 46 seed stations of "Roslesozashchita" (Figure III.3.14) that have modern technical equipment (Figure III.3.15) and qualified staff.

The criteria for assessing the current state of work on documenting of forest reproductive material may be the quantity of seed lots used for reforestation and afforestation in the Russian Federation that were certified in 2005-2011. Experts from FSFI "Roslesozashchita" evaluate about 10,000 lots of seeds annually. All these seed lots were issued standard certificates indicating the sowing qualities of seeds and the place of production.

Figure III.3.14. **Branches of FSFI "Rosleszashchita" and areas of their operations**

Филиалы - Branches

Federal Law of the Russian Federation does not specify the documentation requirements for a batch of seedlings or saplings of trees. The current reforestation regulations set only general requirements to planting stock, i.e. the regionalized seeds that meet the requirements established in accordance with the Federal Law "On Seed Breeding" (1997) shall be used to grow planting stock and create forest plantations

Figure III.3.15. **Typical laboratory equipment for forest seed quality assessment in the branches of FSFI "Rosleszashchita"**

Currently in Russia there is no system of quality control (identification) of forest plant stock. A new version of the Forest Rehabilitation Rules is being developed to establish requirements for the quality of forest plant stock used in reforestation and afforestation. Appropriate control measures may well be implemented in the country by the 46 seed stations that cover the entire territory of the Russian Federation. See also Section III.4.4.

Seeds harvested in the seed production sites are referred to a particular category (see section III.4.4) provided that these facilities are properly designed, certified and included in SGBS. All SGBS objects in Russia are applied a uniform reporting and documentation system - every SBGS object complete a standard passport.

At the starting point of SP and mother plantation establishment, natural plantation or forest plantation designation for the PSO purposes, PSO establishment, creating clone banks, trial, provenance and population and environmental plantations, experts prepare passports which are further used by "Roslesozashchita" and its branches to keep the record of the created SGBS objects in the whole of Russia.

SP, PSO, plus trees and stands, mother plantations are the subjects to certification. Certification is conducted by the permanent commission of the forest management authority in the subject of the Russian Federation.

The information on the genetic inventory of SPs and other SGBS objects can be found in III.3.6.

3.4. Forest genetic resource collections: federal and reserve seed collections

According to the Federal Law "On Seed Breeding" (1997) and the Guidance on forest seed breeding in the Russian Federation (2000), federal and reserve seed funds are created in Russia in order to ensure continuous supply with seeds of high hereditary properties and sowing qualities in the amounts necessary for reforestation and afforestation needs.

Federal seed funds are forest seed stocks intended for the regions of the Russian Federation, which have no or limited seed production, and are used to help legal and physical persons engaged in forestry, in cases of natural disasters or other emergencies, as well as for genetic conservation of forest plants. Federal seed funds use harvested seeds that have certificates proving the grade and sowing quality of seeds. Federal seed funds are financed by the federal budget and other sources not prohibited by law. Federal seed funds are federal property.

Territorial bodies of federal forest management authority form reserve seed funds to provide seeds for reforestation and afforestation in lean years. Stored genetic material can be used to restore the productive stands adapted to the growing conditions after harvesting, fires, natural disasters, man-made disasters or other emergencies.

The Federal Forest Seed Fund operates in Pushkin, Moscow Region, since 2008. Here spruce, pine and larch seeds are stored at the temperature of -18 ° C. Seeds are collected for the fund in areas of temporary seed orchards [10] and plantations allocated for felling. At present, the Federal Forest Seed Fund is capable of storing 25 tons of coniferous species seeds (about ½ of the need to carry out reforestation works in the subjects of the Russian Federation). Seeds can be stored for 30 years without sowing quality loss due to the optimal storage conditions: separation of seeds, drying till 5% moisture content, vacuum packaging, etc. (Figure III.3.16).

Figure III.3.16. **Federal Forest Seed Fund.**
Stages of work: separation, drying, packaging, storing

In 2011 the FFA decided to build an acorn storage facility that will provide supply southern regions of the country with plant stocks.

[10] In the areas of intensive localized clear felling the temporary forest seed orchards are allocated in mature and maturing plantations of normal breeding category and are specially prepared for harvesting the seeds. Felling of in temporary forest seed orchards is combined with the optimal timing of harvesting cones, fruits and seeds.

3.5. The state of current and emerging technologies

Forest biotechnology is the youngest area of Russian biotechnology. Modern biotechnologies used for the *ex situ* conservation of forest genetic resources can be divided into several categories.

Conservation of forest genetic resources using cryobanks. Modern methods of the conservation of the plant gene pool include cryobanks of seeds, pollen, tissues and meristems. One of the promising technologies is the deep freezing of seeds in liquid nitrogen (-196 ° C) or in the nitrogen vapor (about -160 ° C).

For more than 50 years in IBPK and Permafrost Institute of SB RAS, Institute of Nature Conservation and MBG have been working on a comparative study of the effect of deep and shallow freezing on the viability of seeds in the chromosomes of the cells of seeds, on the growth and development of plants from frozen seeds, and etc. The techniques of data collection were described, seed passport template was designed and the modes and methods for their long-term storage were justified (Tikhonov, 1985, 1988, 1982, 1999). The Biology and Soil Science Institute, Far East Branch of RAS, conducted the first experiments on freezing seeds of the Far Eastern woody plants (Smith, 1994.1996, 1999, 2005), revealed species-specific responses of seeds on a deep freeze (Voronkov, 2000; Zhuravlev et al, 2004), and developed the *in vitro* cryopreservation technique of the production clones of aspen (IBCH RAS). The experiments on the seeds of rare plant species are still ongoing.

Since 1980s in Russia the experiments on the storage of seeds of agricultural plants in permafrost have been conducted (Danilova, 1982, 1984). In IBPK of the Yakut Scientific Center of the Russian Academy of Sciences some types of seeds have been kept in these conditions for more than 30 years, and show 90-100% of germination during the tests.

Conservation of forest genetic resources using the *in vitro* bank storage of the plant material. These technologies are used to create the *in vitro* banks of rare and endangered forest species, as well as to create a bank of elite genotypes of tree species. Currently, these technologies are designed for different types of deciduous and coniferous trees and shrubs in NIILGiS, SPFRI. Studies are under way to establish methods of *in vitro* cultivation of stem and embryonic cultivars of Norway spruce (see also Section III.4.5).

In vitro culture is also used for the development of the alternative technologies to provide pharmaceutical industry with raw herbs, which will help to keep the species in the wild. For example, the Institute of Soil Biology, FEB RAS, has developed drugs produced from the biomass of Manchurian birthwort (*Aristolochia mandshuriensis*).

These assessments are objective, since the molecular variability is virtually independent from the environment and the development stage of the organisms. Genetic markers can be used to conduct an inventory of SPs and other SGBS objects which helps to clarify the actual layouts of plants in the SGBS sites and assess their genetic potential. In 2008 the first sectoral genetic laboratory with the "Roslesozashchita" started operating in Pushkin, Moscow Region. In 2010 a genetic laboratory was created in the "Roslesozashchita" branch in the Center for Forest Protection, Krasnoyarsk Territory. The Methods of genetic certification of SPs, genetic inventory of the plus tree ramets in clone banks were developed and are being applied in practice. Genetic clone identification of the corresponding plus trees is carried out by means of the RAPD-DNA analysis. New genetic characteristics are added to the database of the plus trees which currently contains more than 15,000 profiles. The seed certification technology based molecular marking is being developed.

3.6. An assessment of major *ex situ* conservation needs

Ex-situ conservation and subsequent reproduction of forest genetic resources has a number of drawbacks and limitations related to the following reasons:

- ✓ a small number of individuals conserved and surviving in the plantation/collection and, consequently, limited genotypic diversity of the material;
- ✓ possible/frequent methodically ill-conceived selection of samples for the transfer to a plantation/collection, which does not provide sufficient representativeness of the conserved gene pool;
- ✓ increased probability of inbreeding leading to the reduction or complete loss of fertility and homozygous of the sample/collection;
- ✓ decrease of genetic diversity of the collection/bank due to inability of many plantation genotypes to survive.

These reasons almost inevitably lead to some degree of genetic erosion stored in a collection/taxon culture. The major *ex situ* conservation issue is maintaining the minimum required number of copies of the stored species, capable of providing sufficiently high genetic diversity, conservation of the genetic structure of the species/population, ability of species/populations to adapt to changing or new life conditions, in particular, climate changes, new forms of diseases, etc. Only careful selection of parent material providing the maximum possible number of genotypic diversity, thorough documentation, use of different lines and clones in crossing, sufficient spatial isolation of the protected collection funds can provide a significant reduction in the degree of genetic erosion that occurs in *ex situ* conservation of forest genetic resources. In this context, the basic needs related to the *ex situ* conservation of forest genetic resources are as follows:

1. <u>expansion of scientific research and practical work</u>
   - ✓ evidence-based sampling of seeds for the living collections of forest genetic resources, field gene banks, woody species seed banks and stores with account for the latest achievements in modern population genetics, knowledge about seed zoning, as well as genetic and morphological diversity of woody species. There is a need to develop special guidelines which will set out principles for selection of storage sites for each species;
   - ✓ studying the mechanisms of seed aging in cryostorage, study of physiological and biochemical processes of aging in long-term germplasm conservation, study of viability and conditions for seed germination of woody plants after different periods of cryopreservation. It is necessary to develop be developed methods of determination the viability and genetic aging of the stored samples for each woody species, and the recommendations for cryostorage of biological material;

✓ use of underground permafrost storage of the Russian Federation for long-term storage of various objects of forest genetic resources (seeds, meristems, pollen, spores, embryos, tissue culture, vegetative shoots, etc.).

The expansion of scientific research and practical work on the *ex situ* conservation of forest genetic resources should be supported by the creation of a single coordinating center and development of complex target programmes, which would bring together the effort of academic institutions, industry institutes, botanical gardens, arboreta, etc., to put into practice the development of forest genetics.

2. <u>It is necessary to ensure stable and adequate funding</u>. Insufficient funding for research, lack of the modern equipment and understaffed personnel and/or their inadequate qualification has an extremely negative impact on the *ex situ* conservation of forest genetic resources in the Russian Federation. Poor funding has also led to the massive loss of natural and experimental objects of the

ex situ conservation of forest genetic resources created in the last century, and reduction of work on the study and creation of such SGBS objects.

Most botanical gardens and arboreta and other enterprises that maintain collections of dendroflora conserved *ex situ* also lack funding.

3. Improvement of legislation on *ex situ* conservation of forest genetic resources. Federal Law of the Russian Federation does not contain direct norms obliging forest stakeholders to implement activities for *ex situ* conservation of forest gene pool. Official measures of *ex situ* conservation of forest gene pool in Russia are limited to the creation of living plant collections and seed banks of the Red Book species in BGs and arboreta, creation of certain categories of SGBS objects in the framework of the forest seed development, and creation of small *in vitro* tissue culture collections of different tree genotypes in the research laboratories.

Most Russian collections of genetic resources, including the VIR collection of plant genetic resources, established at the beginning of the last century, are now vulnerable in terms of legal status due to the fact that the country has not defined the status of such collections in the legislation. The issues of collection, conservation, study and management of forest genetic resources are not regulated at the legal level either. Currently, the draft of the Federal Law “On Plant Genetic Resources” is discussed in the Russian Federation; however it does not cover the forest genetic resources.

One of the most serious problems for many Russian BGs and arboreta is the uncertainty of the legal status of their territories. It is necessary to ensure the sustainability of their status as the protected areas of federal significance in order to save the BG and arboreta system which is considered the national treasure in accordance with the Federal Law “On Specially Protected Natural Territories”.

Since 2007 (the year of the adoption of the Forest Code which determines special order of use for the SGBS objects) in Russia there has been a widespread practice of lend lease of forest areas occupied by the SGBS sites for timber harvesting, hunting, etc. The location of the SGBS objects on such leased territories does not guarantee the safety of these facilities and eliminates the possibility of allocating public funds (federal budget, regional budgets) for their maintenance and operation. In December 2010 SPs and other objects of forest seed breeding were included into the Forest Code as one of the SPA categories (previously only PSOs were legally defined as SPA). The new formulation of the Forest Code by issuing the order of the Federal Forestry Agency it allows to determine as SPA all objects of forest seed breeding, including those with the function of *ex situ* conservation of forest genetic resources, however the subjects of the Russian Federation does not always use this opportunity.

4. Improving public information policy. In the Russian Federation there is no common scientific methodological and information center for the *ex situ* conservation of forest genetic resources, summarizing information on all species and all institutions *ex-situ* collections. Analysis of the data has shown disunity and duplication of information on living collections of forest genetic resources, botanical gardens and arboreta, almost complete lack of information on the *in vitro* living collections of forest genetic resources, dissociation of approaches to documentation and description of the profiles of forest genetic resources conserved *ex situ*. Need for coordination and establishment of an information portal is dictated by the fact that forest genetic resources conserved *ex situ* are concentrated in the organizations of many ministries and agencies. In the absence of a unified information policy their piecemeal actions often impede sustainable conservation and efficient use, threaten with irreplaceable losses of genetic collections and stores of forest genetic resources. To secure the *ex situ* conservation of forest genetic resources and effective and biologically safe use in scientific and commercial purposes the country needs a unified state information policy.

Formation of a unified information policy is all the more important because the organization of work on the *in situ* and *ex situ* conservation of forest genetic resources conservation should be interconnected.

5. Creating a system of federal forest reserve seed funds. Creation of reserve funds of forest seeds in Russia is a strategically important national task. It will only get more acute in case of pos-

sible large-scale natural disasters (such as fires in 2010), man-made disasters (such as the accident at the nuclear power plant), as well as changes in habitat due to global warming. The technologies of establishment of such funds have been developed. However, measures to create such funds at the federal level have not been undertaken. The problem is the absence of the decision of the Russian Government on the implementation of measures for the conservation of forest genetic resources, and the related provisions in the forest legislation.

Given the scale of the problem, it seems clear that the Russian Federation needs to establish several gene banks and federal/reserve forest seed funds in the European part of the country, the Urals, Siberia and the Far East. Establishment of one genetic bank and one forest seed reserve fund is inexpedient but for several reasons:

- high costs of sending samples;
- expenditures on creating different, technologically incompatible storage conditions for seeds of different forest plant species;
- possibility of losing the entire collection in cases of natural disasters or man-made disasters.

According to Article 83 of the new Forest Code, the subjects of the Russian Federation are not authorized to carry out forest seed breeding. In fact, currently the subjects of the Russian Federation are legally unable to harvest/purchase seeds of forest plants, i.e. form reserve seed funds. The FFA has prepared the changes to be introduced in the Forest Code of the Russian Federation to correct the situation.

It should be noted that the Russian Federation has not yet developed a unified scientifically based strategy for selecting material to establish seed banks/reserve funds of forest woody species. A collection scheme based on adequate representation of forest seed areas can be considered as one of the alternatives to such strategy. To best meet these goals a hierarchical system of forest seed zones and areas should be improved, taking into account the available information on the genetic differentiation of local populations and ecotypes obtained as a synthesis of data from morphological (phenetic), adaptive and molecular characteristics.

6. <u>Establishing a cryobank of seeds of the main forest forming species</u>. In Russia there is still no specialized cryobank for storing forest seed, pollen, grains and meristems. Russian scientists have practical experience in creating seed cryobanks. The presence of permafrost areas in Russia is a real opportunity to create such a bank in the country. A priority would be to create an international cryobank of woody species seeds using “free and reliable natural cold” of everfrozen grounds. It is possible to develop a programme “National genetic cryobank of seeds, pollen and meristems of forest forming species of Russia” in order to create a cryobank of forest genetic resources on the national or international level. It is necessary to support the initiative of scientists to create a genetic cryobank seeds, pollen and tissue cultures of the main forest forming species of Russia in Krasnoyarsk, as well as the works undergoing in Yakutia.

6. <u>SGBS objects and their inventory</u>. The Single Genetics and Breeding System in Russia is unique and has no analogues in the world. However, due to insufficient funding and prolonged process of reassignment of responsibility for the objects of conservation of forest genetic resources, SGBS is not used effectively; some forest breeding sites are removed from the forest fund and converted. It happens, in particular, due to the lack of understanding of the true value of the created SGBS objects not only by the general public but also by economic entities.

The share of the SGBS objects whose objectives include the *ex situ* conservation of forest genetic resources, differs in different regions of the country and, therefore, it is necessary to analyze the representativeness of the SGBS objects in terms of their species lists, characteristics of the population structure of plants, targets and territorial location.

In order to preserve the gene pool of the available plus trees it is necessary to expedite the work on creating the clone banks. It is required to establish new trial and provenance trial plantations, which are of great scientific and practical importance for the forest seed breeding. The necessary forestry activities should be carried out to preserve the already established plantations.

A full inventory of the SGBS objects established by the USSR State Forestry (1973) and other programmes and initiatives has not been completed yet. The synthesis and analysis of survey data has not been conducted either. It is proposed to consider that even if the trial is not 100% retained we should still keep what is left, rather than write it off for formal reasons without taking into account the genetic and scientific value of the remaining material and the unique opportunities of the research on these objects.

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

4.1. The importance of sustainable management and use

The strategic goals of good governance and utilization of forest genetic resources include conservation and sustainable use of genetic capacity of woody species of the Russian Federation to enhance the stability, productivity, and quality of forests, reduction of the reproduction period of various products, performing functions related to biosphere, environment protection and resources by forest ecosystems. Good governance is based on the internationally recognized approaches to sustainable forest management, on the principle of sustainable use, recognition of forest as the ecological framework of the planet.

Sustainable management and utilization of forest genetic resources implies:

- ✓ conservation and study of the genetic diversity of woody plants;
- ✓ balanced use of woody plants with different genetic, environmental and phytocoenotic characteristics and economic characteristics due to the growing conditions and demand for the relevant products, the optimal combination of local, regional and national interests;
- ✓ preserving and forming the genetic diversity of forest communities with simple and complex structure;
- ✓ removal and use of forest woody plant species of specified purpose;
- ✓ development of seed and vegetative (including the use of modern biotechnology methods) propagation methods of valuable woody plant genotypes;
- ✓ replacement of low value plantations, eliminating the effects of the depauperization of woody plant gene pool as a result of negative selection and forestry practices, and other factors.

4.2. Utilization of conserved forest reproductive material and major constraints to their use

4.2.1. Forest reproduction and afforestation

Provide quality reproduction of forest resources and expansion of protective afforestation is considered in the Russian Federation as a prerequisite to the use of forests. The main objectives of forest management in the area of forest regeneration is timely restoration of forests with economically valuable forest species in clearings and burned areas, to replace the destroyed plants, and reduction of non-wooded forest land of the forest fund. Reforestation is a process that includes a set of measures for reforestation, plantation maintenance and forest use.

Under the new Forest Code since 2007 all reforestation works are carried out by the subjects of the Russian Federation. Forest restoration in the areas outside the lease and forest fund areas damaged by fires and other adverse factors is funded by subventions - dedicated funds from the federal budget. All reforestation activities in leased forest areas are planned and conducted by the tenants in accordance with forest development projects and at their own expenses.

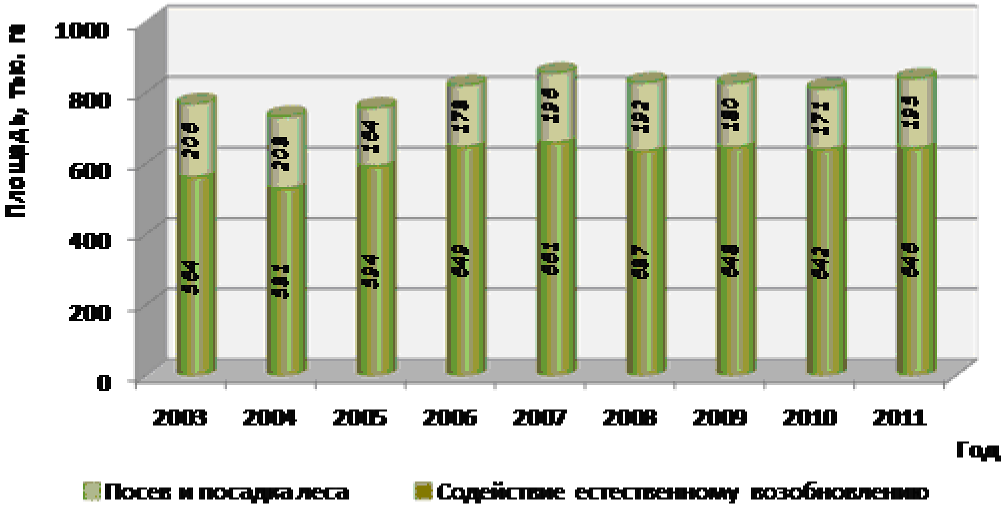


Figure III.4.1. **Dynamics of the reforestation works on the forest fund land, thousand ha**
Площадь, тыс. га – Area, thousand ha
Посев и посадка леса – Forest sowing and planting
Содействие естественному возобновлению – Promotion of natural regeneration

The peculiarity of the Russian forestry is the relative diversity of forest planting methods (dominated by mechanized planting of 2-3-year-old seedlings at the density of about 5 thousand individuals/ha) and promotion of natural forest regeneration. The major approach to forest restoration in the country is promoting natural regeneration (Figure III.4.1) which is very important for the conservation/maintaining of the natural genetic diversity of plantations.

In addition to reforestation the FFA holds annual afforestation on forest fund lands and lands of other categories, so in 2011 these works have covered the area of 5654 hectares.

Forest plantations produce mostly boarding. The share of forest crops significantly higher in the southern regions of the country (Figure III.4.2). Throughout the country, the share of forest plantations created in different years is not more than 3% of the forested area. This contrasts with the amount of planting and indicates poor performance of silvicultural activities (Shutov, 2008).

Figure III.4.2. **Distribution of measures to promote natural regeneration and forest production by federal districts of the Russian Federation in 2011**

Дальневосточный – Far Eastern
Сибирский – Siberian
Уральский – Urals
Северо-Кавказский – North Caucasian
Южный – Southern
Приволжский – Volga
Центральный – Central
Северо-Западный – Northwestern

Создание культур – Establishment of plantations
Лесовосстановление – Reforestation
Доля площади – Share of area

In the Russian Federation plantations are created mainly with indigenous species. The main tree species used for the establishment of forest plantations are pine, spruce, Siberian stone pine, larch, oak, birch. The share of the exotic tree species plantations in the Russian Federation is negligibly small.

In 2011, the FFA structures responsible for reforestation and afforestation have cultivated 731 million units of standard seedlings and saplings. In 2012 it was planned to grow 737.8 million standard seedlings and saplings in forest nurseries (in spring, 2011, the demand for the forest plantation establishment was 779 million items).

4.2.2. Forest seed regionalization

Genetic heterogeneity of woody species within their vast habitats on the territory of the Russian Federation requires strict management order of harvesting and use of seeds of main forest forming species, taking into account the hereditary characteristics and habitat conditions. Bad experience of field-protective forestation and large-scale establishment of oak forests in the USSR in 1949-1953 made the country’s foresters learn a lesson of practical application of the restrictions on seed transfer.

Geographical and environmental movement of woody species seeds for forest cultivation is regulated through of seed zoning. Seed zoning in the Russian Federation is established depending on woody species. The basic unit is the forest seed zoning is a seed site, i.e. a designated area within the range of the species with a relatively homogeneous natural conditions and genotypic composition of populations with distinct natural and economical features. Each seed site has adopted a general order of forest seed breeding management and use of seed material with homogenous hereditary properties.

The basis for the development and adoption of “Seed zoning of the main of forest forming species in the USSR” in 1982 was mainly the findings of the research on variation in natural populations and provenance plantations, as well as the results of the natural geographical zoning of the territory. In 2013 it is planned to prepare a new seed zoning of the main forest forming species of the Russian Federation which will be based on the results of the assessment of the genetic differentiation level in forest forming species populations.

Seed zoning is applied by forest stakeholders; it determines the distance of seed transfer and use of forest plant seeds outside the forest seed sites.

According to the seed zoning in 1982 the use of forest plant seeds imported from other countries, in particular, seeds of pine and spruce from the Republic of Belarus, Ukraine, Latvia, Lithuania and Estonia, is allowed in the Russian Federation.

4.2.3. Reproductive material record

After the administrative reform of the forestry sector associated with the introduction of the new Forest Code (2006) in the Russian Federation there is no legally established and applied system of recording sources of forest reproductive material of plants (seeds, seedlings, propagula, cuttings, etc.) and its turnover (storage, realization, transportation, etc.). Physical and legal persons who use reproductive material for forest reproduction are not required to inform the public authorities on its turnover. Accordingly, there is no common database on the turnover of forest reproductive material. According to the order of statistical reporting FFA receives from executive authorities of the subjects of the Russian Federation only the most general information about the volumes of forest seed harvesting and propagation material production without any specification. Thus, in most cases, there is no information about the place of harvesting or production, storage location, species, etc. of the harvested seeds.

This circumstance does not allow the state to ensure the effective control over the exploitation of forest seed, trafficking in batches of seeds and their use in accordance with seed zoning. The situation is aggravated by the fact that the authority to manage forest reproduction, as well as the authority to conduct federal forest surveillance (in accordance with the Forest Code) was transferred to the subjects of the Russian Federation since 2007. The Federal Forestry Agency and its subordinate forestry departments in the federal districts perform only sporadic and selective control measures over execution of the authority transferred to the subjects of the Russian Federation in the field of forest relations. Unfortunately, recently more evidence of the use of the unzoned or uncertified forest plant seeds in the regeneration of the forests have been revealed. FFA is considering the introduction of the control over the circulation of forest reproductive material in the Russian Federation.

In the absence of control over the circulation of reproductive material in the Russian Federation, no records of import and export of forest plant seeds are kept. The reporting forms used in forest rehabilitation do not provide for representation of such information by the subjects of the Russian Federation to FFA.

According to the Federal Service for Veterinary and Phytosanitary Surveillance (Rosselhoznadzor) botanical gardens and arboreta (in particular, through various exchange programmes), research institutions, private collectors, gardeners, etc. are officially engaged into export/import of seeds and seedlings of forest genetic resources. However, there is no record system for the turnover of reproductive material. In the absence of a unified information system on forest genetic resources it is impossible get complete and accurate information about the reproductive material exported to/ imported from other country/countries. The official statistics provided by the Federal Customs Service of the Russian Federation on the import/export of seeds and forest planting material are presented in Table IV.12. However, this information is obviously incomplete.

Besides, in some regions of the country (Far East, the Baikal region, Altai, Caucasus, etc.) the shadow international market of the reproductive material of forest trees and shrubs is very active. For example, as the result of the inspection the Tomsk interdistrict environmental prosecutor's office has opened a criminal investigation into smuggling a thousand of tons of pine nuts (www.genproc.gov.ru/news/subjects/).

4.3. Implementation of the programmes of sustainable use of forest genetic resources: forest breeding and seed breeding

The founders of forest breeding in Russia were such great research foresters as N. Nesterov, M. Turskii, W. Ogievskii, V. Sukachyov, L. Pravdin, A.Yablokov, E. Prokazin, etc. In order to improve forest genetic resources in Russia the forest breeding methods based on the group (population) and individual selection are used. This work is carried out at the SGBS objects that have been created across the country (see Chapter III.2 and III.3).

Individual selection is based on the selection and genetic study of the plus and elite trees. Positive selection requires the following sequence of actions:

- ✓ breeding inventory of plantations and identification of plus trees and plus stands;
- ✓ creation of plus tree clone banks;
- ✓ establishment of plus tree mother plantations;
- ✓ establishment of primary seed orchards with plus trees of seed and vegetative progeny;
- ✓ establishment of trial plantations of plus seed bearers (using special methods);
- ✓ selection of elite trees based on the results of plus trees trials in the trial plantations;
- ✓ establishment of secondary seed orchards by using vegetative progeny of elite trees.

In the Russian forestry the following characteristics of the selection material of trees and shrubs are assessed:

- ✓ productivity (wood, biomass, etc.);
- ✓ stem and timber quality (straightness, taperingness, stacking, defectiveness, marketability, technical properties, output of assortments and cellulose, etc.);
- ✓ resin productivity, tenacity, yielding ability and fruit quality, etc.;
- ✓ resistance (to low temperature, drought, salinity, excess soil moisture, insect pests, disease, flue gas emissions, radionuclides, etc.);
- ✓ reproduction characteristics (abundance and quality of seeds, ability to autonomic reproduction in nature and culture);
- ✓ phenology characteristics (forms of early, late and transient start of vegetation, forms of early, late and middle end of vegetation);
- ✓ response to soil fertility, agricultural techniques and stress factors;
- ✓ competitiveness, comparative efficacy in mixed composition plantations (Table IV.13).

There are positive results of pine and stone-pine selection by resin productivity and Siberian stone pine selection by nut yield. There is a method developed for functional testing to allow for the early detection of the most important properties of woody plants in the conditions of special environmental nursery. It was found that a one-time selection of plus resin productive pine trees leads to a substantial increase of resin productivity in their offspring. It allows growing highly resin productive artificial pine plantations in the forest zone of the European part of Russia (up to and including the Urals) for the production of valuable wood chemical products. In addition, these plantations will be more resistant to the root fungus which currently causes enormous economic damage to forest production. In the conditions of the Altai Mountains of the Siberian stone pine breeding for nut yield was conducted. High-yielding clones have been identified, pollinators have been selected, and recommendations on the use of the breeding material production have been developed. Vegetative propagation of high-yielding Siberian stone pine forms with stable fruiting have demonstrated good performance. It was shown that the stone pine plantation created by inoculation of the best clones, produce crops of nuts 2-2.2 times higher than the yield of the best natural stone pine stands. Economically valuable clones of pine, spruce, Siberian pine, suitable for the creation of own-rooted and grafted target plantations, fast-growing and economically valuable forms (clones) of poplar, aspen, Karelian birch have been identified.

Less significant results were obtained at the preliminary evaluation stage of such complex characteristics of polygenic nature as growth speed and productivity. There is a relatively low (1-10%) share of plus trees that provide a fast-growing offspring in trial plantations of the 1st class age. In many trials the growth of plus trees offspring does not differ from the controlled growth. The share of trees with greater height in some certain cases ranges from 2.8 to 6.5%. The difference between the offspring of certain populations in this feature (within one forest seed site) reaches 7-9%. Hundreds of forms (clones) grown on the area of over 800 hectares have been tested in various regions of the Russian Federation (Figure III.3.7, Table IV.14).

The lessons learnt in Russian practice has shown that the genetic effect of the primary SP determined by the growth rate of the TP is estimated at an average of 09.08% with a variance of 5 - 25% (Efimov, 1987; Morden, Raevskiy Akimov, 1998).

With regard to the environmental and genetic variability structure of the basic selectable characteristic, i.e. overall productivity, as well as its main components - stem height and diameter, which are the criteria for the plus trees selection, the majority of Russian researchers are inclined to believe that they are typical quantitative features, characterized by complex genetic conditioning, low effects of additive genetic dispersion and significant environmental lability. When testing the progeny of plus trees in different environmental backgrounds the Genotype-Environment interaction is often detected. The differences in homeostasis levels are also found at the population level. A significant contribution to the variability of quantitative features can belong to “mother” effects and environmental aftereffect, environmental and genetic effects competition (Dragavtsev, 1981). Heritability in terms of productivity characteristics is much less than 15% in most studies.

Population breeding is based on the selection and genetic study of the best natural (plus) plants and guarantees a stable, reliable predictable breeding effect while maintaining a high level of genetic variability of plants that is characteristic of natural populations. Population breeding scheme requires the following steps: 1) selection of plus stands and establishment of the “population” PSOs on their basis; in some cases creation of clonal population PSOs can be possible 2) plus stand trial for progeny and selection of “elite” stands among them, separation of the established PSOs into “plus” and “elite”, 3) further breeding on the basis of the “elite” stands. It is obvious that this method of creating population PSOs is much easier than creation of SPs on the basis of plus trees, especially clonal ones. Population seed breeding requires designation and protection of the best gene pool of the local population of the species.

Russian foresters have carried out the studies of the forest species characteristics on the basis of provenance trial plantations, and tests of the candidates into cultivar populations for certain species. The best cultivar populations (ecotypes) in provenance plantations have been identified and recommended for the production of birch, larch, pine, etc. Seed zoning have been prepared for different main forest forming species. It was found that in most provenance trial points productivity and safety are usually characteristic of local origin, and that ignoring genetic and breeding principles of forests regeneration can lead to large losses: up to 4 productivity classes in case of unregulated transfer of seeds in latitudinal and longitudinal directions; up to 30% of unauthorized use of seeds by edaphic ecotypes; up to 20% of unauthorized use of seeds by breeding categories of trees (Kotov, 1996).

In general, broad knowledge has been gained on the population trend in research including the established provenance trial plantations (mean age of 40 years) and the results of many years of research in different regions of the country.

In 1960's - 1980's a state programmes and set of guidelines on forest improvement through breeding were adopted. In 1971 Russia established the Central Research Institute of Forest Genetics and Breeding which would direct the breeding and genetic studies in the country and coordinate the work carried out by the FFA research institutions in different forest areas. The institute established the Council on Problems in Forest Genetics, Breeding, Seed Production and Introduction, which has defined the main directions of breeding and genetic research. The necessary regulatory, methodological and legal framework has been developed for the further improvement of forest management and silvicultural business. However, the country's transition to the new economic conditions drastically changed the priorities. The scientific and production activities on the management of forest genetic resources have been curtailed gradually in 10-15 years.

In 2003 the Russian Government adopted the “Concept of Development of Forest Management in the Russian Federation for 2003-2010” in which the general issues of selection and genetic seed breeding were spelled out adequately. The strategy of development of the forestry sector in the Russian Federation for the period up to 2020 (2008) provides for the introduction of the intensive reproduction model on the breeding and genetic basis. According to the draft of the state programmes “The development of forestry in 2012 - 2020 years” approved in the Ministry of Finance and Economic Development, it is planned to build about 30 modern forest seed breeding centers by 2020 to ensure the supply of high-quality planting material to the regions. However, at present the system of methodological and scientific support for genetic and breeding works does not function and provides no service to the regional research institutions subordinated to FFA, universities, academic research institutions.

Forest plans of the subjects of the Russian Federation are not always consistent and complete, but still envisage activities in forest seed breeding based on the principles of plus selection. However, the subventions allocated to the subjects of the Russian Federation from the federal budget for the implementation of the Forest Code powers do not envisage the funds for the forest species breeding programmes.

In general we regret to state that though the unique trials held and plantations established in Russia for study and rational use of forest genetic resources surpass all those abroad in terms of coverage areas and the number of lineages represented, their exploration degree and use for practical purposes leaves much to be desired.

4.4. The state of use and management of forest reproductive materials; forest reproductive material availability, demand and supply

In Russia the forest seed breeding activities are carried out in accordance with the Forest Code of the Russian Federation, the Federal Law “On Seed Breeding” and the Guidelines for the forest seed breeding in the Russian Federation (2000). In 2006 the Forest Code of the Russian Federation (Article 83) handed over the authority of forest reproduction to the subjects of the Russian federation, however, the authority to manage forest seed breeding was retained by FFA.

The aim of forest seed breeding is to provide forest reproduction with the improved zoned seeds and planting material with good sowing qualities and hereditary properties. Objects of the Single genetics and breeding system (SGBS) are created, their genetic certification is carried out, federal seed reserve funds are formed and seed control is performed in order to address this issue. These areas of work in Russia are covered by the Department coordinating the establishment and operation of SGBS, Department of seed control and federal fund formation of the Central office of FSFI "Roslesozashchita" as well as seed stations in the branch offices.

To ensure the concentration of the activities in the sphere of forest seed breeding and planting material with improved hereditary properties Russia has started the establishment of a network of forest seed breeding centers (FSBS). According the programme of "Forestry Development for 2012-2020" approved in September 2012 by the Ministry of Finance and Ministry of Economic Development, about 30 modern forest breeding and seed production centers, which will provide the regions with quality seeds are supposed to be constructed on the territory of Russia before 2020. The centers will be equipped with modern production lines for forest seed and raw seed processing, and for the production of improved woody species planting material with ball-rooted system and valuable hereditary properties. A project of FSBS location in the Russian Federation has been drafted. In 2012 five FSBS for the greenhouse production of planting material with ball-rooted system have already been created.

Depending on their hereditary characteristics forest plant seeds are divided into the following categories: cultivar, improved and normal. Normal seeds are harvested in PSO (except for the below cases), TSO [11], as well as from normal trees in the stands (including cutting areas) of normal breeding category. Improved seeds are harvested in the seed areas created or allocated on the basis of phenotype selection, but not tested on progeny, including primary SPs (clonal and family), as well as the SPs of high genetic value, on the PSOs formed in plantations established by the seed harvested in PSs and SP (wherein the seeds have to be harvested from not less than 50 trees, clones, families). Cultivar seeds are produced in the sites that have passed the offspring genetic evaluation identified as cultivar populations, cultivar hybrids and included in the State Register of Protected Selection Achievements (www.gossort.com), including the secondary SPs created with the vegetative progeny of elite trees; on primary SPs, PSOs and other plantations whose genetic value is confirmed by the results of seed progeny tests.

According to the Forest Code of the Russian Federation (Article 65) the improved and cultivar seeds shall be used for the regeneration of forests or, if such seeds are not available, normal seeds of forest plants shall be used. But it is necessary to take into account the problem of the optimal ratio of the forests areas of different categories (Semerikov et al, 1998). The use of the unzoned seeds or forest plant seeds with uncertified sowing and other qualities is not allowed in forest regeneration.

SP is one of the main objects of forest seed breeding in the Russian Federation. As of 01.01.2012 the "Roslesozashchita" database lists 6238.8 hectares of the SPs of various species (see section III.3.2.3, Figure III.3.13 and Table IV.15). The volume of seeds with improved hereditary properties harvested in SPs is 1-2% of the total forest seed production for reforestation and afforestation. Currently seeds with improved hereditary properties that are harvested in SPs, PSOs and PSs make not more than 5% of the total weight of seed used for reforestation. In 2010-2012 a number of regions of the Russian Federation saw a deficit of seeds for regeneration of forests.

In general we can sate the low efficiency of budget fund use for the implementation of the measures related to forest seed breeding: the annual cost of seed production is 300 million rubles, the annual cost of planting material production makes 700 million rubles (the cost of creating one hectare of forest seed plantation is 2 million rubles by its seed-bearing age).

[11] In the areas of intensive localized clear felling the temporary forest seed orchards are allocated in mature and maturing plantations of normal breeding category and are specially prepared for harvesting the seeds. Felling of in temporary forest seed orchards is combined with the optimal timing of harvesting cones, fruits and seeds.

4.5. The state of current and emerging technologies

***In vitro* reproduction of woody plants (microclonal propagation technology).** There are two main ways of clonal micropropagation - organogenesis and somatic embryogenesis - including the use of the artificial seed technology. In Russia these technologies are undergoing the process of scientific research and are rarely found in practice. At present the clonal micropropagation technology has been developed for the following species: aspen, Karelian birch, silver birch (Forest Institute, KRC RAS SPFRI), oak, birch, including Karelian birch, triploid forms of white and grey poplar, aspen forms resistant to rot and mold (NIILGiS), aspen (VNIILM), hardwoods, including triploid forms of aspen, downy birch, silver birch, Karelian birch, willow, ash, hawthorn, viburnum, mountain ash, lilac; works on conifers - spruce and common pine –are in progress (Branch of the Institute of Bioorganic Chemistry). The technology of artificial seed production for valuable coniferous species is being developed. An undoubted advantage of using the microclonal propagation technology is obtaining the planting material resistant to heart rot for aspen, and increasing stock volume for birch. In order to produce cultivar planting material the microclonal propagation of ornamental and fruit woody plants such as lilac, rhododendron, hawthorn and viburnum, mountain ash, etc. (RPE “Mikroklon”) has been introduced in the production technology.

Biotechnological methods of plant breeding allowed initiating the establishment of the Karelian birch plantations for the production of valuable timber. Priority is given to fast-growing forms of birch and aspen to create fuel and energy plantations.

Microclonal propagation technology can be used for the establishment of *in vitro* banks of rare and endangered forest species, as well as to create a bank of elite tree genotypes which can then be used to produce high-quality planting material to create plantations and for breeding purposes. However, we should remember that the plantations created as a result of artificial regeneration of a limited number of individuals will be less genetically diverse, consequently, less productive and less resilient to adverse environmental factors.

Genetic modification. This is the technology of using the basic methods of genetics, i.e. mutagenesis, polyploidy, genetic engineering - new forms of trees with desired characteristics. In Russia they are working on the transgenic forms of aspen and birch. They have created a form that is completely resistant to herbicides based on phosphinothricin (Shestibratov et al, 2011) and developed a technology of genetic transformation of ash and willow. The forms with the increased productivity are at the stage of field trials (Leningrad region). IBCh RAS is developing technologies for creating transgenic forms of forest woody plants with reduced lignin content and a high proportion of cellulose; transgenic aspen forms with the gene Xeg and contain high amounts of cellulose, increased rate of growth (20-30%) and low hemicellulose are going through greenhouse trials (Shestibratov et al, 2012). Plants are created for the bioenergy needs.

NIILGiS has identified the most promising hybrids derived from the crossing of different forms of aspen and white poplar.

Methods of molecular marking are used in genetic certification of SPs, CBs and PTs. (see section III.3.6.3.). Researches are conducted on application of the molecular marking methods to improve the principles and approaches of forest zoning, certification and control of the legal origin of timber, certification and control of pest status of planting material and stands, improvement the efficiency of breeding works.

4.6. Assessment of needs to improve the forest genetic resources management and use

<u>1. Turnover and control of reproductive materials</u>. FFA is considering the introduction control over the circulation of reproductive material of forest plants in the Russian Federation. First steps in this

direction have been taken. The situation analysis of the country has been completed, as well as the analysis of the experience of recording seed sources of forest plants and their trafficking in the country - members of the Organization for Economic Cooperation and Development. The Concept of activities on the control over the turnover forest plant reproductive material in the Russian Federation has been developed.

In the near future Russia will carry out a reform of forest seed breeding, and make changes to the system of state control over the turnover of reproductive material. It is necessary to prepare and adopt the following set of documents:

- ✓ Administrative Rules for Seed Control (state control),
- ✓ package of regulations (Rules of forest seed breeding, Rules of the forest seed breeding system operation, Rules for creating objects of forest seed breeding, Rules of production of certain forest seed categories, Rules of harvesting, handling, storage and use of forest plant seeds, Rules of sale and transportation of forest seed batches, Rules of formation and use of forest seed reserve funds)
- ✓ draft federal law - strengthening administrative punishment for violations of laws and regulations on forest seed breeding (Code of Administrative Offences)
- ✓ draft federal law on the delineation of authority between the Russian Federation and the subjects of the Russian Federation (Forest Code).

It is also planned to develop a unified system of electronic document management and state control over the turnover of forest reproductive material (UEDMS) "Forest plant seeds", a continuous chain of information on the utilized reproductive material.

The reorganization of the control system over the circulation of forest reproductive material in the Russian Federation is all the more urgent as the genetic resources of the world are getting more and more commercialized (see section III.7); and, not only cultivar seeds but also the seeds of the populations of old-growth forest ecosystems with high genetic diversity should have a higher price.

2. Seed zoning. Currently, the conditions are ripe for the clarification of the existing seed zoning. In 2013 FFA is planning to prepare seed zoning for the main forest-forming species of the Russian Federation that will replace the existing "Seed zoning of the main tree species in the USSR." This should be done to reflect the latest research findings from provenance trial plantations, and with the application of modern methods of population phenetics and molecular genetics in collaboration with specialists from the RAS. This approach is promising because, first, the seed zoning should ideally be based on the data on the spatial population structure of species, and secondly, only molecular methods allow quantifying the genetic variation stock and its distribution in space and time. Researches from many countries, including Russia, helped reveal the geographical confinedness of molecular genetic variability of species of the main forest forming conifers and hardwoods to the geographical region, and evaluate the dynamic processes of biodiversity conservation and adaptation to global climate change on the example of provenance plantations. Provided that a large number of different markers are used, these data reflect the integral evaluation of genetic variation and can be used in addition to conventional approaches (assessment of variability of different characteristics in natural populations and provenance plantations, to identify population boundaries by the forest phenetics methods, etc.) when refining the seed zoning schemes.

3. Seed selection. Currently in Russia they mainly use plus methods and individual selection. At that, significant resources allocated in the Russian Federation for the development of plus selection, stand in contrast to the small budget of the gene pool conservation programmes, research and alternative breeding programmes. Therefore, the immediate problem of forestry and forest science in general, is to justify the optimum ratio of the areas of natural and homogenous forests, especially created by using different methods of selection. Regarding the latter, in the seed breeding practice these areas should be clearly separated, and breeding schemes of for each of them should be developed.

Individual selection based on the selection and genetic study of plus and elite trees ensures the increase of the overall productivity and timber quality only at the stages of identification the elite trees, and that it why large-scale establishment of SPs is not economically viable without previously conducted progeny test of the plus trees used as the basis. In addition, homogeneous plantations created by using individual selection will be characterized by low genetic diversity and will require high quality care and favorable growing conditions. So, they can occupy limited forest land areas the best in terms of productivity, and their contribution to high quality timber production can be significant. Artificial regeneration of forests with cultivar seeds should be implemented by using the plantation forestry technology but only in those areas where only the 1st and 2nd quality class stands used to grow. This will allow optimizing the ratio of the areas that are restored through natural regeneration, creating cultures of normal (non-cultivar) seeds on the one hand and creating plantations with cultivar seed on the other. Besides, there will be a substantial increase in the efficiency of the selection process.

Population selection based on the selection and genetic study of the best natural (plus) stands guarantees a stable, reliable and predictable breeding effect while maintaining a high level of genetic variability of stands inherent in natural populations. It is distinguished by the simplicity of the process, providing a lower cost of seeds. Therefore, artificial plantations that were created using population selection should occupy much larger areas in Russia than the plantations created on the basis of individual selection.

Taking into account the modern ecological and genetic outlook, when determining the strategy and tactics of forest genetics and breeding and seed selection activities, we should not antedate different approaches, but commensurate their contribution, and conduct a balanced policy paying due attention to genetic reserves, natural forests and population selection in creation of homogenous forests on the one hand, and individual selection on the basis of plus and elite trees when creating plantation forests on the other. At that, the establishment of improved forests should not lead to the destruction of the natural historical population structure and reduce the genetic potential of populations of the forest forming species. This means that breeding programmes based on the individual selection should apply restrictions using intensive forest cultivation technology in the conditions most appropriate for the given species.

4. The Single Genetics and Breeding System. The share of different categories of SGBS objects in different regions of Russia is not the same, as well as the prospects of their use for the genetic diversity conservation and production of improved seeds and cultivar populations. Their representativeness needs to be assessed.

The selected fund of the forest forming plus trees is not sufficiently (no more than 10%) involved in the progeny test. The number of typology plantations is limited too. In relation to the plus tree funds a more strategically correct measure would be an informal review, establishment clone banks and trial plantations for the early selection of the “elite trees” and creation of the 2nd and 3rd generation plantations that ensure increased productivity of homogenous forests. Creating clone banks will also preserve the gene pool of the available plus trees.

However, selection of plus trees is only the first stage of selection. The next stage is their genetic evaluation in trial plantations. The scale of establishing trial plantations is by no means satisfactory. Young age of the existing plantations (mainly 1st class) and lack of uniform testing procedures make it difficult to obtain objective estimates and lead to ambiguous and conflicting conclusions about the genetic properties of the starting material. It is necessary to integrate the Russian experience in progeny tests of plus trees, update the developed draft guidelines, prepare and implement the Russian programme of creating a network of trial plantations and population and environmental plantations.

In the country there are only a few cases of establishing hybrid and seed plantations of interpopulation and interspecies crossing, capable of providing the heterosis effect in the seed progeny.

Identification and production of cultivar trees for various purposes should become one of the priorities in the forest seed breeding. It is necessary to develop the Russian programme of trial plantation establishment on the basis of the offspring of plus trees and PSOs, and further study of these plantations. Due to the predominant use of the improved planting material to create plantation forests the issue of assessing the "genotype- planting density" effect is extremely relevant.

It is necessary to create new provenance trial plantations and study the existing ones. Provenance trial plantations are recognized world-wide as the valuable objects for dynamic biodiversity conservation and for the research on the adaptation processes of forest woody species to global climate change. In particular, it is undoubtedly interesting to analyze the selective processes in forest populations, which can be marked by the selected (involved in adaptive processes and bearing selective pressure) genes (allozymes, EST, SNP, etc.). Currently, only molecular methods allow quantitatively assessment of the stock volatility and its distribution in space and time. Researches in many countries, including Russia, have revealed the geographical confinement of molecular genetic variability of the main forest forming conifer and hardwood species to geographic regions. Provided that a large number of different markers are used these data reflect the integral evaluation of genetic variation and can be used in addition to the traditional approach (estimate of the growth rate of provenance trial plantations) when refining of seed zoning schemes.

Primary SPs are established in Russia on an area 6238.8 ha. Currently, they are the only real source of improved seeds. In the process of the establishment of trial plantations on the basis of the SP offspring and the research conducted, more and more experimental data showing that primary plantations can produce a significant breeding effect (from 7 to 25% according to foreign sources). However, the genetic value of the Russian "production" SPs is rather low as they were established when there was a lack of selection breeders, poor organizational structure of seed production and deadline "pressure" (Nekrasov, 1981). The main factors that reduce their effectiveness are as follows:

- ✓ Low quality of plus trees selection. The share of an apparent "defect" was at least 20%. This was mainly due to non-compliance with the required levels of height and diameter of the barrel, low pruning. Creaming of almost all productive forests has also had an indirect impact on the quality of the selection as the best specimens had already been selected for cutting.
- ✓ Low quality of Russian SPs, especially the clonal ones. First of all, this is manifested in large quantities (up to 30-40%) of rootstock trees with dead and oppressed grafts. Another drawback is the genealogical progeny labeling errors, and sometimes loss of clone and family allocation patterns. This greatly reduces the possibility of improving the genetic value of SPs through culling clones and families that proved poor in trial plantations.

In recent years the rate of SP establishment in several regions of Russia has considerably decreased. Lack of selection breeders, poor organizational structure of seed production and deadline "pressure" today have reduced the SP selective value, so the feasibility of SP establishment on an industrial scale is questionable. At that, an inventory and repair of these sites; control of the progeny labeling accuracy; and comparative study of the breeding value of the SPs created within the framework of the woody species variety testing are urgently required.

The following activities are necessary in this respect:

- to evaluate the vegetative progeny of plus trees in the existing SPs;
- to create trial plantations, including those in the dense plantation forests (using the information on the growth rate and vegetative seed-bearing of the offspring);
- to establish new and renew the existing SPs.

The work must be carried out taking into account the information about the trial plantation growth rate, as well as the growth rate and seed-bearing of the clones in the given SP.

Permanent seed orchards have been established in Russia on the area of 20,579.6 hectares, however, they make virtually no contribution to the production of improved seeds, as they were formed by thinning natural underwood or forest plantations with the unknown breeding value. Seeds produced in such plantations are classified as "normal." This method of PSO establishment leads to a double irrational expenditure of funds - first on establishing dense forest plantation, and then on their intensive thinning. It is advisable to give up the formation of such seed areas. It is potentially better to create PSOs by sparse planting or seeding of improved breeding material derived from plus stands, plus trees and seed plantations.

Population PSOs based on plus stands and genetic reserves can rightfully be the ancestors of cultivar populations characterized by high productivity and environmental sustainability. In fact, such synthetic cultivar populations represent the main scientific and methodological principle of Russian foresters, i.e. "forest is a geographical phenomenon."

Softwood SPs and PSOs are not exploited to the full. At the age of 20 and over, they almost fall out of seed production due to inaccessibility of cone yield. Lack of reliable equipment and devices for ascending to the crown of very tall trees makes it practically impossible to use them for seed production. In foreign countries, seed harvesting in mature coniferous plantations is carried out by a specially trained team of climbers. This practice should be implemented in the future in the large-scale forest seed farms. Another technological solution is pruning crowns of seed trees. This technique is widely used abroad. In 2007 NIILGiS prepared recommendations on crown formation, and proposed a technology of prolonging the operational age of an SP for 10-15 years.

The Russian grand experiment, i.e. the identification of plus trees and genetic reserves, creation of seed plantations, provenance and trial plantations of forest forming species planted in 1970s-1980s across Russia and presenting a unique platform for learning and formation of modern systems of forest use/genetic diversity use, requires close attention, because many of the sites were "left behind" and may be lost forever as a result of the formal approach applied during the inventory of 2007-2008.

The SGBS objects are of great scientific and practical importance. Their conservation and maintenance needs stable funding and adequate organizational and methodological support. It is necessary to compare the genetic and population indices (heterozygosity, polymorphism, allelic diversity) of natural populations and SGBS objects in order to evaluate the effectiveness of plant breeding and gene conservation measures and organize monitoring of genetic diversity at the country level.

5. <u>Scientific support for forest seed breeding</u>. Changes in the forest sector of the Russian Federation and the related reorganization of applied science have created some difficulties for the development of forest selection. First of all, the coordination of scientific research in the sector, interaction of industrial and academic institutions and international cooperation was deteriorated. They are also affected by short-term (1-3 years) contracts on scientific studies during the last decade and the lack of funding of certain projects which prevents implementation of comprehensive studies, procurement of modern equipment, support/operation of scientific schools and research areas, staff turnover. All this is aggravated by extremely low wages of researchers in the sector.

It is necessary to ensure the continuation of research in forest genetics and breeding, considering it an important national goal that is in full conformity with the law "On selection achievements" and the law "On seed breeding." A great capacity has been built in forest seed breeding in terms of plus and population areas, e.g. SGBS objects. And nowadays it is important to continue studying them and use the knowledge gained to solve current problems of forest seed breeding in Russia. It is necessary to preserve the existing scientific potential and created an experimental basis in the form of previously established trial plantations, clone banks, SPs and other trial facilities as well as to ensure the continuity of research, conservation and use of the results achieved.

Forest genetics and breeding should be future-oriented in accordance with the adopted state funded target programmes. Development of such programmes should be one of the state priorities. Research activities funding should be done through tenders of the breeding programmes for a period of minimum 5 years.

At the same time, funding for scientific support of forest breeding and genetics should be supported by the timber industry of the country. This is particularly the case of biotechnology and plantation forestry development.

Attention should be paid to the situation of the Institute of Forest Genetics and Breeding in order to resume the functioning of the NIILGiS Council on the Problems of Forest Genetics, Breeding and Seed Production, and give this institution the coordinating role in this regard.

6. Conservation of genetic potential at forest exploitation and forest regeneration. Population [12] is a genetically integrated and co-adapted system in which the process of evolution has formed the optimal genotypic composition of individuals with defined spatial structure of genetic diversity. The systems of forest use and forestry measures should seek to ensure 1) conservation of genotype diversity and, 2) keeping them in a balanced natural state. The optimal solution to this problem from the standpoint of conservation of forest genetic diversity is possible provided that the exploitation of a population and subsequent recovery of its stock will be based on the maximum possible preservation principle of the natural self-reproduction structure (Vidyakin, 2007). In forestry terms it means that reforestation should be mainly natural or through measures promoting natural regeneration, i.e. from the environmental point of view and from the perspective of forest genetic diversity conservation, the most effective strategy in the silvicultural practice is to use the planting material genetically more or less identical to the natural stands, previously confined to the given territory. It is necessary to observe two conditions: 1) planting material must originate from a sufficiently large number of trees from natural stands (from tens to thousands of individuals), 2) compliance with the seed zoning rules and regulations. These requirements are adequately met by the traditional technologies: promoting natural regeneration, seed collection in the cutting area, etc. The choice of the optimal planning of logging schemes, ensuring the maximum possible preservation of growth is also important. There is a need to develop genetically-based technologies of various types of cuttings and to promote natural regeneration, including seed-tree cutting method that provides a complete reproduction of the genetic structure of the original stands.

According to the programme of “Forestry Development for 2012-2020” about 30 modern forest breeding and seed production centers, which will provide the regions with quality seeds are supposed to be constructed on the territory of Russia before 2020. “Providing high quality planting material” would not cause an environmental disaster, but contribute to the real improvement of Russian forests only if it is provided with the financial and organizational, scientific support (methodology), and strictly control in terms of seed collection for these centers. Otherwise, our descendants will have unsustainable, low productive forests as a result of lack of understanding of the genetic processes and recommendations of forest geneticists.

7. Biotechnology in forestry. Russian biotechnologists do not offer any solutions to the forest sector based on the application of modern biotechnological approaches taking in to account Russian experience of creating SGBS objects or works to improve the forest-forming species. Before using microclonal propagation technology it is necessary to identify worthy objects, evaluate their (vegetal) offspring and assess the genetic potential of the SGBS objects by using modern technologies.

At the same time, it is necessary to develop a balanced strategy of intensive plantation forestry, - even if we select 20 best genotypes of any species and propagate them across the country by microclonal propagation techniques, as a result we can get fragile homogeneous stands. Ignoring

[12] Populations have a multilevel hierarchical system. Populations are formed within physiographic regions; population groups occupy vast landforms - highlands, lowlands, plains, river terraces of large rivers. Migration complexes comprising several population groups have very large areas and tend to cross several natural zones.

the ecosystem and population approaches, lack of attention to the modest achievements of Russian forest breeders may result in the loss of valuable gene pool of the Russian forests.

It would be promising to introduce marker-assisted selection (Marker-Assisted Selection - MAS), i.e. improving the selection process through fast molecular diagnostics of the offspring with valuable properties. Most of the traditional DNA markers are selectively neutral. For all its high volatility and ease of analysis they are loosely related to with the adaptability of individuals, and only indirectly reflect the variability within populations of those characteristics which are required to obtain the breeding effect. The QTL-mapping approach, or the identification and mapping of quantitative trait loci are used to find these relationships. In many countries and regions there funding programmes for targeted developments in molecular genetics and functional genomics. These projects are costly and include only several economically important tree species such as *Pinus Taeda*, Douglas fir and poplar in the USA; Norway spruce, common pine and *Pinus pinaster* in Europe; the eucalyptus trees in the tropics, and some other species. The new markers that are being developed are the genes to undergo the genetic control of adaptive and economically important characteristics. Implementation of these projects will only be possible provided a sufficient research on the genomes of forest woody plants and assessment of the practical relevance of the effects of “genetic formula transformation” of the quantitative characteristics arising from the change of the limiting factors (Dragavtsev, 2003).

8. <u>Precautionary approach to working with transgenic organisms</u>. According to the Forest Sector Development Strategy of the Russian Federation for the period 2008 to 2020, “... creation of the technology shall be completed and trial plantations of genetically modified plants with desired properties shall be established by 2017. It was planned to introduce the production technology of cultivating plantations from the planting materials with desired commercially valuable properties starting from 2018.” This is another example of poor coordination and lack of qualified professionals, - the wording has not obviously gone through a peer review.

In 2006, at the 8th Conference of the Parties to the UN Convention on Biodiversity genetically modified trees were recognized as a global environmental threat. In 2008, the 9th Conference of the Parties reaffirmed the need for a precautionary approach when dealing with genetically modified trees.

Commercial cultivation of transgenic plants in the open ground in Russia is not allowed. Terms of sanitary safety in forests, approved by the Government of the Russian Federation (2006), prohibit cultivation and use in forests of plants foreign to the natural ecological systems, as well as created by artificial means, without the measures developed to prevent their uncontrolled reproduction. One of the requirements of the voluntary forest certification is a ban on the use of genetically modified organisms.

It is almost impossible to work out effective measures to prevent uncontrolled reproduction of genetically modified trees (GMT). It is impossible to prevent pollen dispersal of genetically modified plants of forest species, unless they are cultivated in greenhouses. Prior to the works on GMT it is necessary to understand the risks associated with the GMT, prepare a forecast and develop technologies to minimize potential adverse effects, create the appropriate legal framework for the use of GMT based on the international instruments and foreign experience and taking into account the specific character of Russian business.

9. <u>As for introduction</u>, it is necessary to develop and approve at the federal level the recommendations on the use of introduced species. However, the expediency of their use must be confirmed by the results of long-term experiments.

10. <u>Ornamental plants</u>. Underestimating of individual selection of various natural forms of forest woody species (primarily ornamental), their genetic study, breeding and introduction led to the fact that Russia is currently an outsider in the market of ornamental woody plant cultivars.

Chapter 5
The State of National Trial programmes, Research, Education, Training and Legislation

Trial programmes, researches, education, training and national legislation related to the species and ecosystem diversity protection, protection of rare species, the Red Book, development of the SPA network, etc. in the Russian Federation are well developed and/or are developing dynamically, but they rarely include specific tasks aimed at addressing issues of study, protection and management of forest genetic resources. The recent analysis of trial programmes, research, education, training and legislation for species and ecosystem diversity in forest areas, protected areas for the conservation of rare species, the Red Book, etc. is presented in detail in the CBD Fourth National Report of the Russian Federation (www.cbd.int), as well as the documents and materials referred to in Chapter 2 of this Report. This chapter contains materials that give an idea of the decision on the issues related to the study, conservation and management of forest genetic resources.

5.1. Research

Russia has a huge potential of highly qualified specialists in genetics, taxonomy, phytocenology, ecology, forest science, geography, i.e. has many of the prerequisites to become one of the countries with well-designed and well-organized system of conservation and sustainable use of forest genetic resources. However, at present in Russia there are no integrated target trial programmes in the field of scientific research on forest genetic resources and methodological support for genetic and breeding operations.

RAS institutes (Table IV.17a) are involved in the projects of the trial programmes of the Presidium of the Russian Academy of Sciences ("Biodiversity", "Wildlife") and the Department of General Biology ("Biological resources of Russia"). The subjects of the projects related to the assessment and monitoring of forest genetic resources are carried out *inter alia* within the programme "Dynamics and conservation of gene pools" in the framework of the trial programme "Living Nature". Forest biodiversity assessment is conducted by the organizations - members of the subprogramme "Russian Forest" (also a part of the RAS trial programme "Wildlife"), however, its genetic research component is small.

In 2003-2008 extensive results were received from one of the largest research trial programmes in the history - "Biodiversity: the scientific basis of biodiversity conservation in Russia" and "Fundamentals of biological resources" - which involved almost all academic biological institutes and partly geographical institutes, as well as lawyers, economists and sociologists. Important results were obtained on the inventory of flora and fauna of Russia; study of modern biodiversity dynamics, its determinants and mechanisms of action; evolution and habitat functions of biodiversity, methodological framework for monitoring biodiversity; genetic basis of biodiversity conservation; principles and techniques of conservation and restoration of rare and endangered species; social and economic mechanisms for biodiversity conservation, etc.

The subjects of the researches related to forest genetic resources, are funded by the Ministry of Education and Science in the form of lots on national trial programmes of supporting priority research and human resource development of the innovative Russia.

FFA is funding researches on forest seed breeding. The FFA research institutions (Table IV.17b) conduct practical research in forest genetics, breeding, cultivar trials and introduction, study of the major tree species response to global climate change, study of the geographic variation of the forest forming species and improvement of seed zoning, forest seed breeding and forest biotechnology. Institutions provide scientific and methodological support of the forest forming species breeding trial programmes, development of selection methods for main forest forming species and development of breeding trial programmes for the development of forest seed production, improvement of crop forecasting methods, processing of seed material and defining of forest seed sowing quality; establishment and operation of seed selection centers, development of methods for monitoring the dynamics of forest genetic resources and assessment of the level of genetic diversity in forest ecosystems. They also provide practical assistance in the establishment of permanent seed basis to the forestry enterprises in the regions.

Russian Foundation for Basic Research (RFBR) provides financial support for short-term (3 years) research projects on a competitive basis. These projects involved individual researchers and small groups (up to 10 people) of researchers. RFBR grants finance the basic researches that often bring together professionals from different academic institutions in order to solve a certain problem. Together with the foreign science supporting funds RFBR finances joint, usually bilateral, researches of Russia and the European countries (Germany, Austria, Italy, etc.), Russia and Japan, etc. The Foundation awards grants for education and training of young professionals in the leading scientific institutions. The share of projects for the study of forest genetic resources funded by the RFBR is small but quite significant for the support the researches on forest genetic diversity conducted by the academic institutions.

Recently, some higher education institutions have joined the process of the research on forest genetic resources (Table IV.17c).

Many protected areas, botanical gardens, arboreta and some private nurseries are involved in the studies of forest genetic resources directly or indirectly (see the Fourth CBD National Report), (see Frame).

Russian organizations are members of the International Union of Forest Research Organizations (IUFRO). Our experts participate in the IUFRO workshops and conferences.

Most of the higher education institutions are engaged in research in cooperation with the institutions of the Federal Forestry Agency and the Russian Academy of Sciences. The trend of integration studies and industry-academic researches, collaborative projects with universities is positive not only for science but also for the quality of training of young specialists and their orientation to work in specialized research institutions.

A negative trend of the last 10 years is the absence or insufficient funding and logistical support of the research in forest genetic resources, destruction of the existing research groups, elimination of the experimental and training facilities network subordinated to forestry research institutions and forestry schools.

Genetic collection of the forest woody species mutations

"Witch's Broom " on the Siberian stone pine (Pinus sibirica) in the Southern Baikal and S.N.Goroshkevich who discovered it

Ltd. «Siberian Academy of Trees and Shrubs» *(http://sadik.tomsk.ru), Tomsk, Director – S.N.Goroshkevich (e-mail: sadik@sibmail.com)*

It is a unique research and production company which is engaged in the study of woody plants, reservations of the gene pool of forest woody plants, breeding and testing of cultivars, production and sale of seedlings for landscaping, reforestation, afforestation and forest land reclamation.

To date, virtually all potentially suitable Siberian species are cultivated. Particular attention is paid to conifers: dozens of ornamental cultivars of Siberian pine (Pinus sibirica), Siberian dwarf pine (Pinus pumila), Korean pine (Pinus koraiensis), Siberian fir (Abies sibirica), Siberian spruce (Picea obovata), Siberian larch (Larix sibirica) have been bred, tested and propagated.

A lot of attention is paid to the testing, reproduction and inclusion dwarf cultivars with abnormal morphogenesis in the breeding programmes. This is mainly mutants with slow growth, impaired or absent apical control, impaired or absent geotropizm (grovelling and weeping forms). Currently, genetic collection includes about 1,500 mutants (they are ornamental cultivars) of the four main genera of the ***Pinaceae*** *family (Pinus - 750, Picea - 400, Abies - 300, Larix - 150). 150 of them have been identified as clones promising for Siberia.*

One of the most promising areas of work is the breeding of new cultivars of woody plants using the gene pool of the world.

Controlled pollination of Siberian stone pine (Pinus sibirica) with the pollen of exotic 5-needle species

A trial plantation of the 2nd generation grafted ornamental cultivars of Siberian stone pine (Pinus sibirica)

5.2. Education and Training

Trained forestry professionals with vocational secondary education in the FFA system are prepared in 20 Forestry Colleges. Annual enrollment is more than four thousand people. Middle ranking forestry professionals are also prepared in 4 forest engineering schools.

Total, there are more than sixty universities that train specialists for various forestry branches. The core institutions preparing specialists in forest genetic resource management are the Moscow State Forest University, Kirov St. Petersburg State Forest Engineering University, Voronezh State Forestry Academy, Ural State Forestry University, and others (Table IV.17d). Several levels of specialists are trained: bachelors, masters, certified graduates. In 2003 the Scientific Methodological Council on Environmental Education was created within the Russian Ministry of Education. In higher education institutions there are training forest farms, arboreta and botanical gardens that are used as educational and experimental sites.

Two of the FFA institutes experienced *inter alia* in e-training of managers and specialists are responsible for retraining and advanced training for managers and specialists of state forest management organizations, public and private forestry business, scientific and educational institutions.

The problem of staffing with young specialists still remains relevant. To ensure qualified staffing of forest authorities in genetics and breeding areas the forestry authorities should enter into agreements on the appropriate target training with the higher educational establishments specialized in forestry, forestry colleges and technical forestry schools. However, a successful solution of staffing problems would be possible if the wages of scientists and foresters will be competitive in relation to other professions. Practical training in universities (with rare exceptions) is not sufficient for training in the sphere of forest genetics and breeding, as it is often far from the natural objects and/or lacks modern laboratory facilities.

5.3. Trial programmes for forest genetic resources

Currently there are no target national trial programmes on forest genetic resources in Russia. Policy documents in this area were approved at the end of the XX century, and now many of them have lost their relevance or legitimacy. In this regard, in the framework of the federal target programme FFA experts have prepared a project “Development of forest seed breeding for the period of 2009-2020”, a draft Concept and a draft Code of Conduct on genetic monitoring of forests, a draft Concept of the long-term programme of genetic improvement of forest in Russia, and a draft Provisions on the conservation of the gene pool of woody species in the forests of Russia, which were not approved in time, but should be considered for further action. Thus, the draft Concept of the long-term programme of forest genetic improvement in Russia provides differentiated staged approach to the development and implementation of individual genetic and breeding activities in the zones of the country; determination of the three stages (till 2020, 2021-2050 and 2051-2100) reflects the real periods necessary for cultivar breeding, testing and the gradual transition to a higher level of production and use of the breeding material of most woody plant species.

Currently, the Government of the Russian Federation is considering the draft state programme “Development of Forestry for 2012-2020” that has already been approved by the Ministry of Finance and the Ministry of Economic Development, and includes six subprogrammes in the key areas of forestry: forest fire protection, protection of forests from pests, forest regeneration, implementation and maintenance of the state register, state forest supervision, stuffing and scientific and technical support, as well as ensuring the implementation of the state programme of forestry development.

Most regions of the Russian Federation have developed forestry development programmes containing sections devoted to forest seed breeding and forest planting. The priority issues of environmental protection in the subjects of the Russian Federation are also envisaged within the framework of the long-term target programmes such as, for example, "Ecology and Natural Resources of the Kursk Region (2011-2013)", "Improvement of the environmental situation in the Ryazan Region (2010-2012)", "Conservation of biological diversity, ensuring protection and development of protected areas of regional importance of the Republic of Adygea (2010-2012)", etc., which, however, very rarely include provisions relating to the conservation of forest genetic resources.

The country has not created any national network of forest genetic resources.

It is necessary to develop and adopt a national programme on forest genetic resources, targeted subprogrammes on individual species. In view of the federal structure of the country and the governance decentralization in the forestry sector in the Russian Federation there is a need to established a hierarchy of strategic planning when the objectives of regional/sectoral programmes are subordinated to the national objectives, as optimal decision-making on the conservation, research and management of forest genetic resources is only possible at the national level. National programme of conservation of forest genetic resources in the Russian Federation would greatly benefit from the cooperation at the European, Asian, circumboreal and global levels.

5.4. National legislation

Russian environmental law is developing in two directions - environmental protection and natural resources. It regulates relations in the sphere of protection, reproduction and use of flora and fauna, and other natural sites and resources, and establishes a system for managing all environmental activities in general and the components of the natural environment in particular. Environmental regulations are also included in sectoral legislation, such as financial, criminal, etc. Therefore, improvement of legislation on the conservation of forest genetic resources should be aimed at the harmonization of forest legislation with other branches of the law, elimination of duplication and conflict, including, the compliance of Russia with the international obligations.

The most important documents for the organization of the conservation and management of forest genetic resources, organization of forest breeding and seed production in the Russian Federation are:

Forest Code of the Russian Federation, 29.01.1997, № 22-FZ (amended in December 30, 2001, July 25, December 24, 2002, December, 10, 23, 2003, August 22, 21, 29, December, 2004, May 9, July 21, 2005.).

Instruction on forest seed breeding in the Russian Federation (2000).

The Federal Law on Seed Breeding (1997).

Seed zoning of the main forest forming species in the USSR (1982).

The document "On Amendments to the Regulations on the formation and use of the federal forest seed fund" is going through a public examination on the website of the Ministry of Natural Resources and Environment.

Federal Law of the Russian Federation does not contain direct norms obliging forest stakeholders to implement activities on the *ex situ* and *in situ* conservation of forest gene pool. The absence of reference to the need for such a legal act in the federal legislation, in principle, does not allow adopting it on the federal level. Accordingly, there are no developed guidance documents that would determine the order of the forest site designation for genetic conservation by the main forest-forming species and regions of the Russian Federation. Currently, FFA is developing a new legal act provided for in Article 65 of the Forest Code of the Russian Federation - “Rules of establishment and designation of objects for forest seed breeding (seed plantations, permanent seed orchards and similar objects).” The draft of the Rules lists the basic principles of plus selection provided in the “Guidelines on forest seed breeding in the Russian Federation.” The system of scientific and methodological support for applied genetic and breeding works that existed in the former Soviet Union requires updating. The needs of the legislation regulating the forest genetic resources are detailed in each of the Chapters of this Report and are given in Table IV.18.

The Russian Federation has adopted the following documents which mention the conservation of forest genetic resources:

- ✓ The Federal Law “On Specially Protected Natural Territories” (1995, amended in December 30, 2001, August 22, December 29, 2004, May 9, 2005, December 4, 2006, March 23, May 10, 2007, 14, July 23, 3, 30 December 2008, December 27, 2009, July 18, 21, 30 November 2011, June 25, 2012). However, the law does not mention that specially protected areas should also perform the function of forest genetic conservation.
- ✓ National Biodiversity Conservation Strategy of Russia adopted by the National Forum on the wildlife conservation in Russia (2001).
- ✓ The Federal Law “On Environmental Protection” (2002).
- ✓ Environmental Doctrine of the Russian Federation (2002).
- ✓ Concept of Forestry Development of the Russian Federation for the period of 2003-2010 (2003).
- ✓ Strategy of the Russian botanical gardens on flora biodiversity (2003).
- ✓ Regulations on the organization and implementation of state environmental monitoring (2003).
- ✓ Strategy of conservation of rare and endangered species of animals, plants and fungi (2004).
- ✓ The Concept of scientific support for phytosanitary and quarantine security of agro-industrial complex of the Russian Federation (2004).
- ✓ Strategy of Forestry Development of the Russian Federation for the period up to 2020 (2008)
- ✓ State political framework of the environmental development of Russia until 2030 (2012).

Proposals for improving the legal framework. Legal mechanisms for the conservation and management of forest genetic resources include three elements: legislation, implementation and enforcement. In general, at the present stage of development Russia is characterized by fairly advanced legislation and lack of effective implementation of the laws.

Improving the legal framework should be aimed at the introduction of biological and ecological foundations for sustainable management of forest genetic resources into the law, taking into account the socio-economic conditions of their implementation. Improving of legal mechanisms should be directed in three ways:

1) improvement of the existing legislation;
2) development of new laws and other legal acts;
3) improvement of the enforcement practice.

In order to improve the current legislation it is appropriate to:

- ✓ create a system of special procedures for the implementation of the legal obligations that allow implementing scientifically based and economically possible measures of conservation, reproduction and management of forest genetic resources
- ✓ strengthen interagency cooperation for the implementation of the legislative acts on the conservation, reproduction and rational use of forest genetic resources
- ✓ develop an Action Plan of the conservation, reproduction and rational use of forest genetic resources and recommend the subjects of the Russian Federation to develop regional action plans synchronized with the federal Action Plan;
- ✓ improve standards that officially regulate the turnover of forest genetic resources;
- ✓ envisage in the annual budgets of all the levels funding for the work related to the record and monitoring of forest genetic resources (primarily the SGBS objects), rare and endangered animal species of plants and fungi, and to the Red Book.
- ✓ include in the Forest Code and sectoral legislation all amendments that strengthen the conservation, reproduction and rational use of forest genetic resources.

It is also necessary to add environmental control to the existing provisions of the Law of the Russian Federation "On the State Border of the Russian Federation", 01.04.1993, N 4730-1; to provide for environmental control to be performed before customs control in the Decree of the Government of the Russian Federation of 19.01.1998, N 60 "On the approval of the crossing points across the state border of the Russian Federation; to make amendments to the Criminal Code of the Russian Federation on the responsibility for the destruction of animals and plants listed in the Red Book of the Russian Federation, as well as trafficking in non-target woody plants.

It is appropriate to consider the possibility of developing a draft federal law "On the forest genetic resources" that will strengthen the legal framework for their conservation and sustainable use.

5.5. Information Dissemination

The Russian system of information exchange in the area of biodiversity conservation has been created anew since 2001. It is a network of portals and websites of the federal and regional governmental institutions (ministries, services and agencies and their local units), research organizations, including institutes and centers of the Russian Academy of Sciences and NGOs. The national network of the websites on biodiversity has significantly expanded. However, only a few of them are dedicated to the forest genetic resources. The most informative among these websites are the Federal Forestry Agency (www.rosleshoz.gov.ru) and the FSFI "Roslesozashchita" (www.rcfh.ru) websites. One of the objectives of FFA is raising public interest in improving the environmental situation and promoting respect and care for forests and forest resources (Article 1, Forest Code of the Russian Federation). The main objective of this work is to raise public awareness about the state of forest resources and their management on the local or regional levels. Public participation enables public authorities, first, to better understand the interests of different groups and, second, to find a consensus on the issues addressed through dialogue.

Botanical gardens and arboreta of Russia also play an important role in the education of school and university students on forest genetic resources. The number of visitors in 2010 was more than 1.7 million people.

To inform the public on the forest law, forest policy and forest development, monitoring, etc. two national newspapers are published, i.e. "Russian forest newspaper" (Rossiyskaya Lesnaya Gazeta) (www.lesgazeta.ru) and "Forest Newspaper" (Lesnaya Gazeta). Materials on forest genetic resources are published in the magazines "Forest Russia" (Lesnaya Rossia) (www.rosleshoz.gov.ru), "Forestry" (Lesnoye Khozyaystvo), "Forestry Information" (Lesnaya Informatsiya), "Silviculture" (Lesovedeniye).

The research results are regularly published in scientific periodicals, i.e. magazines “Genetics”, “Ecology”, “Forest Science”, university publications (“Forest Gazette”, “BSAU Journal”, “Journal of Forestry Engineering”, “KSAU Journal”, “Bulletin of TSU” and etc.), monographs, and conference proceedings. The important ways to disseminate scientific knowledge are regular publication of academic and popular literature, creation websites of educational and scientific institutions, as well as the organization of international and Russian scientific meetings to discuss issues of the study and conservation of forest genetic resources. During last few years several scientific conferences were organized with the support of RFBR and IUFRO jointly with the RAS institutes and of the FFA institutions: 1st, 2nd and 3rd International Meeting on “Conservation of Forest Genetic Resources in Siberia” (2007, 2009 and 2011), 4th IUFRO Conference on Breeding and Genetic Resources of the five-needle pines (Tomsk, 2011), the Russian-Austrian workshop on modern genetic methods used in forestry (Vienna, 2008).

Table IV.19 ranks Russia's needs in terms of public awareness raising. The widespread and accepted public slogan saying that we “need to conserve forest biodiversity” is rarely associated in the mind of people with the conservation of forest genetic resources, since there is no understanding of the complex and multi-faceted nature of biodiversity which is revealed at different levels of life organization: ecosystem, species, population and genetic. Popularization of the knowledge on forest genetic resources is the first and most important task of the academic and industry science.
Currently, there is no information system on conservation and sustainable use of forest genetic resources in the Russian Federation.
Coordination mechanisms of the work on forest genetic resources in the country have not been developed.

Chapter 6
The State of Regional and International Collaboration

The international cooperation of the Russian Federation is effected within the framework of the multilateral conventions and agreements, international organizations as well as bilateral treaties and agreements with the CIS countries, neighbouring countries and beyond.

6.1. International networks and programmes

Currently The Russian Federation is not taking part in any international target programmes on forest genetic resources.

Russia was one of the first signatories to the 1993 agreement establishing the International Plant Genetic Resources Institute (IPGRI). A number of joint activities were scheduled. In 2002 an agreement was signed on cooperation between IPGRI and Tsentrlessem (currently FSFI "Roslesozashchita"). However, Russia has not yet become a member of the European Forest Genetic Resources (EUFORGEN).)[13] Accordingly, the country has also failed to fully participate in more specialized programmes prepared in the European Union in the framework of EUFORGEN. However, experts from "Roslesozashchita", NIILGiS, FSFI "NIIgorlesekol", and NRIF took part in EUFORGEN workshops (workshops on black poplar, on deciduous, coniferous and noble hardwoods). In June 2005, the first training workshop on the conservation of forest biodiversity for Young Scientists organized by IPGRI was held in Pushkino (Moscow Region).

Russian experts participated in the strategy development for SEBI-2010 (Streamlining European Biodiversity Indicators), and, in particular, have developed criteria and indicators (including genetic) for the wild and poorly domesticated/cultivated populations/species which include forest woody plants.

Since 2003 NRIF has been working on the Russian-Scandinavian project "Larch" jointly with the Forest Society Helgeland, Norway. The works on the larch research continued in the project "SibLarch" of the INTEREG programme "Northern Periphery" which was carried out in collaboration with research organizations and other institutions of Finland, Iceland, Norway and Sweden. The first sections of the provenance plantations were established in the Arkhangelsk Region.

NRIF staff participated in the development of the international project EAN-SEABUCK «Establishment of European-Asian network for the development of strategies to enhance the sustainable use of sea buckthorn" which is funded by the Sixth Framework Programme of the European Union. In the course of the project five workshops were held in Russia, China and Uzbekistan, brochures on the cultivation, processing, product development, marketing, and product quality of sea buckthorn were prepared and published. Cooperation with Canada is being developed as well: a pilot project on sea buckthorn funded by «Partnerships for Tomorrow Program Phase II» has been developed.

[13] EUFORGEN (European Forest Genetic Resources Programme) is a cooperative program of the European countries to ensure effective conservation and sustainable use of forest genetic resources in Europe. EUFORGEN is funded by the participating countries and is coordinated by IPGRI in collaboration with the FAO Forestry Department.

Various organizations of Russia, i.e. and the FFA and RAS institutions, universities, SPAs etc. cooperate with organizations in other countries on bilateral and multilateral projects funded by RFBR, Ministry of Education, scientific and environmental foundations of Western European or Asian countries.

In 2011 the first project of genome-sequencing of Siberian larch was launched in Russia. The works are funded by the Northern Federal University (Krasnoyarsk), with the support of the programme "Scientific and pedagogical personnel of innovative Russia" - the projects under the guidance of visiting researchers (Texas A & M University, USA, and the University of Gottingen, Germany). It is planned to decipher the complete genome of larch on the latest sequencing platforms for the first time in the world. The work is complicated not only by the size of the genome of conifers which is about 6 times more than the human genome and its complex organization, but also the poorly developed infrastructure (in Russia and, particularly, in Siberia) necessary for high-tech researches: high cost of reagents, problems with the import of the equipment, inadequate customs policy for reagents and instruments, etc. However, regardless of these difficult conditions Russian scientists have taken up this ambitious task together with the leading international forest genomics centers.

Information on the international networks and programmes on forest genetic resources in Russia is not collected, so this Report does not include information on the co-operation on SPAs, botanical gardens, arboreta, etc. (see the 4th CBD National Report). Table IV.20 presents an incomplete list of activities.

6.2. International agreements

The rules of the international law are an important element of the current Russian legislation. These standards are important in relation to the regulation of protection, reproduction and use of forest genetic resources because an effective solution to these problems is possible only through coordinated actions of many countries. The harmonization of national legislations which have transboundary resources, including rights to their use in the territory under the exclusive jurisdiction of the states, is the basis for the conservation and management of populations of species that live in different countries.

According to the Convention on Biological Diversity (CBD) all the parties to the Convention should take steps to preserve ecosystems and natural habitats and populations of species in their natural habitat, improve national legislation, conserving biological diversity (including genetic diversity of forests), and to ensure the sustainable use of the biological diversity components and the equitable sharing of benefits arising from the utilization of genetic resources and the sharing of relevant technologies. In general, the CBD does not directly regulate, but is a valuable international legal instrument. Different aspects of forestry biodiversity information in the country are reflected in the "Report on Russia's fulfillment of the CBD obligations", prepared by VNIILM for the 9th Conference of the Parties to CBD (2008).

The Convention on Wetlands that are of international importance especially as waterfowl habitats – the Ramsar Convention - establishes the criteria for identifying wetlands of international importance. The Convention obliges Parties to identify such land in accordance with the criteria, to develop management plans and establish the appropriate nature management order. Russia has unique resources of natural wetlands. The Resolution of the Government of the Russian Federation on the wetlands of international importance identifies 35 related objects in the country. Data on forest swamps are registered in the Forest Fund of the Russian Federation.

The Convention on the Protection of the World Cultural and Natural Heritage defines the criteria and procedure for the inclusion of natural and cultural sites in the list of World Cultural and Natural Heritage, and imposes restrictions on economic activities in these areas. Russia is represented in the World Heritage List of UNESCO by 15 cultural and 8 natural sites. They include the Virgin Komi Forests, Lake Baikal, Volcanoes of Kamchatka, Golden Mountains of Altai, Western Caucasus, the Central Sikhote-Alin, State Natural Biosphere Reserve of Uvs Nuur Basin, Natural System of Wrangel Island. Curonian Spit National Park is listed as a Russian-Lithuanian object in C (v) ("cultural landscape"). In August 2008, Russia organized a workshop "The Virgin Komi Forests as a model of World Natural Heritage."

The Convention on International Trade in Endangered Species of wild flora and fauna in Endangered Species (CITES) defines the rules for the export and import of animal and plant species threatened with extinction. Russia has established the lists of endangered species of animals and plants according to their vulnerability and the procedure for international trade in species. In 2006 a handbook "Customs control and struggle against smuggling of CITES objects in the international circulation (regulations and training materials)" was published. It summarizes the results of the successful practice of suppressing the illicit movement of animals and plants across the customs border of the Russian Federation. In 2008, the Federal Service for Supervision of Natural Resource Usage approved a new regulation on the implementation of the state function of authorization to export from the Russian Federation and import into its territory of animals and plants, their parts or products derived from them, subject to the specified list of animals and plants of CITES.

By the decision of the Customs Union of the Russian Federation licensing for the export of Korean pine seeds and timber was introduced in Russia.

Conservation of forest genetic resources is also based on bilateral and multilateral conventions and agreements for individual species and groups of living organisms. A number of commitments for the conservation of rare and endangered species are included in the Agreement on the book of rare and endangered plant and animal species - the Red Book of the CIS, bilateral agreements between Russia and the United States, Japan, Republic of Korea and the DPRK.

The Convention for the Protection of Wild Flora and Fauna and Natural Habitats (Bern Convention) pays great attention to the conservation of rare and endangered species. Russia is not a party to the Convention, but is a participant in some of the agreements made thereunder, and is involved in as observers in the ongoing activities and *de facto* takes a considerable number of measures for the conservation of rare and endangered species and their inhabitation under this agreement.

Implementing some other conventions and international agreements contributes to the conservation and sustainable use of forest genetic diversity. These include, first and foremost, the UN Framework Convention on Climate Change, the Convention on Environmental Impact Assessment in a Transboundary Context, the Protocol on Strategic Environmental Assessment, etc. Signing and ratification of the agreements/conventions (including the Berne Convention, the Cartagena and the Nagoya Protocols) would in principle be useful for the Russian Federation as they contribute to the integration of the conservation and management of forest genetic resources in the international environmental process, the process of strategic environmental assessment. However, these issues must be accompanied by a thorough evaluation of the financial and socio-economic consequences for the Russian Federation.

In addition to the international agreements there are international organizations whose documents are advisory, but are used as a base for the legislation development at the national and regional levels. FFA represents Russia in the Committee on Forestry of the Food and Agriculture Organization of the United Nations, the UN Forum on Forests, participates in the activities of the Working Group of the Montreal Process on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forest and the “Forest Europe Process”. In the working groups of the last two processes Russian experts are developing indicators to measure the genetic diversity of forests. The Pan-European Biological and Landscape Diversity Strategy was adopted at the Ministerial Conference “Environment for Europe” (1995). The aim of the strategy is the maintenance and enhancement of biological and landscape diversity in Europe, *inter alia* through the conservation of habitats of rare and endangered species. The strategy is advisory, but is used by the Council of Europe as a mechanism for the implementation of the CBD at the regional (European) level.

In addition to the international conventions and other international agreements, Russia's international commitments are determined by its participation in a number of international organizations, commissions and programmes: UNESCO Man and Biosphere Programme, Council of Europe, the Economic Commission for Asia and the Pacific, the Programme for the Protection of the Arctic flora and fauna, the International Union for Conservation of Nature, etc.

Over the past 10 years, despite the fact that the volume of Russia's obligations under international agreements on biodiversity is growing, the international financial support for the country in this area has reduced.

6.3. Priorities and needs to promote international collaboration

The main priorities of Russia in terms of the future international cooperation are summarized in Table IV.21.

Chapter 7

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

Almost all forest ecosystems and elements of their biodiversity, genetic resources derived from cultivars/population cultivars of trees and shrubs, and genetic resources represented *ex-situ* and/or received as a result of scientific research represent a pool of national forest genetic resources.

The issue of genetic resources, access and benefit-sharing has become relevant for Russia after the ratification of the Convention on Biological Diversity in 1995. As the country has not yet established a National Coordinating Center on the issues of access to genetic resources. The issues of the national and domestic policy in this area are addressed by the Department of Environmental Protection of the Ministry of Natural Resources and Environment and by the Department of Science of the Ministry of Economic Development and Trade of the Russian Federation. Work on the selection, conservation of genetic resource diversity, regulation of "access and benefit-sharing" in the agrarian sector has been carried out by the Russian Academy of Agricultural Sciences, and the medical aspects of the problem - by the Russian Academy of Medical Sciences. Researches on forest genetic resources are conducted in the FFA branch institutes, institutes of RAS, some educational institutions - universities and institutes (see Section III.5.1). Botanical gardens, arboreta, protected natural areas are stakeholders representing the interests of the country in relation to access and benefit-sharing of forest genetic resources. We should also mention the formation of the "small business" in the country during the last decade that is based on the use of forest genetic resources in such areas as the use of natural medicinal plants and other non-timber resources, selection work, breeding of ornamental trees and shrubs etc. for commercial purposes. A special environmental regime is established in the areas densely populated by indigenous peoples of the North, Siberia and the Far East (see Section III.8.2.), whose communities are interested in solving the problems of access to genetic resources in their territory. It is difficult to define the interest of the rural population who are traditionally the users of the forest genetic resources in this area, because the use of resources by the population of forest villages is not legally regulated like it is regulated in case of the indigenous peoples.

The owner of the genetic resources and their beneficial qualities and properties is the State, which, according to Article 72 of the Constitution of the Russian Federation, under the joint jurisdiction with the subjects of the Russian Federation, addresses the issues of "ownership, use and disposal of land, subsoil, water and other natural resources." The issues of patenting and protection of rights in relation to the access to genetic resources and benefit-sharing are addressed by the Russian Patent and Trademark Office and the Ministry of Justice of the Russian Federation.

Fair and equitable sharing of benefits arising from the utilization of genetic resources is one of the three objectives of the Convention on Biological Diversity. Recommended approaches and principles have been developed at the international level: the Bonn Guidelines on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (2002) and the Nagoya Protocol on Access to Genetic Resources and Benefit Sharing (2010). All Parties to the CBD has been suggested to implement their provisions and principles through national legislation.

Currently in Russia there is no specific legislation on this subject. At the federal level there are no clear standards for the regulation of access to genetic resources and especially benefit-sharing issues. In the absence of any federal regulation the subjects of the Russian Federation may independently apply the proposed provisions and principles, establish their own rules to the extent consistent with all applicable federal laws.

The existing legislation in the country does not take into account all aspects of the access to genetic resources and benefit possibilities; the system of patenting and protection of intellectual property rights has not been developed though it would allow addressing the commercial interest of the owners and users of genetic resources. However, Russia has established mechanisms and procedures for the confiscation of animals and plants, which contributes to the fulfillment of the international obligations of Russia. The legislative part of the problems of access and benefit-sharing is regulated by the following federal laws:

- ✓ Patent Law (1993)
- ✓ On Veterinary Medicine (1993)
- ✓ On Selection Achievements (1994)
- ✓ On Copyright and Related Rights (1994)
- ✓ On State Regulation of Foreign Trade (1994)
- ✓ On Wildlife (1995)
- ✓ On Science and State Science and Technology Policy (1996)
- ✓ On Participation in International Information Exchange (1996)
- ✓ On State Regulation of Genetic Engineering (1996).

There is no practice of agreements and arrangements for access and sharing of the benefits arising from the predicted results in Russia. There is some experience of "contractual arrangements" (mainly in the sphere of industrial microbiology, pharmacology and selection) regulating access to genetic resources and benefit-sharing. However, this experience has drawbacks such as disregard of the interests of other stakeholders, including the true owner, i.e. the state, the significant expenditures on the negotiation process, etc. There is a need to shift to multilateral agreements, transparency of the process, and its monitoring and common practice of reliable compensation.

Some progress in this area is related to the research in the field of genetics and molecular biology, the results of which may contribute to the so-called “wide patenting” achievements, when molecular structure, biochemical composition, DNA and RNA, useful properties identified and revealed through research are patented.

After Russia entered into the World Trade Organization it began to work on the patent system of selection achievements, which are based on the source transgenic cultivars, including the ones included in the State Register of breeding achievements; the system of differential gene patenting (marker gene, a gene coding particular protein, promoter of the gene, etc.) and technologies to use it are being developed, as well as the legal practice in this area.

According to the recommendations of the National Biodiversity Conservation Strategy in Russia (2001) the International Conference "Conservation of genetic resources" (St. Petersburg, 2004), and "Biodiversity and Genetic Resources of Russia: methodological, legal and economic aspects" (Moscow, 2005) were held. Russia has prepared the report on fulfilling obligations under Article 15 of the CBD. The Focal Point has created an Internet portal on the access to genetic resources (www.sevin.ru/rugenres).

In order to implement the International Treaty on Plant Genetic Resources for Food and Agriculture of the Russian Federation a draft federal law "On plant genetic resources" is being discussed. It "does not extend to the collection, conservation, study and rational use of forest genetic resources of plants in the Russian Federation." The preparation of the Law of the Russian Federation "On the genetic resources of forest plants" is relevant because it is important to have common requirements to the improvement of the relevant legislation.

It is necessary to start negotiations on the preparation of the International Agreement on genetic resources of forest plants.

Chapter 8

The Contribution of Forest Genetic Resource Management to Food security and Sustainable Development to Food Security, Poverty Alleviation and Sustainable Development

Forest genetic resources of the Russian Federation are of strategic importance for the sustainable economic development of the country, its food and environmental security. The Russian Federation has the biggest area of forests - 809,090 ha or 20.1% of the total forest area in the world. Russia's forests provide a decisive contribution to the Millennium Development Goals, especially in achieving environmental sustainability, poverty eradication and empowerment of indigenous peoples.

8.1. Food security

The use of the plant resources is in the first place in terms of the consumption of biological resources is in Russia. It includes the provision of timber and fuel, genetic resources for breeding in agriculture and forestry, functions of "feeding landscape" for the local rural population - permanent and seasonal rural population and indigenous minorities of the North, Siberia, Far East and Caucasus, - recreational , aesthetic, and other functions.

Conservation of forest genetic resources is important for the food security of the country. Hundreds of types of food forest resources and medicinal plants (Table IV.22) grow in the forests of the Russian Federation. They are of great social and economic importance, are widely used by the population in household, and demanded on both domestic and foreign markets. Biological and operational stocks of many of them are significant, and some of them are very large.

The most popular kinds of wild fruit and berry plants are cranberry, cowberry, blueberry, raspberry, cloudberry, swamp blueberry and many others. Mushrooms are very valuable forest food. In Russia there are about 3,000 species of mushrooms, and more than 200 species are edible. In folk (traditional) medicine and scientific medicine about 3,000 species of higher (vascular) plants are used. In scientific medicine of the country of almost 200 species of plants are allowed for the use, 65% of them are wild. Resources of many species of medicinal plants in the forests of Russia are very vast.

Among the wild nut plants the greatest food security value belongs to 3 types of pine trees with the well-known seed called "pine nut": Siberian stone pine (*Pinus sibirica*), Korean pine (*P. koraiensis*) and dwarf pine (*Pinus pumila*). The total area of pine forests in Russia is 40 million hectares. Lon-time average annual biological stock of nuts in these forests is about 1 million tonnes. The area of the middle-aged maturing, mature and over-mature stands of dwarf pine in the territory of the Russian Federation is more than 30 million hectares, the average long-term biological stock of nuts is 2.5-2.6 million tonnes.

One of the important uses of non-timber forest products is gathering of birch juice. In Russia there are about 40 species of birch trees. Weeping birch and white birch are used for the industrial production of juice. The biggest reserves of this resource are concentrated in the Siberian (42.4% of the total stock), Urals (21.7%) and Northwestern (15.5%) Federal Districts.

In many regions of the Russian Federation forest food resource harvesting (fruits, berries, nuts and mushrooms), collection of medicinal plants and selling them to the processors are the main source of livelihood for the rural population and the population of the forest villages.

Forests are intensively used for agriculture, primarily for haying and grazing of livestock, and beekeeping. According to the State Forest Register (01.01.2011), the area of forest pastures is 11 556.5 thousand ha (397.5 thousand hectares in the European-Ural part, 11 159.0 thousand hectares - in the Asian). Forest honey plants are widely used in beekeeping as a source of nectar and pollen. The main types of honey trees and shrubs of the Russian forests are lime (honey productivity of 1000 kg/ha), acacia acacia (up to 800 kg/ha), maples (up to 250 kg/ha), willows (up to 150 kg/ha) and others. The total area occupied by these species of trees is more than 10,000 hectares.

The area of pre-tundra forests and sparse taiga are used in reindeer herding as reindeer pastures. These are primarily suffruticose-sedgy-cotton grass, dwarf birch, grass-moss, willow-herb-moss, lichen-shrub (*Duschekia*, kedrovnikovye, willow moss and lichenous) subarctic tundras and suffruticose-lichen, willow, dwarf pine and grassy sparse forests; in the taiga these are lichen forest types, as well as lowland, transitional and hummocky bog and marsh complexes. The total area of reindeer pastures in the country is more than 300 million hectares.

The forests of the Russian Federation are rich in hunting fauna. The major game species include brown bear - 150-160 thousand individuals, lynx - 20-22 thousand individuals, and elk - 500-600 thousand individuals, wild boar - 250-350 thousand individuals, roe deer - 800-850 thousand individuals, marten - 200-230 thousand individuals, sable - 1.2-1.5 million individuals, hare - 4.5-5.0 million individuals, capercaillie - 3.8-4.0 million individuals, grouse - about 10 million individuals. Hunting for the needs household of and the use of forests for hunting is of great economic and social importance in many regions of the Russian Federation.

Collecting and harvesting of non-timber forest resources and food, medicinal plants, agriculture, hunting and recreational activities in many cases bring in more revenue than timber harvest. The introduction of the rich non-timber forest resources in commercial operation is one of the tasks of the forest sector in the Russian Federation.

8.2. Poverty alleviation and livelihood

About 60,000 large, medium and small businesses located in all regions of the country are engaged into the reproduction and protection of forests, harvesting and processing of timber. In 45 subjects of the Russian Federation the production of paper products makes 10 - 50% of the total of the industrial production volume in these regions. Forest products are widely used in many branches of industry, construction, agriculture, printing, trading etc. The reform of forestry has led to a decrease in the number of forest industry workers (see Figure I.6).

Forest genetic resources have the potential to contribute to hunger and poverty alleviation through satisfying the basic needs and supporting the sustainable development of the forest dependent poor social groups (Table IV.22). In the Russian Federation there is neither poverty issue as is it in the understanding of Asian and African countries, nor the problems of integrated ecosystem management for individual tribes, but there is poverty of forest villages where residents of the North cannot eat properly, have enough warm clothes and heat their homes as their income is less than $ 500 (US dollars).

Traditionally Russians visit places of recreation and tourism located in most of the recreational forest facilities in Russia almost throughout the year. In the summer months recreational load on the forest increases tens or hundreds of times, in particular due to the large-scale gathering of berries and mushrooms, medicinal plants, birch juice, etc. for the household needs. More than 60% of the total forest land area used for various types of recreation and tourism is made up of the protected forests (excluding Forest State Nature Reserves, protected and specially protected areas of national parks, preserve forest areas, etc.), as well as the urban forests. Thus, the total area of forest land used in Russia for various types of recreation and tourism is more than 500 million hectares, or 64% of the total area of forest fund land and the land outside the forest fund.

Indigenous peoples of the North, Siberia and Far East are living in 26 regions of the Russian Federation (Figure III.8.1). The total population of the 160 indigenous peoples is about 240 thousand people. The resettlement of indigenous minorities represents in many ways the same zone as the distribution of boreal forests in Russia.

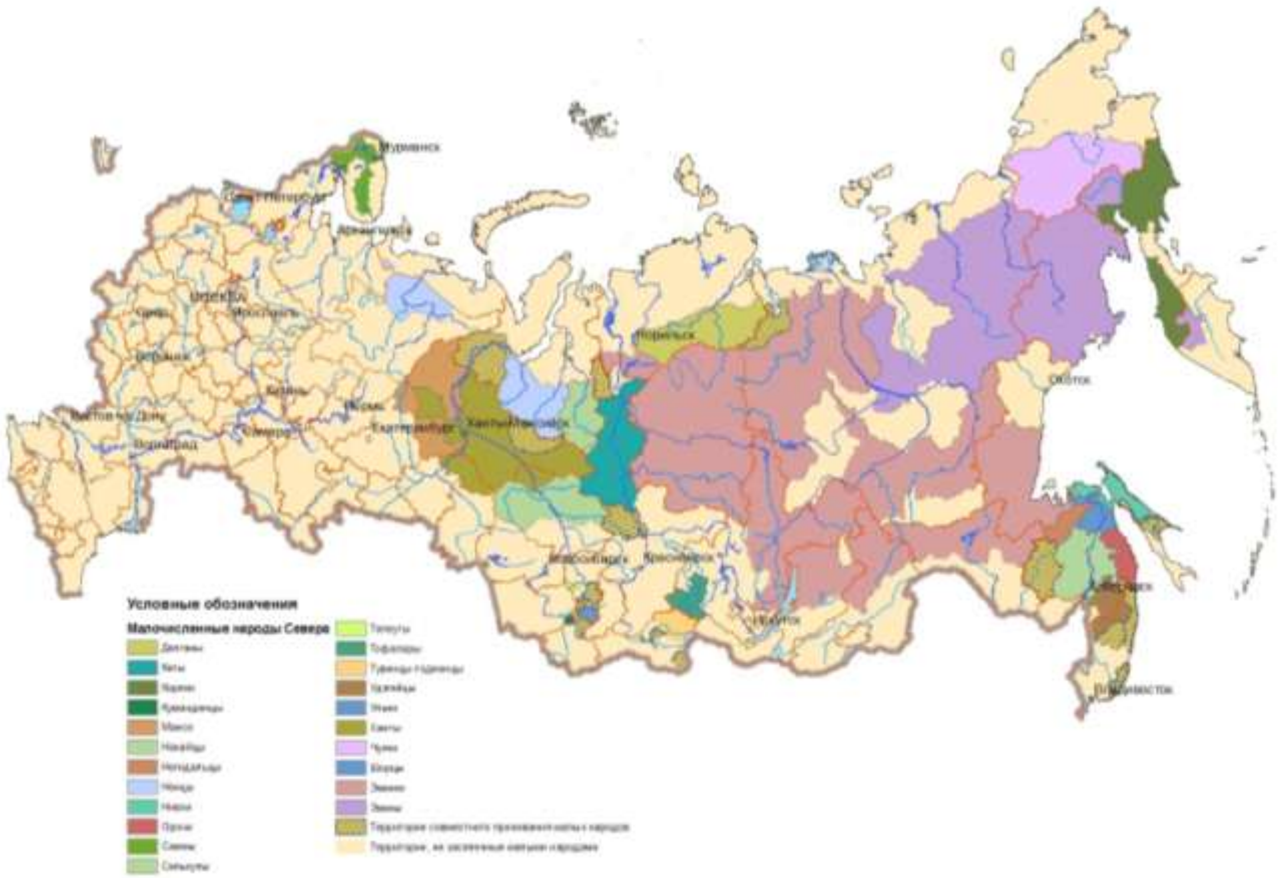


Figure III.8.1. **Resettlement of the minor indigenous peoples of the Russian Federation**
Условные обозначения – Map key
Малочисленные народы Севера – Minor indigenous peoples of the North
Долганы – Dolgans
Кеты – Kets
Коряки – Koryaks
Кумандинцы – Kumandins
Манси – Mansi
Нанайцы – Nanais
Негидальцы – Negidals
Ненцы – Nenets
Орочи – Oroch people
Саамы – Sami
Селькупы – Selkups
Телеуты – Teleuts
Удэгейцы – Udege
Ульчи – Ulchs
Ханты – Khants
Чукчи – Chukchis
Шорцы – Shorians
Эвенки – Evenks
Эвены – Evens
Территории совместно проживающих народов – Territories of the peoples living together
Территории, не заселенные малыми народами – Territories not inhabited by the minor peoples

Indigenous peoples live in dispersed groups and use forests extensively for deer grazing, horse breeding, hunting, wood harvest for traditional livelihood, gathering plants and mushrooms. In addition, forests are located in sacred places and tracts of indigenous peoples related to the worship of ancestral spirits, spirits of patrons. The use of forests by indigenous peoples is complex and extensive, so the space requested by them in the woods as hunting grounds and deer grazing ranges makes up from a few thousand to one million hectares or more. The process of creating the territories of traditional nature use (TTNU) and allocating them for the communities and subnational entities of indigenous peoples was launched in 1990. In 2009 the "Concept of sustainable development of indigenous minorities of the North, Siberia and Far East of the Russian Federation" was approved. Most of the existing TTNU were created on the basis of the regional legislation, and have an extremely poor legal protection. The Association of the indigenous minor peoples of the North, Siberia and Far East has created these information resources: www.ibin.org; www.raipon.org, www.taigarescue.org.

The leasing of the pine nut harvesting zones to the representatives of the indigenous peoples for forest non-timber production ensures the protection and sustainable use of nearly a million acres of the most important pine forests which serves the interests of the local communities and contributes to the conservation of these valuable forests. For example, in 2012 with the support of the World Wildlife Fund and the Forest Service of Primirski Krai, 461 hectares of the Bikin pine nut harvesting zones and water conservation forests were leased to the indigenous peoples' community "Tiger" for 49 years for harvesting of food forest resources, primarily pine nuts.

Forest genetic resources of the Russian Federation are essential for ensuring environmental sustainability and health of the population, have actual or potential value for food and agriculture, and poverty alleviation. In Russia, the measures aimed at forest management of genetic resources contribute to achieving the development goals of the Millennium Declaration.

Chapter IV: Reference Tables

Table IV.1. **Forest characteristics and areas (FRA) (Data of Global forest assesment 2011)**

Forest origin	Area (ha)
Primary forests	260 000 000*
Naturally regenerated forests and nonforested area	582 994 500
Forest stands, open stands, orchards and plantations	20 091 600
TOTAL	**863 086 100**

* expert estimate.

Table IV.2. **Forest ownership and area (Data of Global forest assesment 2011)**

Forest ownership	Area (ha)
Public	863 086 100
Private	0
Others	0

Table IV.3. **Major forest type categories and main tree species in FRA 2000**

EZ Level 2 Major Forest Types	Area (covered by forest type), thousand ha*	Main species for each type	
		Trees	Other species if applicable
EZ Level 1 (FRA 2000) Temperate			
Pelagic forests of temperate zone	15626,76	Cedar, Larch, Oak, Linden, Birch	
Continental forests of temperate zone	32359,68	Pine, Spruce, Birch, Oak, Linden	
Steppe of temperate zone	95488,85	Pine, Oak, Linden, Ash, Maple, Birch	
Desert of temperate zone	331,01	Oak, Ash, Maple	
Mountain system of temperate zone	3928,59	Oak, Beech, Pine, Fir, Ash, Birch, Alder	
EZ Level 1 (FRA 2000) Boreal			
Coniferous forests of boreal zone	588856,4	Spruce, Larch, Pine, Cedar, Fir, Birch, Aspen	
Forest tundra of boreal zone	359637,9	Spruce, Larch, Stone birch, Birch	Siberian dwarf-pine
Mountain systems of boreal zone	87027,64	Larch, Cedar, Fir, Pine, Birch	

* The reference materials are the data of the State Forest Register on the areas of land where forests are located (including forest land, defense and security land, settlement land where forests are located, the land of protected areas and other land categories) as for 01.01.2011

Table IV.3a. **The composition of species, as is common in the statistical reports of the Federal Forestry Agency of the Russian Federation**

The table includes 115 tree and shrub species belonging to 610 species of woody plants (trees, shrubs and vines) of 107 genera of tracheophytes. The list includes 546 native and 64 introduced species of trees.

№	Species	Species
		Coniferous trees
1	Spruce	***Picea abies*** **(L.) Karst.;** ***P. obovata*** **Ledeb.;** ***P. x fennica*** **(Regel) Kom.;** ***P. ajanensis*** **(Lindl. et Gord.) Fisch. ex Carr.**; ***P. orientalis*** (L.) Link; ***P. koraiensis*** Nakai; *P. glehnii* (Fr. Schmidt) Mast.; *P. engelmannii* Engelm.*; *P. pungens* Engelm.*
2	Cedar	***Pinus sibirica*** **Du Tour**; ***P. koraiensis*** **Siebold et Zucc.**; *P. cembra* L.*
3	Larch	***Larix sibirica*** **Ledeb.;** ***L. gmelinii*** **(Rupr.) Kuzen.;** ***L. kamtschatica*** **(Rupr.) Carr.**; ***L. x czekanowskii*** **Szaf.;** ***L. cajanderi*** **Mayr;** *L. x lubarskii* Sukacz.; *L. olgensis* A. Henry; *L. x maritima* Sukacz.; *L. decidua* Mill.*, *L. kaempferi* (Lamb.) Carriere*, *L. x polonica* Racib.*
4	Juniper tree-	*Juniperus excelsa* Bieb.; *J. sabina* L.; *J. foetidissima* Willd.; *J. rigida* Siebold & Zucc.
5	Fir	***Abies sibirica*** **Ledeb;** ***A. nephrolepis*** **(Trautv.) Maxim.;** ***A. nordmanniana*** **(Stev.) Spach;** ***A. sachalinensis*** **Fr. Schmidt;** *A. holophylla* Maxim.; *A. mayriana* (Miyabe et Kudo) Miyabe et Kudo; *A. alba* Mill.*
6	Pine	***Pinus sylvestris*** **L.**; *P. pallasiana* D. Don; *P. densiflora* Siebold et Zucc.; *P. kochiana* Klotzsch ex C. Koch; *P. pityusa* Stev.; *P. x funebris* Kom.; *P. eldarica* Medw.*; *P. pinea* L.*; *P. strobus* L.*, *P. contorta* Dougl. ex Loud.*
7	Thiess	*Taxus baccata* L., *T. cuspidata* Siebold et Zucc. ex Endl.
		Deciduous trees
8	Apricot	*Armeniaca mandshurica* (Maxim.) Skvorts.; *A. sibirica* (L.) Lam.; *A. vulgaris* Lam.*
9	Aralia	*Aralia elata* (Miq.) Seem.
10	Cork tree	*Phellodendron amurense* Rupr.; *Ph. sachalinense* (Fr. Schmidt) Sarg.
11	Birch	***Betula pendula*** **Roth;** ***B. pubescens*** **Ehrh.;** ***B. platyphylla*** **Sukacz.;** ***B. mandshurica*** (Regel) Nakai; *B. kamtschatica* (Regel) Jansson ex V.Vassil.; *B. cajanderi* Sukacz.; *B. korshinskyi* Litv.; *B. demetrii* Ig.Vassil.; *B. krylovii* G. Kryl.; *B. x kusmisscheffii* (Regel) Sukacz.; *B. litwinowii* Doluch.; *B. medwediewii* Regel; *B. microphylla* Bunge; *B. megrelica* Sosn.; *B. prochorowii* Kuzen. & Litv.; *B. raddeana* Trautv.
12	Stone Birch	***Betula ermanii*** Cham.; ***B. davurica*** Pall.; ***B. costata*** Trautv.; ***B. lanata*** (Regel) V. Vassil.; *B. schmidtii* Regel
13	Beech	***Fagus orientalis*** Lipsky; *F. sylvatica* L.
14	Cherry	*Cerasus avium* (L.) Moench.; *C. araxina* Pojark.; *C. maximowiczii* (Rupr.) Kom.; *C. incana* (Pall.) Spach; *C. vulgaris* Mill.*;
15	Elm	***Ulmus glabra*** Huds.; ***U. laevis*** Pall.; ***U. minor*** Mill. (= *U. carpinifolia* Rupr. ex Sukhow); ***U. japonica*** (Rehd.) Sarg.; ***U. laciniata*** (Trautv.) Mayr; *U. pumila* L.; *U. macrocarpa* Hance
16	Honey locust	*Gleditsia caspia* Desf.*; *G. triacanthos* L.*
17	Hornbeam	***Carpinus betulus*** L.; *C. orientalis* Mill. *C. cordata* Blume
18	Pear	*Pyrus communis* L.; *P. caucasica* Fed.; *P. ussuriensis* Maxim.; *P. salicifolia* DC.; *P. elaeagrifolia* Pall.
19	Zelkova	*Zelkova carpinifolia* (Pall.) C. Koch; *Z. serrata* (Thunb.) Makino
20	Oak	***Quercus robur*** **L.;** ***Q. mongolica*** **Fisch. ex Ledeb.;** ***Q. petraea*** **L. ex Liebl.;** *Q. hartwissiana* Stev.; *Q. iberica* Stev.; *Q. pedunculiflora* C. Koch; *Q. dentata* Thunb.; *Q. imeretina* Stev. & Woronow; *Q. crispula* Blume; *Q. pubescens* Willd., *Q. pontica* C. Koch; *Q. rubra* L.*; *Q. suber* L.*
21	Willow tree	***Salix alba*** **L.;** ***S. fragilis*** **L.;** ***S. caprea*** **L.;** ***S. maximowiczii*** **Kom.**; ***S. nipponica*** **Franch. et Savat.**; ***S. rorida*** **Laksch.**; ***S. taraikensis*** **Kimura**; ***S. udensis*** **Trautv. et C.A. Mey.**; *S. pentandra* L.; *S. daphnoides* Vill.; *S. triandra* L.; *S. pseudopentandra* (B. Floder.) B. Floder.; *S. pierotii* Miq.; *S. schwerinii* E. Wolf; *S. babylonica* L.*
22	Kalopanax	*Kalopanax septemlobus* (Thunb.) Koidz.
23	Nettle-tree	*Celtis glabrata* Stev. ex Planch.; *C. caucasica* Willd.
24	Catalpa	*Catalpa speciosa* (Warder ex Barney) Warder ex Engelm.*
25	Chestnut	*Castanea sativa* Mill.

№	Species	Species
26	Maple	***Acer platanoides* L.**; ***A. pseudoplatanus*** L.; ***A. campestre*** L.; ***A. mono*** Maxim.; ***A. ukurunduense*** Trautv. et C.A. Mey; *A. mandshuricum* Maxim.; *A. velutinum* Boiss.; *A. barbinerve* Maxim.; *A. hyrcanum* Fisch. & C.A. Mey.; *A. tegmentosum* Maxim.; *A. komarovii* Pojark.; *A. laetum* C.A. Mey.; *A. microsieboldianum* Nakai; *A. stevenii* Pojark.; *A. trautvetteri* Medw., *A. ginnala* Maxim.; *A. tataricum* L.; *A. ibericum* Bieb.; *A. pictum* Thunb.; *A. pseudosieboldianum* (Pax) Kom.; *A. mayrii* Schwer.; *A. tschonoskii* Maxim.; *A. japonicum* Thunb.; *A. negundo* L.*; *A. turkestanicum* Pax*; *A. saccharum* Marsh.*
27	Lapin	*Pterocarya pterocarpa* (Michx.) Kunth ex I. Iljinsck.
28	Linden	***Tilia cordata* Mill.; *T. amurensis* Rupr.; *T. begoniifolia*** Stev.; ***T. mandshurica*** Rupr.; *T. sibirica* Bayer; *T. taquetii* Schneid.; *T. tomentosa* Moench; *T. platyphyllos* Scop.; *T. euchlora* C.Koch.; *T. dasystyla* Stev.; *T. maximowicziana* Shirasawa; *T. mongolica* Maxim.; *T. x vulgaris* Hayne*(= *T. europeaea* L.*)
29	Magnolia	*Magnolia hypoleuca* Siebold et Zucc.
30	Almonds	*Amygdalus georgica* Desf. ; *A. zangezura* Fed. & Takht.; *A. nana* L.; *A. communis* L.; *A. fenzliana* (Fritsch) Lipsky
31	Alder	***Alnus incana* (L.) Moench; *A. glutinosa* (L.) Gaertn.; *A. hirsuta* (Spach) Turcz. ex Rupr.**; *A. sibirica* (Spach) Turcz. ex Kom.; *A. barbata* C.A. Mey; *A. x pubescens* Tausch.; *A. subcordata* C.A. Mey; *A. japonica* (Thunb.) Steud.
32	Marchurian Walnut	*Juglans mandshurica* Maxim.; *J. ailanthifolia* Carr.; *J. regia* L.*, *J. nigra* L.*
33	Aspen	***Populus tremula* L.**; *P. davidiana* Dode
34	Holly	*Ilex crenata* Thunb.; *I. rugosa* Fr. Schmidt; *I. aquifolium* L.*
35	Sycamore	*Platanus orientalis* L.*
36	Locust	***Robinia pseudoacacia*** L.*
37	Rowan	*Sorbus aucuparia* L.; *S. sibirica* Hedl.; *S. albovii* Zinserl.; *S. amurensis* Koehne; *S. armeniaca* Hedl.; *S. velutina* (Albov) Schneid.; *S. sambucifolia* (Cham. & Schlecht.) M. Roem.; *S. subfusca* (Ledeb.) Boiss.; *S. buschiana* Zinserl.; *S. torminalis* (L.) Crantz.; *S. graeca* (Spach) Lodd. & Schauer; *S. caucasica* Zinserl.; *S. kamtschatcensis* Kom.; *S. colchica* Zinserl.; *S. persica* Hedl.; *S. commixta* Hedl.; *S. schemachensis* Zinserl.; *S. domestica* L.*
38	Haloxylon	*Haloxylon persicum* Bunge ex Boiss. & Buhse.; *H. ammodendron* (C.A. Mey.) Bunge.; *H. aphyllum* (Minkw.) Iljin.
39	Boxwood	*Buxus hyrcana* Pojark.; *B. colchica* Pojark.
40	Plum	*Prunus spinosa* L.; *P. divaricata* Ledeb.; *P. domestica* L.*
41	Poplar	***Populus alba* L.; *P. suaveolens* Fisch.; *P. nigra* L.; *P. koreana* Rehd.; *P. laurifolia* Ledeb.; *P. maximowiczii* A. Henry; *P. x canescens* (Ait.) Smith;** *P. amurensis* Kom.; *P. simonii* Carr.; *P. balsamifera* L.*; *P. italica* (Du Roi) Moench*;
42	Pistachio	*Pistacia mutica* Fisch. & C.A. Mey.
43	Hmelegrab	*Ostrya carpinifolia* Scop.
44	Bird-cherry tree	*Padus avium* Mill.; *P. asiatica* Kom.; *P. maackii* (Rupr.) Kom.; *P. ssiori* (Fr. Schmidt) Schneid.; *P. virginiana* (L.) Mill.*
45	Chosenia	***Chosenia arbutifolia*** (Pall.) A. Skvorts.
46	Mulberry	*Morus alba* L.*; *M. bombycis* Koidz.; *M. nigra* L.*
47	Apple	*Malus orientalis* Uglitzk.; *M. sylvestris* Mill.; *M. mandshurica* (Maxim.) Kom.; *M. praecox* (Pall.) Borkh.; *M. baccata* (L.) Borkh.*; *M. domestica* Borkh.*; *M. prunifolia* (Willd.) Borkh.*
48	Ash	***Fraxinus excelsior* L.**; ***F. mandshurica* Rupr.**; ***F. oxycarpa*** Willd.; *F. angustifolia* Vahl; *F. lanuginosa* Koidz.; *F. rhynchophylla* Hance; *F. americana* L.*; *F. lanceolata* Borkh.*; *F. pennsylvanica* Marsh.*
Coniferous shrubs		
49	Elfin cedar	***Pinus pumila* (Pall.) Regel**
50	Juniper	*Juniperus communis* L.; *J. sibirica* Burgsd.; *J. davurica* Pall.; *J. oblonga* Bieb.; *J. pygmaea* C. Koch; *J. oxycedrus* L.; *J. pseudosabina* Fisch.& C.A. Mey.; *J. conferta* Parl.; *J. isophyllos* C. Koch.; *J. sargentii* (A. Henry) Takeda ex Koidz.
51	Microbiota	*Microbiota decussata* Kom.
Deciduous shrubs and woody vines		

№	Species	Species
52	Actinidia	*Actinidia kolomikta* (Maxim.) Maxim.; *A. arguta* (Sieboldt & Zucc.) Planch. ex Miq.; *A. polygama* (Sieboldt & Zucc.) Miq.
53	Bamboo (Sassa)	*Sasa kurilensis* (Rupr.) Makino & Shibata; *S. spiculosa* (Fr. Schmidt) Makino; *S. megalophylla* Makino et Uchida; *S. depauperata* (Takeda) Nakai; *S. senanensis* (Franch.et Savat.) Rehd.
54	Barberry	*Berberis amurensis* Maxim.; *B. orientalis* Schneid.; *B. densiflora* Boiss. & Buhse; *B. vulgaris* L.; *B. sibirica* Pall.; *B. turcomanica* Kar.
55	Euonymus	*Euonymus verrucosa* Scop.; *E. europaea* L.; *E. macroptera* Rupr; *E. velutina* Fisch. & C.A. Mey.; *E. sieboldiana* Blume; *E. planipes* (Koehne) Koehne; *E. nana* Bieb.; *E. miniata* Tolm.; *E. alata* (Thunb.) Siebold; *E. maackii* Rupr.; *E. maximowicziana* Prokh.; *E. pauciflora* Maxim.; *E. sachalinensis* (Fr. Schmidt) Maxim.; *E. sacrosancta* Koidz.; *E. latifolia* (L.) Mill.
56	Dwarf arctic birch	***Betula middendorffii*** Trautv. et C.A. Mey.; ***B. ovalifolia*** Rupr.; *B. nana* L.; *B. fruticosa* Pall.; *B. fusca* Pall. ex Georgi; *B. tortuosa* Ledeb.; *B. rotundifolia* Spach; *B. divaricata* Ledeb.; *B. humilis* Schrank; *B. exilis* Sukacz.
57	Hawthorn	*Crataegus sanguinea* Pall.; *C. orientalis* Pall. ex Bieb.; *C. dahurica* Koehne ex Schneid.; *C. chlorocarpa* Lenne et C. Koch; *C. chlorosarca* Maxim.; *C. caucasica* C. Koch; *C. curvi-sepala* Lindm.; *C. maximowiczii* Schneid.; *C. microphylla* C. Koch; *C. monogyna* Jacq.; *C. pinnatifida* Bunge; *C. pontica* C. Koch.; *C. pentagyna* Waldst. & Kit.; *C. laevigata* (Poir.) DC.
58	Elder	*Sambucus racemosa* L.; *S. sibirica* Nakai; *S. miquelii* (Nakai) Kom.; *S. nigra* L.; *S. williamsii* Hance; *S. kamtschatica* E. Wolf.; *S. manshurica* Kitag.
59	Weigela	*Weigela middendorffiana* (Carr.) C. Koch; *W. praecox* (Lemoine) Bailey; *W. suavis* (Kom.) Bailey
60	Grapes	*Vitis amurensis* Rupr.; *V. sylvestris* C.C. Gmel.; *V. cognetiae* Pulliat ex Planch.; *V. vinifera* L.*; *V. labrusca* L.*
61	Ampelopsis	*Ampelopsis brevipedunculata* (Maxim.) Trautv.; *A. japonica* (Thunb.) Makino
62	Cherry bush	*Cerasus fruticosa* Pall., *Cerasus tomentosa* (Thunb.) Wall.*
63	Daphne	*Daphne altaica* Pall.; *D. caucasica* Pall.; *D. kamtschatica* Maxim.; *D. mezereum* L.; *D. jezoen-sis* Maxim.
64	Hydrangea	*Hydrangea paniculata* Siebold; *H. petiolaris* Siebold et Zucc.
65	Tamarix	*Tamarix hohenackeri* Bunge; *T. gracilis* Willd.; *T. hispida* Willd.; *T. laxa* Willd.
66	Partenocissus	*Parthenocissus tricuspidata* (Siebold. & Zucc.) Planch.; *P. quinquefolia* (L.) Planch.*; *P. inserta* (A.Kerner) Fritsch*
67	Deutzia	*Deutzia parviflora* Bunge; *D. glabrata* Kom.
68	Thorn	*Lycium barbarum* L.; *L. ruthenicum* Murr.; *L. chinense* Mill.*
69	Derain	*Cornus mas* L.
70	Jerusalem thorn	*Paliurus spina-christi* Mill.
71	Buckwheat (kandim)	*Calligonum aphyllum* (Pall.) Guerke
72	Staff Vine	*Celastrus flagellaris* Rupr.; *C. orbiculata* Thunb.; *C. strigillosa* Nakai.
73	Blackberries and raspberries	*Rubus caesius* L.; *R. nessensis* W. Hall; *R. x castoreus* Laest.; *R. canescens* DC.; *R. caucasi-cus* Focke; *R. hirtus* Waldst. & Kit.; *R. idaeus* L.; *R. crataegifolius* Bunge; *R. komarovii* Nakai; *R. matsumuranus* Levl. & Vaniot
74	Honeysuckle	*Lonicera xylosteum* L.; *L. tatarica* L.; *L. edulis* Turcz. ex Freyn; *L. caerulea* L.; *L. altaica* Pall.; *L. orientalis* Lam.; *L. glehnii* Fr. Schmidt; *L. caprifolium* L.; *L. chrysantha* Turcz. ex Ledeb.; *L. iberica* Bieb.; *L. maackii* (Rupr.) Herd.; *L. maximowiczii* (Rupr.) Regel; *L. microphylla* Willd. ex Schult.; *L. floribunda* Boiss. & Buhse; *L. praeflorens* Batal.; *L. ruprechtiana* Regel; *L. sacha-linensis* (Fr. Schmidt) Nakai ; *L. steveniana* Fisch. ex Pojark.; L. *chamissoi* Bunge ex P. Kir.; *L. hispida* Pall. ex Schult.
75	Zhostera	*Rhamnus cathartica* L.; *Rh. davurica* Pall.; *Rh. diamantiaca* Nakai; *Rh. imeretina* Booth; *Rh. pallasii* Fisch. & C.A. Mey.; *R. ussuriensis* Ja. Vassil.
76	Planch	*Oplopanax elatus* (Nakai) Nakai (= *Echinopanax elatus* Nakai)

№	Species	Species
77	Willow	*Salix acutifolia* Willd.; *Salix cinerea* L.; *S. aurita* L.; *S. dasyclados* Wiim.; *S. viminalis* L.; *S. purpurea* L.; *S. starkeana* Willd. (= *S. livida* Wahlenb.); *S. tenuijulis* Ledeb.; *S. gracilistyla* Miq.; *S. phylicifolia* L.; *S. integra* Thunb.; *S. myrsinifolia* Salisb.; *S. lapponum* L.; *S. alaxensis* Cov.; *S. arctica* Pall.; *S. berberifolia* Pall.; *S. fimbriata* (A. Skvorts.) Czer.; *S. bebbiana* Sarg.; S. *boganidensis* Trautv.; *S. fuscescens* Anderss.; *S. pyrolifolia* Ledeb.; *S. dshugdshurica* A. Skvorts.; *S. jenisseensis* (Fr. Schmidt) B. Floder.; *S. rhamnifolia* Pall.; *S. phlebophylla* Anderss.; *S. recurvigemmis* A. Skvorts.; *S. kimurana* (Miyabe et Tatew.) Miyabe et Tatew.; *S. sphenophylla* A. Skvorts.; *S. hastata* L.; *S. brachypoda* (Trautv. et Mey.) Kom.; *S. brachycarpa* Nutt.; *S. pulchra* Cham.; *S. krylovii* E. Wolf; *S. nummularia* Anderss.; *S. ovalifolia* Trautv.; *S. polaris* Wahlenb.; *S. divaricata* Pall.; *S. reticulata* L.; *S. glauca* L.; *S. saxatilis* Turcz. ex Ledeb.; *S. myrtilloides* L.; *S. caspica* Pall.
78	Shadberry	*Amelanchier ovalis* Medik.; *A. canadensis* (L.) Medik.*; *A. spicata* (Lam.) C Koch*
79	Viburnum	*Viburnum opulus* L.; *V. burejaeticum* Regel & Herd.; *V. sargentii* Koehne; *V. lantana* L.; *V. furcatum* Blume ex Maxim.; *V. wrightii* Miq.; *V. orientale* Pall.; *V. edule* (Michx.) Rafin.; *V. mongolicum* (Pall.) Rehd.; *V. tinus* L.*;
80	Karagan	*Caragana arborescens* Lam.; *C. jubata* (Pallas) Poiret.; *C. spinosa* (L.) Vahl ex Hornem; *C. grandiflora* (Bieb.) DC.; *C. frutex* (L.) C. Koch; *C. mollis* (Bieb.) Bess.; *C. ussuriensis* (Regel) Pojark.
81	Cotoneaster	*Cotoneaster melanocarpus* Fisch. ex Blytt
82	Manchurian Dutchman's -pipe	*Aristolochia manshuriensis* Kom.
83	Bladdernut	*Staphylea colchica* Stev.; *S. pinnata* L.
84	Buckthorn	*Frangula alnus* Mill.
85	Gooseberry	*Grossularia burejensis* (Fr. Schmidt) Berger; *G. acicularis* (Smith) Spach.; *G. reclinata* (L.) Mill.; *G. uva-crispa* (L.) Mill.*
86	Prairieweed	*Pentaphylloides davurica* (Nestl.) Ikonn.; *P. fruticosa* (L.) O. Schwarz; *P. mandshurica* (Maxim.) Sojak; *P. parvifolia* (Fisch. ex Lehm.) Sojak
87	Laurel	*Laurocerasus officinalis* M. Roem.
88	Filbert	*Corylus avellana* L.; *C. heterophylla* Fisch. ex Trautv.; *C. colurna* L.; *C. imeretica* Kem.; *C. colchica* Albov; *C. mandshurica* Maxim.; *C. pontica* C. Koch*; *C. maxima* Miller*
89	Lespedeza	*Lespedeza tomentosa* (Thunb.) Maxim.; *L. davurica* (Laxm.) Schindl.; *L. bicolor* Turcz.; *L. cyrtobotrya* Miq.; *L. juncea* (L. fil.) Pers.
90	Lemongrass	*Schisandra chinensis* (Turcz.) Baill.
91	Goof	*Elaeagnus orientalis* L.; *E. caspica* (Sosn.) Grossh.; *E. angustifolia* L.*; *E. argentea* Pursh*
92	Maack	*Maackia amurensis* Rupr. et Maxim.
93	Magnolia	*Magnolia hypoleuca* Siebold et Zucc.
94	Micromeles alnifolia	*Micromeles alnifolia* (Siebold et Zucc.) Koehne
95	Sea buckthorn	*Hippophaë rhamnoides* L.
96	Alder (alder bush)	***Duschekia fruticosa* (Rupr.) Pouzar, *D. maximowiczii* (Call.) Pouzar.**
97	Princepia	*Princepia sinensis* (Oliv.) Bean
98	Ninebark	*Physocarpus amurensis* (Maxim.) Maxim., *Ph. opulifolius* (L.) Maxim.*
99	Laburnum	*Chamaecytisus ruthenicus* (Fisch. ex Woloszcz.) Klaskova; *Ch. albus* (Hacq.) Rothm.; *Ch. zingeri* (Nenuk. ex Litv.) Klaskova
100	Rhododendron	***Rh. aureum* Georgi;** *Rh. adamsii* Rehd.; *Rh. brachycarpum* D. Don; *Rh. camtschaticum* Pall.; *Rh. caucasicum* Pall.; *Rh. dauricum* L.; *Rh. hypopitys* Pojark.; *Rh. ledebourii* Pojark.; *Rh. luteum* Sweet; *Rh. mucronulatum* Turcz.; *Rh. parvifolium* Adams; *Rh. ponticum* L.; *Rh. redowskianum* Maxim.; *Rh. schlippenbachii* Maxim.; *Rh. sichotense* Pojark.
101	Rosa (rose)	*Rosa acicularis* Lindl.; *R. canina* L.; *R. rugosa* Thunb.; *R. glabrifolia* C.A. Mey. ex Rupr.; *R. iberica* Stev. ex Bieb.; *R. davurica* Pall.; *R. pimpinellifolia* L.; *R. majalis* Herrm.; *R. maximowicziana* Regel; *R. marretii* Levl.; *R. mollis* Smith; *R. oxyodon* Boiss.; *R. oxyacantha* M. Bieb.; *R. laxa* Retz.; *R. amblyotis* C.A. Mey.; *R. x kamtschatica* Vent.; *R. koreana* Kom.; *R. gallica* L.; *R. corymbifera* Borkh.; *R. floribunda* Stev.; *R. villosa* L.
102	Fieldfare	*Sorbaria pallasii* (G. Don fil.) Pojark.; *S. sorbifolia* (L.) A. Br.; *S. rhoifolia* Kom.

№	Species	Species
103	Swida	*Swida alba* (L.) Opiz; *S. sanguinea* (L.) Opiz; *S. australis* (C.A. Mey) Jav.; *S. koenigii* (Schneid.) Pojark. ex Grossh.; *S. sericea* (L.) Holub*
104	Lilac	*Syringa amurensis* Rupr.; *S. reticulata* (Blume) Hara, *S. wolfii* Schneid.; *S. josikaea* Jacq. fil.*; *S. vulgaris* L.*; *S. persica* L.*
105	Sumac	*Cotinus coggygria* Scop.*
106	Currant	*Ribes nigrum* L.; *R. pauciflorum* Turcz. ex Pojark.; *R. alpinum* L.; *R. biebersteinii* Berl. ex DC.; *R. pallidiflorum* Pojark.; *R. orientale* Desf.; *R. dikuscha* Fisch. ex Turcz.; *R. komarovii* Pojark.; *R. procumbens* Pall.; *R. maximoviczianum* Kom.; *R. mandshuricum* (Maxim.) Kom.; *R. meyeri* Maxim.; *R. horridum* Rupr.; *R. triste* Pall.; *R. spicatum* Robson; *R. sachalinense* (Fr. Schmidt) Nakai; *R. atropurpureum* C.A. Mey; *R. ussuriense* Jancz.; *R. latifolium* Jancz.; *R. hispidulum* (Jancz.) Pojark.; *R. glabellum* (Trautv. et C. A. Mey.) Hedl.; *R. fragrans* Pall.; *R. palczewskii* (Jancz.) Pojark.; *R. aureum* Pursh*; *R. odoratum* Wendl.*; *R. rubrum* L.*
107	Spiraea or meadow-sweet	*Spiraea betulifolia* Pall.; *S. beauverdiana* Schneid.; *S. dahurica* (Rupr.) Maxim.; *S. salicifolia* L.; *S. flexuosa* Fisch. ex Cambess; *S. pubescens* Turcz.; *S. media* Fr. Schmidt; *S. ussuriensis* Pojark.; *S. schlothauerae* Ignatov et Worosch.
108	Sumac	*Rhus coriaria* L.
109	Shizophragma	*Schizophragma hydrangeoides* Siebold et Zucc.
110	Eurotia	*Krascheninnikovia ceratoides* (L.) Gueldenst.
11	Toxicodendron orientale	*Toxicodendron orientale* Greene (= *Rhus orientale* (Greene) Schneid.); *T. trichocarpum* (Miq.) O.Kuntze
112	Redbud	*Cercis siliquastrum* L.
113	Philadelphus	*Philadelphus caucasicus* Koehne; *P. tenuifolius* Rupr. & Maxim.; *P. coronarius* L.*; *P. latifolius* Schrad. ex DC.*
114	Exochorda	*Exochorda serratifolia* S. Moore
115	Eleutherococcus (Akantopanax)	*Eleutherococcus sessiliflorus* (Rupr. ex Maxim.) S.Y. Hu (=*Acanthopanax sessiliflorus* (Rupr. Et Maxim.) Seem.); *E. senticosus* (Rupr.et Maxim.) Maxim

*introduced species are marked with asterisk,
****** main forest forming tree species and shrub species are in ***bold italics*** .

Table IV.3b. **List of endemic (and hemiendemic) tree species and shrubs of the Russian Federation ***

Name of species in English	Name of species in Latin	Note
	European part	
Pallasiana pine**	*Pinus pallasiana* D. Don.	Crimean-Novorossiysk endemic
Greenweed	*Genista albida* Willd.	Crimean-Caucasian endemic
Don greenweed	*Genista tanaitica* P.A. Smirn.	Endemic to the South-East of the European part of Russia (Donetsk - Don)
Alaun cotoneaster	*Cotoneaster alaunicus* Golits.	Endemic to the Central Russain Upland
Antoninae cotoneaster	*Cotoneaster antoninae* Juz. ex Orlova	Endemic Fennoscandia
Cotoneaster	*Cotoneaster cinnabarinus* Juz.	Endemic to Russia (East Fennoscandia)
Kola alder	*Alnus kolaensis* Orlova	Endemic to northern Scandinavia and the Kola Peninsula
	Siberia	
Willow	*Salix rhamnifolia* Pallas	Easten Siberia
Cotoneaster	*Cotoneaster lucidus* Schlecht.	Endemic to the Southern Baykal region
Siberian linden	*Tilia sibirica* Bayer	Endemic to Westren Siberia
Almond	*Amygdalus pedunculata* Pall.	Hemiendemic of Southern Siberia
	Far East	
Porokhov birch	*Betula prochorowii* Kuzen. et Litv.	Endemic to Tukuringra

Name of species in English	Name of species in Latin	Note
Kamchatka elder	*Sambucus kamtschatica* E. Wolf	Endemic to the Kamchatka Peninsula
Wiegela	*Wiegela suavis* (Kom.) Bailey.	Endemic to the mountains of the lower Amur River region
Kamchatka daphne	*Daphne kamtschatica* Maxim.	Endemic to the Kamchatka Peninsula
Tolmachev honeysuckle	*Lonicera tolmatchevii* Pojark.	Endemic to Russia (the Sakhalin Island)
Willow	*Salix darpirensis* Jurtz. et Khokhr.	Endemic to south-east of the Cherskogo Range
Willow	*Salix erythrocarpa* Kom.	Endemic to Okhotsk
Magadan willow	*Salix magadanensis* Nedoluzko	Endemic to the northern part of the Okhotsk seashore
Kamchatka larch**	*Larix kamtschatica* (Rupr.) Carr.	Endemic to the Kamchatka Peninsula
Korean Dahurian larch**	*Larix olgensis* A. Henry	Endemic to Southern Primorye
Larch **	*Larix ×maritima* Sukacz.	Endemic to the shore of the Sea of Japan
Microbiota	*Microbiota decussata* Kom.	Endemic to Sikhote Alin. The only endemic genus in the flora of Russia
Sakhalin fir	*Abies sachalinensis var. gracilis* (Kom.) Farjon (= *A. gracilis* Kom.) ***	Endemic to the Kamchatka Peninsula
Sikhote rhododendron	*Rhododendron sichotense* Pojark.	Local Endemic to (Sikhote Alin)
Kamchatka ash	*Sorbus kamtschatcensis* Kom.	Endemic to the Kamchatka Peninsula
False spiraea	*Sorbaria rhoifolia* Kom.	Local Endemic to (Sikhote Alin)
Podznjakov sorbocotoneaster	*Sorbocotoneaster pozdnjakovii* Pojark.	Endemic to Russia (south of Yakutia). (Aldan river) and the northern part of the Khabarovsk Territory (Uda river). The only species of spontaneous hybridogeneous genus.
Currant	*Ribes fontaneum* Boczkarn.	Endemic to Sikhote Alin
Schlothauer spiraea	*Spiraea schlothauerae* Ignatov et Worosch.	Local Endemic to Badzhal
Kamchatka dogrose	*Rosa x kamtschatica* Vent.	Endemic of the Kamchatka Peninsula
	Caucasus	
Barberry	*Berberis iberica* Stev. et Fisch. ex DC.	Endemic of Caucasus
Litvinov irch	*Betula litwinowii* Doluch (Syn. *B. recurvata* Ig. Vassil.)	Endemic of Caucasus
Raddea birch	*Betula raddeana* Trautv.	Endemic to Central and Eastern Caucasus
Oak	*Quercus iberica* Stev.	Endemic of Caucasus
Oak	*Quercus imeretina* Stev. & Woronow	Endemic of Caucasus
Albov daphne	*Daphne alboviana* Woronow ex Pobed.	Endemic of Western Caucasus
Baksan daphne	*Daphne baksanica* Pobed.	Local Endemic (Central Caucasus)
Caucasus daphne	*Daphne caucasica* Pall.	Endemic of Caucasus
Daphne	*Daphne circassica* Woronow ex Pobed.	Local Endemic of Caucasus
Daphne	*Daphne glomerata* Lam.	Endemic of Caucasus
Daphne	*Daphne pseudoserica* Pobed.	Endemic of Western Caucasus
Voronov daphne	*Daphne woronowii* Kolak.	Endemic of Western Transcaucasia
Plum	*Prunus divaricata* Ledeb. subsp. caspica Browicz	Endemic of Eastern Caucasus
Caucasus pear	*Pyrus caucasica* Fed.	Endemic of Caucasus
Georgian pear	*Pyrus georgica* Kuth.	Endemic of Caucasus
Grossheim pear	*Pyrus grossheimii* Fed.	Endemic of Eastern Caucasus
Sakhokia pear	*Pyrus sachokiana* Kuth.	Endemic of Caucasus
Pear	*Pyrus salicifolia* Pall.	Endemic of Caucasus

Name of species in English	Name of species in Latin	Note
Hawthorn	*Crataegus caucasica* C. Koch	Endemic of Caucasus
Hawthorn	*Crataegus eriantha* Pojark.	Endemic of Caucasus
Greenweed	*Genista abchasica* Sachok.	Endemic of Western Transcaucasia
Greenweed	*Genista angustifolia* Schischk.	Endemic of Western Caucasus
Greenweed	*Genista compacta* Schischk.	Endemic of Western Caucasus
Greenweed	*Genista humifusa* L.	Endemic of Western Caucasus and Western Transcaucasia
Kolakovski greenweed	*Genista kolakowskyi* Sachok.	Endemic of Western Transcaucasia
Lipski greenweed	*Genista lypskyi* Novopokr.	Endemic of Western Transcaucasia
Greenweed	*Genista suanica* Schischk.	Endemic of Western Transcaucasia
Oriental spruce	*Picea orientalis* (L.) Link	Endemic of Caucasus
Buckthorn	*Rhamnus depressa* Grub.	Endemic of Caucasus
Buckthorn	*Rhamnus imeretina* Booth	Endemic of Caucasus
Buckthorn	*Rhamnus microcarpa* Boiss.	Endemic of Caucasus
Buckthorn	*Rhamnus pallasii* Fisch. & C.A. Mey.	Endemic of Caucasus
Buckthorn	*Rhamnus spathulifolia* Fisch. et C.A. Mey.	Endemic of Caucasus
Honeysuckle	*Lonicera buschiorum* Pojark.	Endemic of Caucasus
Honeysuckle	*Lonicera steveniana* Fisch. ex Pojark.	Endemic of Caucasus
Kazbek willow	*Salix kazbekensis* A.K. Skvorts.	Endemic of Greater Caucasus
Kikodze willow	*Salix kikodseae* Goerz	Endemic of Western Transcaucasia
Kuznetsov willow	*Salix kuznetzowii* Laksch. ex Goerz	Endemic of Caucasus
Willow	*Salix pantosericea* Goerz	Endemic of Caucasus
Cotoneaster	*Cotoneaster morulus* Pojark.	Endemic of Caucasus
Cotoneaster	*Cotoneaster nefedovii* Galushko	Endemic of Central Caucasus
Cotoneaster	*Cotoneaster saxatilis* Pojark.	Endemic of Caucasus
Cotoneaster	*Cotoneaster soczavianus* Pojark.	Endemic of Caucasus
Dutchman's pipe	*Aristolochia iberica* Fisch. et C.A. Mey. ex Boiss.	Endemic of Transcaucasia
Dutchman's pipe	*Aristolochia steupii* Woronow	Endemic of Western Caucasus
Maple	*Acer ibericum* Bieb.	Endemic of Eastern Caucasus
Maple	*Acer laetum* C.A. Mey.	Endemic of Caucasus
Maple	*Acer sosnowskyi* Doluch.	Endemic of Western Transcaucasia
Colchis bladdernut	*Staphylea colchica* Stev.	Endemic of Caucasus
Bearded alder	*Alnus barbata* C.A. Mey.	Endemic of Caucasus
Holly	*Ilex stenocarpa* Pojark.	Endemic of Caucasus
Caucasian fir	*Abies nordmanniana* (Stew.) Spach	Endemic of Caucasus
Broom	*Chamaecytisus hirsutissimus* (C. Koch) Czer.	Endemic of Western Caucasus and Western Transcaucasia
Caucasian rhododendron	*Rhododendron caucasicum* Pall.	Endemic of Caucasus
Sorbus	*Sorbus armeniaca* Hedl.	Endemic of Caucasus
Sorbus	*Sorbus buschiana* Zinserl.	Endemic of Caucasus
Sorbus	*Sorbus caucasica* Zinserl.	Endemic of Caucasus
Sorbus	*Sorbus colchica* Zinserl.	Endemic of Western Caucasus and Western Transcaucasia
Sorbus	*Sorbus fedorovii* Zaikonn.	Endemic of Caucasus
Sorbus	*Sorbus hajastana* Gabr.	Endemic of Caucasus
Sorbus	*Sorbus migarica* Zinserl.	Endemic of Caucasus
Sorbus	*Sorbus subfusca* (Ledeb.) Boiss.	Endemic of Caucasus

Name of species in English	Name of species in Latin	Note
Sorbus	*Sorbus velutina* (Albov) Schneid.	Endemic of Caucasus
Dogwood	*Swida koenigii* (C.K. Schneid.) Pojark. ex Grossh.	Endemic of Western Transcaucasia
Pitsunda pine**	*Pinus pityusa* Stev.	Endemic of Caucasus
Caucasian currant	*Ribes caucasicum* Bieb.	Endemic of Caucasus
Caucasian mock orange	*Philadelphus caucasicus* Koehne	Endemic of Caucasus
Dog-rose	*Rosa awarica* Gussejnov	Endemic of Eastern Caucasus
Dog-rose	*Rosa balcarica* Galushko	Endemic of Central Caucasus
Dog-rose	*Rosa borissovae* Chrshan.	Endemic of Western Caucasus
Dog-rose	*Rosa brotherorum* Chrshan.	Endemic of Central and Eastern Cauca-sus
Dog-rose	*Rosa buschiana* Chrshan.	Endemic of Caucasus
Dog-rose	*Rosa valentinae* Galushko	Endemic of Central Caucasus
Dog-rose	*Rosa altidaghestanica* Gussejnov	Endemic of Eastern Caucasus
Dog-rose	*Rosa galushko* Demurova	Endemic of Central Caucasus
Dog-rose	*Rosa darginica* Gussejnov	Endemic of Eastern Caucasus
Dog-rose	*Rosa adenophylla* Galushko	Endemic of Central Caucasus
Dog-rose	*Rosa zaramagensis* Demurova	Endemic of Central Caucasus
Dog-rose	*Rosa irinae* Demurova	Endemic of Central Caucasus
Dog-rose	*Rosa kamelinii* Gussejnov	Endemic of Eastern Caucasus
Dog-rose	*Rosa kossii* Galushko	Endemic of Central Caucasus
Dog-rose	*Rosa marschalliana* Sosn.	Endemic of Caucasus
Dog-rose	*Rosa nisami* Sosn.	Endemic of Eastern Caucasus
Dog-rose	*Rosa uniflora* Galushko	Endemic of Caucasus
Dog-rose	*Rosa pubicaulis* Galushko	Endemic of Western Caucasus
Dog-rose	*Rosa oxyodon* Boiss.	Endemic of Caucasus
Dog-rose	*Rosa subbuschiana* Gussejnov	Endemic of Eastern Caucasus
Dog-rose	*Rosa prilipkoana* Sosn.	Endemic of Caucasus
Dog-rose	*Rosa praetermissa* Galushko	Endemic of Central Caucasus
Dog-rose	*Rosa prokhanovii* Galushko	Endemic of Central Caucasus
Dog-rose	*Rosa sachokiana* P. Jarosch.	Endemic of Caucasus
Dog-rose	*Rosa obtegens* Galushko	Endemic of Central and Eastern Cauca-sus
Dog-rose	*Rosa oplisthes* Boiss.	Endemic of Caucasus
Dog-rose	*Rosa teberdensis* Chrshan.	Endemic of Caucasus
Dog-rose	*Rosa terscolensis* Galushko	Endemic of Central Caucasus
Dog-rose	*Rosa tlaratensis* Gussejnov	Endemic of Eastern Caucasus
Dog-rose	*Rosa tuschetica* Boiss.	Endemic of Central and Eastern Cauca-sus
Dog-rose	*Rosa dolichocarpa* Galushko	Endemic of Central Caucasus
Dog-rose	*Rosa usischensis* Gussejnov	Endemic of Eastern Caucasus
Dog-rose	*Rosa khasautensis* Galushko	Endemic of Central Caucasus
Dog-rose	*Rosa tchegemensis* Galushko	Endemic of Central Caucasus
Dog-rose	*Rosa tscherekensis* (Galushko) Galushko	Endemic of Central Caucasus
Dog-rose	*Rosa cziragensis* Gussejnov	Endemic of Eastern Caucasus
Dog-rose	*Rosa hirtissima* Lonacz.	Endemic of Caucasus
Sumach ash	*Fraxinus coriariifolia* Scheele	Endemic of Eastern Caucasus

* The range and volume of species are in line with the summary given in "Vascular Plants of Russia and Boardering States" by S. K. Cherepanov (1995). The exception is the two species (Far East): Magadan willow - the species described rather recently and included in the Red Book of the Magadan Region (2008).

** Species with available molecular genetic data.

*** The scientific name used in the original paper is given in parentheses.

Table IV.3c. **List of interspecific hybrids of woody plants of the Russian Federation (by Koropachinsky, Milutin, 2006, as amended)**

Interspecific hybrid	Marker*	Source
Pinus L. – Pine		
Pinus x *funebris* Kom. (*P. sylvestris* L. x *P. densiflora Siebold et Zucc.*)**	az	Potenko, Popkov, 2003; Potenko, 2003
Pinus sibirica Du Tour x *P. pumila* (Pall.) Regel. **	az, mt	Politov et al., 1999; Goroshkevich et al., 2007, 2010; Petrova et al., 2007, 2010, 2012; Goroshkevich et al., 2008, 2009; Petrova et al., 2008
Picea A. Dietr – Spruce		
Picea abies (L.) Karst. x *P. obovata* Ledeb.	az, nSSR	Krutovskii, Bergmann, 1995; Politov, Krutovskii, 1998; Goncharenko, Padutov, 1999
P. obovata Ledeb x *P. ajanensis* (Lindl. et Gord.) Fisch. ex Carr.		
P. obovata Ledeb x *P. koraiensis* Nakai	az	Potenko, 2007; Politov et al., 2011
P. ajanensis (Lindl. et Gord.) Fisch. ex Carr. x *P. koraiensis* Nakai		
Larix Mill. – Larch		
Larix gmelinii (Rupr.) Kuzen. x *L. sibirica* Ledeb.	az, cp, mt	Semerikov, 2007
Larix gmelinii (Rupr.) Kuzen. x *L. cajanderi* Mayr	az, cp, mt	Semerikov, 2007
Larix gmelinii (Rupr.) Kuzen. x *L. gmelinii var. japonica (Maxim. ex Regel) Pilg. (=L. kurilensis)****		
Larix gmelinii (Rupr.) Kuzen. x *L. olgensis* A. Henry	az, cp, mt	Semerikov, 2007
L. cajanderi Mayr x *L. gmelinii var. japonica (Maxim. ex Regel) Pilg.* (Rupr.) Carr. (=*L. kurilensis)*		
L. gmelinii var. japonica (Maxim. ex Regel) Pilg. (=*L. kurilensis)* x *L. olgensis* A. Henry		
Betula L. – Birch		
Betula pendula Roth x *B. ermanii* Cham.		
B. ermanii Cham. x *B. divaricata* Ledeb.		
Betula pendula Roth x *B. microphylla* Bunge		
Alnus Mill. – Alder		
Alnus glutinosa (L.) Gaertn. x *A. incana* (L.) Moench		
Alnus kolaënsis Orlova x *A. incana* (L.) Moench**	rDNA-ITS2	Ilyinskii et al., 2006
A. japonica (Thunb.) Steud. x *A. incana* (L.) Moench		
A. japonica (Thunb.) Steud. x *A. hirsuta* (Spach) Turcz. ex Rupr.		
A. subcordata C.A. Mey. x *A. incana* (L.) Moench		
Populus L. – Poplar		
Populus alba L. x *P. tremula* L.		
P. laurifolia Ledeb. x *P. nigra* L.		
P. suaveolens Fisch. x *P. laurifolia* Ledeb		
Salix L. – Willow		
Salix starkeana Willd. x *S. bebbiana* Sarg.		

Interspecific hybrid	Marker*	Source
S. alba L. x *S. fragilis* L.		
S. viminalis L. x *S. phylicifolia* L.		
S. hastata L.x *S. phylicifolia* L.		
S. repens L. x *S. rosmarinofolia* L.		
S. alba L. x *S. excelsa* S.G. Gmelin		
S. viminalis L. x *S. caprea* L.		
S. myrsinifolia Salisb. x *S. phylicifolia* L.		
S. reptans Rupr. x *S. nummularia* Anders		
S. arbuscula L. x *S. phylicifolia* L.		
S. phylicifolia L. x *S. reptans* Rupr.		
S. phylicifolia L. x *S. cinerea* L.		
S. phylicifolia L. x *S. viminalis*		
S. phylicifolia L. x *S. dasyclados* Wimm.		
S. phylicifolia L. x *S. hastata* L.		
S. phylicifolia L. x *S. jenisseensis* (Fr. Schmidt) B. Floder.		
S. lapponum L. x *S. myrtilloides*		
S. lapponum L. x *S. aurita*		
S. myrsinifolia Salisb. x *S. cinerea* L.		
S. glauca L. x *S. phylicifolia* L.		
S. glauca L. x *S. arctica* Poll.		
S. dasyclados Wimm. x *S. caprea* L.		
S. dasyclados Wimm. x *S. cinerea* L.		
S. lanata L. x *S. herbacea* L.		
S. cinerea L. x *S. myrsinifolia* Salisb.		
S. aurita L. x *S. reptans* Rupr.		
S. pyrolifolia Ledeb. x *S. myrsinifolia* Salisb.		
S. pyrolifolia Ledeb. x *S. jenisseensis* (Fr. Schmidt) B. Floder		
S. cinerea L. x *S. vinogradovii* A. Skv.		
S. lapponum L. x *S. caprea* L.		
S. triandra L. x *S. dasyclados* Wimm.		
S. viminalis L. x *S.pulchra* Cham.		
S. viminalis L. x *S. miyabeana* Seemen.		
S. abscondita Laksch. x *S. dasyclados* Wimm.		
S. tschuktschorum A. Skv. x *S. saxalitis* Turcz. ex Ledeb.		
S. pulchra Cham. x *S. polaris*		
S. fuscescens Anderss. x *S. pulchra* Cham.		
S. fuscescens Anderss. x *S. arctica* Cham.		
S. fuscescens Anderss. x *S. udensis* Trautv. et Mey.		
S. dasyclados Wimm. x *S. miyabeana* Seemen		
S. berberifolia Pall. x *S. saxatilis Turcz. ex Ledeb.*		
S. arctica Pall. x *S. chamissonis* Anderss.		
S. arctica Pall. x *S. phlebophylla* Anderss.		
S. alaxensis Coville x *S. pulchra* Cham.		
S. krylovii E. Wolf. x *S. glauca* L.		
S. pentandra L. x *S. pseudopentandra* Flod.		
S. alatavica Kar. et Kir. ex Stschegl. x S. *arctica* Pall.		
S. reptans Rupr. x *S. glauca* L.		

Interspecific hybrid	Marker*	Source
S. hultenii Floder. x *S. gracilistyla* Miq.		
S. caprea L. x *S. schwerinii* E. Wolf		
S. integra Thunb. x *S. caprea* L.		
S. brachypoda (Trautv. et Mey.) Kom. x *S. integra* Thunb.		
Quercus L. – Oak		
Quercus robur L. x *Q. pubescens* Willd.		
Quercus robur L. x *Q. petraea* (Mattuschka) Liebl.		
Q. dentata Thunb. x *Q. mongolica* Fisch. ex Ledeb.	az	Potenko et al., 2007
Q. crispula Blume x *Q. mongolica* Fisch. ex Ledeb.		
Ulmus L. – elm		
Ulmus pumila L. x *U. macrocarpa* Hance		
U. pumila L. x *U. japonica* (Rehd.) Sarg.		
U. macrocarpa Hance x *U. japonica* (Rehd.) Sarg.		
Malus Mill. – Apple tree		
Malus pumila Mill. x *M. baccata* (L.) Borkh.		
M. prunifolia (Willd.) Borkh. x *M. baccata* (L.) Borkh.		
Tilia L. – Linden		
Tilia taquetii C.K.Schneid x *T. amurensis* Rupr.		
Fraxinus – Ash		
Fraxinus rynchophylla Hance x *F. mandschurica* Rupr.		

* There are cases of confirming hybridity by using molecular genetic markers: az - allozymes, mt - mitochondrial DNA, cp - chloroplast DNA, nSSR - nuclear microsatellite loci, rDNA-ITS2 - internal transcribed spacer of ribosomal DNA.
** Cases of hybridization, not mentioned in the summary (Koropachinsky, Milutin, 2006).
*** The scientific name used in the original paper is given in parentheses.

Table IV.3d. **Levels of inter-population genetic subdivision of tree species populations in the Russian Federation according to molecular genetic markers**

Region	Genus	Species	Marker	Indicator ce	N_p	N_{ind}	$N_{ind}cp$	N_l	F_{ST}	Source
Ural	*Pinus*	*sylvestris*	allozymes	F_{ST}	11	758	68,9	13	0,021	Shigapov et al., 1997
Ural	*Pinus*	*sylvestris*	allozymes	F_{ST}	84	3482	41,5	18	0,029	Yanbayev, 2002
Eastern Europe, Siberia	*Pinus*	*sylvestris*	allozymes	F_{ST}	26	770	29,6	21	0,028	Goncharenko, Silin, 1997
Eastern Europe, Siberia	*Pinus*	*sylvestris*	allozymes	G_{ST}	26	770	29,6	21	0,034	Goncharenko, Silin, 1997
Trans-Urals	*Pinus*	*sylvestris*	allozymes	F_{ST}	5	157	31,4	15	0,016	Belokon et al., 1998
Primorye	*Pinus*	*sylvestris*	allozymes	F_{ST}	4			24	0,064	Potenko 2003
East of the Russian Plain	*Pinus*	*sylvestris*	allozymes	F_{ST}	4	200	50,0	13	0,024	Filippova et al., 2006
Western Siberia - Turgay	*Pinus*	*sylvestris*	allozymes	F_{ST}	10	500	50,0	13	0,024	Filippova et al., 2006
Trans-Urals	*Pinus*	*sylvestris*	allozymes	F_{ST}	8	400	50,0	13	0,013	Filippova et al., 2006
Ural mountains	*Pinus*	*sylvestris*	allozymes	F_{ST}	11	550	50,0	13	0,031	Filippova et al., 2006
Ural mountains and ajoining territories	*Pinus*	*sylvestris*	allozymes	F_{ST}	33	1650	50,0	13	0,029	Filippova et al., 2006
Russia	*Pinus*	*sylvestris*	allozymes	F_{ST}	24	811	30,9	13	0,081	Semerikov, 1991
Western Siberia, wet moor - dryland	*Pinus*	*sylvestris*	allozymes	F_{ST}	14	602	43,0	14	0,030	Sannikov, Petrova, 2003
Eastern Europe, wet moor - dryland	*Pinus*	*sylvestris*	allozymes	F_{ST}	10	365	36,5	14	0,040	Sannikov, Petrova, 2003
Ukranian Carpathians, mountain-piedmont	*Pinus*	*sylvestris*	allozymes	FST	10	409	40,9	14	0,072	Sannikov, Petrova, 2003
Nothern Caucasus	*Pinus*	*sylvestris*	allozymes	F_{ST}	5	203	40,6	13	0,022	Sannikov, Petrova, 2003
Western Siberia, dryland	*Pinus*	*sylvestris*	allozymes	F_{ST}	10	447	44,7	14	0,028	Sannikov, Petrova, 2003
Western Siberia, wet moor	*Pinus*	*sylvestris*	allozymes	F_{ST}	8	240	30	16	0,028	Larionova, Ekart 2010
Primorye	*Pinus*	*x funebris*	allozymes	F_{ST}	5			24	0,098	Potenko 2003
Primorye	*Pinus*	*densiflora*	allozymes	F_{ST}	3			24	0,030	Potenko 2003
Siberia	*Pinus*	*sibirica*	allozymes	F_{ST}	9	107	11,9	20	0,040	Goncharenko, Silin, 1997
Siberia	*Pinus*	*sibirica*	allozymes	G_{ST}	9	107	11,9	20	0,042	Goncharenko, Silin, 1997
Tomsk region, Altai, Western Sayans	*Pinus*	*sibirica*	allozymes	F_{ST}	11			15	0,025	Politov et al., 1992; Politov, 2007
Baikal region	*Pinus*	*sibirica*	allozymes	F_{ST}	20			22	0,044	Politov, 1998; 2007
Siberia	*Pinus*	*sibirica*	nuclear microsatellites	F_{ST}	6			5	0,085	Mudrik et al., 2010

Region	Genus	Species	Marker	Indicator ce	N_p	N_{ind}	$N_{ind}cp$	N_l	F_{ST}	Source
Far East	*Pinus*	*koraiensis*	allozymes	F_{ST}	17	889	52,3	23	0,018	Velikov, Potenko, 2006
Far East	*Pinus*	*koraiensis*	allozymes	G_{ST}	17	889	52,3	23	0,021	Velikov, Potenko, 2006
Far East, China, Korea	*Pinus*	*koraiensis*	allozymes	F_{ST}	14			23	0,018	Belokon, 2007, Politov, 2007
Sakhalin, Chukotka	*Pinus*	*pumila*	allozymes	F_{ST}	5	63	12,6	22	0,043	Goncharenko et al., 1993
Sakhalin, Chukotka, Iturup	*Pinus*	*pumila*	allozymes	F_{ST}	5	78	15,6	20	0,049	Goncharenko, Silin, 1997
Sakhalin, Chukotka, Iturup	*Pinus*	*pumila*	allozymes	G_{ST}	5	78	15,6	20	0,051	Goncharenko, Silin, 1997
Baikal region	*Pinus*	*pumila*	allozymes	F_{ST}	12			32	0,073	Malyuchenko et al., 1998
Area in the boaders of Russia	*Pinus*	*pumila*	allozymes	F_{ST}	29			28	0,080	Politov, 2007
Primorye, Kamchatka, Baikal region	*Pinus*	*pumila*	allozymes	F_{ST}	3	75	25,0	16	0,050	Nakonechnaya et al., 2010
Easten Siberia and Far East	*Picea*	*ajanensis*	allozymes	F_{ST}	5	94	18,8	25	0,030	Goncharenko, Padutov, 1999
Central, Western and Eastern Europe, Ural, Siberia	*Picea*	*abies & obovata*	allozymes	F_{ST}	10	n/a		25	0,095	Krutovskii, Bergmann, 1995
Central, Western and Eastern Europe, Ural, Siberia	*Picea*	*abies & obovata*	allozymes	F_{ST}	11				0,080	Politov, Krutovskii, 1998; Politov, 2007
Eastern Europe, Ural, Siberia	*Picea*	*abies & obovata*	nSSR	F_{ST}	5			4	0,122	Mudrik et al., 2010; Zhulina et al., 2012
Eastern Europe	*Picea*	*abies & obovata*	allozymes	F_{ST}	5	281	56,5	12	0,081	Nakvasina et al., 2008
Central, Western and Eastern Europe, Ural, Siberia	*Picea*	*obovata*	allozymes	F_{ST}	14	518	37,0	14	0,039	Yanbayev, 2002; Yanbayev et al., 1997
Central Siberia	*Picea*	*obovata*	allozymes	F_{ST}	13			22	0,029	Larionova et al., 2007
Western and Central Siberia	*Picea*	*obovata*	allozymes	F_{ST}	4			25	0,052	Goncharenko, Padutov, 1999
Western and Central Siberia	*Picea*	*obovata*	allozymes	G_{ST}	4			25	0,061	Goncharenko, Padutov, 1999
Easten Siberia and Far East	*Picea*	*ajanensis*	allozymes	G_{ST}	5	94	18,8	25	0,032	Goncharenko, Padutov, 1999
Easten Siberia and Far East	*Picea*	*ajanensis* (=*P. jezoensis*)*	allozymes	F_{ST}	9	282	35,3	20	0,024	Potenko & Knysh 2003
Easten Siberia, Far East, Kamchatka	*Picea*	*ajanensis* (=*P. jezoensis*)	allozymes	F_{ST}	12	377	31,4	20	0,076	Potenko 2007
Sakhalin	*Picea*	*glehnii*	allozymes	F_{ST}	3	35	11,7	25	0,029	Goncharenko, Padutov, 1999
Sakhalin	*Picea*	*glehnii*	allozymes	G_{ST}	3	35	11,7	25	0,030	Goncharenko, Padutov, 1999
Western Sayans	*Abies*	*sibirica*	allozymes	F_{ST}	3			19	0,042	Larionova, Ekart, 2005
Central Siberia	*Abies*	*sibirica*	allozymes	F_{ST}	9			7	0,052	Larionova et al., 2007
Tomsk region	*Abies*	*sibirica*	allozymes	F_{ST}	5			20	0,015	Larionova, Ekart, 2012

Region	Genus	Species	Marker	Indicator ce	N_p	N_{ind}	$N_{ind}cp$	N_l	F_{ST}	Source
Ural, Siberia	*Abies*	*sibirica*	allozymes	F_{ST}	22	1119		3	0,102	Semerikova, Semerikov, 2006
Ural, Siberia	*Abies*	*sibirica*	allozymes	F_{ST}	38	1832	48,2	3	0,087	Semerikova et al., 2011
Ural, Siberia	*Abies*	*sibirica*	chloroplast mi-crosatellites	R_{ST}	32	41		2	0,081	Semerikova et al., 2011
Ural, Siberia	*Abies*	*sibirica*	chloroplast mi-crosatellites	AMOVA	29			2	0,037	Semerikova, Semerikov, 2007
Sakhalin, Kunashir	*Abies*	*sachalinensis*	allozymes	F_{ST}	12	342	27,0	8	0,090	Semerikova et al., 2011
Sakhalin, Kunashir	*Abies*	*sachalinensis*	chloroplast mi-crosatellites	R_{ST}	11	305	27,7	2	0,029	Semerikova et al., 2011
Sakhalin, Kunashir	*Abies*	*sachalinensis*	chloroplast mi-crosatellites	AMOVA	7			2	0,017	Semerikova, Semerikov, 2007
Far East	*Abies*	*nephrolepis*	allozymes	F_{ST}	5	167	33,4	6	0,039	Semerikova et al., 2011
Far East	*Abies*	*nephrolepis*	chloroplast mi-crosatellites	R_{ST}	4	142	35,5	2	0,090	Semerikova et al., 2011
Far East	*Abies*	*nephrolepis*	chloroplast mi-crosatellites	AMOVA	3				0,148	Semerikova, Semerikov, 2007
Siberia	*Abies*	*sibirica*	AFLP	F_{ST}	20			117	0,140	Semerikova, Semerikov, 2011
Siberia , Far East	*Abies*	*sibirica, nephro-lepis, sacha-linensis*	AFLP	F_{ST}	23			117	0,530	Semerikova, Semerikov, 2011
Ural	*Larix*	*sibirica (=L. sukaczewi)*	allozymes	F_{ST}	12	452	37,7	13	0,064	Yanbayev, 2002
Ural	*Larix*	*sibirica (=L. sukaczewi Ural population)*	allozymes	F_{ST}	20	570	28,5	10	0,064	Putenikhin et al., 2004
Central Siberia	*Larix*	*sibirica*	allozymes	F_{ST}	6			14	0,076	Larionova et al., 2007
Krasnoyarsk Territory, Taimyr	*Larix*	*sibirica*	allozymes	F_{ST}	7			15	0,070	Larionova, Oreshkova, 2010
Siberia	*Larix*	*sibirica*	allozymes	F_{ST}	15			12	0,079	Semerikov et al., 1999
Krasnoyarsk Territory, Tyva	*Larix*	*sibirica*	allozymes	F_{ST}	8	233	29,1	15	0,038	Oreshkova, 2010
Chita region, Evekiya	*Larix*	*gmelinii*	allozymes	F_{ST}	4	106	26,5	17	0,079	Oreshkova et al., 2006
Easten Siberia	*Larix*	*gmelinii*	allozymes	F_{ST}	6			11	0,021	Semerikov et al., 1999
Chita region	*Larix*	*gmelinii*	allozymes	F_{ST}	3			15	0,020	Larionova, Oreshkova, 2010
Yakutia, Magadan region	*Larix*	*cajanderi*	allozymes	F_{ST}	5			14	0,152	Larionova, Oreshkova, 2010
North-East of Asia	*Larix*	*spp.*	allozymes	F_{ST}					0,202	Semerikov et al., 1999

Region	Genus	Species	Marker	Indicator ce	N_p	N_{ind}	$N_{ind}cp$	N_l	F_{ST}	Source
Far East	*Larix*	*spp.*	mt DNA	F_{ST}	54			1	0,786	Polezhayeva, 2010
Far East	*Larix*	*spp.*	mt DNA	N_{ST}	54			1	0,823	Polezhayeva, 2010
Far East	*Larix*	*spp.*	mt DNA	AMOVA	54			1	0,620	Polezhayeva, 2010
Far East	*Larix*	*populations*	mt DNA	AMOVA	54			1	0,200	Polezhayeva, 2010
Far East	*Larix*	*spp.*	chloroplast mi-crosatellites	F_{ST}				1	0,144	Polezhayeva, 2010
Far East	*Larix*	*spp.*	chloroplast mi-crosatellites	R_{ST}				1	0,432	Polezhayeva, 2010
Primorye	*Larix*	*olgensis*	RAPD	G_{ST}	12				0,270	Zhuravlyov et al., 2010
European Russia	*Quercus*	*robur*	RAPD	F_{ST}	4			48	0,098	Yakovlev, Kleinshmit, 2002
Southern Ural	*Quercus*	*robur*	allozymes	F_{ST}	15			5	0,097	Gabitova 2012
Southern Ural	*Quercus*	*robur*	ISSR	F_{ST}	6			67	0,530	Gabitova 2012
Primorye	*Quercus*	*dentata*	allozymes	F_{ST}	4			13	0,018	Potenko et al., 2007
Primorye	*Quercus*	*mongolica*	allozymes	F_{ST}	7			13	0,023	Potenko et al., 2007
Primorye	*Quercus*	*mongolica & dentata*	allozymes	F_{ST}	11			13	0,035	Potenko et al., 2007
Ural	*Populus*	*tremula*	allozymes	F_{ST}	9	416	46,2	19	0,147	Yanbayev, 2002
Ural	*Populus*	*nigra*	allozymes	F_{ST}	2	136	68,0	14	0,032	Yanbayev, 2002
Ural	*Betula*	*pendula*	allozymes	F_{ST}	24	921	38,4	17	0,051	Yanbayev, 2002
Ural	*Acer*	*platanoides*	allozymes	F_{ST}	28	959	34,3	16	0,045	Yanbayev, 2002
Ural	*Acer*	*negundo*	allozymes	F_{ST}	4	150	37,5	6		Yanbayev, 2002

Notes.

N_p number of populations studied
N_{ind} number of investigated individuals
$N_{ind}cp$ number of investigated individuals in the sample average
N_l number of investigated loci
F_{ST} proportion of inter-population variation in the total variability (Wright, 1973)
G_{ST} proportion of inter-population variation in the total variability (Nei, 1973)
R_{ST} proportion of inter-population variation in the total variability in the microsatellite
N_{ST} proportion of inter-population variation in the total variability of kinship with the haplotype
AMOVA proportion of inter-population variation in the total variability (analysis of molecular variance)
* Scientific name used in the original article is given in brackets.

Table IV.3e. **Levels of intra-population genetic diversity of tree species populations in the Russian Federation according to molecular genetic markers**

Region	Genus	Species	Markers	Np	N_{ind}	$N_{ind}CP$	N_l	P_{100tot}	P_{100}	P_{99}	P_{95}	A_{tot}	A	A_e	H_E	H_O	Source
Ural	*Pinus*	*sylvestris*	allozymes	11	758	68,9	21			59,4	48,3		2,18		0,183	4	Shigapov et al., 1997
Ural	*Pinus*	*sylvestris*	allozymes	84	3482	41,5	21				54,0	3,00			0,190		Yanbayev, 2002
Eastern Europe, Siberia	*Pinus*	*sylvestris*	allozymes	26	104	29,6	21			85,7	71,4	4,48	2,43		0,283	0,275	Goncharenko, Silin, 1997
Trans-Urals	*Pinus*	*sylvestris*	allozymes	5	157	31,4	18		75,0						0,252	0,239	Belokon et al., 1998
Khabarovsk Territory, Primorye	*Pinus*	*sylvestris*	allozymes	4			24				61,5		2,11		0,249	0,223	Potenko 2003
Ural	*Pinus*	*sylvestris*	allozymes	20	1000	50,0	17			68,8			2,20		0,240	0,236	Filippova et al., 2006
East of the Russian Plain	*Pinus*	*sylvestris*	allozymes	4	200	50,0	17			67,7			2,28		0,258	0,250	Filippova et al., 2006
Western Siberia and Nothern. Turgay	*Pinus*	*sylvestris*	allozymes	10	500	50,0	17			67,7			2,17		0,254	0,247	Filippova et al., 2006
Trans-Urals - Nothern Turgay	*Pinus*	*sylvestris*	allozymes	12	540	45,0	12			60,4			2,13		0,222	0,226	Sannikov, Petrova, Semerikov, 2002
Russia	*Pinus*	*sylvestris*	allozymes	24	811	30,9	17		60,5				2,11	1,39	0,219	0,218	Semerikov, 1991
Western Siberia, dryland	*Pinus*	*sylvestris*	allozymes	7	301	43,0	17				68,9		2,20		0,255	0,241	Sannikov, Petrova, 2003
Western Siberia, wet moor	*Pinus*	*sylvestris*	allozymes	7	301	43,0	17				68,0		2,20		0,250	0,240	Sannikov, Petrova, 2003
Eastern Europe, dryland	*Pinus*	*sylvestris*	allozymes	5	165	33,0	17				68,9		2,20		0,261	0,244	Sannikov, Petrova, 2003
Eastern Europe, wet moor	*Pinus*	*sylvestris*	allozymes	5	200	40,0	17				68,9		2,20		0,239	0,234	Sannikov, Petrova, 2003
Ukranian Carpathians, mountain	*Pinus*	*sylvestris*	allozymes	7	286	40,9	17				65,6		2,10		0,247	0,233	Sannikov, Petrova, 2003
Ukranian Carpathians, piedmont	*Pinus*	*sylvestris*	allozymes	3	123	41,0	17				68,9		2,20		0,255	0,252	Sannikov, Petrova, 2003
Nothern Caucasus, continuous area	*Pinus*	*sylvestris*	allozymes	3	132	44,0	17				72,2		2,10		0,210	0,194	Sannikov, Petrova, 2003
Nothern Caucasus, slightly disjuctive area	*Pinus*	*sylvestris*	allozymes	2	71	35,5	17				72,2		2,00		0,185	0,203	Sannikov, Petrova, 2003
Western Siberia, drylan	*Pinus*	*sylvestris*	allozymes	10	447	44,7	17				69,3		2,23		0,253	0,241	Sannikov, Petrova, 2003
Eastern Europe	*Pinus*	*sylvestris*	allozymes	6	231	38,5	17				67,6		2,20		0,259	0,248	Sannikov, Petrova, 2003
Central Kazakhstan, steppe forests	*Pinus*	*sylvestris*	allozymes	5	215	43,0	17				68,9		2,20		0,268	0,269	Sannikov, Petrova, 2003

Region	Genus	Species	Markers	Np	N_{ind}	$N_{ind}CP$	N_l	P_{100tot}	P_{100}	P_{99}	P_{95}	A_{tot}	A	A_e	H_E	H_O	Source
Western Siberia, wet moor	*Pinus*	*sylvestris*	allozymes	8	240	30	22	72,73			63,64	2,73		1,35	0,205	0,203	Larionova, Ekart 2010
Primorye	*Pinus*	*x funebris*	allozymes	5			24				60,8		2,18		0,239	0,234	Potenko 2003
Primorye	*Pinus*	*x funebris*	allozymes	1	10	10,0	21			76,2	76,2		2,05		0,261	0,314	Goncharenko, Silin, 1997
Primorye	*Pinus*	*densiflora*	allozymes	3			24				45,9		1,98		0,201	0,196	Potenko 2003
Western Siberia, Trans-baikalia	*Pinus*	*sibirica*	allozymes	9	107	11,9	20			50,0	45,0		1,90		0,169	0,168	Goncharenko, Silin, 1997
Ural, Western, Central Siberia, Baikal	*Pinus*	*sibirica*	allozymes	41	1543	37,6	18						1,40		0,090		Podogas, 1993
Tomsk region, Altai, Western Sayans	*Pinus*	*sibirica*	allozymes	9			19						1,80		0,158		Krutovskii et al., 1995; Politov, 2007
Western and Central Siberia	*Pinus*	*sibirica*	allozymes	13			19						1,70		0,140		Politov, 2007
Baikal region	*Pinus*	*sibirica*	allozymes	18			31						1,60		0,118		Politov, 2007
Siberia	*Pinus*	*sibirica*	nuclear microsat-ellites	6			5								0,712	0,534	Mudrik et al.,
Far East	*Pinus*	*koraiensis*	allozymes	1	13	13,0	20			50,0	50,0		1,80		0,212	0,233	Goncharenko, Silin, 1997
Far East	*Pinus*	*koraiensis*	allozymes	4	70	17,5	32			41,4	35,2		1,50		0,133	0,150	Politov, 1988, 2007; Belokon, 2007
Far East, China, Korea	*Pinus*	*koraiensis*	allozymes	12	1830	152,5	30	83,3	55,3		37,5	2,73	1,87	1,23	0,139		Belokon, 2007, Politov, 2007
Far East, China, Korea	*Pinus*	*koraiensis*	allozymes	12	1830	152,5	27	83,3	55,3		37,5	2,73	1,87	1,23	0,120	0,113	Belokon, 2007
Far East	*Pinus*	*koraiensis*	allozymes	25	889	52,3	26	88,5		58,0	48,0	3,35	1,92		0,182	0,180	Velikov, Potenko, 2006
Sakhalin, Chukotka	*Pinus*	*pumila*	allozymes	5	63	12,6	22							2,01	0,257		Goncharenko et al., 1993
Sakhalin, Chukotka, Iturup	*Pinus*	*pumila*	allozymes	6	78	13,0	20			75,0	70,0		2,75		0,271	0,282	Goncharenko, Silin, 1997
Kamchatka, Kunashir	*Pinus*	*pumila*	allozymes	4	127	31,7	27	81,5	74,1						0,231	0,228	Politov et al., 2006
Baikal region	*Pinus*	*pumila*	allozymes	10			32						2,00		0,234		Politov, 2007
Primorye, Kamchatka, Baikal region	*Pinus*	*pumila*	allozymes	3	75	25,0	16	93,8	72,9	72,9	68,8	2,75	2,19	1,41	0,291	0,247	Nakonechnaya et al., 2010
Easten Siberia, Far East, Kamchatka	*Picea*	*ajanensis* (=*P. jezoensis*)	allozymes	12			20	100,0	83,8		60,8		2,42		0,201	0,193	Potenko 2007
Eastern Europe, Siberia	*Picea*	*abies*	allozymes	8			25			80,0	52,0	3,24	2,12				Goncharenko, Padutov, 1999

Region	Genus	Species	Markers	Np	N_{ind}	$N_{ind}CP$	N_{l}	P_{100tot}	P_{100}	P_{99}	P_{95}	A_{tot}	A	A_{e}	H_{E}	H_{O}	Source
Central, Western and Eastern Europe, Ural, Siberia	*Picea*	*abies & obovata*	allozymes	11			24		80,7				2,54		0,237		Krutovskii, Bergmann, 1995; Politov, Krutovskii, 1998, Politov, 2007
Eastern Europe, Ural, Siberia	*Picea*	*abies & obovata*	nuclear microsatellites	5			4	100	100	100	100		4,90	2,26	0,515	0,403	Mudrik et al., 2010, Zhulina et al., 2012
Eastern Europe	*Picea*	*abies & obovata*	allozymes	5	281	56,5	12	100,0	93,4	90,0	75,0	3,58	2,98	1,89	0,373	0,364	Nakvasina et al., 2008
Ural	*Picea*	*obovata*	allozymes	14	518	37,0	17				71,0	2,80			0,249		Yanbayev, 2002
Central Siberia	*Picea*	*obovata*	allozymes	13			22		90,9		54,6		2,95	1,25	0,168	0,159	Larionova et al., 2007
Transbaikalia, Mongolia	*Picea*	*obovata*	allozymes	5	150	30	22		61,8				1,73	1,18	0,109	0,106	Kravchenko et al., 2012
Ural, Western, Central Siberia	*Picea*	*obovata*	allozymes	4			25			92,0	72,0	3,28	2,72		0,257	0,244	Goncharenko, Padutov, 1999
Sakhalin	*Picea*	*glehnii*	allozymes	3	35	11,7	25			66,7	62,7	2,28	1,88		0,234	0,234	Goncharenko, Padutov, 1999
Central Siberia	*Abies*	*sibirica*	allozymes	9			20		35,0		20,0		1,45	1,13	0,057	0,064	Larionova et al., 2007
Western Sayans	*Abies*	*sibirica*	allozymes	3			19			47,4			1,79	1,19	0,104	0,087	Larionova, Ekart, 2005
Tomsk region	*Abies*	*sibirica*	allozymes	5			20		20,0		15,0		1,25	1,11	0,056	0,055	Larionova, Ekart, 2012
Western and Central Siberia	*Abies*	*sibirica*	allozymes	6	64		24	62,5				1,96					Goncharenko, 1999
Ural, Siberia	*Abies*	*sibirica*	allozymes	22	1119		15			19,1			1,32		0,083	0,081	Semerikova, Semerikov, 2006
Ural, Siberia	*Abies*	*sibirica*	allozymes	38	1832	48,2	11					1,60	1,48		0,110	0,107	Semerikova et al., 2011
Ural, Siberia	*Abies*	*sibirica*	AFLP	1	7		173								0,080		Semerikova et al., 2011
Nothern Ural	*Abies*	*sibirica*	AFLP	3	21	7,0		55,6	38,5						0,144		Semerikova, Semerikov, 2011
Central, Southern Ural, European part of the Russian Federation	*Abies*	*sibirica*	AFLP	5	32	6,4		53,0	32,8						0,119		Semerikova, Semerikov, 2011
Nothern, Western and Central Siberia	*Abies*	*sibirica*	AFLP	3	22	7,3		47,9	35,0						0,126		Semerikova, Semerikov, 2011
Southern Siberia	*Abies*	*sibirica*	AFLP	6	45	7,5		69,2	42,5						0,151		Semerikova, Semerikov, 2011
Baikal region and Transbaikalia	*Abies*	*sibirica*	AFLP	3	17	5,7		47,9	30,8						0,123		Semerikova, Semerikov, 2011
Throughout the area	*Abies*	*sibirica*	AFLP	20	137	6,9		77,8	36,6						0,134		Semerikova, Semerikov, 2011
Siberia	*Abies*	*sibirica*	chloroplast microsatellites	29	1129	39,0	2	100,0				43,00	12,10	7,22	0,874		Semerikova, Semerikov, 2007
Sakhalin, Kunashir	*Abies*	*sachalinensis*	allozymes	4	39		24	79,2				2,08					Goncharenko, 1999

Region	Genus	Species	Markers	Np	N_{ind}	$N_{ind}CP$	N_l	P_{100tot}	P_{100}	P_{99}	P_{95}	A_{tot}	A	A_e	H_E	H_O	Source
Sakhalin, Kunashir	*Abies*	*sachalinensis*	allozymes	12	342	27,0	11	72,7	51,5			2,20	1,57		0,097	0,099	Semerikova et al., 2011
Sakhalin, Kunashir	*Abies*	*sachalinensis*	AFLP	8	58	7,3	173								0,156		Semerikova et al., 2011
Sakhalin	*Abies*	*sachalinensis*	AFLP	2	15	7,5		76,1	56,4						0,191		Semerikova, Semerikov, 2011
Sakhalin, Kunashir	*Abies*	*sachalinensis*	chloroplast microsatellites	7	144	20,6	2					49,00	15,00	12,40	0,964		Semerikova, Semerikov, 2007
Khabarovsk Territory	*Abies*	*nephrolepis*	allozymes	2	11		24	45,8				1,58					Goncharenko, 1999
Far East	*Abies*	*nephrolepis*	allozymes	5	167	33,4	11	54,5	29,1			1,80	1,38		0,083	0,071	Semerikova et al., 2011
Far East	*Abies*	*nephrolepis*	AFLP	1	7		173								0,122		Semerikova et al., 2011
Far East	*Abies*	*nephrolepis*	AFLP	2	16	8,0		69,2	42,7						0,153		Semerikova, Semerikov, 2011
Far East	*Abies*	*nephrolepis*	chloroplast microsatellites	3	94	31,0	2	100,0				31,00	17,30	11,90	0,940		Semerikova, Semerikov, 2007
Kamchatka	*Abies*	*sachalinensis var. gracilis* (=*A. gracilis*)	allozymes	1	25		11		36,4				1,40		0,135	0,102	Semerikova et al., 2011
Kamchatka	*Abies*	*sachalinensis var. gracilis* (=*A. gracilis*)	AFLP	1	7		173								0,083		Semerikova et al., 2011
Primorye	*Abies*	*holophylla*	allozymes	1	30		11		27,3				1,30		0,117	0,097	Semerikova et al., 2011
Primorye	*Abies*	*holophylla*	chloroplast microsatellites	1	20		2	100,0					11,00	6,50			Semerikova, Semerikov, 2007
Ural	*Larix*	*sibirica (=L. sukaczewii* Ural population)	allozymes	12	452	37,7	20				33,0	1,15			0,043		Yanbayev, 2002
Central Siberia	*Larix*	*sibirica*	allozymes	6			22		63,6		22,7		1,91	1,18	0,094	0,090	Larionova et al., 2007
Krasnoyarsk Territory, Taimyr	*Larix*	*sibirica*	allozymes	7	149	21,3	22	68,2			27,7	1,95		1,18	0,095	0,092	Larionova, Oreshkova, 2010
Krasnoyarsk Territory, Tyva	*Larix*	*sibirica*	allozymes	8	233	29,1	22		68,18		31,82		2,14	1,17	0,097	0,091	Oreshkova, 2010
Chita region	*Larix*	*gmelinii*	allozymes	3	90	30	22	68,2			19,7	1,82		1,07	0,053	0,05	Larionova, Oreshkova, 2010
Chita region, Evekiya	*Larix*	*gmelinii*	allozymes	4	106	26,5	17			94,1	76,5		2,59	1,21	0,141	0,100	Oreshkova et al., 2006
Yakutia, Magadan region	*Larix*	*cajanderi*	allozymes	5			22	63,6			30,0	2,04		1,14	0,101	0,082	Larionova, Oreshkova, 2010
Primorye	*Larix*	*olgensis*	RAPD	10	102	10,2	440	98,4							0,150		Lyovina et al., 2008
Petrova Island	*Taxus*	*cuspidata*	allozymes	1			22		45,5				1,73		0,149	0,164	Potenko, 2001

Region	Genus	Species	Markers	Np	N_{ind}	$N_{ind}CP$	N_l	P_{100tot}	P_{100}	P_{99}	P_{95}	A_{tot}	A	A_e	H_E	H_O	Source
Republic of Mariy-El	*Quercus*	*robur*	allozymes	4	203	50,9	12		75,0	70,8	62,5	2,90	2,45		0,175	0,170	Yakovlev et al., 1999 a, b
European part of Russia	*Quercus*	*robur*	RAPD	4			48			100,0	77,8		2,00	1,40	0,250		Yakovlev, Kleinshmit, 2002
Ural	*Quercus*	*robur*	allozymes	13	621	47,8	19				71,0	3,76			0,264		Yanbayev, 2002
Ural	*Quercus*	*robur*	allozymes	2	27	13,5	17		38,3				1,50		0,121	0,142	Mullagulov et al., 2008
Primorye	*Quercus*	*dentata*	allozymes	4		32,0	18		59,8		50,0		2,36		0,199	0,198	Potenko et al., 2007
Primorye	*Quercus*	*mongolica*	allozymes	7		32,0	18		66,7		47,6		2,28		0,165	0,161	Potenko et al., 2007
Ural	*Populus*	*tremula*	allozymes	9	416	46,2	19				100,0	3,10			0,315		Yanbayev, 2002
Ural	*Populus*	*nigra*	allozymes	2	136	68,0	18				17,0	1,60			0,051		Yanbayev, 2002
Ural	*Betula*	*pendula*	allozymes	24	921	38,4	20				60,0	2,80			0,205		Yanbayev, 2002
Ural	*Acer*	*platanoides*	allozymes	28	959	34,3	20				30,0	2,00			0,077		Yanbayev, 2002
Ural	*Acer*	*negundo*	allozymes	4	150	37,5	15				31,0	1,31			0,059		Yanbayev, 2002

Notes.

Np number of populations studied
N_{ind} number of investigated individuals
$N_{ind}CP$ number of investigated individuals in the sample average
N_l number of investigated loci
P_{100tot} percentage of polymorphic loci at 100% of the criteria of polymorphism in general at sight
P_{100} percentage of polymorphic loci at 100% of the criteria for polymorphism in an average population
P_{99} percentage of polymorphic loci in 99% of the criteria for polymorphism in an average population
P_{95} percentage of polymorphic loci, 95% criteria polymorphism in an average population
A_{tot} number of alleles per locus on average in general at sight
A number of alleles per locus on average in an average population
A_e effective number of alleles
H_E average expected heterozygosity
H_O average observed heterozygosity
* Scientific name, used in the original article is given in brackets.

Table IV.3f. **Assessment of the inbreeding levels obtained by using molecular genetic markers at different development stages of individuals in woody plants populations of the Russian Federation**

Region	Genus	Species	Markers	Stage	N_p	N_{ind}	$N_{ind}cp$	N_l	F	F_{IS}	Source

Region	Genus	Species	Markers	Stage	N_p	N_{ind}	$N_{ind}cp$	N_l	F	F_{IS}	Source
Eastern Europe, Siberia	*Pinus*	*sylvestris*	allozymes	mature	26	769,6	29,6	21		-0,010	Goncharenko, Silin, 1997
Eastern Europe, Siberia	*Pinus*	*sylvestris*	allozymes	mature	18	586	32,6	21		-0,014	Goncharenko et al., 1994
Ural, Eastern Europe	*Pinus*	*sylvestris*	allozymes	mature	8	758	94,75	12		0,148	Shigapov et al., 1995
Trans-Urals	*Pinus*	*sylvestris*	allozymes	mature	5	157	31,4	15		0,052	Belokon et al., 1998
Primorye	*Pinus*	*sylvestris*	allozymes	mature	4			24		0,044	Potenko 2003
East of the Russian Plain	*Pinus*	*sylvestris*	allozymes	mature	4	200	50	13		0,019	Filippova et al., 2006
Western Siberia – Turgay	*Pinus*	*sylvestris*	allozymes	mature	10	500	50	13		0,016	Filippova et al., 2006
Trans-Urals	*Pinus*	*sylvestris*	allozymes	mature	8	400	50	13		-0,019	Filippova et al., 2006
Ural mountains	*Pinus*	*sylvestris*	allozymes	mature	11	550	50	13		0,010	Filippova et al., 2006
Ural mountains and ajoining territories	*Pinus*	*sylvestris*	allozymes	mature	33	1650	50	13		0,048	Filippova et al., 2006
Russia	*Pinus*	*sylvestris*	allozymes	mature	24	811	30,9	13	-0,001	-0,012	Semerikov, 1991
Western Siberia wet moor and dryland	*Pinus*	*sylvestris*	allozymes	mature	14	602	43	14		0,028	Sannikov, Petrova, 2003
Eastern Europe, wet moor and dryland	*Pinus*	*sylvestris*	allozymes	mature	10	365	36,5	14		0,021	Sannikov, Petrova, 2003
Ukranian Carpathians mountain and pied-mont	*Pinus*	*sylvestris*	allozymes	mature	10	409	40,9	14		0,061	Sannikov, Petrova, 2003
Nothern Caucasus, various hights	*Pinus*	*sylvestris*	allozymes	mature	5	203	40,6	13		-0,002	Sannikov, Petrova, 2003
Western Siberia, dryland	*Pinus*	*sylvestris*	allozymes	mature	10	447	44,7	14		0,014	Sannikov, Petrova, 2003
Western Siberia, wet moor	*Pinus*	*sylvestris*	allozymes	mature	8	240	30	16	-0,011	-0,015	Larionova, Ekart 2010
Primorye	*Pinus*	*x funebris*	allozymes	mature	5			24		0,006	Potenko 2003
Primorye	*Pinus*	*densiflora*	allozymes	mature	3			24		0,020	Potenko 2003
Siberia	*Pinus*	*sibirica*	allozymes	mature	9	107,1	11,9	20		-0,022	Goncharenko, Silin, 1997
Central and Western parts of the area	*Pinus*	*sibirica*	allozymes	mature	11					-0,047	Politov, 2007
Baikal region	*Pinus*	*sibirica*	allozymes	blastema	20		2073	20		0,080	Politov, 2007
Siberia	*Pinus*	*sibirica*	allozymes	mature	9	333	37	9		-0,019	Politov, 2007
Siberia	*Pinus*	*sibirica*	allozymes	blastema	9	2786,4	309,6	8	0,079	0,073	Politov, 2007
Siberia	*Pinus*	*sibirica*	allozymes	blastema	35	6266	179	10		0,053	Politov, 2007
Sakhalin, Chukotka, Iturup	*Pinus*	*pumila*	allozymes	mature	5	78	15,6	20		-0,069	Goncharenko, Silin, 1997
Sakhalin, Chukotka	*Pinus*	*pumila*	allozymes	mature	5	63	12,6	22		-0,076	Goncharenko et al., 1993
Kamchatka, Kunashir	*Pinus*	*pumila*	allozymes	mature	5	161	32,2	23		-0,007	Belokon et al., 2010
Kamchatka, Kunashir	*Pinus*	*pumila*	allozymes	blastema	5	1172	234,4	23		0,139	Belokon et al., 2010
Kamchatka, Kunashir	*Pinus*	*pumila*	allozymes	mature	4	127	31,75	11		0,007	Politov et al., 2006; Politov, 2007

Region	Genus	Species	Markers	Stage	N_p	N_{ind}	$N_{ind}cp$	N_l	F	F_{IS}	Source
Kamchatka, Kunashir	*Pinus*	*pumila*	allozymes	blastema	4	861	215,1	10		0,208	Politov et al., 2006; Politov, 2007
Kamchatka, Kunashir	*Pinus*	*pumila*	allozymes	mature	4	127	31,75	27		0,013	Politov et al., 2006; Politov, 2007
Kamchatka, Kunashir	*Pinus*	*pumila*	allozymes	blastema	4	861	215,1	23		0,157	Politov et al., 2006; Politov, 2007
Baikal, littoral	*Pinus*	*pumila*	allozymes	blastema	5		95	9		0,054	Politov, 2007
Baikal, subalpine	*Pinus*	*pumila*	allozymes	blastema	5		185	9		0,256	Politov, 2007
Baikal	*Pinus*	*pumila*	allozymes	blastema	11		129	9		0,137	Politov, 2007
Baikal , Kamchatka, Primorye	*Pinus*	*pumila*	allozymes	mature	3	75	25	16		0,149	Nakonechnaya et al., 2010
Far East	*Pinus*	*koraiensis*	allozymes	mature	17	889	52,3	23		0,011	Velikov, Potenko, 2006
Far East	*Pinus*	*koraiensis*	allozymes	mature	11	540	49,1	23		0,016	Potenko, Velikov, 1998
Far East	*Pinus*	*koraiensis*	allozymes	mature	5	246	49,2	17		0,012	Potenko, Velikov, 2001
Far East	*Pinus*	*koraiensis*	allozymes	blastema	5	2460	492	17	0,009	0,059	Potenko, Velikov, 2001
Far East , China, Korea	*Pinus*	*koraiensis*	allozymes	blastema	12	1830	152,5	27		0,058	Belokon, 2007, Politov, 2007
Far East	*Pinus*	*koraiensis*	allozymes	mature	4	70	17,5	8		-0,166	Belokon, 2007, Politov, 2007
Far East	*Pinus*	*koraiensis*	allozymes	blastema	4	530	132,4	8		0,033	Belokon, 2007, Politov, 2007
Far East	*Pinus*	*koraiensis*	allozymes	mature	4	70	17,5	16		-0,126	Belokon, 2007, Politov, 2007
Far East	*Pinus*	*koraiensis*	allozymes	blastema	4	530	132,4	16		0,032	Belokon, 2007, Politov, 2007
Easten Siberia and Far East	*Picea*	*ajanensis* (=*P. jezoensis*)*	allozymes	mature	9	282	35,3	20		0,007	Potenko & Knysh 2003
Easten Siberia, Far East, Kamchat-ka,Sakhalin	*Picea*	*ajanensis* (=*P. jezoensis*)	allozymes	mature	12	377	31,4	20	0,004		Potenko 2007
Southern Ural, Bashkir, the Cis-Ural region	*Picea*	*obovata*	allozymes	mature	8	256	32	7		0,078	Yanbayev et al., 1997
Central Siberia	*Picea*	*obovata*	allozymes	mature	13			22		0,0012	Larionova et al., 2007
Transbaikalia, Mongolia	*Picea*	*obovata*	allozymes	mature	5	150	30	18		0,071	Kravchenko et al., 2012
Western and Central Siberia	*Picea*	*obovata*	allozymes	mature	4	130	32,5	25		-0,012	Goncharenko, Padutov, 1999
Far East	*Picea*	*ajanensis*	allozymes	mature	5	94	18,8	25		-0,054	Goncharenko, Padutov, 2001
Sakhalin	*Picea*	*glehnii*	allozymes	mature	3	46	15,3	25		-0,037	Goncharenko, Padutov, 2001
Western Sayans	*Abies*	*sibirica*	allozymes	mature	3			19		0,1231	Larionova, Ekart, 2005
Central Siberia	*Abies*	*sibirica*	allozymes	mature	9			7		0,061	Larionova et al., 2007
Tomsk region	*Abies*	*sibirica*	allozymes	mature	5			4	0,026	0,0086	Larionova, Ekart, 2012

Region	Genus	Species	Markers	Stage	N_p	N_{ind}	N_{ind}cp	N_l	F	F_{IS}	Source
Ural, Siberia	*Abies*	*sibirica*	allozymes	mature	22	1119		3		0,013	Semerikova, Semerikov, 2006
Ural, Siberia	*Abies*	*sibirica*	allozymes	mature	38	1832	48,2	3		0,025	Semerikova et al., 2011
Sakhalin, Kunashir	*Abies*	*sachalinensis*	allozymes	mature	12	342	27	8		-0,029	Semerikova et al., 2011
Far East	*Abies*	*nephrolepis*	allozymes	mature	5	167	33,4	6		0,122	Semerikova et al., 2011
Kamchatka	*Abies*	*sachalinensis var. gracilis* (*=A. gracilis*)	allozymes	mature	1	25	25	4		0,248	Semerikova et al., 2011
Primorye	*Abies*	*holophylla*	allozymes	mature	1	30	30	3		0,174	Semerikova et al., 2011
Central Siberia	*Larix*	*sibirica*	allozymes	mature	6			14		-0,0425	Larionova et al., 2007
Krasnoyarsk Territory, Taimyr	*Larix*	*sibirica*	allozymes	mature	7	149	21,3	15		-0,039	Abaimov et al., 2010 Biodiversity of Larch in the Asian Russia,
Krasnoyarsk Territory, Tyva	*Larix*	*sibirica*	allozymes	mature	8	233	29,1	15		0,017	Oreshkova, 2010
Siberia	*Larix*	*sibirica*	allozymes	mature	15			12		0,059	Semerikov et al., 1999
Western Siberia, Ural	*Larix*	*sibirica*	allozymes	mature	5	242	48,4	11		0,053	Semerikov, Matveyev, 1995
Western Siberia, Ural	*Larix*	*sibirica*	allozymes	germinating propagules	4	239	59,75	11		0,102	Semerikov, Matveyev, 1995
Easten Siberia	*Larix*	*gmelinii*	allozymes	mature	6			11		0,024	Semerikov et al., 1999
Chita region	*Larix*	*gmelinii*	allozymes	mature	3	90	30	15		0,0367	Abaimov et al., 2010 Biodiversity of Larch in the Asian Russia,
Chita region, Evekiya	*Larix*	*gmelinii*	allozymes	mature	4	106	26,5	17		0,229	Oreshkova et al., 2006
Yakutia, Magadan region	*Larix*	*cajanderi*	allozymes	mature	5	117	23,4	14		0,039	Abaimov et al., 2010 Biodiversity of Larch in the Asian Russia,
Ural	*Larix*	*sibirica* (*=L. sukaczewii*)	allozymes	mature	20	570	28,5	10	0,295	0,253	Putenikhin et al., 2004
Southern Ural, populations of broadleaved and coniferous-broadleaved zones	*Quercus*	*robur*	allozymes	mature	9			5	0,145		Gabitova 2012
Southern Ural, marginal populations	*Quercus*	*robur*	allozymes	mature	3			5	0,129		Gabitova 2012
Southern Ural, isolated, population insignificant in number	*Quercus*	*robur*	allozymes	mature	3			5	0,180		Gabitova 2012
Southern Ural	*Quercus*	*robur*	allozymes	mature	13	621	47,8	19	0,230		Yanbayev, 2002

Region	Genus	Species	Markers	Stage	N_p	N_{ind}	$N_{ind}cp$	N_l	F	F_{IS}	Source
Bashkir Trans-Urals , isolates	*Quercus*	*robur*	allozymes	mature	2	27	13,5	7	0,145	0,106	Mullagulov et al., 2008
Primorye	*Quercus*	*dentata*	allozymes	mature	4			13		0,004	Potenko et al., 2007
Primorye	*Quercus*	*mongolica*	allozymes	mature	7			13		0	Potenko et al., 2007
Ural	*Acer*	*platanoides*	allozymes	mature	28	959	34,3	16		0,077	Yanbayev, 2002

Notes

N_p number of populations studied
N_{ind} number of investigated individuals
$N_{ind}cp$ number of investigated individuals in the sample average
N_l number of investigated loci
F inbreeding coefficient (Wright, 1978)
F_{IS} inbreeding coefficient (Nei, 1977)
* Scientific name used in the original article is given in brackets.

Table IV.4. **Priority species of trees, shrubs and woody vines ***

Priority species			Reason for priority
Scientific name	Tree (T) or other (O)	Native (N) or exotic (E)	
Main forest forming species			
Coniferous			
Pine.	T	N	Forest forming and economic importance
Japanese red pine – *Pinus densiflora* Siebold et Zucc.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 2)
Pine – *Pinus sylvestris* L. var. cretacea Kalen.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 3)
Pine – *Pinus x funebris* Kom. (*P. densiflora* Siebold et Zucc. x *P. sylvestris* L.)	T	N	threatened (timber harvesting is not allowed)
Pallasiana pine – *Pinus pallasiana* D. Don.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 1)
Pitsunda pine – *Pinus pityusa* Stev.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 2)
Spruce	T	N	Forest forming and economic importance
Sakhalin spruce – *Picea glehnii* (Fr. Schmidt) Mast.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 3)
Fir.	T	N	Forest forming and economic importance
Fir – *Abies mayriana* (Miyabe et Kudo) Miyabe et Kudo	T	N	threatened (timber harvesting is not allowed)
Manchurian fir – *Abies holophylla* Maxim.	T	N	threatened (timber harvesting is not allowed)
Sakhalin fir – *Abies sachalinensis var. gracilis* (Kom.) Farjon	T	N	threatened (timber harvesting is not allowed)
Larch	T	N	Forest forming and economic importance
Korean Dahurian larch – *Larix olgensis* A. Henry	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 2)
Siberian stone pine – *Pinus sibirica* Du Tour	T	N	Forest forming and economic importance
Korean pine – *Pinus koraiensis* Siebold. et Zuscc.	T	N	threatened (timber harvesting is not allowed), economic, social
Juniper	T	N	Forest forming and economic importance
Stinking juniper – *Juniperus foetidissima* Willd.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 2)
Grecian juniper – *Juniperus excelsa* Bieb.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 2)
Needle juniper – *Juniperus rigida* Siebold et Zucc. subsp. litoralis Urussov	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 2)
Hard-wooded broadleaved			
Oak	T	N	Forest forming and economic importance

Priority species			Reason for priority
Scientific name	Tree (T) or other (O)	Native (N) or exotic (E)	
Beech	T	N	Forest forming and economic importance
Hornbeam	T	N	Forest forming and economic importance
Ash	T	N	Forest forming and economic importance
Ash, Siebolda ash– *Fraxinus lanuginosa* Koidz. (Fraxinus sieboldiana auct).	T	N	threatened (timber harvesting is not allowed)
Maple	T	N	Forest forming and economic importance
Sycamore maple *Acer pseudoplatanus* L.	T	N	threatened (timber harvesting is not allowed)
Fullmoon maple – *Acer japonicum* Thunb.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 1)
Elm and other elm trees	T	N	Forest forming and economic importance
Stone birch – (*Betula davurica* Pall.; *B. ermanii* Regel; *B. costata* Trautv.)	T	N	Forest forming, environmental protection importance
Saxaul	T	N	Forest forming and environmental protection importance, conservation of biodiversity
Locust *Robinia pseudoacacia* L.	O	E	Environmental protection importance, conservation of biodiversity
Soft-wooded broadleaved			
Birch	T	N	Forest forming, economic and social importance
Karelian birch – *Betula pendula* Roth var. carelica (Merckl.) Hamet-Ahti.	T	N	threatened (timber harvesting is not allowed)
Maximovich birch – Betula maximowicziana Regel	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 1)
Raddea birch – *Betula raddeana* Trautv.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 3)
Iron birch – *Betula schmidtii* Regel	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 3)
Aspen – *Populus tremula* L.	T	N	Forest forming, economic and social importance
Speckled alder – *Alnus incana* (L.) Moench	T	N	Forest forming and economic importance
Common alder – *Alnus glutinosa* (L.) Gaertn.	T	N	Forest forming and economic importance
Linden	T	N	Forest forming, economic and social importance
Linden Maximowic – *Tilia maximowicziana* Shirasawa	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 1)
Poplar			Forest forming, environmental protection importance
Woody willows			Forest forming, environmental protection importance
Other woody species			

Priority species			Reason for priority
Scientific name	Tree (T) or other (O)	Native (N) or exotic (E)	
Apricot	T	N	threatened (timber harvesting is not allowed)
Manchurian apricot *Armeniaca mandshurica* (Maxim.) Skvorts.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 3)
Japanese angelica tree – *Aralia elata* (Miq.) Seem	T	N	Economic and social importance
Amur cork tree – *Phellodendron amurense* Rupr.	T	N	threatened (timber harvesting is not allowed)
Sakhalin cork tree - *Phellodendron sachalinense* (Fr. Schmidt) Sarg.	T	N	threatened (timber harvesting is not allowed)
Eastern hornbeam – *Carpinus orientalis* Mill.	T	N	Economic importance, conservation of biodiversity
Honeylocust	T	E	Conservation of biodiversity
Pear	T	N	threatened (timber harvesting is not allowed), economic, social
Zelkova – *Zelkova carpinifolia* (Pall.) C. Koch.	T	N	threatened (timber harvesting is not allowed)
Cork oak – Quercus suber L.	T	E	economic, social
Oak – *Quercus dentata* Thunb.	T	N	threatened (timber harvesting is not allowed), Red Book of the Russian Federation (category 3), conservation of biodiversity
Oak – *Quercus crispula* Blume	T	N	threatened (timber harvesting is not allowed)
Hackberry	T	N	conservation of biodiversity
Sweet chestnut – *Castanea sativa* Mill.	T	N	conservation of biodiversity, economic importance
Wig-nut – *Pterocarya pterocarpa* (Michx.) Kunth ex I. Iljinsk.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 3)
Almond	T	N	conservation of biodiversity, economic importance
Juglans ailanthifolia Carr.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 3)
Circassian walnut – *Juglans regia* L.	T	E	timber harvesting is not allowed, economic and social importance
Manchurian walnut – *Juglans mandshurica* Maxim.	T	N	threatened (timber harvesting is not allowed), economic and social importance
Sorbus.	T	N	economic and social importance
Box tree	T	N	threatened (timber harvesting is not allowed)
Box tree *Buxus colchica* Pojark.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 2)
Alycha – *Prunus divaricata* Ledeb.	T	N	threatened (timber harvesting is not allowed), economic and social importance
Japanese yew – *Taxus cuspidata* Siebold et Zucc. ex Endl.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 2)

Priority species			Reason for priority
Scientific name	Tree (T) or other (O)	Native (N) or exotic (E)	
Common yew– *Taxus baccata* L.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 3)
Turpentine tree – *Pistacia mutica* Fisch. et C.A. Mey.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 3)
Bird cherry.	T	N	economic and social importance
Cherry	T	N	threatened (timber harvesting is not allowed), social
Mulberry	T	E	threatened (timber harvesting is not allowed), economic importance
Apple tree	T	N, E	threatened (timber harvesting is not allowed), economic, social
Bothocaryum – *Bothrocaryum controversum* (Hemsl. ex Prain) Pojark.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 3)
Prickly castor-oil tree – *Kalopanax septemlobus* (Thunb.) Koidz.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 3)
Magnolia – *Magnolia hypoleuca* Siebold et Zucc. (Magnolia obovata Thunb.)	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 1)
Sorbus– *Micromeles alnifolia* (Siebold et Zucc.) Koehne [*Sorbus alnifolia* (Siebold et Zucc.) Koehne]	T	N	threatened (timber harvesting is not allowed)
Turkish hazel – *Corylus colurna* L.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 2)
Oriental plane – *Platanus orientalis* L.	T	E	threatened (timber harvesting is not allowed)
European hop-hornbeam – *Ostrya carpinifolia* Scop.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 2)
Oriental persimon – *Diospyros lotus* L.	T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 2)
Shrubs			
Actinidia	O	N	economic and social importance
Birch	O	N	environmental protection importance
Hawthorn	O,T	N	economic, social
Willows	O	N	environmental protection importance
Wright viburnum – *Viburnum wrightii* Miq.	O. T	N	threatened (timber harvesting is not allowed)
Siberian dwarf-pine – *Pinus pumila* L.	O	N	environmental protection, social
Colchis bladdernut – *Staphylea colchica* Stev.	O, T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 3)
Pinnate bladdernut – *Staphylea pinnata* L.	O, T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 3)

Priority species			Reason for priority
Scientific name	Tree (T) or other (O)	Native (N) or exotic (E)	
Hazel	O	N	Economic, social
Juniper	O	N	Economic, social
Sea buckthorn	O, T	N	Economic, social
Holly – *Ilex sugerokii* Maxim.	O	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 3)
Rhododendron *Rhododendron fauriei* Franch.	O, T	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 3)
Dog-rose	O	N	Economic, social
Pearlbush – *Exochorda serratifolia* S. Moore	O	N	threatened (timber harvesting is not allowed); Red Book of the Russian Federation (category 1)

* The priority species include the main forest forming species, other tree species, some shrub species, species of trees and shrubs that are included in the Red Book of the Russian Federation (plants and fungi), and also in the list of species of trees and shrubs that are not allowed to be used for timber harvesting (threatened), with economic, social or cultural importance, as well as invasive species (priority removal).

Table IV.4a. **Species of trees, shrubs and woody vines, included in the Red Book of the Russian Federation, but not presented in the reserves of the Russian Federation**

Species of plants	Category*	Region*
Gymnospermous		
Cupressaceae		
Juniperus conferta Parl.	3	FE
Juniperus excelsa Bieb.	2	C
Juniperus foetidissima Willd.	2	E, C
Pinaceae		
Pinus pallasiana D.Don	1	C
Pinus pityusa Stev.	2	C
Angiosperm dicotyledons		
Anacardiaceae		
Pistacia mutica Fisch. et C.A.Mey.	3	C
Araliaceae		
Hedera pastuchowii Woronow	2	C
Aristolochiaceae		
Aristolochia manchuriensis Kom.	1	FE

Caprifoliaceae		
Lonicera etrusca Santi	3	C
Lonicera tolmatchevii Pojark.	2	FE
***Fabaceae* (*Leguminosae*)**		
Genista humifusa L.	3	C
Genista tanaitica P.Smirn.	3	E
Lespedeza cyrtobotrya Miq.	3	FE
Pueraria lobata (Willd.) Ohwi	3	FE
Juglandaceae		
Pterocarya pterocarpa (Michx.) Kunth ex Iljinsk.	3	C
Myricaceae		
Myrica gale L.	2	E
Rosaceae		
Amygdalus pedunculata Pall.	3	ES
Cotoneaster lucidus Schlecht.	3	ES
Exochorda serratifolia S.Moore	1	FE
Sorbocotoneaster pozdnjakovii Pojark.	3	ES
Salicaceae		
Salix gordejevii C.C.Chang et A.Skvortsov	1	ES
Staphyleaceae		
Staphylea pinnata L.	3	C
Vitaceae		
Ampelopsis japonica (Thunb.) Makino	1	FE

* **Categories**: 1 - threatened, 2 - shrinking in number, 3 - rare;
** **Regions**: E - Eastern Europe, C - Caucasus, ES - Easten Siberia, FE - Far East
(by Cherepanov, 1995)

Table IV.5. **Species of trees, shrubs and woody vines used in the Russian Federation**

Species	Native (N), exotic (E)	Current uses (code)*	Type of management system	Area managed, thousand ha (for 01.01.2011)
Main forest forming species				
Coniferous				
Pine	N	1,2,3,4,5,6	natural forest, plantation , agro-forestry	120 065,4 (mostly Pinus sylvestris L.)
Spruce	N	1,2,3,4,5,6	natural forest, plantation , agro-forestry	77 793,2
Fir	N	1,2,3,4,6	natural forest, plantation	14 220,7
Larch	N	1,2,3,4,6	natural forest, plantation	275 842,4
Siberian stone pine *Pinus sibirica* Du Tour	N	1,2,3,4,6	natural forest, plantation	38 872,8
Korean pine *Pinus koraiensis* Siebold. et Zucc.	N	1,2,3,4,6	natural forest, plantation	
Juniper	N	1,3,4,5,6	natural forest, agroforestry	2,2
Hard-wooded broadleaved				

Species	Native (N), exotic (E)	Current uses (code)*	Type of management system	Area managed, thousand ha (for 01.01.2011)
Oak	N	1,3,4,5,6	natural forest, plantation , agro-forestry	6894,0 (including 3673,5 of seed origin and 3220,5 –vegetative)
Beech	N	1,2,3,4,5,6	natural forest, plantation , agro-forestry	685,9
Hornbeam	N	1,3,5,6	natural forest, plantation , agro-forestry	273,4
Ash	N, E	1,2,3,4,5,6	natural forest, plantation , agro-forestry	664,2
Maple	N	1,3,4,5,6	natural forest, plantation , agro-forestry	340,3
Elm	N	1,3,5,6	natural forest, plantation , agro-forestry	383,8
Stone birch (*Betula davurica* Pall.; *B. ermanii* Cham.; *B. costata* Trautv.)	N	1,3	natural forest, forest plantations	8874,3
Saxaul	N	1,3,5	planted forest, agroforestry	0,7
Locust *Robinia pseudoacacia* L.	E	1,4,5,6	planted forest, agroforestry	57,8
Soft-wooded broadleaved				
Birch	N	1,2,3,4,5,6	natural forest, plantation , agro-forestry	115967,6
Aspen Populus tremula L.	N	1,2,3,5,6	natural forest, plantation , agro-forestry	23794,9
Speckled alder Alnus incana (L.) Moench	N	1,2,3,4,5,6	natural forest, plantation , agro-forestry	2582,1
Common alder *Alnus glutinosa* (L.) Gaert.	N	1,2,3,4,6	natural forest, plantation	954,2
Alder *Alnus hirsuta* (Spach) Turcz. et Rupr.	N	1,3,4,5,6	natural forest, agroforestry	
Linden	N	1,4,5,6	natural forest, plantation , agro-forestry	3349,2
Poplar	N	1,2,3,4,5,6	natural forest, plantation , agro-forestry	961,9
Woody willows	N	1,3,4,5,6	natural forest, plantation , agro-forestry	1589,5
Chosenia *Chosenia arbutifolia* (Pall.) A. Skvorts.	N	1,2,5	natural forest	No data
Other tree species				
Apricot	N	4,5,6	natural forest, plantation , agro-forestry	1,9
Japanese angelica tree *Aralia elata* (Miq.) Seem.	N	4,6	natural forest	No data
Amur cork tree *Phellodendron amurense* Rupr.	N	1,4,6	natural forest, plantation	1,1
Eastern hornbeam *Carpinus orientalis* Mill.	N	1,4,6	natural forest, plantation	4,7
Honeylocust	E	4.5.6	planted forest, agroforestry	5,3

Species	Native (N), exotic (E)	Current uses (code)*	Type of management system	Area managed, thousand ha (for 01.01.2011)
Pear	N	1,4	natural forest, planted forest	28,4
Zelkova	N	1,4,6	planted forest	0,4
Cork oak *Quercus suber* L.	E	4,5,6	planted forest, agroforestry	No data
Hackberry	N	1,4,5	planted forest	No data
Candle tree	E	6	planted forest	No data
Chestnut *Castanea sativa* Mill.	N	1,4,5,6	natural forest, plantation , agro-forestry	21,0
Wing nut	E	4,6	planted forest	No data
Almond	N	4,5,6	natural forest, plantation , agro-forestry	No data
Circassian walnut *Juglans regia* L.	E	1,4,5,6	natural forest, plantation , agro-forestry	10,2
Manchurian walnut *Juglans mandshurica* Maxim.	N	1,4,5,6	natural forest, plantation , agro-forestry	6,8
Sorbus	N	4,5,6	natural forest, plantation , agro-forestry	0,1
Box tree	N	1,6	natural forest, plantation	0,7
Alycha *Prunus divaricata* Ledeb.	N	4,5,6	natural forest, agroforestry	0,7
Yew	N	1,4,5,6	natural forest	No data
Pistachio	N	1,4,5,6	natural forest, plantation , agro-forestry	0,1
Bird cherry	N	1,4,6	natural forest, agroforestry	8,1
Sweet cherry *Cerasus avium* (L.) Moench	N	1,4,6	natural forest, plantation	No data
Mulberry	E	1,4,5,6	natural forest, plantation , agro-forestry	0,4
Eucommia	E	3,5	planted forest, agroforestry	No data
Apple tree	N	1,4,5,6	natural forest, planted forest, agroforestry	5,0
Shrubs				
Bamboo	N	6	natural forest	1,7
Barberry	N	4,5,6	natural forest, agroforestry	No data
Dwarf birch	N-	3,4	natural forest	27416,8
Spindle tree	N	4,5,6	natural forest, agroforestry	0,2
Hawthorn	N	4,5,6	natural forest, agroforestry	2,8
Elder	N	4,5,6	natural forest, agroforestry	No data
Grapes	N	4,6	natural forest, plantations	No data
Tamarisk	N	3,4,5,6	natural forest, agroforestry	7,5
Calligonum *Calligonum aphyllum* (Pall.) Guerke	N	3,4,5	natural forest, agroforestry	5,1
Honeysuckle	N	4,5,6	natural forest, agroforestry	No data
Marsh elder	N	3/4/5/6	natural forest, agroforestry	4978,9
Arrowwood	N	4,5,6	natural forest, agroforestry	No data
Pea shrub	N	5,6	natural forest, agroforestry	No data

Species	Native (N), exotic (E)	Current uses (code)*	Type of management system	Area managed, thousand ha (for 01.01.2011)
Siberian dwarf-pine *Pinus pumila* (Pall.) Regel	N	3,4	natural forest	38555,4
Gooseberry	N	4	natural forest, planting	No data
Hazel	N	3,4,5,6	natural forest, agroforestry	10,5
Oleaster	N, E	4,5,6	natural forest, agroforestry	7,4
Juniper	N	4,6	natural forest	0,8
Sea buckthorn	N	4,5,6	natural forest, plantation, agro-forestry	5,7
Rhododendron	N	4, 6	natural forest	0,4
Dogwood	N	5,6	natural forest, agroforestry	No data
Currant	N	4,5,6	natural forest, agroforestry	3,4
Meadowsweet	N	6	natural forest, planting	No data
Mock orange	N	6	natural forest	No data
Dog-rose	N	4,5,6	natural forest, agroforestry	No data

* **Uses**: 1 Solid wood products 2 Pulp and paper, 3 Energy 4 Non-wood forest products (food, fodder, medicines, etc.), 5 Used in agroforestry systems (shelterbelts, erosion control planting, forestry horticulture etc.) 6 Other (planting of greenery, landscaping)

Table IV.6. **Main species of trees, shrubs and woody vines, providing environmental services or social values**

Species	Native (N) and exotic (E)	Environmental service or social value (code*)
Main forest forming species		
Pine	N	1,3,4,5
Spruce	N	1,3,4,5,6
Fir	N	1,3,4,5
Larch	N	1,3,4,5
Cedar *Pinus sibirica* Du Tour, *P. koraiensis* Siebold. et Zucc.	N	1,3,4,5
Juniper	N	1,3,4,5,6
Oak	N	1,2,3,4,5
Beech	N	1,2,3,5
Hornbeam	N	1,2,3,5
Ash	N	1,2,3,5
Maple	N	1,2,3,5
Elm	N	1,2,3,5
Stone birch (*Betula davurica* Pall.; *B. ermanii* Cham.; *B. costata* Trautv.)	N	1,2,3
Saxaul	N	1,3
Locust *Robinia pseudoacacia* L.	E	1,3,5
Birch	N	1,2,3,4,5,6
Aspen *Populus tremula* L.	N	1,2,3,5,6
Speckled alder *Alnus incana* (L.) Moench	N	1,2,3,5

Species	Native (N) and exotic (E)	Environmental service or social value (code*)
Common alder Alnus glutinosa (L.) Gaert.	N	1,2,3,5
Linden	N	1,2,3,4,5
Poplar	N	1,3,5
Woody willows	N	1,3,5,6
Other woody species		
Apricot	N	1,3
Amur cork tree *Phellodendron amurense* Rupr.	N	3,5
Eastern hornbeam *Carpinus orientalis* Mill.	N	3,5
Honeylocust	E	1,3,5
Pear	N	1,2,3
Cork oak *Quercus suber* L.	E	1,3,5
Hackberry	N	1,3
Candle tree	E	1,3
Sweet chestnut *Castanea sativa* Mill.	N	1,3,5
Wing nut	N	1,3,5
Almond	N	1,3,5
Circassian walnut	E	1,3,4,5
Manchurian walnut *Juglans mandshurica* Maxim.	N	1,3,4,5
Sorbus	N	1,3,4,5
Box tree	N	1,3,5,6
Alycha *Prunus divaricata* Ledeb.	N	1,3
Yew	N	1,3,5,6
Pistachio	N	1,2,3,5
Bird cherry	N	1,2,3,5
Sweet cherry *Cerasus avium* (L.) Moench	N	3
Chosenia *Chosenia arbutifolia* (Pall.) A. Skvorts. (Chosenia macrolepis (Turcz.) Kom.)	N	1,2,3
Mulberry	N, E	1,2,3,4,5
Apple tree	N, E	1,3,4,5
Shrubs		
Bamboo	N	1,2,3,5
Barberry	N	1,3,5
Dwarf birch	N	1,2,3
Spindle tree	N	1,3,5
Hawthorn	N	1,3,5
Elder	N	1,2,3
Cherry	N	2,3,4
Tamarisk	N	1,3,5
Calligonum *Calligonum aphyllum* (Pall.) Guerke	N	1,3

Species	Native (N) and exotic (E)	Environmental service or social value (code*)
Marsh elder	N	1,5,6
Siberian dwarf-pine *Pinus pumila* (Pall.) Regel	N	1,2,3,4
Hazel	N	1,3,5,6
Oleaster	N, E	1,3,5
Juniper	N	1,3,4,5,6
Sea buckthorn	N	1,2,3,4,5
Rhododendron	N	1,2,3,4,5
Dogwood	N	1,3,5

* Services and values include: 1 soil and water conservation, including watershed management 2 Soil fertility, 3 Biodiversity conseravtion, 4 Cultural Values, 5 Aesthetic values, 6 Religious values.

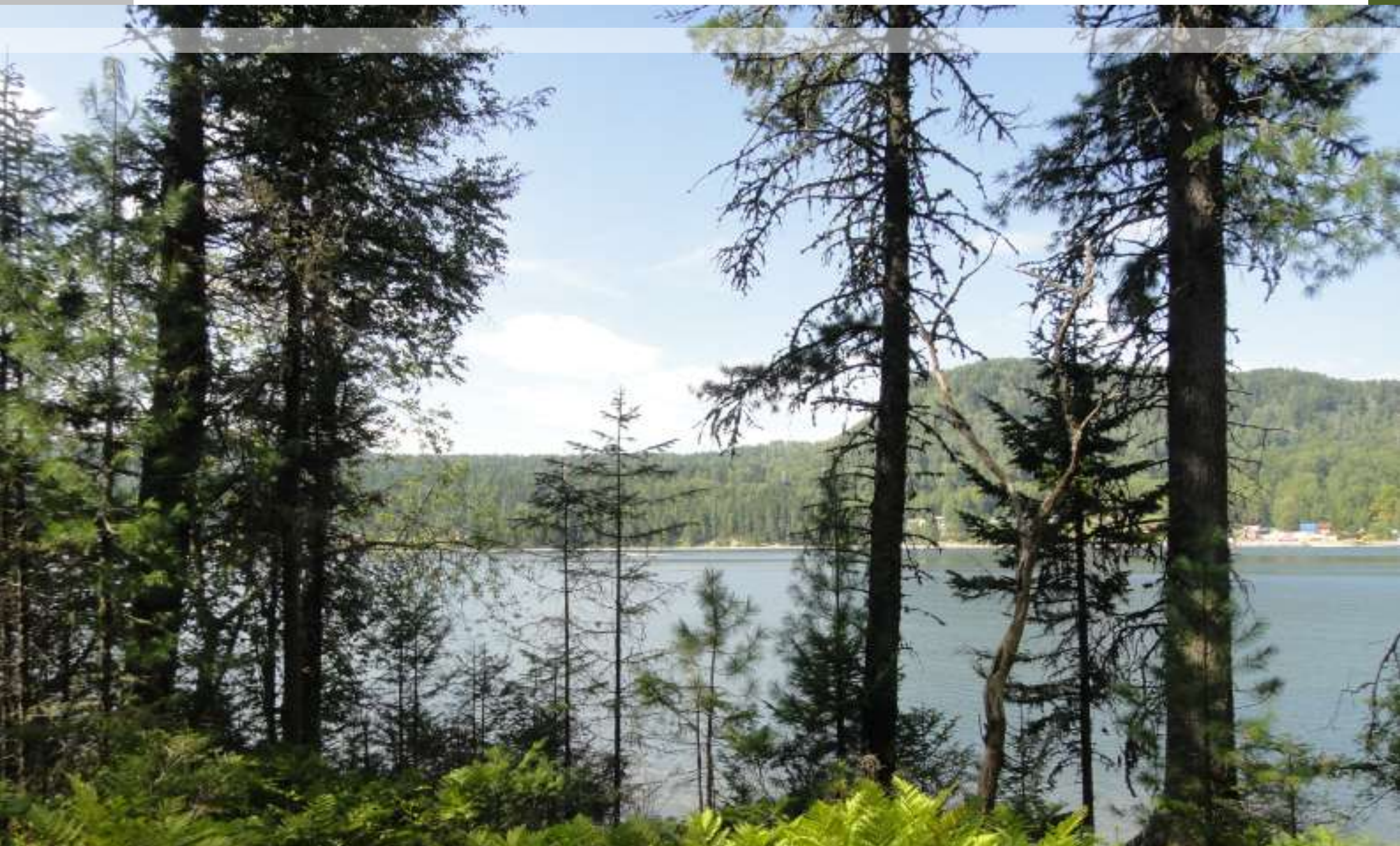


Table IV.7. **Species of trees, shrubs and woody vines in the Russian Federation fully or partially endangered in terms of genetic resources conservation**

Species (scientific name)	Area (ha) of species' natural distribution	Average number of trees per hectare	Proportion of species' natural distribution (%)	Distribution in the country: widespread (W), rare (R), or local (L)	Type of threat (Code**)	Threat category		
						High	Medium	Low
Trees								
Japanese maple – *Acer japonicum* Thunb. (1)*	no data; Sakhalin region (Kunashir)	no data; total around 10 individuals	no data; nothern border of the area.	L	15	+		
Turpentine tree *Pistacia mutica* Fisch. et C.A. Mey (3)	around 232 ha	416-862 individual/ha	no data; nothern border of the area.	L	3,4,5,7, 11,12		+	
Prickly castor-oil tree *Kalopanax septemlobus* (Thunb.) Koidz. (3)	no data; 100 stations; south of Primorsky Krai, Sakhalin region	From 4 to 12-16 (20) individual/ha. Total population is 5-20 thousand individuals	no data; nothern border of the area.	L	3,12,15		+	
Maximovich birch *Betula maximowicziana* Regel (1)	no data; Sakhalin region (Island Kunashir)	no data; total population is several hundreds of individuals	no data; nothern border of the area.	L	15	+		
Raddea birch *Betula raddeana* Trautv.(3)	no data; Caucaus (upper forest – lower subalpain belt)	no data	no data; Endemic of Caucasus	R	3,4,15			+
Iron birch *Betula schmidtii* Regel (3)	Total distribution area is around 800 km² 80000 ha), area of forest with the participation of species is 10% and more – around 25 thousand ha; South of Primorsky Krai	no data; single or in small groups	no data; nothern border of the area.	L	3,12			+
Turkish hazel *Corylus colurna* L. (2)	no data; Caucasus	no data	no data; nothern border of the area.	R	3,15		+	
European hop-hornbeam *Ostrya carpinifolia* Scop. (2)	no data; Caucasus	no data	no data; nothern-eastern border of the area	R	3,4,12, 15		+	
Box tree *Buxus colchica* Pojark. (2 a)	no data; Caucasus	no data; total population is from 20 to 100 thousand individuals	no data	R	3,6			+
Bothocaryum *Bothrocaryum controversum* (Hemsl. ex Prain) Pojark. (3)	no data; Kunashir Island-Sakhalin region	no data; total population is up to 500 individuals; found single	no data; nothern-eastern border of the area.	L	4,15		+	

Species (scientific name)	Area (ha) of species' natural distribution	Average number of trees per hectare	Proportion of species' natural distribution (%)	Distribution in the country: widespread (W), rare (R), or local (L)	Type of threat (Code**)	Threat category		
						High	Medium	Low
Oriental persimon *Diospyros lotus* L. (3)	no data	no data	no data	R	3,4,15			+
Oak – *Quercus dentata* Thunb. (3)	no data; South of Primorsky Krai, Sakhalin region	no data; insignificant number	no data; nothern border of the area	R	12,3,4, 15			+
Walnut *Juglans ailanthifolia* Carr. (3)	no data; Sakhalin region (Southern part of the Sakhalin Island and the Kunashir Island)	no data; total population is 500-1000 individuals	less than 1 %; nothern-eastern border of the area	L	15		+	
Wig-nut – *Pterocarya pterocarpa* (Michx.) Kunth ex I. Iljinsk. (3)	no data; Krasnodar Territory (Black Sea coast from River Ashe to River Psou) and dagestan (Samur estuary)	no data; total population is 1-5 thousand individuals	less than 1 %; nothern border of the area	R	4,1		+	
Magnolia – *Magnolia hypoleuca* Siebold et Zucc. *(Magnolia obovata* Thunb.*)* (1)	no data; Sakhalin region (Kunashir Island)	no data; total population is – up to 500 individuals	less than 1 %; nothern border of the area	L	15	+		
Manchurian apricot *Armeniaca mandshurica* (Maxim.) Skvorts. (3)	no data; South of Primorsky Krai	Commonly not more than 100 individual/ha, more rarely – up to 200 and more	no data; nothern-eastern border of the area.	R	6,4,12, 11			+
Colchis bladdernut *Staphylea colchica* Stev. (3)	no data; Krasnodar Territory (Black Sea coast from Anapa to Sochi)	no data; total population is from 20 to 100 thousand individuals	less than 5 %; Endemic of Caucasus	R	15,4			+
Pinnate bladdernut *Staphylea pinnata* L. (3)	no data	no data; total population is around 20 thousand individuals	no data	R	4			+
Linden Maximowic *Tilia maximowicziana* Shirasawa (1)	no data; Sakhalin region (Kunashir Island)	no data; total several hundreds ofindividuals	less than 1 %; nothern border of the area	L	15	+		
Grecian juniper *Juniperus excelsa* Bieb. (2)	no data; Krasnodar Territory (Black Sea coast from Sukko River to Mezyb River)	no data; total population is 1-5 thousand individuals	no data; border of the area	R	4,6,11			+
Stinking juniper *Juniperus foetidissima* Willd. (2)	no data; Krasnodar Territory, Republic of Dagestan	no data; total population is 1-5 thousand individuals	no data; border of the area	R	4			+

Species (scientific name)	Area (ha) of species' natural distribution	Average number of trees per hectare	Proportion of species' natural distribution (%)	Distribution in the country: widespread (W), rare (R), or local (L)	Type of threat (Code**)	Threat category		
						High	Medium	Low
Needle juniper *Juniperus rigida* Siebold et Zucc. s.l. (2)	no data; Primorsky Krai (south)	no data; total population is 1-2 thousand individuals	no data; nothern border of the area	R	15,12,6			+
Korean Dahurian larch *Larix olgensis* A. Henry (2)	16,5 thousand ha; Primorsky Krai (south)	no data; forest forming species	no data	W	12,3,5, 15			+
Sakhalin spruce *Picea glehnii* (Fr. Schmidt) Mast. (3)	no data; Sakhalin region (Sakhalin Island and Southern Kurils)	no data; total population is more than 500 thousand individuals	no data; nothern border of the area	R	4,12			+
Japanese red pine *Pinus densiflora* Siebold et Zucc. (2)	12,3 thousand ha (with participation and domination of the species); Primorsky Krai (south)	no data; does not form solid wood, found single or in groups	no data; nothern border of the area	R	4,12			+
Pallasiana pine *Pinus pallasiana* D. Don. (1)	less than 1000 ha; Krasnodar Territory (Black Sea coast of Caucasus)	800-1100 individual/ha (without sprouting and staddle)	no data	L	4,12,6, 11		+	
Pitsunda pine Pinus pityusa *Stev.* [P. brutia Ten. subsp.pityusa (Stev.) Nahal] (2)	around 1200 ha; Krasnodar Territory (coast from Anapa to Adler)	no data	no data; endemic race of the Black Sea coast of Caucasus	R	4,6		+	
Pine *Pinus sylvestris L. var. cretacea* Kalen. *[P. cretacea (Kalenicz.)* Kondr.*]* (3)	no data	no data; total several hundreds of mature individuals	no data; rare ecotype of common pine	R	4,6,7		+	
Common yew *Taxus baccata* L. (2)	no data; Caucasus	no data	no data	R	3,4,15			+
Japanese yew *Taxus cuspidata* Siebold et Zucc. ex Endl. (3)	no data; Primorye Khabarovsk Territory (south-east), Sakhalin region (Sakhalin Island and Southern Kurils)	no data; in Primorsky Krai 10 thousand individuals, in the Khabarovsk territory – around 300 individuals	no data; nothern border of the area	R	15,12,4			+
Shrubs								
Holly *Ilex sugerokii* Maxim.(3)	no data; not more than 10 stations; Sakhalin region (south)	no data; total population is 100-500 thousand individuals	no data; nothern border of the area	L	4,12			+

Species (scientific name)	Area (ha) of species' natural distribution	Average number of trees per hectare	Proportion of species' natural distribution (%)	Distribution in the country: widespread (W), rare (R), or local (L)	Type of threat (Code**)	Threat category		
						High	Medium	Low
Devil's club *Oplopanax elatus* (Nakai) Nakai (2)	no data; South of Primorsky Krai	no data; total population is 1-5 thousand individuals	no data; nothern border of the area	R	12,15		+	
Tolmachev honeysuckle *Lonicera tolmatchevii* Pojark. (2)	60-70 km^2; Sakhalin region (Tym river basin)	no data; total population is 500-1000 individuals	100 %	L	1,4,15	+		
Spindle tree *Euonymus nana* Bieb. (1)	no data; Central Caucasus – from the upstream of Teberda till the revine of Cherek Benzegiyski	no data; total population is not more than a thousand individuals	no data;	L	4,15	+		
Daphniphyllum humile Maxim. ex Franch. et Savat. (2)	no data; Kunashir Islands and Iturup in the Sakhalin region	no data; probable total population is 1-5 thousand individuals	no data; nothern border of the area	L	4,12,15		+	
Rhododendron *Rhododendron fauriei* Franch. (3)	around 10 thousand ha Primorsky Krai (Sikhote-Alin reserve)	no data; 8 local popultions are known	no data; nothern-eastern border of the area	L	15,12			+
Schlippenbach's rosebay *Rhododendron schlippenbachii* Maxim. (2)	no data; South of the Khasan region and South of Primorsky Krai	no data	no data; nothern-eastern border of the area	L	1,12,4,6		+	
Tschonoskii rhododendron *Rhododendron tschonoskii* Maxim. (3)	no data; south of the Kunashir Island Sakhalin region	no data; total population is 1-5 thousand individuals	no data; nothern-eastern border of the area	L	15			+
Leptopus *Leptopus colchicus* (Fisch. et C.A. Mey. ex Boiss.) Pojark. (3)	Krasnodar Territory (from River Sochi til River Psou)	total population is not more than 3-5 thousand individuals	no data; major part is in the area in Georgia	L	15,3,6		+	
Astracantha *Astracantha arnacantha* (Bieb.) Podlech. [*Astragalus arnacantha* Bieb.] (2)	no data; Krasnodar Territory (Black Sea coast from Anapa to Novorossiysk and Gelendzhik)	no data; 8 local populations are known	50 %	L	4,6	+		
Calophaca wolgarica (L. fil.) DC. (2)	no data; Stavropol Territory, Republic of Kamykiya, Astrakhan, Volgograd, Orenburg, Rostov, Samara, Ulyanovsk regions	no data; populations are very few, found single or in small groups	more than 50 %; Endemic to the south-east of Europe	R	4,6,15		+	

Species (scientific name)	Area (ha) of species' natural distribution	Average number of trees per hectare	Proportion of species' natural distribution (%)	Distribution in the country: widespread (W), rare (R), or local (L)	Type of threat (Code**)	Threat category		
						High	Medium	Low
Eremosparton *Eremosparton aphyllum* (Pall.) Fisch. et C.A. Mey. (2)	no data; noth and north-west of the Caspian Sea region	no data	no data; western and northern-western border of the area; main part is in Kazakhstan	R	5,15			+
Ewersmannia *Ewersmannia subspinosa* (Fisch. ex DC.) B. Fedtsch. (1)	no data; only in Bolshoy Bogdo in the Astrakhan region	no data; total several hundreds of generated individuals in 2 p	less than 1 %; western most range	L	15,12,6	+		
Greenweed *Genista albida* Willd. (3)	no data; Krasnodar and Stavropol Territory, Dagestan and Adygeya	no data	around 60 %; Crimean and Caucasian endemic;	R	4,6		+	
Don greenweed *Genista tanaitica* P. Smirn. (3)	no data; Belgorodsk, Voronezh, Kursk, Rostov and Volgograd regions	no data; found single or in small groups	100 %; Endemic to thesouth-eastern European part of Russia (Donetsk-Don)	R	5,4			+
Bushchat *Lespedeza cyrtobotrya* Miq. (3)	no data; Primorsky Krai (south of the Khasan region)	no data; in forests – found single or in small groups, forms tangles on open rolling	less than 1 %; nothern border of the area	L	15,12,4			+
Deutzia *Deutzia glabrata* Kom. (2)	no data; the Jewish Autonomous Region (Bira and Bidzhan river basins, Leninsk, Smidovich, Oktyabrsk regions), south of Primorsky Krai (Nezhinka river basin)	no data; total not less than 500-1000 individuals	no data; nothern-eastern border of the area	R	15,12,4,6		+	
Gale *Myrica gale* L. (2)	no data; Republic of Karelia, Leningrad region	no data; total around 10 thousand individuals	no data; eastern border of the area	R	4,12		+	
Almond *Amygdalus pedunculata* Pall. (3)	no data; Republic of Buryatia	no data	less than 1 %; 4 sites	R	11,4,12			+
Alaut cotoneaster *Cotoneaster alaunicus* Golits. (3)	no data; Moscow, Tula, Oryol, Ryazan, Kursk, Voronezh, Belgorodsk, Volgograd, Samara region, Udmurtia	no data; from single individuals up to several dozens per population	100 %; Endemic to the Central Russian Upland	R	4,12			+

Species (scientific name)	Area (ha) of species' natural distribution	Average number of trees per hectare	Proportion of species' natural distribution (%)	Distribution in the country: widespread (W), rare (R), or local (L)	Type of threat (Code**)	Threat category		
						High	Medium	Low
Cotoneaster *Cotoneaster cinnabarinus* Juz. (3)	no data; the Kola Peninsula and Nothern Korelia	no data; total not more than 1000 individuals	100 %; Endemic to Russia (Eastern Fennoscandia)	R	15,4			+
Cotoneaster *Cotoneaster lucidus* Schlecht. (3)	no data; the Republic Buryatia, Irkutsk region	no data; insignificant in number. Does not form continuous thickets, scattered (sngle or in groups)	100 %; Endemic to Russia (south of Central Siberia)	R	4,12			+
Cherry princepia *Princepia sinensis* (Oliv.) Bean (2)	no data; Primorsky Krai (south)	no data; approximate population 500-1000 individuals	no data; north-western border of the area	L	4,12,15,11		+	
Perlbush *Exochorda serratifolia* S. Moore (1)	no data; Primorsky Krai (sothwestern part)	no data; total around 350 individuals	no data; 2 northwestern most sites of the species area	L	15,12	+		
False spiraea *Sorbaria rhoifolia* Kom. (3)	no data; Primorski Krai and Khabarovsk Territory (east)	no data; total population is 20 - 100 thousand individuals	100 %; Endemic to Russia (Sikhote Alin)	R	12,4			+
Podznjakov sorbocotoneaster *Sorbocotoneaster pozdnjakovii* Pojark. (3)	no data; Yakutia (south-east of the Aldan river), Khabarovsk Territory (north of the Uda river basin)	no data; 8 populations, 30 and more individuals in each	100 %; Endemic to Russia (south of Yakutia and an isolated population in the Amur region)	R	12,4			+
Gordeev willow *Salix gordejevii* Chang et Skvorts. (1)	no data; the Zabaikalye Territory	no data; total less than 500 individuals	no data; one population	L	5	+		
Altai daphne *Daphne altaica* Pall. *(*incl. *D. sophia* Kalen.*, D. taurica* Kotov*)* (1)	no data; the Altai Territory, Belgorodsk region	no data; total in the European part of Russia from 500 to1000 individuals; in Siberia – no data	no data; border of the area	R	15,4,12	+		
Baksan daphne *Daphne baksanica* Pobed. (1)	no data; the Kabardino-Balkarian Republic	no data; total not more than 500 individuals	100 %; Local Endemic to Russia (Central Caucasus)	L	15,4	+		

Species (scientific name)	Area (ha) of species' natural distribution	Average number of trees per hectare	Proportion of species' natural distribution (%)	Distribution in the country: widespread (W), rare (R), or local (L)	Type of threat (Code**)	Threat category		
						High	Medium	Low
Daphne *Daphne cneorum* L. (3)	no data; in Bryansk region-around 10 ha; Bryansk and Kursk region	no data; total several thhousand individuals	no data; nothern-eastern border of the area.	R	15,4,6			+
Wright viburnum *Viburnum wrightii* Miq.(3)	no data; Sakhalin region (south of the Sakhalin Island and the Southern Kurils)	no data; total 1-5 thousand individuals	no data; nothern border of the area.	R	12,4,15		+	
Shore juniper *Juniperus conferta* Parl. (3)	no data; Sakhalin region (south of the Sakhalin Island)	no data; total 500-1000 thousand individuals	no data; nothern border of the area.	R	4,6		+	
Sargent juniper *Juniperus sargentii* (A. Henry) Takeda ex Koidz. (3)	Around 1000 ha; Sakhalin region (south of the Sakhalin Island and the Southern Kurils)	no data; total 30-40 stations	no data; nothern border of the area.	R	15,6,12			+
Microbiota *Microbiota decussata* Kom. (2)	no data; the biggest populations occupy areas around 1000 ha Primorsky Krai (southern and western spurs of Sikhote-Alin) and Khabarovsk Territory (south till the borders of the Khor and Anuy rivers)	no data; total 30-40 sites	no data;	R	15,6,12			+
Vines								
Pastuchov ivy *Hedera pastuchowii* Woronow (2)	no data; around 5 stations	no data; populations are insignificant in number	no data; nothern border of the area	L	4,7		+	
Manchurian birthwort*Aristolochia manshuriensis* Kom. (1)	no data; Primorsky Krai (south)	no data; total population is less than 500 individuals	no data; nothern border of the area	L	1,4,12, 15	+		
Pueraria *Pueraria lobata* (Willd.) Ohwi (3)	no data; Primorsky Krai (south of the Khasan region)	no data; few in number, found in small grpoups	less than 1 %; nothern border of the area	L	15,12,4		+	

Species (scientific name)	Area (ha) of species' natural distribution	Average number of trees per hectare	Proportion of species' natural distribution (%)	Distribution in the country: widespread (W), rare (R), or local (L)	Type of threat (Code**)	Threat category		
						High	Medium	Low
Hortensia *Hydrangea petiolaris* Siebold et Zucc. (3)	no data; Sakhalin region (sothern part of the Sakhalin Isalnd, the Souther Kurils)	no data; total population is 20-100 thousand individuals (around 50 stations)	no data; nothern border of the area	R	4,12			+
Schizophragma hydrangeoides Siebold et Zucc. (1)	no data; Sakhalin region (Kunashir Island)	no data; total population is 500-1000 individuals	less than 1 %; nothern-eastern border of the area	L	15,4,12		+	

* – In brackets we provide the category of the rarity status of species (subspecies) of wild plants listed in the Red Book of the Russian Federation. The table includes the species of tree and shrub species listed in the Red Book of the Russian Federation (plants and fungi (2008) and with the status of rarity: 0 - probably extinct, 1 - threatened 2 - dwindling in number 3 - rare. 4 – no certain status

** Type of threat:
1 Forest cover reduction and degradation 9 Acidification of soil and water
2 Forest ecosystem diversity reduction and degradation 10 Pollutant emissions
3 Unsustainable logging 11 Pests and diseases
4 Management intensification 12 Forest fires
5 Competition for land use 13 Drought and desertification
6 Urbanization 14 Rising sea level
7 Habitat fragmentation 15 Other (please specify) ___________________
8 Uncontrolled introduction of alien species

Table IV. 8a. **The annual quantity of seeds produced and current state of identification of main forest trees other woody species**

Scientific name	Native (N) or Exotic (E)	Total quantity of seeds used (Kg)	Quantity of seeds from documented sources (provenance/ delimited seed zones)	Quantity of seeds from tested provenances (provenance trials established and evaluated)	Quantity that is genetically improved (from seed orchards)
Total	*N*	469135,24	469135,24	7818,38	387,00
Coniferous	*N*	166698,86	166698,86		
Pine	*N*	40602,41	40602,41		
Spruce	*N*	5745,45	5745,45		
Cedar	*N*	2366,80	2366,80		
Larch	*N*	117777,20	117777,20		

Oak	*N*	38529,30	38529,30		

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

Species/ Scientific name	Native (N) or exotic (E)	Total quantity of seedlings planted, thousand items	Quantity of seedlings from documented sources (provenance/ delimited seed zones), thousand items.	Quantity of seedlings from tested provenances (provenance trials established and evaluated)	Quantity of vegetative reproductive material used	Quantity of seedlings that are genetically improved
Total		780 000*	34048,80			

* The official statistical reporting FFA does not provide any information on the number of formation of planted seedlinds / saplings. However, indirectly, the amount of these works can be seen from the amount of the created forest plantations and afforestation sites in the country. Thus, according to the official data in 2011 the Russian Federation established 195,404 hectares of forest plantations, and 628.2 hectares of afforestation sites. Consequently, while the standard is four thousand seedlings per 1 ha of forest plantations, only in 2011 about 780 million units of seedlings of various species of forest plants were planted in the country.

Table IV.9. **List forest species for which genetic variability has been evaluated**

Species		Morphological traits	Adaptive and production characters assessed	Molecular characterization
Morphological traits	Adaptive and production characters assessed			
			+	+
Picea obovata	*N*	+	+	+
Picea koraiensis	*N*	+		+
Picea ajanensis (= P. jezoensis)	*N*	+	+	+
Picea glehnii	*N*	+		+
Picea ajanensis (= P. microsperma)	*N*	+		+
Pinus sylvestris	*N*	+	+	+
Pinus sibirica	*N*	+	+	+
Pinus koraiensis	*N*	+	+	+
Pinus pumila	*N*	+		+
Abies sibirica	*N*	+	+	+
Abies nordmanniana	*N*	+		+
Abies holophylla	*N*	+		+
Abies nephrolepis	*N*	+		+
Abies sachalinensis	*N*	+		+
Abies sachalinensis var. gracilis	*N*	+		+
Larix sibirica	*N*	+	+	+
Larix x czekanowskii	*N*	+	+	+
Larix kamtschatica	*N*	+		+
Larix cajanderi	*N*	+	+	+
Larix olgensis	*N*	+		+
Juniperus communis	*N*	+		+
Juniperus sabina	*N*	+		+
Quercus robur	*N*	+	+	+
Tilia cordata	*N*			
Betula pendula	*N*	+	+	+
Betula pubescens	*N*	+	+	
Populus tremula	*N*		+	+
Populus alba	*N*		+	
Alnus incana	*N*	+	+	
Alnus glutinosa	*N*	+	+	
Salix spp.	*N*	+	+	

Table IV.10. **Target species of trees that are included in the *in situ* conservation programmes / unit (as of January 1, 2012)**

Species	Purpose for establishing conservation unit	Number of populations or stands conserved	Total area, ha
Common pine *Pinus sylvestris* L.	plus stands		9395,2
	permanent seed orchards		5952,4
	forest genetic reserves		102683,5
Weymouth pine *Pinus strobus* L.	plus stands		9,2
Pine *Pinus sylvestris* L. *var. cretacea* Kalen.	forest genetic reserves		191,5
Pine *Pinus kochiana* Klotzsch ex C. Koch	permanent seed orchards		10,0
Crimean pine *Pinus pallasiana* D. Don	permanent seed orchards		37,2

Species	Purpose for establishing conservation unit	Number of populations or stands conserved	Total area, ha
Western yellow pine *Pinus ponderosa* Douglas ex C.Lawson	permanent seed orchards		4,2
Common spruce *Picea abies* (L.) Karst.	plus stands		1536,9
	permanent seed orchards		1183,1
	forest genetic reserves		19699,6
Siberian spruce *Picea obovata* Ledeb.	plus stands		186,7
	permanent seed orchards		613,0
	forest genetic reserves		4198,0
Hybrid spruce *Picea x mariorika* Boom (*P. mariana* (Mill.) Britton, Sterns & Poggenb. *x P. omorica* (Pancic) Purkyne)	permanent seed orchards		121,2
Spruce *Picea ajanensis* (Lindl. et Gord.) Fisch.	permanent seed orchards		45,0
	forest genetic reserves		4519,4
Siberian larch *Larix sibirica Ledeb.*	plus stands		323,9
	permanent seed orchards		202,0
	forest genetic reserves		3645,7
Siberian larch (Ural population) *Larix sibirica Ledeb. (= L. sukaczewii* Dyl.)	plus stands		297,3
	permanent seed orchards		261,0
	forest genetic reserves		12065,7
European larch *Larix decidua* Mill.	plus stands		6,2
Japanese larch *Larix kaempferi* (Lamb.) Carriere	permanent seed orchards		6,0
Japanese larch *Larix kaempferi* (Lamb.) Carriere	plus stands		5,2
Polish larch *Larix x polonica* Racib.	plus stands		3,1
Hybrid larch *Larix x eurolepis* A.Henry *(L. kaempferi* (Lamb.) Carriere *x L. decidua* Mill.*)*	plus stands		5,9
	permanent seed orchards		10,0
Gmelin larch *Larix gmelinii* (Rupr.) Kuzen.	permanent seed orchards		70,0
Gmelin larch (Amur population) *Larix gmelinii* (Rupr.) Kuzen.	permanent seed orchards		32,0
Korean Dahurian larch *Larix olgensis* A. Henry	plus stands		0,5
Cajander larch *Larix cajanderi* Mayr	forest genetic reserves		2430
Kurile larch *Larix kamtschatica* (Rupr.) Carr.	permanent seed orchards		5,0
Gmelin larch (Okhotsk population) *Larix gmelinii* (Rupr.) Kuzen.	permanent seed orchards		83,5
Common silver fir *Abies alba* Mill.	plus stands		1,4
Siberian fir *Abies sibirica* Ledeb	plus stands		141,4
	forest genetic reserves		1537,0
Caucasian fir *Abies nordmanniana* (Stev.) Spach	plus stands		113,0
	permanent seed orchards		18,8

Species	Purpose for establishing conservation unit	Number of populations or stands conserved	Total area, ha
	forest genetic reserves		1708,0
Manchurian fir *Abies holophylla* Maxim.	plus stands		5,5
Siberian stone pine *Pinus sibirica* Du Tour	plus stands		553,9
	permanent seed orchards		3670,1
	forest genetic reserves		10045,9
Korean stone pine *Pinus koraiensis* Siebold et Zucc.	plus stands		125,0
	permanent seed orchards		2483,9
	forest genetic reserves		16915,0
English oak *Quercus robur* L.	plus stands		1166,3
	permanent seed orchards		4265,7
	forest genetic reserves		9979,5
Red oak *Quercus rubra* L.	plus stands		14,3
	permanent seed orchards		99,5
Hartwiss oak *Quercus hartwissiana* Stev.	plus stands		17,9
	permanent seed orchards		155,2
Durmast oak *Quercus petraea* L. ex Liebl.	plus stands		333,8
	permanent seed orchards		234,2
	forest genetic reserves		2232,0
Downy oak *Quercus pubescens* Willd.	forest genetic reserve		516,2
Oak *Quercus variabilis* Blume	permanent sees plantation		1,3
Monglian oak *Quercus mongolica* Fisch. ex Ledeb.	permanent seed orchards		5,0
Oriental beech *Fagus orientalis* Lipsky	plus stands		514,4
	permanent seed orchards		344,3
	forest genetic reserves		4857,7
Silver birch *Betula pendula* Roth	plus stands		171,3
	permanent seed orchards		46,5
	forest genetic reserves		4869,5
Karelian birch *Betula pendula Roth var. carelica* (Merckl.) Hämet-Ahti	permanent seed orchards		60,8
Circassian walnut *Juglans regia* L.	permanent seed orchards		40,5
Black walnut *Juglans nigra* L.	plus stands		31,1
	permanent seed orchards		49,8
Small-leafed linden *Tilia cordata* Mill.	plus stands		181,5
	permanent seed orchards		107,0
	forest genetic reserve		2172,9
European ash *Fraxinus excelsior* L.	permanent seed orchards		8,6
Green ash *Fraxinus lanceolata* Borkh.	permanent seed orchards		5,2
Chestnut *Castanea sativa* Mill.	permanent seed orchards		54,9
Turkish hazel *Corylus colurna* Albov	permanent seed orchards		8,6

Species	Purpose for establishing conservation unit	Number of populations or stands conserved	Total area, ha
Pecan nut Carya pecan (Marsh.) Engl.	permanent seed orchards		1,5
Siberian elm *Ulmus pumila* L.	permanent seed orchards		13,0
European white elm *Ulmus laevis* Pall.	permanent seed orchards		2,0
Wych elm *Ulmus glabra* Huds.	permanent seed orchards		2,0
White cedar *Chamaecyparis lawsoniana* (A. Murr.) Parl.	permanent seed orchards		2,1
Black poplar *Populus nigra* L.	forest genetic reserves		737,6
Calligonum *Calligonum aphyllum* (Pall.) Guerke	permanent seed orchards		101,0
Krascheninnikovia ceratoides (L.) Gueldenst.	permanent seed orchards		40,0
Apple tree *Populus nigra* L.	permanent seed orchards		10,0
Robinia *Robinia pseudoacacia* L.	permanent seed orchards		1,8
Black locust *Gleditsia triacanthos* L.	permanent seed orchards		13,1
Honeysuckle *Lonicera tatarica* L.	plus stands		8,6
	permanent seed orchards		5,0
Siberian pea shrub *Caragana arborescens* Lam.	plus stands		6,4
	permanent seed orchards		1,0
Currant *Ribes aureum* Pursh.	plus stands		6,8
	permanent seed orchards		82,3
Grey Douglas fir *Pseudotsuga menziesii* (Mirb.) Franco	plus stands		0,1
	permanent seed orchards		1,5
Red cedar *Thuja plicata* Lamb.	plus stands		0,2
Redwood bur *Sequoia sempervirens* (D. Don) Endl.	permanent seed orchards		0,8
Oriental plane *Platanus orientalis* L.	permanent seed orchards		2,0
Common alder *Alnus glutinosa* (L.) Gaert.	plus stands		2,0
	forest genetic reserves		355,5
Sorbus *Sorbus aucuparia* L.	permanent seed orchards		5,0
Aspen *Populus tremula* L.	plus stands		40,5
	forest genetic reserves		140,5
Total in the forestry fund lands	**plus stands**		15205,5
	permanent seed orchards		20579,6
	forest genetic reserves		205500,7

Table IV.11. **The work on the *ex situ* conservation of forest genetic resources**

Species		Field collections				Germplasm bank			
Scientific name	Native (N) or exotic (E)	Collections, provenance or progeny tests, arboreta or conservation stands		Clone banks*		In vitro (including cryo conser-vation)		Seed banks (not reserve seed funds!)	
		Number of stands	Total population is, ha	Number of banks	Area, ha	Number of banks	Total	Number of banks	Total
Total in the forestry fund lands of the Russian Federation:					*589*				
Pine	N				*311*	-	-		
Spruce	N				*83*	-	-		
Larch	N				*64*	-	-		
Fir					*0*	-	-		
Cedar					*87*	-	-		
Oak					*13*				
Beech					*21*				
Birch					*5*				
Walnut					*0*				
Robinia					*2*				
Other					*5 with robinia*				

*** The data on the area of the clone banks**

Table IV.12. **The number of seeds and propagules transferred internationally per annum - average for 2007-2011. * (According to the Federal Customs Service of the Russian Federation)**

Species	Native (N), exotic (E)	Quantity of seed, kg		Number of vegetative propagules, items		Number of seedlings		Purpose
Scientific name		Import	Export	Import	Export	Import	Export	
Living unrooted cuttings and slips		-	-	7210920	200600	-	-	no data
Grafted trees, shrubs and bushes		-	-	-	-	3824898	301246	no data
Forest trees		175	15	-	-	727719	22330	no data
Rooted cuttings and young trees		-	-	-	-	7815408	139564	outdoor growing
Other trees, shrubs and bushes		-	-	-	-	9622966	13954	outdoor growing
Caucasian fir *Abies nordmanianna* (Stev.) Spach	N	-	6024	-	-	-	-	-

* * Data are exclusive of the data on the international trade with the Republic of Belarus and the Republic of Kazakhstan (01.07.2010). It is known that in 2011-2012 significant volumes of seed and planting material were purchased from the Republic of Belarus due to the need to restore large areas of the Russian forests destroyed by the fires and windblow.

Table IV.13. **Forest improvement programmes**

Species		Improvement programme objectives					
Scientific name	Native (N) or exotic (E)	Timber	Pulpwood	Energy	MP*	NWFP**	Other
Common pine *Pinus sylvestris* L.	N	+	-	+	+	+	
Common spruce – *Picea abies* (L.) Karst.	N	+	+	+	+	+	
Siberian larch (Ural population) *Larix sibirica* Ledeb.	N	+	-	-	+	+	
Siberian stone pine *Pinus sibirica* Du Tour	N	+	-	-	+	+	
Lodgepole pine *Pinus contorta* Dougl. ex Loud.	E	-	+	-	-	-	-
Birch	N	+	-	+	+	+	
Karelian birch – *Betula pendula* Roth var. carelica (Merckl.) Hämet-Ahti							
Aspen	N	-	-	+	-	+	
Alder	N	-	-	+	-	+	

* MC: Multipurpose tree improvement programme

**NWFP: Non-wood forest products

Table IV.14. **Tree improvement trials**

Scientific name	Plus trees		Provenance trials		Progenies trials		Clonal testing and development			
	Native (N) or exotic (E)	Number	Area, ha	Number of proves	Area, ha	Number of families	Area, ha	Number of clones tested	Clone bank area, ha	Number of clones used
Pine *Pinus sp.*	N		427,7							
Common pine *Pinus sylvestris* L.	N	16062	187,0		384,7		310,8		128,9	
Lodgepole pine *Pinus contorta* Dougl. ex Loud.	N	22			20,2		0,0		0,0	
Weymouth pine *Pinus strobus* L.	N	58			0,0		0,0		0,0	
Pine *Pinus sylvestris* L. *var. cretacea* Kalen.	N	66			0,0		0,0		0,0	
Pine *Pinus kochiana* Klotzsch ex C. Koch	N	7			0,0		0,0		0,0	
Crimean pine *Pinus pallasiana* D. Don	N	72			0,0		0,0		0,0	
Pitsunda pine *Pinus pityusa* Stev.	N	23			0,0		0,0		0,0	
Common spruce *Picea abies* (L.) Karst.	N	4712	81,0		267,3		79,3		32,1	
Siberian spruce *Picea obovata* Ledeb.	N	935			10,0		3,0		5,0	
Hybrid spruce *Picea x mariorika* Boom (*P. mariana* (Mill.) Britton, Sterns & Poggenb. *x P. omorica* (Pancic) Purkyne)	N	227			12,5		0,6		0,0	
Spruce *Picea ajanensis* (Lindl. et Gord.) Fisch.	N	70			0,0		0,0		0,0	
Siberian larch *Larix sibirica* Ledeb.	N	1775	6,3		3,0		18,0		22,0	

Scientific name	Plus trees		Provenance trials		Progenies trials		Clonal testing and development			
	Native (N) or exotic (E)	Number	Area, ha	Number of proves	Area, ha	Number of families	Area, ha	Number of clones tested	Clone bank area, ha	Number of clones used
Siberian larch (Ural population) *Larix sibirica* Ledeb.	N	1384	20,2		8,3		41,0		5,8	
European larch *Larix decidua* Mill.	N	307			0,0		1,3		0,0	
Japanese larch *Larix kaempferi* (Lamb.) Carrière (= *Larix leptolepis* (Siebold. & Zucc.) Gord.)	N	33			0,0		0,0		0,0	
Japanese larch *Larix kaempferi* (Lamb.) Carrière	N	49			0,0		2,2		0,0	
Polish larch *Larix x polonica* Racib.	N	28			0,0		0,0		0,0	
Hybrid larch *Larix x eurolepis* A.Henry *(L. kaempferi* (Lamb.) Carriere *x L. decidua* Mill.*)*	N	8	0,0		1,0		1,0		0,0	
Gmelin larch *Larix gmelinii* (Rupr.) Kuzen.	N	28			0,0		0,0		0,0	
Gmelin larch (Amur population) *Larix gmelinii* (Rupr.) Kuzen. (= *Larix amurensis* Boiss.)	N	268			0,0		0,0		0,0	
Dahurian larch *Larix dahurica* Turcz. ex Trautv.	N	22			0,0		0,0		0,0	
Korean Dahurian larch *Larix olgensis* A. Henry	N	10			0,0		0,0		0,0	
Cajander larch *Larix cajanderi* Mayr	N	15			0,0		0,0		0,0	
Kurile larch *Larix kamtschatica* (Rupr.) Carr.	N	18			0,0		0,0		0,0	
Common silver fir *Abies alba* Mill.	N	45			0,0		0,0		0,0	
Siberian fir *Abies sibirica* Du Tour	N	106			0,0		0,0		0,0	

Scientific name	Plus trees		Provenance trials		Progenies trials		Clonal testing and development			
	Native (N) or exotic (E)	Number	Area, ha	Number of proves	Area, ha	Number of families	Area, ha	Number of clones tested	Clone bank area, ha	Number of clones used
Caucasian fir *Abies nordmanniana* (Stev.) Spach	N	236			0,0		0,0		0,0	
Manchurian fir *Abies holophylla* Maxim.	N	49			0,0		0,0		0,0	
Siberian stone pine *Pinus sibirica Du Tour*	N	2093			40,9		86,1		22,2	
Himalayan cedar *Cedrus deodara* (Roxb.) G. Don fil.	N	1			0,0		0,0		0,0	
Korean stone pine *Pinus koraiensis* Siebold et Zucc.	N	908			0,0		1,0		1,0	
English oak *Quercus robur* L.	N	2850	76,7		54,8		13,3		3,8	
Red oak *Quercus rubra* L.	N	87			4,0		0,0		0,0	
Hartwiss oak *Quercus hartwissiana* Stev.	N	34			3,0		0,0		0,0	
Durmast oak *Quercus petraea* L. ex Liebl.	N	418			0,0		0,0		0,0	
Downy oak *Quercus pubescens* Willd.	N	7			0,0		0,0		0,0	
Beech *Fagus sylvatica* L.	N	19			0,0		0,0		0,0	
Oriental beech *Fagus orientalis* Lipsky	N	606			3,5		20,5		0,0	
Silver birch *Betula pendula* Roth	N	323			0,0		5,0		0,0	
Karelian birch *Betula pendula* Roth *var. carelica* (Merckl.) Hämet-Ahti	N	82			0,5		0,4		0,0	
Circassian walnut *Juglans regia* L.	N	20			0,0		0,0		0,0	
Black walnut *Juglans nigra* L.	N	152			0,7		0,0		0,0	

Scientific name	Plus trees		Provenance trials		Progenies trials		Clonal testing and development			
	Native (N) or exotic (E)	Number	Area, ha	Number of proves	Area, ha	Number of families	Area, ha	Number of clones tested	Clone bank area, ha	Number of clones used
Small-leafed linden *Tilia cordata* Mill.	N	136			0,0		0,0		0,0	
Linden *Tilia begonifolia* Stev.	N	1			0,0		0,0		0,0	
European ash *Fraxinus excelsior* L.	N	142			0,0		0,0		0,0	
Green ash *Fraxinus lanceolata* Rorkh.	N	72			0,0		0,0		0,0	
Chestnut *Castanea sativa* Mill.	N	27			0,0		0,0		0,0	
Pecan nut Carya pecan (Marsh.) Engl.	N	0			0,0		0,4		0,0	
Chinese elm *Ulmus parvifolia* Jacq.	N	10			0,0		0,0		0,0	
Siberian elm *Ulmus pumila* L.	N	41			0,0		2,0		0,0	
European white elm *Ulmus laevis Pall.*	N	29			0,0		0,0		0,0	
Maple *Acer trautvetteri* Medw.	N	5			0,0		0,0		0,0	
Black poplar *Populus nigra* L.	N	48			0,0		0,0		2,2	
White poplar *Populus alba* L.	N	10			0,0		0,0		0,0	
Robinia *Robinia pseudoacacia* L.	N	35			0,0		2,0		0,0	
Black locust *Gleditsia triacanthos* L.	N	124			5,6		0,0		0,0	
Apricot *Armeniaca vulgaris* Lam.	N	29			0,0		0,0		0,0	
Grey Douglas fir *Pseudotsuga menziesii* (Mirb.) Franco	N	63			1,3		0,0		0,0	

Scientific name	Plus trees		Provenance trials		Progenies trials		Clonal testing and development			
	Native (N) or exotic (E)	Number	Area, ha	Number of proves	Area, ha	Number of families	Area, ha	Number of clones tested	Clone bank area, ha	Number of clones used
Norway maple *Acer platanoides* L.	N	1			0,0		0,0		0,0	
Red cedar *Thuja plicata* Lamb.	N	26			0,0		0,0		0,0	
Redwood bur *Sequoia sempervirens* (D. Don) Endl.	N	19			0,0		0,0		0,0	
Oleaster *Elaeagnus angustifolia* L.	N	10			0,0		0,0		0,0	
Common alder *Alnus glutinosa* (L.) Gaert.	N	1			0,0		0,0		0,0	

Table IV.15. **Seed orchards (forest seed orchards – FSO)**

Species (Scientific name)	Seed orchards*			FSO, ha		FSO of high genetic value, ha	
	Number	Genera-tion**	Total area, ha	Area of the certified FSO	Seed produc-ing	Total	Certified
Common pine *Pinus sylvestris* L.			3306,5	2491,2	2323,3	97,5	54,0
Lodgepole pine *Pinus contorta* Dougl. ex Loud.			6,4	0,0	0,0	0,0	0,0
Crimean pine *Pinus pallasiana* D. Don			7,0	7,0	7,0	0,0	0,0
Mountain pine *Pinus mugo* Turra			1,0	1,0	1,0	0,0	0,0
Common spruce *Picea abies* (L.) Karst.			1220,2	975,9	796,2	11,5	0,0
Siberian spruce *Picea obovata* Ledeb.			87,8	42,8	23,8	0,0	0,0
Blue spruce *Picea pungens* Engelm.			16,9	0,0	0,0	0,0	0,0
Hybrid spruce *Picea x mariorika* Boom (*P. mariana* (Mill.) Britton, Sterns & Poggenb. *x P. omorica* (Pancic) Purkyne)			11,0	11,0	11,0	0,0	0,0
Siberian larch *Larix sibirica* Ledeb.			368,9	295,7	208,8	0,0	0,0
Siberian larch (Ural population) *Larix sibirica* Ledeb.			327,4	205,0	199,0	21,6	0,0
European larch *Larix decidua* Mill.			9,4	9,4	9,4	0,0	0,0
Japanese larch *Larix kaempferi* (Lamb.) Carriere (= *Larix leptolepis* (Siebold. & Zucc.) Gord.)			1,9	0,0	0,0	0,0	0,0
Hybrid larch *Larix x eurolepis* A.Henry *(L. kaempferi (Lamb.) Carriere x L. decidua Mill.)*			5,0	5,0	0,0	0,0	0,0
Caucasian fir *Abies nordmanniana* (Stev.) Spach			2,0	0,0	0,0	0,0	0,0
Siberian stone pine *Pinus sibirica* Du Tour			329,6	166,9	133,9	0,0	0,0
Korean stone pine *Pinus koraiensis* Siebold et Zucc.			79,2	35,0	35,0	0,0	0,0
English oak *Quercus robur* L.			330,4	73,6	61,6	0,0	0,0
Red oak *Quercus rubra* L.			4,9	2,4	2,4	0,0	0,0
Oriental beech *Fagus orientalis* Lipsky			11,0	10,0	0,0	0,0	0,0
Silver birch *Betula pendula* Roth			12,2	5,2	5,2	0,0	0,0

Species (Scientific name)	Seed orchards*			FSO, ha		FSO of high genetic value, ha	
	Number	Genera-tion**	Total area, ha	Area of the certified FSO	Seed produc-ing	Total	Certified
Karelian birch *Betula pendula Roth var. carelica* (Merckl.) Hämet-Ahti			38,8	10,1	10,1	0,0	0,0
Black walnut *Juglans nigra* L.			2,0	0,0	0,0	0,0	0,0
Small-leafed linden *Tilia cordata* Mill.			1,2	0,0	0,0	0,0	0,0
European ash *Fraxinus excelsior* L.			4,0	0,0	0,0	0,0	0,0
Siberian elm *Ulmus pumila* L.			10,0	0,0	0,0	0,0	0,0
Robinia *Robinia pseudoacacia* L.			5,0	0,0	0,0	0,0	0,0
Black locust *Gleditsia triacanthos* L.			21,5	20,0	10,0	0,0	0,0
Common smoke tree *Cotinus coggygria* Scop.			5,0	0,0	0,0	0,0	0,0
Grey Douglas fir *Pseudotsuga menziesii* (Mirb.) Franco			12,6	0,6	0,0	0,0	0,0

Table IV.16. **Type of reproductive material available ***

Species	Type of material	Available for national requests only		Available for international requests	
		Commercial	Research	Commercial	Research
Cedar *Pinus sibirica* Du Tour	seed	+	+	+	+
	cuttings	-	+	-	+
Spruce	seed	+	+	+	+
Common spruce *Picea abies* (L.)	seed	+	+	-	-
	grafting material	-	+	-	-
	grafted seedlings	+	+	-	-
Larch	seed	+	+	+	+
Siberian larch *Larix sibirica* Ledeb.	seed	+	+	-	-
Pine *Pinus sylvestris* L.	seed	+	+	-	-
	grafting material	-	+	-	-
Birch *Betula pendula* Roth, *B. pubescens* Ehrh.	meristem	-	+	-	-
Aspen *Populus tremula* L.	meristem	-	+	-	-
Poplars *Populus* spp.	pollen	+	+	+	+
	cuttings	+	+	+	+
Lodgepole pine *Pinus contorta* Douglas ex Loudon	seeds	+	+	+	+
Sea buckthorn *Hippophaë rhamnoides L*	seeds	+	+	+	+
	cuttings	+	+	+	+

* On demand the seeds of almost all the Far East trees and shrubs can be provided in small quantities.

Tables IV.17a-d. **Institutions involved with conservation and use of forest genetic resources**

Table IV.17a. **Institutions of the Russian Academy of Sciences**

Name of institution	Type of institution	Research area	Contact information
Federal State-Funded Research Institution N.I. Vavilov Institute of General Genetics, Russian Academy of Science (RAS IOGen) Laboratory of Population Genetics	state-funded	Study of population-genetic structure, phylogeny and phylogeography of conifers as a basis for conservation and management of their gene pools. The study of gene pools of the main forest conifers in Russia (Siberian stone pine, complexes of the European, Siberian, and hybrid "Finnish" spruce, pine) using molecular genetic markers	119333, Moscow, Gubkina str. 3 Telephone: (499) 135-62-13 Fax: (499) 132-89-62 E-mail: iogen@vigg.ru Web: www.vigg.ru
Federal State-Funded Research Institution Institute of Forest Science (ILAN RAS)	state-funded	Study of ecophysiological and population genetic characteristics of the main forest forming species, the development of the environmental forest monitoring principles, conservation of genetic resources and natural diversity of forest ecosystems	Sovetskaya 21, Uspenskoe, Moscow region, 143030 Russia Web: www.ilan.ras.ru
Federal State-Funded Research Institution Branch of the Institute of Shemyakin and Ovchinnikov Bioorganic Chemistry, RAS	state-funded	Forest biotechnology, clonal micropropagation of plants (including poplar, conifer)	Moscow region, Pushchino
Federal State-Funded Research Institution Forest Research Institute of Karelian Research Center, Russian Academy of Science (FRI KarRC RAS)	state-funded	Selection of pine and fir, study of the population-genetic structure of the intact and anthropogenically modified plantations of conifers using molecular genetic markers	11 Pushkinskaya St., 185910 Petrozavodsk, Karelia, Russia Tel.: +7 (8142) 76-81-60 +7 (8142) 76-95-00 Fax: +7 (8142) 76-81-60 E-mail: forest@krc.karelia.ru Web: forestry.krc.karelia.ru
Federal State-Funded Research Institution Komarov Botanical Institute, RAS	state-funded	Genetic and taxonomic studies of firs using molecular genetic markers	197376, Saint-Petersburg, Popov, 2 Web: www.binran.ru
Federal State-Funded Research Institution Botanical Garden-Institute, Ufa Scientific Center, Russian Academy of Science	state-funded	Study of population-genetic structure of forest trees as a basis for the conservation and management of their gene pools	450080, Ufa, Mendeleyev, 195, block 3 Telephone: +7(347) 228-13-55 Fax: +7 (347) 252-60-33 E-mail: botsad@anrb.ru Web: www.ufabotgarden.ru
Federal State-Funded Research Institution Institute of Plants and Animals of the Ural Branch of Russian Academy of Science	state-funded	Phylogeny, phylogeography and population genetic structure of larch, fir, pine, juniper, wild herbaceous plants using molecular genetic markers	620144, Yekaterinburg, 8 March, 202/3 Tel. +7(343) 210-38-53 +7(343) 210-38-54 +7(343) 210-38-55 Fax: +7 (343) 210-38-53 E-mail: info@ipae.uran.ru common@ipae.uran.ru Web: www.ipae.uran.ru

Name of institution	Type of institution	Research area	Contact information
Federal State-Funded Research Institution Botanical Garden of UB RAS	state-funded	Population biology of coniferous forest tree species in North Eurasia as a theoretical basis of modern silviculture geographic, genetic and ecological differentiation of populations of common pine, evolutionary pyroecology	620144, Yekaterinburg, 8 March, 202 Tel./Fax: +7 (343) 210-38-59 E-mail: common@botgard.uran.ru Web: www.uran.ru/structure/institutions/botgards/index.html
Federal State-Funded Research Institution Central Siberian Botanical Garden SB RAS	state-funded	Biodiversity Research of Siberian flora, its structural and dynamic organization, the development of the concept of biodiversity conservation at different levels of the organization. Ecological basis for the rational use of plant resources, development of the methodology to conserve the gene pool of the natural flora in the botanical gardens. Acclimatization, introduction and breeding of plants to maintain and enrich the gene pool of useful plants.	Novosibirsk Web: www.csbg.nsc.ru
Federal State-Funded Research Institution Institute of Monitoring of Climatic and Ecological System Siberian Branch of the Russian Academy of Sciences (IMCES SB RAS)	state-funded	Analysis of the evolutionary relationships, processes of differentiation and integration of gene pools and environmental aspects of population-genetic structure of cedar pines. Varietal selection of Siberian stone pines for nuts and decorative puposes	634055, Tomsk, 10/3, Academichesky ave. Tel. +7 (3822) 49-22-65 Fax (382-2) 491-950 E-mail: post@imces.ru Web: www.imces.ru
Federal State-Funded Research Institution Sukachev Institute of Forest. Siberian Branch of the Russian Academy of Sciences (IF SB RAS)	state-funded	Biospheric role, ecological function and biodiversity of forest ecosystems; Condition monitoring, management and reproduction of forest resources of Siberia. Karyological and population genetic studies of common pine, larch, Siberian spruce. Plantation establishment and geographical study of Siberian stone pine, larch. The development and improvement of methods of *in vitro* conifer cultivation	660036, Krasnoyarsk, Akademgorogok 50, 28 Tel. +7 (391) 249-44-47 Tel./Fax: (391) 243-36-86 Email: institute_forest@ksc.krasn.ru Web: www.forest.akadem.ru West Siberian branch in Novosibirsk
Federal State-Funded Research Institution Siberian Institute of Plant Physiology and Biochemistry, Russian Academy of Sciences (SIPPB SB RAS)	state-funded	Use of molecular genetic markers (RAPD) to assess the genetic diversity of the Far Eastern larch	664033, Irkutsk, Lermontov,132, m/b 317. Tel. +7 (3952) 42-67-21 Fax: +7 (3952) 51-07-54 Email: matmod@sifibr.irk.ru Web: www.sifibr.irk.ru
Federal State-Funded Research Institution Pacific Institute of Geography FEB RAS Kamchatka Branch Laboratory of Plant Ecology		The study of phenotypic variation dwarf Siberian pine in Kamchatka due to soil and climatic conditions.	683000, Petropavlovsk-Kamchatsky, Rybakov ave., 19a, Tel. 26-24-37, http://www.terrakamchatka.org
Federal State-Funded Research Institution Biology and Soil Science FEB RAS (BPI FEB RAS)	state-funded	Study of biodiversity, ecology and evolution of the animals and plants, soil of the Asia-Pacific region, the development of scientific principles and technology management, conservation and reproduction of biological resources of the Russian Far East. The use of molecular genetic markers (RAPD) to assess the genetic diversity of the Far Eastern larch	Vladivostok, 100 years Ave., 159 Tel. +7 (423) 231-07-18 Fax 8(423) 231-01-93 E-mail: ibss@eastnet.febras.ru Web: www.ibss.febras.ru

Table IV.17b. **Institutions of the Federal Forestry Agency**

Name of institution	Type of institution	Activities and programmes	Contact information
Federal State Institution "Russian Centre of Forest Protection" (FSFI "Roslesozaschita")	state-funded	Specialized laboratory for DNA analysis at the central office and in the Krasnoyarsk branch, maintaining databases on forest seed objects and forest gene pool conservation objects of the Russian Federation with the participation of the 42 branches.	Telephone/Fax: (495) 993-34-07, (496) 532-66-62, 532-40-00, 537-10-55 E-mail: rcfh.cancz@yandex.ru Web: www.rcfh.ru Address: 141207, Moscow region, Pushkino, Nadsonovskaya, 13
Federal State Institution "Northern Research Institute of Forestry" (FSFI NRIF)	state-funded	Study of the single genetic and breeding system in the north of European Russia. The study of provenance and trial pine and spruce platations in the European North. Forest seed production. Ex situ conservation of forest species	Address: 163062 Arkhangelsk, Nikitova, 13 Telephone: (8182) 61-79-55 Fax: (8182) 61-25-78 E-mail: forestry@ptl-arh.ru Web: www.sevniilh-arh.ru
State-funded Federal Unitary Enterprise "Scientific-Research Institute of Forest Genetics and Plant Breeding" (FSUE NIILGiS)	state-funded	Scientific and methodological support of the implementation of forest species breeding programs	Address: 394043, Voronezh, Lomonosova, 105 Telephone: (4732) 53-92-38 Fax: (4732) 53-94-36 E-mail: ilgis@lesgen.vrn.ru Web: http://www.niilgis.ru/
Federal State Institution "St. Petersburg Research Institute of Forestry" (FSFI SPFRI)	state-funded	Development of methodology for integrated assessment of Norway spruce genotypes to create plantations of high genetic value. The study of provenance and trial plantations of pine and spruce in the north-west Russia. Biotechnology.	194021, Saint-Petersburg, Russia, Institutsky ave., 21 Telephone: (812) 552-80-21 Fax: (812) 552-80-42 E-mail: spb-niilh@inbox.ru Web: www.spb-niilh.ru
Federal State Institution "Far Eastern Forestry Research Institute" (FSFI FEFRI)	state-funded	Research on forest and subjects of the single genetic-breeding system in the Far East. The creation of artificial plantations of the selection value. *Ex situ* conservation of forest species.	680020, Russia, Khabarovsk, Volochayevskaya, 71 Tel./Fax: (4212) 21-67-98 E-mail: dvniilh@gmail.com Web: http://dalniilh.ru/
Federal budget organization "All-Russian Research Institute for Silviculture and Mechanization of Forestry" (FSFI VNIILM)	state-funded	Forest research and solving forest related problems in Russia. Creation of artificial plantations of selection value.	141202, Moscow region, Pushkino, Institutskaya, 15 Telephone: (495) 993-30-54 Fax: (495) 993-41-91 E-mail: vniilm@pues.ru Web:http://www.fguvniilm.ru

Table IV.17c. **Higher education institutions involved in research of the forest genetic resources**

Name of institution	Type of institution	Research area	Contact information
FSEI Bashkir State Agrarian University	state-funded	Study of population-genetic structure of coniferous, deciduous and herbaceous forest plants, development of the principles of conservation and sustainable use of gene pools of forest plants.	http://www.bsau.ru
FSEI Perm State University,	state-funded	Reproductive biology and biotechnology, population genetics and radiation mutagenesis of metasperms.	http://www.psu.ru

Department of Botany and Plant Genetics	state-funded	Optimization of reforestation, development of genetic and breeding basis of the seed production of the main forest species.	http://www.tsu.ru
FSEI Institute of Biology, Ecology, Soil science, Forestry and Agriculture	state-funded	Development of scientific basis for the formation and use of the gene pools of the main tree species, Development of technologies for cloning trees.	http://www.agri.sci-nnov.ru
Tomsk State University	state-funded	Study of genotypic diversity of forest trees in relation to issues of evolution, selection, and environmental protection, rational use of FGR.	http://www.vsu.ru
FSEI Nizhny Novgorod State Academy of Agriculture	state-funded	Study of genotypic diversity of forest trees in relation to issues of evolution, selection, and environmental protection, rational use of FGR	http://www.vglta.vrn.ru

Table IV.17d. **Higher education institutions that train specialists in forest genetic resources management**

Name of institution	Type of institution	Areas of specialist training	Contact information
FSBEI HPO “Moscow State Forest University” Faculty of Forestry MSFU Arboretum	state-funded	“Forest science” (Bachelors and Masters) Skills upgrading and retraining of specialists Training of scientific and pedagogical staff: postgraduate and doctoral	http://www.mgul.ac.ru
FSBEI HPO «Saint-Petersburg State University of Forestry n.a. S.M. Kirov “ Faculty of Forestry Affiliates: Syktyvkar Forest Institute Lisinsk educational and experimental forestry Okhtinsk educational and experimental forestry	state-funded	“Forest science” (bachelors and masters) Skills upgrading and retraining Training of scientific and pedagogical staff: postgraduate and doctoral	http://ftacademy.ru
FSBEI HPO «Voronezh State Academy of Forestry” Forest Faculty	state-funded	“Forest science” (Bachelors and Masters) Skills upgrading and retraining Training of scientific and pedagogical staff: postgraduate and doctoral	http://www.vglta.vrn.ru
FSBEI HPO «Uralsky State Forestry University” Engineering and Environmental Department Forest Faculty	state-funded	“Forestry”, “Forest science”, “Nature”, “Protection of the environment and natural resources” (Bachelors and Masters) Skills upgrading and retraining Training of scientific and pedagogical staff: postgraduate and doctoral studies in the area “Forest culture, selection, seeds”; “Forestry, forest science, forest management and forest taxation”	http://www.usfeu.ru
FSBEI HPO «Bashkir State Agrarian University” Department of Land and Forestry	state-funded	“Forestry”, “Forest science” (specialists) “Forest science” (masters) Skills upgrading and retraining	http://www.bsau.ru

Name of institution	Type of institution	Areas of specialist training	Contact information
FSBEI HPO «Nizhny Novgorod State Academy agriculture" Faculty of Forestry	state-funded	"Forestry" (specialists) Skills upgrading and retraining	http://www.agri.sci-nnov.ru
FSBEI HPO «Volga State University of Technology" (Yoshkar-Ola) Faculty of Forestry and Environment	state-funded	"Forest science", "Ecology and Nature" (Bachelors and Masters), "Nature" (specialists in environment management and natural resources use). Skills upgrading and retraining	http://www.volgatech.net
FSBEI HPO «Tomsk State University" Institute of biology, ecology, soil science, agriculture and forestry	state-funded	"Forestry and aesthetic forestry " "Ecology" (specialists)	http://bio.tsu.ru
"Altai State Agrarian University" (Barnaul) Agronomy Department	state-funded	«Forest science» (Bachelors)	http://www.asau.ru
FSBEI HPO «Siberian Federal University" Institute of Economics, Management and Nature Department of Forest Science Department of Wildlife, Resources and Reserves.	state-funded	"Global environmental problems", "Dendroecology", "Sustainable development and environmental security" (Masters) "Ecology" (specialists), "Environmental Protection" (Masters)	http://eco.sfu-kras.ru
FSBEI HPO «Siberian State Technological University" (Krasnoyarsk) Faculty of Forestry	state-funded	"Forest science" (Bachelors and Masters) Training of scientific and pedagogical staff: postgraduate and doctoral in the following areas: "Forest culture, selection, seeds", "Forest management and forest taxation", "Ecology", "Silviculture, forest fires and their control"	http://www.sibstu.kts.ru
FSBEI HPO «Pacific State University" Far Eastern Institute of Forestry Department of Natural Resources and Ecology	state-funded	"Forestry" (engineers, experts) Training of scientific and pedagogical staff: postgraduate studies in "Ecology"	http://ipe.khstu.ru
FSBEI HPO «Far East State Agrarian University" Faculty (Institute) of forest	state-funded	"Forest science" (bachelor and master); "Forestry" (engineers, experts) Skills upgrading and retraining	http://www.dalgau.ru
FSBEI HPO «Buryat Agriculture State Academy n.a. V.R. Filippov» (Ulan-Ude) Agronomy Department	state-funded	"Forest science" (Bachelors and Masters); "Forestry" (engineers, experts)	http://www.bgsha.ru
FSBEI HPO «State Agriculture Maritime Academy" (Ussuriysk) Institute of Forestry and Park Forestry School of Forestry "Dalnevostochniy"	state-funded	"Forestry" (engineers, experts) Training of scientific and pedagogical staff: postgraduate and doctoral	http://www.primacad.ru

Table IV. 18. **Needs for development forest genetic resources legislation**

Needs	Priority level			
	Not applicable	Low	Moderate	High
Improve forest genetic resources legislation				+

Needs	Priority level			
	Not applicable	Low	Moderate	High
Improve reporting requirements				+
Consider sanctions for non-compliance				+
Create forest genetic resources targeted regulations				+
Improve effectiveness of forest genetic resources regulations				+
Enhance cooperation between forest genetic resources national authorities				+
Create a permanent national commission for conservation and management of forest genetic resources				+
Other (specify)				

Table IV.19. **Awareness raising needs**

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

Table IV.20. **Review of the main activities implemented in the framework of networks and their results**

Network name	Activities*	Species involved (scientific names)
Russian-Scandinavian project «Larch»	Development, introduction and implementation of joint research projects: seed collections of different larch species growing in Russia (17 climatypes) and the inception of the seed collection of the provenance trial platations	larch
The «SibLarch» project of the framework of INTEREG «Northern Periphery" programme	Development, introduction and implementation of joint research projects: creating provenance trial platations of larch Arckhangelsk region and Komi Republic	larch
Project EAN-SEABUCK «Creating a Euro-Asian network to develop a strategy for sustainable use of sea buckthorn"	Information exchange, development of technical advice, development of strategies for the conservation of genetic resources, exchange of germplasm	sea buckthorn
Project on sea buckthorn in the framework of «Partnerships for Tomorrow Programme Phase II» (Canada)	Development, introduction and implementation of joint research projects	sea buckthorn
Pan-European econet	Information exchange, development of technical advice, development of strategies for the conservation of genetic resources: PA association and integration into European Ecological Network	types of boreal and temperate forests
Initiative Network of the Model Forests of Russia	Information exchange (indirectly) development of technical advice (indirectly) development of strategies for the conservation of genetic resources (indirectly)	types of boreal and temperate forests
Information Network for Indigenous Biodiversity	Information exchange (indirectly) - Sites created www.ibin.org; www.raipon.ru	types of boreal and temperate forests

Network name	Activities*	Species involved (scientific names)
Projects (with the support of international funds, especially GEF) aimed at the implementation of integrated ecosystem management on the local level and preservation of traditional knowledge in the area of nature use (in the Murmansk region, in the Nenets Autonomous District, Krasnoyarsk Territory, the northern regions of the Republic of Yakutia, in the Kamchatka Territory).	Information exchange (indirectly) development of technical advice (indirectly) development of strategies for the conservation of genetic resources (indirectly)	types of boreal and temperate forests

Table IV.21. **Needs for international collaboration and networking**

Needs	Priority level			
	Not applicable	Low	Moderate	High
Understanding the state of diversity				+
Enhancing in situ management and conservation				+
Enhancing ex situ management and conservation of			+	
Enhancing use of forest genetic resources			+	
Enhancing research				+
Enhanced education and training				+
Enhancing legislation				+
Enhancing information management and early warning systems in the area of forest genetic resources				+
Enhancing public awareness				+

Table IV. 22. **Species of trees and other woody species that are important for food security and livelihood**

Species		Use for	
Scientific name	Native (N) or exotic (E)	food security	poverty reduction
Manchirian apricot – *Armeniaca mandshurica* (Maxim.) Skvorts.	N	fruit harvesting by people	personal needs
Siberian apricot – *Armeniaca sibirica* (L.) Lam.	N	fruit harvesting by people	personal needs
Kolomkita vine – *Actinidia kolomikta* (Maxim.) Maxim.	N	fruit harvesting by people	personal needs
Yangtao actinidia – *Actinidia arguta* (Siebold et Zucc.) Planch. ex Miq.	N	fruit harvesting by people	personal needs
Common barberry – *Berberis vulgaris* L.	N	food industry, fruit	personal needs, sale in markets
Siberian barberry – *Berberis sibirica* Pall.	N	fruit harvesting by people	personal needs
Silver birch – *Betula pendula* Roth	N	birch juice	house-building, personal needs, heating houses in rural areas, manufacture and sale in markets of handicrafts made of birch bark, making bath brooms

Species		Use for	
Scientific name	Native (N) or exotic (E)	food security	poverty reduction
White birch – *Betula pubescens* Ehrh.	N	birch juice	house-building, personal needs, heating houses in rural areas, manufacture and sale in markets of handicrafts made of birch bark, making bath brooms
Daurian hawthorn – *Crataegus dahurica* Koehne ex Schneid.	N	fruit harvesting by people	personal needs
Blood-red hawthorn – *Crataegus sanguinea* Pall.	N	food and pharmaceutical industry	personal needs, sale in markets
Midland hawthorn – *Crataegus laevigata* (Poir.) DC.	N	food and pharmaceutical industry	personal needs
Quickthorn – *Crataegus monogyna* Jacq.	N	food and pharmaceutical industry	personal needs
Commomn elder – *Sambucus nigra* L.	N	food and pharmaceutical industry	personal needs
Oriental beech – *Fagus orientalis* Lipsky	N	seed harvesting by people	house-building, personal needs
Common beech – *Fagus sylvatica* L	N	seed harvesting by people	house-building, personal needs
Amur grape – *Vitis amurensis* Rupr.	N		personal needs
Ground cherry – *Cerasus fruticosa* Pall.	N		personal needs
Pear – *Pyrus caucasica* Fed.	N		personal needs
Common pear – *Pyrus communis* L.	N	food industry, fruit	personal needs
Ussurian pear – *Pyrus ussuriensis* Maxim.	N		personal needs
Common oak – *Quercus robur* L.	N		house-building, heating houses in rural areas
European spruce – *Picea abies* (L.) Karst.	N		house-building, heating houses in rural areas
Siberian spruce – *Picea obovata* Ledeb.	N		house-building, heating houses in rural areas
Honeysuckle – *Lonicera caerulea* L.	N		personal needs
Honeysuckle – *Lonicera edulis* Turcz. ex Freyn	N		personal needs
Basket willow – *Salix viminalis* L.	N		personal needs, manufacture and sale of handicrafts from twigs (baskets, wicker furniture, etc.)
Garden serviceberry – *Amelanchier ovalis* Medik.	N	fruit harvesting by people	personal needs
Buryat cranberry – *Viburnum burejaeticum* Regel et Herd.	N	fruit harvesting by people	personal needs
Cranberry – *Viburnum opulus* L.	N	food industry, fruit	personal needs, sale in markets
Sargent creanberry bush – *Viburnum sargentii* Koehne	N	fruit harvesting by people	personal needs

Species		Use for	
Scientific name	Native (N) or exotic (E)	food security	poverty reduction
Sweet chestnut – *Castanea sativa* Mill.	N	food industry, fruit	personal needs, sale in markets
Common hazel – *Corylus avellana* L.	N	food industry, fruit	personal needs, sale in markets
Hazel – *Corylus heterophylla* Ficsh. ex Trautv.	N	fruit harvesting by peo-ple	personal needs
Chinese magnolia vine – *Schisandra chinensis* (Turecz.) Baill.	N	food and pharmaceutical industry, fruit	personal needs, sale in markets
Small-leaved lime – *Tilia cordata* Mill.	N	pharmaceutical indus-try, flowers	house-building, personal needs, beekeeping, manufacture and sale in markets of handicrafts made of wood and bast
Siberian larch – *Larix sibirica* Ledeb.	N		house-building, heating houses in rural areas
Sea buckthorn – *Hippophaë rhamnoides* L.	N	food and pharmaceuti-cal industry, fruit	personal needs, sale in markets
Speckled alder – *Alnus incana* (L.) Moench;	N		heating houses in rural areas
Black alder – *Alnus glutinosa* (L.) Gaertn.	N		Heating houses in rural area
Munchurian walnut – *Juglans mandshurica* Maxim.	N		personal needs
Aspen – *Populus tremula* L.	N		building and heating houses in rural areas
Amur mountain ash – *Sorbus amurensis* Koehne	N	fruit harvesting by peo-ple	personal needs
Siberian mountain ash – *Sorbus sambucifolia* Cham. et Schlecht.	N	fruit harvesting by peo-ple	personal needs
European mountain ash – *Sorbus aucuparia* L.	N	Food and pharmaceuti-cal industry, fruit	house-building, personal needs, sale in markets
Siberian ash – *Sorbus sibirica* Hedl.	N	Food and pharmaceuti-cal industry, fruit	personal needs, sale in markets
Blackthorn – *Prunus spinosa* L.	N	fruit harvesting by peo-ple	personal needs
Alycha – *Prunus divaricata* Ledeb.	N	food industry, fruit	personal needs, sale in markets
Dikusha currant – *Ribes dikuscha* Fisch. ex Turcz.	N	fruit harvesting by peo-ple	personal needs,
Buffallo currant – *Ribes fragrans* Pall.	N	fruit harvesting by peo-ple	personal needs,
Garden currant – *Ribes acidum* Turcz. ex Pojark.	N	fruit harvesting by peo-ple	personal needs,
Currant – *Ribes procumbens* Pall.	N	fruit harvesting by peo-ple	personal needs,
Black currant – *Ribes nigrum* L.	N	Food and pharmaceuti-cal industry, fruit	personal needs, sale in markets
Korean pine – *Pinus koraiensis* Siebold et Zucc.	N	food industry (seeds – «Cedar nuts»)	personal needs, sale in markets
Siberian pine – *Pinus sibirica* Du Tour	N	food industry (seeds – «Cedar nuts»)	house-building, personal needs, sale in markets
Siberian dwarf-pine – *Pinus pumila* (Pall.) Regel	N	food industry (seeds – «Cedar nuts»)	personal needs, sale in markets

Species		Use for	
Scientific name	Native (N) or exotic (E)	food security	poverty reduction
Scotch pine – *Pinus sylvestris* L.	N		house-building, heating houses in rural areas, resin harvesting
Bird cherry – *Padus asiatica* Kom.	N	food and pharmaceutical industry, fruit	personal needs
European bird cherry – *Padus avium* Mill.	N	food and pharmaceutical industry, fruit	personal needs
Dahurian rose – *Rosa davurica* Pall.	N	food and pharmaceutical industry, fruit	personal needs, sale in markets
Dogrose – *Rosa acicularis* Lindl.	N	food and pharmaceutical industry, fruit	personal needs, sale in markets
Cinnamon rose – *Rosa majalis* Herrm.	N	food and pharmaceutical industry, fruit	personal needs, sale in markets
Rammans rose – *Rosa rugosa* Thunb.	N	food and pharmaceutical industry, fruit	personal needs, sale in markets
Cancer rose – *Rosa canina* L.	N	fruit harvesting by people	personal needs
Spiny eleutorococus – *Eleutherococcus senticosus* (Rupr. et Maxim.) Maxim.	N	pharmaceutical industry	personal needs
Oriental wild apple – *Malus orientalis* Uglitzk.	N	fruit harvesting by people	personal needs
Crab apple – *Malus sylvestris* Mill.	N	fruit harvesting by people	personal needs
Manchurian crab apple – *Malus mandshurica* (Maxim.) Kom.	N	fruit harvesting by people	personal needs
Apple tree – *Malus praecox* (Pall.) Borkh.	N	fruit harvesting by people	personal needs
Introduced			
Appricot tree – *Armeniaca vulgaris* Lam.	E	food industry, fruit	personal needs, sale in markets
Common quince – *Cydonia oblonga* Mill.	E	food industry, fruit	personal needs
Grape vine – *Vitis vinifera* L.	E	food industry, fruit	personal needs, sale in markets
Dayberry – *Grossularia uva-crispa* (L.) Mill.	E	food industry, fruit	personal needs, sale in markets
Bay tree – *Laurus nobilis* L.	E	food industry, leaves	personal needs, sale in markets
Lumbert nut – *Corylus maxima* Mill.	E	food industry, fruit	personal needs, sale in markets
Oleaster – *Elaeagnus angustifolia* L.	E	food industry, fruit	personal needs, sale in markets
Cırcassıan wallnut – *Juglans regia* L.	E	food industry, fruit	personal needs, sale in markets
Black chokerberry – *Aronia melanocarpa* (Michx.) Elliot.	E	food and pharmaceutical industry, fruit	personal needs, sale in markets
Commomn plum – *Prunus domestica* L.	E	food industry, fruit	personal needs, sale in markets
Red currant – *Ribes rubrum* L.	E	food industry, fruit	personal needs, sale in markets

Species		Use for	
Scientific name	Native (N) or exotic (E)	food security	poverty reduction
Apple – *Malus domestica* Borkh.	E	food industry, fruit	personal needs, sale in markets