MINISTRY OF FORESTRY OF THE REPUBLIC OF BELARUS
STATE SCIENTIFIC INSTITUTION
"THE INSTITUTE OF FOREST OF THE NATIONAL ACADEMY OF SCIENCES OF BELARUS"

BELARUSIAN FORESTRY DEVELOPMENT PROJECT
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REPORT

about performance of works of the 8th stage
"Develop and update information database of selected populations, climatic types, species, forms, individual genotypes *in situ*; Register of endangered species, subspecies, forms, and individual populations, conservation of which is not effective without using biotechnology in natural surroundings; establish *ex situ* collections of economically valuable woody species which are resistant to climate stress on the premises of State Forestry Enterprises and the National Forest Selection-Seed Production Center of the Ministry of Forestry of the Republic of Belarusin accordance with the zoning. The final research report"

contract No. BFDP/GEF/CQS/16/09-25/17 as of October, 20, 2017

Activity 1.3.3: "Identification and creation of a collection of forms of forest woody plants resistant to climatic stress, rare and economically valuable wood species on the premises of the National Forest Selection-Seed Production Center"

Executor

Director of State Scientific Institution
"The Institute of Forest of the National Academy of Sciences of Belarus"

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Acronyms

CBD – Convention on Biological Diversity
DEFS – Dvinskaya Experimental Forest Station of the Institute of Forest of the NAS of Belarus
DNA – Deoxyribonucleic acid
FGR – Forest Genetic Resources
KEFS – Korenevskaya Experimental Forest Station of the Institute of Forest of the NAS of Belarus
NAS of Belarus – National Academy of Sciences of Belarus
NFSSPC – National Forest Selection-Seed Production Center
RNA – Ribonucleic Acid
SEFI – State Experimental Forestry Institution
SFI – State Forestry Institution
SNP – Single Nucleotide Polymorphism
SPFA – State Production Forestry Association
SPNA – Specially Protected Natural Area
bp – base pair
ha – hectare
km – kilometer
pcs. – pieces
St. – street

Executive summary

1. The work was carried out in November 2019 – February 2020 within the **eighth stage** of the «Develop and update information database of selected populations, climatic types, species, forms, individual genotypes *in situ;* Register of endangered species, subspecies, forms, and individual populations, conservation of which is not effective without using biotechnology in natural surroundings;establish *ex situ* collections of economically valuable woody species which are resistant to climate stress on the premises of State Forestry Enterprises and the National Forest Selection-Seed Production Center of the Ministry of Forestry of the Republic of Belarus in accordance with the zoning. The final research report» of the activity 1.3.3. under contract No. BFDP/GEF/CQS/16/09-25/17 dated October 20, 2017.

2. The object of the research is the populations, climatic types, types, forms, specific genotypes of forest woody plants that are resistant to climatic stress, rare and economically valuable tree species, identified and selected for the creation of *ex situ* collection.

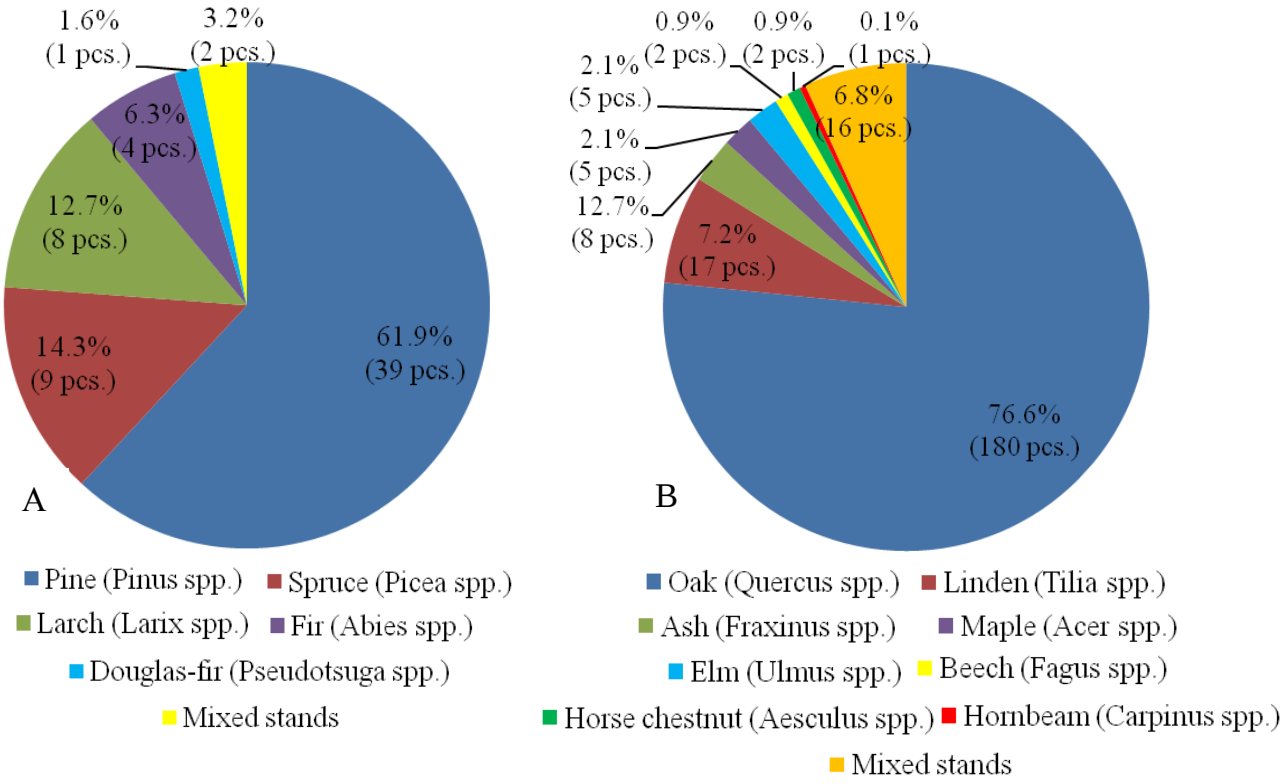
3. The aim of the eighth stage was the creation of *ex situ* collection of forms and types of commercially valuable tree species resistant to climatic stress, on the basis of State Forestry Institutions and the National Forest Selection-Seed Production Center of the Ministry of Forestry of the Republic of Belarus taking into account zoning, as well as the development and updating of the information database of selected populations, climatic types, species, forms, different genotypes *in situ* and creation of the Register of endangered species, subspecies, types and individual populations, the preservation of which in natural conditions without the application of biotechnology is not effective.

4. The main methods of reaching the objective of the stage during the development of information database and creation of the Register will include the methods of designing, system analysis, selection and synthesis of main components. Creation of *ex situ* collection of types and forms of tree species will be based on the use of biotechnological (vegetative and micropropagation) and farming (growing the seedlings) methods.

5. Based on the developed criteria and standards, as well as expeditionary surveys of forest ecosystems, an information database of populations, climatic types, species, forms, different genotypes *in situ* of particular interest for creating *ex situ* collections of forest tree plants resistant to climatic stress, rare and economically valuable tree species was created and updated.

6. The database contains the information on *in situ* selected coniferous (63 objects) and deciduous (235 objects) tree species. The representatives of coniferous species included in it belong to five species: Pine (*Pinus* spp.), Spruce (*Picea* spp.), Larch (*Larix* spp.), Fir (*Abies* spp.) and Douglas-fir (*Pseudotsuga* spp.); and deciduous species – to eight: Oak (*Quercus* spp.), Linden (*Tilia* spp.), Ash (*Fraxinus* spp.), Maple (*Acer* spp.), Elm (*Ulmus* spp.), Beech (*Fagus* spp.), Horse chestnut (*Aesculus* spp.) and Hornbeam (*Carpinus* spp.) (Figure A). Information about species, spatial layout and location, geographic coordinates, area and age of the object is given. The objects included in the database are classified according to the codes of categories of stands and their protection status.

7. The Register of endangered species, subspecies, forms and individual populations, the preservation of which in natural conditions without the use of biotechnology is not effective, has been created and it describes: *(1)* tree species listed in the Red Book of the Republic of Belarus (Silver fir, Dwarf birch); *(2)* economically valuable forms of tree species that grow in limited areas and are characterized by a low degree of heritability of target signs (Karelian birch); *(3)* marginal and/or peripheral populations of tree species (spruce forest outliers). The recommended ways of the species reproduction include micropropagation (Dwarf birch, Karelian birch) and inoculation method (Silver fir, Norway spruce).



A – coniferous species; B – deciduous species

Figure A. Species composition distribution of the objects included in the information database of the populations, climatic types, species, forms, genotypes *in situ*

8. The following steps were accomplished to create *ex situ* collections of forest tree plants forms resistant to climatic stress, rare and economically valuable tree species on the basis of State Forestry Institutions and the National Forest Selection-Seed Production Center of the Ministry of Forestry of the Republic of Belarus with regard to zoning:

(8.1) International and local experience of creation of collections of forest woody plants resistant to climate change and rare economically valuable species and the efficiency of means and methods of forest genetic resources (FGR) conservation were studied and generalized:

– determined that purposeful conservation of genetic resources of plants can be achieved in two ways: *in situ* (maintenance and renewal of viable populations of species in their natural habitat) and *ex situ* (conservation of components of biodiversity outside of their natural habitats). Conservation of FGR with *in situ* methods is not always possible because of a various reasons (strong dependence on the processes proceeding in close proximity to borders of the allocated conservation units, emergence of fire and pests, fragmentation of the protected areas, etc.). In such cases the application of *ex situ* methods could be the alternative;

– the methods of conservation of *ex situ* forest genetic resources (FGR) include *(1)* genetic banks (seeds, pollen, DNA, *in vitro* cultures, cryogenically frozen tissues, organs and parts of plants); *(2)* field genetic banks, maintanined by botanical gardens and arboretums; *(3)* breeding units (clonal and family orchards, test plantations and provenance trials); *(4)* seed orchards of species in a vulnerable position; *(5)* conservation stands with controlled structure. The main attention is paid to maintaining a genetic diversity of economically significant species;

– the international legal basis in the field of conservation of FGR can be considered rather mature. The most significant international agreements for the Republic of Belarus are the Convention on Biological Diversity (CBD); the Strategic Plan for Biodiversity 2011-2020, including Aichi Biodiversity Targets; the Nagoya Protocol to the CBD; the Global Plan of Action for the Conservation, Sustainable Use and Development of Forest Genetic Resources. There is a large number of international initiatives in conservation of genetic resources of plants. At the national level, in the Republic of Belarus, the Strategy of the Republic of Belarus on Conservation and Sustainable Use of Biodiversity, including the National Plan of Action for Conservation and Sustainable Use of Biological Diversity for 2016-2020, has been created; The National Strategy of Sustainable Social and Economic Development of the Republic of Belarus till 2030 (2014) has been approved; The Forest Code of the Republic of Belarus (2015) has been adopted; the Program of Conservation of Forest Genetic Resources and Development of Genetically Improved Seed Production of Forest Forming Species of Belarus till 2030 has been created;

– nowadays research programs for maintaining species and genetic diversity of forests *ex situ* are taken place worldwide. According to data in the report on the state of FGR (FAO, 2014), about 1,800 species of forest plants are cultivated *ex situ*. A total quantity of storing units is about 160,000, most of which are field plantations. The vast majority of storing units belongs to species and sorts of high economical significance, such as *Pinus*, *Eucalyptus*, *Albizia*, *Acer*, *Quercus*, *Acacia*, *Terminalia*, etc. As of 2015 in European countries (excluding the Russian Federation) the total area of *ex situ* collections was 11,553 hectares in 37 countries. The greatest attention, at the same time, is paid to the Scotch pine (*Pinus sylvestris*), the European spruce (*Picea abies*) and the English oak (*Quercus robur*) which represent 60% of all existing *ex situ* collections in Europe;

– according to the report on the state of European forests (2015), the Republic of Belarus takes the second place by the area of units for *ex situ* conservation of FGR among 37 European countries (excluding the Russian Federation). The unique *ex situ* collection fund (more than 30 units) has been created in Belarus within the system of measures for maintaining of biological and genetic diversity of forest woody species. the Institute of Forest of the National Academy of Science of Belarus has the Genetic Bank of Forest Woody Species that include the collections of seeds (more than 250 samples), DNA (more than 4,500 samples), *in vitro* cultures (112 clones of 30 species). There are several botanical gardens and arboretums on the territory of Belarus. Their collections mostly include ornamental forms;

– studying, analysis and generalization of international and local experience on creation and conservation of FGR collection funds have shown that one of the most effective ways of *ex situ* conservation of FGR is the creation of seed banks and field collections which are a strategic resource and a basis of sustainable reproduction of FGR.

(8.2) A comprehensive system of criteria and standards for the selection of populations, ecotypes and individual forest woody species in accordance with their value, specificity and the necessity for preservation was developed:

– criteria and standards for selection of special valuable and unique trees are studied and described in detail: age of a tree, trunk size, species of a tree, state of a tree, tree form;

– the analysis of databases, characteristics of existing nature sanctuaries and on-site investigation of some forest stands has allowed marking out the following categories of special valuable stands: *(1)* relic sites of the forest which have remained from a native plant communities; *(2)* sites of the forest with valuable tree species; *(3)* representative old-age stands; *(4)* forest stands of native species located outside the species range; *(5)* sites of the forest with native species of woody flora which are endangered; *(6)* botanical collections; *(7)* parks, gardens and lanes;

– criteria and standards for selection of highly productive forest stands (plus forest stands) and trees (plus trees) of the Scotch pine, Norway spruce, English oak, European larch, Silver fir, European ash are studied and described in detail;

– application of a comprehensive system of criteria and standards for the selection of populations, ecotypes and individual forms of forest tree species, based on their value, specifics and the need to preserve ensured the inclusion of productive, adaptive and biologically sustainable genetic material in the *ex situ* collection.

(8.3) Reproductive material for the creation of *ex situ* collection of forest tree plants forms resistant to climatic stress, rare and economically valuable tree species was selected and prepared:

– analysis of species and form diversity of the dendroflora of Belarus showed that it is represented by 51 species at seed-bearing age (with regard to their form diversity) of native and introduced woody flora. They are: Amur cork tree; Dahurica birch; Dwarf birch; European silver birch; Red birch; Karelian birch; European beech; European white elm; Dutch elm; Wych elm; Ginkgo; Hornbeam; Pedunculate oak; Pedunculate oak (pyramidal form); Durmast oak; Norway spruce; Norway spruce (weeping form); Norway spruce (serpentine form); Whortleberry willow; Shagbark hickory; Sycamore; Norway maple; Silver maple; American basswood; Silver linden; Common lime; Large-leaved linden; Manchurian linden; Small-leaved linden; European larch; Polish larch; Siberian larch; Common alder; European aspen; Silver fir; Caucasian fir; Douglas fir; Locust; White pine; Scots pine; Siberian stone pine; Austrian pine; White poplar; Canadian poplar; Grey poplar; Chinese poplar; Black poplar; Black poplar (pyramidal form); White ash; Common ash; Green ash;

– in general, four groups of plants served as the basis for the creation of *ex situ* collection (Figure B).

9. Selection and harvesting of reproductive material of forms and species of tree plants biologically resistant to climatic stress and phytopathogens are based on the following works:

(9.1) Selection and genetic evaluation and selection of climatic types of coniferous silvicultures of different geographical origin resistant to climatic stress was carried out:

– *Scots pine*. Selective and genetic evaluation of 67 climatic types was carried out in 50-year-old provenance trials of the Dvinskaya experimental forest base of the Institute of Forest of the National Academy of Sciences of Belarus. There were determined the intensity of growth in height and in diameter, stem volume and stem wood volume for each climate type and forest subzone (Figure C):

(a) the average height of 50-year-old climatic types of Scots pine varies from 12.4 (Chernigov) to 18.4 m (Cherkasy). Low heights are peculiar to northern climatic types of the Middle and Southern taiga subzones (14.7-16.4 m), as well as the Southern steppes subzone. The climatic types of the Northern semi-desert subzone, the Northern steppes subzone and the Northern subzone of the Hardwood zone, as well as the Southern subzone of the Hardwood zone from the areas located to the south of the local climatic type (from Belarus), have the maximum heights;

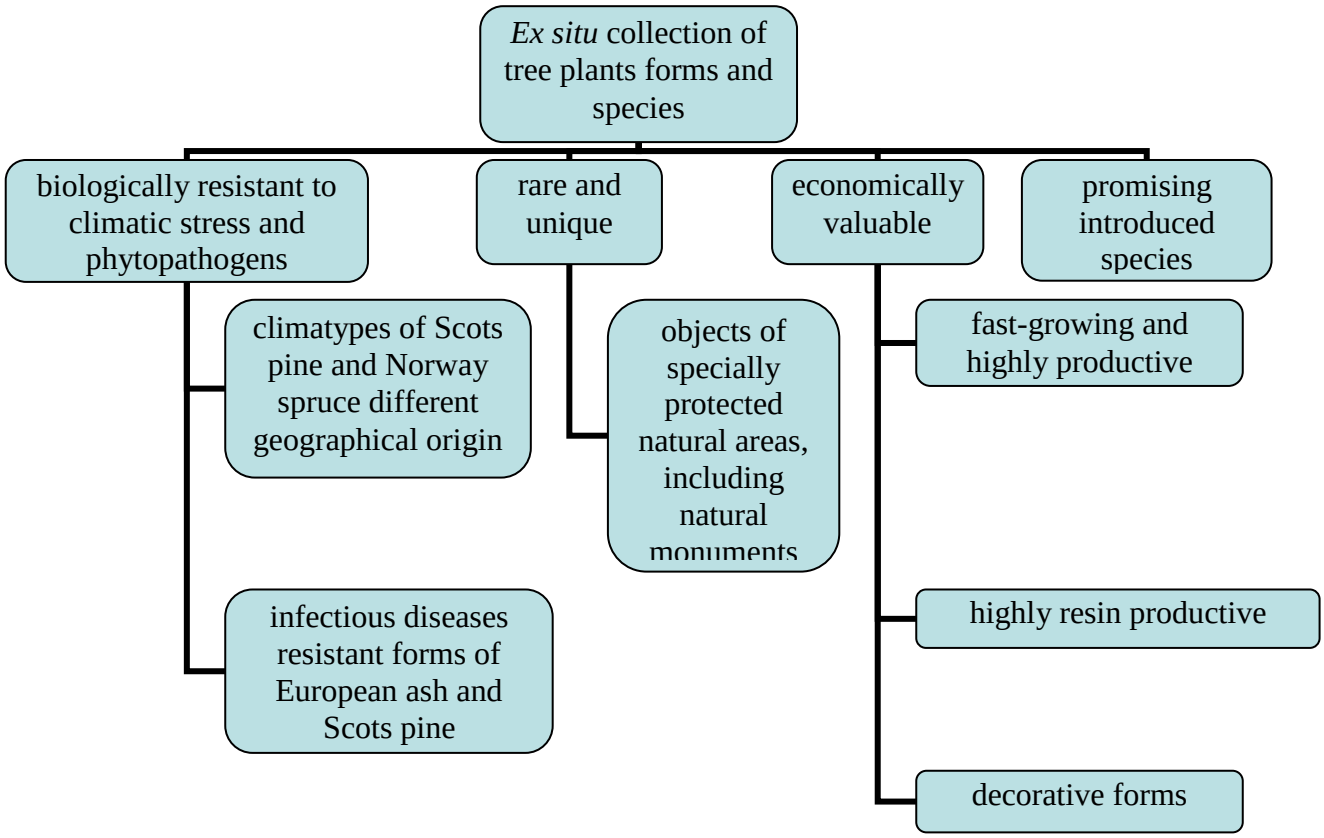


Figure B. Structure *ex situ* of the collection of forest tree plant forms resistant to climatic stress, rare and economically valuable tree species

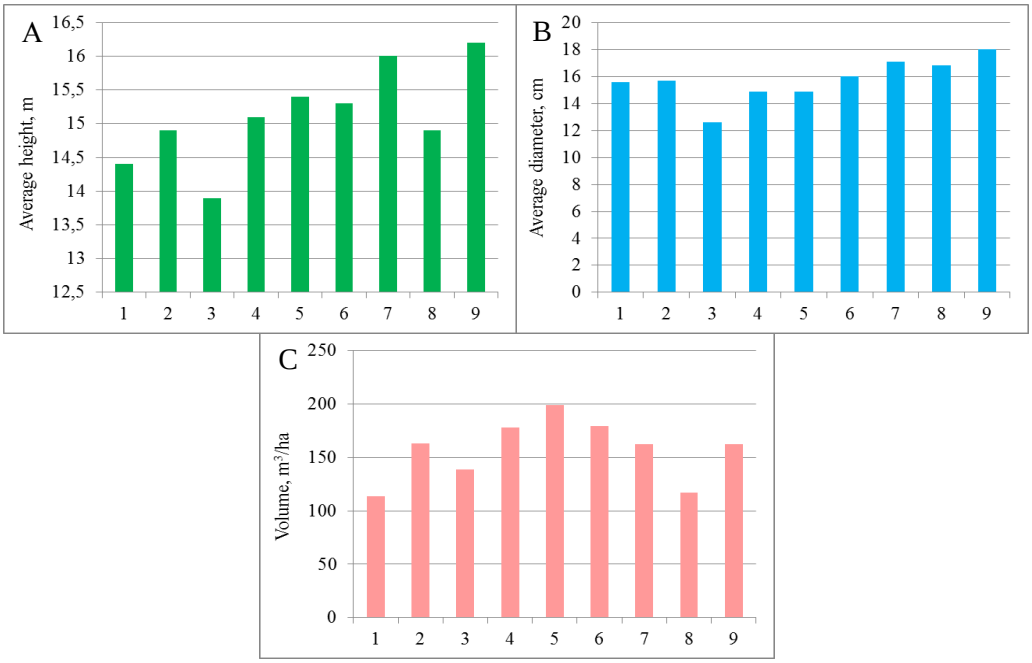
(b) the average diameters are in the range from 11.7 (Kirov) to 20.3 cm (Armenia). The best indicators belong to climatic types from the Southern subzone of the Hardwood zone (climatic types from Omsk, Tambov, Sumy, Poltava regions) and the Subzones of the Northern and Southern Steppes (Armenia, Saratov, Pavlodar and Orenburg regions). The relatively low average diameters of the climatic types from the regions located closer to the object of study (Mixed wood zone and the Northern subzone of the Hardwood zone) are due to the high survival rate of such climatic types, as evidenced by high wood volume;

(c) the climatic types from the Southern subzone of the Mixed wood zone, the Northern and the Southern subzones of the Hardwood zone have the largest stem wood volume: Chuvash – 309 m^3/ha, Lithuanian – 290 m^3/ha, Gorky – 273 m^3/ha, Ryazan – 288 m^3/ha, Bryansk – 257 m^3/ha, Lipetsk – 270 m^3/ha, Kiev – 293 m^3/ha, Volyn – 294 m^3/ha, and Cherkasy – 296 m^3/ha regions (Figure C);

– *Norway spruce*. Selective and genetic evaluation of 21 climatic types of Norway spruce was carried out in 39- and 41-year-old provenance trials of the Cherikov forestry enterprise (Mogilev region). There were determined the intensity of growth in height and in diameter, stem volume and stem wood volume for each climate type and geographical region (Figure D):

(a) the climatic types from Belarusian region, North-West region (Leningrad, Pskov, Kaluga) and South-West region (Zakarpattia, Ivano-Frankivsk, Rovno, Lviv) are characterized by the maximum height (17.9-19.8 m);

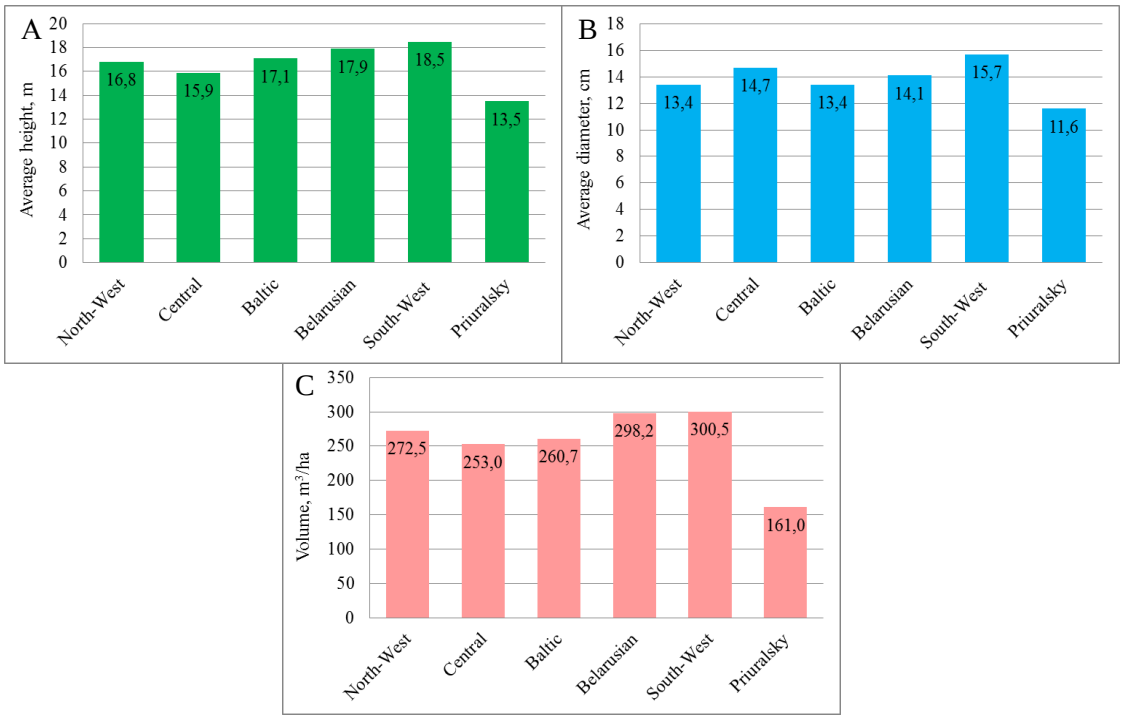
(b) the largest diameter was observed in climatic types of the southern origin (19 cm) (Ivano-Frankivsk). Local samples (Belarusian region) have average diameter (11.9-15.3 cm);



Forest subzone: *1* – Middle Taiga Subzone; *2* – Southern Taiga Subzone; *3* – Northern Softwood Predominance Subzone; *4* – Southern Subzone with Equal Part of Softwood and Hardwood Species; *5* – North Subzone of Monodominant Forests; *6* – Southern Subzone of Polydominant Thermophilic Forests; *7* – Subzone of the Northern Steppes; *8* – Subzone of the Southern Steppes; *9* – Subzone of the Northern Semi-Desert

A – average height, m; B – average diameter, cm; C – volume, m^3/ha

Figure C. Selective and genetic evaluation of climatic types of Scots pine of various geographic locations (on forest subzones)



Geographical regions: North-West, Central, Baltic, Belarusian, South-West, Priuralsky

A – average height, m; B – average diameter, cm; C – volume, m^3/ha

Figure D. Selective and genetic evaluation of climatic types of Norway spruce of various geographic locations (on regions)

(c) the highest wood volume per 1 ha was found in spruce origin from Ivano-Frankivsk, Rovno, Leningrad regions and Estonia (percentage of control ranging from 106 to 134%). The volume of the local climatic type (Mogilev) is 308 m^3/ha. The lowest wood volume per 1 ha is observed in the origin from Tatarstan, Udmurtia, Vologda and Kostroma regions (153-167 m^3/ha);

– it was established that the selection of Scots pine for maximum productivity and biological stability should be carried out among plantations from Belarus and neighboring regions of Ukraine, Russia and Lithuania; Norway spruce – from local populations, as well as the southern and western regions on Belarus.

(9.2) Selection of native tree species forms resistant to phytopathogens was carried out:

– ash stands were examined in 20 forest enterprises of six regions at the total area of 1,835 hectares (Vasilevichi, Rechitsa experimental, Ivye, Lida, Bogushevsk, Liozno, Novogrudok, Starobin, Vitebsk, Uzda, Stolin, Lyuban, Glusk, Stolin, Ivatsevichi, Drogichin, Lepel, Tolochin, Osipovichi experimental, Logoisk forestries). The trees of the European ash not affected phenotypically by necrosis of branches were identified in stands of three forestries (Logoisk, Osipovichi experimental and Stolin). Three candidate genes (cSNP- and GEM-markers) of resistance of the European ash to infectious necrosis of branches were studied;

– based on the phenotypic selection of trees and their molecular genetic marking, the European ash forms resistant to infectious necrosis of branches were selected. 50 plantlets were received by grafting from ten European ash clones tolerant to the infectious necrosis of branches. Their microclonal propagation was carried out;

– the selection of plants in forest nurseries of seven forestry enterprises, as well as by seed germination in the laboratory, was carried to identify the seedlings of tree species resistant to infectious lodging. Based on the molecular and genetic marking, 15 most represented loci associated with resistance to infection lodging (GH19, Hsp90, CaM, SAM, ABA/WDS, Hsp70, AAI_LTSS, MiAMP1 (AMP1), Stress/antifungal, Disease resistance gene (R), BAX inhibitor (BI)-1/YccA, CHS, DHN, DEF, AMP4) were selected;

– a set of genetic markers (15 loci) intended for screening and assessment of the level of activity of genes associated with resistance to infection lodging of Scots pine (Pinus sylvestris) plantlets was developed. Homologous loci associated with resistance to infectious lodging were identified for Norway spruce (*Picea abies*), Black alder (*Alnus glutinosa*), Silver birch (*Betula pendula*).

10. Selection and harvesting of reproductive material of forms and species of tree plants rare and unique are based on the following works:

– a brief analysis of the current structure and dynamics of the system of specially protected natural areas of Belarus was prepared. It is shown that at present it includes 1,297 objects with a total area of 1,870.1 thousand hectares including one nature reserve (Berezinsky Biosphere), four national parks (Belovezhskaya Pushcha, Bráslavskie Ozera, Narochansky and Pripyat), 99 republican wildlife reserves and 282 local wildlife reserves, and 326 republican natural monuments of nature and 585 local natural monuments (Table A). It was determined that the share of the area of protected natural areas in Belarus is 9.02%. At the same time, starting from 2013, their number increased significantly (+77).

Table A – System of specially protected natural areas of Belarus (as of December 2019)

SPNA status	Criteria / indicators		
	number, units	total area, thousand hectares	share of SPNA in the total area of the republic, %
nature reserves and national parks	5	475.5	2.29
wildlife reserves, including:	381	1,381.1	6.66
republican	*99*	*971.0*	*4.68*
local	*282*	*410.1*	*1.98*
natural monuments, including:	911	13.5	0.07
republican	*326*	*3.5*	*0.02*
local	*585*	*10.0*	*0.05*
TOTAL	**1,297**	**1,381.1**	**9.02**

– it was determined that in the western regions of Belarus the specially protected natural areas occupy the greatest share in the total area (including Brest region – 14.96%, Grodno region – 10.07%), the lowest – in the east (including Gomel region – 7.38%, Mogilev region – 4.60%). 12 SPNA objects (two national reserves of the republican significance, monuments of national and local significance, two and eight, respectively), or 1.72% (Figure D) are located in Minsk.

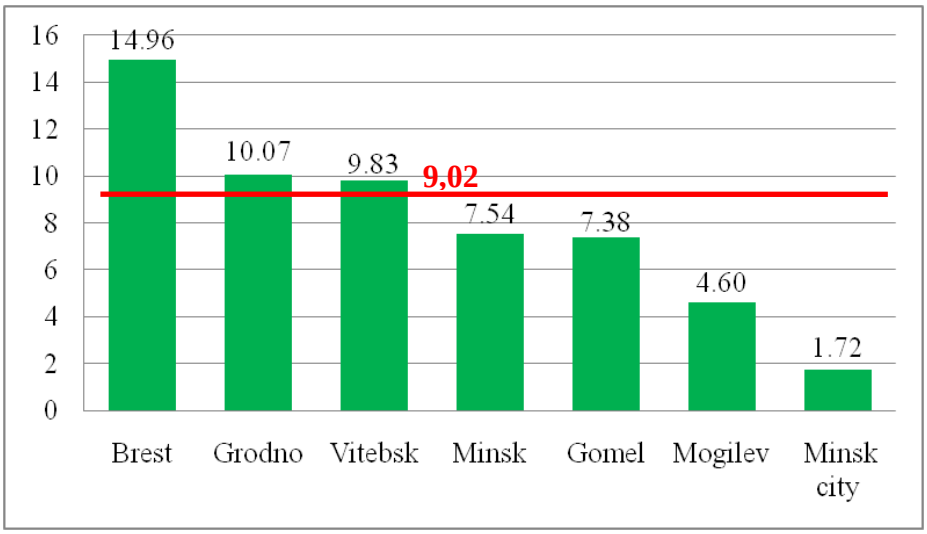


Figure E. Share of specially protected natural areas of Belarus within the total area of the regions and the Republic (in %)

– the formation structure is analyzed and a brief description of forest ecosystems of the nature reserves and national parks, the republican and local wildlife reserves and natural monuments of Belarus is given;

– analysis of the species composition of the botanical natural monuments of republican significance showed that it includes 16 woody species (57 monuments, or 66.3% of the total number of botanical natural monuments of republican significance): pedunculate oak, Norway spruce, Scots pine, Weymouth pine, black pine, European larch, Caucasian fir, Californian fir, Karelian birch, European beech, small-leaved linden, American linden, Yellow horse chestnut, green ash aucuba-leaved, sycamore maple, shagbark hickory. The remaining 33.7% of the monuments are represented by parks, botanical gardens and tree

nurseries, forest stands. The following woody species are preserved in the botanical natural monuments of local significance: Silver fir, Siberian larch, Silver birch, Norway maple, Aspen, Poplar, Wych and Field elm, Wild cherry;

– in general, 14 tree species, including listed in the Red Book of Belarus, were selected for the creation of a collection of forms of forest woody plants resistant to climatic stress, rare and economically valuable tree species (Table B).

Table B – List of tree species selected in the *ex situ* collection in the context of forest ecosystems objects of specially protected natural areas of Belarus

Tree species	Forest object			
	nature reserves and national parks	wildlife reserves	natural monuments	forest stands of exploitable forests
Scots pine	+			
Silver fir	+		+	
Douglas fir		+		
Siberian larch			+	
Weymouth pine				+
Pedunculate oak	+		+	
Small-leaved linden	+			
Largeleaf linden	+			
Karelian birch		+		
European beech	+			+
Sycamore maple	+			
Common ash	+			
European white elm	+			
White poplar	+			

11. Selection and harvesting of reproductive material of forms and species of tree plants economically valuable are based on the following works:

(11.1) Inventory of the breeding and collection fund of local and introduced forest tree species promising for forestry of Belarus was carried out, fast-growing and highly productive forms of tree species were identified, including the use of molecular genetic tagging of genes, and selected:

– it is noted that plus trees play the main role in the formation of breeding fund of fast-growing and highly productive trees of forest tree species within the permanent forest-seed base, and among breeding and genetic objects – archives of plus trees clones and archive-uterine orchards. Various *ex situ* collections (e.g., field, *in vitro* and seed) make a significant contribution to the creation of the collection fund;

– the features of the distribution in the territory of Belarus and the species composition of plus trees were analyzed. It is shown that 2,588 plus trees were certified in the composition of the permanent forest-seed base of Ministry of Forestry of the Republic of Belarus. Plus trees were selected in all six state production forestry associations (SPFA) their number is distributed unevenly in the territory of Belarus (Figure F). The largest amount of plus trees is selected in Gomel and Vitebsk SPFA (733 and 490 pcs, respectively), the smallest – in Brest (285 pcs.);

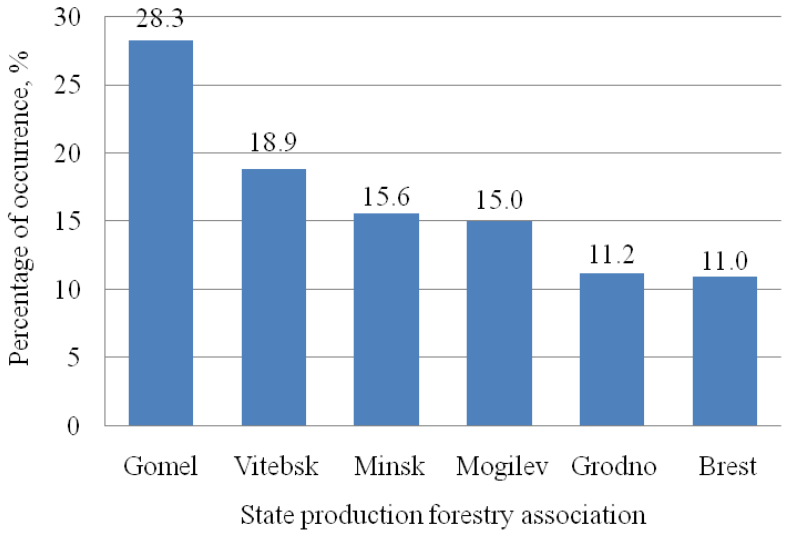


Figure F. Percentage of plus trees occurrence in the territory of the state production forestry associations (in percent)

– it was established that plus trees are represented by 13 local and introduced forest tree species, including six coniferous and seven deciduous (Table C). The Scots pine, collected in the territory of all six SPFAs, accounts for more than 60% of plus trees (1,572 pcs.). Four species of plus trees (European ash, Green-bark aspen, European beech and Silver fir) were selected in only one SPFA (Mogilev, Gomel, Grodno and Brest respectively);

Table C – Distribution and species composition of plus trees by state production forestry associations of Belarus

Tree species	State production forestry associations						Total, pcs.
	Brest	Vitebsk	Gomel	Grodno	Minsk	Mogilev	
Scots pine	161	344/15	346/23	213/14	294/15	214/27	1572/94
English oak	12	–	318	9	24	32	395
Norway spruce	43	83/1	–	–	31	57	214
Silver birch	12	36	38	8	6	–	100
European larch	6	–	–	38	32	20	96
Black alder	36	–	25	7	–	14	82
Siberian larch	–	27	–	8	–	17	52
Karelian birch	–	–	–	–	9	14	23
European ash	–	–	–	–	–	19	19
Weymouth pine	11	–	–	–	8	–	19
Green-bark aspen	–	–	6	–	–	–	6
European beech	–	–	–	6	–	–	6
Silver fir	4	–	–	–	–	–	4

– analysis of the collection fund has shown that so far more than 30 sites were created for conservation of fast-growing and highly productive forms of local and introduced forest tree species, which contain the following collections: *(1)* clones and forms of elite and plus trees of Scots pine, Norway spruce, Karelian birch on archive-uterine orchards (299 clones and forms); *(2)* families of plus trees of Scots pine, European spruce in family orchards (66 families); *(3)* climatypes of Scots pine, Norway spruce in geographical cultures (266 climate types); *(4)* collection on testing the offsprings of plus trees of Scots pine, Norway spruce, English oak in test cultures (1,267 families);

– the collection *in vitro* fund of fast-growing and highly productive forms of forest tree species, formed on the basis of the Institute of Forest of the National Academy of Sciences of the Republic of Belarus was described, which includes more than 40 clones of species of *Betula* types and their hybrids (*B. pendula*, *B. pubescens* Ehrh., triploid hybrid birch); species of *Populus* and their hybrids (*P. trichocarpa* Torr. et Gray, *P. koreana* Rehder, *P. simonii* Carriere, *P. wislizenii* Sarg., *Populus* × *petrowskiana* R.I. Schrod., *Populus* × *canadensis* Moench, *P. tremula*; species of *Salix* (*Salix caprea* L., *S. fragílis* L.);

– a molecular genetic tagging of the genes, controlling lignin biosynthesis (*Cad*, *O-Comt*, *Pal*, *4Cl*) of fast-growing and highly productive forms of Scots pine and Norway spruce, was carried out. In general, no significant differences were revealed between the fast-growing and moderately-growing genotypes. The use of the advanced DNA analysis methods allowed to reveal a number of features. Polymorphism, characteristic only for the fast-growing forms of pine in the sample under study, was determined by the *Cad* gene of Scots pine in the primer annealing zone. The genetic spectrum, detected only in the group of fast-growing forms of Norway spruce, resulted from the restriction of lignin peroxidase by *RsaI* enzyme;

– the Register of fast-growing and highly productive forms of selection and collection fund of forest woody species was created.

(11.2) Inventory of the breeding and collection fund of local and introduced forest tree species promising for forestry of Belarus was carried out, highly resin productive forms of tree species were identified, including the use of molecular genetic tagging of genes, and selected:

– a complex selection and genetic evaluation of resin productivity of 310 phenotypes of Scots pine in five stands of natural origin was carried out. The average value of resin productivity of the analyzed trees was M = 13.1 g. The Scots pine trees were divided into categories depending on the value of the selected feature: low (up to 40%), medium (41-160%), high (161-200%) and very high (201% or more) resin productivity with respect to the average value (13.1 g). 25 plus trees were selected, the resin productivity of which was 250% or more in comparison with the average value;

– the correlation of resin productivity with the thickness and type of bark was studied. The high correlation of resin productivity and the thickness and height of the coarse bark along the trunk was established (r = 0.41) that forms the basis for recommending this value for the selection of trees with high resin productivity. The selection and use of reproductive material of trees with coarse bark is necessary to obtain high wood pulp and high resin productivity;

– an inventory of selection and genetic objects of SFI "Korenevskaya experimental forest station of the Institute of Forest of the NAS of Belarus" (collection-mother orchard of Scots pine clones with high resin productivity, three

archive-mother orchards of Scots pine plus trees), identification and selection of forms with high resin productivity were carried out. 24 clones with high resin productivity were selected in the archive-mother orchards;

– the degree of heritability of the resin productivity level of seed progeny after open pollination of Scots pine trees was studied. It was established that the hereditary variation is of significant proportion (8.55%) in the general phenotypic variation of resin productivity (11.55%) of the Scots pine clones. The resin productivity hereditability factor is 0.45;

– six clones of Scots pine from the collection-mother orchard of forms with high resin productivity were used to prepare vegetative material, it was cloned by grafting techniques, plant material was cultivated and included in the *ex situ* collection;

– the Register of high resin productivity forms of selection and collection fund of forest woody species was created.

(11.3) *Ex situ* collection includes 14 decorative varieties of Scots pine grown in the Central Botanical Garden of the NAS of Belarus, included in 2016-2017 in the "State Register of Varieties" and recommended by State Institution "State Inspection for Testing and Protection of Plant Varieties" to be used in the territory of the Republic of Belarus.

12. The clones of the introduced forest tree species included in the composition of the *ex situ* collection being created that are promising for the forestry of Belarus were described: deciduous species (*Tilia caucasica*, *Tilia dasystyla* Steven, *Acer saccharinum*); Chinese clone P.ShHG of *Populus* L., *Fagus sylvatica* L.), and coniferous species (*Pseudotsuga menziesii* (Mirb.) Franco, *Pinus sibirica* Du Tour, *Pinus koraiensis* Sieb. et Zucc.), and etc.

13. The work on identification, selection and breeding of forest tree plant forms resistant to climatic stress, rare and economically valuable tree species carried out in the territory of the National Forest Selection-Seed Production Center, Korenevskaya and Dvinskaya experimental forest stations of the Institute of Forest of the National Academy of Sciences resulted in the creation of *ex situ* collection with the total area of 3.05 ha. 1214 seedlings and saplings of more than 35 coniferous and deciduous wood species and their varieties were planted. Arrangement of planting spots is 5 × 5 m. The collection is represented by:

– climatic stress resistant origin of Scots pine and European spruce, selected as part of provenance trials and promising introduced species (*Tilia caucasica* and *Tilia dasystyla*);

– clones of Scots pine with high resin productivity;

– forms of European ash resistant to phytopathogens, Scots pine genotypes resistant to infectious lodging;

– rare species listed in the Red Book of the Republic of Belarus (Silver fir, Dwarf birch);

– eight natural monuments of national and local significance (English oak, Silver fir, Siberian larch);

– fast-growing and high production clones and forms of Scots pine, Norway spruce, European larch, Douglas-fir, English oak, European beech, Small-leaved linden, Norway maple, Silver birch (including Black-barked birch and Silver birch ‘dalecarlica’), poplars (including Aspen, Simon poplar, White poplar, Petrowskiana poplar, Black poplar, Canadian poplar);

– clones of lyre-shaped, bush and standard forms of Karelian birch, as well as clones with highly patterned timber;

– seed progeny of coniferous introduced trees (Weymouth pine, Siberian cedar pine and Korean cedar pine, Japanese white pine, Korean fir, Nordmann fir);

– food species (Walnut, Manchurian walnut, Butternut, Heart-shaped walnut, Black mulberry);

– 14 varieties of decorative forms of Scots pine, Silver maple, etc.

The created *ex situ* collection is aimed at the preservation of biological and genetic diversity of tree species, increasing the productivity and biological sustainability of forests being created.

Introduction

Climate change, air and soil pollution, distribution of pests and diseases, illegal fellings have a negative impact on the state of forests, leading to decrease in their biological stability and extinction. The monitoring of the vital state of European forest stands, which was carried out in 2014 (more than 5,611 control sites in 24 countries), showed that 23.9% of the estimated trees were seriously damaged or died [State of Europe's Forests, 2015]. Among the most affected species there were the English oak (*Quercus robur* L.), the Durmast oak (*Q. petraea* (Matt.) Liebl.), Maritime pine (*Pinus pinaster* Aiton) and the European beech (*Fagus sylvatica* L.). In Belarus the examples of negative influence of climate change is dieback of Ash (*Fraxinus excelsior* L.), European spruce (*Picea abies* (L.) H. Karst.), Scotch pine (*Pinus sylvestris* L.), which has been observed in recent years.

The global climate change becomes more and more relevant for the forest sector on the global scale and regionally (for the Republic of Belarus), because forests are one of the most vulnerable ecosystems. The drought of 2010 in Central Europe lowered more than half the net primary production of forest cenoses and led to economic losses of about 10 billion US dollars [Bastos et al., 2014]. Global climate change can make essential the correction of the strategy of forest management and cause the need of genetic resources conservation for preserving forest sustainability in conditions of the environment changes without the decrease in a genetic diversity of forests.

In this regard the main objective and strategic priority of sustainable forest management is rational use and conservation of forest genetic resources to maintain a genetic diversity for ensuring the principle of constant integrity of genetic information among generations and ability of populations to adapt to various conditions of the environment.

Now in Belarus conservation of the valuable forest gene pool and its use in breeding and seed production are carried out according to State Standard of the Republic of Belarus 1709-2006 "Sustainable Forest Management and Forest Use. Forest Seed Production. The General Requirements", already realized Program of Conservation of Forest Genetic Resources and Development of Genetically Improved Forest Seed Production in the Republic of Belarus till 2015, the newly developed Program of Conservation of Forest Genetic Resources and Development of Genetically Improved Seed Production of Forest Forming Species of Belarus till 2030 and the Forest Code of the Republic of Belarus.

At the same time under the strengthening of climate change influence the transformation of the composition and the structure of forests occurs. The strategy of adaptation of forestry of the Republic of Belarus to climate change till 2050 provides the modification of the structure of forests. Thus, the need for forest breeding work aimed at obtaining of genetically valuable, highly adaptive and ecologically flexible, resistant and productive in new conditions forms of forest tree species appeared. Potential source of breeding material will be the collection of forms of forest woody plants that have to be established as a result of performance of the project. Selected forms will be resistant to climatic stress or characterized as rare and economically valuable tree species perspective for growing in climate change conditions.

Currently, the maximum use of valuable forest genetic resources also faces such challenges as:

– the lack of the uniform information database and the register of initial sources (*in situ*) of resistant to climatic stress, rare and economically valuable forms of plants owing to their geographical and departmental separation;

– the essential distinctions of woody vegetation in different geographical regions of Belarus, expressed in the peculiar species structure of the forests in different sub-provinces;

– the decrease in productivity and stability of forest stands and individual trees, especially in case of old-age ones, of a number of woody species;

– biological features of maturing, storage and growing of the reproductive material of different woody species.

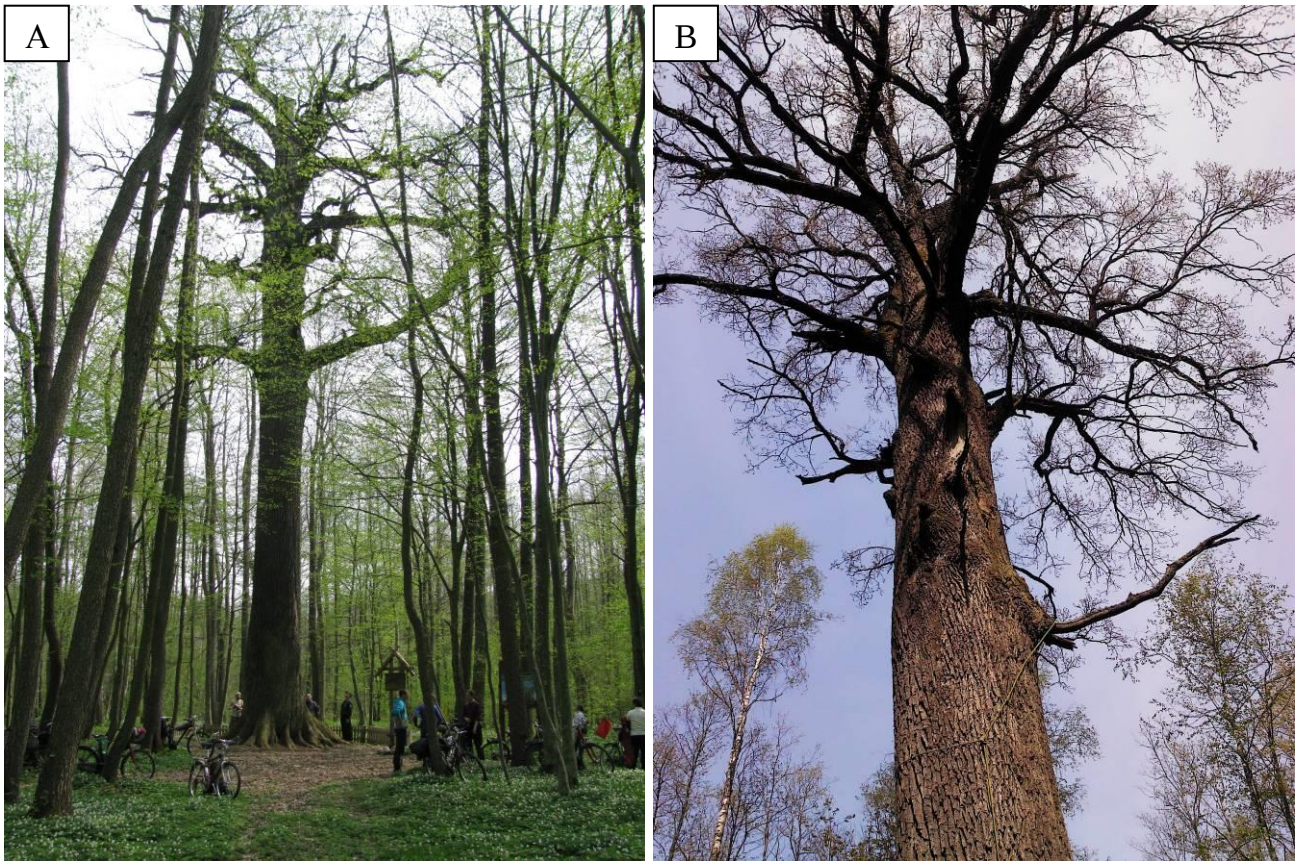
The creation of the collection of forms of forest woody plants resistant to climatic stress, as well as rare and economically valuable tree species on the basis of State Forestry Enterprises and the National Forest Selection-Seed Production Center is aimed at overcoming the above described problems by inclusion in the structure of collection the most valuable forest genetic resources of Belarus. On a global scale the creation of such collection will promote increase in efficiency of forestry and sustainable forest management.

Thus, the main aim of the activity is search and selection of forms of forest woody plants resistant to climatic stress or rare and economically valuable tree species and creation of the collection of the selected forms. The collection will provide: *(a)* the preservation of economically valuable genetic material of tree species for its further use in breeding and creation of new varieties; *(b)* the conservation of the most productive and adapted genotypes in the conditions of climate change and spread of invasive diseases and pests; *(c)* management of rare and endangered species.

1 Creation of up-to-date information database of selected populations, climatic types, species, forms, different genotypes *in situ*

During the selection of populations, climatic types, species, forms, individual genotypes *in situ* and their including into database adhered to the following criteria and standards:

– *age of a tree*. The parameter is identified with the use of increment borers. Cores are sampled at the level of a root neck or at the height of 1.3 meters above ground level. In the latter case the real age of the tree is calculated as the sum of the value determined with core plus 5 years (for deciduous species) or plus 10 years (for coniferous species). The age has to be not less than 100 years or for fast-growing trees (species of genus *Populus*, *Salix*) not less than 70 years. The higher the age, the more interesting the tree is from scientific and informative point of view (Figure 1.1).



A – Tsar Oak (trunk circumference is 6.32 m; age is 350 years);
B – Patriarch Oak "Pozhezhinsky" (trunk circumference is 6.35 m; age is 350 years)

Figure 1.1. Old-age English oak trees in Belarus (Brest region, Malorita district)

Table 1.1 reflects the distribution of old-age trees with trunk girth higher than 3 m by species and age groups. On the territory of Belarus such trees usually stand separately or in small groups.

The main old-age trees on the territory of Belarus, whose age is instrumentally proved, are the Scotch pine (380 years old on raised bogs, 300 years on mineral soils) and the English oak (350 years old).

Table 1.1 – Distribution of old-age trees with trunk girth higher than 3 m by species and age groups on the territory of Belarus, %

Tree species	Age, years					
	100-120	121-150	151-200	201-250	older 250	**Total, %**
Quercus robur	7.1	8.8	22.0	5.1	1.0	**43.9**
Tilia cordata	2.0	11.1	3.0	3.3	–	**19.4**
Acer platanoides	1.3	2.3	3.8	–	–	**7.3**
Pinus sylvestris	0.3	0.3	1.5	5.1	0.3	**7.3**
Larix sibirica	2.3	2.8	0.3	–	–	**5.3**
Fraxinus excelsior	1.5	1.0	1.3	–	–	**3.8**
Ulmus glabra	0.8	1.3	1.0	0.3	–	**3.3**
Populus alba	1.5	–	–	–	–	**1.5**
Picea abies	1.0	0.3	–	–	–	**1.3**
Populus sp.	0.3	0.8	–	–	–	**1.0**
Populus canadensis	1.0	–	–	–	–	**1.0**
Larix decidua	0.3	0.5	–	–	–	**0.8**
Alnus glutinosa	0.8	–	–	–	–	**0.8**
Pinus sibirica	–	0.8	–	–	–	**0.8**
Betula pendula	–	0.5	–	–	–	**0.5**
Ulmus laevis	–	–	0.3	0.3	–	**0.5**
Pinus strobus	0.3	–	0.3	–	–	**0.5**
Betula nigra	0.3	–	–	–	–	**0.3**
Acer pseudoplatanus	0.3	–	–	–	–	**0.3**
Abies alba	0.3	–	–	–	–	**0.3**
Prunus avium	0.3	–	–	–	–	**0.3**
ИТОГО	**21.2**	**30.3**	**33.3**	**13.9**	**1.3**	**100.0**

– *trunk size.* As biometric parameters of a tree are closely connected with age (which is not always possible to find out precisely) and growth conditions, one of the main selection criteria of rare and unique forms is trunk diameter and trunk girth of tree (measured at a height of 1.3 m above ground level). The analysis of scientific publications showed similar approach to the definition of unique old-age trees. Thus the Ukrainian scientist A.L. Lypa suggested preserving trees with a trunk girth of more than 3 m. The Polish scientists recommend preserving the oak and the poplar trees with a trunk girth of more than 3.77 m; beech, linden, pine and spruce trees with a trunk girth of more than 3.142 m; the ash-trees with a trunk girth of more than 2.50 m. English experts think that trees with a trunk girth of more than 3.2 m are potentially interesting; trees with a trunk girth of more than 4.7 m are valuable from the point of view of need of their conservation; and trees with a trunk girth of more than 6.25 m are ancient ones.

The results of the analysis of the existing old-age trees show that trees with a trunk girth of 4 m and more (for fast-growing poplars and willows the value is 5 m and more) can belong to the category of the oldest trees. The study of the age of trees with 3-meter trunk girth has shown that in conditions of the open area (without intake of mineral fertilizers) the English oak reaches this value at the 100-year age. If such tree grows in conditions of the open area on farmlands its age can vary within 70-80 years, and the 100-year boundary is reached with the trunk girth of 350-420 m. What concerns the oak trees growing inside the forest stand in optimal soil they reach the 3-meter trunk girth at the age of 120-180 years;

– *a tree species*. The following groups of trees are regarded as special valuable: *(1)* oaks, ashes, beeches, hornbeams, lindens, maples and coniferous trees; *(2)* representatives of introduced species that were planted for long-term testing of adaptation of the species to local conditions which have reached the age of fructification and producing seeds regularly and demonstrate high productivity and vitality; *(3)* tree species with cultural, esthetic, informative or scientific value; *(4)* the best representatives of some tree species; (5) woody species included in the Red Book of the Republic of Belarus;

– *state of a tree*. According to a scale of categories of state of trees (Technical Code of Practice 026-2006) the trees which are belong to categories "dying", "the recent dead standing tree", and "the old dead standing tree" can't be referred to special valuable objects. It is desirable to select the trees showing high level of vitality, or trees whose state can be potentially improved or conserved when holding special measures;

– *a tree form*. The trees with a rare form of a trunk and crown, coloring of trunks, leaves or needles are special valuable.

The analysis of characteristics of the existing nature sanctuaries and original observations of some forest stands allows marking out the following categories of special valuable forest stands:

– *relic sites of the forest* which have remained from a native plant communities. The analysis of forest inventory and management materials shows that on certain sites there are forest stands up to 270 years old. However, on-site study demonstrates that a considerable part of a century old forest stands is presented by mires or other low-productive types of the forest in which, as a rule, there are no outstanding large trees, despite their old age. Another considerable share of old forests is represented by sites which are located on river floodplains or mineral islands among mires or in remote places far from forest roads, thus, territorially inaccessible;

– *sites of the forest with valuable tree species*. This point concerns forest stands with the Karelian birch (irrespective of age) and sites with representatives of introduced species that were planted for long-term testing of adaptation of the species to local conditions and that show no signs of invasive behavior. There are three introduced species of woody plants that demonstrate high productivity and vitality in soil and climate conditions of Belarus and showed no signs of invasive behavior in experimental forest plantations during 100 and more years of observation. They are European larch, Weymouth pine, European beech. In Table 1.2 there is an example of distribution (share, %) of old-age stands by age groups on the territory of Grodno region;

– *representative old-age stands* are the examples of the best experience of forest management at the beginning of the last century;

– *forest stands of native species located outside the species range.* There are several populations of Norway spruce and Grey alder outside northern boundary of those species ranges and populations of European hornbeam outside the southern boundary of this species range in Belarus;

– *sites of the forest with native species of woody flora which are endangered*. In Belarus this refers to species *Abies alba* (I category of national nature protection value) and *Quercus petraea* (II category);

– *parks, gardens and lanes* which are a part of cultural heritage of Belarus and works of landscape gardening art. On the territory of Belarus there are about 600 ancient parks or their fragments, as a rule, partially remained from primary stands;

– *botanical collections* which are the result of collective efforts of many people for many years for the purpose of creation of collections of woody and shrubby plants of native and introduced species.

Table 1.2 – Distribution (share, %) of old-age stands by age groups on the territory of Grodno region

Category of stand, tree species	Age, years					
	100-120	121-150	151-200	201-250	251-300	**Total, %**
Floodplain oak stand	3.1	3.1	15.6	3.1	3.1	**28.1**
Upland oak stand	–	6.3	3.1	6.3	6.3	**21.9**
Oak and lime stand	–	6.3	12.5	–	–	**18.8**
Pine stand	–	–	6.3	3.1	–	**9.4**
Hornbeam lane	3.1	–	–	–	–	**3.1**
Small-leaved linden lane	–	3.1	–	–	–	**3.1**
Siberian Larch lane	3.1	–	–	–	–	**3.1**
Broad-leaved species lane	3.1	–	–	–	–	**3.1**
European beech stand	3.1	–	–	–	–	**3.1**
European larch stand	3.1	–	–	–	–	**3.1**
Weymouth pine stand	3.1	–	–	–	–	**3.1**
TOTAL	**21.9**	**18.8**	**37.5**	**12.5**	**9.4**	**100.0**

Based on the developed criteria and standards, as well as conducted expeditionary surveys of forest ecosystems, an information database of populations, climatic types, species, forms, different genotypes *in situ* which are of particular interest for creating *ex situ* collection of forest tree plants resistant to climatic stress, rare and economically valuable tree species was created and updated. The database was developed in Excel format and contains information about the selected coniferous (63 objects) and deciduous (235 objects) tree species (Appendix A).

Each object is assigned a key number of the plot, information about the species, territorial location and terrain correlation, geographic coordinates, area and age of the object. The objects included in the database are classified according to the codes of stand categories (1 – a tree and/or a group of trees, 2 – sections of the forest, 3 – old parks and alleys) and their protection status (1 – detected; 2 – examined, 3 – key biotope, 4, 5 – natural monument of local and republican significance, respectively, recommended to allocate; 6, 7 – selected natural monument of local and republican significance, respectively).

Database analysis of the populations, climatic types, species, forms, different genotypes of coniferous wood species *in situ* (Appendix A, Table A.1) showed that its composition includes five varieties: Pine (*Pinus* spp.), Spruce (*Picea* spp.), Larch (*Larix* spp.), Fir (*Abies* spp.) and Douglas-fir (*Pseudotsuga* spp.) (Figure 1.2). The largest number of objects is represented by pines (61.9%), 81.2% of which are Scots pine, 10.3% – Weymouth pine, 8.5% – Black pine. Variety *Picea* is represented by one species – Norway spruce (14.7%), including serpentine-shaped and weeping forms; *Pseudotsuga* – Douglas-fir (1.6%). Variety *Abies* is represented by three species (European silver fir, Californian fir, Caucasian fir), variety *Larix* – by two species (European and Siberian larch).

Database analysis of the populations, climatic types, species, forms, individual genotypes of deciduous wood species *in situ* (Appendix A, Table A.2) showed that its composition includes eight varieties: Oak (*Quercus* spp.), Linden (*Tilia* spp.), Ash (*Fraxinus* spp.), Maple (*Acer* spp.), Elm (*Ulmus* spp.), Beech (*Fagus* spp.), Horse chestnut (*Aesculus* spp.) and Hornbeam (*Carpinus* spp.) (Figure 1.3).

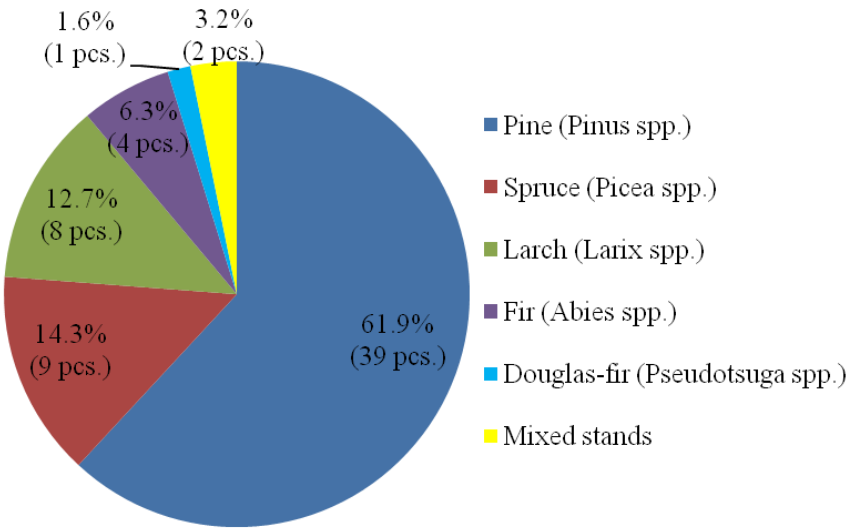


Figure 1.2. Species composition distribution of objects of coniferous species included in the database of populations, climatic types, species, forms, genotypes *in situ*

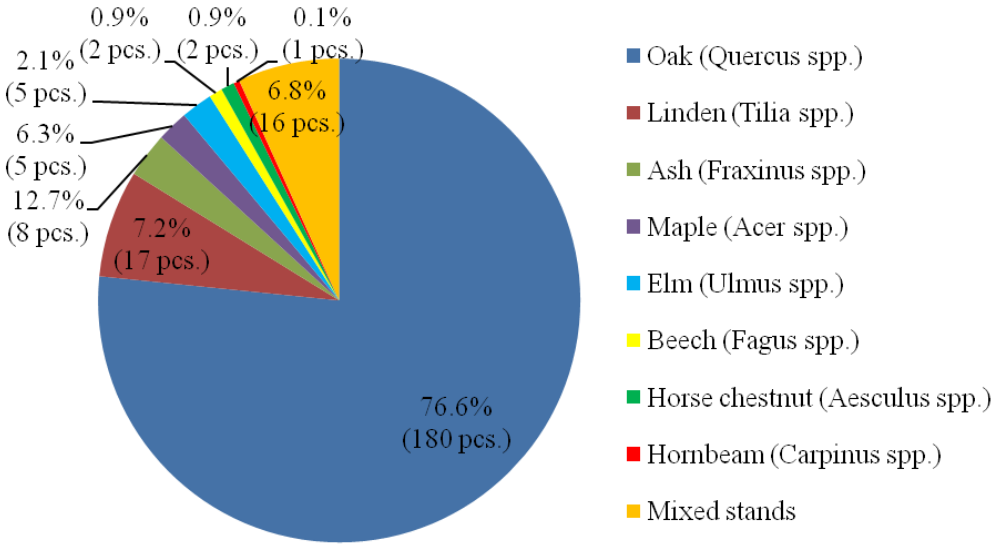


Figure 1.3. Species composition distribution of objects of deciduous species included in the database of populations, climatic types, species, forms, genotypes *in situ*

The largest number of objects is represented by English oak (76.6%), including three pyramid-shaped ones. Variety *Tilia* is represented by two species (Small-leaved and American linden), *Fraxinus* (European ash and Green ash) – by two species, *Acer* (Norway maple and Sycamore maple) – by two species, and *Ulmus* (Scotch elm and European white elm); one species for variety *Fagus* (European beech), *Aesculus* (Horse chestnut) and *Carpinus* (Common hornbeam).

2 Register of endangered species, subspecies, forms and individual populations, the preservation of which in natural conditions without the use of biotechnology is not effective

The created register of endangered species, subspecies, forms and individual populations, the preservation of which in natural conditions without the use of biotechnology is not effective, contains:

– tree species listed in the Red Book of the Republic of Belarus (Silver fir, Dwarf birch);

– economically valuable forms of tree species that grow in limited areas and are characterized by a low degree of heritability of target signs (Karelian birch);

– marginal and/or peripheral populations of tree species (spruce forest outliers).

Figure 2.1. 75% of Silver fir trees are categorized as "without signs of weakening"

1. European silver fir (*Abies alba* Mill.) – large monoecious evergreen tree up to 33 m high with trunk diameter up to 80 cm. The crown is almost cylindrical with multicipital branches. Bark is whitish-gray, smooth. Needles are 2-3 cm long, linear, planar, comb-arranged in 2 rows, glossy, dark green, grooved of top, slightly cariniform at the bottom, with 2 light stripes; needles of reproductive shoots is almost 4-sided. Microstrobili and female cones are in the upper part of the crown; cones are upright, 10-16 cm long, at maturation they fall into separate brown flakes. Cover scales are longer than seed scales, bent down, with a bent-down edge at the tip. Sprouts are oval, not covered with resin. Seeds are large, with wide light wings.

Evaluation of the state of the marginal population of European white fir of Nikor forestry of the National Park Belovezhskaya Pushcha (quarter 562, section 13) was carried out to include the tree species into the composition of the *ex situ* collection being created.

The population grows in natural conditions beyond the continuous distribution area. Growing under the conditions of D_2 on an area of 3.4 hectares, the *Oxalidosa* type fir forest is a complex in structure and mixing tree stand: the composition of the 1st storey is 35.4% Silver fir, 13.6% Maple, 11.6% Oak, 10.4% Spruce, 7.5% Linden, 4.1% Aspen and 0.6% Black alder. Age – 120 years; forest density – 0.7; volume – 315 m^3/ha. In the second storey – 78.8% Hornbeam, 7.3% Maple, 5.3% Linden, 5.1% Oak, 3.6% Spruce. Age – 40 years; forest density – 0.2; volume – 53 m^3/ha.

In general, the condition of the main stand canopy (first storey) of fir forest is estimated as "healthy with signs of weakening" (average condition index is 84.7%). During the field survey, 131 trees of the first storey were assessed. Across the entire spectrum of species, there dominate the trees without signs of weakening and weakened trees – 56.5 and 35.9%, respectively. The number of heavily weakened trees is 7.63%. Among the 16 Silver fir trees assessed on the test area, 75% of the trees are categorized with no signs of weakening, the remaining 25% are categorized as weakened (Figure 2.1). All the species surveyed on the permanent test plot can be arranged in the following order as their condition improves: Hornbeam (condition index - 72.6%) > Oak (78.8%) > Spruce (85.0%) > Maple (92.1%) > Silver fir (92.5%) > Aspen (93.3%) > Linden (95.0%) > Black alder (100.0%).

In addition, 174 trees of the 2nd storey were assessed. Across the entire spectrum of species, there dominate the trees without signs of weakening and weakened trees – 44.8 and 42.5%, respectively. The number of heavily weakened trees is 12.1%, and those drying-out

Figure 2.2. Silver fir regeneration within the fence

are 0.6%. All the species surveyed on the permanent test plot can be arranged in the following order as their condition improves: Spruce (condition index – 60.0%) > Ash (70.0%) > Hornbeam (77.0%) > Linden (77.5%) > Wych elm (77.9%) > Oak (82.5%) > Maple (91.9%).

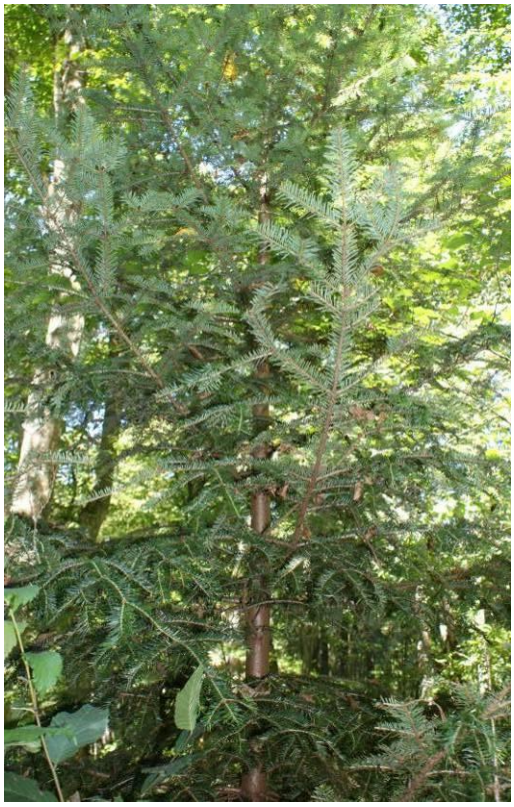


Figure 2.3. Silver fir tree of new generation

The main threat to this stand is the lack of sufficient natural regeneration of fir as a result of damage by wild ungulates (fir needles are characterized by a high content of protein-vitamin compounds). The installation of a protective mesh fence around the test plot led to a sharp increase in the natural regeneration of fir – up to several tens of thousands per hectare (Figure 2.2), with 2 trees reaching tree size (6 cm in diameter) (Figure 2.3). For comparison, behind the fence, there is almost no understorey of fir.

Seed material was collected in the population of Silver fir for obtain planting material for including of *ex situ* collection. The recommended biotechnological method for propagating Silver fir is grafting method.

2. Dwarf birch (*Betula nana* L.) is an intensively branched low-growing bush 1-1.5 m high, with dark-brown tracing or ascending branches (Figure 2.4). Young branches are fluffed, with glandular warts, later almost bare. Leaves are 0.5-1.5 cm long and 1-2 cm wide, wide-wedge-shaped, kidney- or heart-shaped, blunt-toothed edge, with 2-4 veins on each side, dark-green, shiny, light green at the bottom, bare, rarely fluffed. Flowers are unisexual, in staminate and pistillate catkins. Catkins on short pedicles, protruding upwards; staminate 0.5-1.5 cm long, pistillate – 5-8 mm long. Fruit – ellipsoid or egg-shaped nut with narrow wings.

Arctic-boreal relict species, located in Belarus, in some localities outside the south-western boundary of the area. Discovered in Borisov, Dokshytsy, Miory, Myadel, Polotsk, Postavy, Rossony, Senno, Sharkovshchina and Shumilino districts. It blooms in April – early May, fruits in May – June. Anemophilous. Reproduction by seeds and vegetation. Anemochore. Low quality of seeds and the nature of the arrangement of individuals in the populations indicate the leading role of vegetative reproduction in the natural renewal of the population of this species.

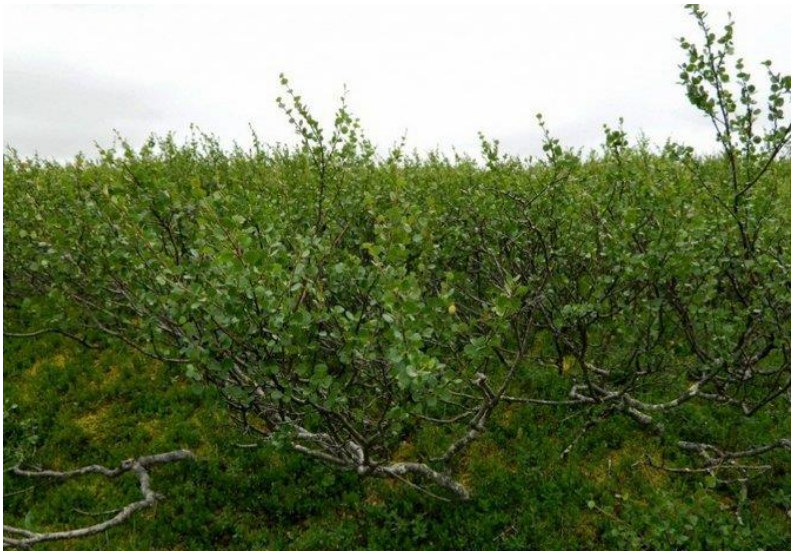


Figure 2.4. Dwarf birch (*Betula nana* L.)

Reproductive material from *in vitro* cultures collection of the Institute of Forest of the NAS of Belarus was included in the composition of the formed *ex situ* collection. The recommended method of biotechnological breeding of dwarf birch is micropropagation.

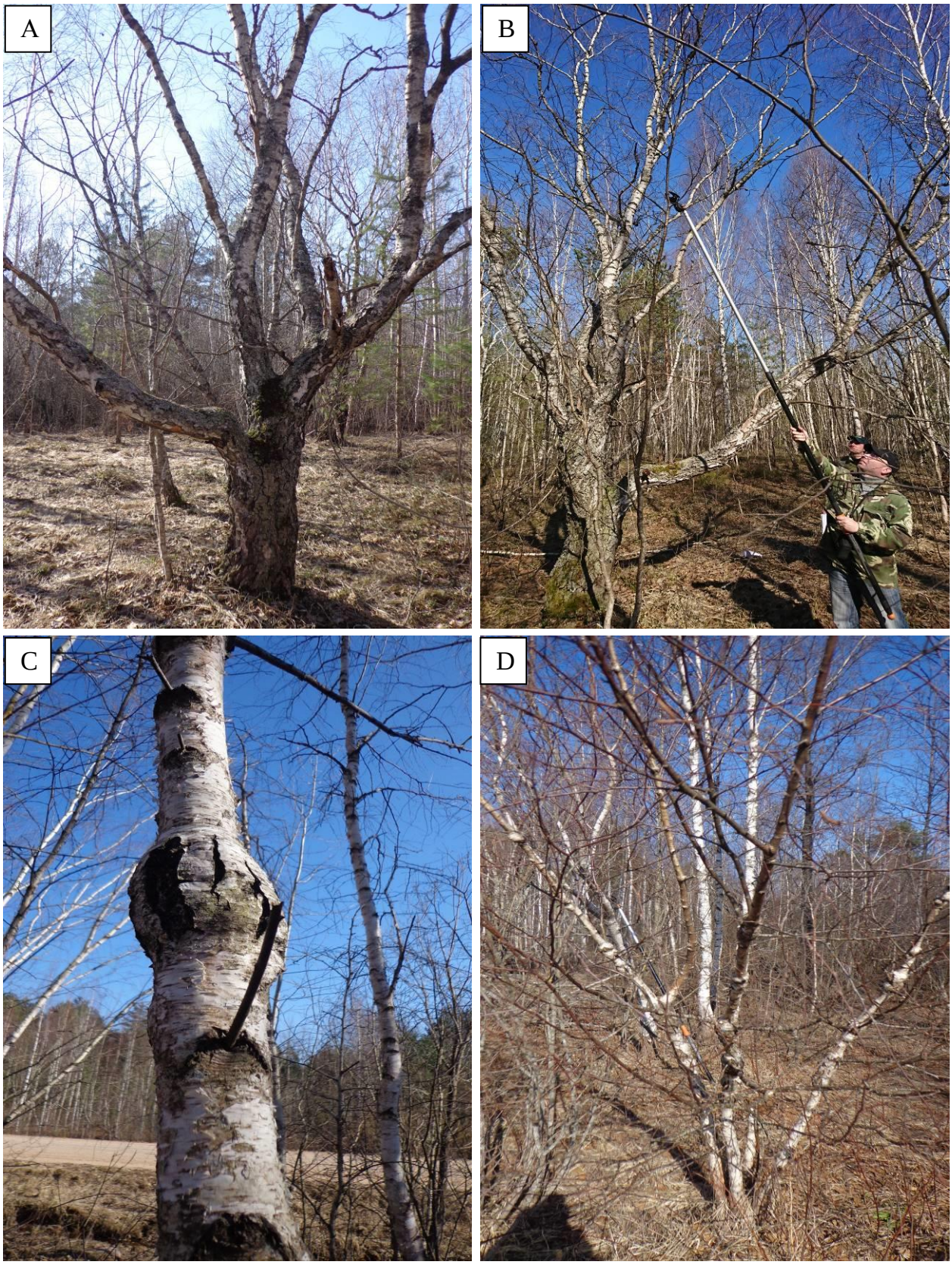
3. *Karelian birch* (*Betula pendula* Roth. *var. carelica* (Mercklin)) is a tree of a second size, less often of the first size, or a shrub with a wide spreading crown and forked-like branching. The trunks and parent branches have thickenings in the form of rumples, nodules, clutch-like exfoliations, covered with thick bark, often with deep longitudinal cracks. The wood of this birch is characterized by high decorative properties. Due to curly grain properties of the wood fiber, a marble-like pattern is formed. Despite the high demand for Karelian birch wood and its significant export potential, the area of its plantations in Belarus as of January 1, 2019 is only 114 hectares, and the total wood stock is 16.3 thousand m^3.

Standard, lyre-shaped and bush forms of Karelian birch were selected in the collection *ex situ* (Figure 2.5):

Standard form is a tree of the first or second size with a straight, normal or poorly tapering trunk. The bark at the base of the trunk is roughly fissured; at height the fracture density decreases, but often small cracks extend even to the crown. The surface of the trunk is usually covered with different-sized swellings, nodules, especially well visible under the thin bark. The pattern of wood is large-veined, relatively evenly distributed along the trunk.

Globular swollen form is the second-sized tree with large spherical swellings along the trunk, alternating with "interceptions" of a smaller diameter. Such barrel-shaped swellings are also found on parent branches. Wood in areas of swellings is more saturated with patterning than in "interceptions".

Lyre-shaped form – trees of this form have a very short trunk, which at a height of 1-2 m branches into two trunks with approximately similar diameter. The swellings have the appearance of small nodules with very dense distribution. The crown is spreading, irregular spherical. Wood has a small but dense pattern. The density of wood of this Karelian birch form puts it in first place for use in the production of artistic products.



A – lyre-shaped form; B – harvesting of vegetative material from the tree of lyre-shaped form for initiation of *in vitro* culture; C – globular swollen form; D – shrub form

Figure 2.5. Formation variety of Karelian birch (*Betula pendula* var. *carelica* (Merckl.) Hämet-Ahti), included in the collection being formed *ex situ*

Short-boled form is a tree of the second, very rarely of the first size, with a short, strongly tapering main trunk. Crown is spreading, misshapen; forked branching is observed. The bark is thick, coarsely fissured in the lower part of the trunk and usually down to the fork. Above – deep longitudinal cracks confined to swellings. Swellings are large, spherical or cylindrical, usually located in forks. Wood has an uneven, relatively small spotty-patterned pattern.

Bush form is a 2-12 m high bush with a low, wide-spreading, often misshapen crown and characteristic forked branching. The bark is thick, covered with deep longitudinal cracks, usually rising high in the crown. The main trunk is very short (up to 0.5 m), splitting into 2-3 (6) thick parent branches. There are numerous spherical, cuff-like swellings and nodules, usually located in forks, on the trunk, as well as on the parent branches. Wood has a very dense, saturated, small-patterned or bonded-patterned, unevenly spread pattern.

Shrub form is characterized by the absence of the main trunk. Trunks branching from the common root (usually from 2 to 8) have different directions (vertical, oblique, saber, creeping), which gives the bush a clumsy look: swellings on the trunks in the form of small nodules.

The vegetative material of Karelian birch was collected in quarter 19 of the Selyava forestry district of the Krupki forestry and in the former plot of the Dubrovka collective farm. The distribution of trees in the area group is curtain-like. The share of uneven-aged tree stand in the composition reaches 3 units, and on the plot of the former collective farm – 5-8 units. The total area is 37 hectares. The state of the population after improvement felling is satisfactory.

Due to the fact that during seeds sowing only 30-40% of Karelian birch plants inherit the pattern property, the recommended biotechnological method for the species reproduction is micropropagation.

4. *Spruce forest outliers of the geobotanical subzone of broad-leaved softwood forests*. On the territory of Belarus there is the southern border of the continuous distribution of the Norway spruce (*Picea abies* (L.) H. Karst.). Outside the natural area, spruce is represented as outlier areas, where it can compete with other species for phytocenotic dominance.

Most of the spruce forest outliers, located to the south of the area border, are preserved in the status of natural monuments of republican significance, as objects of scientific, forestry and botanical value. However, in recent years there has been a problem of the cessation of functioning of natural monuments in connection with the spruce fall (Table 2.1).

Table 2.1 – Location of natural monuments whose protection status is associated with marginal populations of woody species

No.	Natural monument name	Region	District	Settlement or distance and direction from the nearest settlement	Terrain reference (street, house, forestry enterprise, forest district, compartment, subcompartment)	Coordinates		Planting area (tree crowns), m^2	Stand age
						N	E		
1	Spruce forest outliers "Mednyanskie"	Brest	Brest	1.5 km to the north-east of Dubitsa station (compart. 240, 262); 2 km to the east of Lake Rogoznyanskoe (compart. 110-112, 133, 157)	Brest forestry enterprise, Mednyansk forest district, compart. 110 (subcompart. 8, 12), 111 (subcompart. 1, 8, 11), 112 (subcompart. 6, 7, 13), 132 (subcompart. 12), 133 (subcompart. 2), 157 (subcompart. 9, 10), 240 (subcompart. 2, 13), 262 (subcompart. 3)	51°50'37	23°46'09	32	65-130
2	Spruce forest outliers "Maloritskie"	Brest	Malorita	4 km to the south-east of Zamshany village	Malorita forestry enterprise, Malorita forest district, compart. 11 (subcompart. 9, 12), 18 (subcompart. 30, 32), 19 (subcompart. 12, 27), 29 (subcompart. 27), 30 (subcompart. 12, 14, 15, 16, 24, 38), 33 (subcompart. 12)	51°49'58	24°08'22	17	45-95
3	Spruce forest outliers "Pozhezhinskie"	Brest	Malorita	–	Malorita forestry enterprise, Pozhezhinsk forest district, compart. 32 (subcompart. 19, 23, 24), 41 (subcompart. 12, 21,37, 39), 54 (subcompart. 2, 7,	51°52'36	23°58'54	68	45-140

No.	Natural monument name	Region	District	Settlement or distance and direction from the nearest settlement	Terrain reference (street, house, forestry enterprise, forest district, compartment, subcompartment)	Coordinates		Planting area (tree crowns), m^2	Stand age
						N	E		
					13, 16), 58 (subcompart. 18), 71 (subcompart. 4, 7), 72 (subcompart. 3, 21), 75 (subcompart. 11), 84 (subcompart. 3), 88 (subcompart. 13), 112 (subcompart. 1, 4, 10, 16), 113 (subcompart. 20, 22, 26, 27), 114 (subcompart. 18, 19), 125 subcompart. 9, 18, 21, 26)				
4	Spruce forest outliers “Dobrushskie"	Gomel	Dobrush	1.5 km to the south-east of the settlement of Chistye Luzhy and 15 km to the north-east of the Dobrush town along the highway Gomel-Bryansk	–	–	–	2,3	–
5	Spruce forest outliers "Kalinkovichskie"	Gomel	Kalinkovichy	5 km to the east of Gorbovichi settlement and 0.5 km to the north-west of Yakimovichi settlement	–	–	–	171,5	–

3 Creation of *ex situ* collection of tree plants forms and species resistant to climatic stress, rare and economically valuable tree species on the basis of state forestry institutions and the National Forest Selection-Seed Production Center of the Ministry of Forestry of the Republic of Belarus with regard to zoning

Creation of *ex situ* collection within the framework of the activities includes the following steps:

1) To study and to summarize the international and local experience of creation of collections of forest woody plants resistant to climate change and rare economically valuable species and the efficiency of means and methods of forest genetic resources conservation.

2) To develop the integrated system of criteria and rules for selection of populations, ecotypes and forms of forest tree species, taking into account their value, specifics and need of conservation.

3) To carry out revision of dendroflora in Belarus in order to find new, unique and ornamental forms as well as rare and endangered species, subspecies and some populations of forest tree species.

4) To conduct genetic and breeding assessment of climatypes of coniferous trees on provenance trials as well as the analysis of the state of the marginal and/or peripheral populations in order to find genetic features ensuring adaptation of woody species to new ecological conditions.

5) To survey forest ecosystems on the territory of Belarus, including those in reserves, national parks, forests which are of scientific and/or historical value and nature sanctuaries in order to determine the level of intraspecific diversity and selection of genetic (form) variants of priority tree species.

6) To carry out the inventory of the breeding and conservation units of the local and introduced forest tree species perspective for establishment of forest plantations in Belarus, as well as determination and selection of economically valuable forms of woody species (high level of resin production, resistance to phytopathogens, fast growth, high productivity).

7) To develop and to staticize the information database and the register of the selected populations, climatypes, species, forms and genotypes existing in natural conditions (*in situ*)*;* to offer the necessary organizational structure and technological solutions on the creation of the collection of forest woody plant forms.

8) To create *ex situ* collection of forms and species of economically valuable woody species resistant to climatic stress on the basis of the National Forest Selection-Seed Production Center; to provide duplication of accessions for ensuring safety of the main collection.

3.1 Study and generalization of international and local experience of creation of collections of forest woody plants and of the efficiency of means and methods of forest genetic resources conservation

Analysis of the current state of biological diversity of forest woody and shrubby plants and the methods of its conservation showed that purposeful conservation of genetic resources of plants can be achieved in two ways: *in situ* (maintenance and renewal of viable populations of species in their natural habitat) and *ex situ* (conservation of components of biodiversity outside of their natural habitats).

The *in situ* techniques are suited better for the preservation of the diversity of rare allelic variants that may be of value in the future, as the volume of material that can be maintained *ex situ* is relatively small. At the species level, it is best achieved when preserving several populations that differ genetically and are in different ecological zones of the area. However, the efficacy of *in situ* approach strongly depends on the processes taking place in the close proximity to the boundaries of these zones (nature of human activities, spreading of invasive species of animals and plants, atmospheric pollution, occurrence of fires, etc.). Besides, the fragmentation of the protected areas leads to the isolation of individual populations of plants, thereby reducing their adaptive capacity with regard to climate change. Due to the above reasons, in some cases it is impossible to preserve certain populations of particular species in their natural habitat conditions. In this situation, it is the most appropriate to use *ex situ* methods, which is especially true for rare or endangered species. Benefits of preserving forest genetic resources *ex situ* are in the possibility of studying the biology of species, their accelerated use in breeding, genetic control of the material, easy access to the collection, and relative guarantee of its safety.

It was found that a group of methods of *ex situ* conservation of forest genetic resources includes: *(1)* genetic banks (seeds, pollen, DNA, *in vitro* cultures, cryogenically frozen tissues, organs and parts of plants); *(2)* field genetic banks, maintanined by botanical gardens and arboretums; *(3)* breeding units (clonal and family orchards, test plantations and provenance trials); *(4)* seed orchards of species in a vulnerable position; *(5)* conservation stands with controlled structure. Among above mentioned forest resources the greatest number is deposited in genetic seed banks and field collections. The main attention is paid to maintaining a genetic diversity of economically significant species.

The analysis of international legal base and international organizations and initiatives in the field of conservation of FGR is carried out. Shown, that the most significant international agreements for the Republic of Belarus are the Convention on Biological Diversity (CBD); the Strategic Plan for Biodiversity 2011-2020, including Aichi Biodiversity Targets; the Nagoya Protocol to the CBD; the Global Plan of Action for the Conservation, Sustainable Use and Development of Forest Genetic Resources. There is a large number of international initiatives in conservation of genetic resources of plants: the Commission on Genetic Resources for Production of Food and Farming of Food and Agriculture Organization of the United Nations (FAO); Botanic Gardens Conservation International (BGCI), https://www.bgci.org/); campaign "Global Trees Campaign" (http://globaltrees.org/); Forest Europe (http://foresteurope.org/); European Program for Forest Genetic Resources (European Forest Genetic Resources Programme (EUFORGEN), http://www.euforgen.org/); Bioversity International (https://www.bioversityinternational.org/). At the national level, in the Republic of Belarus, the Strategy of the Republic of Belarus on Conservation and Sustainable Use of Biodiversity, including the National Plan of Action for Conservation and Sustainable Use of Biological Diversity for 2016-2020, has been created; The National Strategy of Sustainable Social and Economic Development of the Republic of Belarus till 2030 (2014) has been approved; The Forest Code of the Republic of Belarus (2015) has been adopted; the Program of Conservation of Forest Genetic Resources and Development of Genetically Improved Seed Production of Forest Forming Species of Belarus till 2030 has been created.

International experience in creation of FGR collection funds are studied with the use of scientific publications, country reports, methodical documents and standards, texts of international agreements and acts as well as the materials on official Internet resources. According to data in the report on the state of FGR (FAO, 2014), about 1,800 species of

forest plants are cultivated *ex situ*. A total quantity of storing units is about 160,000, most of which are field plantations. The vast majority of storing units belong to species and sorts of high economical significance, such as *Pinus*, *Eucalyptus*, *Albizia*, *Acer*, *Quercus*, *Acacia*, *Terminalia*, etc. As of 2015 in European countries (excluding the Russian Federation) the total area of *ex situ* collections was 11,553 hectares in 37 countries (Figure 3.1).

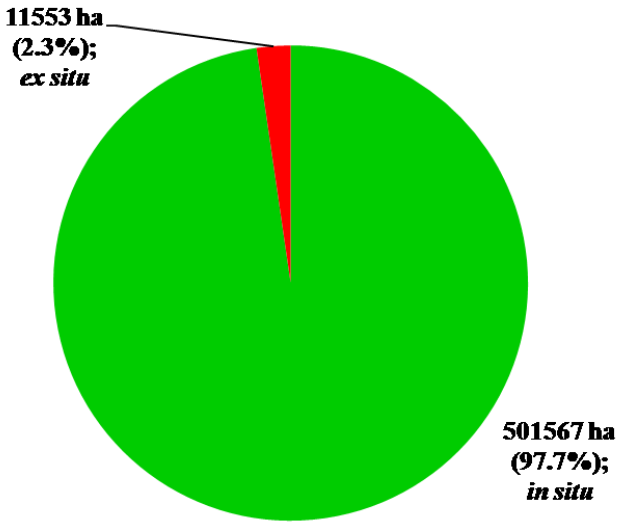


Figure 3.1. The total area (in *ha*) of *in situ* and *ex situ* conservation of forest genetic resources in Europe (2015)

The greatest attention in Europe is paid to genetic resources *ex situ* conservation of Scotch pine (*Pinus sylvestris*), Norway spruce (*Picea abies*) and English oak (*Quercus robur*) (60% of all existing *ex situ* collections in Europe). Among introduced species extensive works are conducting with Douglas fir (*Pseudotsuga menziesii*) (Figure 3.2). The detailed descriptions of application of *ex situ* methods for conservation of FGR in Germany, Lithuania, Norway, Poland, Russia, Ukraine, Finland, Sweden, the countries of North America are available.

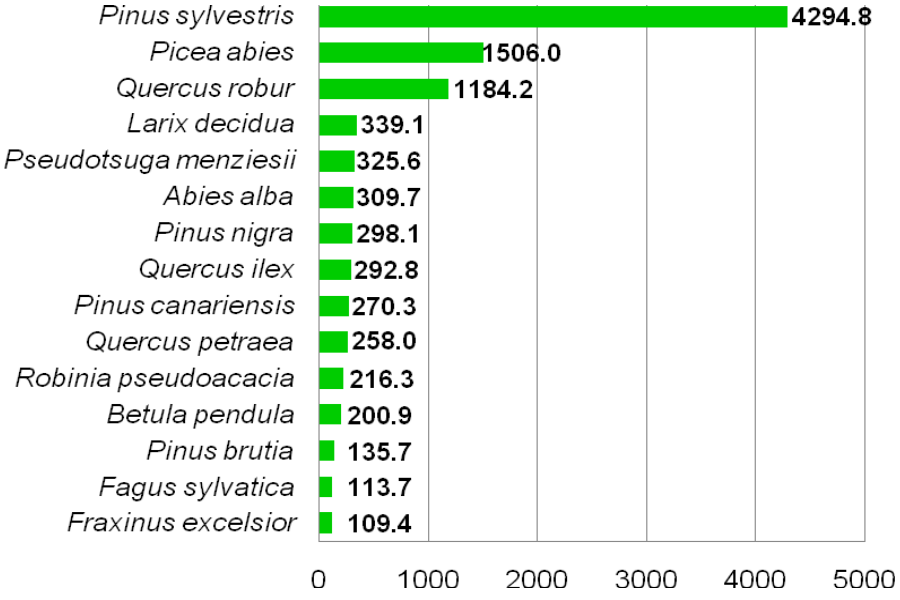


Figure 3.2. The total area (in *ha*) of *ex situ* collections of woody species in Europe (for *ex situ* collections with more than 100 hectares area) (as of 2015)

Local experience of creation of FGR collection funds in Belarus and the efficiency of means and methods of their conservation were studied with the use of scientific publications and the country report "Condition of Biodiversity for Production of Food and Maintaining Agriculture in the Republic of Belarus" (2016) as well as by synthesis of information on creation of *ex situ* collection funds by Experimental Forest Bases and the Genetic Bank of Forest Woody Species of the Institute of Forest of the NAS of Belarus. According to the report on the condition of European forests (2015), the Republic of Belarus takes the second place by the area of created units for *ex situ* conservation of forest genetic resources among 37 European countries (excluding the Russian Federation), with Ukraine being the top. (Figure 3.3).

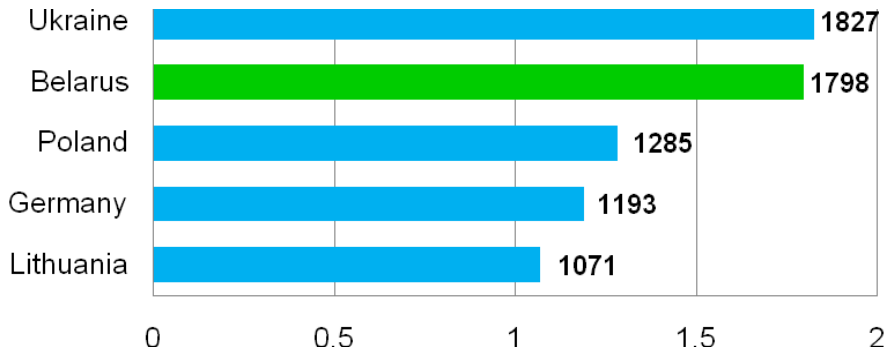


Figure 3.3. The total area (in *ha*) of *ex situ* collections in European countries (for *ex situ* collections with more than 1000 hectares area) (as of 2015)

In Belarus more than 30 *ex situ* conservation units were established for gene pool of coniferous and deciduous tree species preservation. They are *(1)* clones and forms of elite and plus trees of Scotch pine (*Pinus sylvestris*), Norway spruce (*Picea abies*), Karelian birch (*Betula pendula* var. *carelica*) on archive-uterine orchards (299 clones and forms); *(2)* families of plus trees of Scots pine, Norway spruce in family orchards (66 families); *(3)* climatypes of Scots pine and Norway spruce in provenance trials (266 climatypes); *(4)* collection on testing the offsprings of plus trees of Scots pine, Norway spruce, English oak (*Quercus robur* L.) in test cultures (1,267 families); *(5)* collections of different species *Pinus* and *Picea* (*Pinetum* – 18 species; *Picetum* – 12 species). The Institute of Forest of the National Academy of Science of Belarus has the Genetic Bank of Forest Woody Species; collections of seeds (more than 250 samples), DNA (more than 4,500 samples), *in vitro* cultures (112 clones of 30 species) have been created.

On the territory of Belarus there are several botanical gardens and arboretums. They are the Central Botanical Garden of the NAS of Belarus (about 100 hectares, more than 10 thousand taxons of plants, cbg.org.by), the Botanical Garden of the Belarusian State University, the Botanical Garden of Belarusian State Agricultural Academy, the Botanical Garden of Belarusian State Technological University, the Dendrology Garden of Glubokoe Experimental Forestry Enterprise (8.2 hectares, over 500 species of trees and shrubs), S.A. Gomza Dendrological Garden of National Park "Narochansky". Generally, collections of woody and shrubby plants of botanical gardens and arboretums mostly include ornamental forms.

In general, analysis and generalization of international and local experience on creation and conservation of FGR collection funds have shown that one of the most effective ways of

ex situ conservation of FGR is the creation of seed banks and field collections which are a strategic resource and a basis of sustainable reproduction of FGR.

3.2 Develop a comprehensive system of criteria and standards for the selection of populations, ecotypes and individual forest woody species

During the stage it was established that two categories of stands, ecotypes and individual forms of forest tree species perform an important role in the forest genetic resources composition: *(1)* rare and unique objects of the flora, represented by old trees and particularly valuable stands; *(2*) selected and productive objects – plus trees and stands.

Criteria and standards for selection of special valuable and unique trees are studied and described in detail. Those are: age of a tree, trunk size, species of a tree, state of a tree, tree form. The analysis of databases, characteristics of existing nature sanctuaries and on-site investigation of some forest stands has allowed marking out the following categories of special valuable stands: *(1)* relic sites of the forest which have remained from a native plant communities; *(2)* sites of the forest with valuable tree species; *(3)* representative old-age stands; *(4)* forest stands of native species located outside the species range; *(5)* sites of the forest with native species of woody flora which are endangered; *(6)* botanical collections; (7) parks, gardens and lanes. The criteria and standards are described in detail in 1st chapter of the report.

Criteria and standards for selection of highly productive forest stands (plus forest stands) are studied and described in detail. Those are: *(1)* stand quality index (Ia-II); *(2)* forest stand average height (at least 10% higher in comparison with a normal average stand in the same conditions at the same age); *(3)* quantity of plus and best normal trees (stand density 1.0-0.7 – not less than 20%; 0.6-0.5 – not less than 25%); *(4)* quantity of minus trees (stand density 1.0-0.7 – no more than 15%; 0.6-0.5 – no more than 10%); *(5)* straight stem and form of a trunk (90% of straight-stemmed trunks); *(6)* natural pruning (pine, larch – not less than 1/3 of a trunk; spruce, fir and ash, oak – not less than 1/5 of a trunk); *(7)* height to a live crown (pine – 65-75% of height of trees; spruce, fir – 30-40%; oak, ash – 45-50%; larch – 50-65%).

The analysis has been carried out and criteria and rules for selection of highly productive trees (plus trees) of Scotch pine, Norway spruce, English oak, European larch, Silver fir, European ash are described in detail. Those are origin (natural, artificial, hybrid); phenological traits (early, average and late blossoming); morphological form (narrow or wide crown); age; height; diameter; trunk volume; crown width (in two directions); crown form (cone-shaped, pyramidal, etc.) and its symmetry; crown length; density of leaves (needles); thickness of skeletal branches (thick, average, thin); length of a zone of a trunk without branches; enclosing of non-living knots (good, average); trunk form (straightness, ratio of solid volume to stacked volume); growth in height with eye assessment (good, average); development of epicormic sprouts on oak trunk (strong, weak, average); characteristic of bark (height of rough bark, colouring, type of fissuring, etc.); sanitary state of a tree and data on blossoming, fructification and type of sexual specialization (male, female, mixed); plus trees indicators in comparison with average values of a forest stand; short characteristic of surrounding trees and other indicators.

Application of a comprehensive system of criteria and standards for the selection of populations, ecotypes and individual forms of forest tree species, based on their value, specifics and the need to preserve ensured the inclusion of productive, adaptive and biologically sustainable genetic material in the *ex situ* collection.

3.3 Identification, selection and harvesting of reproductive material of tree species for *ex situ* collections of forms and types of commercially valuable tree species resistant to climatic stress

Analysis of species and form diversity of the dendroflora of Belarus showed that it is represented by 51 species at seed-bearing age (with regard to their form diversity) of native and introduced woody flora (Table 3.1).

Table 3.1 – List of native and introduced tree species (with regard to their form diversity) of dendroflora of Belarus which individuals reached seed-bearing age

No.	English names	Scientific names
1	2	3
1.	Amur cork tree	*Phellodendron amurense* Rupr.
2.	Dahurica birch	*Betula dahurica* Pall.
3.	Dwarf birch	*Betula nana* L.
4.	Silver birch	*Betula pendula* Roth
5.	Red birch	*Betula nigra* L.
6.	Karelian birch	*Betula pendula* Roth. var. carelica Mercklin
7.	European beech	*Fagus silvatica* L.
8.	European white elm	*Ulmus laevis* Pall.
9.	Dutch elm	*Ulmus minor* Mill.
10.	Wych elm	*Ulmus glabra* Huds. non Mill.
11.	Ginkgo	*Ginkgo biloba* L.
12.	Hornbeam	*Carpinus betulus* L.
13.	Pedunculate, or English oak	*Quercus robur* L.
14.	Pedunculate oak (pyramidal form)	*Quercus robur* L.
15.	Durmast oak	*Quercus petraea (*Matt.) Liebl.
16.	Norway spruce	*Picea abies* (L.) Karst.
17.	Norway spruce (weeping form)	*Picea abies* (L.) Karst.
18.	Norway spruce (serpentine form)	*Picea abies* (L.) Karst.
19.	Whortleberry willow	*Salix myrtilloides* L.
20.	Shagbark hickory	*Carya ovata (Mill.) K. Koch.*
21.	Sycamore	*Acer pseudoplatanus* L.
22.	Norway maple	*Acer platanoides* L.
23.	Silver maple	*Acer saccharinum* L.
24.	American basswood	*Tilia americana* L.
25.	Silver linden	*Tilia tomentosa* Moench.
26.	Common lime	*Tilia europaea* L.
27.	Large-leaved linden	*Tilia platyphyllos* Scop.
28.	Manchurian linden	*Tilia mandshurica* Rupr. & Maxim.
29.	Small-leaved linden	*Tilia cordata* Mill.
30.	European larch	*Larix decidua* Mill.
31.	Polish larch	*Larix* var. *polonica* Racib.
32.	Siberian larch	*Larix sibirica* Led.
33.	Common alder	*Alnus glutinosa* (L.) Gaertn.
34.	Europen aspen	*Populus tremula* L.
35.	Silver fir	*Abies alba* Mill.
36.	Caucasian fir	*Abies nordmanniana* (Stev.) Spach.
37.	Douglas fir	*Pseudotsuga menziesii* (Mirb.) Franco

Continuation of the Table 3.1

1	2	3
38.	Locust	*Robinia pseudoacacia* L.
39.	White pine	*Pinus strobus* L.
40.	Scots pine	*Pinus sylvestris* L.
41.	Siberian stone pine	*Pinus sibirica* Du Tour
42.	Austrian pine	*Pinus nigra* Arn.
43.	White poplar	*Populus alba* L.
44.	Canadian poplar	*Populus* × *canadensis* Moench
45.	Grey poplar	*Populus* × *canescens* (Aiton) Sm.
46.	Chinese poplar	*Populus simonii* Carr.
47.	Black poplar	*Populus nigra* L.
48.	Black poplar (pyramidal form)	*Populus nigra* L.
49.	White ash	*Fraxinus americana* L.
50.	European ash	*Fraxinus excelsior* L.
51.	Green ash	*Fraxinus pennsylvanica* Marshall

Four groups of plants are the basis for the creation of *ex situ* collection:
– biologically resistant to climatic stress and phytopathogens;
– rare and unique;
– economically valuable;
– promising introduced species.

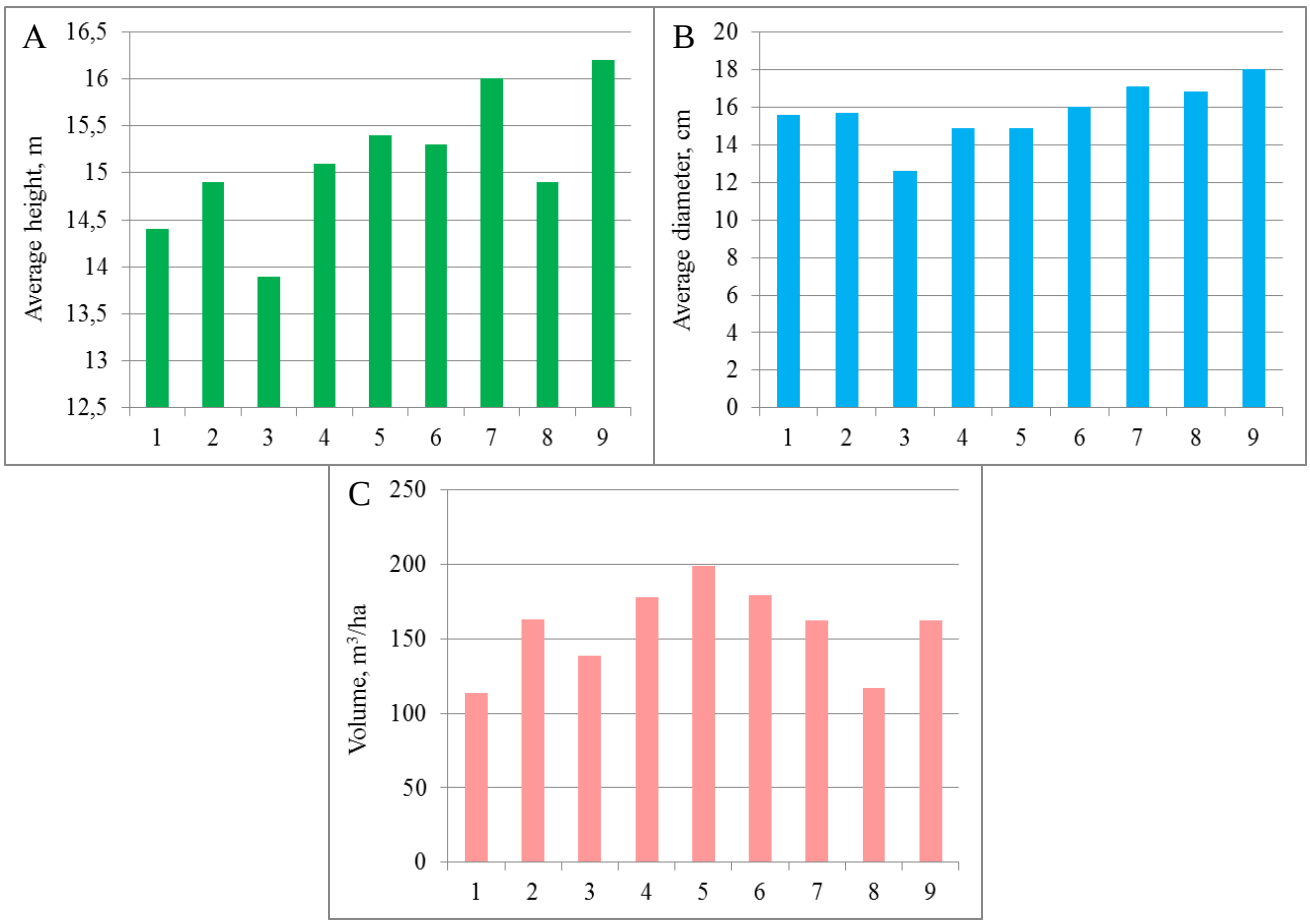
3.3.1 Forms and types of tree plants biologically resistant to climatic stress and phytopathogens

3.3.1.1 Selection and genetic evaluation and selection of climatic types of coniferous silvicultures of different geographical origin resistant to climatic stress

Scots pine. Selective and genetic evaluation of 67 climatic types of Scots pine was carried out in 50-year-old provenance trial plantations of the Dvina experimental forest base of the Institute of Forest of the National Academy of Sciences of Belarus. There were determined the intensity of growth in height and in diameter, stem volume and stem wood volume for each climate type and forest subzone (Figure 3.5):

– the average height of 50-year-old climatic types of Scots pine varies from 12.4 (Chernigov) to 18.4 m (Cherkasy). Low heights are peculiar to northern climatic types of the Middle and Southern taiga subzones (14.7-16.4 m), as well as the Southern steppes subzone. The climatic types of the Northern semi-desert subzone, the Northern steppes subzone and the Northern subzone of the Hardwood zone, as well as the Southern subzone of the Hardwood zone from the areas located to the south of the local climatic type (from Belarus), have the maximum heights;

– the average diameters are in the range from 11.7 (Kirov) to 20.3 cm (Armenia). The best indicators belong to climatic types from the Southern subzone of the Hardwood zone (climatic types from Omsk, Tambov, Sumy, Poltava regions) and the Subzones of the Northern and Southern Steppes (Armenia, Saratov, Pavlodar and Orenburg regions). The relatively low average diameters of the climatic types from the regions located closer to the object of study (Mixed wood zone and the Northern subzone of the Hardwood zone) are due to the high survival rate of such climatic types, as evidenced by high wood volume;



Forest subzone: *1* – Middle Taiga Subzone; *2* – Southern Taiga Subzone; *3* – Northern Softwood Predominance Subzone; *4* – Southern Subzone with Equal Part of Softwood and Hardwood Species; *5* – North Subzone of Monodominant Forests; *6* – Southern Subzone of Polydominant Thermophilic Forests; *7* – Subzone of the Northern Steppes; *8* – Subzone of the Southern Steppes; *9* – Subzone of the Northern Semi-Desert

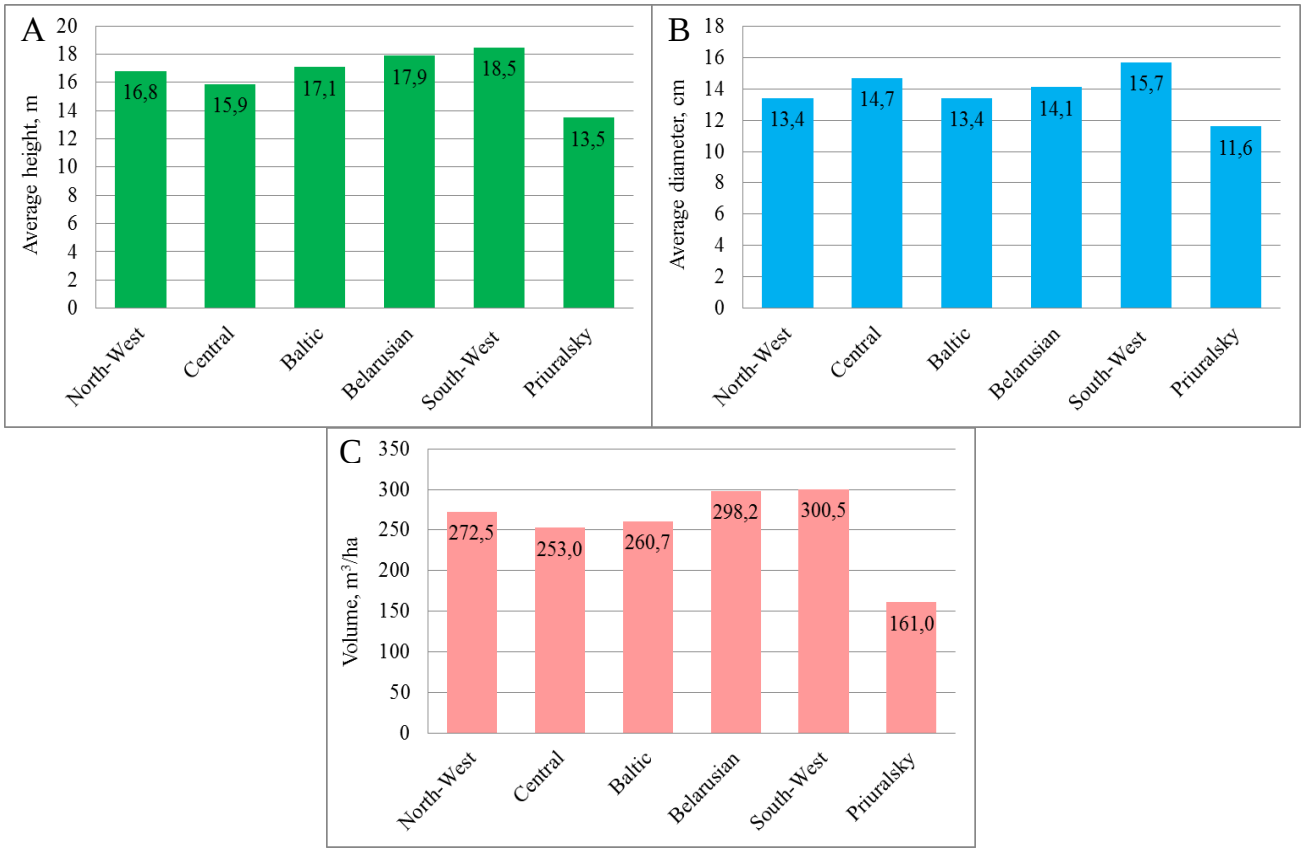
A – average height, m; B – average diameter, cm; C – volume, m^3/ha

Figure 3.5. Selective and genetic evaluation of climatic types of Scots pine of various geographic locations (on forest subzones)

– the climatic types from the Southern subzone of the Mixed wood zone, the Northern and the Southern subzones of the Hardwood zone have the largest stem wood volume: Chuvash – 309 m^3/ha, Lithuanian – 290 m^3/ha, Gorky – 273 m^3/ha, Ryazan – 288 m^3/ha, Bryansk – 257 m^3/ha, Lipetsk – 270 m^3/ha, Kiev – 293 m^3/ha, Volyn – 294 m^3/ha, and Cherkasy – 296 m^3/ha regions.

The results of a comprehensive assessment of climatic types in provenance trials show that, selection for maximum productivity should be conducted among the origins of Belarus and the surrounding regions of Ukraine, Russia and Lithuania.

Norway spruce. Selective and genetic evaluation of 21 climatic types of Norway spruce was carried out in 39- and 41-year-old provenance trial plantations of the Cherikov forestry enterprise (Mogilev region). There were determined the intensity of growth in height and in diameter, stem volume and stem wood volume for each climate type and geographical region (Figure 3.6):



Geographical regions: North-West, Central, Baltic, Belarusian, South-West, Priuralsky

A – average height, m; B – average diameter, cm; C – volume, m^3/ha

Figure 3.6. Selective and genetic evaluation of climatic types of Norway spruce of various geographic locations (on regions)

– the climatic types from Belarusian region, North-West region (Leningrad, Pskov, Kaluga) and South-West region (Zakarpattia, Ivano-Frankivsk, Rovno, Lviv) are characterized by the maximum height (17.9-19.8 m);

– the largest diameter was observed in climatic types of the southern origin (19 cm) (Ivano-Frankivsk). Local samples (Belarusian region) have average diameter (11.9-15.3 cm);

– the highest wood volume per 1 ha was found in spruce origin from Ivano-Frankivsk, Rovno, Leningrad regions and Estonia (percentage of control ranging from 106 to 134%). The volume of the local climatic type (Mogilev) is 308 m^3/ha. The lowest wood volume per 1 ha is observed in the origin from Tatarstan, Udmurtia, Vologda and Kostroma regions (153-167 m^3/ha).

Thus, to create sustainable high-yield spruce plantations in the natural and climatic conditions of Belarus, it is advisable to use the seeds of the local population, as well as those of the southern and western regions. The use of seeds from the northern and eastern regions for these growing conditions is not recommended.

Vegetative material for propagation by grafting and for inclusion in the composition of the *ex situ* collection being created was prepared from the stands of Scots pine and Norway spruce biologically resistant to climatic stress selected by means of selection and genetic evaluation.

3.3.1.2 Forms of native tree species resistant to phytopathogens

European ash. In order to identify the Belarusian forms tolerant to the infectious necrosis of branches, ash stands were examined in 20 forest enterprises of six regions at the total area of 1,835 hectares (Vasilevichi, Rechitsa experimental, Ivye, Lida, Bogushevsk, Liozno, Novogrudok, Starobin, Vitebsk, Uzda, Stolin, Lyuban, Glusk, Stolin, Ivatsevichi, Drogichin, Lepel, Tolochin, Osipovichi experimental, Logoisk forestries). The surveys in the ash stands of three forestries (Logoisk, Osipovichi experimental and Stolin) helped to identify the European ash trees not affected phenotypically by the necrosis of branches, the material from which was selected to determine the resistance to infectious necrosis of branches.

The association transcriptomics method was applied to verify the potentially tolerant individuals of the European ash. Currently, several genes of the MADS-box family are presented in the literature as the DNA-markers of ash resistance to the pathogen of the necrosis of branches: SNP-marker (Gene 22343 Predicted mRNA scaffold3139) and two GEM-markers (Gene 19216 Predicted mRNA scaffold2427 и Gene 23247 Predicted mRNA scaffold3380). Polymorphic SNP-region (SNP-marker) was amplified using primers AshRB_22343-F1 (GGTTTCTCTTCTGCAGCGAG) and AshRB_22343-R3 (TCCATGATCATCTTGCTGAG) and sequenced by Sanger-based genetic analyzer ABI Prism 310 (Figure 3.7).

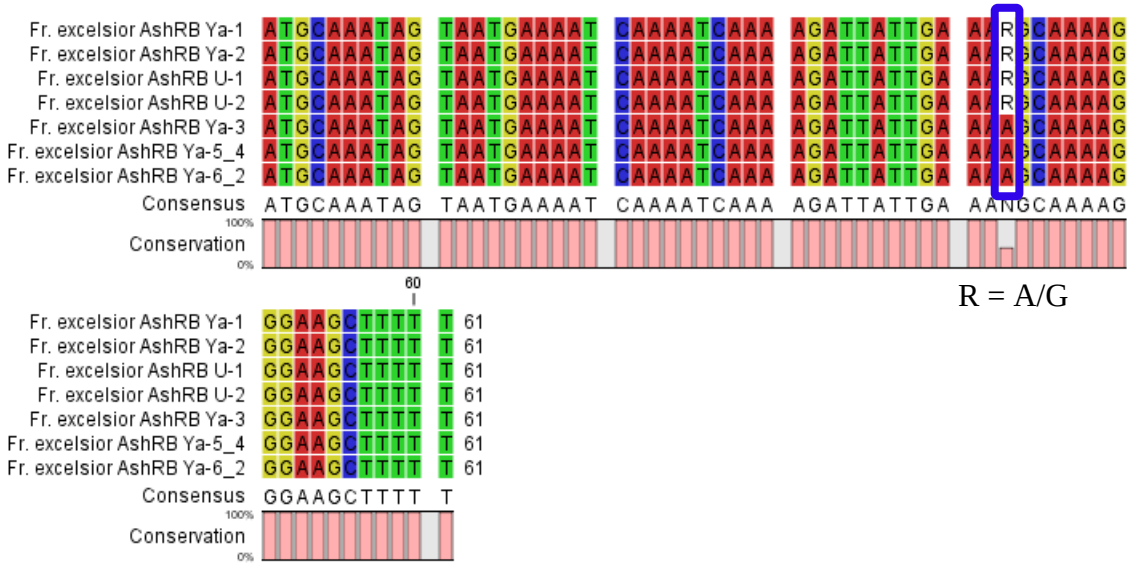


Figure 3.7. Fragment of SNP-region that stipulates the European ash tolerance to the pathogen of branches necrosis

As Figure 3.7 shows, the selected individuals of ash contain the nitrogenous base "A" and "A/G" in position 43, which corresponds to susceptible (trees Ya-3, Ya-5_4, Ya-6_4) and tolerant individuals (trees Ya-1, Ya-2, U-1 and U-2). The identified low level of GEM-marker genes expression in the individuals under study is associated with multifactorial regulation of their activity (environmental factors, intracellular factors, genotypic individual environment, etc.).

Based on the phenotypic selection of trees and their molecular and genetic marking, the European ash forms resistant to infectious necrosis of branches were selected (Table 3.2).

Table 3.2 – Database of the European ash forms resistant to infectious necrosis of branches

Sample code	Forestry, forest district	Geographical coordinates		Description of the facility	State category
		latitude	longitude		
Ya-1	Osipovichi experimental, Daraganovo	53°12'13	28°25'32	6Ppl2Ash2Lin+B; age 100 years; undergrowth h = 4 m	1
Ya-2	Osipovichi experimental, Daraganovo	53°12'13	28°25'33	6Ppl2Ash2Lin+B; age 100 years; undergrowth h = 3 m	1
Ya-3	Osipovichi experimental, Daraganovo	53°12'13	28°25'34	6Ppl2Ash2Lin+B; age 100 years; undergrowth h = 3.5 m	1
Ya-4	Osipovichi experimental, Daraganovo	53°12'13	28°25'35	6Ppl2Ash2Lin+B; age 100 years; undergrowth h = 3 m	1
Ya-5	Osipovichi experimental, Daraganovo	53°12'27	28°25'26	single tree; age 70 years; d = 46 cm; h = 23 m	1
L-1	Logoisk, Logoisk	54°21'58	27°88'81	ash cultures 8Ash2S; age 6 years	1
L-2	Logoisk, Logoisk	54°21'59	27°88'83	ash cultures 8Ash2S; age 6 years	1
U-1	Stolin, Tursko-Ledetsk	52°47'44	26°59'46	felled tree; age 80-100 years	–
U-2	Stolin, Tursko-Ledetsk	52°47'44	26°59'46	felled tree; age 115 years	–
U-3	Stolin, Tursko-Ledetsk	52°47'44	26°59'46	felled tree; age 113 years	–

The material with ash trees potentially resistant to the branches necrosis was selected for micropropagation *in vitro* and creation of grafts (Figures 3.8, 3.9).

Figure 3.8. Micropropagation of the European ash individuals resistant to infectious necrosis of branches

Figure 3.9. Grafting of the branchlets of the European ash individuals resistant to infectious necrosis of branches

In general, the cleft graft method was used to create 50 plantlets of European ash clones resistant to the infectious necrosis of branches. *F. excelsior* and *F. pennsylvanica* were used as rootstock.

Scots pine. The seedlings were selected in forest nurseries of Baranovichi, Kletsk, Molodechno, Glubokoye experimental, Kalinkovichi, Zhlobin, and Bobruisk forestries, as well as by seed germination in the laboratory (Figure 3.10).

Figure 3.10. Scots pine seed germination in the laboratory

The preliminary analysis of gene activity of the Scots pine seedlings under different temperature conditions was carried out for the molecular and genetic marking of the loci associated with resistance to infectious lodging of seedlings: control (22 °C) and low positive temperature (4 °C) using high-production transcriptome sequencing.

The analysis of the Scots pine seedlings transcriptomes allowed to determine the ordinary spectrum of the loci associated with resistance to infectious lodging of seedlings. EST-loci of the gene family were identified: glycosyl hydrolase (GH19), antimicrobial polypeptides (AMP), calcium-binding proteins (CBP); alpha-amylase inhibitors, lipid-transporter proteins, seed reserve proteins (AAI-LTSS), polypeptides with antifungal activity (SS/AF) and resistance gene PsACRE, previously described for Scots pine. Besides the genes associated with protective responses to stress factors, including those stipulated by the impact of low temperatures - cold-shock proteins (in particular of dehydrin family) and chaperone proteins (Hsp70 and Hsp90 family) were identified. Based on the data obtained, 15 most represented loci associated with resistance to infection lodging (GH19, Hsp90, CaM, SAM, ABA/WDS, Hsp70, AAI_LTSS, MiAMP1 (AMP1), Stress/antifungal, Disease resistance gene (R), BAX inhibitor (BI)-1/YccA, CHS, DHN, DEF, AMP4) were selected. The functional importance of the identified loci is shown in Table 3.3.

Based on the data obtained, a set of genetic markers (consisting of 15 loci) intended for screening and assessment of the level of activity of genes associated with resistance to infection lodging of Scots pine seedlings was developed. Using the international database of nucleotide sequences NCBI based on gene ontology, the homologous loci associated with resistance to infectious lodging were identified for Norway spruce (*P. abies*), Black alder (*A. glutinosa*), Silver birch (*B. pendula*), and a set of markers was developed on their basis.

Table 3.3 – The identified loci associated with the resistance to infectious lodging

Locus	Functional value
GH19, chitinase	chitinase (GH19) – plant enzymes that catalyze chitin degradation. They are the resistance factor under the influence of phytopathogenic fungi and phytophagous insects, destroying the cell wall containing chitin
Hsp90	heat shock protein (chaperone protein) is involved in folding, stabilizes proteins in case of heat stress, is a protein catabolism factor. It is associated with stress reactions, including infections
CaM	a protein with calcium-binding activity, participates in the physiological responses of cells to the environmental changes
SAM	key enzyme in the biosynthesis of ethylene – the element of the signaling pathway of the plant defense responses to pathogen
ABA/WDS	proteins associated with water deficit stress and are induced by the presence of abscisic acid
Hsp70	heat shock protein (chaperone protein) is involved in folding, stabilizes proteins in the reaction to cold, salt and biotic stresses
AAI_LTSS	proteins, alpha-amylase inhibitors, transport lipids, are associated with defense responses.
MiAMP1 (AMP1), SpAMP4 (AMP4)	antimicrobial protein, inhibits microorganisms metabolism
Stress/antifungal	protein associated with responses to salt stress, is characterized by antifungal activity
Disease resistance gene (R)	protein associated with immune response
BAX inhibitor (BI)-1/YccA	protein associated with resistance of plants to pathogens
CHS	enzyme, determined in the biosynthesis of chalcones and stilbenes (including pinosilvin), having antimicrobial activity
DHN	protein associated with defense responses under cold stress and dehydration, and is involved in the anti-stress action spectrum of salicylic acid
DEF	antimicrobial protein, inhibits microorganisms metabolism

3.3.2 Rare and unique forms and types of tree plants

An expedition survey of the forest ecosystems in Belarus including the territories of nature reserves, national parks, forests of scientific and/or historical importance, wildlife reserves, natural monuments was carried out, intraspecies diversity was identified and genetic (formation) variations of priority tree species were selected.

A brief analysis of the structure and current status of the system of specially protected natural areas of Belarus was prepared. It is shown that at present it includes 1,297 objects with a total area of 1,870.1 thousand hectares including one nature reserve (Berezinsky Biosphere), four national parks (Belovezhskaya Pushcha, Bráslavskie Ozera, Narochansky and Pripyatsky), 99 republican wildlife reserves and 282 local wildlife reserves, and 326 republican natural monuments of nature and 585 local natural monuments. It was identified that the specially protected natural areas occupy 9.02% of the total area of the republic. At the same time, since 2013, their number has increased significantly (+77).

Generally, it was determined that in the western regions of Belarus the specially protected natural areas occupy the greatest share in the total area (including Brest region –

14.96%, Grodno region – 10.07%), the lowest – in the east (including Gomel region – 7.38%, Mogilev region – 4.60%). 12 SPNA objects (two national reserves of the republican significance, monuments of national and local significance, two and eight, respectively), or 1.72% are located in Minsk.

The formation structure is analyzed and a brief description of forest ecosystems of the nature reserves and national parks of Belarus is given. It is shown that pine forests prevail in the territories under study. The results of the expeditionary survey of the data on the objects of specially protected natural areas and the selection of genetic (formation) variations of priority tree species (Scots pine, Silver fir, English oak, Small-leaved linden, Common ash, etc.) are presented.

The structure of the republican and local wildlife reserves of Belarus was studied (Figures 3.11, 3.12). It was established that the number of wildlife reserves of republican significance is 2.9 times less than the number of wildlife reserves of local significance. However, their total area is more than twice as large (971.0 and 410.1 thousand hectares, respectively). In all regions of the country the number of reserves of local significance is higher than those of republican significance (except Minsk, where local nature reserves are absent). In this case the largest areas of national reserves are located in Brest region (344.7 thousand hectares or 35.5%), of local significance – Gomel region (96.9 thousand hectares or 23.6%).

The structure of the natural monuments of republican and local significance was studied. It was established that the largest number of natural monuments of republican and local significance are located in the territory of Grodno (95, or 29.1% of the total amount) and Vitebsk (141, or 24.1%) regions, respectively. The absolute number of natural monuments of local importance in the territory of all regions and Minsk is higher compared to the monuments of republican significance. Analysis of the total area occupied by the natural monuments by the regions showed that 40 % of all monuments of republican significance is concentrated in Minsk region, in Grodno region – 31% of the areas of local significance.

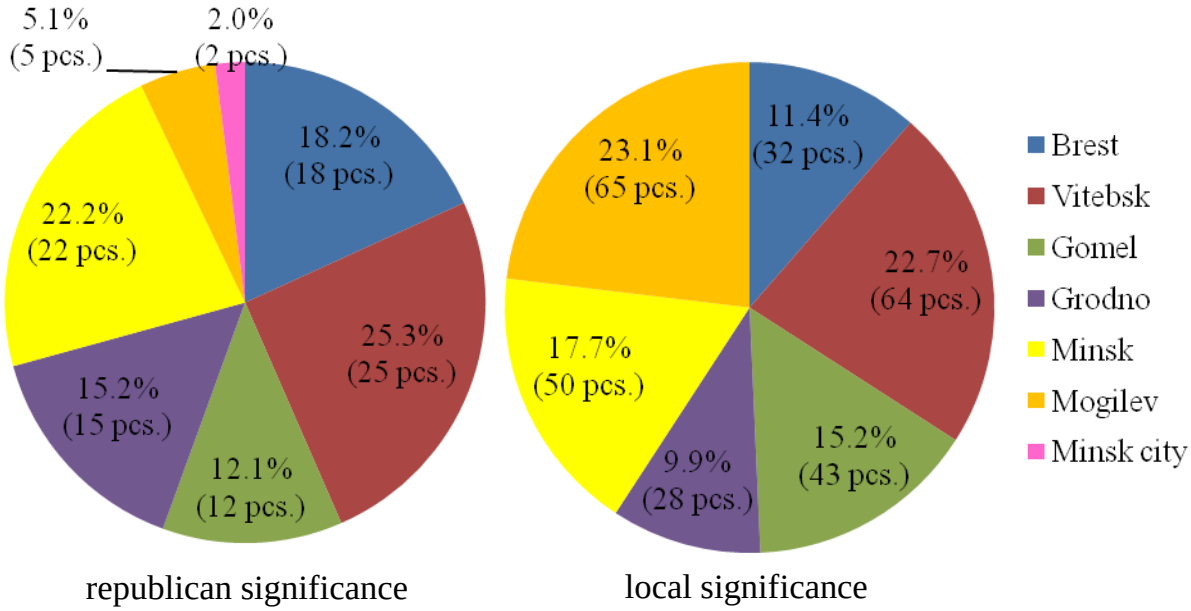


Figure 3.11. Quantitative distribution of the reserves of Belarus by region (quantity, % / pcs.)

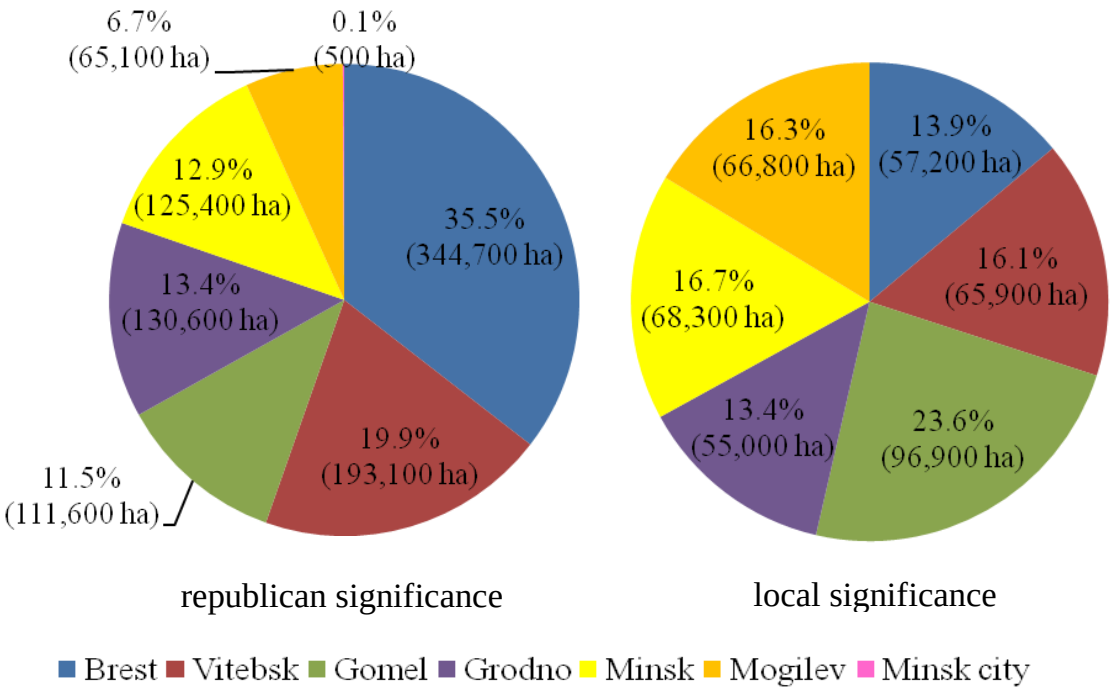


Figure 3.12. Distribution of the areas of nature reserves of Belarus by region (area, in % / ha)

The botanical monuments of nature perform the main role in the preservation and restoration of valuable forest ecosystems and objects. They are characterized by uneven distribution over the territory of Belarus (Figure 3.13). The analysis showed that the largest number of botanical monuments of nature of republican significance is located in the territory of Brest (25, or 29.1% of the total amount) and Minsk (23, or 26.7%) regions. In Brest and Mogilev regions the botanical natural monuments make up 86.2 and 78.6%, respectively, of the total area within the existing natural monuments of republican significance.

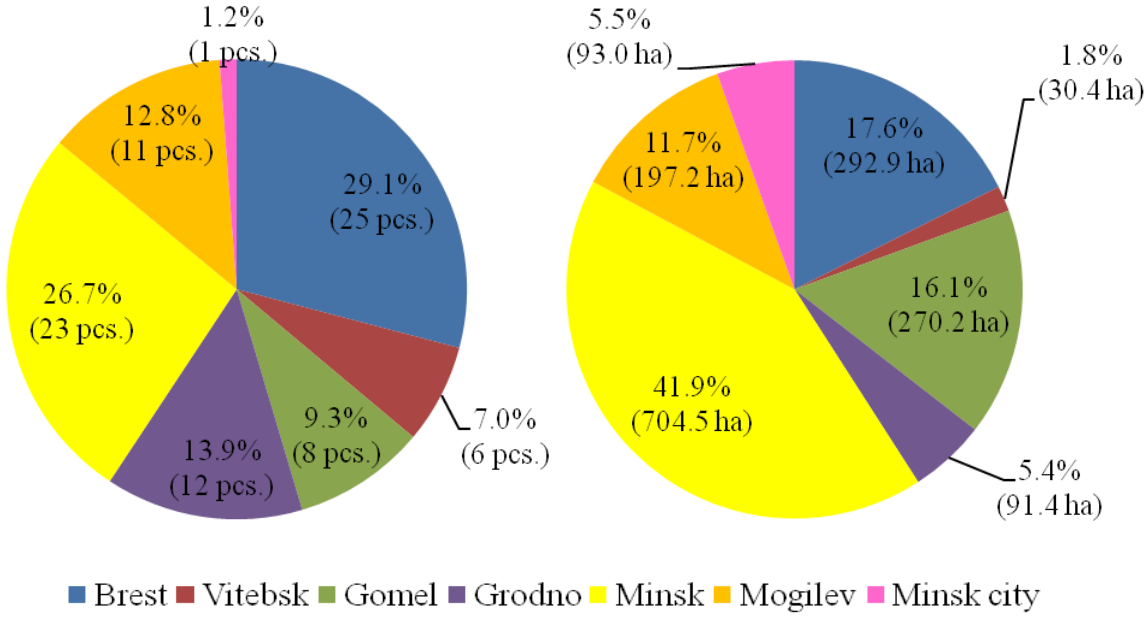


Figure 3.13. Distribution of botanical natural monuments of republican significance in Belarus by regions (area, in % / ha)

The situation to the contrary is observed in Vitebsk region, where the botanical natural monuments of republican significance are represented only by 7.0% of the total number of monuments in the region. If we analyze the total areas of botanical monuments of nature of the republican significance in the context of regions (Figure 3.13), the largest areas are located in Minsk (704.5 hectares, or 41.9%), Brest (295.9 hectares, or 17.6%) and Gomel (270.2 hectares, or 16.1%) regions. In Mogilev region the area of botanical natural monuments of republican significance is 98.6% of the total area of these SPNA of the area.

Analysis of the species composition of the botanical natural monuments of republican significance showed that it includes 16 woody species (57 monuments, or 66.3% of the total number of botanical natural monuments of republican significance) (Table 3.4).

Table 3.4 – Species composition of the botanical natural monuments in Belarus of the republican significance

Tree species	Region						Total, pcs.
	Brest	Vitebsk	Gomel	Grodno	Minsk	Mogilev	
English oak / *Quercus robur* L.	8 / 1	4 / 1	3 / 1	2 / -	6 / 1	3 / 2	26 / 6
Norway spruce / *Picea abies* (L.) H. Karst.	1 / 3		- / 2				1 / 5
Karelian birch / *Betula pendula* var. *carelica* (Merckl.) Hämet-Ahti	1				2		3
European beech / *Fagus sylvatica* L.	2						2
Yellow horse chestnut / *Aesculus octandra* Marsh.				1	1		2
Weymouth pine / *Pinus strobus* L.	2						2
Shagbark hickory / *Carya ovata* (Mill.) K. Koch	1						1
Sycamore maple / *Acer pseudoplatanus* L.					1		1
American linden / *Tilia americana* L.					1		1
Small-leaved linden / *Tilia cordata* Mill.					1		1
European larch / *Larix decidua* Mill.	1						1
Caucasian fir / *Abies nordmanniana* (Steven) Spach	1						1
Californian fir / *Abies concolor* var. *lowiana* (Gordon) Lemmon					1		1
Scots pine / *Pinus sylvestris* L.						1	1
Black pine / *Pinus nigra* J.F. Arnold					1		1
Aucuba-leaved green ash / *Fraxinus pennsylvanica* Marsh. var. *aucubaefolia*				1			1
Parks, botanical gardens, forest stands	4	1	2	8	9	5	29
TOTAL	25 / 4	6 / 1	8 / 3	12 / -	24 / 1	11 / 2	86 / 11
Note: the number after the fraction is the number of stands formed by one edificator species, pcs.							

The botanical nature monuments of republican significance include free-standing trees and stands formed by one species-edificator. The largest number of monuments was created for such a tree species as English oak: 26 trees and six oak stands. The remaining 33.7% of the monuments are represented by parks, botanical gardens and tree nurseries, and forest stands. Their formation is carried out simultaneously by different tree species. It should be

noted that in addition to the lists of species presented in the Table 3.4, the following woody species are preserved in the botanical natural monuments of local significance: Silver fir (*Abies alba* Mill.), Siberian larch (*Larix sibirica* Ledeb.), Silver birch (*Betula pendula* Roth), Norway maple (*Acer platanoides* L.), Aspen (*Populus tremula* L.), Poplar (*Populus* L.), wych (*Ulmus glabra* Huds.) and field (*Ulmus suberosa* Moench) elm, wild cherry (*Prunus avium* (L.) L.).

In general, 14 tree species, including listed in the Red Book of Belarus, were selected for the creation of a collection of forms of forest woody plants resistant to climatic stress, rare and economically valuable tree species (Table 3.5).

Table 3.5 – List of tree species selected in the *ex situ* collection in the context of forest ecosystems objects of specially protected natural areas of Belarus

Tree species	Forest object			
	nature reserves and national parks	wildlife reserves	natural monuments	forest stands of exploitable forests
Scots pine	+			
Silver fir	+		+	
Douglas fir		+		
Siberian larch			+	
Weymouth pine				+
Pedunculate oak	+		+	
Small-leaved linden	+			
Largeleaf linden	+			
Karelian birch		+		
European beech	+			+
Sycamore maple	+			
Common ash	+			
European white elm	+			
White poplar	+			

Survey and collection of seed material in the following SPNA objects were carried out to create an *ex situ* collection.

1. Natural monument of local significance in the Indura forestry district of the Grodno forestry, represented by the alley and stands of Siberian larch (*Larix sibirica* Ldb.) (Figure 3.14) and European beech, created by planting forest crops within the management of forestry in the XIX century. Coordinates of the natural monument: latitude – 53°29'40.00"; longitude – 23°52'02,70".

The alley of Siberian larch is 0.88 km long. There are 170 Siberian larch trees in the alley. The average height of the trees is 37.8 m, the average perimeter is 182 cm. The trees are 115 years old.

The Siberian larch stand (quarter 158, section 5) with an area of 0.6 hectares was added to the permanent forest seed base in 2005 as a plus forest stand (number 19/3 in the state register). Composition 4Lch1P3O2B+Asp,Hb. The stand is 104 years old. Type of forest is sorrel larch wood, type of growing conditions – C_2, bonitet IA, density 0.5. 8 plus Siberian larch trees grow in the stand. The average diameter of the plus stand is 57.1 cm (according to the mensurational description – 48 cm). Plus stand and plus trees growing in it have good sanitary condition. Natural regeneration is represented by single plants.

Figure 3.14. Stand (left) and plus trees (right) of Siberian larch
(Indura forest district, Grodno forestry)

2. Natural monument, represented by a group of silver fir trees of different ages (*Abies alba* Mill.) (Volkovysk forestry district, Volkovysk forestry; quarter 130, section 4). Silver fir is a boreal relict species that grow in the territory of Belarus outside its natural area. It belongs to the number of rare and endangered plant species listed in the Red Book of the Republic of Belarus. 19 individuals of silver fir grow under the conditions of a sorrel oak grove with an admixture of spruce, birch, aspen, and single pines. The composition is 3O2S1F1B1Asp+P. Trees are 70 years old, type of growing conditions – C_2, bonitet I, density 0.6. Stand coordinates: latitude – 53°11'01,1"; longitude – 24°21'47,1". The average diameter of the trees is 30.3 cm, the average height is 18.3 m. The average length of the crown is 14.9 m. The average width of the crown is 7.5 m. The sanitary conditions of the stand are satisfactory. A large number of self-seeding silver fir is found under the canopy of stand (Figure 3.15).

Figure 3.15. Stand (left) and natural regeneration (right) of Silver fir
(Volkovysk forest district, Volkovysk forestry)

3. Natural monuments of nature of republican and local significance, represented by single old-growth trees of pedunculate oak (Figures 3.16, 3.17):

– Tsar-Oak Tadulinsky (Tadulino village, Volosovichi forestry district, Lepel forestry, Vitebsk region) (55°08'20" N 27°41'03" E). The tree is about 400 years old.

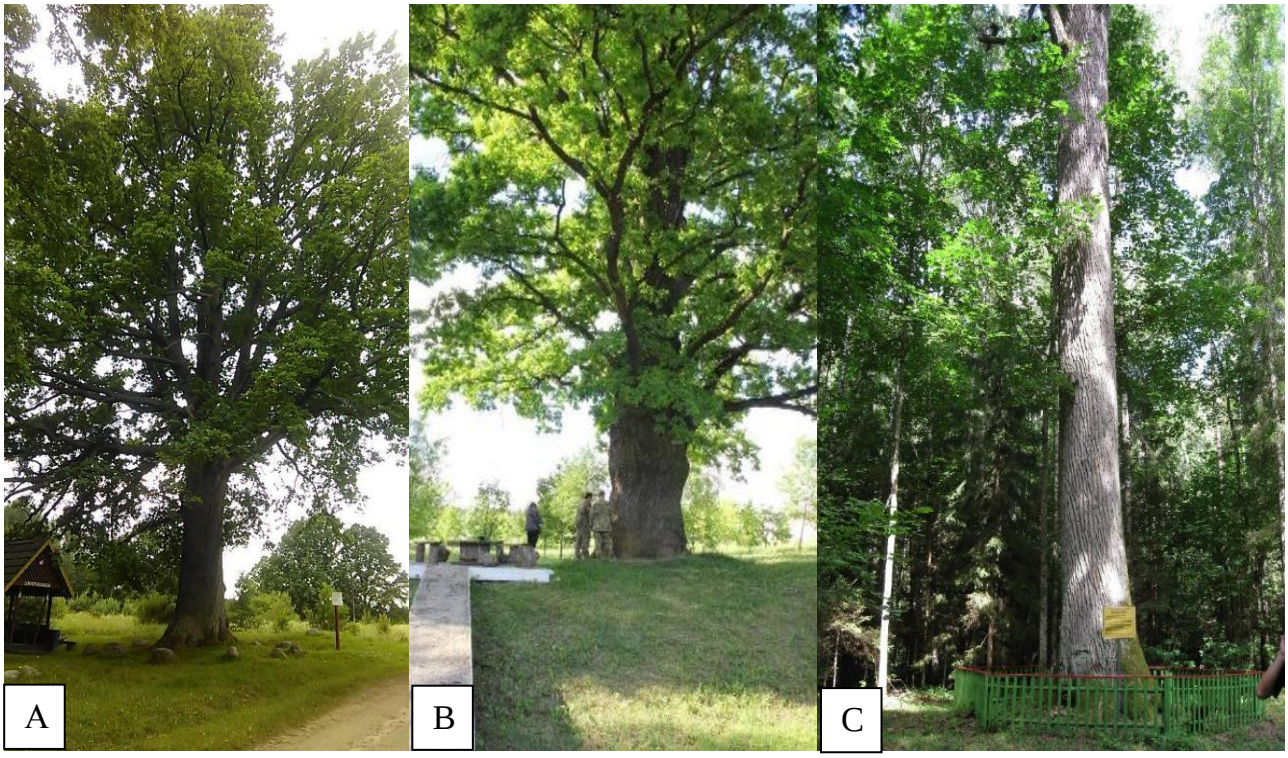
– Oak Volat (village Bolshiye Krugovichi, Krugovichi forestry district, Gantsevichi forestry, Brest region) (52°46'41" N 26°37'38" E). The tree is about 230 years old.

– Oak-Gigant (two kilometers southeast of the village of Khomichi, Khomichi forestry district, Bykhov forestry, Mogilev region). The tree is about 300 years old.

– Century-old oaks of Kozhan-Gorodok (Kozhan-Gorodok village, Dvoretskoe forestry district, Luninets forestry, Brest region) (52°12'00" N 27°00'52" E). The tree is about 300 years old.

– Tsar-Oak Pozhezhinsky (five kilometers to the east of the village of Staroye Romatovo, Pozhezhyno forestry district, Malorita district, Brest region) (51°53'04" N 24°02'10" E). The height of the tree is 46 meters, with a diameter of 2.14 meters. The age is about 800 years.

– Oak-Patriarch Pozhezhinsky (two kilometers to the west of the village of Staroye Romatovo, Pozhezhyno forestry district, Malorita district, Brest region) (51°53'33" N 23°57'07" E). The height of the tree is about 40 m, the diameter of the trunk is 1.96 m, at the base its circumference is more than 5 m. The tree is about 700 years old.



A – Tsar-Oak Tadulinsky (Vitebsk region); B – Oak Volat (Brest region);
C – Oak-Giant (Mogilev region)

Figure 3.16. Natural monuments of English oak

A – Century-old oaks of Kozhan-Gorodok; B – Tsar-Oak Pozhezhinsky;
C – Oak-Patriarch Pozhezhinsky

Figure 3.17. Natural monuments of English oak (Brest region)

3.3.3 Economically valuable forms and types of tree species

3.3.3.1 Fast-growing and highly productive forms of selection and collection fund of tree species

Plus trees play the main role in the formation of breeding fund of fast-growing and highly productive trees of forest tree species within the permanent forest-seed base, and among breeding and genetic objects – archives of plus trees clones and archive-uterine orchards. Various *ex situ* collections (e.g., field, *in vitro* and seed) make a significant contribution to the creation of the collection fund.

The features of the distribution in the territory of Belarus and the species composition of plus trees were analyzed. It is shown that 2,588 plus trees were certified in the composition of the permanent forest-seed base. Plus trees were selected in all six state production forestry associations (SPFA) their number is distributed unevenly in the territory of Belarus (Figure 3.18).

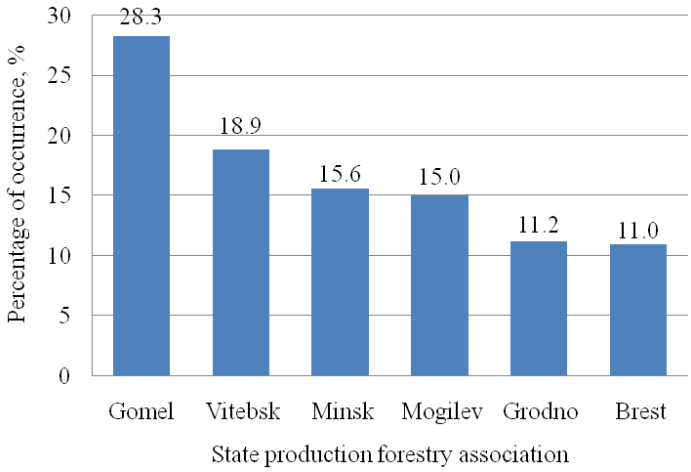


Figure 3.18. Percentage of plus trees occurrence in the territory of the state production forestry associations

The largest amount of plus trees is selected in Gomel and Vitebsk SPFA (733 and 490 pcs, respectively), the smallest – in Brest (285 pcs.). It was established that plus trees are represented by 13 local and introduced forest tree species, including six coniferous and seven deciduous (Table 3.6).

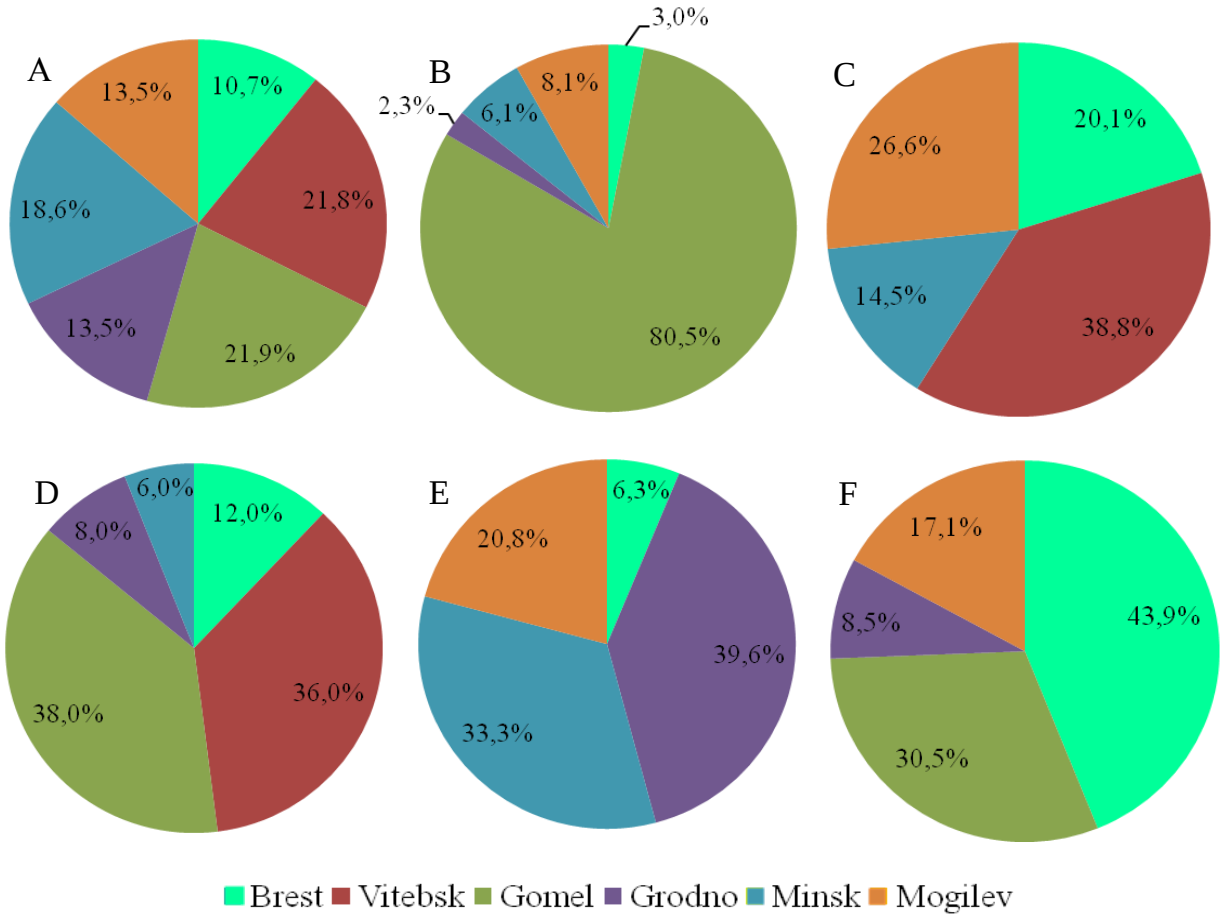
The Scots pine, collected in the territory of all six SPFAs, accounts for more than 60% of plus trees (1,572 pcs.). Four species of plus trees (European ash, green-bark aspen, European beech and silver fir) were selected in only one SPFA (Mogilev, Gomel, Grodno and Brest respectively).

Table 3.6 – Distribution and species composition of plus trees by state production forestry associations of Belarus

Tree species	State production forestry associations						Total, pcs.
	Brest	Vitebsk	Gomel	Grodno	Minsk	Mogilev	
Scots pine / *Pinus sylvestris* L.	161	344/15	346/23	213/14	294/15	214/27	1572/94
English oak / *Quercus robur* L.	12	–	318	9	24	32	395
Norway spruce / *Picea abies* (L.) H. Karst.	43	83/1	–	–	31	57	214
Silver birch / *Betula pendula* Roth	12	36	38	8	6	–	100
European larch / *Larix decidua* Mill.	6	–	–	38	32	20	96
Black alder / *Alnus glutinosa* (L.) Gaertn.	36	–	25	7	–	14	82
Siberian larch / *Larix sibirica* Ledeb.	–	27	–	8	–	17	52
Karelian birch / *Betula pendula* var. *carelica* (Merckl.) Hämet-Ahti	–	–	–	–	9	14	23
European ash / *Fraxinus excelsior* L.	–	–	–	–	–	19	19
Weymouth pine / *Pinus strobus* L.	11	–	–	–	8	–	19
Green-bark aspen / *Populus tremula* L.	–	–	6	–	–	–	6
European beech / *Fagus sylvatica* L.	–	–	–	6	–	–	6
Silver fir / *Abies alba* Mill.	4	–	–	–	–	–	4
Total	285/0	490/16	733/23	289/14	404/15	387/27	2588/95
Note: the number after the fraction – including the number of elite trees, pcs.							

It was determined that the plus trees of various tree species are unevenly selected in the territory of Belarus (Figure 3.19). Thus, the largest number of plus trees of English oak, silver birch, Scots pine was selected in the territory of Gomel SPFA. At the same time, 80% of the total amount of the plus trees of oak are concentrated in the territory of SPFA. The largest amount of plus trees of Norway spruce was selected in the territory of Vitebsk SPFA, European larch – in Grodno SPFA, black alder – in Brest SPFA.

The species content of plus trees, their distribution by the forestries was studied in detail for each SPFA. Thus, the diversity of the plus trees varies from four (Vitebsk SPFA) to eight (Brest and Mogilev SPFAs). Among forestries, in the territory of which plus trees of the greatest number of trees are presented simultaneously, Osipovichi experimental forestry of Mogilev SPFA (six – Scots pine, Norway spruce, English oak, black alder, European larch and European ash) and Buda-Koshelevo experimental forestry of Gomel SPFA (five – Scots pine, English oak, silver birch, black alder, green-bark aspen) stand out. Plus trees of three tree species were selected in the territory of Baranovichi, Borisov experimental, Grodno, Kletsk and Pruzhany forestries.



A – Scots pine; B – English oak; C – Norway spruce; D – Silver birch; E – European larch; F – Black alder

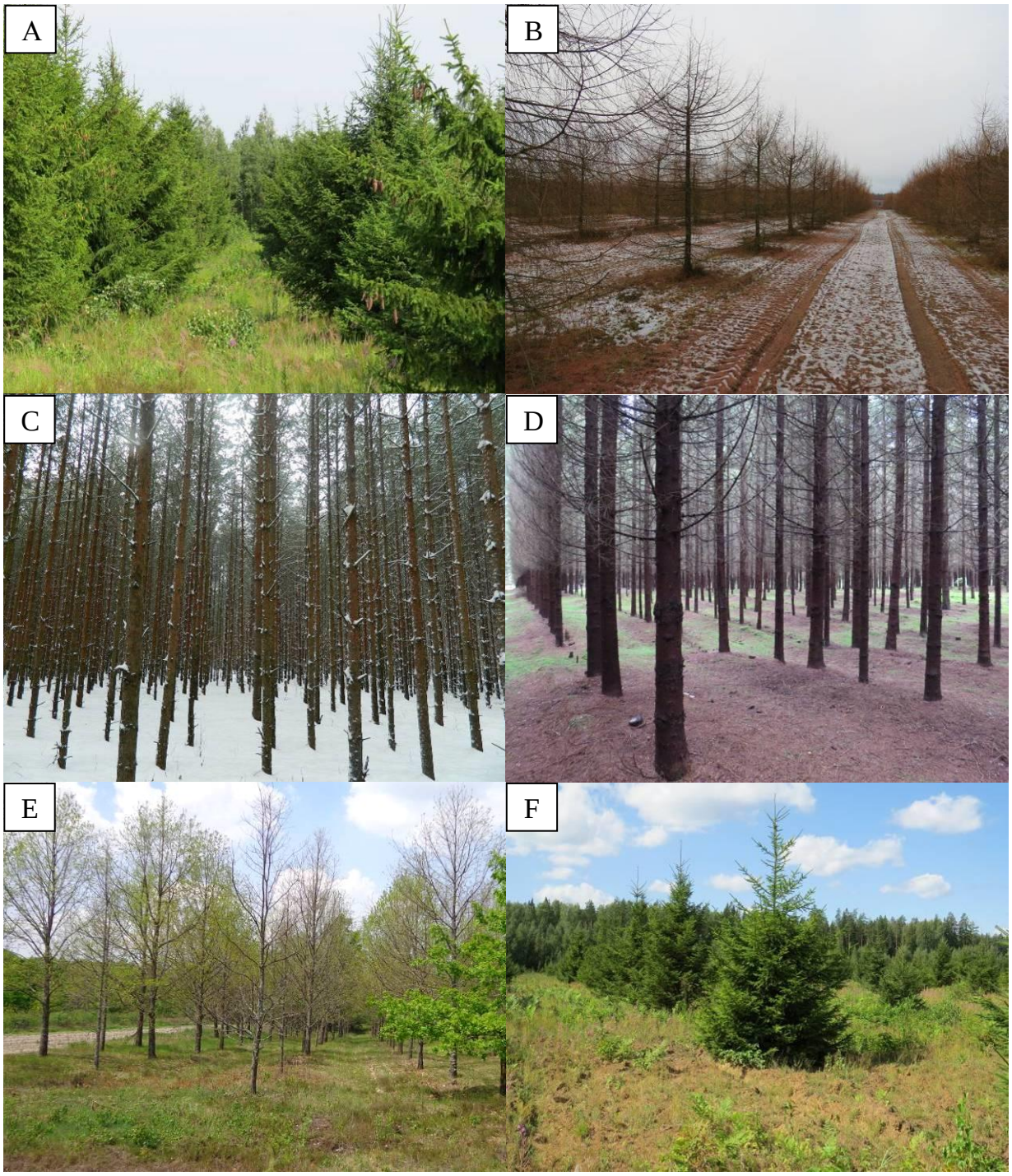
Figure 3.19. Distribution of plus trees of six tree species by state production forestry associations

By now, more than 30 sites were created for conservation of fast-growing and highly productive forms of local and introduced forest tree species, which contain the following collections: *(1)* clones and forms of elite and plus trees of Scots pine, Norway spruce, Karelian birch on archive-uterine orchards (299 clones and forms); *(2)* families of plus trees of Scots pine, European spruce in family orchards (66 families); *(3)* climatypes of Scots pine, Norway spruce in geographical cultures (266 climate types); *(4)* collection on testing the offsprings of plus trees of Scots pine, Norway spruce, English oak in test cultures (1,267 families) (Figure 3.20).

A collection of elite and plus trees clones is represented by archive-uterine orchards and comprises: Scots pine – 4 archive-uterine orchards of plus and elite trees, created on the area of 10.8 ha, represented by 140 clones; Karelian birch – 1 archive-uterine orchards, created on the area of 4.1 ha, represented by 6 forms of highly patterned timber; Norway spruce – 4 archive-uterine orchards on the area of 7.1 ha, represented by 164 clones of plus and elite trees.

A collection of plus trees families is represented by family orchards and comprises: Scots pine – family orchards in the area of 1.2 ha, represented by 30 families of plus trees; Norway spruce – family orchards on the area of 1.7 ha, represented by 36 families of plus trees.

A collection on testing the seed progeny of plus trees is presented by test cultures and comprises: Scots pine – 6 plots of test cultures on the area of 8.8 ha, 858 families of plus trees being tested; Norway spruce – 3 plots of test cultures on the area of 6.7 ha, 257 families of plus trees being tested; English oak – 2 plots of test cultures on the area of 8.7 ha, 152 families of plus trees.



A – archives of clones of Norway spruce; *B* – archives of clones of European larch; *C* – geographical cultures of Scots pine; *D* – test cultures of Norway spruce; *E* – seed orchards of English oak; *F* – seed orchards of Norway spruce

Figure 3.20. *Ex situ* collection fund of fast-growing and highly productive forms of forest tree species

The collection *in vitro* fund of fast-growing and highly productive forms of forest tree species, formed on the basis of the Institute of Forest of the National Academy of Sciences of the Republic of Belarus was described, which includes more than 40 clones of species of *Betula* types and their hybrids (*B. pendula*, *B. pubescens* Ehrh., triploid hybrid birch); species of *Populus* and their hybrids (*P. tremula*, *P. trichocarpa* Torr. et Gray, *P. koreana* Rehder, *P. simonii* Carriere, *P. wislizenii* Sarg., *Populus* × *petrowskiana* R.I. Schrod., *Populus* × *canadensis* Moench,; species of *Salix* (*Salix caprea* L., *S. fragílis* L.) (Figure 3.21).

Figure 3.21. *In vitro* collection fund of fast-growing and highly productive forms of forest tree species

Based on these studies, the Registers of fast-growing and highly productive forms of selection and collection fund of forest woody species were created.

3.3.3.2 Highly resin productive forms of Scots pine

A natural stands. A complex selection and genetic evaluation of resin productivity of 310 phenotypes of Scots pine in five stands of natural origin of Korenevka and Zyabrovska forest districts of SFI "Korenevka experimental forest station of the Institute of Forest of the NAS of Belarus" (KEFS), and Kalinino forest district of Gomel Experimental Forestry was carried out. The resin productivity and phenotypes of Scots pine were determined on the direct characteristic by the modified express-method of minor wounding. The devices for the collection of soft resin in the form of tubes with a diameter of 9 mm were installed at 1.3 m from the soil surface. The depth of the wounds on timber was 5 mm. The daily output of soft resin in grams was taken as the biological resin productivity index (Figure 3.22).

The average value of resin productivity of the analyzed trees was M = 13.1 g. The Scots pine trees were divided into categories depending on the value of the selected feature: low (up to 40%), medium (41-160%), high (161-200%) and very high (201% or more) resin productivity with respect to the average value (13.1 g). 25 plus trees were selected, the resin productivity of which was 250% or more in comparison with the average value (Table 3.7).

The correlation of resin productivity with the thickness and type of bark was studied. The high correlation of resin productivity and the thickness and height of the coarse bark along the trunk was established (r = 0.41) that forms the basis for recommending this value for the selection of trees with high resin productivity. The selection and use of reproductive material of trees with coarse bark is necessary to obtain high wood pulp and high resin productivity.

Figure 3.22. Method of micro-wounding express diagnostics of the degree of Scots pine resin productivity

Table 3.7 – Register of high resin productivity forms of selection fund of Scots pine in stands of natural origin

Tree number	Resin productivity, g	Diameter, cm	Height, m	Coarse bark length, m	Crown diameter, m	Bark thickness (index)
1	2	3	4	5	6	7
4/7	141.31	45.0	30.2	8.0	6.0	0
3/33	130.73	43.0	29.5	8.0	5.0	0
3/15	121.73	68.0	29.0	8.0	9.0	0
3/5	116.18	48.0	28.4	9.1	5.1	0
3/18	114.52	60.0	33.1	8.0	9.0	0
3/16	112.07	62.0	30.2	8.3	4.7	0
3/11	108.17	50.0	29.4	7.4	7.5	0
3/19	103.96	50.0	30.5	10.9	6.5	0
4/12	97.91	54.0	29.4	5.5	6.5	0
3/21	96.23	78.0	30.0	10.4	9.5	0
5/34	93.51	37.0	29.6	4.5	6.5	0
4/4	85.55	43.0	32.8	5.0	6.0	0
3/16	82.50	47.0	30.5	12.6	6.0	0
3/17	82.49	42.0	31.2	8.9	7.0	0
3/8	79.80	50.0	33.5	8.4	5.5	0

Continuation of the Table 3.7

1	2	3	4	5	6	7
3/12	79.66	57.0	32.2	9.1	8.0	2
1/5	75.94	42.0	28.8	6.6	6.0	1
3/6	75.46	50.0	33.0	9.5	6.0	0
4/18	72.51	38.0	31.8	7.2	4.5	0
2/12	71.99	60.0	30.5	9.0	9.0	1
5/34	68.89	33.0	28.0	3.5	5.5	1
3/6	68.19	60.0	30.8	12.9	7.5	0
4/8	67.69	41.0	28.7	5.8	5.0	0
4/11	66.12	30.0	30.5	5.8	4.0	0
3/10	65.49	52.0	30.7	9.4	6.0	0

A selection and genetic objects. An inventory of selection and genetic objects of SFI "Korenevskaya experimental forest station of the Institute of Forest of the NAS of Belarus":

– *site No. 1*: collection-mother orchard of the Scots pine clones with high resin productivity. Year of creation – 1985, area – 1.5 hectares. The collection includes vegetative progeny of 21 plus trees of Scots pine, characterized by a high yield of resin from Begoml, Baranovichi, Bykhov, Vitebsk, Gantsevichi, Gomel experimental, Zhitkovichi, Krupki, Logoisk, Oktyabrsky and Cherikov forestries. Designation of the site is to preserve the gene pool of the Scots pine forms with high resin productivity, to use as the starting material for laying seed clone orchards of the second generation;

– *site No. 2*: archive-mother orchard of the Scots pine plus trees. Year of creation – 1983, area – 3.0 hectares. 50 clones of Scots pine plus trees from Zhitkovichi, Glusk, Bobruisk, Lepel, Bykhov, Gomel experimental, Klichev, Gantsevichi, Ivatsevichi, Pruzhany, and Baranovichi forestries. Spacing of trees at the orchard is 6 × 6 m;

– *site No. 3*: archive-mother orchard of the Scots pine plus trees. Year of creation – 1985, area – 3.5 hectares. The collection includes vegetative progeny of 55 Scots pine plus trees from Narovlya specialized, Zhitkovichi, Osipovichi experimental, Rechitsa experimental, Kalinkovichi, Chechersk specialized, Lelchitsy, Yelsk and Kostyukovichi forestries. Spacing of trees at the orchard is 6 × 6 m;

– *site No. 4*: archive-mother orchard of the Scots pine. Year of creation – 1987, area – 2.3 hectares. The vegetative progeny of 18 Scots pine plus trees from Buda-Koshelevo experimental, Rechitsa experimental, Gomel experimental and Chechersk specialized forestries is represented. Planting is made in blocks of 20 grafted plants of one plus tree.

Based on the analysis, 24 clones with high resin productivity growing in the archive-mother orchards were selected (Table 3.8).

Six clones of Scots pine from the collection-mother orchard of forms with high resin productivity were used to prepare vegetative material, it was cloned by grafting techniques, plant material was cultivated that will be included in the *ex situ* collection (Figure 3.23).

Table 3.8 – Register of high resin productivity forms of selection and collection fund of Scots pine in the composition of permanent forest seed base

Clone No.	Diameter, cm	Moisture content of wood	Resin productivity, g
28/533	12.96	15.62	3.12
28/523	13.80	18.49	3.72
27/1207	14.19	19.28	4.59
27/1212	14.07	16.07	4.09
51/387	15.58	17.96	6.00
28/524	16.91	19.57	5.11
85a/936	14.99	15.74	3.92
28/527	15.48	17.51	3.26
28/427	14.48	15.42	3.73
42a/1254	15.01	17.94	5.85
85a/920	14.82	18.96	4.32
58/548	14.12	16.88	4.19
27/1208	13.78	18.00	5.40
28/524	15.00	17.09	4.98
32/418	14.23	17.83	2.83
42a/1257	13.28	17.04	4.43
28/423	16.06	18.31	6.11
42a/1263	13.05	18.80	4.14
42a/1265	13.09	18.21	4.64
28/424	13.59	17.06	4.85
51/381	16.29	18.11	5.87
42a/1253	12.61	16.14	4.73
28/529	15.31	17.32	4.07
42a/1231	14.47	16.33	4.06

Figure 3.23. Grafted vegetative material of the Scots pine clones with high resin productivity

3.3.3.3 Decorative forms of Scots pine

Ex situ collection includes 14 decorative varieties of Scots pine grown in the Central Botanical Garden of the NAS of Belarus, included in 2016-2017 in the "State Register of Varieties" and recommended by State Institution "State Inspection for Testing and Protection of Plant Varieties" to be used in the territory of the Republic of Belarus. Their brief description is given below.

Figure 3.24. *P. sylvestris* "Ascending"

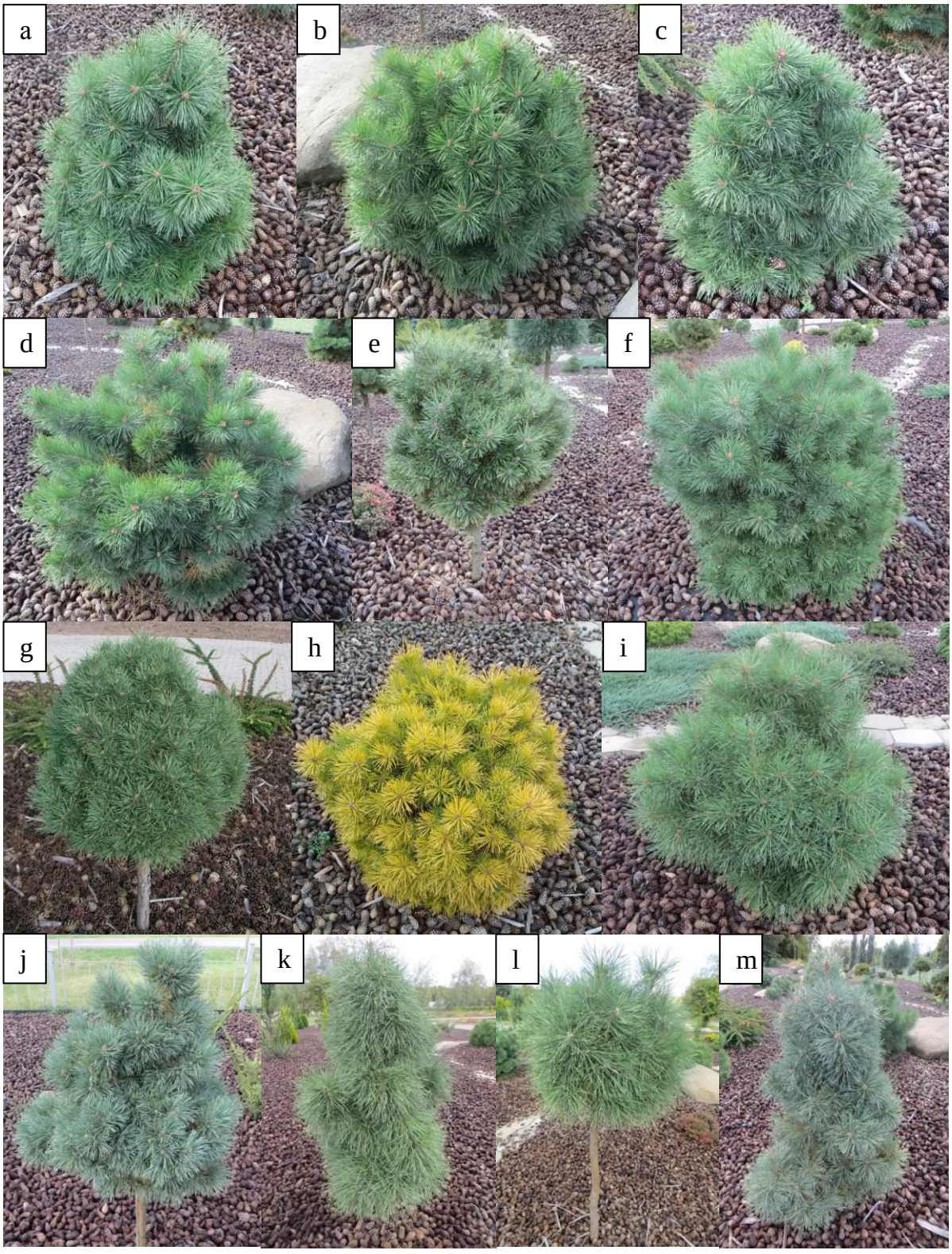
Pinus sylvestris "**Ascending**" is a dwarf form with cushion-type crown. Dense branching. Axial shoots are absent. At the age of 12 years, the plant height is 60-70 cm, diameter is 90-100 cm. Annual growth is 10-15 cm. Shoots are greenish-brown. Green, curved needles with average width and 3-4 cm long, densely located on the shoots. Sprouts are dark brown, elongated, 1-1.5 cm long. It is characterized by best growth and decorative properties in open areas with good lighting. It is not demanding to soil moisture and fertility, fresh, medium and subacid sandy loams and light and clay loams are preferable (Figure 3.24).

Pinus sylvestris "**Emerald**" is a dwarf form with round crown. Dense branching. Axial shoots are weakly expressed. At the age of 12 years, the plant height is 60-70 cm, diameter is 70-80 cm. Annual growth is 10-13 cm. Shoots are light brown. Green, straight needles, 5-7 cm long, densely located on the shoots. Sprouts are brown, elongated, 1-1.5 cm long. It is characterized by best growth and decorative properties in open areas with good lighting. It is not demanding to soil moisture and fertility, fresh, medium and subacid sandy loams and light and clay loams are preferable (Figure 3.25a).

Pinus sylvestris "**Imeni Chelyuskintsev**" is a dwarf form with ball-shaped crown. Dense branching. Axial shoots are not expressed. At the age of 12 years, the plant height is 60-70 cm, diameter is 70-80 cm. Annual growth is 14-17 cm. Shoots are green-brown. Green, straight needles, 6-7 cm long, densely located on the shoots. Sprouts are light-brown, elongated, 1-1.2 cm long. It is characterized by best growth and decorative properties in open areas with good lighting. It is not demanding to soil moisture and fertility, fresh, medium and subacid sandy loams and light and clay loams are preferable (Figure 3.25b).

Pinus sylvestris "**Pyramid**" is a dwarf form with cone crown. Dense branching. Axial shoots are vividly expressed. At the age of 12 years, the plant height is 50-55 cm, diameter is 55-60 cm. Annual growth is 10-12 cm. Shoots are light brown. Green, curved, narrow needles, 5-6 cm long, densely located on the shoots, yellow-green in winter. Sprouts are brown, elongated, 1-1.5 cm long. It is characterized by best growth and decorative properties in open areas with good lighting. It is not demanding to soil moisture and fertility, fresh, medium and subacid sandy loams and light and clay loams are preferable (Figure 3.25c).

Pinus sylvestris "**Sprawlingg**" is a dwarf form with round asymmetric crown. Dense branching. Shoots are gray-brown, raising, axial shoots are absent. At the age of 12 the height of the plant is 80-90 cm, diameter is 120-130 cm. Annual growth is 20-25 cm. Green, curved needles with average width and 6-7 cm long, densely located on the shoots. Sprouts are elongated, reddish-brown, 1-1.5 cm long. It is characterized by best growth and decorative properties in open areas with good lighting. Low demand for soil moisture and fertility (Figure 3.25d).



a – Emerald; *b* – Imeni Chelyuskintsev; *c* – Pyramid; *d* – Sprawling; *e* – Uzdenskaya; *f* – Tolstushka; *g* – Elegant; *h* – Yellowish; *i* – Minchanka; *j* – Forest Beauty; *k* – Bonsai; *l* – Slutskaya; *m* – Chizhovskaya

Figure 3.25. Decorative varieties of Scots pine

Pinus sylvestris "**Uzdenskaya**" is a dwarf form with round, slightly asymmetric crown. Dense branching. Axial shoots are absent. At the age of 9 years, the height is 50-55 cm, diameter is 55-60 cm. Annual growth is 5-7 cm. Shoots are brown. Green, narrow, straight needles, 2-4 cm long, yellow-green in winter. Sprouts are brown, elongated, 0.5-1 cm long. It is characterized by best growth and decorative properties in open areas with good lighting. It is not demanding to soil moisture and fertility, fresh, medium and subacid sandy loams and light and clay loams are preferable (Figure 3.25e).

Pinus sylvestris "**Tolstushka**" is a dwarf form with unevenly round asymmetric crown. Dense branching. Axial shoots are not expressed. At the age of 12 years, crown height and diameter is 100-110 cm. Annual growth is 17-22 cm. Shoots are green-brown. Green, curved needles with average width and 6-4 cm long, densely located on the shoots, yellowish on the tips of needles in winter. Sprouts are red-brown, cone-shaped, 1-1.5 cm long. It is characterized by best growth and decorative properties in open areas with good lighting. It is not demanding to soil moisture and fertility, fresh, medium and subacid sandy loams and light and clay loams are preferable (Figure 3.25f).

Pinus sylvestris "**Elegant**" is a dwarf form with wide egg-shaped compact crown. Dense branching. Axial shoots are absent. At the age of 14 years, the height of the crown is 95-100 cm, diameter is 80-85 cm. Annual growth is 5-7 cm. Shoots are brown. Gray-green, straight or slightly curved needles, 4-5 cm long, densely located on the shoots. Sprouts are gray-brown, elongated, 0.7-1 cm long. It is characterized by best growth and decorative properties in open areas with good lighting. It is not demanding to soil moisture and fertility, fresh, medium and subacid sandy loams and light and clay loams are preferable (Figure 3.25g).

Pinus sylvestris "**Yellowish**" is a dwarf form with round crown. Dense branching. Axial shoots are absent. At the age of 12 years, the plant height is 60-65 cm, crown diameter is 70-75 cm. Annual growth is 10-12 cm. Shoots are light brown. Needles are light green, narrow, straight, 5-6 cm long, densely located on the shoots, gets yellowish tint in autumn. Sprouts are light-brown, elongated, 0.8-1 cm long. It is characterized by best growth and decorative properties in open areas with good lighting. It is not demanding to soil moisture and fertility, fresh, medium and subacid sandy loams and light and clay loams are preferable (Figure 3.25h).

Pinus sylvestris "**Minchanka**" is a dwarf form with egg-shaped crown. Dense branching. Axial shoots are not expressed. At the age of 12 years, the plant height is 80-85 cm, crown diameter is 95-100 cm. Annual growth is 15-17 cm. Shoots are light brown. Green-gray, curved needles with average width and 5-7 cm long, densely located on the shoots. Sprouts are brown, elongated, 1-1.7 cm long. It is characterized by best growth and decorative properties in open areas with good lighting. It is not demanding to soil moisture and fertility, fresh, medium and subacid sandy loams and light and clay loams are preferable. Decorative by crown form, color and form of needles (Figure 3.25i).

Pinus sylvestris "**Forest Beauty**" is a dwarf form with cone-shaped crown. Branching is of medium density. Expressed axial shoots. At the age of 10 years, the plant height is 65-70 cm, crown diameter is 60-70 cm. Annual growth is 4-5 cm. Shoots are light brown. Needles are gray-green, narrow, curved, 4-5 cm long, densely located on the shoots, slightly yellowish in autumn. Sprouts are gray-brown, short, 0.5-0.7 cm long. It is characterized by best growth and decorative properties in open areas with good lighting. It is not demanding to soil moisture and fertility, fresh, medium and subacid sandy loams and light and clay loams are preferable (Figure 3.25j).

Pinus sylvestris "**Bonsai**" is a slowly growing plant, crown shape is close to cone-shaped. Expressed axial shoots. At the age of 10 years, the plant reaches height of 120-130 cm and

diameter of 80-90 cm. The shoots are light brown, arranged relatively loosely, the branching at the tips is denser. Annual growth in height is 13-15 cm. Needles are gray-green, wide, 12-15 cm long, densely located on the shoots of the previous year growth. Sprouts are gray-brown, elongated, 1.5-2 cm long. It is characterized by best growth and decorative properties in open areas with good lighting. It is not demanding to soil moisture and fertility, fresh, medium and subacid sandy loams and light and clay loams are preferable (Figure 3.25k).

Pinus sylvestris "**Slutskaya**" is a dwarf form with asymmetric round crown. Dense branching. Axial shoots are absent. At the age of 7 years, the plant height is 65-70 cm, crown diameter is 75-80 cm. Annual growth is 15-17 cm. Shoots are light brown. Gray-green, wide, slightly curved needles, 10-11 cm long, densely located on the shoots. Sprouts are gray-brown, elongated, 1.5-2 cm long. It is characterized by best growth and decorative properties in open areas with good lighting. It is not demanding to soil moisture and fertility, fresh, medium and subacid sandy loams and light and clay loams are preferable. Decorative by crown form, color and form of needles (Figure 3.25l).

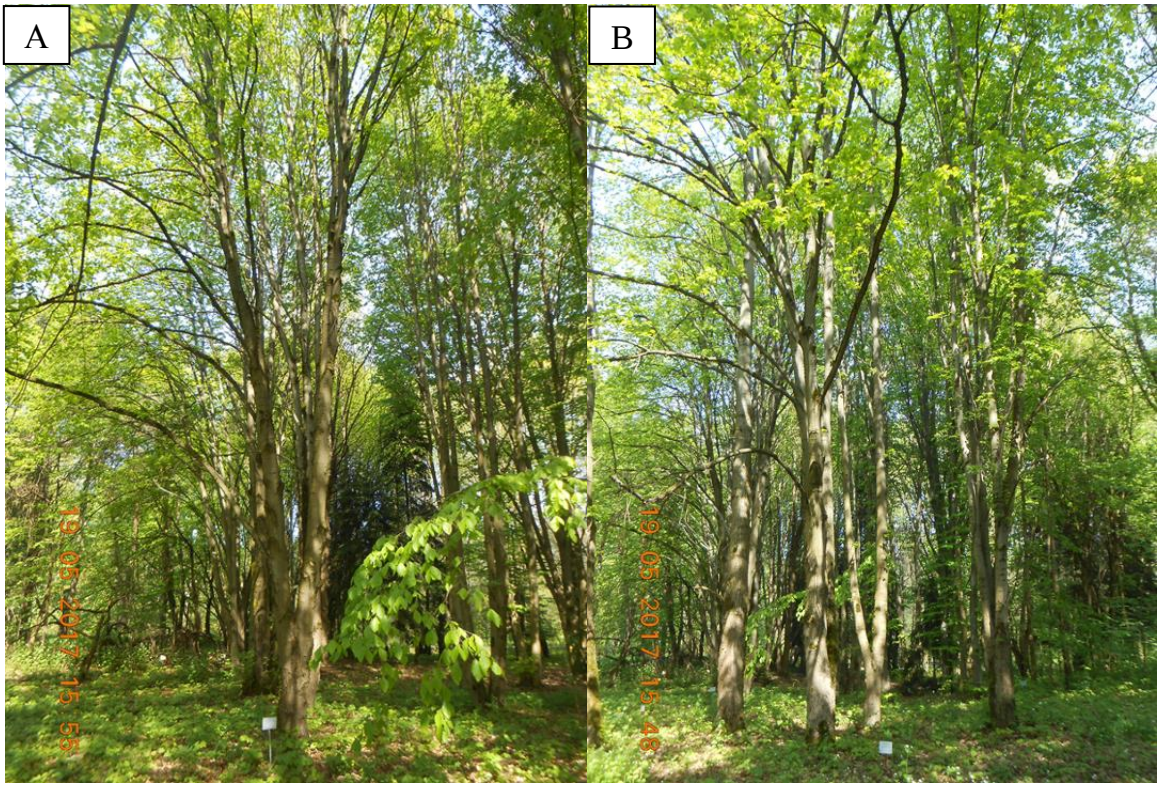
Pinus sylvestris "**Chizhovskaya**" is a slowly growing plant, crown shape is close to cone-shaped. Dense branching. Expressed axial shoots. At the age of 13 years, the crown height reaches 110-120 cm and diameter 65-70 cm. Annual growth is about 18 cm. Shoots are gray-brown. Needles are gray-green, curved, broad, 6-7 cm long, with yellowish tips. Sprouts are light-brown, strongly resin-soaked, elongated, 1.5-2 cm long. It is characterized by best growth and decorative properties in open areas with good lighting. It is not demanding to soil moisture and fertility, fresh, medium and subacid sandy loams and light and clay loams are preferable. Decorative by crown form, color and form of needles (Figure 3.25m).

3.3.4 Promising introduced species

1. *Tilia caucasica* is a tree up to 35 m high and with broad egg-shaped crown. Young shoots are almost bare, yellowish-brown. Leaves are broad oval, 6-14 cm long, slant cut at the base, at the top are stretched into a thin tip, edges are acutiserrate, bare on top, dark green, glaucous below, with bundles of whitish hairs at the fiber nodes. The upper side of the leaves is dark green, the back side is glaucous, with bundles of whitish hairs around the fibers. The bract is narrow, up to 8 cm long. Flowers are light yellow, gathered in drooping inflorescence (3-8). Abundant flowering. It flowers from late June to early July. Fruits – round or slightly elongated nuts, ribbed, hairy. Place of origin – the Caucasus, the Crimea and the north-eastern part of Asia Minor mountains. Thermophilic. Tolerates droughts, but develops well on fertile, moist soil. Quite durable – lives up to 200-300 years. It may be used equally well as s powerful specimen tree in single or in alley and group plantings in parks (Figure 3.26a).

2. *Tilia dasystyla* Steven is a tree up to 20 m high with straight trunk coated with dark gray bark. Young shoots are a dark brown, bare. Buds are oblong, bare, 4-5 mm long, 2-3 mm wide, dark brown. Leaves are broad egg-shaped, 8-11 cm long, 6-8 cm wide, on top elongated, at the base – truncated or slightly heart-shaped, somewhat asymmetrical, toothed, triangular teeth, sharp pointed, dark green at the top, bare, shiny , light green from below, bare, tufted with direct, simple, yellowish hairs in the corners of the veins. Flowers (and styles) loosely fluffed. The inflorescence is equal to the length of the bract, with 3-5 flowers. Fruits – nuts, woody, fluffed, with 5 well-defined edges. Grows from late April to early October. Average growth rate. Tilia Dasystyla blooms in July-August. Fruit ripens in September. Complete tolerance for winter conditions. Poor rooting of the grafts. Can be

used for landscaping. In its natural form is found in Ukraine (Crimea), in northern Iran, the North-West of Turkey, Azerbaijan, Georgia, and Dagestan. Rarely observed in culture (Figure 3.26b).

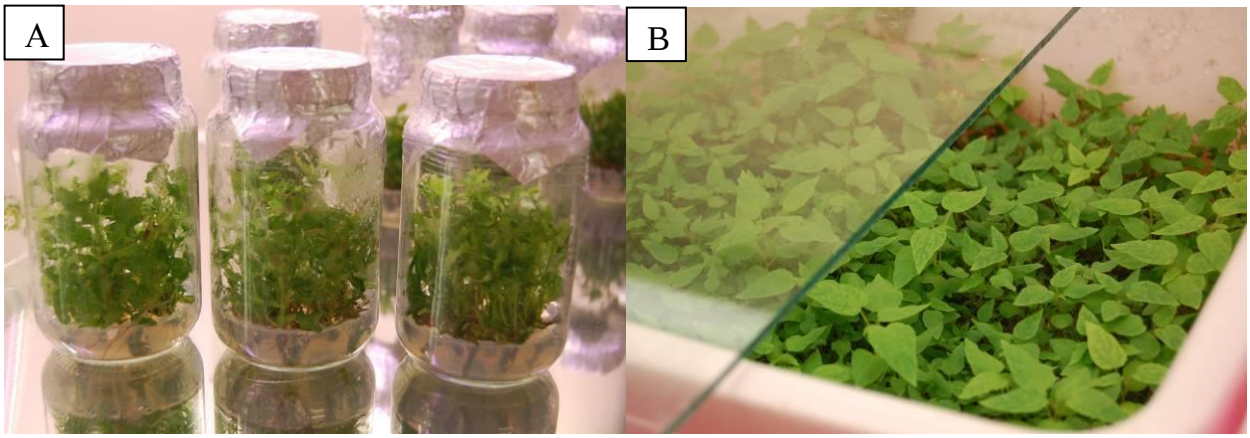


A – *Tilia caucasica*; B – *Tilia dasystyla*

Figure 3.26. Introduced linden species resistant to pathogens

3. *Acer saccharinum* is a tree with a wide spreading crown 15-20 m high (up to 30) and the diameter of the crown up to 12-20 m. Bark is light gray with shallow long cracks. Leaves on long stakes are bright green on top, silver on the bottom, deeply cut into 5 parts with large teeth. Autumn color is yellow or orange with purple-reddish tinge. Blooms before leafing. Flowers are reddish or greenish. Wings are large, spread out at a closed angle. Has fragile wood. Grows rapidly. Light-demanding, but can tolerate slight shading. Quite undemanding to soil conditions. Tolerates short-term soil drought and temporary flooding. Tolerates soil compaction, grows well on cobbled streets. Tolerates city conditions. Resistant to fungal diseases of leaves. High tolerance to winter conditions.

4. *Populus* L., Chinese clone P.ShHG is a sample for the collection of fast growing poplar clones. Introduced *in vitro* as a promising source of raw material for energy industry and pulp and paper industry, as well as the planting material for landscaping and windbreaks. This clone was produced in China in the result of hybridization of *Populus pseudo-cathayana* × *Populus deltoides* Barry (clone P.ShHG: *Populus pseudo-cathayana* × P. *deltoides* Barry cv Shan Hai Guan), is characterized by high growth rate, ease of vegetative propagation, resistance to drought and excessive moisture, to soil salinity and insect pests, as well as high quality of wood (Figure 3.27).



A – aseptic culture; B – adaptation of micro-grafts to normal conditions

Figure 3.27. *Populus* L., Chinese clone P.ShHG

5. Silvicultures of European beech (*Fagus silvatica* L.) (Ross forestry district, Volkovysk forestry) with an area of 1.1 and 1.0 ha (quarter 150 section 9 and quarter 151 section 8, respectively) are characterized by the composition 10Beech+B (Figure 3.28). Type of growing conditions is D_2. The average height of both stands is 26 m, the average diameter is 32 cm, bonitet I, density 0.5. The average diameter is 25.4 cm and 26.2 cm, the average height is 23.6 m and 24.0 m, respectively. The stands are in a good sanitary state. In the spring of 2019, 50 European wild beech wildlings were dug out and planted in containers of various sizes to form a collection.

Figure 3.28. Stand (left) and natural regeneration (right) of European beech wood (Ross forest district, Volkovysk forestry)

6. Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) – 18 plus trees were examined in the territory of the Priluksky nature reserve and the Central Botanical Garden of the National Academy of Sciences of Belarus (Figure 3.29).

The survey showed that by the structure of the crust, the Douglas fir trees growing in the territory of the wildlife reserve are characterized by three phenotypes characterized by different productivity (Figure 3.30, Table 3.9):

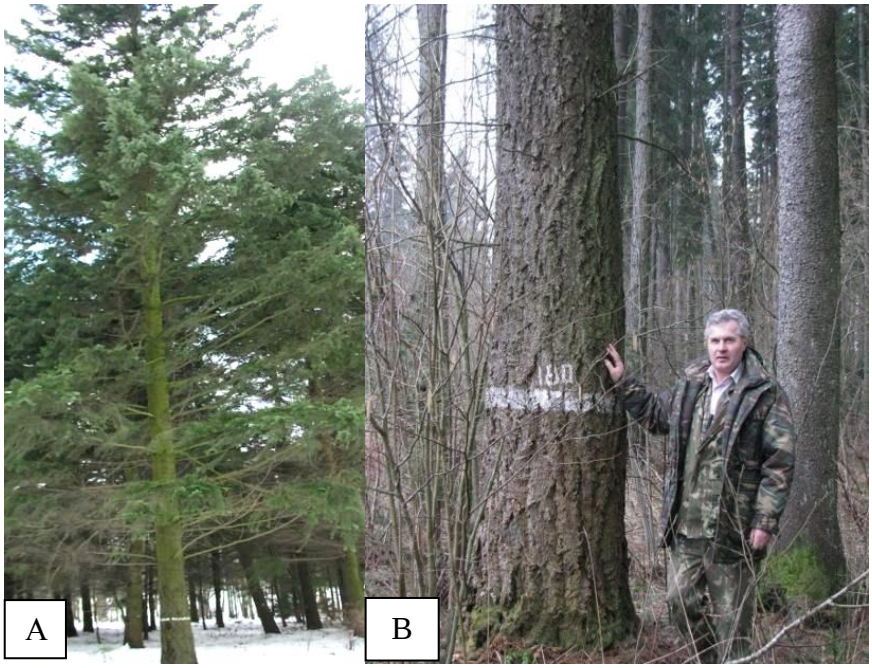
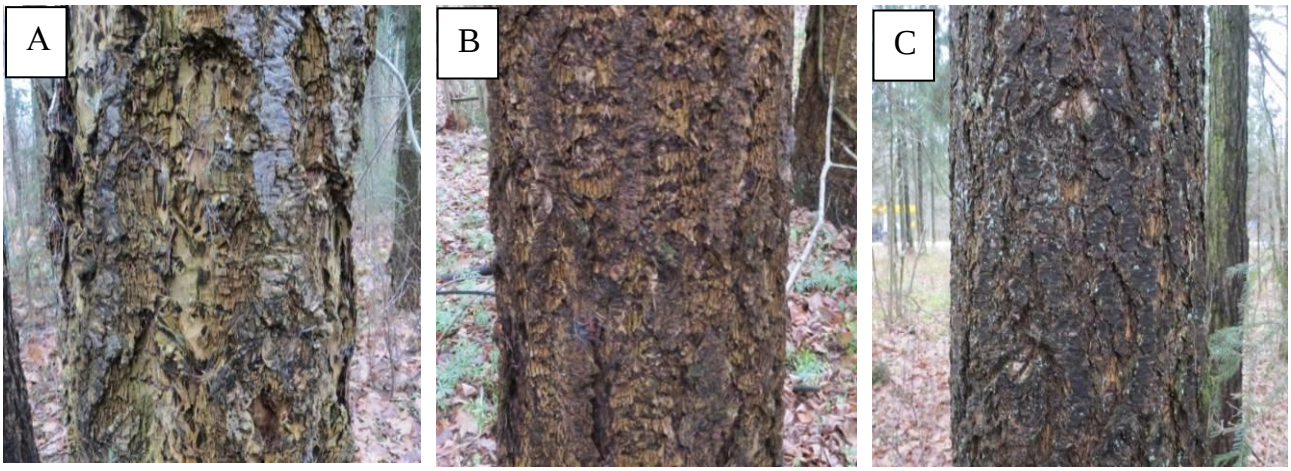


Figure 3.29. Plus trees of Douglas-fir in the Central Botanical Garden of the NAS of Belarus (A) and the Pryluksky nature reserve (B)

A) cork deep-fissured (coarse-cork). The crust is corky, light, in the form of big plates more than 5 cm thick with voids separated by deep fissures. Approximately at the age of 70-75 years, it gradually exfoliates and falls to a height of 2-3 m in the butt-log portion. A new one actively forms replacing the fallen crust;

B) cork medium-fissured (transitional). The crust is relatively dense, up to 4-5 cm thick, longitudinally fissured, cracks with medium depth. A peeling of the crust at the root collar to a height of 0.7-1.0 m is observed;

C) cork fine-fissured (smooth-cork). The crust is dense, thin, up to 2-3 cm thick, the plates are small, separated by shallow cracks, do not exfoliate.



A – coarse-cork; B – transitional; C – smooth-cork

Figure 3.30. Douglas fir phenotypes by crust structure

Table 3.9 – Characteristics of Douglas fir trees with different crust structures

Phenotype	Height, m		Diameter,cm	
	M±m	Min.–Max.	M±m	Min.–Max.
Coarse-cork	30.8±0.7 a	14.8 – 39.8	42.7±1.5 a	16.4 – 67.0
Transitional	28.5±0.7 a	12.1 – 39.5	35.6±1.1 b	14.3 – 64.4
Smooth-cork	23.2±0.8 b	11.4 – 38.2	24.7±1.0 c	13.4 – 57.6
Note: M is the mean value; ± m is the error of the mean value; the values of the indicators, marked with the same letters, do not differ significantly at P<0.05.				

Based on the results of the survey six *Pseudotsuga menziesii* trees were selected for inclusion in the composition of *ex situ* collection.

7. Korean cedar pine (*Pinus koraiensis* Sieb. et Zucc.) – a curtain of trees growing in the territory of forest nursery of Volkovysk forest district was surveyed. Geographical coordinates: latitude – 53°14′03,28″; longitude – 24°10′53,55″. Forest seed material and stocks for interspecies grafting on Scots pine in the territory of a greenhouse complex of the National forest breeding and seed production center was prepared (Figure 3.31).

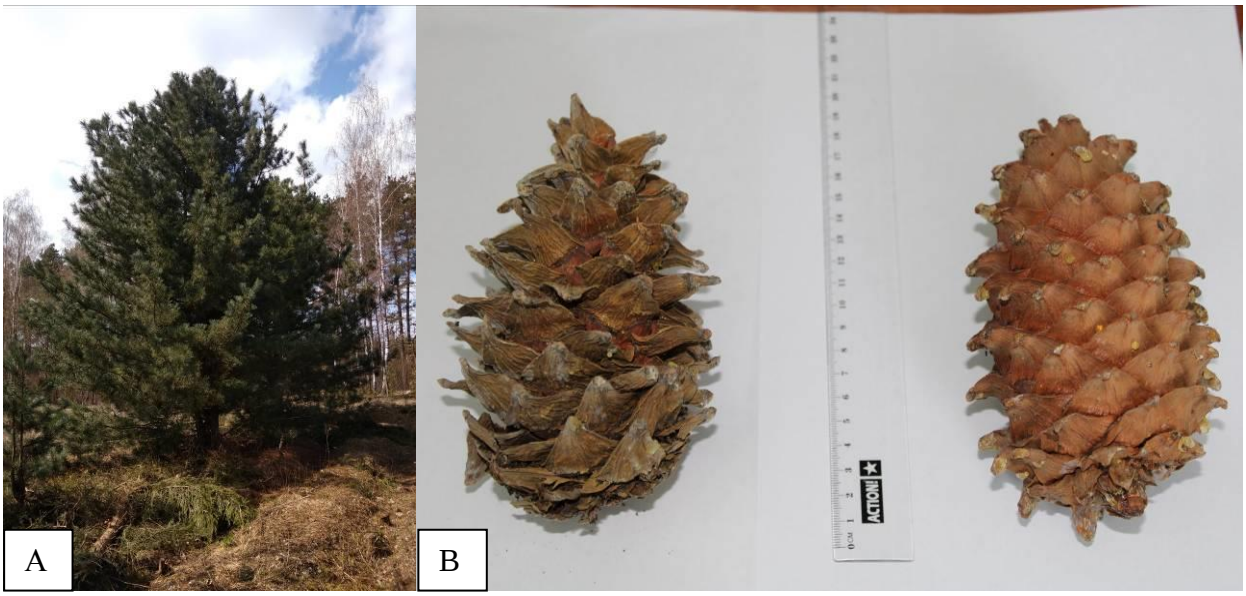


Figure 3.31. Korean cedar pine (A), growing on territory of the permanent forest nursery of SFI "Volkovysk Forestry" and forest seed materials harvested from this tree (B)

8. Siberian cedar pine (*Pinus sibirica* Du Tour) – seed orchards of Pinus sibirica planted in 1989 in SFI "Glubokoye Experimental Forestry" on the area of 2.8 ha was examined. Planting was carried using ungrafted seedlings grown in the forest nursery from seeds brought from central Siberia. Distance in row is 5 m, distance between rows is 8 m, initial density is 235 pcs. / ha. Treatments between rows were performed on a regular basis by mowing unwanted herbaceous and woody shrubs, and by soil cultivation. In 2013 the formation of crowns of the cultivated trees was carried out.

Currently, 128 trees of Siberian stone pine and three Korean pine trees grow in the plantation. Plants preservation is 19.8%. The mean values of the measurements are as follows: height – 4.46 m; trunk diameter at the root collar – 19.4 cm; trunk diameter at

1.3 m – 13.1 cm; length of the live crown – 3.88 m; diameter of the crown projection – 3.02 m. Average number of tips in cultivated trees was 3.16, the presence of the first year cones was observed in 3.8% of the trees, the second year cones – in 20.6%.

9. Stand of Weymouth pine (*Pinus strobus* L.) (Indura forest district, Grodno forestry). Growing in quarter 135, section 20. Composition is 10Wp. The stand is 115 years old. Type of forest is bracken pine wood, type of growing conditions – C_2, bonitet IA, density 0.7. The sanitary condition of the stand is healthy with signs of weakening. Stand coordinates: latitude – 53°30'46.7"; longitude – 23°52'10.0". The average diameter of the stand is 50.4 cm, the average height is 29.4 m. The average length of the crown is 13.7 m, the average width of the crown is 6.3 m. The natural reforestation is represented by single specimens, heavily damaged by ungulates.

3.4 *Ex situ* collection of tree plant forms and types resistant to climatic stress, rare and economically valuable tree species

The work on identification, selection and breeding of forest tree plant forms resistant to climatic stress, rare and economically valuable tree species carried out in the territory of the National Forest Selection-Seed Production Center, Korenevskaya and Dvinskaya experimental forest stations of the Institute of Forest of the National Academy of Sciences resulted in the creation of *ex situ* collection with the total area of 3.05 ha. 1214 seedlings and saplings of more than 35 coniferous and deciduous wood species and their varieties were planted. Arrangement of planting spots is 5 × 5 m. The collection is represented by:

– climatic stress resistant origin of Scots pine and European spruce, selected as part of provenance trials and promising introduced species (*Tilia caucasica* and *Tilia dasystyla*);

– clones of Scots pine with high resin productivity;

– forms of European ash resistant to phytopathogens, Scots pine genotypes resistant to infectious lodging;

– rare species listed in the Red Book of the Republic of Belarus (Silver fir, Dwarf birch);

– eight natural monuments of national and local significance (English oak, Silver fir, Siberian larch);

– fast-growing and high production clones and forms of Scots pine, Norway spruce, European larch, Douglas-fir, English oak, European beech, Small-leaved linden, Norway maple, Silver birch (including Black-barked birch and Silver birch ‘dalecarlica’), poplars (including Aspen, Simon poplar, White poplar, Petrowskiana poplar, Black poplar, Canadian poplar);

– clones of lyre-shaped, bush and standard forms of Karelian birch, as well as clones with highly patterned timber;

– seed progeny of coniferous introduced trees (Weymouth pine, Siberian cedar pine and Korean cedar pine, Japanese white pine, Korean fir, Nordmann fir);

– food species (Walnut, Manchurian walnut, Butternut, Heart-shaped walnut, Black mulberry);

– 14 varieties of decorative forms of Scots pine, Silver maple, etc.

The created *ex situ* collection is aimed at the preservation of biological and genetic diversity of tree species, increasing the productivity and biological sustainability of forests being created.

3.4.1 National Forest Selection-Seed Production Center

In 2019, land plot with area 1 ha for planting of *ex situ* collection was selected and prepared in the territory of the National Forest Selection-Seed Production Center (Figure 3.32). The soil of the plot is sod-podzolic, weakly podzolized arable, temporarily excessively moisturized, loamy, on light loam, underlain by clay loam, average moraine with the depth of 32 cm. Arable horizon is gray loam, light clay loam, fresh, with large lamellar structure, loose, rare roots, sharp wavy transition border.

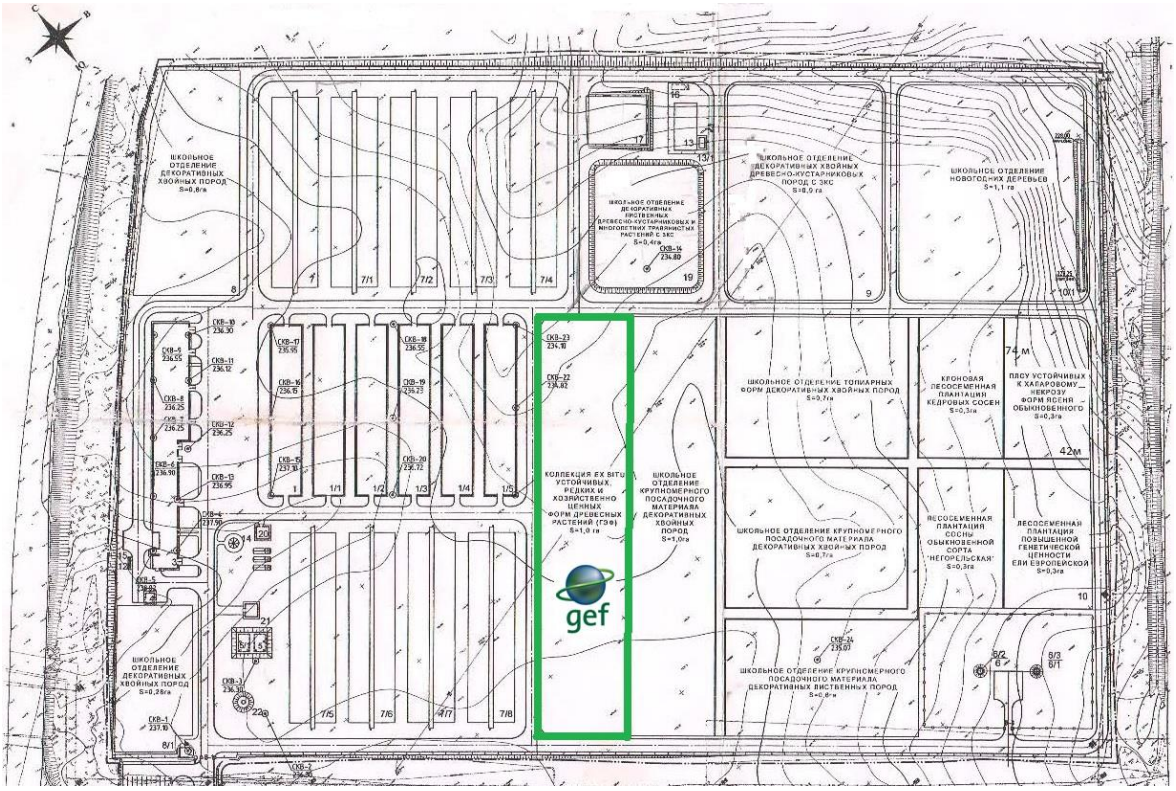


Figure 3.32. Area to locate *ex situ* collection in the territory of the National Forest Selection-Seed Production Center

Agrochemical analysis showed that the mean value of the land plot acidity is 5.18 and remains within the best acidity value during the growth of most tree species. Average humus content is 2.02%, indicating a sufficient content of organic matter in soil (average by content degree according to V.S. Pobedov's classification). The average content of exchangeable potassium is 13.28 mg/100 g of soil (minimum value is 11.8 mg/100 g soil, maximum – 15.2 mg/100 g soil), which corresponds to the minor dynamics of exchangeable potassium in soil. Content of soil samples is established at the level from medium (III) to increased (IV). The average content of mobile phosphor is 8.98 mg/100 g of soil (minimum value is 7.3 mg/100 g soil, maximum – 11.5 mg/100 g soil), which corresponds to the minor dynamics of mobile phosphor in soil. The degree of soil content is established as medium (III). The ground water level is at the depth of 2 m.

In general, the soil, where *ex situ* collection is laid, is described as semihydromorphic gleyed from the bottom and temporarily excessively moisturized, which will be favorable for the growth of trees. The humus content in the upper layer of soil in the area is more than 2%, which is above the minimum acceptable value for laying forest-seed plantations. By

content of mobile phosphor forms and exchangeable potassium forms have also the parameter exceeding the lower limit, pH is within the best range.

Arrangement of planting spots is 5 × 5 m. The seedlings and saplings were planted in October-November 2019 (Figure 3.33). Table 3.10 shows a scheme of *ex situ* collection in the territory of the National Forest Selection-Seed Production Center.

Figure 3.33. Laying of *ex situ* collection of tree forms resistant to climatic stress, rare and economically valuable tree species in the territory of the National Forest Selection-Seed Production Center

Table 3.10 – Scheme of *ex situ* collection of tree forms resistant to climatic stress, rare and economically valuable tree species in the territory of the National Forest Selection-Seed Production Center

Row No.	Plant No.									
1	1	2	3	4	5	6	7	8	9	10
2	11	12	13	14	15	16	17	18	19	20
3	21	22	23	24	25	26	27	28	29	30
4	31	32	33	34	35	36	37	38	39	40
5	41	42	43	44	45	46	47	48	49	50
6	51	52	53	54	55	56	57	58	59	60
7	61	62	63	64	65	66	67	68	69	70
8	71	72	73	74	75	76	77	78	79	80
9	81	82	83	84	85	86	87	88	89	90
10	91	92	93	94	95	96	97	98	99	100
11	101	102	103	104	105	106	107	108	109	110
12	111	112	113	114	115	116	117	118	119	120
13	121	122	123	124	125	126	127	128	129	130
14	131	132	133	134	135	136	137	138	139	140
15	141	142	143	144	145	146	147	148	149	150
16	151	152	153	154	155	156	157	158	159	160
17	161	162	163	164	165	166	167	168	169	170
18	171	172	173	174	175	176	177	178	179	180
19	181	182	183	184	185	186	187	188	189	190
20	191	192	193	194	195	196	197	198	199	200
21	201	202	203	204	205	206	207	208	209	210
22	211	212	213	214	215	216	217	218	219	220
23	221	222	223	224	225	226	227	228	229	230
24	231	232	233	234	235	236	237	238	239	240
25	241	242	243	244	245	246	247	248	249	250
26	251	252	253	254	255	256	257	258	259	260
27	261	262	263	264	265	266	267	268	269	270
28	271	272	273	274	275	276	277	278	279	280
29	281	282	283	284	285	286	287	288	289	290
30	291	292	293	294	295	296	297	298	299	300
31	301	302	303	304	305	306	307	308	309	310
32	311	312	313	314	315	316	317	318	319	320
33	321	322	323	324	325	326	327	328	329	330
34	331	332	333	334	335	336	337	338	339	340
35	341	342	343	344	345	346	347	348	349	350
36	351	352	353	354	355	356	357	358	359	360
37	361	362	363	364	365	366	367	368	369	370
38	371	372	373	374	375	376	377	378	379	380
39	381	382	383	384	385	386	387	388	389	390
40	391	392	393	394	395	396	397	398	399	400
41	401	402	403	404	405	406	407	408	409	410
42	411	412	413	414	415	416	417	418	419	420
43	421	422	423	424	425	426	427	428	429	430

Explication:

The row 1-2 – plants No. 1-20 (reserve area);

The row 3 – Scots pine (*Pinus silvestris* L.), ornamental varieties: "Sprawling" – plants No. 21-22; "Minchanka" – plants No. 23-24; "Изумруд" – plants No. 25-26; "Uzdenskaya" – plants No. 27-28; "Imeni Chelyuskintsev" – plants No. 29-30;

The row 4 – Scots pine (*Pinus silvestris* L.), ornamental varieties: "Sprawling" – plant No. 31; "Ascending" – plants No. 32-34; "Pyramidальная" – plants No. 35-37; "Elegant" – plants No. 38-40;

The row 5 – Scots pine (*Pinus silvestris* L.), ornamental varieties: "Forest Beauty" – plants No. 41-45; "Bonsai" – plants No. 46-48; "Slutskaya" – plants No. 49-50;

The row 6 – Scots pine (*Pinus silvestris* L.), ornamental varieties: "Yellowish" – plants No. 51-54; "Tolstushka" – plants No. 55-60;

The row 7 – Scots pine (*Pinus silvestris* L.), ornamental varieties: "Chizhovskaya" – plants No. 61-63; "3-18" – plants No. 64-70;

The row 8 – Korean cedar pine (*Pinus koraiensis* Sieb. et Zucc.) of generative origin, a seed harvesting place: the permanent forest nursery of SFI "Volkovysk Forestry" – plants No. 71-74; Bykhov – plants No. 75-76; the Central Botanical Garden of the National Academy of Sciences of Belarus – plants No. 77-80;

The row 9 – Siberian cedar pine (*Pinus sibirica* Du Tour) of vegetative origin, a graft harvesting place: SFI "Lyakhovichi Forestry" – plant No. 81; SEFI "Glubokoe Experimental Forestry" – plants No. 82-86; the Central Botanical Garden of the National Academy of Sciences of Belarus – plants No. 87-90.

The row 10 – Silver fir (*Abies alba* Mill.) of generative origin, a seed harvesting place: National Park "Belovezhskaya Pushcha" – plants No. 91-95; SFI "Volkovysk Forestry" – plants No. 96-100;

The row 11 – European larch (*Larix decidua* Mill.) of generative origin, a seed harvesting place: the plus genotypes of the Republic of Poland (*Larix polonica* Racib.) – plants No. 101-102; the forest nursery of SFI "Schuchin Forestry" – plants No. 103-110;

The row 12 – Siberian larch (*Larix sibirica* Ledeb.) of generative origin, a seed harvesting place: the plus stand of the Indura forest district of SFI "Grodno Forestry" – plants No. 111-120;

The row 13 – Norway spruce (*Picea abies* (L.) Karst.) of vegetative origin: climatypes from the provenance trials of SFI "Cherikov Forestry" (82/20 Rivne) – plants No. 121, 124; (82/9 Ivano-Frankivsk) – plant No. 122; (22/9) – plant No. 123; (82/2 Rivne) – plant No. 125; (62/88) – plant No. 126; (82/19 Zakarpattia) – plant No. 127; (11 Chernihiv) – plants No. 128, 129; (82/16 Zakarpattia) – plant No. 130;

The row 14 – Norway spruce (*Picea abies* (L.) Karst.) of vegetative origin: climatypes from the provenance trials of SFI "Cherikov Forestry" (82/19 Zakarpattia) – plants No. 131, 139; (82/9 Ivano-Frankivsk) – plants No. 132, 140; (11 Chernihiv) – plants No. 133, 134; (82/16 Zakarpattia) – plants No. 135, 136; (82/16 Zakarpattia) – plant No. 136; (82/2 Rivne) – plant No. 137; (82/20 Rivne) – plant No. 138;

The row 15 – Norway spruce (*Picea abies* (L.) Karst.) of vegetative origin: a breeding clones of candidates to elite (65/147) – plant No. 141; (5/476) – plant No. 142; (22/43) – plant No. 143; (21/138) – plant No. 144; (5/485) – plant No. 145; (65/146) – plant No. 146; (61/501) – plant No. 147; (21/141-1) – plant No. 148; (3/16) – plant No. 149; (81/227) – plant No. 150;

The row 16 – Norway spruce (*Picea abies* (L.) Karst.) of vegetative origin: a breeding clones of candidates to elite (21/142) – plant No. 151; (52/8) – plant No. 152; (22/44) –

plant No. 153; (81/234) – plant No. 154; (46/213) – plant No. 155; (29/200) – plant No. 156; (81/225) – plant No. 157; (3/17) – plant No. 158; (3/14) – plant No. 159; (15/257) – plant No. 160;

The row 17 – Scots pine (*Pinus silvestris* L.) of vegetative origin: climatypes from the provenance trials of SFI "Dvinskaya Experimental Forest Base of the Institute of Forest of the NAS of Belarus" (23/7 Voronezh) – plants No. 161, 169; (14/17 East Kazakhstan) – plant No. 162; (28/15 Chuvash) – plants No. 163, 168; (42/14 Komi) – plant No. 164; (39/11 Tselinograd) – plant No. 165; (38/10 Lipetsk) – plant No. 166; (к/4 Vitebsk) – plant No. 167; (42/13 Komi) – plant No. 170;

The row 18 – Scots pine (*Pinus silvestris* L.) of vegetative origin: climatypes from the provenance trials of SFI "Dvinskaya Experimental Forest Base of the Institute of Forest of the NAS of Belarus" (38/10 Lipetsk) – plant No. 171; (15/19 Chita) – plants No. 172, 176; (42/13 Komi) – plant No. 173; (21/3 Bryansk) – plants No. 174, 178; (14/17 East Kazakhstan) – plant No. 175; (42/14 Komi) – plant No. 177; (39/11 Tselinograd) – plant No. 179; (к/4 Vitebsk) – plant No. 180;

The row 19 – Scots pine (*Pinus silvestris* L.) of vegetative origin: the highly resin productive clones (34) – plants No. 181, 187; (18) – plant No. 182; (40) – plants No. 183, 190; (35) – plants No. 184, 189; (44) – plants No. 185, 188; (3) – plant No. 186;

The row 20 – Scots pine (*Pinus silvestris* L.) of vegetative origin: the highly resin productive clones (40) – plants No. 191, 197; (35) – plants No. 192, 196; (3) – plants No. 193, 198; (34) – plant No. 194; (18) – plants No. 195, 199; (44) – plant No. 200;

The row 21 – Scots pine (*Pinus silvestris* L.) of vegetative origin: a breeding clones of plus trees National Park "Belovezhskaya Pushcha" (262) – plant No. 201; (187) – plant No. 202; (301) – plant No. 203; (298) – plant No. 204; (176) – plant No. 205; (209) – plant No. 206; (168) – plant No. 207; (152) – plant No. 208; (195) – plant No. 209; (206) – plant No. 210;

The row 22 – Douglas fir (*Pseudotsuga menziesii* (Mirbel) Franco.), of vegetative origin, a graft harvesting place: the Pryluksky nature reserve, the clones of plus tree "1" – plants No. 211-214; the clones of plus tree "2" – plants No. 215-218; the clones of plus tree "3" – plants No. 219-220;

The row 23 – Douglas fir (*Pseudotsuga menziesii* (Mirbel) Franco.), of vegetative origin, a graft harvesting place: the Pryluksky nature reserve, the clones of plus tree "5" – plants No. 221-224; the clones of plus tree "4" – plants No. 225-228; the clones of plus tree "3" – plants No. 229-230;

The row 24 – Weymouth pine (*Pinus strobes* L.) of generative origin, a seed harvesting place: the Indura forest district of SFI "Grodno Forestry" (compart. 135, subcompart. 20) – plants No. 231-233; Five-needle pine (*Pinus parviflora*) of generative origin, a seed harvesting place: the Republic of Poland – plants No. 234-236; Korean fir (*Abies koreana*) of vegetative origin – plants No. 237-238; Nordman fir (*Abies nordmanniana*) of generative origin, a seed harvesting place: the Central Botanical Garden of the National Academy of Sciences of Belarus – plants No. 239-240;

The row 25 – English oak (*Quercus robur* L.) of generative origin, a seed harvesting place: selection seed of National Park "Belovezhskaya Pushcha" (1001) – plants No. 241-242; (BP36) – plant No. 243; (4078) – plant No. 244; Oak-Patriarch Pozhezhinsky (Pozhezhyno forestry district, SFI "Malorita Forestry") – plant No. 245; (4077) – plant No. 246; (1035) – plants No. 247-248, 250; (1004) – plant No. 249;

The row 26 – English oak (*Quercus robur* L.) of generative origin, a seed harvesting place: Tsar-Oak from the National Park "Belovezhskaya Pushcha" – plants No. 251-255; arboretum of SEFI "Glubokoe Experimental Forestry" – plants No. 256-260;

The row 27 – English oak (*Quercus robur* L.) of generative origin, a seed harvesting place: Oak-Gigant (Khomichi forestry district, SFI "Bykhov Forestry") – plants No. 261-265; Oak Volat (Krugovichi forestry district, SFI "Gantsevichi Forestry") – plants No. 266-270;

The row 28 – English oak (*Quercus robur* L.) of generative origin, a seed harvesting place: Tsar-Oak Tadulinsky (Volosovichi forestry district, SFI "Lepel Forestry") – plants No. 271-275; Korenevka forestry district, SFI "Korenevskaya Experimental Forest Base of the Institute of Forest of the NAS of Belarus" – plants No. 276-280;

The row 29 – Planting material obtained by the method of microclonal propagation: the clone of plus genotype of Fluffy birch (*Betula pubescens* Ehrh.) (fb3f1) – plants No. 281-283; the clone of Dwarf birch (*Betula nana*) (Bn2a1) – plants No. 284-286; the clone of Black birch (*Betula obscura Kotula ex Fiek*) (ch1) – plants No. 287-288; the clone of Silver birch 'dalecarlica' (*Betula pendula f. dalecarlica*) (Rl3) – plants No. 289-290;

The row 30 – Planting material obtained by the method of microclonal propagation: the clones of plus genotypes of Silver birch (*Betula pendula* Roth.) (6-167/9) – plants No. 291-293; (171) – plants No. 294-297; (52-84/8) – plants No. 298-300;

The row 31 – Planting material obtained by the method of microclonal propagation: the clones of Karelian birch (*Betula pendula var. carelica* (Merckl.) Hämet-Ahti), standard form (73) – plants No. 301-304; lyre-shaped form (An) – plants No. 305-307; bush form (3) – plants No. 308-310;

The row 32 – *Populus* L., Chinese clone P.ShHG of vegetative origin, propagation by microcuttings – plants No. 311-315; the clone of White poplar (*Populus alba* L.), micropropagation – plants No. 316-320;

The row 33 – Planting material obtained by the method of microclonal propagation: the clone of aspen (gray-bark form) (*Populus tremula* L.) (V22) – plants No. 321-324; the clone of aspen (green-bark form) (*P. tremula* L.) (215) – plants No. 325-327; the clone of aspen (green-bark form) (*P. tremula* L.) (AS2) – plants No. 328-330;

The row 34 – Planting material obtained by the method of microclonal propagation: the clone of Black Poplar (*Populus trichocarpa* Torr. et A. Gray.) – plants No. 331-333; the clone of Canadian Poplar (*Populus* × *canadensis* Moench.) – plants No. 334-336; the clone of Petrowskiana Poplar (*Populus* × *petrowskiana* R.I. Schröd. ex Regel) – plants No. 337-340;

The row 35 – American linden (*Tilia americana*) of vegetative origin, propagation by microcuttings – plants No. 341-345; Small-leaved linden (*Tilia cordata* Mill.) – plants No. 346-350;

The row 36 – Linden (*Tilia dasystyla* Steven) of vegetative origin, propagation by microcuttings – plants No. 351-355; Caucasian lime (*Tilia caucasica* Rupr.) of vegetative origin, propagation by microcuttings – plants No. 356-360;

The row 37 – Common ash (*Fraxinus excelsior* L.) of vegetative origin, a graft harvesting place: SEFI "Osipovichi Experimental Forestry" – plants No. 361-365; of generative origin (V) – plants No. 366-367; (E) – plants No. 368-369; (D) – plant No. 370;

The row 38 – Common ash (*Fraxinus excelsior* L.) of generative origin: (A) – plants No. 371-372; (B) – plants No. 373-374; (G) – plants No. 375-37; (1818-030318/27-78) – plant No. 377; (Ya2-Uzda) – plants No. 378-379; (D) – plant No. 380;

The row 39 – European beech (*Fagus sylvatica* L.) of generative origin, a seed harvesting place: the Ross forest district of SFI "Volkovysk Forestry" (compart. 150 / subcompart. 9; compart. 151 / subcompart. 8) – plants No. 381-390;

The row 40 – European beech (*Fagus sylvatica* L.) of generative origin, a seed harvesting place: the Indura forest district of SFI "Grodno Forestry" (compart. 158 /

subcompart. 4) – plants No. 391-396; the Ross forest district of SFI "Volkovysk Forestry" (compart. 150 / subcompart. 9; compart. 151 / subcompart. 8) – plants No. 397-400;

The row 41 – Silver maple (*Acer saccharinum* L.) of vegetative origin, propagation by microcuttings – plants No. 411-415; Norway maple (*Acer platanoides* L.) – plants No. 416-420;

The row 42 – Manchurian walnut (*Juglans mandshurica* Maxim.) of generative origin, a seed harvesting place: arboretum of SEFI "Glubokoe Experimental Forestry" – plant No. 411; Butternut (*Juglans cinerea* L.) of generative origin, a seed harvesting place: arboretum of Negorelsky Training and Experimental Forestry – plant No. 412; Walnut (*Juglans regia* L.) of generative origin, a seed harvesting place: SFI " Dyatlovo Forestry" – plants No. 413-414; Heartnut (*Juglans cordiformis* Maxim.) of generative origin, a seed harvesting place: arboretum of Negorelsky Training and Experimental Forestry – plants No. 415-416; Black mulberry (*Morus nigro* L.) of generative origin, a seed harvesting place: SFI «Lyakhovichi Forestry» – plant No. 417-420.

The row 43 – plants No. 421-430 (reserve area).

3.4.2 Korenevskaya Experimental Forest Station of the Institute of Forest of the NAS of Belarus

A land plot for arrangement of *ex situ* collection with the area of 0.85 ha was selected and prepared in the territory of Korenevskaya Experimental Forest Station of the Institute of Forest of the NAS of Belarus (KEFS) in forest nurseries of Korenevka forestry district. Arrangement of planting spots is 5 × 5 m. The seedlings and saplings were planted in October-November 2019 (Figure 3.34). Table 3.11 shows a scheme of *ex situ* collection plantation in the territory of the KEFS.

Explication:

The row 1 – Scots pine (*Pinus silvestris* L.), ornamental varieties: "Imeni Chelyuskintsev" – plant No. 1; "Forest Beauty" – plants No. 2-6; "Tolstushka" – plants No. 7-12;

The row 2 – Scots pine (*Pinus silvestris* L.), ornamental varieties: "Chizhovskaya" – plants No. 13-20; "Yellowish" – plants No. 21-24;

The row 3 – Scots pine (*Pinus silvestris* L.), ornamental varieties: "Pyramid" – plant No. 25; "Emerald" – plants No. 26-27; "Imeni Chelyuskintsev" – plant No. 28; "Uzdenskaya" – plants No. 29-30; "Ascending" – plants No. 31-33; "Bonsai" – plants No. 34-36;

The row 4 – Scots pine (*Pinus silvestris* L.), ornamental varieties: "Pyramid" – plants No. 37-38; "Minchanka" – plants No. 39-40; "Sprawling" – plants No. 41-43; "Elegant" – plants No. 44-46; "Slutskaya" – plants No. 47-48;

The row 5 – Siberian cedar pine (*Pinus sibirica* Du Tour) of vegetative origin, a graft harvesting place: the Central Botanical Garden of the National Academy of Sciences of Belarus; SEFI "Glubokoe Experimental Forestry" – plants No. 49-54; Korean cedar pine (*Pinus koraiensis* Sieb. Et Zucc.), of generative origin, a seed harvesting place: the permanent forest nursery of SFI "Volkovysk Forestry" – plants No. 55-58; the Central Botanical Garden of the National Academy of Sciences of Belarus – plants No. 59-60;

The row 6 – Silver fir (*Abies alba* Mill.) of generative origin, a seed harvesting place: SFI "Volkovysk Forestry" – plants No. 61-66; National Park "Belovezhskaya Pushcha" – plants No. 67-72;

Figure 3.34. Laying of *ex situ* collection of tree forms resistant to climatic stress, rare and economically valuable tree species in Korenevskaya Experimental Forest Station of the Institute of Forest of the NAS of Belarus

Table 3.11 – Scheme of *ex situ* collection of tree forms resistant to climatic stress, rare and economically valuable tree species in Korenevskaya Experimental Forest Station of the Institute of Forest of the NAS of Belarus

Row No.	Plant No.											
31	361	362	363	364	365	366	367	368	369	370	371	372
30	349	350	351	352	353	354	355	356	357	358	359	360
29	337	338	339	340	341	342	343	344	345	346	347	348
28	325	326	327	328	329	330	331	332	333	334	335	336
27	313	314	315	316	317	318	319	320	321	322	323	324
26	301	302	303	304	305	306	307	308	309	310	311	312
25	289	290	291	292	293	294	295	296	297	298	299	300
24	277	278	279	280	281	282	283	284	285	286	287	288
23	265	266	267	268	269	270	271	272	273	274	275	276
22	253	254	255	256	257	258	259	260	261	262	263	264
21	241	242	243	244	245	246	247	248	249	250	251	252
20	229	230	231	232	233	234	235	236	237	238	239	240
19	217	218	219	220	221	222	223	224	225	226	227	228
18	205	206	207	208	209	210	211	212	213	214	215	216
17	193	194	195	196	197	198	199	200	201	202	203	204
16	181	182	183	184	185	186	187	188	189	190	191	192
15	169	170	171	172	173	174	175	176	177	178	179	180
14	157	158	159	160	161	162	163	164	165	166	167	168
13	145	146	147	148	149	150	151	152	153	154	155	156
12	133	134	135	136	137	138	139	140	141	142	143	144
11	121	122	123	124	125	126	127	128	129	130	131	132
10	109	110	111	112	113	114	115	116	117	118	119	120
9	97	98	99	100	101	102	103	104	105	106	107	108
8	85	86	87	88	89	90	91	92	93	94	95	96
7	73	74	75	76	77	78	79	80	81	82	83	84
6	61	62	63	64	65	66	67	68	69	70	71	72
5	49	50	51	52	53	54	55	56	57	58	59	60
4	37	38	39	40	41	42	43	44	45	46	47	48
3	25	26	27	28	29	30	31	32	33	34	35	36
2	13	14	15	16	17	18	19	20	21	22	23	24
1	1	2	3	4	5	6	7	8	9	10	11	12

The row 7 – Norway spruce (*Picea abies* (L.) Karst.) of vegetative origin: a breeding clones of candidates to elite: (21/142) – plant No. 73; (65/146) – plant No. 74; (5/483) – plant No. 75; (62/8) – plant No. 76; (61/504) – plant No. 77; (46/213) – plant No. 78; (3/16) – plant No. 79; climatypes from the provenance trials of SFI "Cherikov Forestry" (82/2 Rivne) – plants No. 80-82; (82/20 Rivne) – plant No. 83; (82/16 Zakarpattia) – plant No. 84;

The row 8 – European larch (*Larix decidua* Mill.) of generative origin, a seed harvesting place: the plus genotypes of the Republic of Poland (*Larix polonica* Racib.) – plant No. 85; the forest nursery of SFI "Schuchin Forestry" – plants 86-96;

The row 9 – European larch (*Larix decidua* Mill.) of generative origin, a seed harvesting place: the forest nursery of SFI "Schuchin Forestry" – plants No. 97-98; Siberian larch (*Larix sibirica* Ledeb.) of generative origin, a seed harvesting place: the plus stand of the Indura Forest district of SFI "Grodno Forestry" – plants No. 99-102; Douglas fir

(*Pseudotsuga menziesii* (Mirbel) Franco.), of vegetative origin, a graft harvesting place: the Pryluksky nature reserve, the clones of plus tree "1" – plants No. 103-108;

The row 10 – Douglas fir (*Pseudotsuga menziesii* (Mirbel) Franco.), of vegetative origin, a graft harvesting place: the Pryluksky nature reserve, the clones of plus tree "2" – plants No. 109-114; the clones of plus tree "3" – plants No. 115-120;

The row 11 – Douglas fir (*Pseudotsuga menziesii* (Mirbel) Franco.), of vegetative origin, a graft harvesting place: the Pryluksky nature reserve, the clones of plus tree "4" plants No. 121-126; the clones of plus tree "5" – plants No. 127-132;

The row 12 – Scots pine (*Pinus silvestris* L.) of vegetative origin: climatypes from the provenance trials of SFI "Dvinskaya Experimental Forest Base of the Institute of Forest of the NAS of Belarus" (14/17 East Kazakhstan) – plants No. 133-134; (15/19 Chita) – plants No. 135-136; (21/3 Bryansk) – plants No. 137-138; (23/7 Voronezh) – plants No.139-140; (28/15 Chuvash) – plants No. 141-142; (38/10 Lipetsk) – plants No.143-144;

The row 13 – Scots pine (*Pinus silvestris* L.) of vegetative origin: climatypes from the provenance trials of SFI "Dvinskaya Experimental Forest Base of the Institute of Forest of the NAS of Belarus" (39/11 Tselinograd) – plants No. 145-146; (42/13 Komi) – plants No. 147-148; (42/14 Komi) – plants No. 149-150; (k/4 Vitebsk) – plants No. 151-152; a breeding clones of plus trees National Park "Belovezhskaya Pushcha" (152) – plants No. 153-154; (168) – plants No. 155-156;

The row 14 – Scots pine (*Pinus silvestris* L.) of vegetative origin: the highly resin productive clones (3) – plant No. 157; (18) – plant No. 158; (34) – plant No. 159; (35) – plant No. 160; (40) – plant No. 161; (44) – plant No. 162; a breeding clones of plus trees National Park "Belovezhskaya Pushcha" (195) – plant No. 163; (206) – plants No. 164-165; (209) – plant No. 166; (262) – plant No. 167; (268) – plant No. 161; (44) – plant No. 168;

The row 15 – Black mulberry (*Morus nigro* L.) of generative origin, a seed harvesting place SFI "Lyakhovichi Forestry" – plants No. 169-174; Heartnut (*Juglans cordiformis* Maxim.) of generative origin, a seed harvesting place: the arboretum of Negorelsky Training and Experimental Forestry – plants No. 175-178; Walnut (*Juglans regia* L.) of generative origin, a seed harvesting place: SFI " Dyatlovo Forestry" – plants No. 179-180;

The row 16 – Common ash (*Fraxinus excelsior* L.) of vegetative origin, a graft harvesting place: SEFI "Osipovichi Experimental Forestry" – plants No. 181-192;

The row 17 – European beech (*Fagus sylvatica* L.) of generative origin, a seed harvesting place: the Ross forest district of SFI "Volkovysk Forestry" (compart. 150 / subcompart. 9; compart. 151 / subcompart. 8) – plants No.193-204;

The row 18 – English oak (*Quercus robur* L.) of generative origin, a seed harvesting place: Oak-Patriarch Pozhezhinsky (Pozhezhyno forestry district, SFI "Malorita Forestry") – plant No. 205; selection seed of National Park "Belovezhskaya Pushcha" (36) – plant No. 206; (1001) – plants No. 207-210; (1004) – plants No. 211-213; (1035) – plants No. 214-216;

The row 19 – English oak (*Quercus robur* L.) of generative origin, a seed harvesting place: Oak Volat (Krugovichi forestry district, SFI "Gantsevichi Forestry") – plants No. 217-220; Tsar-Oak Tadulinsky (Volosovichi forestry district, SFI "Lepel Forestry") – plants No. 221-224; Oak-Gigant (Khomichi forestry district, SFI "Bykhov Forestry") – plants No. 225-228;

The row 20 – English oak (*Quercus robur* L.) of generative origin, a seed harvesting place: Oak Volat (Krugovichi forestry district, SFI "Gantsevichi Forestry") – plants No. 229-232; Tsar-Oak Tadulinsky (Volosovichi forestry district, SFI "Lepel Forestry") – plants

No. 233-236; Oak-Gigant (Khomichi forestry district, SFI "Bykhov Forestry") – plants No. 237-240;

The row 21 – English oak (*Quercus robur* L.) of generative origin, a seed harvesting place: Korenevka forestry district, SFI "Korenevskaya Experimental Forest Base of the Institute of Forest of the NAS of Belarus" – plants No. 241-246; arboretum of SEFI "Glubokoe Experimental Forestry" – plants No. 247-252;

The row 22 – Linden (*Tilia dasystyla* Steven.) of vegetative origin, propagation by microcuttings – plants No. 253-258; Caucasian lime (*Tilia caucasica* Rupr.) of vegetative origin, propagation by microcuttings – plants No. 259-264;

The row 23 – American linden (*Tilia americana* L.) of vegetative origin, propagation by microcuttings – plants No. 265-269; Caucasian lime (*Tilia caucasica* Rupr.) of vegetative origin, propagation by microcuttings – plants No. 270-276;

The row 24 – Silver maple (*Acer saccharinum* L.) of vegetative origin, propagation by microcuttings – plants No. 277-288;

The row 25 – Planting material obtained by the method of microclonal propagation: the clones of plus genotypes of Silver birch (*Betula pendula* Roth.) (6-167/3) – plants No. 289-291; (52-84/8) – plants No. 292-294; (171b) – plants No. 295-297; (6-167/9) – plants No. 298-300;

The row 26 – Planting material obtained by the method of microclonal propagation: the clone of Black birch (*Betula obscura* Kotula ex Fiek) (ch1) – plants No. 301-306; the clone of Silver birch 'dalecarlica' (*Betula pendula f. dalecarlica*) (Rl3) – plants No. 307-312;

The row 27 – Planting material obtained by the method of microclonal propagation: the clones of Karelian birch (*Betula pendula var. carelica* (Merckl.) Hämet-Ahti), lyre-shaped form (An) – plants No. 313-316; bush form (3) – plants No. 317-320; standard form (73) – plants No. 321-324;

The row 28 – Planting material obtained by the method of microclonal propagation: the clone of Dwarf birch (*Betula nana* L.) (Bn2a1) – plants No. 325-330; the clone of plus genotype of Fluffy birch (*Betula pubescens* Ehrh.) (fb3f1) – plants No. 331-336;

The row 29 – Planting material obtained by the method of microclonal propagation: the clone of aspen (green-bark form) (*Populus tremula* L.) (AS 2) – plants No. 337-339; the clone of aspen (gray-bark form) (*P. tremula* L.) (V22) – plants No. 340-342; the clone of aspen (green-bark form) (*P. tremula* L.) (215) – plants No. 343-344; the clone of aspen (gray-bark form) (*P. tremula* L.) (117-3) – plants No. 345-346; the clone of aspen (gray-bark form) (*P. tremula* L.) (2301) – plants No. 347-348;

The row 30 – *Populus* L., Chinese clone P.ShHG of vegetative origin, propagation by microcuttings: (1) – plants No. 349-402; (2) – plants No. 403-406; the clone of White poplar (*Populus alba* L.), micropropagation – plants No. 407-410;

The row 31 – Planting material obtained by the method of microclonal propagation: the clone of Black Poplar (*Populus trichocarpa* Torr. et A. Gray.) (31) – plants No. 411-416; the clone of Petrowskiana Poplar (*Populus ×petrowskiana* R.I. Schröd. ex Regel) (Petr-49) – plants No. 417-422.

3.4.3 Dvinskaya Experimental Forest Station of the Institute of Forest of the NAS of Belarus

A land plot for arrangement of *ex situ* collection with the area of 1.2 ha was selected and prepared in the territory of the Dvinskaya Experimental Forest Station of the Institute

of Forest of the NAS of Belarus (DEFS) (Psuya forestry district, compart. 2, subcompart. 31). Arrangement of planting spots is 5 × 5 m. The seedlings and saplings were planted in October-November 2019 (Figure 3.35). Table 3.10 shows a scheme of *ex situ* collection plantation in the territory of the DEFS.

Figure 3.35. Laying of *ex situ* collection of tree forms resistant to climatic stress, rare and economically valuable tree species in Dvinskaya Experimental Forest Station of the Institute of Forest of the NAS of Belarus

Table 3.12 – Scheme of *ex situ* collection of tree forms resistant to climatic stress, rare and economically valuable tree species in Dvinskaya Experimental Forest Station of the Institute of Forest of the NAS of Belarus

Row No.	Plant No.																									
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
2	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
3	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
4	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
5	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130
6	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156
7	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182
8	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208
9	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234
10	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
11	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286
12	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312
13	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338
14	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364
15	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390
16	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416
17	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442

Explication:

The row 1 – Planting material obtained by the method of microclonal propagation: the clones of plus genotypes of Silver birch (*Betula pendula* Roth.) – (171b) – plants No. 1-5; (6-167/9) – plants No. 6-10; (52-84/8) – plants No. 11-18; (6-167/3) – plants No. 19-26;

The row 2 – Planting material obtained by the method of microclonal propagation: the clone of Black birch (*Betula obscura Kotula ex Fiek*) (ch1) – plants No. 27-31; the clone of Silver birch 'dalecarlica' (*Betula pendula f. dalecarlica*) (Rl3) – plants No. 32-36; the clone of plus genotype of Fluffy birch (*Betula pubescens* Ehrh.) (fb3f1) – plants No. 37-44; the clones of Karelian birch with high-shredded wood (*Betula pendula var. carelica* (Merckl.) Hämet-Ahti) (S08419) – plants No. 45-52;

The row 3 – Planting material obtained by the method of microclonal propagation: the clones of Karelian birch (*Betula pendula var. carelica* (Merckl.) Hämet-Ahti), bush form (3) – plants No. 53-58; standard form (73) – plants No. 59-64; the clone of Dwarf birch (*Betula nana* L.) (Bn2a1) – plants No. 65-70; the clone of Karelian birch (*Betula pendula var. carelica* (Merckl.) Hämet-Ahti), lyre-shaped form (An) – plants No. 71-78;

The row 4 – Planting material obtained by the method of microclonal propagation: the clone of aspen (green-bark form) (*Populus tremula* L.) (215) – plants No. 79-83; (AS 2) – plants No. 84-88; the clones of aspen (gray-bark form) (V22) – plants No. 89-93; (117-3) – plants No. 94-98; (2301) – plants No. 99-104;

The row 5 – *Populus* L., Chinese clone P.ShHG of vegetative origin, propagation by microcuttings: (1) – plants No. 105-109; (2) – plants No. 110-118; Planting material obtained by the method of microclonal propagation: the clone of Petrowskiana Poplar (*Populus ×petrowskiana* R. I. Schröd. ex Regel) (Petr-49) – plants No. 119-123; the clone of Black Poplar (*Populus trichocarpa* Torr. et A. Gray.) (31) – plants No. 124-128; the clon of White Poplar (*Populus alba* L.) – plants No. 129-130;

The row 6 – Silver maple (*Acer saccharinum* L.) of vegetative origin, propagation by microcuttings – plants No. 131-144; Common ash (*Fraxinus excelsior* L.) of vegetative origin, a graft harvesting place: SEFI «Osipovichsky Experimental Forestry» – plants No. 145-156;

The row 7 – English oak (*Quercus robur* L.) of generative origin, a seed harvesting place: Tsar-Oak from the National Park «Belovezhskaya Pushcha» – plants No. 157-165; Tsar-Oak Tadulinsky (Volosovichi forestry district, SFI «Lepel Forestry») – plants No. 166-174; arboretum of SEFI «Glubokoe Experimental Forestry» – plants No. 175-182;

The row 8 – English oak (*Quercus robur* L.) of generative origin, a seed harvesting place: Oak Volat (Krugovichi forestry district, SFI «Gantsevichi Forestry») – plants No. 183-191; Oak-Gigant (Khomichi forestry district, SFI «Bykhov Forestry») – plants No. 192-200; Korenevka forestry district, SFI "Korenevskaya Experimental Forest Base of the Institute of Forest of the NAS of Belarus" – plants No. 201-208;

The row 9 – Common ash (*Fraxinus excelsior* L.) of vegetative origin, a graft harvesting place: SEFI "Osipovichi Experimental Forestry" – plants No. 209-219; Oak-Patriarch Pozhezhinsky (Pozhezhyno forestry district, SFI "Malorita Forestry") – plant No. 220; selection seed of National Park "Belovezhskaya Pushcha" (1004) – plants No. 221-222; (1035) – plants No. 223-226; (1001) – plants No. 227-234;

The row 10 – Caucasian lime (*Tilia caucasica* Rupr.) of vegetative origin, propagation by microcuttings – plants No. 235-247; Linden (*Tilia dasystyla* Steven.) of vegetative origin, propagation by microcuttings – plants No. 248-260;

The row 11 – Caucasian lime (*Tilia caucasica* Rupr.) of vegetative origin, propagation by microcuttings – plants No. 261-273; Linden (*Tilia dasystyla* Steven.) of vegetative origin, propagation by microcuttings – plants No. 274-286;

The row 12 – Black mulberry (*Morus nigro* L.) of generative origin, a seed harvesting place: SFI "Lyakhovichi Forestry" – plants No. 287-291; European beech (*Fagus sylvatica* L.) of generative origin, a seed harvesting place: the Ross forest district of SFI "Volkovysk Forestry" (compart. 150 / subcompart. 9; compart. 151 / subcompart. 8) – plants No. 292-307; American linden (*Tilia americana* L.) of vegetative origin, propagation by microcuttings – plants No. 308-312;

The row 13 – Siberian cedar pine (*Pinus sibirica* Du Tour) of vegetative origin, a graft harvesting place: SEFI "Glubokoe Experimental Forestry" – plants No. 313-319; the Central Botanical Garden of the National Academy of Sciences of Belarus – plants No. 320-322; Scots pine (*Pinus silvestris* L.) of vegetative origin: the highly resin productive clones (3) – plant No. 323; (18) – plant No. 324; (34) – plant No. 325; (35) – plant No. 326; (40) – plant No. 327; (44) – plant No. 328; climatypes from the provenance trials of SFI "Dvinskaya Experimental Forest Base of the Institute of Forest of the NAS of Belarus" (14/17 East Kazakhstan) – plants No. 329-330; (15/19 Chita) – plants No. 331-332; (21/3 Bryansk) – plants No. 333-334; (23/7 Voronezh) – plants No. 335-336; (28/15 Chuvash) – plants No. 337-338;

The row 14 – Korean cedar pine (*Pinus koraiensis* Sieb. et Zucc.) of generative origin, a seed harvesting place: the permanent forest nursery of SFI "Volkovysk Forestry" – plants No. 339-345; the Central Botanical Garden of the National Academy of Sciences of Belarus – plants No. 346-348; Scots pine (*Pinus silvestris* L.) of vegetative origin: a breeding clones of plus trees National Park "Belovezhskaya Pushcha" (176) – plant No. 349; (178) – plant No. 350; (195) – plant No. 351; (202) – plant No. 352; (262) – plant No. 353; (301) – plant No. 354; climatypes from the provenance trials of SFI "Dvinskaya Experimental Forest Base of the Institute of Forest of the NAS of Belarus" (38/10 Lipetsk) – plants No. 355-356; (39/11 Tselinograd) – plants No. 357-358; (42/13 Komi) – plants No. 359-360; (42/14 Komi) – plants No. 361-362; (k/4 Vitebsk) – plants No. 363-364;

The row 15 – Douglas fir (*Pseudotsuga menziesii* (Mirbel) Franco.), of vegetative origin, a graft harvesting place: the Pryluksky nature reserve, the clones of plus tree "1" – plants No. 365-370; the clones of plus tree "2" – plants No. 371-376; the clones of plus tree "3" – plants No. 377-383; the clones of plus tree "4" – plants No. 384-390;

The row 16 – Silver fir (*Abies alba* Mill.) of generative origin, a seed harvesting place: SFI "Volkovysk Forestry" – plants No. 391-400; National Park "Belovezhskaya Pushcha" – plants No. 401-404; Norway spruce (*Picea abies* (L.) Karst.) of vegetative origin: climatype from the provenance trials of SFI "Dvinskaya Experimental Forest Base of the Institute of Forest of the NAS of Belarus" (11 Chernihiv) – plant No. 405; climatypes from the provenance trials of SFI "Cherikov Forestry" (82/9 Ivano-Frankivsk) – plant No. 406; (82/16 Zakarpattia) – plant No. 407; (82/19 Zakarpattia) – plant No. 408; (82/20 Rivne) – plant No. 409; Douglas fir (*P. menziesii* (Mirbel) Franco.), of vegetative origin, a graft harvesting place: the Pryluksky nature reserve, the clones of plus tree "5" – plants No. 410-416;

The row 17 – Siberian larch (*Larix sibirica* Ledeb.) of generative origin, a seed harvesting place: the plus stand of the Indura forest district of SFI "Grodno Forestry" – plants No. 417-420; European larch (*Larix decidua* Mill.) of generative origin, a seed harvesting place: the forest nursery of SFI "Schuchin Forestry" – plants No. 421-432; Norway spruce (*Picea abies* (L.) Karst.) of vegetative origin: a breeding clones of candidates to elite : (44/250) – plant No. 433; (22/541) – plant No. 434; (63/200) – plant No. 435; (86/159) – plant No. 436; (21/137) – plant No. 437; (37/223) – plant No. 438; (5/480) – plant No. 439; (61/76) – plant No. 440; (3/17) – plant No. 441; (81/231) – plant No. 442.

Conclusion

As a result of work to identify, select and propagate forms of forest tree plants that are resistant to climate stress, rare and economically valuable tree species, an *ex situ* collection was created on the basis of the National Forest Selection-Seed Production Center of the Ministry of Forestry of the Republic of Belarus. For accounting of zone distinctions of woody vegetation of Belarus, which is especially expressed from the North to the South, duplicates of the main collection was created on the territory of the state forestry institutions "Dvinskaya Experimental Forest Base of the Institute of Forest of the NAS of Belarus" and "Korenevskaya Experimental Forest Base of the Institute of Forest of the NAS of Belarus" located in the North and the South of Belarus respectively. The total area of the ex situ collection is 3.05 ha. 1214 seedlings and saplings of more than 35 coniferous and deciduous wood species and their varieties were planted.

The collection is represented by:

– climatic stress resistant origin of Scots pine and European spruce, selected as part of provenance trials and promising introduced species (*Tilia caucasica* and *Tilia dasystyla*);

– clones of Scots pine with high resin productivity;

– forms of European ash resistant to phytopathogens, Scots pine genotypes resistant to infectious lodging;

– rare species listed in the Red Book of the Republic of Belarus (Silver fir, Dwarf birch);

– eight natural monuments of national and local significance (English oak, Silver fir, Siberian larch);

– fast-growing and high production clones and forms of Scots pine, Norway spruce, European larch, Douglas-fir, English oak, European beech, Small-leaved linden, Norway maple, Silver birch (including Black-barked birch and Silver birch ‘dalecarlica’), poplars (including Aspen, Simon poplar, White poplar, Petrowskiana poplar, Black poplar, Canadian poplar);

– clones of lyre-shaped, bush and standard forms of Karelian birch, as well as clones with highly patterned timber;

– seed progeny of coniferous introduced trees (Weymouth pine, Siberian cedar pine and Korean cedar pine, Japanese white pine, Korean fir, Nordmann fir);

– food species (Walnut, Manchurian walnut, Butternut, Heart-shaped walnut, Black mulberry);

– 14 varieties of decorative forms of Scots pine, Silver maple, etc.

During implementation of the project at the intermediate stages some scientific and technical products were developed. The use of products mentioned allowed achieving the main goal of the action and creating the *ex situ* collection. They are:

– analytical note about international and local experience of creation of collections of forest woody plants resistant to climate change, efficiency of means and methods of conservation of forest genetic resources;

– integrated system of criteria and rules for selection of populations, ecotypes and forms of forest tree species, taking into account their value, specifics and need of conservation;

– data obtained during the revision of dendroflora in Belarus aimed at finding new, unique and ornamental forms as well as rare and endangered species, subspecies and some populations of forest tree species;

– database of the results of genetic and breeding assessments of climatypes of coniferous trees on provenance trials and monitoring of the state of marginal and/or

peripheral populations of woody species of Belarus;

– list of genetic (form) variants of priority tree species which are selected in forest ecosystems in Belarus including those in reserves, national parks, forests which are of scientific and/or historical value and nature sanctuaries;

– registers of economically valuable forms of woody species preserved in breeding and conservation units and characterized by *(1)* fast-growth and high productivity, *(2)* high level of resin production, *(3)* resistance to phytopathogens;

– staticized information database of the selected populations, climatypes, species, forms and genotypes existing in natural conditions (*in situ*);

– register of endangered species, subspecies, forms and some populations whose conservation under natural conditions isn't effective and application of biotechnologies is desirable.

In general, the *ex situ* collection and its doublets is characterized both by the high practically focused orientation (production of planting stock of biologically resistant and economically valuable forms) and the scientific importance (providing the initial material for forest genetic researches and breeding).

Results of the project are aimed at improvement of the scientific and practical basis of sustainable forest management on the base of conservation and maintenance of biodiversity, productivity, renewal ability and stability of forest ecosystems. The development of project results will promote effective implementation of forest biocoenosis functions, such as ecological, economic and social at the local, national and global levels in the future.

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ANNEX A

Information database of selected populations, climatic types, species, forms, different genotypes *in situ*

Table A.1 – Information database of selected populations, climatic types, species, forms, different genotypes of coniferous tree species *in situ*

Key plot number	Category*	Tree species	Region, district, town	Area correlation	Geographical coordinates		Status**	Area, ha (m^2)	Age, years
					northern latitude	eastern longitude			
1	2	3	4	5	6	7	8	9	10
1017	2	European larch	Brest, Pruzhany, Kulyany village	Pruzhany forestry, Zelenevichi forest district, quarter 37, sec. 9	52°57'14"	24°49'59"	4	0.7	140
1021	2	Stand of European larch "Molchadskoye"	Brest, Baranovichi, Molchad village	3.0 km north-east of Molchad	53°21'31"	25°44'05"	7	1.6	–
1022	1	Norway spruce of serpentine shape "Brestskie" (2 pcs.)	Brest, Brest city	in the western part of Brest recreation park with other trees of Norway spruce; enclosed by a metal fence; location: from the south-west corner of the fence to tree No. 1 – 7.3 m, to tree No. 2 – 6.3 m, distance between trees – 4.5 m	52°05'33"	23°40'24"	7	0.03	70
1024	1	Spruce forest outliers "Mednyanskie"	Brest, Brest, Dubitsa station	1.5 km north-east of station Dubitsa; Brest forestry, Medno forest district, quarter 110 (sec. 8, 12), quarter 111 (sec. 1, 8, 11), quarter 112 (sec. 6, 7, 13), quarter 132 (sec. 12), quarter 133 (sec. 2), quarter 157 (sec. 9, 10), quarter 240 (sec. 2, 13), quarter 262 (sec. 3)	51°50'37"	23°46'09"	7	32.0	65-130
1029	1	Weymouth pine "Zhabinkovskaya"	Brest, Zhabinka, Zditovo village	1.5 km north of village Zditovo.	52°12'46"	24°03'30"	7	0.3	80
1043	1	Forest plot of Weymouth pine	Brest, Pruzhany	–	52°36'30"	24°21'44"	7	0.3	80

Continuation of the Table A.1

1	2	3	4	5	6	7	8	9	10
1040	1	Spruce forest outliers "Maloritskie"	Brest, Malorita, Zamshany village	4 km south-east of village Zamshany; Malorita forestry, Malorita forest district, quarter 11 (sec. 9, 12), quarter 18 (sec. 30, 32), quarter 19 (sec. 12, 27), quarter 29 (sec. 27), quarter 30 (sec. 12, 14, 15, 16, 24, 38), quarter 33 (sec. 12)	51°49'58"	24°08'22"	7	17.0	45-95
1041	1	Spruce forest outliers "Pozhezhinskie"	Brest, Malorita	Malorita forestry, Pozhezhino forest district, quarter 32 (sec. 19, 23, 24), quarter 41 (sec. 12, 21,37, 39), quarter 54 (sec. 2, 7, 13, 16), quarter 58 (sec. 18), quarter 71 (sec. 4, 7), quarter 72 (sec. 3, 21), quarter 75 (sec. 11), quarter 84 (sec. 3), quarter 88 (sec. 13), quarter 112 (sec. 1, 4, 10, 16), quarter 113 (sec. 20, 22, 26, 27), quarter 114 (sec. 18, 19), quarter 125 (sec. 9, 18, 21, 26)	51°52'36"	23°58'54"	7	68.0	45-140
1044	1	Caucasian fir "Mankovichskie" (2 pcs.)	Brest, Stolin, Stolin city	Tereshkovoy St., opposite building 12a, 80 meters to the west of the entrance of «Mankovichi» park. Tree No. 1 (split at 1.2 m high) grows 2 m away from the road, tree No. 2 – behind the fence in the garden, 5.5 m away frin tree No. 1	51°53'47"	26°52'29"	7	0.006	90
2003	3	Larch	Vitebsk, Orsha, Ustye village	–	54°26'18"	30°23'02"	2	in work	115
2005	1	Scots pine	Vitebsk, Senno	0.2 km south-east of village Rodnoe Selo and 6.5 km south-east of Bogushevsk	54°48'36"	30°18'47"	2	in work	120
2009	1	Norway spruce of serpentine shape (2 pcs.)	Vitebsk, Liozno, Liozno city	arboretum of Liozno forestry	55°00'22"	30°47'04"	2	in work	35
2010	1	Scots pine (14 pcs.)	Vitebsk, Liozno, Vishni village	1 km north-east of village Vyshni; Liozno forestry, Dobromyslinsk forest district, quarter 51, 61, 60, 79	54°53'21"	30°32'53"	4	1.82	230
2016	1	Scots pine	Vitebsk, Rossony, Kulneva village	Sokolishchensk village council	55°43'34"	28°33'01"	2	in work	230
2024	3	Square Khrapovitsky	Vitebsk, Verkhnedvinsk, Kokhanovichi	–	55°52'06"	28°07'50"	4	1.46	135-180
2066	1	Scots pine	Vitebsk, Shumilino, Glushitsa village	0.9 km west of village Glushitsa; Shumilino forestry, Koziany forest district, quarter 51, sec. 17	55°31'33"	29°34' 29"	6	0.0002	260

Continuation of the Table A.1

1	2	3	4	5	6	7	8	9	10
3004	2	Spruce forest outliers "Dobrushskie"	Gomel, Dobrush	1.5 km south-east from village Chistye Luzhi and 15 km north-east of city Dobrush on the Gomel-Bryansk highway	–	–	7	2.3	–
3006	2	Spruce forest outliers "Kalinkovichskie"	Gomel, Kalinkovichi	5 km east of village Gorbovichi and 500 m North-west of village Yakimovichi	–	–	7	171.5	–
3010	2	Stand of Scots pine	Gomel, Gomel, Tsykuny	1.5 km north of village Tsykuny; Gomel experimental forestry, Makeevka forest district, quarter 179, sec. 10	–	–	6	3.5	–
3012	2	Stand of Scots pine	Gomel, Gomel, Studenaya Guta	2.0 km southwest of village Studenaya Guta; Gomel experimental forestry, Teryuha forest district, quarter 315, sec. 2	–	–	6	5.7	–
3015	2	Stand of Scots pine	Gomel, Gomel, Teryukha	5 km south-east of village Teryukha; Gomel experimental forestry, Teryukha forest district	–	–	6	22.0	–
3016	2	Stand of Scots pine	Gomel, Gomel, Grabovka	2 km south-west from village Grabovka; Gomel experimental forestry, Grabovka forest district, quarter 35, sec. 1	–	–	6	24.0	–
3018	1	Scots pine	Gomel, Elsk, Vishenki	1 km from village Vyshenki on the Elsk-Kochishchi highway; Elsk forestry, Kochishchi forest district, quarter 46, sec. 25	51°45'27"	29°02'16"	6	0.01	50
3027	2	Unique forest areas (Scots pine)	Gomel, Lelchitsy, Markovichi	3.8 km north-west of village Markovichi; Lelchitsy forestry, Markovichi forest district, quarter 2, sec. 24, 25, 30, 35	57°24'70"	22°64'92"	6	18.7	–
3036	2	Stand of Scots pine	Gomel, Mozyr, Mitki	500 m north of village Mitki; Mozyr experimental forestry, quarter74, sec. 1, 5, 16, 25	–	–	6	23.0	110
3056	1	Pine "The Queen"	Gomel, Khoiniki	–	–	–	6	–	–
3079	1	Larch spp.	Gomel, Gomel city	Proletarskaya st. 8	52°25'22"	31°00'48"	1	–	–
4008	1	Scots pine	Grodno, Grodno, Gozha	–	53°48'59"	23°51'40"	2	33.1663	230

Continuation of the Table A.1

1	2	3	4	5	6	7	8	9	10
4009	1	Scots pine	Grodno, Schuchin, Schuchin city	Schuchin forestry, Schuchin forest district, quarter 175, sec. 15	53°36'40"	24°48'37"	4	120.702	190
4010	1	Scots pine	Grodno, Schuchin, Schuchin city	Schuchin forestry, Schuchin forest district, quarter 175, sec. 15	53°36'40"	24°48'38"	2	130.0	210
4011	1			Schuchin forestry, Schuchin forest district, quarter 162, sec. 6	53°36'39"	24°47'23"	4	138.859	190
4031	1	Scots pine	Grodno, Lida, Novitsky II	Tretyakov village council	53°50'40"	25°22'40"	5	207.289	300
4034	1	Scots pine	Grodno, Lida, Verh Lida	–	53°57'20"	25°19'19"	2	129.621	210
4046	2	Scots pine	Grodno, Lida, Belogruda	floodplain of the Ditva River	53°47'58"	25°09'45"	4	3,186.07	235
4054	2	Stand of Scots pine	Grodno, Novogrudok, Vsielub	Novogrudok forestry, Vsielub forest district, quarter 68, sec. 29	53°46'47"	25°45'25"	4	31,235.3	190
4067	2	Weymouth pine	Grodno, Grodno, Indura	Grodno forestry, Indura forest district, quarter 135, sec. 20	53°30'46"	23°52'10"	2	3,000.0	115
4068	1	Siberian larch		Grodno forestry, Indura forest district, quarter 135	53°30'47"	23°52'21"	2	159.404	90
4069	2	Siberian larch		Grodno forestry, Indura forest district, quarter 158, sec. 4	53°29'40"	23°52'02"	4	23,478.3	95
4082	1	Scots pine	Grodno, Volkovysk, Zabogony	–	53º06'52.5"	24º39'04"	2	89.0367	190
4085	2	Silver fir	Grodno, Volkovysk	Volkovysk forestry, Volkovysk forest district, quarter 130, sec. 4	53°11'01"	24°21'47"	5	19,857.8	70
5001	1	Scots pine	Minsk, Nesvizh, Nesvizh city	to north of Nesvizh along the road R11	53°56'00"	26°37'17"	2	in work	200
5002	1	Silver fir		–	53°16'38"	26°42'32"	2	in work	70
5006	1	Norway spruce of weeping shape	Minsk, Vileika, Kurenets	Liberty Square, 5	54°33'52"	26°59'41"	5	0.0006	115

Continuation of the Table A.1

1	2	3	4	5	6	7	8	9	10
5007	2	Mossy pine forest	Minsk, Molodechno, Krasnoe	northern outskirts of village Krasnoe	54°16'02"	27°03'22"	2	in work	180
5029	1	Scots pine	Minsk, Volozhin, Milkovschina	–	54°10'58"	26°15'52"	2	–	195
5039	1	California fir "Chizhevichskaya"	Minsk, Kopyl, Novye Doktorovichi	11 km south-east of Kopyl, 6 km south-west of village Novye Doktorovichi, on the southern outskirts of Chizhevichi, 100 m north-east of the carpentry shop	–	–	7	0.0016	–
5053	1	Black pines "Smilovichskie"	Minsk, Cherven, Smilovichi	township Smilovichi, 16 M. Gorkogo St. (hostel of Smilovichi State Agricultural College)	53°45'07"	28°00'23"	7	0.029	–
6003	2	Stand of Weymouth pine "Chigirinsky"	Mogilev, Kirovsk, Chigirinka	Bobruisk forestry, Chigirinka forest district, quarter 35	53°25'21"	29°51'00"	7	3.9	–
6017	1	Scots pine	Mogilev, Bobruisk, Mikhailovka	4.4 km south-east of village Mikhailovka; Bobruisk forestry, Domanovo forest district, quarter 69, sec. 2	53°01'31"	29°08'19"	6	0.009	200
6040	2	Reference stand of Scots pine	Mogilev, Osipovichi, Britsalovichi	2.5 km south-east of village Britsalovichi	53°22'28"	28°49'25"	6	5.7	–
6042	1	Larch	Mogilev, Slavgorod, Uluki	0.8 km south of village Uluki	53°34'45"	30°56'34"	6	0.02	–
6043	2	Reference stand of Scots pine	Mogilev, Khotimsk, Burosovo	2.3 km south-west of village Borosovo	53°20'16"	32°31'57"	6	15.0	110
6044	2	Reference stand of Scots pine	Mogilev, Khotimsk, Gornja	1 km south-west of village Gornia	53°18'23"	32°33'21"	6	17.0	75
6045	2			0.8 km south of village Gornia	53°18'23"	32°33'21"	6	40.8	80-90
6047	2			0.8 km south of village Gornia	53°18'91"	32°34'26"	6	24.4	90

Continuation of the Table A.1

1	2	3	4	5	6	7	8	9	10
6046	2	Reference stand of Scots pine	Mogilev, Khotimsk, Varvarovka	1 km south-west from village Varvarovka	53°20'52"	32°35'36"	6	30.0	90-100
6052	1	Larch	Mogilev, Khotimsk, Olshov	in north-western part of village Olshov	53°25'39"	32°37'11"	6	0.0004	200
6061	1	Pine-giants	Mogilev, Bykhov, Dunaek	2.4 km east of village Dunaek	53°25'43"	29°57'58"	7	3.3	–
6070	2	Provenance trials of Norway spruce	Mogilev, Cherikov, Polypen	1.0 km north-west of village Polypen; Cherikov forestry, Jesery forest district, quarter 41, sec. 24	53°31′10"	31°11′51"	4	16.83	–
6071	2	Pinery	Mogilev, Cherikov, Cherikov city	5 km south-west of Cherikov; Cherikov forestry, Jesery forest district, quarter 68, sec. 19	53°32'01"	31°19'43"	2	–	около 12
6072	2	Stand of European larch	Mogilev, Cherikov, Cherikov city	10 km south-east of Cherikov; Cherikov forestry, Veprino forest district, 38 quarter	53°31'58"	31°31'53"	2	–	120
6075	3	Pechersk Forest Park	Mogilev, Mogilev city	western outskirts of Mogilev	53°56'08"	30°17'11"	4	–	–
6089	1	Douglas-fir	Mogilev, Osipovichi Komarin	1.3 km north-west of village Komarin; Osipovichi experimental forestry, Daraganovo forest district, quarter 5, sec. 38	53°12'21"	28°25'31"	2	–	около 6
7014	2	Scots pine	Minsk city	island in Tsnyanskoye reservoir	53°57'49"	27°34'49"	2	37.3739	> 130

Notes:
*Category: 1 – a tree and/or a group of trees, 2 – sections of the forest, 3 – old parks and alleys;
**Status: 1 – detected; 2 – examined, 3 – key biotope, 4, 5 – natural monument of local and republican significance, respectively, recommended to allocate; 6, 7 – selected natural monument of local and republican significance, respectively.

Table A.2 – Information database of selected populations, climatic types, species, forms, different genotypes of deciduous tree species *in situ*

Key plot number	Category*	Tree species	Region, district, town	Area correlation	Geographical coordinates		Status**	Area, ha (m^2)	Age, years
					northern latitude	eastern longitude			
1	2	3	4	5	6	7	8	9	10
1001	1	English oak	Brest, Gantsevichi, Bolshie Krugovichi	Ogorevichi village council	52°46'41"	26°37'38"	4	–	230
1002	1	English oak	Brest, Pinsk, Zhitnovichi	Pinsk forestry, Zhitnovichi forest district, quarter 19, sec. 29	52°03'43"	25°58'40"	2	–	220
1003	1	English oak	Brest, Ivatsevichi, Bobrovichi	cemetery in village Bobrovichi	52°36'55"	25°46'38"	6	–	140/235
1004	1	English oak	Brest, Ivatsevichi, Vygonoschi	–	52°34'45"	25°53'46"	2	–	160
1005	1	Small-leaved linden	Brest, Ivanovo, Motol	central square Motol	52°18'55"	25°36'01"	4	–	130
1006	1	English oak	Brest, Ivanovo, Dostoevo	–	52°13'07"	25°38'04"	4	–	110
1007	1	English oak	Brest, Drogichin, Imenin	–	52°14'20"	25°54'56"	2	–	185
1008	1	English oak		–	52°14'50"	25°55'11"	4	–	135
1009	2	English oak	Brest, Drogichin, Radostovo	–	51°58'07"	24°56'29"	2	–	150
1010	3	English oak	Brest, Malorita, Zamshany	Khotislav village council	51°58'56"	24°56'13"	4	–	120-180
1011	1	English oak	Brest, Kobrin, Divin	Kobrin experimental forestry, Povitev forest district, quarter 12, sec. 25	51°58'21"	24°41'60"	2	–	135

Continuation of the Table A.2

1	2	3	4	5	6	7	8	9	10
1012	1	English oak	Brest, Kobrin, Divin	Sovetskaya St., private estate	51°57'56"	24°35'48"	2	–	130
1013	1	English oak	Brest, Kobrin, Magdalin	Kiselevetsk village council	52°11'15"	24°23'55"	4	–	185
1014	1	English oak	Brest, Malorita, Gruszka	–	51°55'14"	24°11'38"	2	–	165
1015	1	English oak	Brest, Kamenets, Velikaya Bolshaya	–	52°20'80"	23°44'58"	2	–	110
1016	1	English oak		–	52°20'5,6"	23°44'50"	2	–	–
1018	2	Oakery	Brest, Drogichin, Svaryn	Drogichin forestry, Beloozersk forest district, quarter 210, sec. 39	51°59'18"	25°02'25"	3	4.9	225
1019	1	Pyramidal Oaks "Baranavichskie"	Brest, Baranovichi, Baranovichi	public garden at the intersection of Komsomolskaya St. and Minina and Pozharskogo St.; among plantations of oak, poplar, white acacia and chestnut 4.5 m away from Komsomolskaya St.	53°07'40"	26°00'02"	7	0.0125	70
1020	1	Twin Oaks "Tuganovichskie"	Brest, Baranovichi, Karczewo	the ancient Tuganovichi park, located at a distance of 0.5 km from the outskirts of Karchevo	53°22'40"	26°08'13"	7	0.023	200
1023	1	Beeches forest purple "Lyutinskie"	Brest, Brest, Luta	in the territory of Lyutin boarding school; tree No. 1, 300 m away from the building of the boarding school in the southeast direction	52°18'17"	23°28'29"	7	0.022	110
1026	1	Oak-Giant "Atechiznensky"	Brest, Zhabinka, Leninsky	old park "Attechizna" north-west from village Leninsly, 300 meters from M1/E30 highway (Brest-Minsk-Russian border), 9 meters from the concrete fence of the distillery	52°10'05"	24°06'23"	7	0.07	500
1027	1	English oak "Petrovichsky-1"	Brest, Zhabinka, Petrovichi	12 meters from the main street of the village in the yard of building No. 2 in the open space	52°08'55"	24°00'06"	7	0.0028	400
1028	1	English oak "Petrovichsky-2"		on lawn, 20 meters away from the central street of the settlement between the club and the dwelling house	52°08'57"	24°00'00"	7	0.05	500

Continuation of the Table A.2

1	2	3	4	5	6	7	8	9	10
1031	2	Oakery "Boretskaya"	Brest, Ivatsevichi, Kushner	1 km from village Kushner, 200 m west of the building Boretsk forest district of Ivatsevichi forestry	52°45'55"	25°17'51"	7	3.6	150
1032	1	Pyramidal Oak "Vysokovsky"	Brest, Kamenets, Vysokoe	in the park of culture and recreation, village Vysokoe, in an open area, 30 meters from the stadium	52°21'56"	23°22'12"	7	0.002	90
1033	1	Oak "Suvorovsky"	Brest, Kobrin, Divin	3 km north-west of settlement Divin along road Divin-Kobrin, at an elevated open space	51°59'10"	24°32'22"	7	0.022	400
1035	1	Century Oaks Kozhangorodokskie (2 pcs.)	Brest, Luninets, Kozhan-Gorodok	oak No. 1 – 44 Sovetskaya St., household plot; oak No. 2 – 100 m from oak No. 1, between poultry farm and household plot	52°12'00"	27°00'50"	7	0.065	300
1037	2	Beeches forest "Velikoritskie"	Brest, Malorita, Velikorita	old park "Velikoritsky", in the far left corner from the entrance (azimuth 45°)	51°56'09"	24°04'04"	7	0.022	150
1038	1	Oak Patriarch "Pozhezhinsky"	Brest, Malorita, Staroe Romatovo	2 km west of village Staroe Romatovo	51°53'33"	23°57'07"	7	0.03	700
1039	1	Tsar-oak "Pozhezhinsky"		3 km east of village Staroe Romatovo	51°53'04"	24°02'10"	7	0.022	800
1078	1	Nevelsk elms	Brest, Pinsk, Nevel	yard of club and feldsher-midwife station	52°22'04"	23°22'34"	6	0.02	–
1082	1	Two English oaks "Rechitsa"	Brest, Stolin, Rechitsa	–	52°33'18"	24°27'20"	6	0.01	–
1085	1	English oak	Brest, Kobrin, Polyatichi	–	52°13'59"	24°16'38"	1	–	–
2001	3	Linden alley	Vitebsk, Orsha. Levki	Kopys village council	54°21'24"	30°20'03"	4	–	140-160
2002	1	English oak	Vitebsk, Orsha, Lemna	Zubovo village council	54°20'25"	30°33'34"	4	–	135

Continuation of the Table A.2

1	2	3	4	5	6	7	8	9	10
2004	1	English oak (4 pcs.)	Vitebsk, Senno, Bogushevsk	Bogushevsk forestry, Sofievka forest district, quarter 18, sec. 25	54°51'23"	30°25'23"	4	–	215
2006	1	English oak	Vitebsk, Shumilino, Erashovo	–	55°10'42"	29°17'17"	2	–	200
2007	1	European white elm	Vitebsk, Orsha, Oreshki	–	54°44'59"	30°28'02"	2	–	100
2008	1	English oak	Vitebsk, Liozno, Kosteevo	1.7 km south-west of village Kosteevo; Liozno forestry	54°55'41"	30°31'15"	2	–	110
2012	2	Oakery sorrel	Vitebsk, Polotsk, Pereki	2.7 km south-west of village Pereki; Verkhnedvinsk forestry, Dernovichi forest district, quarter 68, sec. 50	55°43'14"	28°32'34"	3	–	200
2013	2	Oakery sorrel	Vitebsk, Полоцкий, д. Переки	2.5 km south-west of village Pereki; Verkhnedvinsk forestry, Dernovichi forest district, quarter 64, sec. 24	55°43'16"	28°25'56"	3	–	195
2014	1	English oak	Vitebsk, Rossony, Sokolische	Zarechnaya St.15	55°46'24"	28°35'44"	2	–	120
2015	1	English oak	Vitebsk, Rossony, Kulnevo	Sokolische village council	55°43'37"	28°33'04"	2	–	120
2017	1	English oak			55°43'44"	28°32'45"	4	–	200
2018	1	Wych elm			55°43'55"	28°32'15"	2	–	170
2019	2	Oak-lime stand			55°43'54"	28°32'32"	2	–	170-200
2020	1	English oak			55°43'53"	28°32'34"	2	–	200
2021	1	English oak			55°43'55"	28°32'37"	2	–	220
2022	1	Small-leaved linden	Vitebsk, Postavy, Svirduny	1.2 km east of village Svirduny, outskirts of village Voyshkily	55°02'28"	26°23'10"	2	–	150
2023	1	English oak	Vitebsk, Postavy, Lintupy	6.9 km north-east of Lintupy, outskirts of village Belyanishki	55°03'53"	26°25'20"	4	–	150
2027	1	Small-leaved linden	Vitebsk, Miory, Leonpol	Sovetskaya St. (next to the road, serviced by Road Maintenance and Construction Department-203, Miory)	55°47'53"	27°46'55"	2	–	190

Continuation of the Table A.2

1	2	3	4	5	6	7	8	9	10
2028	1	Small-leaved linden	Vitebsk, Miory, Lipovka	10 km from Miory towards Polotsk	55º38'28"	27º45'35"	2	–	–
2029	1	English oak	Vitebsk, Miory, Kletnov Dvor	former manor on lake	55°36'07"	27°35'00"	2	–	200
2030	1	English oaks	Vitebsk, Postavy, Malkovichi	Postavy forestry, Gruzdovo forest district	55°02'18"	26°53'17"	4	–	235
2034	3	Linden alley	Vitebsk, Sharkovshchina, Yuzefovo	Germanovichi village council	55°26'15"	27°46'51"	2	–	170
2035	1	Group of oaks	Vitebsk, Sharkovshchina, Pischelevka	near the reserve "Yelnya"	55°29'34"	27°43'10"	4	–	190
2037	1	English oak "Sakhonovsky"	Vitebsk, Verkhnedvinsk, Vyshnarevo	26 km from Verkhnedvinsk on the outskirts of Vyshnarevo	–	–	7	0.035	410
2038	1	English oak "Yustiyanovsky"	Vitebsk, Verkhnedvinsk, Yustiyanovo	5 km from Verkhnedvinsk in village Yustiyanovo, on the right bank of the Zapadnaya Dvina	–	–	7	0.070	200
2039	3	Gluboksky Arboretum	Vitebsk, Glubokoe	2.5 km east of Glubokoe	52°00'47"	26°59'22"	7	8.200	–
2040	1	Oak Giant "Sitsevsky"	Vitebsk, Dokshitsy, Bolshoye Sitsa	18 km west of Dokshitsy, in the park of Bolshoye Sitsa	–	–	7	0.065	–
2041	1	Tsar-oak "Tadulinsky"	Vitebsk, Lepel, Tadulino	street on the east side, 17 m away from the nearest residential home in village Tadulino, 15 km south-east of the town of Lepel	55°08'20"	27°41'03"	7	0.050	–
2042	2	Oakery "Yaznenskaya"	Vitebsk, Miory, Bosyanki-2	300-400 m from village Bosyanki-2; Disna forestry, Yazno forest district, quarter 35	54°48'01"	28°52'22"	7	22.000	–
2043	3	Beshenkovichi Palace and Park Ensemble	Vitebsk, Beshenkovichi, Beshenkovichi	–	55°02'40"	29°27'41"	6	42,775.0	–

Continuation of the Table A.2

1	2	3	4	5	6	7	8	9	10
2044	3	Bocheykovsky manor and park ensemble	Vitebsk, Beshenkovichi, Bocheykovo	–	55°01'02"	29°09'07"	6	10.0	–
2049	3	City park Verkhnedvinsk	Vitebsk, Verkhnedvinsk	–	–	–	6	42,780.0	–
2050	1	Oak stands	Vitebsk, Verkhnedvinsk, Tabolki	1.1 km north-east of village Tabolki	52°44'91"	28°24'19"	6	56.0	85-170
2051	1	Oak stands	Vitebsk, Verkhnedvinsk, Mikhalino	1.35 km south of village Mikhalino	52°44'91"	28°24'19"	6	58.7	65
2052	1	Oak stands	Vitebsk, Verkhnedvinsk, Belyany	3.0 km south of village Belyany	52°44'91"	28°24'19"	6	62.0	65-75
2053	3	Arboretum	Vitebsk, Verkhnedvinsk	southern outskirts of Verkhnedvinsk; Verkhnedvinsk forestry	55°46'40"	27°55'59"	6	42,934.0	–
2056	1	Oak Giant "Volat"	Vitebsk, Gorodok, Prudniki	outskirts of village Prudniki, in the north-western part of lake Losvido	55°24'29"	29°59'14"	6	42,827.0	150
2061	3	Vysokoye	Vitebsk, Orsha, Vysokoye	in the north-western part of Vysokoye	54°38'44"	30°25'51"	6	42,920.0	–
2062	3	Arboretum	Vitebsk, Orsha, Kopys	0.2 km east of the building of Kopys forest district in Orsha forestry	54°19'24"	30°17'19"	6	6.0	–
2068	1	Small-leaved linden	Vitebsk, Shumilino, Krasnomay	0.2 km north-east of village Krasnomay, in glague linden forest	55°31'23"	29°31'04"	6	0.0002	300
2069	3	Oak Alley		north-eastern outskirts of Krasomay	55°31'20"	29°30'50"	6	0.1155	300
3001	1	English oak "Buda - Koshelevsky-1"	Gomel, Buda-Koshelevo, Sharibovka	2.5 km south-west of village Sharibovka	55°25'27"	28°05'57"	7	0.02	–
3002	1	English oak "Buda - Koshelevsky-2"	Gomel, Buda-Koshelevo, Potapovka	0.5 km south of village Potapovka	52°46'43"	30°32'10"	7	0.02	–

Continuation of the Table A.2

1	2	3	4	5	6	7	8	9	10
3007	1	English oak "Danilevichsky"	Gomel, Lelchitsy, Danilevichi	3 km north-east of the building of Danilevichi forest district of Lelchitsy forestry	52°57'11"	29°46'48"	7	0.02	–
3008	2	Plot of unique oakery "Rechitsky"	Gomel, Rechitsa, Uznozh	250 m north-west of village Uznozh	53°35'54"	27°20'48"	7	74.6	–
3058	2	Oakery upland	Gomel, Gomel, Orlensk	0.7 km south-east of village Orlensk; Gomel experimental forestry, Калининское forest district, quarter 117, sec. 16	52°15'04"	31°00'54"	3	–	–
3060	1	Small-leaved linden	Gomel, Gomel, Kalinino	–	52°16'18"	31°01'38"	2	–	–
3061	1	English oak	Gomel, Gomel, Tsagelnya	Molodezhnaya St. 4	52°18'46.3'	31°02'42.2"	2	–	–
3062	1	English oak	Gomel, Vetka, Yanovo	–	52°50'00"	31°29'57"	2	–	–
3063	2	Oakery floodplain	Gomel, Dobrush, Dobrush city	1.2 km west of Dobrush; Gomel experimental forestry, Shabrin forest district, quarter 312, sec. 2	52°24'14"	31°16'16"	2	7.2	–
3065	2	English oak	Gomel, Rechitsa	Rechitsa experimental forestry, Milograd forest district	52°30'32"	31°15'27"	3	–	–
3066	2	Oakery glague-sorrel	Gomel, Rechitsa, Krasnaya Dubrova	Vasilevichi forestry, Liskovo forest district, quarter 34, sec. 27, 29, 30, 31	52°17'06"	30°03'47"	3	–	–
3066	1	English oak		Vasilevichi forestry, Liskovo forest district	52°17'07"	30°03'49"	2	–	–
3066	1	English oak		Vasilevichi forestry, Liskovo forest district	52°17'04"	30°03'49"	2	–	–
3067	1	English oak	Gomel, Svetlogorsk, Uznozh	–	52°31'33"	29°35'12"	2	–	–
3068	1	English oak	Gomel, Svetlogorsk, Svetlogorsk cuty	–	52°37'49"	29°46'14"	2	–	–

Continuation of the Table A.2

1	2	3	4	5	6	7	8	9	10
3069	2	Oakery sorrel	Gomel, Oktyabrsk, Horomtsy	1.1 km southeast of village Horomtsy; Oktyabrsk forestry, Zabolote forest district, quarter 43, sec. 6	52°40'26"	28°38'49"	3	–	–
3072	2	Oakery floodplain	Gomel, Narovlya, Narovlya city	2.8 km north of Narovlya; Narovlya special forestry, Kolegovo forest district, quarter 149, sec. 15	51°50'10"	29°28'45"	3	3.1	–
3073	2	Oakery floodplain		Narovlya special forestry, Kolegovo forest district, quarter 184, sec. 4, 8	51°48'46"	29°29'08"	3	–	–
3074	1	English oak	Gomel, Mozyr, Sanyuki	2.0 km north of village Sanyuki; Mozyr experimental forestry, Michalki forest district, quarter 61, sec. 11	51°52'02"	29°15'09"	4	–	–
3075	2	Oakery sorrel	Gomel, Kalinkovichi, Kalinkovichi city	0.5 km east of Kalinkovichi; Kalinkovichi forestry, Kalinkovichi forest district, quarter 62, sec. 43	52°07'37"	29°22'02"	4	2.5	–
3076	2	Oakery cereal-bracken	Gomel, Mozyr, Prudok	13.5 km west of village Prudok; Mozyr experimental forestry, Moiseevo forest district, quarter 76, sec. 5	52°04'38"	28°54'41"	3	3.5	–
3077	1	English oak	Gomel, Lelchitsy, Krasnoberezhe	Novaya St., 7	51°52'45"	28°26'23"	2	–	–
3078	1	English oak	Gomel, Oktyabrsk, Dzerzhinsk	–	51°39'37"	27°34'11"	2	–	–
4001	1	English oak	Grodno, Grodno, Privalki	Shkolnaya St., 13	53°56'47"	23°55'10"	2	306.0	100
4002	1	English oak		Shkolnaya St., 42	53°56'48"	23°54'59"	2	349.0	100
4003	1	European ash		Shkolnaya St., 46	53°56'48"	23°54'57"	2	283.0	100
4004	1	European ash		Shkolnaya St., 3	53°56'46"	23°55'34"	2	79.0	140
4005	1	English oak	Grodno, Grodno, Lesnitca	–	53°48'55"	23°54'14"	2	383.0	90
4006	1	English oak		–	53°49'06"	23°53'43"	4	408.0	110
4007	1	English oak		–	53°49'15"	23°53'18"	2	365.0	100
4012	2	Oakery	Grodno, Schuchin, Schuchin city	Schuchin forestry, Schuchin forest district, quarter 193, sec. 14	53°37'31"	24°51'02"	3	19,238.0	100

Continuation of the Table A.2

1	2	3	4	5	6	7	8	9	10
4013	2	Oakery	Grodno, Schuchin, Leschanka	Schuchin forestry, Schuchin forest district	53°38'28"	24°39'42"	4	81,564.0	150-200
4014	1	English oak	Grodno, Grodno, Dorgun	400 m south of village Dorgun	53°48'00"	23°35'59"	2	454.0	80
4019	1	English oak "Freedom"	Grodno, Grodno, Golynka	Sopotskin village council	53°46'26"	23°34'14"	4	397.0	95
4020	1	English oak	Grodno, Grodno, Khvoynany	Skidel village council	53°32'16"	24°15'30"	2	387.0	100
4021	1	English oak	Grodno, Schuchin, Puzynovtsy	400 m south of village Puzynovtsy	53°32'44"	24°27'33"	4	412.0	220
4026	2	Broadleaved stand	Grodno, Grodno, Kashubintsy	100 m south of village Kashubintsy; Skidel forestry, Skidel forest district, quarter 82, sec. 20, 21	53°36'35"	24°12'40"	5	80,240.0	180
4027	3	Alley of broadleaved tree species	Grodno, Grodno, Milkovschina	Skidel village council	53°33'34"	24°23'57"	2	1200.0	115
4028	2	Oakery	Grodno, Schuchin, Starye Gerniki	Schuchin forestry, Schuchin forest district, quarter 54, sec. 28	53°40'18"	24°44'04"	2	226.0	180
4029	1	English oak	Grodno, Schuchin, Starye Gerniki	–	53°40'12"	24°15'02"	2	232.0	100
4030	1	English oak	Grodno, Schuchin, Golovichpolye	on the territory of the boarding-school	53°43'49"	24°46'13"	4	504.0	160
4032	1	English oak	Grodno, Lida, Verch-Lida	–	53°57'04"	25°17'29"	2	403.0	140

Continuation of the Table A.2

1	2	3	4	5	6	7	8	9	10
4033	1	English oak	Grodno, Lida, Verch-Lida	–	53°57'14"	25°18'16"	2	408.0	130
4035	1	English oak		–	53°57'13"	25°18'49"	2	366.0	100
4036	1	Small-leaved linden	Grodno, Lida, Luchki	–	53°50'54"	25°29'40"	2	134.0	150
4039	2	Oakery	Grodno, Lida	Lida forestry, Lida forest district	53°48'51"	25°19'07"	3	248,827.0	200
4040	1	European ash	Grodno, Lida, Mozheikovo	on the territory of the park	53°43'21"	24°59'19"	2	260.0	80
4041	1	English oak	Grodno, Lida, Bobry	on the territory of the church	53°43'45.9'	25°09'40.8"	4	594.0	170
4042	3	English oak	Grodno, Lida, Tarnovo	on the outskirts of the estate	53°47'52"	25°08'57"	4	20,074.0	150
4043	1	European ash	Grodno, Lida, Gornji	private estate	53°51'04"	25°16'44"	2	221.0	110
4044	1	English oak	Grodno, Lida, Railway station "Belogrudy"	along the local roads	53°47'14"	25°11'09"	4	579.0	170
4045	1	English oak	Grodno, Lida, Lake Porecansky	north coast	53°46'54"	25°11'09"	2	288.0	140
4048	1	Small-leaved linden	Grodno, Lida, Zarechany	in the middle of farmlands	53°40'28"	25°20'43"	2	316.0	150
4049	1	Norway maple	Grodno, Lida, Dvorishche	–	53°59'41"	25°23'11"	2	220.0	140
4050	1	Norway maple	Grodno, Zelva, Penyugi	south-west of the village	53°00'19"	24°52'52"	2	325.0	144

Continuation of the Table A.2

1	2	3	4	5	6	7	8	9	10
4051	1	Small-leaved linden	Grodno, Zelva, Penyugi	south-west of village Penyugi	53°00'19"	24°52'53"	2	209.0	111
4052	3	Small-leaved linden	Grodno, Ivie, Survilishki	fragment of the park around former manor house, part of the aisle of Small-leaved linden and Norway maple	54°11'10"	25°49'36"	2	–	110
4053	1	English oak	Grodno, Novogrudok, Ponemon	Novogrudok forestry, Shchorsy forest district, quarter 53, sec. 23	53°38'18"	26°14'56"	4	327.0	220
4055	1	English oak	Grodno, Novogrudok, Shchorsy	–	53°39'17"	26°10'03"	4	201.0	180
4056	1	English oak	Grodno, Korelichi, Pesochnaya	–	53°29'11"	26°23'57"	2	529.0	100
4057	1	English oak	Grodno, Novogrudok	Novogrudok forestry, Svityaz forest district, quarter 50, sec. 5	53°25'54"	25°54'07"	2	308.0	200
4058	1	English oak		Novogrudok forestry, Svityaz forest district, quarter 44, sec. 21	53°26'36"	25°57'56"	4	827.0	160
4059	2	Oakery	Grodno, Zelva	Volkovysk forestry, Zelva forest district, quarter 101, sec. 18	53°07'56"	24°56'55"	3	22,044.0	185
4061	1	English oak	Grodno, Schuchin, Novy Dvor	Kostelnaya St. 22, private estate on the road	53°48'53"	24°33'28"	2	185.0	105
4062	1	Norway maple		near the catholic church	53°49'00"	24°33'18"	2	1,920.0	130
4063	2	Oakery	Grodno, Ostrovets, Ostrovets sity	outskirts of Ostrovets	54°35'09"	25°57'54"	4	136,543.0	130
4064	1	English oak		Beregovaya St.	54°36'36"	25°58'29"	4	424.0	150
4065	1	English oak		Beregovaya St.	54°36'37"	25°58'31"	4	283.0	150
4066	1	English oak	Grodno, Schuchin, Naroshi	on the outskirts among agricultural land of Ostrinsky village council	53°47'27"	24°29'24"	4	674.0	160
4070	3	English oak	Grodno, Berestovitsy, Knyazevichi	along a local road	53°22'40"	23°57'16"	4	16,215.0	110
4071	3	Broadleaved tree species	Grodno, Berestovitsy, Krasniki	–	53°22'41"	24°00'21"	2	–	105

Continuation of the Table A.2

1	2	3	4	5	6	7	8	9	10
4072	1	European ash	Grodno, Mosty, Gudevichi	–	53°22'33"	24°09'49"	2	198.0	140
4073	1	English oak	Grodno, Mosty	Schuchin forestry, Mosty forest district, quarter 95, sec. 5	53°28'49"	24°23'13"	4	10,341.0	170
4074	1	English oak	Grodno, Mosty, Zapolye	in the woods near the old manor of Zapolye forest district of Shchuchin forestry	53°26'46"	24°28'48"	2	537.0	110
4075	2	English oak	Grodno, Schuchin	Schuchin forestry, Rozhanki forest district, quarter 102, sec. 18	53°28'35"	24°54'03"	4	72,631.0	205
4076	2	English oak	Grodno, Mosty, Stukaly	reserve "Lipichanskaya Pushcha"	53°28'35"	24°54'03"	3	855,122.0	230
4077	1	English oak	Grodno, Schuchin, Zachepichi	–	53°29'11"	24°59'31"	2	295.0	160
4078	1	English oak		–	53°29'04"	24°59'39"	2	240.0	150
4079	1	English oak		–	53°29'04"	24°59'48"	2	238.0	150
4081	2	Oakery	Grodno, Volkovysk	Volkovysk forestry, Volkovysk forest district, reserve "Castle Forest"	53°11'58"	24°34'39"	3	–	160
4083	1	English oak	Grodno, Volkovysk, Zabogony	outskirts of Zabogony	53°06'52"	24°39'03"	2	205.0	175
4086	1	English oak	Grodno, Slonim	Slonim forestry, Senkovshchina forest district, quarter 117, sec. 11	53°06'45"	25°11'49"	4	300.0	200
4087	2	Oakery	Grodno, Mosty camping "Oaks"	–	53°25'34"	24°40'36"	3	361.0	150
4088	2	Oakery	Grodno, Grodno	Skidel forestry, Ozery forest district, quarter 20, sec. 8, reserve "Ozery"	53°47'28"	24°10'31"	4	71,020.0	170-220
4089	2	Oakery		Skidel forestry, Ozery forest district, quarter 46, sec. 7, reserve "Ozery"	53°46'22"	24°11'24"	3	35,403.0	130-170
4090	2	Oakery		Skidel forestry, Ozery forest district, quarter 46, sec.11, reserve "Ozery"	53°45'56"	24°11'38"	2	–	160
4091	1	English oak	Grodno, Ostrovets, Trokeniki	manor complex of artist Bogush-Shishka, along the linden alley	–	–	1	–	–

Continuation of the Table A.2

1	2	3	4	5	6	7	8	9	10
4092	1	English oak	Grodno, Novogrudok, Lubcha	2.4 km north of settlement Lubcha	53°46'32"	26°04'28"	4	–	190
4093	1	Aucuba-leaved green ash "Zhemyslavsky"	Grodno, Ivie, Zhemyslavl	80 m south-west of the main entrance to the administration building of Agricultural Production Cooperative "Zhemyslavl", in the central part of the architectural and park ensemble	52°28'35"	29°58'06"	7	0.02728	–
4094	1	Yellow horse chestnut "Raytsevsky"	Grodno, Korelichi, Zelenets	0.1 km north of Korelichi-Valevka road, in the eastern part of village Zelenets, in the south-eastern part of the park, former rural health post	54°07'54"	25°45'51"	7	0.02148	–
4095	1	Oak-tee "Svityazyansky"	Grodno, Novogrudok, Valevka	0.45 km north of northern coast of Svityaz lake, 50 m east of the felling between quarters 52 and 54	53°27'55"	26°01'38"	7	0.03732	–
4096	1	Winter oak "Senkovshchinsky"	Grodno, Slonim, Ednachi	1.5 kilometers north of Kostrovichi-Niz road, 2 km south of village Ednachi, 200 m north-east of intersection of field edges and clearing in village Ednachi	53°27'47"	25°53'14"	7	0.03671	–
5003	1	English oak	Minsk, Nesvizh, Kozly	agricultural land	53°09'39"	26°31'34"	7	–	230
5005	3	Linden-oak alley	Minsk, Myadel, Zasvir	–	54°50'32"	26°40'49"	4	–	220-270
5008	1	European white elm	Minsk, Molodechno, Talui	Lebedevichi village council	54°18'52"	26°35'34"	5	–	230
5009	1	English oak	Minsk, Molodechno	Molodechno forestry, Lebedevka forest district, quarter 94, sec. 17	54°21'36"	26°43'32"	4	–	165
5010	2	Oakery upland	Minsk, Soligorsk, Sakovichi	Starobino forestry, Listopadovichi forest district, quarter 36, sec. 24	52°42'25"	27°37'24"	3	–	225
5011	3	Hornbeam Alley	Minsk, Molodechno, Mamony	along the artificial channel among farmlands	54°15'59"	26°37'58"	2	–	85
5012	1	English oak	Minsk, Soligorsk, Dolgoye	400 m south-west of village Dolgoye along local roads	52°36'19"	27°33'28"	2	–	140

Continuation of the Table A.2

1	2	3	4	5	6	7	8	9	10
5013	2	Oakery	Minsk, Kleck, Smolichi	750 m south of village Smolichi; Kleck forestry, Kolki forest district, quarter 31, sec. 3	52°48'59"	27°00'24"	2	3.0	170
5014	3	Oakery	Minsk, Kopyl	Kopyl forestry, Orlik forest district, quarter 32, sec. 24, 25	52°52'07"	26°57'55"	3	5.6	180
5015	3	Oakery	Minsk, Starye Dorogi	Starye Dorogi forestry, Falichi forest district, quarter 3, выд 19	53°07'11"	28°22'53"	3	6.4	205
5016	1	Wych elm	Minsk, Pukhovichi, Maryina Gorka	healthcare institution "Regional Children's Center"	53°31'26"	28°08'16"	2	–	120
5018	1	English oak	Minsk, Pukhovichi, Ducory	on the territory of park	53°40'32"	27°58'04"	4	–	155-205
5020	1	English oak	Minsk, Borisov, Staro-Borisov	on the territory of the State Educational Institution "Staroborisovskaya sanatorium boarding-school"	54°16'41"	28°28'32"	4	–	145-160
5021	1	English oak	Minsk, Borisov	–	54°16'11"	28°40'57"	2	–	145
5022	2	English oak		–	54°18'09"	28°41'55"	4	–	140
5023	3	Linden alley	Minsk, Logoisk, Zavishino	on the territory of school	54°28'42"	27°39'09"	4	–	135
5024	1	European ash	Minsk, Minsk, Lysaya Gora	–	54°10'33"	27°32'57"	5	–	170
5025	1	Small-leaved linden	Minsk, Logoisk, Panishevschina	–	54°06'21"	27°43'14"	2	–	140
5028	2	Oakery	Minsk, Minsk, Lyakhovschina	Minsk forestry, Ratomka forest district, quarter 89, sec. 7	–	–	2	1.6	130
5030	1	English oak	Minsk, Volozhin, Borovikovschina	–	53°57'51"	26°42'30"	4	–	270

Continuation of the Table A.2

1	2	3	4	5	6	7	8	9	10
5031	1	English oak "Lyubushansky-1"	Minsk, Berezina, Machesk	18 km south-east of the town of Berezino, 5 km south-west of village Machesk, 1 km north-west of village Zabrodye, 100 meters south of the district road Lyubushany-Duleby, on the edge of the forest	–	–	7	0.0177	–
5032	1	English oak "Lyubushansky-2"		18 km south-east of the town of Berezino, 5.3 km south-west of village Machesk, 1.1 km north-west of village Zabrodye, 400 meters south of the district road Lyubushany-Duleby, on the edge of the forest	–	–	7	0.0165	–
5035	1	Two intergrown of English oak "Golynkovsky"	Minsk, Kletsk, Sinyavka	20 km south-west of the town of Kletsk, 4 km south-west of village Sinyavka, 2.0 km west of village Sloboda, 150 m west of district road Sinyavka-Soveyki	52°57'46"	26°27'45"	7	0.02	–
5036	1	English oak "Novinkovsky"	Minsk, Kletsk, Zaostrovechye	19 km south of Kletsk, 10 km west of village Zaostrovechye, 0.3 km east of village Chasha, 50 m north of the district road between villages Chasha and Drabovshchina	52°53'51"	26°46'52"	7	0.018	–
5037	1	Yellow horse chestnut "Bobovnyansky"	Minsk, Kopyl, Bobovnia	15 km north-west of the town of Kopyl, 100 m south-west of the hospital in village Bobovnia	–	–	7	0.0016	–
5038	1	Sycamore maples "Bobovnyansky"		15 km north-west of the town of Kopyl, the village of Bobovnya, Parkovy lane, about 1, 3 and 5	–	–	7	0.048	–
5040	2	Oakery "Shchomyslitskaya"	Minsk, Minsk, Shchomyslitsa	0.6 km south of the Minsk Ring Road (M9), northeast of village Shchomyslitsa	53°49'20"	27°27'22"	7	42,910.0	–
5043	1	English oak "Kozlovsky" (Oak-Yakub)	Minsk, Nesvizh, Kozly	14 km south-west from Nesvizh, 0.4 km south-east of village Kozly, 0.4 km east of the farm	53°09'55"	26°31'15"	7	0.031	–
5046	1	Pyramidal Oak "Zaozersky"	Minsk, Nesvizh, Zaozerye	2 km north-east of Nesvizh, village Zaozerye, Ozernaya St., opposite the house 28	53°13'10"	26°40'06"	7	0.018	–
5077	1	Small-leaved linden	Minsk, Lyuban, Yushkovichi	50 m to south-east of village shop building	52°48'07"	27°50'10"	6	0.001257	150

Continuation of the Table A.2

1	2	3	4	5	6	7	8	9	10
5049	1	American lindens "Novoveskovye"	Minsk, Stolbtsy, Vorotishche	18 km south-west of the town of Stolbtsy, 1.5 km north-west of village Vorotishche, 0.9 km south-east of village Novaya Veska, 0.4 km south-west of village Velikiy Dvor, in the territory of Novaya Veska secondary school	53°22'08"	26°33'55"	7	0.02	–
5050	1	Small-leaved lindens "Миколаевичские"	Minsk, Stolbtsy, Mikolaevshchina	8 km south-east of the town of Stolbtsy, 0.4 km north-west of village Mikolaevshchina, on the right bank of Neman river, in the territory of the memorial estate "Smolnia"	53°24'22"	26°50'13"	7	0.034	–
5078	1	English oak	Minsk, Lyuban, Listenka	–	52°38'25"	28°01'17"	6	0.001257	150
5079	2	Stand of English oak	Minsk, Lyuban, Plastok	–	52°45'23"	28°07'57"	6	3.20	140-200
5098	2	Oakery-3	Minsk, Soligorsk, Yaskovichi	6.2 km north-east of village Yaskovichi; Starobino forestry, Yaskovichi forest district, quarter 30, sec. 37	52°36'10"	27°27'06"	6	2.10	150-170
5099	2	Oakery-1	Minsk, Soligorsk, Listopadovichi	1.1 km south-east of the southern outskirts of Listopadovichi; Starobino forestry, Listopadovichi forest district, quarter 23, sec. 6	52°42'49"	27°32'23"	6	12.00	170-200
5100	2	Oakery-2		3.1 km south of the southern outskirts of Listopadovichi; Starobino forestry, Listopadovichi forest district, quarter 39, sec. 13	52°41'27"	27°31'16"	6	5.20	150-200
5101	1	Norway maple	Minsk, Soligorsk, Bolshie Zavshitsy	6 m south of the building of Educational institution "Zavshitsy State Education Basic Kindergarten-School"	52°50'00"	27°20'17"	6	0.02	110
5108	1	English oak	Minsk, Molodechno, Zaskovichi	Lebedinsk village council	54°24'30"	26°36'34"	2	–	–
5109	1	English oak	Minsk, Molodechno, Shikovo	Lebedinsk village council	54°24'20"	26°37'12"	4	–	–
6007	1	Century oak "October"	Mogilev, Osipovichi, Chuchye	2 km south-west of village Chuchye	–	–	7	0.0016	–

Continuation of the Table A.2

1	2	3	4	5	6	7	8	9	10
6009	1	Century tree of English oak	Mogilev, Mogilev city	9 m from the house 26 on the Menzhinsky St.	53°53'49"	30°19'11"	6	0.02	300
6010	1	Century tree of English oak		15 m from the house 18a on the Plekhanovo St.	53°53'49"	30°19'11"	6	0.008	300
6011	3	Dashkovsky park	Mogilev, Mogilev, Dashkovka	–	53°44'11"	30°16'51"	6	3.4	–
6012	1	English oak	Mogilev, Belynichi, Zaozerye	4.0 km south-west of village Zaozerye	54°02'03"	29°26'15"	6	0.02	400
6013	2	Oakery		6.8 km south-west of village Zaozerye; Belynichi forestry, Esmonty forest district, quarter 48, sec. 10	54°01'51,835"	29°22'7,695"	6	25.0	100
6014	2	Oakery	Mogilev, Bobruisk, Bobruisk city	2 km east of Bobruisk (on the left bank)	53°06'32"	29°16'41"	6	29.6	105-160
6015	2	Oakery floodplain	Mogilev, Bobruisk, Domanovo	550 m to south-west from village Domanovo along the Loma-Domanovo highway (P31)	53°01'81"	29°15'52"	6	629.0	–
6016	1	Oak-Giant	Mogilev, Bobruisk, Bobruisk city	intersection Gogol St. and Chongarskaya St.	53°08'33"	29°13'48"	6	0.0625	300
6018	2	Oak grove in the tract "Oaks"	Mogilev, Bykhov, Bykhov city	3.0 km south-east of Bykhov	53°6'32,615"	29°16'41,504"	6	5.0	105-160
6019	2	Oak grove		1.0 km west of village Voronino and 6.0 km east of city Bykhov	53°06'32"	29°16'41"	6	3.0	105-160
6020	1	Oak-Giant	Mogilev, Bykhov, Khomichi	2.5 km east of village Khomichi; Bykhov forestry, Khomichi forest district, quarter 61, sec. 3	53°20'26"	30°00'10"	6	0.007	146
3070	1	English oak	Mogilev, Glusk, Dvor-Glusha	1.0 km north-west from of village Dvor-Glusha, the Bobruisk-Starye Dorogi highway	53°05'02"	28°48'17"		–	–
6025	2	Oakery	Mogilev, Glusk, Simonovichi	2.6 km west of village Simonovichi along the Simonovichi-Oryzhnia highway	53°45'53"	28°35'30"	6	5.5	160
6031	2	Trilesin giants	Mogilev, Dribin	150 m north of the Trilesino pond	–	–	6	3.3	–

Continuation of the Table A.2

1	2	3	4	5	6	7	8	9	10
6023	2	Oakery	Mogilev, Glusk, Zorka	5.7 km north-west of village Zorka	52°44'32"	28°22'35"	6	19.46	170
6024	2	Oakery		3.3 km north-west of village Zorka	52°44'34"	28°25'91"	6	9.85	160
6026	2	Oakery		5 km north-west of village Zorka	52°44'34"	28°22'56"	6	19.94	160
6027	2	Oakery		3.1 km north-west of village Zorka	52°44'91"	28°24'19"	6	9.0	170
6033	2	Oak Grove	Mogilev, Kirovsk, Dumanovshchina	1.9 km north-west of village Dumanovshchina on the highway "road R-93-Dumanovshchina-Guta"	53°12'61"	29°16'43"	6	19.0	110
6051	1	Freestanding English oak	Mogilev, Khotimsk, Olshov	in the northwestern part of village Olshov-1	53°25'42"	32°37'13"	6	0.0006	213
6053	1	Two freestanding English oaks	Mogilev, Khotimsk, Zaozerye	4.5 km south-east of village Zaozerye	54°02'03" 54°02'03"	29°24'35" 29°24'35"	6	0.0006	300-320
6054	1	Oak Giant	Mogilev, Chaussy, Riminka	–	–	–	6	0.02	–
6057	1	Oak Giant	Mogilev, Cherikov, Cherikov city	Cosmonavtov St., at the evening school building	53°34'05"	31°22'53"	6	0.02	–
6059	3	City Park	Mogilev, Shklov, Shklov city	city center of Shklov on the Collective farm St.	54°12'18"	30°17'33"	6	20.0	–
6060	1	Freestanding English oaks	Mogilev, Shklov	on the south side of the road between Troitsa-Chirchino road and the forest	–	–	6	107.4	–
6062	3	Grudinovsky park	Mogilev, Bykhov	–	–	–	7	10.0	–
7001	1	English oak	Minsk, Minsk city	Romenskaya St., 8/6	53°51'59"	27°33'46"	4	–	116
7002	1	English oak		Avtodorovskaya St., 8	53°52'38"	27°31'16"	2	–	75

Notes:
*Category: 1 – a tree and/or a group of trees, 2 – sections of the forest, 3 – old parks and alleys;
**Status: 1 – detected; 2 – examined, 3 – key biotope, 4, 5 – natural monument of local and republican significance, respectively, recommended to allocate; 6, 7 – selected natural monument of local and republican significance, respectively.