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PROGRESS REPORT 4

Report on preparation of amendments to standards and other technological regulations in the forest sector and on improvement proposals for the existing methods and approaches to biological and landscape diversity conservation during forest management and forest use

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Project Activity 3.1.1.3: Development of methods and techniques of conservation of biological and landscape diversity during forest management and forest exploitation

Consultant:

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«Development of methods and techniques of conservation of biological and landscape diversity during forest management and forest exploitation»

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List of main abbreviations, terms and definitions

STB – standard of Belarus;
BelSISC – Belarusian State Institute for Standardization and Certification;
TR – technological regulations;
RUE – Republican unitary enterprise;
RB – Republic of Belarus;
SM – sanitary measures;
BSTU – Belarusian State Technological University;
SPFA – state production forestry association;
Ministry of Forestry – Ministry of Forestry of the Republic of Belarus;
SFE – state forestry enterprise;
RLA – regulatory legal acts;
SPNA – specially protected natural areas;
FSC – Forest Stewardship Council;
TCCP – technical code of common practice;
FUR – forest use restrictions;
TC – taxation card;
EA – economic activities;
FCR – Forest cutting rules;
WGS 84 – World Geodetic System;
UTM – Universal Transverse Mercator;
CS-42 – 1942 coordinates systems;
DBMS – database management system;
TGC – type of growing conditions;
FF – final felling;
FAO – United Nations Food and Agricultural Organization;
FC – forest component;
CSC – clear sanitary cuts;
SSC – selective sanitary cuts;
DC – debris clean-up;
EGFF – even gradual final felling;
LGFF – long-lasting gradual final felling;
GFF – gradual final felling;
VSFF – voluntary selective final felling;
CFF – clear-cut final felling;
Biotope is a natural feature (a portion of land or water) with uniform environmental conditions, a habitat of certain species of wild animals and plants;
FIRUE – forest inventory republican unitary enterprise;
Forest fund is lands allocated for forestry purposes;
Forest lands are forest fund lands covered with forest or temporarily unstocked forest areas reserved for forest growth and forestry purposes (logging areas, fire sites, open stands, barren lands, glades, dead forest stands, forest nurseries, plantations or sparse woodlands, etc.) allocated for forestry purposes.

Executive summary

The goal of the study. The goal of the study under project activity 3.1.1.3: "Development of methods and techniques of conservation of biological and landscape diversity during forest management and forest exploitation" is to review applicable regulatory legal acts in the forest sector and to prepare draft amendments to national standards of forest certification and other technological regulations in the forest sector.

Main methodological issues. The task was to prepare amendments to national standards and proposals for improvement of methods and approaches of biological and landscape diversity conservation during forest management and forest use on forest areas.

Main objectives of the study:

– to develop draft national standards of the Republic of Belarus, including:

a) draft national standard STB 1708 «Sustainable forest management and forest use. Main requirements» (revised);

b) draft national standard STB «Group certification of forest management and forest use systems. Requirements» revised by reference to international PEFC standard ST 1002:2018 «Group Forest Management Certification – Requirements»;

c) draft national standard STB 2157–2016 (PEFC ST 2002:2013) «Chain of custody certification of timber and non-timber products. Main requirements».

– to review international best practices of methods and approaches to biological and landscape diversity conservation during forest use: European best practices;

– to develop proposals for improvement of methods, techniques, technology for biological diversity conservation as a part of forest protection action plan;

– to improve methods, techniques, technology for biological diversity conservation as a part of forest restoration action plan;

– to review the legal framework of forest cuts, forest restoration, demarcation of cutting areas, forest inventory to explore opportunities for planning of biodiversity conservation actions;

– to develop proposals for improvement of forest use planning practices in the context of biological diversity conservation.

Main stages. The study involved the following works:

1) selection of applicable regulatory legal acts in the forest sector, literary and Internet sources; primary analysis of the selected data; 2) review of domestic and international best practices of existing methods and approaches to biological diversity conservation during forest use; 3) development of proposals for improvement of methods and approaches of biological and landscape diversity conservation during forest management and forest use on forest areas.

Nature conservation and social impacts. Nature conservation impacts involve further improving of applicable forest and conservation laws as regards methods and approaches to biological diversity conservation during forest management and forest use. Social impacts can be achieved by using the study outcomes for educational purposes and promotion of sustainable attitude toward wildlife, raising awareness of biological diversity conservation in forest ecosystems, creation of forest sites network (forest sites under low anthropogenic effect, unique wildlife objects, other biodiversity objects, etc.) for ecological education of children, youth and adult population.

Introduction

Conservation of biological diversity of forest ecosystems is indispensable for sustainable forest management and forest use. The year of 2020 was marked with the end of the United Nations Decade on Biodiversity, The Strategic Plan for Biodiversity (2011-2020); the progress review of 5 strategic goals and 20 Aichi biodiversity targets was done.

As a result, it has been justified that conservation of considerable part of global biodiversity is absolutely contingent on forest use because it is forests that house an overwhelming majority of global terrestrial biodiversity.

Preservation and maintenance of ecosystem, species and genetic diversity of forests is crucial for promotion of forest resilience.

Many countries with developed forest sector (for example, Finland, Sweden, Norway) set the priority for natural biodiversity conservation in their national forest policies and timber supply of the industry.

Conservation of natural biological diversity during forest use, primarily, during forest cuts is a priority task of the modern forest sector. Short-cycle clear cuts on large areas of forests can significantly alter the forest environment and negatively affect biodiversity. Therefore, it is essential to ensure living and settling of species on areas of intensive forest use as well as to create and maintain specially protected natural areas (SPNA) and a network of nature conservation, recreational and protective forests.

To eliminate negative impacts of forest cuts, it is required to create conditions for conservation of key biotopes and key forest components (habitats of rare species of plants, animals, mushrooms) at the preparatory stage of cutting operations. The key biotopes and forest components will maintain the pattern structure of natural habitats vital to forest species and to create opportunities for their further distribution in future.

The study resulted in the review of international and national approaches to biological diversity conservation during forest management and forest use, drafted amendments to national standards and proposals for improvement of methods and approaches of biological and landscape diversity conservation during forest management and forest use on forest areas.

The study outcomes can be used to further develop and improve Belarusian forest and nature conservation laws, to promote ecological awareness, to apply ecological and silvicultural knowledge to professional practices of forestry workers for preparation of fellings, forest use, forest inventory, forest protection, forest regeneration and afforestation.

1 Goal, objectives and methodology of the study

1.1. Goal of the study

The goal of the study is to review applicable regulatory legal acts in the forest sector and to prepare draft amendments to national standards of forest certification and other technological regulations in the forest sector.

1.2 Objectives of the study

Main objectives:

– to develop draft national standards of the Republic of Belarus, namely:

a) draft national standard STB 1708 «Sustainable forest management and forest use. Main requirements» (revised);

b) draft national standard STB «Group certification of forest management and forest use systems. Requirements» revised by reference to international PEFC standard ST 1002:2018 «Group Forest Management Certification – Requirements»;

c) draft national standard STB 2157–2016 (PEFC ST 2002:2013) «Chain of custody certification of timber and non-timber products. Main requirements»;

– to review international best practices of methods and approaches to biological and landscape diversity conservation during forest use: European best practices;

– to develop proposals for improvement of methods, techniques, technology for biological diversity conservation as a part of forest protection action plan;

– to improve methods, techniques, technology for biological diversity conservation as a part of forest restoration action plan;

– to review the legal framework of forest cuts, forest restoration, demarcation of cutting areas, forest inventory to explore opportunities for planning of biodiversity conservation actions;

– to develop proposals for improvement of forest use planning practices in the context of biological diversity conservation.

1.3 Legal framework and general requirements

The following information and legal resources were used to select applicable regulatory legal documents in the forest sector: National legal Internet portal of the Republic of Belarus, National Fund of technological regulations, specialized legal information systems, information retrieval systems, foreign databases of regulatory and legal information and dedicated websites of the current international agreements and initiatives. The documents were proved to be accurate and up-to-date by means of a) cross-validation of data contained in a legal document in online databases and b) specialized information search system (relevance of data is ensured by software developer).

The task was set to develop draft national standards (STB), including main standard «Sustainable forest management and forest use. Main requirements», draft standards «Group certification of forest management and forest use systems. Requirements» revised by reference to international PEFC standard ST 1002:2018 «Group Forest Management Certification – Requirements», draft standard «Chain of custody certification of timber and non-timber products. Main requirements».

The draft national standards were developed with observance of the current Belarusian legislation.

2 Objects and methodology of the study

2.1 Objects of the study

Objects of the study are national standards of the Republic of Belarus in the field of forest certification as well as technological regulations applicable for the forest sector when it comes to metods and approaches of biological diversity conservation.

2.2 Methodology of the study

2.2.1 Stages of the development of national standards

The development of national standards is guided by Resolution of the State Standardization Committee of the Republic of Belarus No. 59 dated 12.07.2017 "On approval of the Rules for the development of the national standards of the Republic of Belarus" [1] (hereinafter referred to as the Rules). The development of a national standard must involve the following stages: preparation, development and review of draft national standard; development and review of the final draft of a national standard; submission of the final draft for expert review.

2.2.2 Development of draft national standards

The preparatory works prior to the development of a draft national standard include: development, approval and compliance of terms of reference for development of a national standard (hereinafter referred to as terms of reference). Draft national standard is developed in compliance with the terms of reference. The draft standard must contain the following sections: scope, normative references; terms, definitions and abbreviations; general provisions; minimum management system requirements; components of the text. An executive summary and a notice about the draft standard development are made for each draft standard being developed.

According to the Rules, the notice about the draft national standard development, the draft national standard with an executive summary are forwarded to Science and Production Republican Unitary Enterprise "Belarusian State Institute for Standardization and Certification" (hereinafter referred to as Gosstandart, BelSISC) to be uploaded to official Gosstandart website to be accessed by all interested parties [2].

2.2.3 Review of database of normative legal information in the forest sector

The following information and legal resources were used to access normative legal information in the forest sector:

– National legal Internet portal of the Republic of Belarus (available at pravo.by) [3]. The portal is supported by the National Centre for Legal Information of the Republic of Belarus

– National Fund of technological regulations (available at tnpa.by) [4]. The National Fund of TR is formed and supported by the State Standardization Committee of the Republic of Belarus;

– legal information system normativka.by (available at normativka.by) [5]. The legal acts are taken from the reference databank of legal information of the Republic of Belarus;

– BSTU library is one of the largest university libraries that possesses its own stock of literature and provides access to full-text databases.

3. Development of draft national standards of the Republic of Belarus

3.1 Draft national standard STB 2157 (revised)

3.1.1 Goal of development of national standard STB 2157 and general information

The terms of reference for the development of STB 2157-20XX "Chain of custody certification of timber and non-timber products. Main requirements" were developed and approved by the Ministry of Forestry of the Republic of Belarus and agreed by the State Standardization Committee of the Republic of Belarus.

The goal of development is to revise STB 2157–2016 (PEFC ST 2002: 2013) [6] to make it compliant with international document PEFC ST 2002: 2020 "Chain of custody of forest-based products - Requirements" [7].

3.1.2 Requirements of national standard STB 2157

The standard sets the requirements to identification of timber and/or non-timber products by origin conforming to PEFC requirements (hereinafter referred to as PEFC product identification). This is done by organization to inform the customer about the origin of timber and (or) non-timber products from sustainably managed forests as well as about any recycled and PEFC-controlled materials contained in the product. The document must contain PEFC claims for each product. PEFC identification of products involves classification of supplied timber and/or non-timber materials by origin categories. The classification is made by converting the information about the origin of the supplied materials into the information about the origin of forest-based products made of the materials.

The standard prescribes methods of product identification, including physical separation method, percentage and credit methods, requirements to the management and procedure for product identification process, health and safety requirements.

The standard can be applied for declaring the conformity of the forest-based product origin as well as for third party evaluation.

3.1.3 Stages of discussion and approval of national standard STB 2157

The draft standard has 8 divisions. An executive summary and a notice about the standard development are attached to the draft standard. The draft STB 2157 and the executive summary were posted on the official Gosstandart website to be available to all interested parties. The documents were forwarded for approval and review to design, research and forest institutions and non-governmental organizations. 15 organizations returned their reviews that contained no comments or suggestions on the draft standard. The final draft was developed and then approved by the Ministry of Forestry of the Republic of Belarus and posted on the website for national standards development https://stb.by ("Development" web page). The Rules compliant file of the standard was made and forwarded to BelSISC for expert review [2].

3.2 Draft national standard STB 1708 (revised)

3.2.1 Goal of development of national standard STB 1708 and general information

The terms of reference for the development of STB 1708-20XX "Sustainable forest management and forest use. Main requirements" were developed and approved by the Ministry of Forestry of the Republic of Belarus and agreed by the State Standardization Committee of the Republic of Belarus.

The goal of development is to bring STB 1708-2006 into compliance with the Forest Code of the Republic of Belarus No. 332-3 dated 24.12.2015 [8], with new approaches towards landscape

and biological diversity conservation, environmental, economic and social aspects of forestry at both the local and international levels, as well as with the international standard PEFC ST 1003:2018 "Sustainable Forest Management – Requirements" [7].

The subjects of standardization are requirements to sustainable forest management and forest use system, its evaluation and improvement; criteria and indicators of sustainable forest management and forest use.

3.2.2 Requirements of national standard STB 1708

The standard sets the main requirements to sustainable forest management and forest use in the Republic of Belarus aiming to ensure high productivity and resilience of forest ecosystems, to promote their biological diversity, to mitigate or eliminate negative effects of forestry production on the environment, sustainability of forest use, cost-effectiveness of forestry production, its social impacts.

The requirements of the standard are applicable to forest management and (or) forest use, as well as to third party evaluation.

3.2.3 Stages of discussion and approval of national standard STB 1708

The draft standard has 12 divisions that were posted on the official Gosstandart website to be available to all interested parties. The draft STB 1708 and its executive summary were forwarded for approval and review to design, research and forest institutions and non-governmental organizations. The draft national standard of the Republic of Belarus STB 1708 has been posted on the website for national standards development https://stb.by ("Development" web page). The Rules compliant file of the standard was made and forwarded to BelSISC for expert review [2].

14 organizations returned their reviews. Comments and suggestions were made by Mogilev SPFA, the Ministry of Natural Resources and Environmental Protection, RUE "Centre for international environmental projects, certification and audit "Ekologiyainvest", EI "Belarusian State Technological University". The feedback was examined and a review summary was made. The final draft of the national standard was prepared on the basis of the review of comments and suggestions. The final draft was agreed by the Ministry of Forestry.

3.3 Draft national standard STB "Sustainable forest management and forest use. Requirements to group forest management"

3.3.1 Goal of development of the national standard STB "Requirements to group forest management"

The goal of development of the STB is to bring forest management and forest use certification systems under the National Conformity System of the Republic of Belarus with the international PEFC (Programme for the Endorsement of Forest Certification) requirements.

The draft STB "Sustainable forest management and forest use. Requirements to group forest management" was developed to make the international standard PEFC 1002:2018 "Group Forest Management Certification – Requirements" [7] applicable in the Republic of Belarus.

3.3.2 Requirements of the national standard "Requirements to group forest management"

The subject of standardization are requirements to a group of legal entities engaged in forest management which was created to jointly implement sustainable forest management and forest use and confirmation of conformity of forest management and forest use systems to the STB 1708 requirements and to the group management system.

The terms of reference for the development of STB "Sustainable forest management and forest use. Requirements to group forest management" were developed and approved by the Ministry of Forestry of the Republic of Belarus and agreed by the State Standardization Committee of the Republic of Belarus (including the title of the standard).

3.3.3 Stages of discussion and approval of national standard STB "Sustainable forest management and forest use. Requirements to group forest management"

The draft standard has 11 divisions. The draft national standard and its executive summary were posted on the official Gosstandart website to be available to all interested parties. The draft STB and its executive summary were forwarded for approval and review to design, research and forest institutions and non-governmental organizations. The draft national standard has been posted on the website for national standards development https://stb.by ("Development" web page). The Rules compliant file of the standard was made and forwarded to BelSISC for expert review [2].

12 organizations returned their reviews. Comments and suggestions were examined and a review summary was made. The final draft of the national standard was prepared on the basis of the review of comments and suggestions. The final draft was agreed by the Ministry of Forestry.

4 Development of proposals for improvement of the existing methods and techniques of biological and landscape diversity conservation during forest use

4.1 Development of proposals for improvement of methods, techniques, technology for biological diversity conservation as a part of forest protection action plan

4.1.1 Conservation of biological diversity when using pesticides for plant protection purposes

Currently, the science of forest protection does not provide enough alternative options to stop using pesticides completely. On the contrary, more intensive forest management and development of nurseries and forest seed facilities of the country as well as widespread artificial reforestation call for heavy use of pesticides and other means of forest protection. On the one hand, this approach can promote the highest possible yield of plants, preservation and biometric indicators of nursery stock, reduce cultivation costs, improve yield of forest seed plantations, protect forest plantations and harvested timber. On the other hand, modern broad-spectrum pesticides are harmful for many non-targeted living organisms; the pesticides pollute air, soil, superficial and underground waters and cause additional hazards for forestry workers. Active and additive substances contained in pesticides are known to be toxic, carcinogenic and mutagenic for a wide range of living organism, including mammals and human beings. Currently, 70 plant-protecting agents have been certified for application in forestry. All of them are chemicals-based and can have adverse environmental impacts. Common practice shows that on average, 8–12 enlisted plant-protecting agents are annually used by forestry enterprises.

The Republic of Belarus has a comprehensive legal framework that regulates the use of pesticides and aims to mitigate their environmental impacts [9–15]. However, not all the legal documents are applicable to the forest sector, some of their provisions are inconvenient for practical implementation. The use of new advanced equipment for plant-protecting agent application is often hindered by the unrefined legal framework. For instance, the use of drones for plant-protection purposes has many advantages over conventional equipment and approaches:

– the treatment is highly precise, e.g., an individual tree top, which results in reduced pesticides consumption and lower environmental impacts;

– small-drop spraying of pesticides cuts the pesticides consumption in half (by 50%);

– no physical impact on soil and cultivated plants;

– no hazards for drone operators (no risk of inhalation and intoxication) due to remote control of the treatment process (3 km);

– treatment can be automated by using the intellectual detection system of pest infestation or weakening of plants [16–19].

4.1.2 Conservation of biological diversity during forest sanitation

Over the recent years, sanitary measures (SM) have been implemented quite extensively, which can be explained by large-scale pathological effects and adverse abiotic factors. Most typically, large-scale forest diebacks are of intermittent character. Currently, we can observe the descending phase of the largest forest pathological processes that have ever been registered by siviculturists (Figure 4.1). Sanitary measures, in particular, clear sanitary cuts have a major effect on forest biodiversity.

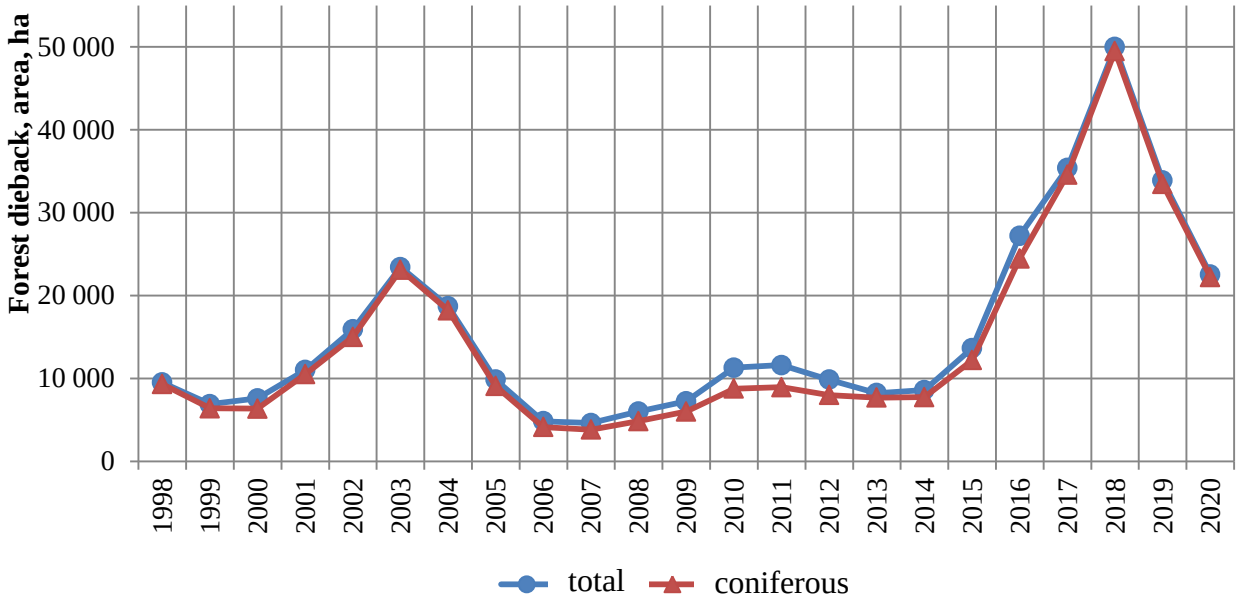


Figure 4.1 – Trends of forest dieback in the forest fund of the Republic of Belarus

Both clear cuts and clear sanitary cuts are bound to disturb natural areas, so it is utterly important to conserve certain internal cenotic components to maintain the forest biodiversity. Such components do not damage the phytosanitary environment and include old dead-standing trees, windfall, hollow trees, clumps of young trees, undergrowth. This simple action of preserving these forest components favours the diversity of habitat conditions and substrates, accumulation of wood organic matter, soil enrichment, natural reforestation.

It is well known that irruptions of wood borers are accompanied by some regulatory and control factors which help to eliminate the pests. Such factors are: growing populations of pest predators and parasites, increased infestation of pathological agents [20]. Removal of dead-standing trees that have been infested and then abandoned by wood borers may have a reverse environmental effect that disturbs natural regulatory mechanisms. Selective sanitary cuts (SSC) and debris clean-up (DC) aim to improve general sanitary conditions and health of forests; therefore, the recently fallen trees and severely weakened trees (in cases provided by the Sanitary Rules [21]) must be removed in the first place. For instance, in ash stands, maximum forest protection effect and control of Chalara ash dieback can be achieved through the removal of drying trees and living fallen trees, but the removal of dead-standing trees have no sanitary effect [22].

During sanitary cuts, it is essential to create favourable conditions for new forest growth, thus, the cuts must be combined with measures promoting natural forest restoration.

Large-scale infestations and dieback of forests, e.g., ash and elm forests of Belarus, call for necessary actions to preserve gene pool of resilient plants. When sanitary and other cuts are carried out, we must strive to preserve even individual trees of the above tree species, in case they have no symptoms of weakening.

Main proposals for mitigation of negative impacts of sanitary cuts on biological diversity of forests:

1. Sanitary cuts, i.e., clear sanitary cuts, selective sanitary cuts and debris clean-up, must ensure that about 10–15 m^3 of non-merchantable old dead-standing trees and windfall trees infested and abandoned by wood borers remain in the forest. This measure is suggested to be laid down in certain chapters of the Sanitary Rules [21];

2. In order to preserve the gene pool of resilient ash and elm trees during all cuts, including clear cuts, undergrowth and individual trees of the mentioned species are to be left in the forest. These species should be listed in Para 35 of the Sanitary Rules [21];

3. In order to conserve the biodiversity of forests and promote their natural regenerative capacity, sub-paragraph 2 paragraph 25 of the Sanitary Rules [21] shall be reworded as follows: “In order to promote natural reforestation, biological diversity of forests, new forest generations of

complex composition and structure, the following forest components must be left during sanitary cuts: trees of condition class I, trees with nests of predatory birds, hollow trees in the quantity of 20 pcs per 1 ha (if available) and (or) groups of 3–5 seed trees in the quantity of 4-5 pcs per 1 ha. Clear sanitary cuts must ensure maximum conservation of undergrowth and promote natural reforestation";

4. Forest restoration on areas temporarily unstocked by clear-cutting must be done by either natural reforestation or combined reforestation with partial forest plantation. Forest restoration on areas unstocked due to pest and disease control must provide for succession of the affected tree species. The succession must follow the natural succession schemes; alternatively, the affected tree species can be used for forest restoration, but its proportion in the species composition must not exceed 5 pcs.

4.1.3 Conservation of biological diversity during cleaning-up of felling areas from logging waste

Logging waste is wood residues containing branches, twigs, needles, leaves, tree tops, stumps, roots, stem parts [23]. Currently, the logging waste is an extensive ecological niche which is estimated at 15–35% of the total timber harvest. The average interval of improvement cuts and other felling types in most forests is 10–20 years. This, the cuts regularly generate new amounts of logging waste. This has a versatile impact on forest environment. On the one hand, it accelerates the cycle of matter and improves habitats of the remaining trees or new generations of forest. On the other hand, it may favour widespread development of forest pests and diseases. Specifically, improvement cuts may result in root rot in young and middle-aged pine forests, in particular, artificial plantations. They may also enhance the invasive factor of pathogenic organisms [24]. Accumulation of logging waste in pine forests was one of the infecting factors that triggered the outbreak of ipid bark beetle and other wood borers which caused large-scale dieback of pine forests starting in 2014 and continuing to this day [23].

Therefore, when carrying out forest cuts, the felling areas must be cleaned, the logging waste must be duly disposed by environmentally and forest friendly methods.

Proposals:

1. Case-specific approaches must be used for cleaning of felling areas from logging waste. Chapter 7 of the Sanitary Rules [21] must be amended by provisions that would allow burning (mulching) of logging waste from infected species when doing clear sanitary cuts and other cuts in wood borer centers, vascular and cancerous diseases in mixed forests. This simple action shall favour the biodiversity without promoting pests and diseases and shall reduce disposal costs of logging waste. The Forest Cutting Rules [23] allow several logging waste clean-up methods to be used simultaneously on one felling area;

2. Paragraph 47 of the Sanitary Rules [21] should be revised; compulsory burning (mulching) of logging waste in blister rust centers should be abolished because it has no scientific justification;

3. A technology should be implemented that would allow using of logging waste in pine forests to reduce stem borers populations that can cause focal damage to forests. It is suggested to implement "Recommendations on using traps in pine forests" developed at BSTU.

4.1.4 Control of alien invasive species that pose a threat to biodiversity

The issue of biological invasions is becoming ever more challenging. New species appear and pose certain threats to various forest associations. The monitoring of invasive phytopathogens has shown that on average one new dendropathogenic species is registered in Belarus annually. Besides, it should be noted that they appear at more frequent intervals (Figure 4.2). Thus, over the past several years, some new domesticated quarantine species have been detected in Belarus. They include alder stem and root necrosis agents, oomycetes *Phytophthora alni,* alder leaf rust agent Melampsoridium *hiratsukanum*, pine-leaf cast agent Cyclaneusma *minus*, oak leaf blight agent *Hyphantria cunea*, etc. It has been reported that distribution areas of many pests are expanding and

approaching the boundaries of Belarus. Some of these invasive species are enlisted in the Unified Register of Quarantine Objects of the Eurasian Economic Union.

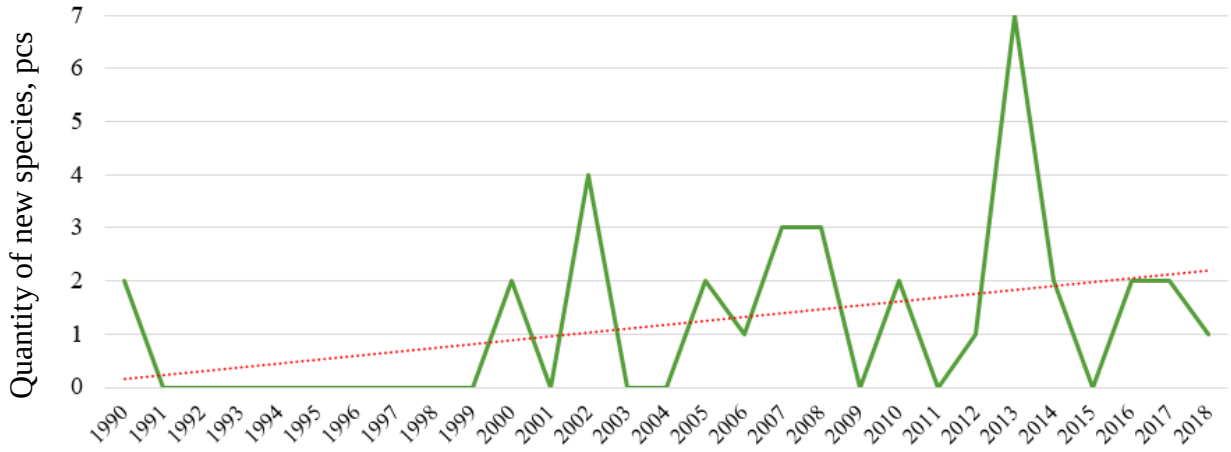


Figure 4.2 – Quantity of invasive phytopathogens by years of invasion in Belarus

Review of phytosanitary risks, monitoring and forecast of distribution as well as control of quarantine species are not carried out in Belarusian forests or are of very irregular character. Such approach contravenes the Law on Plant Protection and Quarantine [12].

Monitoring and effective control of the new phenomena are impeded by insufficient information about pathogen invasion symptoms, practices of diagnosing of adventitious species, lack of techniques to forecast their distribution as well as rules for detection and control of the new pathogens. All these factors pose large threats to sustainable forest use, productivity and biodiversity of forest ecosystems.

Proposals:

1. To estimate phytosanitary risks of quarantine objects that are potentially dangerous for the national forest sector;
2. To develop a forecasting algorithm for pest and disease invasions of the territory of Belarus;
3. To establish a working system based on up-to-date diagnostic techniques for monitoring of invasive pests and disease agents;
4. To develop recommendations for detection and control of quarantine pests and disease agents in Belarusian forests, in particular, pathogens of the highest phytosanitary risks.

4.2 Improvement of methods, approaches, technology for biological diversity conservation as a part of forest restoration action plan aimed to maintain species and genetic diversity of forests

Forest restoration is a key component of responsible and sustainable forest management. An important task is to preserve biological diversity of forest ecosystems while maintaining cost-effectiveness of restoration actions on temporarily unstocked areas or forested areas badly affected by adverse weather factors.

4.2.1 Ways of biological diversity conservation during forest restoration

Biological diversity conservation during forest restoration shall be done in several ways.

Firstly, genetic diversity conservation of restored areas shall be ensured. Unique genetic objects, i.e., superior and elite trees, superior stands, genetic reserves, shall be identified and preserved. The genetic reserves shall be located in specially protected natural areas as well. The development concept of forest seed breeding shall be revised; the sources of seeds with valuable hereditary properties shall be localized. To achieve this, trees and stands with unique properties must be identified, their hereditary properties must be checked and permanent seed depots must be established in certain geographical locations. Locally, genetic diversity conservation can be

promoted by extensive natural reforestation which mainly occurs from local genetically diverse sources of seeds.

Secondly, species diversity of trees shall be maintained and enhanced during forest restoration. In many cases, the limiting factor is insufficient soil fertility which does not make it possible to use various species in forest plantations. However, the species diversity of Belarusian artificial forests plantations is also limited by the common practices of forest nurseries to grow nursery stock of coniferous species which are considered to be most valuable. A wider use of partial forest plantations and simultaneous reservation of seed trees of maximum possible species can promote species diversity of artificial plantations. The same action will promote genetic diversity of restored forest stands.

Thirdly, forest restoration actions shall be aimed to preserve not only species diversity of forests but also other forest biogeocenosis components. These components primarily include undergrowth, live soil cover that are heavily affected by both forest cuts and restoration preparatory works. In order to prevent the species diversity loss of undergrowth and live soil cover, it is required to keep seed biogroups which will ensure conservation of undergrowth and live soil cover components within the biogroup boundaries. Soil cultivation must be done in the way to minimize the width of the cultivated corridors, having regard to the fact that soil cultivation must mitigate the competitive impact of weed grass and vegetation. Precision farming that provides access to spatial coordinates of plant rows will make it possible to reduce the width of both cultivation corridors and weeding corridors.

Fourthly, biological diversity conservation can be highly promoted if the operating load on natural forest ecosystems is reduced. The concept of plantation systems shall be revised and repurposed for multifunctional plantations which are aimed to replace the timber which has been harvested during cuts of natural forest. Large-scale multifunctional plantations can be established through maximum possible use of lands transferred to the forest sector from other land users for the purpose of timber plantations. The technology for establishment and maintenance of such plantations is very much the same as for common forest plantations.

4.2.2 Conservation and maintenance of genetic diversity of restored forest stands

The forest seed breeding of Belarus goes along two directions: population and plantation seed breeding, each having approximately the same proportion in the total seed harvest for forest restoration. The main goal of the plantation seed breeding is to promote forest productivity and quality of timber whereas the population seed breeding is intended to conserve and improve biological diversity of forests, their resilience to adverse environmental factors.

Main source of seeds for forest restoration is a permanent forest seed facility with forest seed plantations as key objects. The forest seed plantations are specialized sites for harvesting of seeds of main tree species. There are first- and second-order forest seed plantations in Belarus (Figure 4.3).

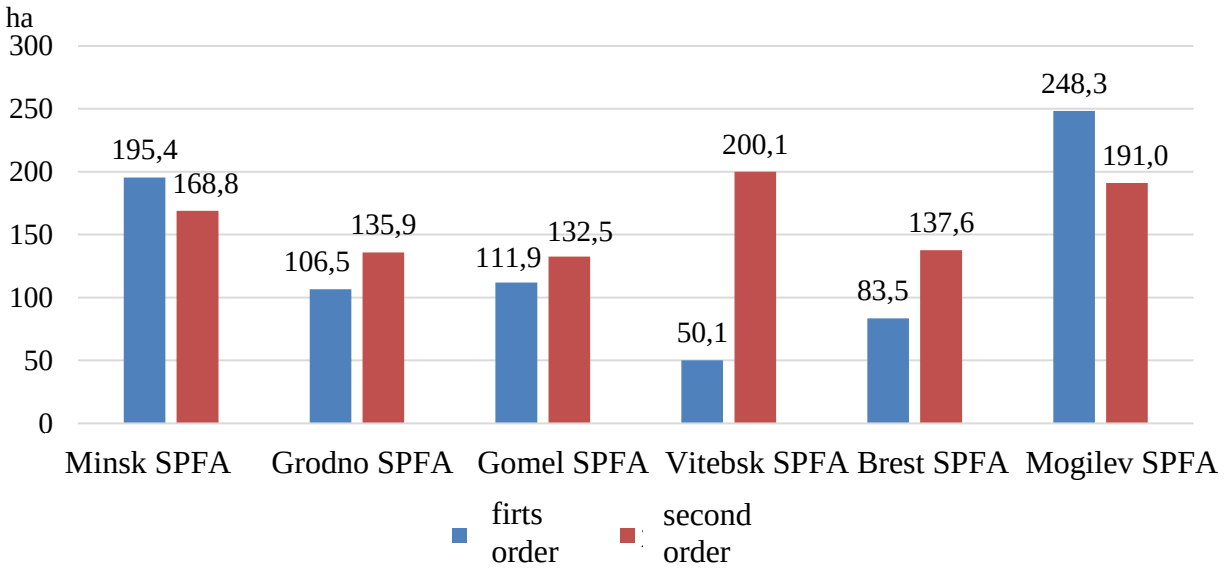


Figure 4.3 – Forest seed plantations by type

As of 2020, the country had 795.53 ha of first-order forest seed plantations, with 23.3% of common pine, 47.6% of English oak and 8.5% of European spruce and larch each. Second-order forest seed plantations occupy 965.87 ha, with 69.9% of common pine and 30.1% of European spruce. The second-order forest seed plantations make the basis for forest seed breeding and increasingly replace the first-order plantations. The areas of annually established forest seed plantations are shown in Figure 4.4.

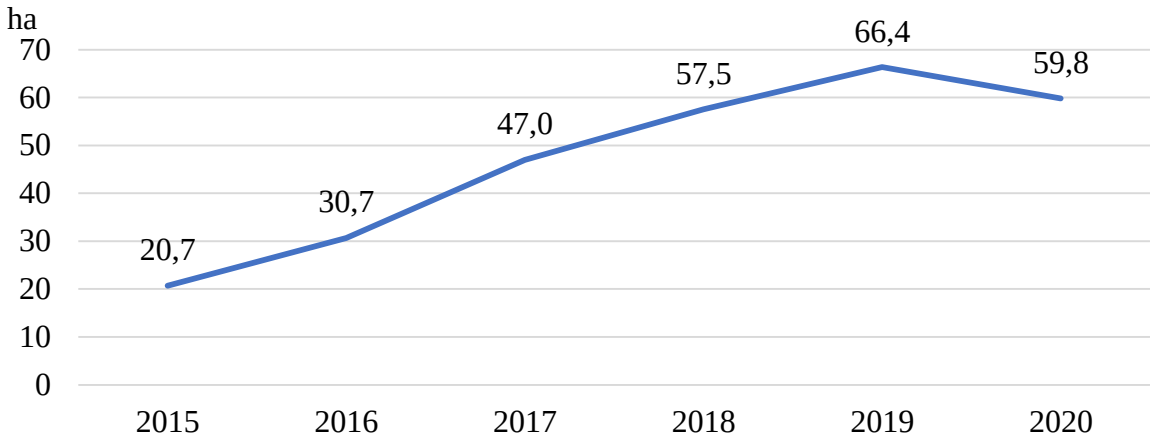


Figure 4.4 – Area of newly established forest seed plantations

The areas of annually established forest seed plantations are spacious due to the ever-growing demand for selection planting stock. The trends of production of the selection planting stock are shown in Figure 4.5.

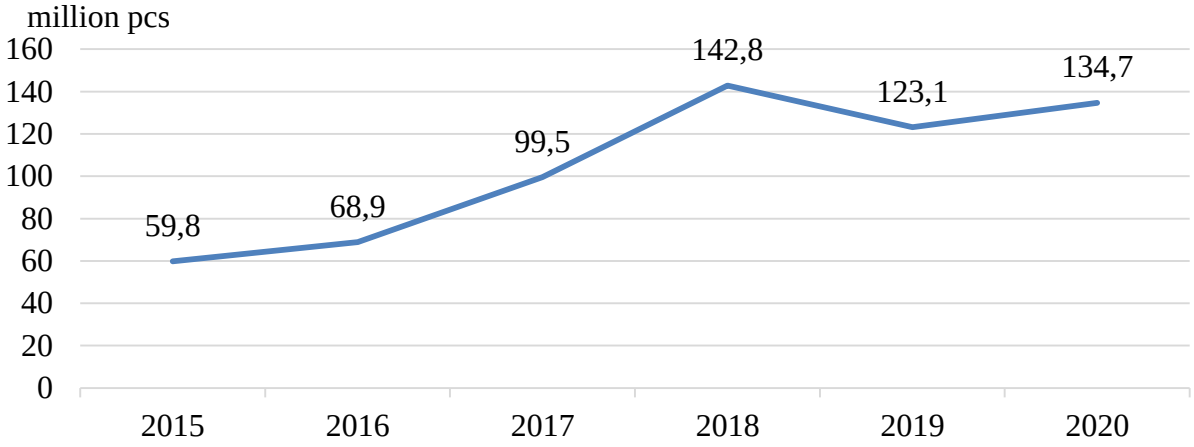


Figure 4.5 – Production of selection planting stock

Over the recent five years, the production of the selection planting stock has nearly doubled. However, the coniferous planting stock has the proportion of over 90% in the forest nurseries, so forest seed plantations of conifers occupy the largest area and most selection saplings and seedlings are those of common pine and European spruce. As more young trees are grown, they are widely used for forest plantations (Figure 4.6).

The proportion of selection planting stock of the total established forest plantations has increased from 42% to 56-57% over the last five years. It should be noted that coniferous planting stock has the largest proportion, so the actual proportion of the selection planting stock is higher. For instance, in 2020 it amounted to 64% of the total established forest plantations of conifers which is considerably higher than 50%. This scenario can pose certain threats to genetic diversity of the established forest plantations of conifers. The situation will further aggravate if second-order plantations occupy larger areas.

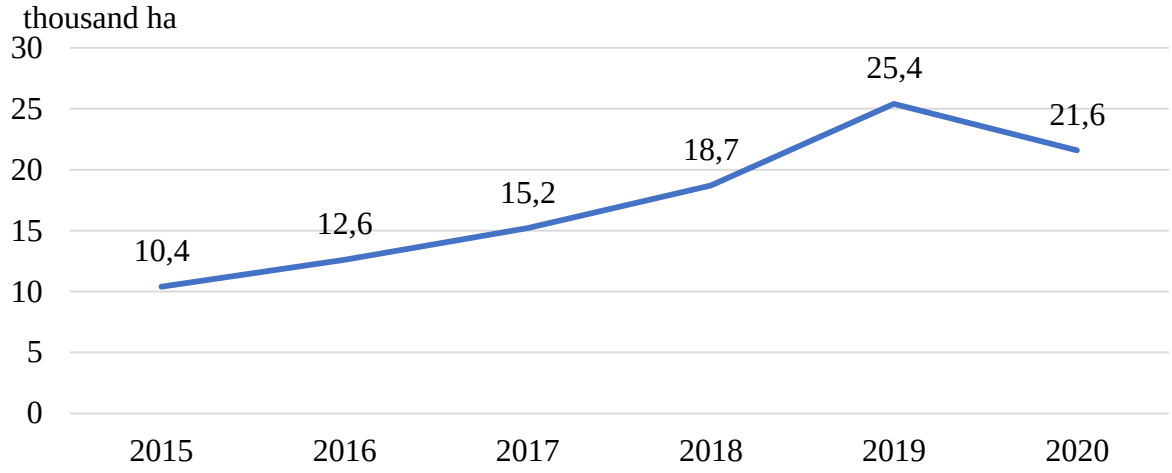


Figure 4.6 – Trends of establishment of forest plantations by selection saplings and seedlings

Potential negative implications for genetic diversity of man-made plantations are caused by the highly limited amount of mother plants that are used to obtain grafted planting stock for second-order plantations. The technology requires elite trees or their vegetative offspring to be used as grafting material. However, the number of elite trees in Belarus was quite inconsiderable, i.e., about 200 common pine trees and 50 European spruce trees. Regular dieback and windblow events affected the trees. Currently, there are about 93 common pine trees and only 1 European spruce tree. Some offspring can be found in archived forest seed plantations. Distribution of elite trees by SPFAs is shown in Figure 4.7.

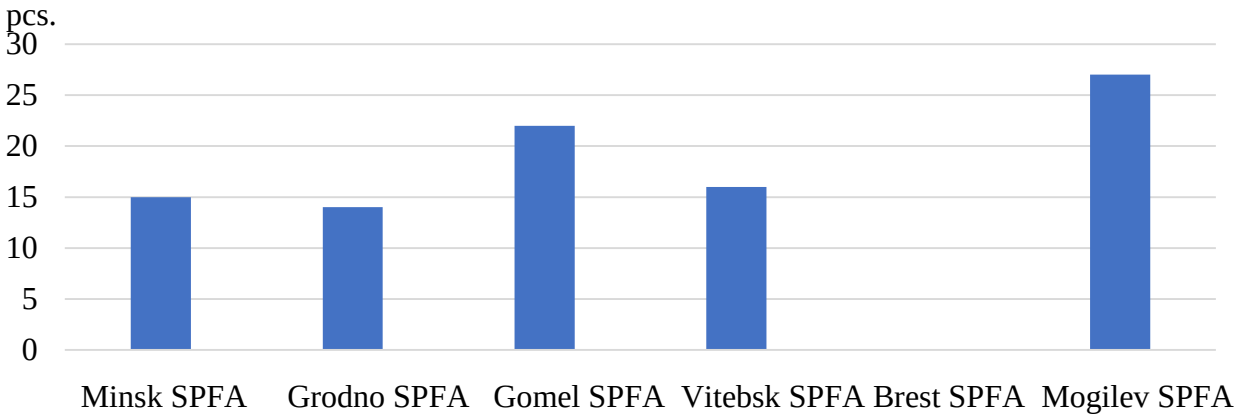


Figure 4.7 – Distribution of elite trees of common pine by SPFAs

Therefore, only limited number of mother trees can be used to collect seeds and to grow planting stock for forest restoration purposes across the country. Besides, there is an uncontrolled migration of mother trees offspring from south to north and in the reversed direction. Climate change drives the trees from northern regions to southern ones and further climate warming can badly affect the resilience of established forest plantations.

These negative impacts can be mitigated if forest seed plantations are established locally, with prevailing local sources of planting stock. However, Figure 4.7 shows that the location of available elite trees does not make it possible, because the establishment of a forest plantation requires minimum 50 clones to be used.

No region has the required number of elite trees of common pine; the situation about European spruce is disastrous at large. Therefore, testing of superior trees offspring and creation of a bank of candidate elite trees must be started immediately for main forest-forming species.

On the other hand, the proportion of population seed breeding must be increased during forest restoration. At present, the potential of superior stands, which are the most productive and resilient local populations, is hardly used. There are 2,423.5 ha of superior stands in Belarus, with 67.7% of common pine, 16.6% of English oak, 7,9% of drooping birch and 3.7% of black alder. Harvesting of seeds in superior stands is highly complicated and requires tree top climbing. A technology has been developed for establishment of population-cloning forest seed plantations on the basis of best trees in superior stands. The technology will make it possible to extensively use the local gene pool of the best forest stands for collection of seeds. However, the current regulatory documents of the Ministry of Forestry do not mention this type of plantations. Therefore, Resolution of the Ministry of Forestry No. 73 dated 19.12.2016 must be duly amended. The enclosed “Guidelines for establishment (creation), identification and use of permanent forest seed facilities on forest areas depending on demand for seeds and forest planting stock for reforestation an afforestation” must be supplemented with a paragraph declaring the possibility to use the best normal and normal trees for establishment of the first-order forest seed plantations. “Requirements to forest seed breeding” (Order of the Ministry of Forestry No. 318 dated 30.12.2019) must also be amended. Paragraph 4.2 must provide for establishment of forest seed plantations by population-based selection.

The potential of natural reforestation must be used to the largest extent possible to conserve local genetic diversity. In the first instance, combined forest restoration must be used more extensively, in particular, the proportion of selection planting stock must be increased. This will make it possible to balance negative impacts on genetic diversity of restored forest stands in the context of the current situation of forest seed breeding. However, partial forest plantations are rarely established, as there is no scientific justification of such issues as optimum conditions, layout plan of plants, methods of quality control and transfer to forested areas. If solutions to these issues are found, the areas of partial forest plantations can be expanded which will favourably affect genetic diversity of the restored forests.

4.2.3 Conservation of species diversity during forest restoration

Mixed artificial forest plantations have a key role in conservation of species diversity. The forest sector of Belarus places high emphasis on establishment of mixed artificial plantations. Figure 4.8 shows trends of creation of mixed forest plantations.

Since 2008 there has been a steady growth of mixed artificial plantations which still remains until this day. Most mixed forest plantations are composed of two species because such plantations are easy to create. Besides, the planting stock grown by forest nurseries is not diverse enough. Over 90% of saplings and seedlings are conifers. Deciduous species have a very small proportion and are mainly represented by English oak. Recently, plantation of drooping birch and black alder has taken an upward trend. In this situation, a wider use of such species as small-leaved linden, Norway maple and witch elm is hardly possible. However, as the areas of European spruce are reduced due to climate change impacts, the above species could replace the spruce and be jointly used in the mixed forest plantations.

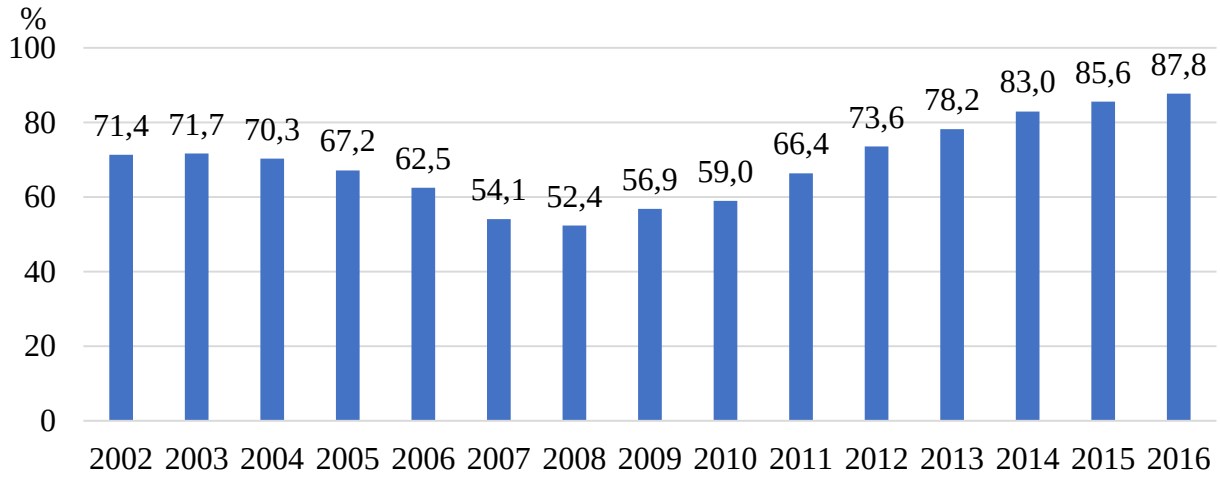


Figure 4.8 – Areas of newly-established mixed forest plantations

One of the most common adaptation tools of forestry aimed to enhance species diversity of forests is support for plants migration. Climate change leads to change in traditional distribution areas of some species. The main goal is to predict the direction in which the plants will migrate and to timely start introducing these plants into species composition of forest stands.

The only non-domestic species whose migration can be monitored is common beech whose traditional distribution area is close to the Belarusian borders (Figure 4.9).

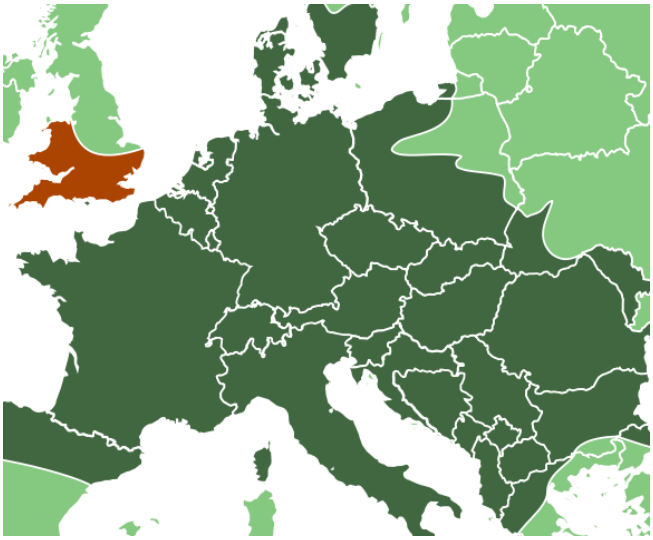


Figure 4.9 – Distribution area of common beech

Migration of some aboriginal species can promote species composition of forests, among them silver fir and durmast oak. Both species are distributed on small areas in western regions of the country (Figures 4.10, 4.11).

According to the Forest Cadastre, silver fir occupies only 11.3 ha in the territory of Belarus. The largest population of this tree species is detachedly located in Tisovik area, Belovezhskaya Pushcha. Individual silver fir trees can be found in the territory of Pruzhanskiy forestry enterprise (Pikhtarnik preserve) and Kletsk forestry enterprise. Silver fir is redlisted relict species, its population demonstrates a steady downward trend.

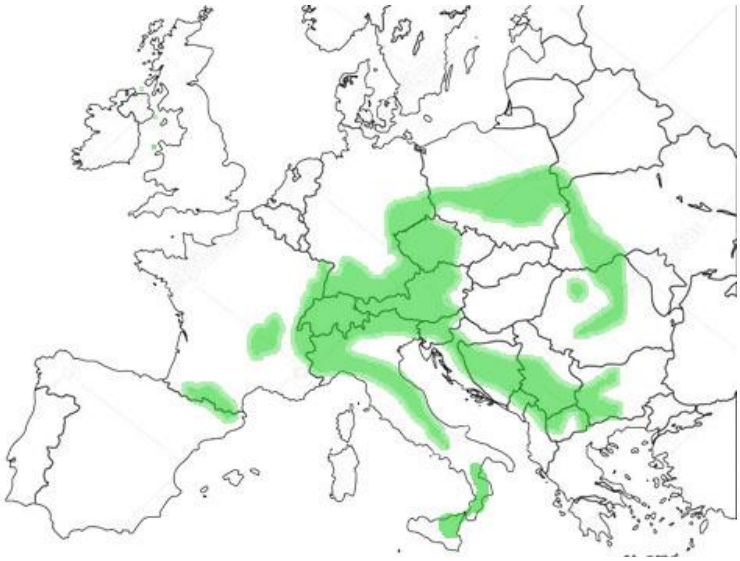


Figure 4.10 – Distribution area of silver fir by data [25]

Durmast oak is widely distributed across Europe; its distribution area covers the territory of Ukraine and approaches the southern border of Belarus. Unlike English oak, the durmast oak is more heat-loving and less demanding to soil fertility and moisture.

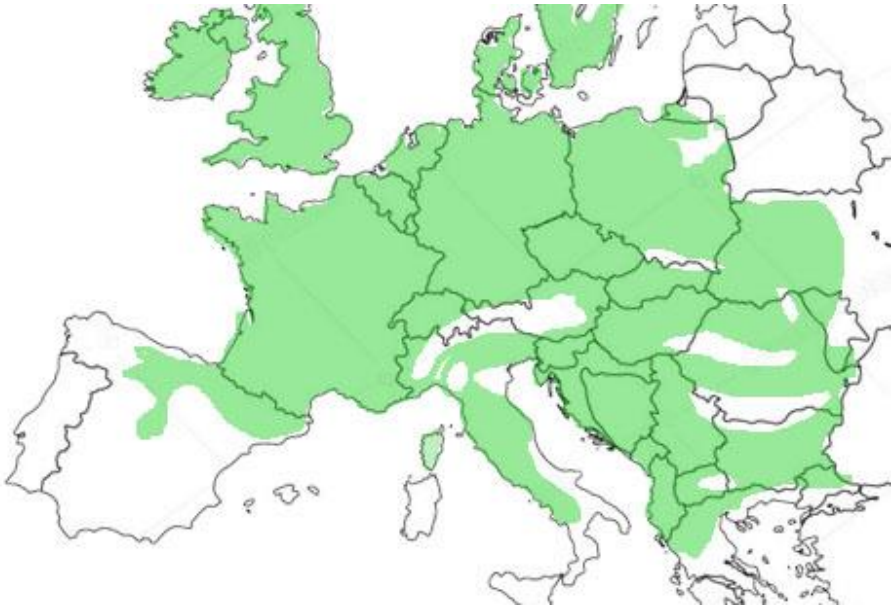


Figure 4.11 – Distribution area of durmast oak

The Forest Cadastre reports that durmast oak occupies 827.4 ha in the territory of Belarus. It can primarily be found in Belovezhskaya Pushcha National Park; however, according to V.I. Parfenov, M.P. Mlycharnik, it occurs in Glubokskiy forestry enterprise and some urban parks. This oak species is a redlisted one.

If seed depots and planting stock growing technology are developed, the three mentioned species can be introduced into mixed forest plantations, predominantly in Brest and Grodno regions and later in the south of Minsk region

Thus, diversification of tree species is mainly impeded by small production volumes of planting stock of small-leaved linden, Norway maple, witch elm, etc. Besides, some forestry workers are quite conservative when it comes to the range of species and mixing schemes.

Species diversity of newly-established forest plantations can also be enhanced by supplementing the species composition with species that were not initially enlisted. This will make it possible to create plantations containing a great variety of species and create biogroups, e.g., hardwood broad-leaved biogroups amidst spruce plantations or biogroups of black alder in lowland pine plantations.

The current "Regulations of reforestation and afforestation" do not contain any direct restrictions or prohibitions on supplementation of forest plantations by various species. However, the experience of various audits shows that the Regulations provide for the supplementation only by the species that are initially enlisted for forest plantation. To eliminate the contradiction it is recommended to amend the Regulations by inserting a clause that would allow supplementation of forest plantations by other coniferous and hardwood broad-leaved species. In the event of uneven dieback of trees, biogroups may be created.

The above method of species diversity enhancement poses certain risks. When forest plantations are supplemented by coniferous or hardwood broad-leaved species, softwood broad-leaved species, e.g., drooping birch, may occasionally be introduced.

Natural reforestation (both assisted and non-assisted) usually requires no special measures to promote species diversity. Sometimes, when natural reforestation is assisted by artificial planting or sowing, the species composition of forest plantations can be supplemented by tree species that otherwise would hardy appear in the area. Current laws on forest regeneration contain no restrictions on using this method of species diversity enhancement. This method is applied when an area contains vigorous trees of main species in the quantity of 3-4 thousand trees per ha, aged two years and older, minimum 1 m high. Therefore, the supplementation provision can be understood as follows: only the species that have already started natural reforestation shall be used for sowing or planting. Consequently, the Regulation must be amended by the following wording: "any tree species can be used to assist natural reforestation by sowing or planting".

Biogroups of seed-bearing plants and groups of preserved undergrowth are good sources of conservation of both genetic and species diversity on areas under forest restoration.

Transition from conservation of individual seed trees to conservation of their biogroups will promote conservation of trees of other species and undergrowth species that will further generate seeds for natural reforestation. Forest cutting rules of the Republic of Belarus [23] provide for preservation of seed-bearing trees and (or) their groups. However, the Rules contain no requirement for preservation of trees of other species or undergrowth plants. Virtually, the regulatory requirement laid down in the Rules is understood as preservation of trees of the species, very frequently the only one, that the forestry workers see as most promising for forest restoration. For instance, in coniferous forests only common pine trees are preserved both as individual seed trees and their groups.

It is necessary to switch from preservation of seed trees groups to untouched seed biogroups that include both undergrowth trees and live soil cover. So, the Forest cutting rules of the Republic of Belarus shall be supplemented by a term of biogroup as a complex of trees, shrubs and grass vegetation intended to conserve biodiversity and forest restoration. Paragraph 25 of the Forest cutting rules shall be amended as follows: all tree and shrub species shall be preserved within a biogroup, moreover, the quantity of seed-bearing trees of main species shall be within 3-5 trees.

Preservation of undergrowth groups is also intended to conserve and promote genetic and species diversity. In this event, multistorey variously-aged forest stands are formed that favourable affect general resilience of forest plantations.

The current edition of "Regulation for reforestation and afforestation" the undergrowth preserved for forest restoration purposes is regarded as a method of non-assisted natural reforestation,

method of assisting to natural reforestation by sowing and (or) planting and method of establishment of partial forest plantations.

In all the three methods, the preserved undergrowth is an indispensable and crucial component of future restored forest, being its core component for methods 1 and 2. If the preserved undergrowth area houses less than 1,000 pcs per ha, complete forest plantations are created, the preserved natural plants are almost fully destroyed during soil cultivation.

However, if this small amount of undergrowth can promote genetic and species diversity in the area, which is highly important when complete forest plantations are established. Preservation of evenly-distributed vigorous undergrowth of main species is labour-intensive and cost-inefficient when soil is cultivated and forest plantations are created. Thus, focus shall be made on preservation of undergrowth groups during forest cuts, soil cultivation, establishment of complete forest plantations and subsequent care.

In order to implement this approach to conservation of genetic and species diversity, it is necessary to add to Paragraph 21 of "Regulations of reforestation and afforestation" the following clause: "It is allowed to preserve biogroups of vigorous forest trees of main species aged two years and older, minimum 0.1 m high". The area of the biogroups shall be deducted from the treated area as well as from the area under forest plantations. Instrumental survey of such areas does not make any sense, so the preserved biogroups area shall be estimated by eye. Therefore, Paragraph 30 of the Regulations shall be supplemented by the following clause: "If applicable, estimation of biogroups area of vigorous forest trees of main species preserved for forest restoration purposes should be done by eye".

When establishing forest plantations, preservation of biogroups of vigorous forest plants shall not be compulsory because the undergrowth left after final felling survives under the abruptly changed conditions. Decision on biogroups preservation must be taken by forestry workers on site by evaluation of the undergrowth condition and prospects for its further development. On the same note, the preserved biogroups makes the creation of complete forest plantations more complicated. This is the reason why forestry workers are reluctant to preserve such biogroups. Along with the amendments to regulatory documents, awareness-building activities must be carried out for forestry professionals during professional development courses, training and workshops.

Main impacts on species diversity of live soil cover are produced by changing growth conditions during forest cuts, by soil cultivation during artificial reforestation or tillage operations during assisted natural reforestation. Tillage operations are aimed to improve survivability of plants, to assist natural reforestation and to inhibit growth of weed trees, shrubs and grass. Unfortunately, there are no effective soil cultivation methods that would preserve soil cover and ensure favourable conditions for forest restoration. Recommendations and promising approaches may involve the following: no soil cultivation or contact herbicide treatment shall be carried out on the whole area; planting layouts shall provide for soil cultivation on maximum 50% of the forest plantation area; sites with low proportion of weed vegetation, e.g., young pine forests, shall be processed by subsurface loosening rather than furrow cutting; pine forests shall be planted by mechanized method without previous soil cultivation.

4.2.4 Afforestation as a method of biological diversity conservation through reduced operational load on natural forest ecosystems

The most effective method of biological diversity conservation in forest ecosystems is to eliminate operational load on the largest possible areas of natural forests that are a home of unique genetic or species diversity. However, the forests are a source of commercially important resources, so plantation growing shall be develop to compensate for the possible losses in forest products.

The Forest Code of Belarus [8] provides for the establishment of forest plantations and prescribes a special forest management regime for them. Forest plantations are excepted from Article 19 "Forest use regime depending on the forest category", Article 65 "Determination of forest cutting ages" and Article 66 "Allowable cuts". Indeed, the legal framework allows cutting of forest plantations for the purpose of cost benefits regardless cutting ages and timber harvest restrictions. So, forest plantations are under extensive exploitation.

Common practices of Belarusian forestry include establishment of forest plantations of previously unstocked areas in compliance with FSC requirements. Therefore, we can speak about

the plantation afforestation in our country. Recent trends in establishment of forest plantations and energy plantations are shown in Figure 4.12.

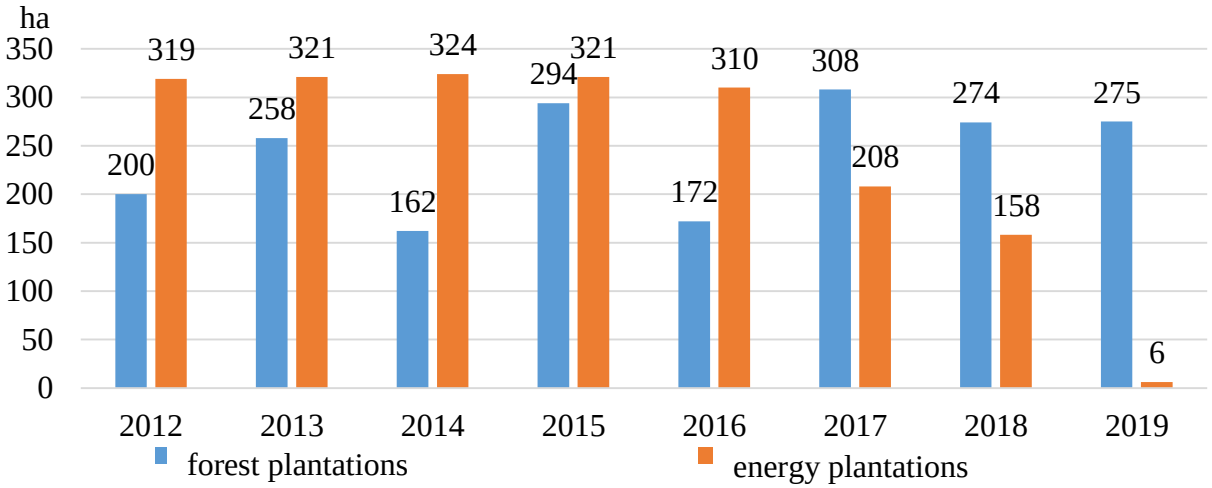


Figure 4.12 – Recent trends in establishment of forest plantations and energy plantations

Over the reviewed period the maximum annual area of resource plantations amounted to 615 ha. Until 2017, the areas of energy plantations exceeded those of forest plantations, most of them were created for growing of pulpwood.

In order to expand areas for establishment and exploitation of resource plantations, it is recommended to use for these purpose all lands transferred to the forest fund and suited for forest plantations. Currently, many of these lands are used for afforestation (Figure 4.13).

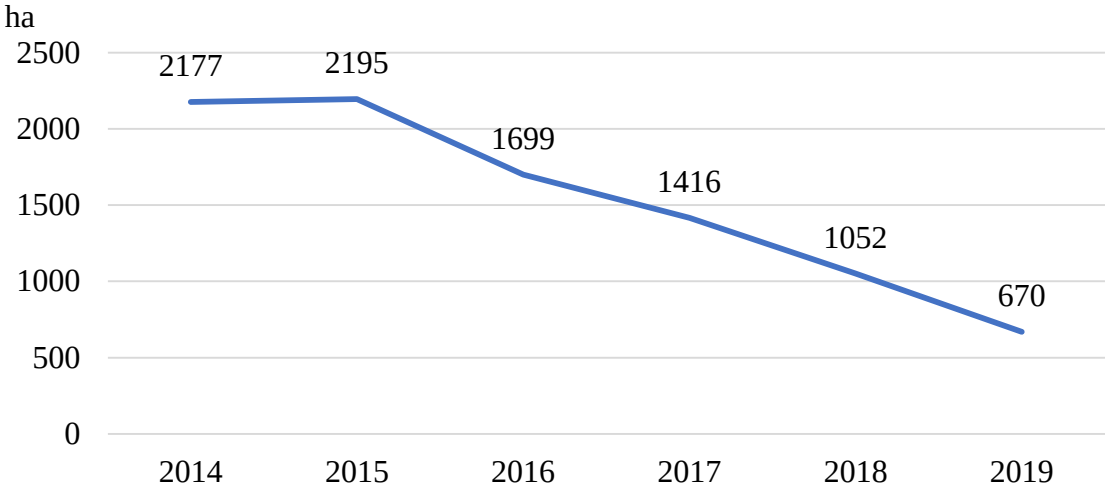


Figure 4.13 – Areas under afforestation

At the same time, the country has a vast amount of lands that are ineffectively used for agricultural purposes and mainly include low-fertile and small sites. Using them for forest plantations could reduce operational load on natural forests in the long run. However, their transfer to the forest fund requires awareness of public administration bodies of their ineffective use. Besides, the transfer is a time-consuming process that follows an established procedure to ensure high quality of work to be done by forestry enterprises.

Certain legal barriers to creation of the resource plantations aimed to reduce operational load on natural forest ecosystems are regulations of the current STB 2515-2017 “Forest plantations of spruce and pine. Requirements to establishment”. The standard was developed for the purposes of supply of large timber consumption centers with the timber resources of desired value. Thus, clusters of forest plantations shall be created around the consumption centres. Special methods shall be applied to intensify the growth of the forest plantations. The currently developed standard for

forest plantations of softwood broad-leaved species is based on the same principles. The provisions of the above standards do not make it possible to grow the resource plantations on the same principles as ordinary forest plantations. Consequently, the standard STB 2515-2017 shall be amended by the clauses that allow growing of resource plantations without any relation to consumption centres and not using special methods of growth intensification. In other words, the plantations shall primarily be designed to reduce operational load on natural forest ecosystems.

Another barrier to extensive establishment of resource plantations is the fact that they are not included in the forest-covered areas and are not calculated in the total forest cover. On the contrary, afforested areas are then defined as forest-covered lands, thus contributing to the forest cover which is a key indicator of many forestry-related strategic documents, including national indicator 15.1.1 "Forest area as a proportion of the total land area" under SDG 15. The existing approach bears no relation to reality as most resource plantations are observationally equivalent to ordinary forest plantations. They cover the land with forest and fully comply with the international definition of "forest" as given by FAO [26] and with other commonly accepted definitions [27].

Inclusion of resource plantations into forest-covered lands will contribute to the achievement of target indicators and thus, will result in their expansion.

4.3 Development of proposals for the improvement of forest use planning in the context of biological diversity conservation

The Forest Cutting Rules of the Republic of Belarus [23] regulate main forest uses and contain many recommendations that favour biological diversity conservation in Belarusian forests. Partial cuts and final felling with preservation of undergrowth promote natural reforestation which is a favourable environmental factor. In the event of final felling without preservation of undergrowth to enable natural reforestation, the Forest Cutting Rules prescribe to leave 10-20 evenly distributed seed-bearing trees per one hectare of the cutting area. Seed-bearing trees can be located in groups of 3-5 trees, the number of groups is 4-5 per one hectare. During clear cuts on the areas larger than one hectare, the Rules prescribe to leave mature healthy trees of pine, oak, maple, linden and black alder in the amount of 10 trees per one hectare in order to ensure species diversity of stands. Thus, the current legal regulations provide ample opportunities to promote biological diversity of Belarusian forests during planning of final fellings.

4.3.1 The role of partial cuts

The review of planning of final fellings has revealed that partial cuts are widely used in the forests where applicable. However, there are stands where partial cuts may be planned but the working-plan officer has prescribed clear cuts. The prescription is not contradictory to the current forest cutting rules but is unreasonable in the context of biological diversity conservation.

Hence, partial cuts can be planned wherever silvicultural principles and the current legislation allow. This approach will increase the final fellings which ensure conservation of the forest environment.

4.3.2 The role of cuts with preservation of undergrowth

Planning of clear cuts with preservation of undergrowth follows the same scenario as that of gradual cuts. Clear cuts with undergrowth preservation are basically planned in the subcompartments with sufficient undergrowth whereas ordinary clear cuts may be planned for some parts. In some cases, gradual cuts are prescribed instead of clear cuts with preservation of undergrowth if applicable. Such decisions must be encouraged because gradual cuts lead to smaller changes in the forest environment than clear cuts with preservation of undergrowth.

Thus, clear cuts with preservation of undergrowth must be planned in the forest stands which have sufficient amount of undergrowth of target species. However, if forest stand characteristics allow gradual cuts, they must be preferred because they are more environmentally friendly.

4.3.3 Registration of rare and typical biotopes

At present, there is a great concern about conservation, reproduction and restoration of flora and fauna, natural landscapes and their resources. Conservation and sustainable use of biological diversity calls for prevention or minimization of adverse natural and anthropogenic impacts on ecosystems, flora and fauna subjects and their natural habitats. These issues can be addressed by identifying rare and typical biotopes and placing them under protection of state forestry enterprise.

The Rules of Identification and Protection of typical and rare biotopes, typical and rare natural landscapes [28] define forest biotopes as a separate group No.6. This group is most crucial for the forest sector. As described in Chapter 0, some biotopes in this group can be regarded as rare biotopes (biotope 6.7, biotope 6.10, biotope 6.13, biotope 6.14 and biotope 6.15) and can easily be identified in the subcompartment database of the forest fund.

The easiest way to identify sites that match the biotope characteristics is to do this during forest inventory operations. The following procedure may be recommended. Before field work, the subcompartment database must be searched to make a list of subcompartments that can be regarded as potential biotopes. During field taxation of the listed subcompartments, the decision is taken whether the subcompartments can be assigned the biotope status. Finally, during office work the final decision is taken on those sites that can be identified as biotopes with regards to their quantity and characteristics. Then, application papers are prepared to transfer the identified typical and rare biotopes under the protection of forestry enterprises as prescribed by the Regulations [29].

If the above transfer procedure is not applicable, subcompartment database can be browsed to identify many biotopes during office work. This procedure is less labour-consuming but cannot ensure identification of all biotopes.

Moreover, many other organizations may be involved in identification of rare and typical biotopes. In any case, they shall use subcompartment database to facilitate the work.

4.3.4 Ways of improvement of regulatory and reference data to prescribe forestry measures during forest inventory

The current regulatory documents for final fellings provide forestry workers with numerous opportunities for biological diversity conservation. The review of some forestry enterprises has shown that final fellings planning favours biological diversity conservation, however, there is still space for more improvement. It should be noted, however, that few other opportunities are open because planning of final fellings by forestry enterprises meets the highest standards and all legally available tools and methods are used to ensure biological diversity conservation. Thus, if we want to expand opportunities for biodiversity conservation when planning final fellings, it could be recommended to include the issues of conservation, reproduction and restoration of flora and fauna in revised regulatory documents.

Besides, it may be advised to include more table view data and less text in future revisions of regulatory documents. Working with table view data appears to be more practical and effective and to result in fewer errors.

4.3.5 Creation of subcompartment database queries

The construction of subcompartment database queries will be aimed at selecting the subcompartments for gradual and clear cuts with preservation of undergrowth. This will require using of reference sources [23, 30] to obtain data which will be represented as reference table in MS Access DBMS. Selection criteria for final fellings (including aspen and birch forests) [23] are listed in a MS Access DBMS reference table under “BR – FF - criteria” title. Along with the field name and format name, the table contains information stored in the field (code of main tree species, code of forest type, code of the highest quality class in the group, code of the lowest quality class in the group, minimum density in the group, maximum density in the group, minimum quantity of undergrowth, thousand pcs/ha, types of feasible final fellings).

The data storage format shall be changed so that queries could use the information about the three undergrowth species (the information is stored in layout 31 as table “m#31” in subcompartment database). So, an SQL-query has been made that creates a new “BR-Undergrowth”

table in the database and fills it with the user-friendly information about the three main undergrowth species. The table contains field name and field format as well as the information stored in the field (site number, Key field: this is used to connect to MAINBASE table; composition coefficient for an undergrowth species, code of an undergrowth species, quantity of an undergrowth species, thousand pcs/ha). The SQL text of the query is given in Appendix 1.

SQL queries have been created for the information stored in the subcompartment database and in the newly-created "BR-Undergrowth" table.

4.3.6 Making a list of potential sites for gradual and clear cuts with preservation of undergrowth

Lists of potential sites for gradual and clear cuts with preservation of undergrowth have been made on the basis of subcompartment databases of three forestry enterprises: Loyevskiy, Minskiy and Shumilinskiy. According to their geobotanical zoning, SFE "Loyevskiy forestry enterprise" is located in the subzone of broadleaved and pine forests, SFE "Minskiy forestry enterprise" and SFE "Shumilinskiy forestry enterprise" are located in the subzone of oak and dark coniferous forests. SFE "Shumilinskiy forestry enterprise" belongs to Vitebsk SPFA, SFE "Minskiy forestry enterprise" to Minsk SPFA, SFE "Loyevskiy forestry enterprise" to Gomel SPFA.

SQL queries made it possible to make lists of subcompartments where gradual cuts can be planned and carried out. The lists were made for exploitable, conservation and protective forests. The sites were selected that meet the legal framework recommendations for planning and implementation of partial final cuts [23, 30]. The recommendations had to be compatible and applicable for use in the subcompartment database.

Table 4.1 gives the list of sites in Minskiy forestry enterprise where gradual cuts can be planned and done.

To sum up, it should be noted that the gradual cuts had previously been planned on 26.7 ha of the selected sites in Minskiy forestry enterprise Partial cuts with preservation of undergrowth were planned for another 2.4 ha. The total area of the cuts amounted to 29.1 ha or 50.4% of the total area of the selected sites. Therefore, there are opportunities to increase the proportion of partial cuts which will favourably affect biological diversity in the region.

Table 4.1 – Forest stands where partial cuts were recommended by working-plan officer (SFE "Minskiy forestry enterprise")

Cuts planned by working-plan officer	Species	Area, ha	Qty of subcompartments
Protective forests			
Cutting of dangerously inclined trees that may damage roads, aerial communication and power transmission lines	С	0,9	1
Exploitable forests			
Clear-cut final felling	Б	2,1	1
Clear-cut final felling	Е	1,7	2
Clear-cut final felling	ОС	3,8	2
Cuts with preservation of undergrowth	Б	2,4	2
Even-gradual cutting	Б	15,5	4
Even-gradual cutting	ОС	0,7	1
Even-gradual cutting	С	6,1	3
Final stage of gradual cuts	ОС	2,9	2
Final stage of gradual cuts	С	1,5	1
Subtotal		36,7	18
Total		37,6	19

Generally, the scenario in those compartments where gradual cuts are recommended (Table 4.2) shows that the proportion of the planned clear cuts is rather small (11.0% or 25.3 ha out of 229.3%).

Table 4.2 – Cuts planned on sites recommended for gradual cutting

Forestry enterprise	Total area of sites, ha	Planned cuts					
		Type of cuts	Qty of subcompartments, pcs	Area od subcompartmetns, ha			
				total	average	minimum	maximum
Loyevskiy	23,0	Gradual cuts	4	23,0	5,75	0,6	12,1
Minskiy	57,7	Gradual cuts	11	26,7	2,43	0,6	8,7
		Cuts with preservation of undergrowth	2	2,4	1,2	0,7	1,7
		Clear cuts	5	7,6	1,52	0,3	2,9
Shumilinskiy	148,6	Gradual cuts	22	125,4	5,7	0,8	15,3
		Cuts with preservation of undergrowth	2	5,5	2,75	2,7	2,8
		Clear cuts	7	17,7	2,53	1,3	6,0
Total	229,3	Gradual cuts	37	175,1	4,73	0,6	15,3
		Cuts with preservation of undergrowth	4	7,9	1,98	0,7	2,8
		Clear cuts	12	25,3	2,11	0,3	6,0

This proves that planning of final fellings is done with due consideration of biological diversity conservation in forests. However, the review makes us conclude that there are still some opportunities for improvement of final felling planning.

Let's analyze those forest sites where the amount of undergrowth allows clear cuts with preservation of the undergrowth. Loyevskiy forestry enterprise has three sites with total area of 13.3 ha. The working-plan officer has planned the final stage of gradual cutting for two of them, while not cuts have been planned for the third site of 9.0 ha. This may be explained by transition to a new forest classification by commercial value, so new cutting ages may be set for some forest sites.

SFE "Minskiy forestry enterprise" has 275 subcompartments with total area of 576.5 ha where clear cuts with preservation of undergrowth can be carried out. Review of the cuts planned for these subcompartments has revealed that all categories of forests comprise 127 subcompartments with total area of 216.3 ha where no cuts have been planned.

In exploitable forests, clear-cut final fellings have been planned for 22 subcompartments with the area of 33.7 ha. The stands occupy 5.8% of the total area of selected subcompartments or 7.8% of selected exploitable forests. In spite of the fact that new categorization of forests makes it difficult to fully evaluate planning of cuts in the chosen areas, the planned clear cuts in exploitable forests suggest that final felling planning can be optimized to promote biological diversity conservation.

Resulting from the review of planned final fellings on sites where gradual cuts or cuts with preservation of undergrowth can be planned, we can conclude that the proportion of partial cuts and cuts with preservation of undergrowth may be expanded. Thus, the system of final felling planning can be improved in this direction which will make forest inventory plans more environmentally friendly.

4.3.7 Making a list of subcompartments that are regarded as rare forest biotopes

SQL queries (example query is given in Appendix 2) to the subcompartment database enabled making of lists of sites matching the criteria of rare forest biotopes as specified by the rules for

identification and protection of typical and rare biotopes and typical and rare natural landscapes [28]. The lists of subcompartments that are regarded as rare forest biotopes were made for the same forestry enterprises as the lists of subcompartments recommended for gradual cuts and clear cuts with preservation of undergrowth, i.e., Loyevskiy, Minskiy and Shumilinskiy.

Thus, the work with the subcompartment database makes us conclude that many potential biotopes can be identified using the database content. Some of these sites can fully meet the requirements that are specified for biotopes by regulatory documents [28]. Other sites may require more thorough studies based on mapping information or field surveys. In any case, the subcompartment database is a useful source of information for identification of typical and rare biotopes.

4.4 Evaluation of potential biodiversity-rich sites in the context of hydrography of forest lands

4.4.1 Preparation of original mapping data

It is widely known that water bodies located on forest lands considerably enhance the biodiversity level in the adjacent areas. Therefore, their accurate mapping during forest inventory as well as categorization of protective capacities of forest belts around water bodies are crucial for forestry actions aimed to promote biodiversity of forest ecosystems.

Currently, the technology of forest inventory involves mapping of hydrological bodies using vector digital maps of national land use system and topographical maps. It is assumed that localization and availability of water bodies will be verified by taxation engineer during field forest inventory. However, some forest lands are located long distances from infrastructure facilities, so not all hydrographical objects are accurately plotted on digital maps of land information system and forest maps. This can result in wrong categorization of protective forests, restrictions on forest management and, ultimately, loss in biodiversity components of biological diversity.

Evaluation of mapping of water bodies on digital forest maps was based on conventional topographical maps of 1:50 000 scale. Despite the long time since their last update (1970s-1990s), the selective filed surveys showed high accuracy of mapping of water bodies located on forest lands. The territory of Shumilinskiy forestry enterprise (Vitebsk SPFA) was defined as a subject of the study. The area has a large proportion of excessively moist lands and high amount of hydrographical bodies. 16 topographical 1:50 000 maps were scanned and reformatted into raster maps. A digital map tile is given in Figure 4.14.

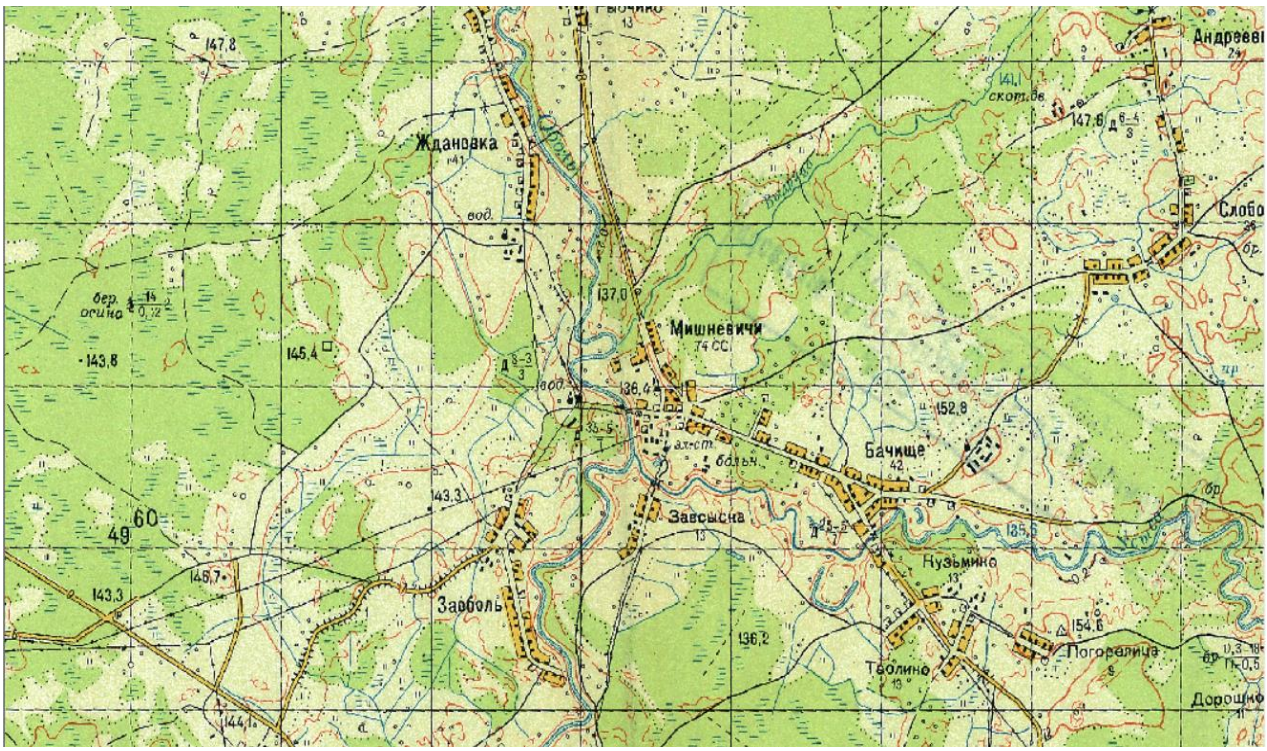


Figure 4.14 – Topographical map tile of the territory of SFE "Shumilinskiy forestry enterprise"

RUE "Belgosles" provided vector digital maps of the studied territory. The maps included two cartographic layers of water bodies: linear hydrography objects and areal hydrography objects (Figure 4.15). The first cartographic layer shows streams, ameliorative drains and small rivers, the second layer depicts lakes and large rivers.

It can generally be seen from Figure 4.15 that the territory of Shumilinskiy forestry enterprise has a wide-spread hydrological network including water bodies and small water flows.

In order to evaluate the plotting of hydrological bodies on forest planimetric and cartographic documents, it is required to match the topographic maps with the vector map layers obtained during forest inventory. Scanned raster images of the topographic maps were bridged to the rectangular coordinate system using the free and most common WGS 84 coordinate system in universal transverse Mercator (UTM) projection. Coordinates on the topographic maps were represented in SC-42 system, so they needed to be transformed by a special-purpose geodetic calculator.

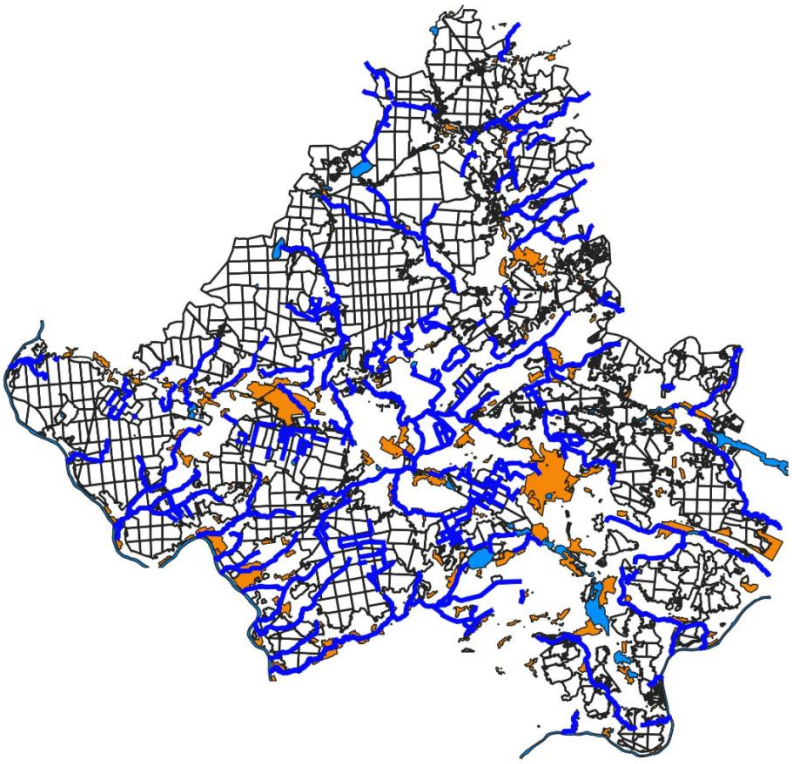


Figure 4.15 – Cartographic layers of linear and areal water bodies by forest inventory data (SFE "Shumilinskiy forestry enterprise")

Bridging of coordinates was done with Quantum GIS. Corner points of the topographic maps were assumed as control points. The corner points were marked with geographical coordinates which were then transformed into WGS 84 planimetric coordinates of UTM projection (Figure 4.16).

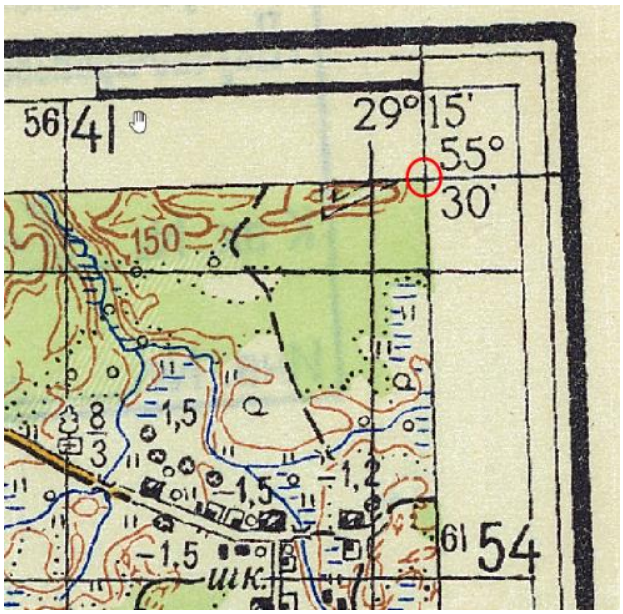


Figure 4.16 – Control points of bridging of topographic maps to the coordinate system

Figure 4.17 shows common interface of bridging the topographic maps to the coordinate system in Quantum GIS.

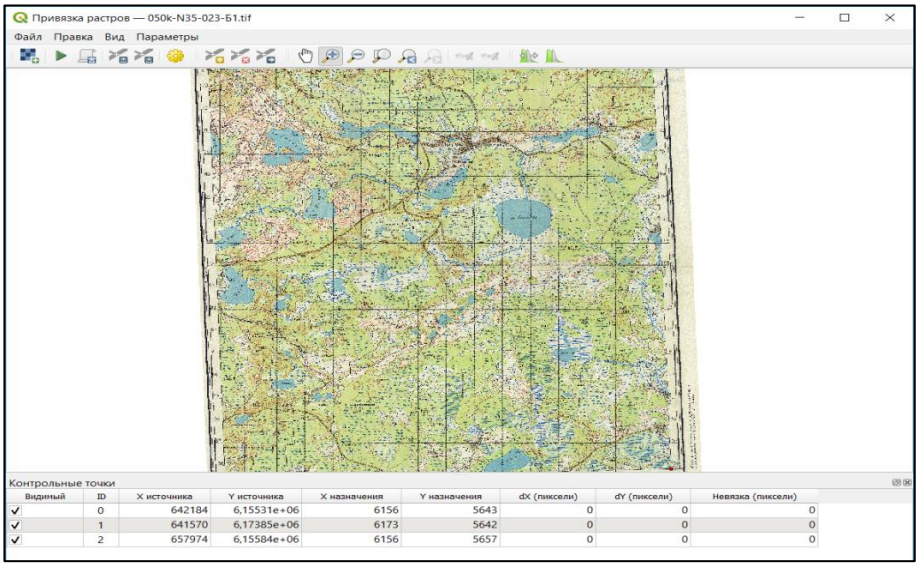


Figure 4.17 – Software interface of bridging the topographic maps to the coordinate system in Quantum GIS

The technology was used to bridge 16 topographic maps of 1:50 000 scale to the coordinate systems, which formed a topographic base for the territory of Shhumilinskiy forestry enterprise (Vitebsk SPFA).

Having regard to the fact that vector map layers and the created topographic base use the same coordinate system, complete bridging was achieved for the given location.

4.4.2 Evaluation of mapping of water bodies on forest planimetric and cartographic documents

Following the preparatory processing of data, a geoinformation layout was created on Quantum GIS platform. The layout included raster topographic base and vector map layers of the forest inventory in the unified coordinate system.

General view of the geoinformation layout is shown in Figure 4.18.

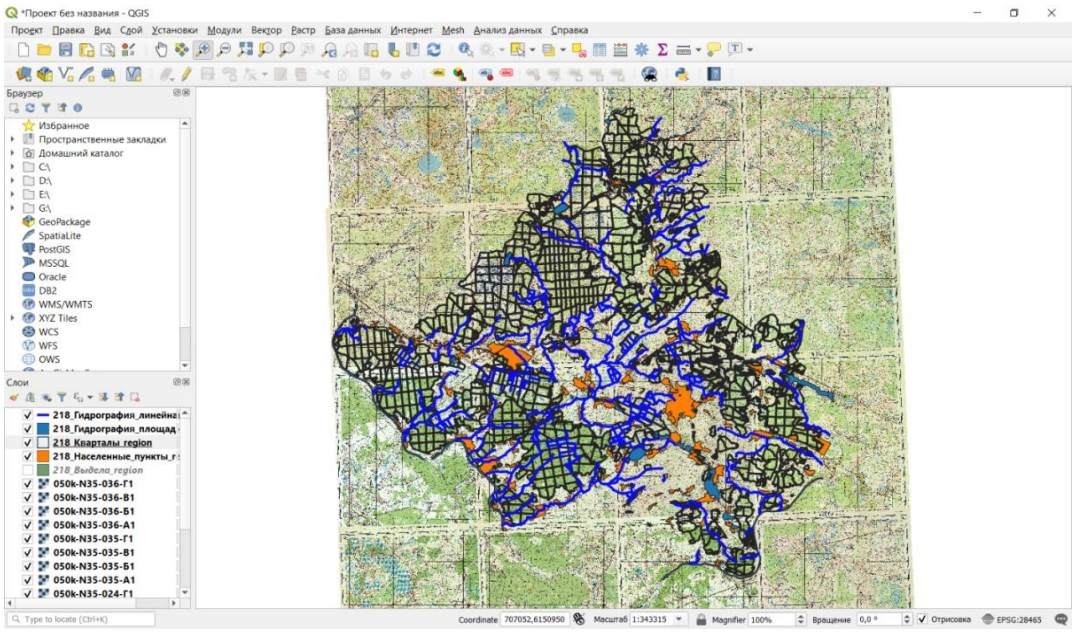
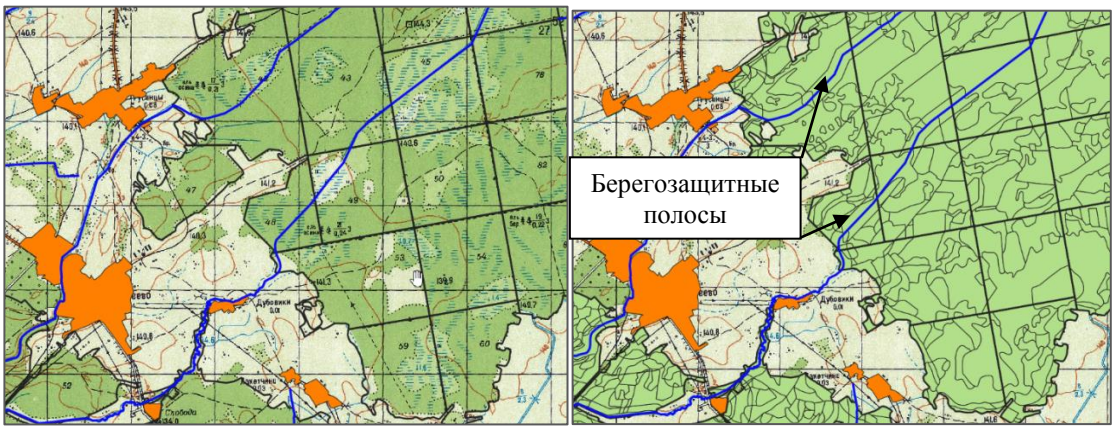


Figure 4.18 – Geoinformation layout of Shumilinskiy forestry enterprise in Quantum GIS

In accordance with the Belarusian law, water bodies must be surrounded with water conservation zones which contain littoral protection belts between 50 and 100 m off the water bank or shore (Figure 4.19).



a) b)

Figure 4.19 – Littoral protection belts around water bodies: a) topographic map tile without subcompartment layer; b) topographic map tile with subcompartment layer and denoted littoral belts

Any final felling is prohibited in forests within littoral protection belts. The restrictions promote and enhance biodiversity of forest ecosystems. Thus, it is highly important to accurately and comprehensively denote the water bodies on planimetric and cartographic documents, as any error can result in biodiversity degradation and loss.

Evaluation of mapping of water bodies on forest planimetric and cartographic documents was done by visual inspection. Raster topographic base was compared to the map layer of water bodies obtained during forest inventory. Some detected inconsistencies are shown in Figure 4.20.

The outcomes of the work prove that most water bodies on forest planimetric and cartographic documents match those on topographic maps. In particular, large hydrological objects, i.e., rivers and lakes, are accurately mapped. However, some small water bodies or their parts can be missing from forest planimetric and cartographic documents (Figure 4.20) which may lead to improper forest management within water conservation zones and badly affect biodiversity in riparian forests. Therefore, accurate and precise mapping of water bodies must be an essential component of any forest inventory with subsequent restriction of forest management on riparian forest lands.

4.4.3 Brief conclusions

Water bodies on forest lands greatly promote biodiversity of the forest ecosystems. In order to preserve them, water conservation zones and littoral protection belts with restricted forest use are designated during forest inventory. Inaccurate or incomplete mapping of hydrological objects on the forest planimetric and cartographic documents result in wrong categorization of protective forests and improper forest management which leads to biodiversity loss.

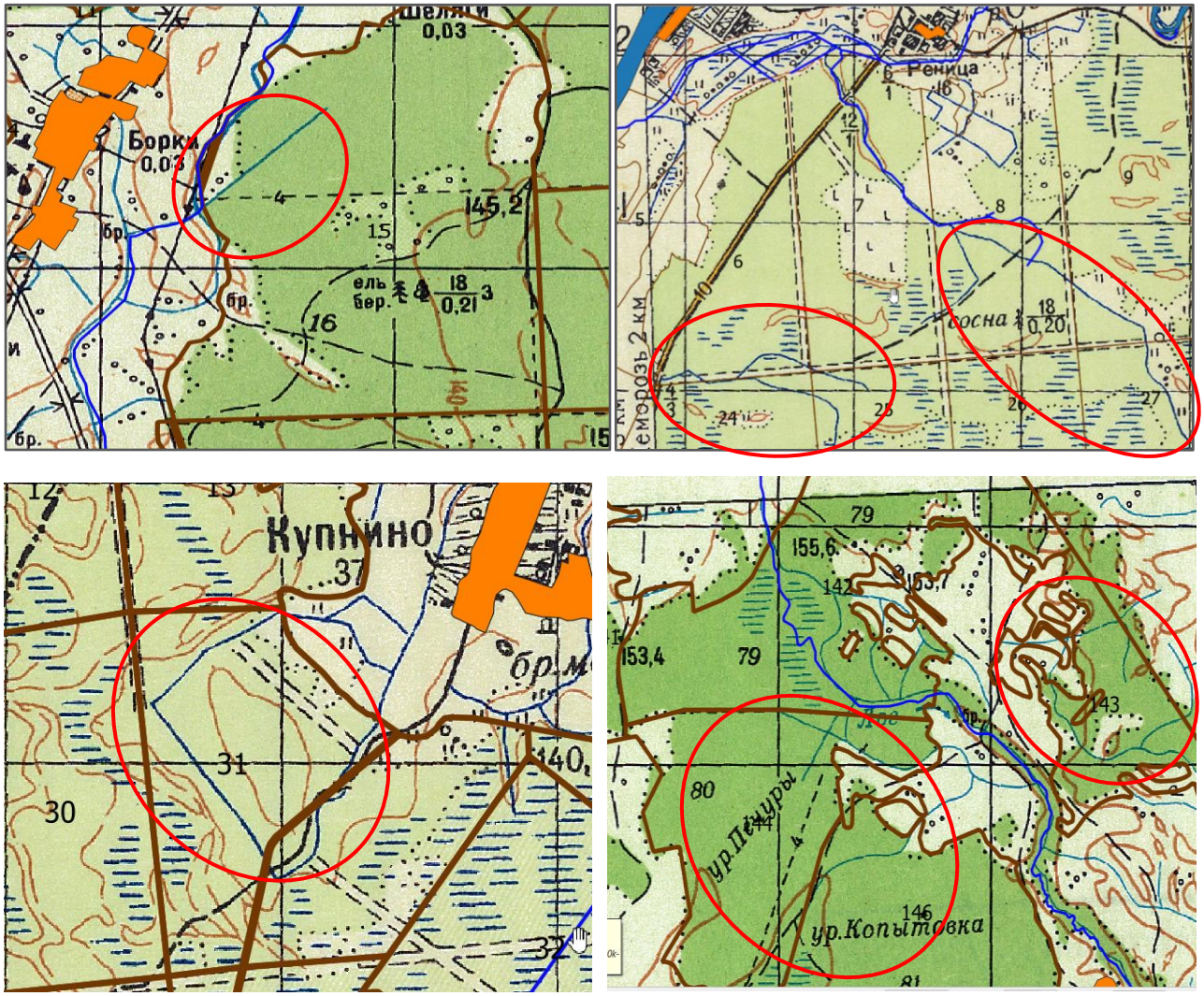


Figure 4.20 – Examples of incomplete mapping of water bodies compared to the topographic base (SFE "Shumilinskiy forestry enterprise")

Evaluation of mapping of hydrological objects on forest planimetric and cartographic documents was based on topographic maps of 1:50 000 scale using Quantum GIS in the territory of Shumilinskiy forestry enterprise. The obtained results prove that water bodies have been mapped on the forest planimetric and cartographic documents in an adequate way. However, there are instances of incomplete mapping of water bodies or their parts located on forest lands. These errors may lead to the wrong categorization of protective forests and, ultimately, to biodiversity loss. The problem can be solved by subsequent thorough studies and large-scale field surveys as well as greater focus on identification of hydrological objects during forest inventory.

4.5 Review of international best practices of biological diversity conservation during forest use: European best practices

Forests occupy 30% of the global lands, they house over 80% of terrestrial flora and fauna (Latvia: 3.35 million ha or 52% of forest lands; Sweden: 28 million ha or 68%; Finland: 26 million ha or 76%; Ukraine: 10.4 million ha or 15.9%; Russia: 1.146 billion ha or 46.6%). Sustainable forest management and forest use must be aimed to have due regard and to preserve biological diversity of forest lands. One of the key problems is lack of good practices of biological diversity conservation during forest use. Problems may also be caused by the lack of explicit requirements to biodiversity conservation during timber harvest and hence, the current laws may be misinterpreted. So, forest use

regulating documents must contain detailed instructions on biodiversity conservation. Best practices of biodiversity conservation during forest use vary across countries and require thorough review.

The report gives a review of good practices of biological diversity conservation as laid down in the forestry-related regulatory legal acts in Lithuania, Poland, Estonia, the Russian Federation, Ukraine, Latvia, Sweden, Finland. Common practices of biodiversity conservation in the reviewed countries largely depends on forest management, state of economy, environmental education and knowledge. Forest management, in its turn, depends on the form of forest ownership (Table 4.3); established practices of forest management; uneven distribution of forest resources (forest cover in different parts of the country); state-of-the-art of forest and nature conservation laws; law enforcement; governmental and public control.

Table 4.3 – Forest ownership in some countries

Ownership	Estonia	Lithuania	Poland	Sweden
Public forest, %	46,0	49,6	79,3	13,0
Private forest, %	53,5	38,9	20,7	72,0
Municipal forest, %	0,5	–	–	15,0
Forest on hold, %	–	11,5	–	–

The study involved a review of regulatory legal acts in the field of biological conservation in the forests of Lithuania (Table 1, Appendix 3), Poland (Table 2, Appendix 3), Estonia (Table 3, Appendix 3), the Russian Federation (Table 4, Appendix 3), Ukraine (Table 5, Appendix 3), Latvia (Table 6, Appendix 3), Sweden (Table 7, Appendix 3), Finland (Table 8, Appendix 3).

5 Review of policy framework on forest cuts, forest restoration, demarcation of cutting areas, forest inventory in order to discover and adopt measures for biodiversity conservation

5.1 Biodiversity conservation in the context of the current policy framework and established practices of forest management

The Convention on Biological Diversity [31] specifies two types of biodiversity conservation, i.e., in-situ and ex-situ.

"In-situ conservation' means conservation of ecosystems and natural habitats, as well as maintenance and regeneration of viable populations of species in the surroundings where they have developed their distinctive properties. As a rule, it involves conservation of biological diversity components in specially protected natural areas (SPNAs), i.e., reserves, preserves, national parks, natural monuments, etc. [32].

Biodiversity conservation beyond the SPNAs is a global issue which builds on sustainable use of biodiversity. Having regard to the commonly known [33] "presumption of economic activity threats", the forest sector shall develop approaches that bring forest use and biodiversity conservation together.

It makes sense to properly understand the difference between sustainable and conventional forest management. Sustainable forest management sees the forest not as a "market garden for timber", but as an ecosystem with sophisticated structure and diverse features that shall be used in a sustainable way. This requires:

– conservation of natural biodiversity, restoration of aboriginal forest phytocenoses, combatting of anthropogenic associations;

– maintenance of the mosaic structure of forest ecosystems and landscapes, i.e., "forest is not a park"; throughout its life, the forest shall contain ancient trees, dead-standing trees, windblown trees, dead wood of various degradation stages; biotopical niches, all components of vegetation;

– promotion of regenerative capacity of forest ecosystems, i.e., priority of natural reforestation and its intensive use for forest growing, each forest population shall leave its "genetic imprint";

– maximum use of partial cuts wherever conforming to the natural changes of forest communities, to produce lower stress on forest ecosystems.

5.2 Ways of promoting biodiversity during forest inventory

The main current technological regulations in the field of forest inventory are "Guidelines for arrangement and scope of forest inventory works" (2017) [34] and TCCP "Technical instructions" [35].

Obviously, field documents shall primarily describe forest characteristics related to biodiversity. Then, the measures for biodiversity conservation and sustainable use shall be planned and recorded in the documents.

Currently, characteristics of the forest areas are recorded in the taxation card and tables of codes [36] which can be filled in with biodiversity specific features and proposed conservation measures.

First of all, the features include the description of storeys (main layouts 10, 31, 32), growth conditions, i.e., quality class, forest type, growth conditions type (layout 3), number of soil-typological group (layout 3), presence of dead-standing trees and forest litter (layout 2), as well as SPNA type.

Besides, layout 1 may contain the description of slope (slope direction, steepness) and restrictions of forest use (according to the list in [36] summing up the requirements of the Forest Code and other regulatory acts).

Relief features are important to determine the status of a subcompartment as an eventual components of environmental networks and (or) representative site for FSC certification. However, recording of relief features was not obligatory during forest taxation in Belarus.

Types of forest use restrictions prove the value of forest sites for biodiversity conservation as they impose limitations on forest cuts and other measures and thus promote biodiversity. Previously, the list of sites under special protection and restrictions of forest use was laid down in the Forest Cutting Rules. It is recommended to add to the existing Forest Cutting Rules the list of current forest use restrictions, their legal background and current restriction regimes.

Some layouts that contain additional information are helpful and can be used for biodiversity description. For instance, layout 23 [36] "Specific features of subcompartment" comprises codes of invasive plant species, giant trees by species, rare species of trees and plants, rare forest formations and forest types, highly valuable forest communities and some other information relevant for biodiversity record and conservation regime. Specialized layout 30 "Redlisted plants and animals" with designated codes is directly intended to describe specially protected biodiversity.

It appears that the list of subcompartment specific features shall be expanded in layout 23 of additional information. Layout 2 shall be supplemented by economic activities. This will make the description of biodiversity and related measures as complete as possible and provide brief information for mensurational description and forest inventory databases. The data can further be used by forestry workers to conserve biodiversity during demarcation of cutting areas and monitoring of forest management.

The list of subcompartment specific features and designated biodiversity conservation measures can be completed by data of the Guidelines [37] developed by the experts of the Institute for Experimental Botany under the National Academy of Sciences of Belarus.

For example, the following features shall be coded: trees of traditional uses (wild-honey trees, trees for splinter and whip harvest [37]), groups of boulders or individual large boulders, man-made concrete structures, etc. These features shall be subject to conservation without additional coding of measures.

Additional codes are needed for the following measures: "conservation of margin areas bordering on non-forested lands" in mature forests, "formation of a margin area" in immature forests, "conservation of windblown trees", "spruce cutting priority" (to prevent replacement of pine by spruce), etc. in compliance with [37]. Some biodiversity conservation measures should be included in the Rules for Cuts as Forest Tending Measures, i.e., the current Forest Cutting Rules should be amended to ensure planning of the above listed measures.

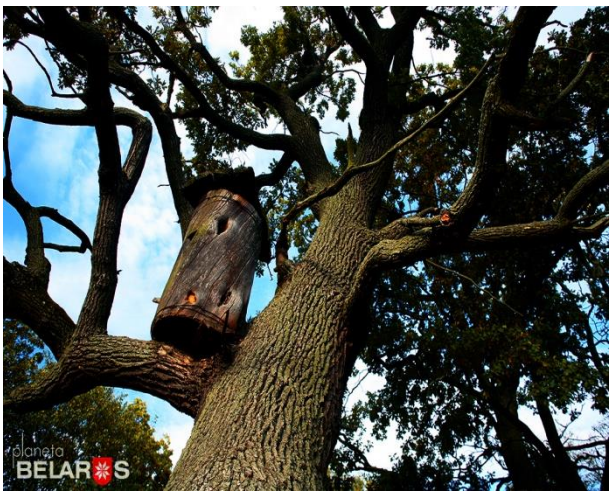
Forest inventory officers and inspecting bodies must carefully fill in the biodiversity related fields in the taxation cards. The quality of field forest inventory shall be assessed by the comprehensiveness of biodiversity specific features.

To our mind, no special survey is required to record some key components of biodiversity as nearly all of them can be identified by visual taxation (Figure 5.1). More demanding special survey may be needed in exceptional events (not during regular forest inventory; in case of additional funding it may be done for the detection of rare, e.g., redlisted, species).

The outcomes of biodiversity features record can be presented as project sheets of biodiversity components, measures for biodiversity enhancement and related tables in the forest inventory project and the Forest Cadastre.

It should be noted that today the high value of natural reforestation as a tool of natural genetic biodiversity conservation and restoration of aboriginal phytocenoses is not directly included in the rules of description of natural under-canopy regeneration during forest inventory. The concern is that if the undergrowth description is not obligatory, is there are no strict regulations or no clear and consistent procedure for description, the undergrowth will not be properly described or not registered at all. Therefore, it will be difficult to monitor regenerative successions and manage them.

The current forest inventory guidelines contain a reasonable instruction saying that "characteristics of forest stands is to be defined if there is undergrowth and young growth under the forest canopy" [34, para. 3 clause 34]. The instruction is rather unclear and inconsistent because the parameters to be defined are prescribed only for "the undergrowth under the canopy of maturing, ripe and overmature forests" [34, clause 50]. This inconsistency may as well be explained by the fact that traditionally the undergrowth was not recorded in young forests, which is also included in the preceding forest inventory guidelines in Belarus:



a)

b)

c)

d)

Figure 5.1 – Additional objects of biodiversity to be coded during field forest inventory:
a) trees of traditional forest use; b) large boulders;
c) groups of boulders; d) man-made concrete-and-stone structures

– Guidelines of 2002 [38]: «5.3.16. If available, the undergrowth under the forest canopy is to be described in forests of age class 3 and older»;

– TCCP 377-2012 [39]: «6.5.17. If available, the undergrowth under the forest canopy is to be described in maturing, ripe and overmature forests».

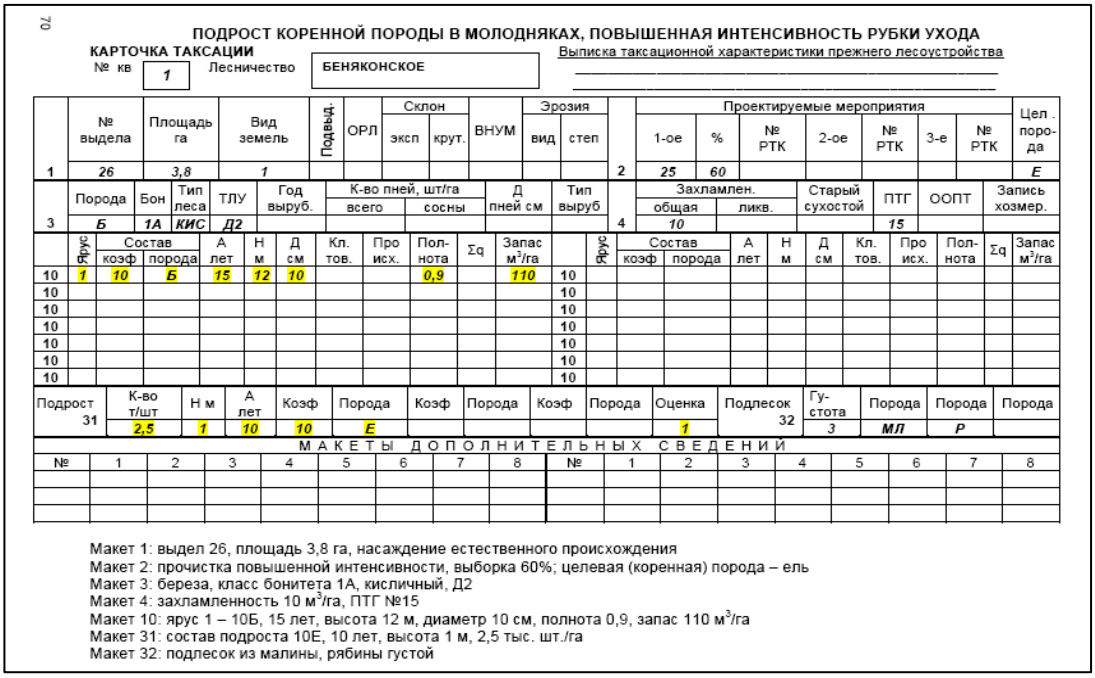
The greatest challenge is to describe the proportion of natural spruce trees in young forests containing grey alder, black alder, willow trees, birch and aspen because the average heights of spruce and softwood broadleaved trees are highly different. Spruce trees tend to appear later than deciduous trees, they grow at much slower rate, very often become overshadowed, which makes this commercially valuable trees develop even more slowly. At the age of 20 years, the average height of under-canopy spruce trees is less than 2 m even in the best growing conditions. At the same time, the deciduous trees will grow as high as 12-16 m depending on the quality class 1-1B. At the age of 10 years, the deciduous trees amount to 6-8 m whereas spruce trees hardly grow as high as 1 m.

The low absolute and relative height of spruce trees (as high as 1/4 of the upper deciduous canopy as per [34, clause 37]) makes it impossible to record their considerable proportions (minimum density) as a separate coniferous storey. Minimum required density of 0.3 [34, clause 37] indirectly proves that the storey requirements of the current forest inventory guidelines are specified not for young forests (minimum required density for young forests is 0.4 [34, clause 20]). Recording of storeys in

natural young forests is not directly prohibited now and was not applied in practice before.

Under the considerable height difference (6 m and above), incorporation of spruce in the united storey and determination of composition coefficients by the quantity of trees [34, clause 20] will not showcase the actual proportion of growing stock and individual forest components in the developing phytocenosis. In similar case, under the height difference of spruce and deciduous trees 6 m and above, open forest plantations [34, clause 43] would be described as the second subordinate storey and would require intensive thinning of the upper deciduous non-target storey.

Figure 5.2 shows example content of a taxation card.



ПОДРОСТ КОРЕННОЙ ПОРОДЫ В МОЛОДНЯКАХ, ПОВЫШЕННАЯ ИНТЕНСИВНОСТЬ РУБКИ УХОДА

КАРТОЧКА ТАКСАЦИИ

№ кв 1 Лесничество БЕНЯКОНСКОЕ

Выписка таксационной характеристики прежнего лесоустройства

	№ выдела	Площадь га	Вид земель	Подвыд.	ОРЛ	Склон эксп	Склон крут.	ВНУМ	Эрозия вид	Эрозия степ		Проектируемые мероприятия 1-ое	%	№ РТК	2-ое	№ РТК	3-е	№ РТК	Цел. поро-да
1	26	3,8	1								2	25	60						Е

	Порода	Бон	Тип леса	ТЛУ	Год выруб.	К-во пней, шт/га всего	К-во пней, шт/га сосны	Д пней см	Тип выруб		Захламлен. общая	Захламлен. ликв.	Старый сухостой	ПТГ	ООПТ	Запись хозмер.
3	Б	1А	КИС	Д2						4	10			15		

	Ярус	Состав коэф	Состав порода	А лет	Н м	Д см	Кл. тов.	Про исх.	Пол-нота	Σq	Запас м³/га		Ярус	Состав коэф	Состав порода	А лет	Н м	Д см	Кл. тов.	Про исх.	Пол-нота	Σq	Запас м³/га
10	1	10	Б	15	12	10			0,9		110	10											
10												10											
10												10											
10												10											
10												10											
10												10											
10												10											

Подрост 31	К-во т/шт	Н м	А лет	Коэф	Порода	Коэф	Порода	Коэф	Порода	Оценка	Подлесок 32	Гу-стота	Порода	Порода	Порода
	2,5	1	10	10	Е					1		3	МЛ	Р	

МАКЕТЫ ДОПОЛНИТЕЛЬНЫХ СВЕДЕНИЙ

№	1	2	3	4	5	6	7	8	№	1	2	3	4	5	6	7	8

Макет 1: выдел 26, площадь 3,8 га, насаждение естественного происхождения
Макет 2: прочистка повышенной интенсивности, выборка 60%; целевая (коренная) порода – ель
Макет 3: береза, класс бонитета 1А, кисличный, Д2
Макет 4: захламленность 10 м³/га, ПТГ №15
Макет 10: ярус 1 – 10Б, 15 лет, высота 12 м, диаметр 10 см, полнота 0,9, запас 110 м³/га
Макет 31: состав подроста 10Е, 10 лет, высота 1 м, 2,5 тыс. шт./га
Макет 32: подлесок из малины, рябины густой

Figure 5.2 – Coding of spruce undergrowth in softwood broadleaved young forests (information about tree storeys is highlighted in yellow)

Natural mixed young forests aged 10 years or older should be described in a way that is similar to open-growing forest plantations with naturally regenerated secondary species. If the height difference between target species and non-target softwood broadleaved species and hornbeam is lower than 6 m, they should be described as one storey, including species composition and density by the quantity of trees. Density should be determined by prevailing species.

If the height difference is above 6 m, target species should be described through the undergrowth or as a separate subordinate storey, if all general requirements to storey determination are observed. The above proposals shall be included in relevant technological regulations. Table 5.1 contains the above proposals and those given further in the report.

Table 5.1 – Promotion of biodiversity during some forestry activities as guided by regulatory documents

Activity	Goal
1 Promotion of biodiversity during forest inventory	
Identification and description of undergrowth in forests aged 10 years or older with difference in storey height 6 m and above (amendments to forest inventory guidelines)	Recording of biodiversity, natural reforestation under the canopy of secondary forests in order to restore aboriginal phytocenoses
Coding of biotopical diversity characteristics (amendments to the list of subcompartment specific features in the table of codes [36] for layout 23)	Recording of available biodiversity (in the taxation description) in order to conserve biodiversity objects during forestry activities and to ensure justified identification of representative sites and key biotopes

Continues table 5.1

Activity	Goal
Coding of biodiversity conservation actions (amendments to the list of forestry activities in the table of codes for taxation cards [36])	Planning of biodiversity conservation actions (formation of forest margins, identification of margins, preservation of windblown trees, care of redlisted plants, etc.)
2 Promotion of biodiversity during planning of forest cuts	
Planning of gradual cuts in forests of target species, irrespectively of the target undergrowth present by the time of first cutting stage (except for TGC B2, B3 because of possible undesirable replacement of pine by spruce)	Conservation of genetic biodiversity of specific populations, lower stress caused by clear cuts
Gradual cuts in forests of non-target species with spruce proportion higher than 2 trees, irrespectively of the target undergrowth present by the time of first cutting stage (in TGC C2-C4, D2-D4)	Conservation of genetic biodiversity of specific populations, natural reforestation under the canopy of secondary forests in order to restore aboriginal phytocenoses, lower stress caused by clear cuts
Planning of selective voluntary cuts in forests of all species, irrespectively of age structure (except for TGC B2, B3 because of possible undesirable replacement of pine by spruce)	Conservation of genetic biodiversity of specific populations, natural reforestation under the canopy of secondary forests in order to restore aboriginal phytocenoses, lower stress caused by clear cuts
Highly intensive improvement cuts in complex forest with target coniferous and hardwood broadleaved species under the canopy	Acceleration of regenerative successions in order to restore aboriginal phytocenoses
3 Promotion of biodiversity during demarcation and taxation of cutting areas	
A unified extended list of conserved local key biotopes (apart from trees and chunks) which can be supplemented by local experts	Recording of key biotopes and their localization for further monitoring of conservation; recording of local specific features of biodiversity and social value of forests
Possibility to preserve (exempt from forest cuts) of young trees of target species and other valuable species without obligatory tree marking	Cost reduction of biodiversity and specific features recording
4 Promotion of biodiversity during forestry operations (forest cuts)	
Use of cutting technology that ensures preservation of young trees and undergrowth of target species	Better conservation of biodiversity during forest cuts, accelerated restoration of aboriginal forest stands
5 Promotion of biodiversity during planning of forest restoration	
Replacement of forest plantations by natural reforestation with preservation of seed-bearing trees and soil mineralization in TGC A2	Conservation of genetic biodiversity of specific populations, cost reduction of restoration of aboriginal forest stands
Blended forest restoration in TGC A3, B2, B3, C2, C3 (preservation of seed-bearing trees and soil mineralization when establishing forest plantations)	Conservation of genetic biodiversity of specific populations, using of parent stand capacity to enhance the quality of future forest
Sufficiency evaluation of undergrowth, including main species and all valuable species	Comprehensive record of species biodiversity for its sustainable use

5.3 Ways of promoting biodiversity during planning of final fellings and regeneration cuts

The main current regulatory documents for forest cuts planning are the 2016 Forest Cutting Rules [23], STB1360-2002 [41], STB 1361-2002 [42], the 2016 Sanitary Rules [43].

The previous Rules [14, clause 5.4.1] stated that "partial final fellings can be carried out in mature forest stands of any species or groups if there are suitable conditions for natural reforestation by main tree species".

A major advantage of partial cuts is lower disturbance of the environment and, therefore, biodiversity, so partial cuts shall be preferred if biodiversity conservation is important.

There is an alternative vision based on the idea that natural processes of changing forest ecosystems must be simulated during forest management. From this perspective, pine forests, which are naturally susceptible to fire hazards, require subsequent restoration of large burnt-out areas, so clear cuts are highly recommended [33]. Spruce forests (probably also oak and ash forests) are phytocenoses of shade-tolerant species, they are characterized by variously-aged phytocenoses with small-scale changes (minor "disturbances, e.g., falls of individual trees or groups of trees') and require selective (voluntary selective and group-gradual) cuts. Two-pass cuts highlight the presence of thin spruce trees as a restoring aboriginal phytocenosis under the canopy of two-storey stands with the upper canopy consisting of mature deciduous trees.

The current cutting rules [23] prescribe partial final fellings if applicable, the criteria are laid down in the effective regulatory acts [23, 40], however, they are rather vague.

There are restrictions related to the density of the tree layer prior to the final stage of partial final felling and after its first stages [23, 40]. If young generation of forest is available, the minimum density is defined only for the final stage of gradual cuts or clear cuts with preservation of the undergrowth [23, para. 20]. Thus, the first stages of cuts can be planned for forest areas without the undergrowth or second layer.

Earlier technological regulations (Figure 5.3) gave more detailed recommendations, including those related to the undergrowth (second layer) of target species before different stages (as well as upon them) of even-gradual and group-selective cuts [30, 42]. In particular, if the canopy density ranged from 0.5 to 0.7, certain amount of target species undergrowth had to be available prior to the first stage of the two-pass even-gradual cut. In earlier versions [30, 43], larger undergrowth amount of "commercially valuable" species was required prior to the final stage than that specified by the recent cutting rules [23].

Приложение Г
(обязательное)

Виды рубок главного пользования в сосновых насаждениях

Таблица Г.1

Тип леса	Класс бонитета	Полнота древостоя	Наличие тыс.шт./га		Состояние и расположение подроста	Вид рубки	Формирование молодого леса	Приоритетная технология
			подрост	II ярус				
С лш A_1 С вер A_2 Сбр A_2 С мш A_2-B_2	IV-II	0,8-1,0	Нет	Нет	Нет или сильно угнетен	Сплошнолесосечная или постепенная, 4-х приемная	Мелколиственно-сосновые с участием ели	Одноопераци-онные машины
С ор B_2 С чер B_3 С кис C_2	II-Ia	0,7-0,8	>3,0	>1,2	Равномерный слабо угнетен	Постепенная, 3-х приемная	Мелколиственно-сосновые с участием ели, дуба	Многоопераци-онные машины
С дм A_4 С бар A_5 С ос A_6	III-V	0,5-0,6	>4,0	>1,5	Равномерный слабо угнетен	Постепенная, 2-х приемная	Мелколиственно-сосновые с участием ели	Канатные мобильные установки
Все типы леса	V- I	0,3-0,4	>5	>1,7	Равномерный слабо угнетен	Сплошнолесосечная или последний прием постепенной	Мелколиственно-сосновые с участием ели	Многоопераци-онные машины
Все типы леса	V- I	0,5-0,6	5-6 окон на 1 га	Нет	Групповой слабо угнетен	Групповo-постепенная	Мелколиственно-сосновые с участием ели	Одноопераци-онные машины
Все типы леса	V- I	0,6-0,7	нет	Нет	Равномерный слабо угнетен	Полосно-постепенная	Мелколиственно-сосновые с участием ели	Одноопераци-онные машины
С ор B_2 С чер B_3 С кис C_2	I-Ia	0,4-0,6	Редкий	>1,7	Равномерный слабо угнетен	Длительно-постепенная	Мелколиственно-сосновые с участием ели	Многоопераци-онные машины
Все типы леса	IV-I	0,5-0,6	Разновозрастное насаждение			Добровольно-выборочная	Мелколиственно-сосновые с участием ели	Многоопераци-онные машины
Примечание - В смешанных сосновых насаждениях с участием в составе ели и дуба проводятся соответствующие виды несплошных рубок главного пользования. Это относится и к насаждениям других пород								

Figure 5.3 – Criteria for prescription of final fellings (incl. undergrowth availability) in earlier versions of cutting rules [30]

In view of the above, even gradual final felling (long-lasting gradual final felling) can be planned for all coniferous stands (probably also hardwood broadleaved), if their density is above 0.4 (above 0.5), irrespectively of the undergrowth availability.

Liberation cutting, which is a part of thinning cuts, can be used for natural reforestation, only if seed scattering is ensured (between cutting stages) and there are favourable conditions for seed sprouting and rooting. Pine trees in TGC B and above require mineralization (removal or thinning of forest litter, primarily, moss). It is recommended to remove birch and aspen trees in the stand itself and adjacent subcompartments.

The mineralization technology must be used prior to seed year in growth conditions B2 and C2 as it will promote rooting of seedlings, first of all, pine. Preliminary burning-out of forest litter may be required on a considerably large area of a subcompartment (simulation of natural forest fires). Man-made forest fires are set in Sweden, most commonly on areas designated for clear cuts.

Softwood broadleaved forests require stand succession from prevailing species to aboriginal conifer (spruce). The succession may be accelerated by even gradual final felling (long-lasting gradual final felling) if there are large amounts of target species in the tree layer of seed maturity for regeneration (age class 3; preferably, age class 4 or older). Essential portion of seeding-capable trees of non-target species (softwood broadleaved) in the upper layer shall be removed during regular thinnings.

It is assumed that the presence of target species (their seeding trees) in the upper softwood broadleaved layer is reliant on the undergrowth available prior to the first cutting stage (e.g., minimum 2 units in the upper layer if no undergrowth is present; minimum one unit if the undergrowth exceed 1 thousand pcs/ha).

The amount of undergrowth shall be estimated only for target (commercially valuable coniferous and hardwood broadleaved species in typical growth conditions) species whereas the main species shall prevail. For instance, if pine is the main species in growth condition A2 [23], the target undergrowth can be regarded as sufficient if the spruce amount is equal to (not exceeding) that of pine. Spruce is a valuable species, however, it is not a target (main) species under these growth conditions. This consideration is proved by Table 2 of STB 1358-2002, indicating pine and spruce.

There are obligatory restrictions on gradual cuts and selective voluntary cuts in variously-aged pine forests with the presence of spruce [10, 14]. The restrictions can prevent unnecessary replacement of pine forests of quality classes 1-1A by spruce forests of quality class 2 or below. Even mossy pine forests are often dominated by spruce undergrowth, particularly, in central and northern subzones. Some regulatory documents on final fellings [23, 30, 40] restrict partial cuts, if there is a possible threat of pine replacement by spruce on poor soils (not specified for TGC A, B). Partial cuts are allowed for richer soils (TGC C, D) [23], however, this is arguable as the replacement will definitely reduce the stand productivity. The problem can be mitigated by intensive promotion of pine, primarily, through soil mineralization.

Selective voluntary cuts are mainly designated for variously-aged stands [23, clause 4 para.4; 30, para. 5.4.7], however, that may not always be the case. For instance, the selective voluntary cuts in littoral forest belts along rivers and other water bodies were always planned, regardless of the uneven age of stands. If the uneven age of forests is needed, it can be achieved by cuts (silvicultural practices of Soviet-era Lithuania). As the undergrowth availability is not regulated by the rules, prevailing species and species composition are not restricted during selective voluntary cuts, only the minimum limit of after-cut density is prescribed for any soil moisture [23, 30, 40]. Therefore, selective voluntary cuts can be recommended for all mature stands, particularly in conservation forests, with density 0.7 and above (Table 5.1).

According to associate professor V.P. Mashkovskiy, any forest site shall be given an opportunity for natural reforestation. Man-made reforestation shall be used only if the regeneration of aboriginal forest is hardly possible.

5.4 Promotion of biodiversity during demarcation of cutting areas

Main effective technological regulations include “The 2016 Demarcation Rules” [44] and TCCP 622-2018 “Technical Requirements” [34] and “Sanitary Rules” [42].

The Cutting Rules and Sanitary Rules contain clauses directly related to the requirements on local biodiversity conservation – clause 25-27, 76 in [23] and clauses 17, 35 in [42].

Similar requirements are laid down in TCCP 622-2018 in greater detail:

«5.3.1 In compliance with [37], selection and inventory of trees exempt from cutting (if available) are done prior to clear-cut final felling. These include:

– seed-bearing trees and groups of seed-bearing trees;

– single trees under the main canopy of the stand;

– single hollow trees, dead-standing trees with the diameter larger than the average diameter of the stand as per taxation description, trees with bird and animal nests;

– certain redlisted tree species and tree species under the protection of land user as prescribed by the procedure established by the Council of Ministers of the Republic of Belarus;

– trees whose cutting is prohibited by Article 64 of the Forest Code of the Republic of Belarus;

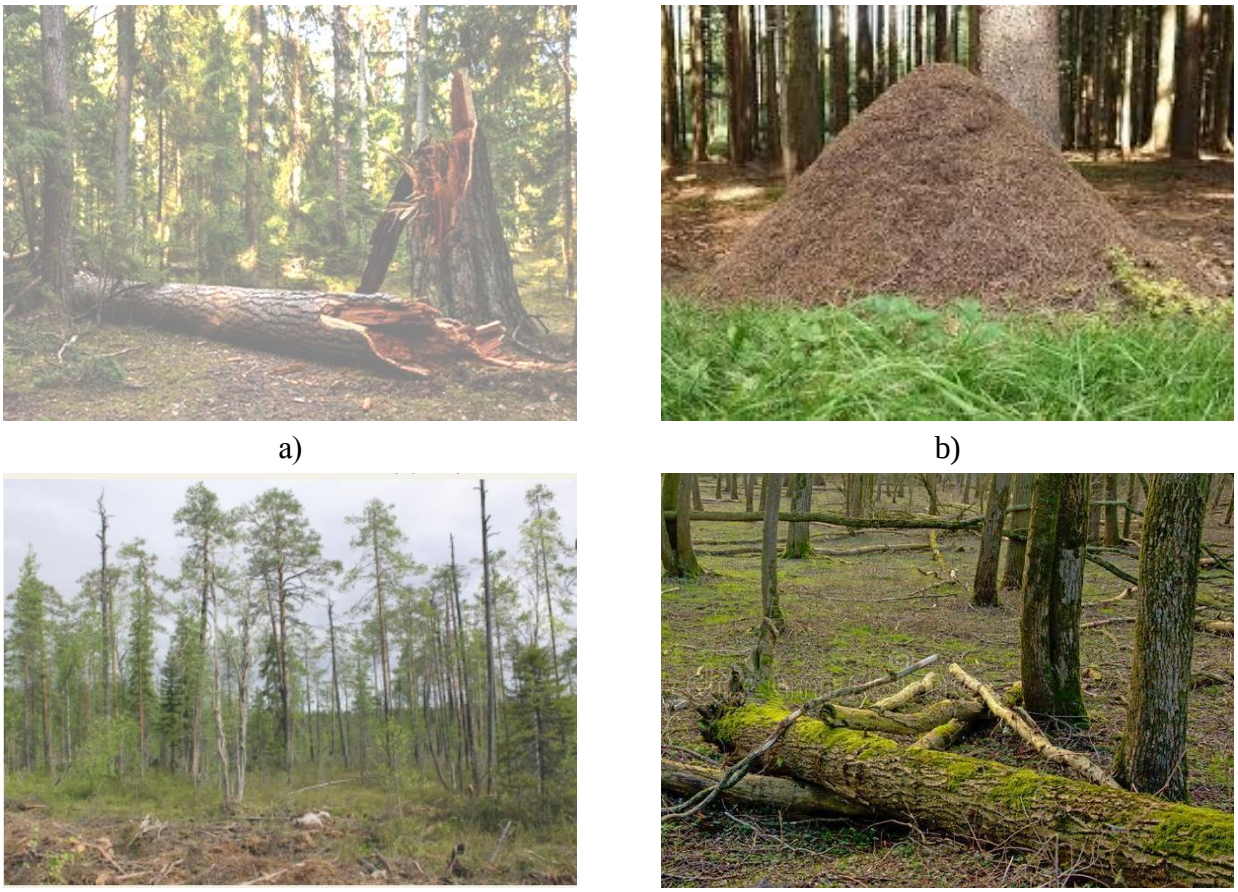
– weakened, severely weakened trees in compliance with [38] (The 2016 Sanitary Rules), up to 10 pcs per 1 ha;

– other trees as per resolution of the legal entity in charge of forest management.

Trees exempt from cutting are marked with paint. Marking is done around the stem perimeter as a 1-3 cm colour band».

Earlier regulatory documents [30, 40, 45] contain less detailed instructions on preservation of hollow trees and other biodiversity-valuable trees.

Review of best practices of the countries advanced in forest management [33], including the Russian Federation [46], reports on FSC certification of Belarusian and Ukrainian forests [47], FSC standards, has revealed that the list of local biodiversity objects (key microbiotopes) should be expanded for certain forest plots. Examples of some objects are given in Figure 5.4.



a) b)

c) d)

Figure 5.4 – Some biodiversity objects to be identified during demarcation of cutting areas:
a) high stumps and debris; b) ant hills;
c) tree belt around an open bog; d) large debris

Apart from the expanded list of preserved trees in various conditions, pieces and (or) microareas of other vegetation layers, the biodiversity objects include dead wood at different degradation stages, large boulders of clumps of boulders, small water streams (incl. temporary), swamped minor depressions, narrow shelter belts around open areas and water bodies, small forest areas of low productivity (e.g., previous centres of mottled butt rot inside pine forests).

Trees not typical of the growth conditions, e.g., black alder trees in dry pine forests, shall be exempt from cutting. Figure 5.1 above shows some other essential biodiversity objects; Table 5.2 gives the expanded list of biodiversity objects which should be attached to the Forest Cutting Rules (also referred to in the Rules for Demarcation of Cutting Areas).

Table 5.2 – List of biodiversity objects (local key microbiotopes) to be marked, recorded and preserved during cuts within cutting sites

Biodiversity object
1 Seed-bearing trees or groups of seed-bearing trees, 10-20 pcs/ha (as per Para. 25 of FCR) and selection reference trees – during partial cuts irrespective of the reforestation type
2 The largest (diameter larger than average) vigorous and resilient living trees of different species, 5-10 pcs/ha (as per Para 27 of FCR) – during clear cuts, in order to diversify the species composition of future forest
3 Giant trees, other old-aged and overmature trees of various species, 5-10 pcs/ha, or their biogroups in order to diversify the age structure of future forest
4 Rare tree species (beech, durmast oak, fur, larch everywhere, hornbeam and grey alder in central forest subzone, etc., except for invasive species)
5 Hardwood broadleaved species (oak, ash, maple, elm, hornbeam, etc.)
6 Melliferous and fruit-bearing trees and large shrubs (linden, maple, apple, pear, rowan, willow, bird cherry, hazel trees, etc.)
7 Trees containing large amounts of bracket fungi (large aspen trees, etc.)
8 Single spruce trees damaged by engraver beetle
9 Fancy-shaped trees (“wolf”-shaped trees, trees with y-shaped tops, twisted trees, trees with large branches, etc.)
10 Large dead-top trees that are prominently higher than the average canopy
11 Trees with rotten butt ends or fire scars
12 Trees at the ant hills and anthills
13 Resilient dead-standing or weakened, severely weakened (dying) trees with higher-than-average diameter, 5-10 pcs/ha (as per Para. 26 of FCR)
14 Trees with bird nests and hollows
15 Trees of traditional uses (wild-honey trees, trees for splinter and whip harvest)
16 Thick tree biogroups (potential shelters for wild animals and birds)
17 Buffer zones adjacent to open landscapes (meadows, swamps, fields, etc.) between 10 and 50 m wide
18 Forest belts around and along water bodies and water currents (incl., temporary), springs – 5-15 m wide belts
19 Swampy forest plots in microdepressions
20 Windblown trees, rotten stumps, other masses of dead wood at various degradation stages
21 Logging waste (branches, tree tops, etc.), chunks (as per Para 76 of FCR)
22 High stumps (snags) and large stumps
23 Large uprooted trees
24 Second storey of the forest stand and its biogroups
25 Biogroups of undergrowth
26 Thinned undergrowth
27 Biogroups of shrubs
28 Habitats of redlisted, rare and valuable species of plants and mushrooms
29 Unexploitable areas of non-mature forest, damaged areas, low-grade timber forest, previous centres of mottled butt rot
30 Large boulders or groups of boulders, including man-made stone-and-concrete structures
31 Other biodiversity objects at the choice of experts of the legal entity in charge

It should be noted that quite many of the biodiversity objects are of no commercial value.

However, they must be protected from damage and other disturbances (relocation) during forest management or forest use.

It is obvious that a comprehensive and illustrated official regulatory act is required to provide guidelines on identification and conservation of microbiotopes on forest sites, possibly, also creation of demonstration sites based on the best practices of the Pskov Model Forest [47].

Not only trees but also other micorbiotopes important for biodiversity conservation must be marked (with paint) and recorded in documents (numbered in the lists, symbols on layouts) in order to ensure conservation and monitoring of the biodiversity objects during demarcation of cutting areas, i.e., during initial improvement cuts in non-mature forests.

For groups of small objects, marking can be done selectively around the perimeter, the objects can be shaped on sketch maps. Paint marking around the perimeter can be done using a special sign, e.g., short vertical lines along and inside the perimeter on the corner objects of the group. This technique can be applied for marking of preserved undergrowth, young growth, other non-mature trees and shrubs.

Seed-bearing trees and groups of seed-bearing trees must be preserved to promote biodiversity conservation in all cases, including during establishment of complete forest plantations to ensure mixed reforestation with natural components of the stand on any area of forest sites.

Genetic and other environmental-biological capacity of preliminary reforestation should be harnessed in the way which does not take account of large young spruce trees and other valuable species of 8, 12 and 16 cm, if they are regarded as target species (at the choice of forestry workers). These trees should not be marked because it is labour-consuming; they can be selectively marked on the edges of large groups. This is important to promote regenerative successions of spruce in former softwood broadleaved forest areas in rich growth conditions (TGC C, D).

Besides the listed actions, some inconsistences between the terminology of the current FCR [23] and Rules for Demarcation should be eliminated. For instance, in Para.4 [23] "undesirable" trees are described. The term "undesirable" is unacceptable from the standpoint of sustainable forest management and Commoner's third law of ecology [33] which states that natural ecosystems do not contain anything "adverse, useless". According to the FCR description, the characteristics of "undesirable" trees match those that are essential for biodiversity conservation. This ambiguous term in the regulatory documents poses certain reputational risks. Less radical terms, e.g., "unpromising", "non-target", "non-commercial" appear to be more acceptable.

"Unpromising" trees are trees that adversely affect the development of superior and auxiliary trees. "Unpromising" trees are less commercially valuable (they have bad shape of stem and top, do not belong to the main species, have mechanical or fungi damage, are dead-standing or dying), they are not essential for biodiversity conservation.

The Forest Cutting Rules [23] and technological standards [40, 41] shall be supplemented by a requirement to apply technology which will promote preservation of target species undergrowth in any amounts (Table 5.1) or at least 1,000 pcs/ha. Technological regulations on forest restoration [48, note in Table 2] contain the requirement for undergrowth preservation as long as it is available in half the amount necessary for the clear cut with preservation of undergrowth.

5.5 Promotion of biodiversity during reforestation and afforestation

The current regulatory documents include: STB 1358-2002 "Sustainable forest management and forest use. Reforestation and afforestation. Technology requirements" (revised in 2011) [48] and the 2016 Regulations on Reforestation and Afforestation [49].

Compared to the previous technological regulations on forest restoration – TCCP 047-2006 [50] – the two documents have been abridged and simplified, however, the main approaches have been retained in [48, 49], i.e., natural reforestation shall be planned for target species undergrowth amount of more than 4 thousand pcs/ha; partial forest plantations or additional planting (for 3 thousand pcs/ha) –1-4 thousand pcs/ha; forest plantations (if applicable in the TGC) – less than 1 thousand pcs/ha; natural reforestation shall be planned otherwise.

Natural reforestation shall be used as much as possible in order to preserve genetic biodiversity. Genetic pools of certain populations and forest sites can be successively transferred to future generations of forests, thus, leaving their "genetic footprint".

It should be noted that the previous Soviet-era regulatory documents recommended the subsequent natural reforestation by pine in ericetal, vaccinium-type and mossy pine forests [51, p.48], i.e., in TGC A2. It was presumed that minimum two years of seed generations will germinate over three years, which will make natural reforestation of the cutting area possible. It is also noted [51, p. 49] that burnt areas of pine forests are successfully restored by the main species after three years.

STB 1358-2002 also highlights the importance of natural reforestation [clause 4.10], however, it contains certain provisions: firstly, establishment of forest plantations is not compulsory if the forest main species is restored over three years (note 2 to Table 1); secondly, seed years interval shall be considered.

Obviously, silviculturists are limited by Para. 2 and Para. 4 Article 28 of the effective Forest Code which is a legacy of the previous Codes, including the Soviet-era Code of the Byelorussian SSR. The latter stated that on lands "with growth conditions suitable for forest plantations", "forest restoration is done within three years from the signing date of the inspection certificate of the cutting area". On lands transferred to the forest fund, forest restoration "is done within three years upon the transfer of lands".

To meet the established time period and fulfil the requirements of the Forest Code, forest plantations are prescribed. The three-year interval is set to ensure forest productivity and to reduce the cutting cycle. In the 1990s, the managerial authorities of the forest sector set a two-year period for the creation of forest plantations in suitable growth conditions. The new time interval was recommended to forestry enterprises, however, it was not included in forest laws. It should be mentioned that the Swedish forest laws prescribe a five-year period of forest restoration.

At present, promotion of forest resilience and conservation of genetic diversity are more important than forest productivity. Higher productivity of forest plantations is reasonably doubted or even rejected. Further discussions can be recommended to ease the strict three-year requirement for the creation of forest plantations in Belarus. A five-year period may be established for natural reforestation.

The practice of complete natural reforestation on non-forest lands in TGC A2 should be given a second glance (table 5.1). Soil mineralization is required in the year prior to the seed year, sufficient amount of seed-bearing trees (minimum 20 pcs/ha) must be preserved prior to cutting [52].

Moreover, combined forest restoration must be used to create forest plantations of pine in TGC A3, B2, B3, C2, so sufficient amount of seed-bearing pine trees (minimum 10 pcs/ha) must be preserved. Groups of seed-bearing spruce trees and spruce undergrowth must be preserved in TGC C3, C4, D3, D4 (Table 5.1).

The proposal to take inventory of all valuable species was made above, in subchapter 5.3.

It should be noted that STB 1358-2002 still contains a chapter on biodiversity conservation, first appeared in [50], and on restrictions on certain forest restoration measures, which are a "disturbing factor", during some seasons of the year.

Conclusion

The study made t possible to develop draft national standards of the Republic of Belarus STB 2157-20XX "Chain of custody certification of timber and non-timber products. Main requirements"; STB 1708-20XX "Sustainable forest management and forest use. Main requirements"; STB "Sustainable forest management and forest use. Requirements to group forest management".

The work under project activity 3.1.1.3 "Development of methods and techniques of conservation of biological and landscape diversity during forest management and forest exploitation" included a review of international best practices of biodiversity conservation during forest management.

The study contains the review of the regulatory legal acts effective in the field of biodiversity conservation in the forests of Lithuania, Poland, Estonia, Russia, Ukraine, Latvia, Sweden, Finland.

Concise proposals on biodiversity conservation:

– maintenance of natural successions and natural reforestation processes;

– mixed forest restoration (combination of natural reforestation and forest plantations);

– preservation of minimum 5% of the forest productive area in untouched condition in order to conserve biodiversity – creation of representative forest sites – creation of micropreserves;

– priority of partial final fellings;

– preservation of single biodiversity trees or biogroups approach to preservation of forest components on clear cut areas;

– preservation of dead wood (dead-standing trees, all broken stems); "the amount of preserved dead wood must be minimum 5% of the timber harvest"; "windblown trees of any diameter shall be preserved, priority – diameter over 20 cm";

– preservation of trees important for biodiversity (biogroup approach in swampy microdepressions, small streams, springs, habitats of rare trees and shrubs, large bird nests; around ant hills, animal dens, piles of windblown trees, groups of promising undergrowth);

– environmental awareness raising;

– practical application of environmental knowledge.

Generally, the forest regulatory legal acts provide the basis for biodiversity conservation during timber harvest in all the reviewed countries. The above actions shall be included in the project documentation of forest users in order to ensure identification, preservation and approval of objects and sites.

Proposals have been made to improve methods, techniques and technology for biological diversity conservation. Forest protection actions affecting the biodiversity at genetic, species and ecosystem levels have been defined, i.e., use of pesticides for plant protection; sanitary cuts; burning of logging waste; low efficiency of forest pests and diseases control.

The report contains proposals to mitigate the negative effects of forest protection actions on forest ecosystems. The proposals can be put into practice by improving the regulatory framework. In order to make the proposed measures effective, awareness of biodiversity conservation must be raised among both forestry workers and general public.

The review of the effective technological regulations, best practices of other countries makes it possible to outline some promising trends for regulatory framework improvement in order to plan biodiversity promotion measures during forest management in Belarus.

First of all, the effective technological regulations should be made better use of; they also should be amended by some provisions that would enhance biodiversity conservation.

All essential features must be coded during field forest inventory (e.g., direction and steepness of slopes, undergrowth of aboriginal species in secondary young forests). Most valuable microbiotopes of taxation subcompartments (trees of traditional uses, fancy shape as well as large boulders, etc.) must be duly recorded to form a network of key biotopes and representative sites. Additional measures must be prescribed to conserve and promote biodiversity (preservation of shelterbelts around open areas).

Apart from trees and chunks listed in the effective technological regulations, an expanded list of objects (debris, boulders, ant hills, microswamps, etc.) must be identified and marked for permanent conservation during taxation of cutting areas. A most comprehensive but expandable list of

microbiotopes to be preserved should be attached to the Forest Cutting Rules and the Rules for Demarcation of Cutting Areas.

According to the existing technological regulations, there is an opportunity to plan even-gradual cuts everywhere (except for moist swampy soils) in mature stands, providing the upper layer density is above 0.5 (including secondary softwood broadleaved forests with sufficient proportion of aboriginal species, particularly, spruce), because there is no requirement of undergrowth availability by the time of first cutting stage. Any partial cuts cannot be planned in growth conditions B2, B3 because of the possible unwanted replacement of pine by spruce. Selective voluntary cuts should also be recommended for any stands with density above 0.7, including those on moist soils irrespective of age structure (diversified age structure required by the current TR can be formed as a result of the cuts).

On clear-cut areas in growth conditions A2, natural reforestation by pine should be planned; combined approach should be chosen for richer or wetter conditions, seed-bearing pine trees must be preserved. In both events, soil mineralization must be ensured prior to the seed year. In the future, it is advised to amend the wording of Para. 2. 4 Article 28 of the Forest Code and to abolish the obligatory three-year period of natural reforestation.

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SQL query «BR - Undergrowth – Create» to create the table «BR – Undergrowth», containing the information about the amount of undergrowth by species

```
SELECT
[M#31].NumberObject,
Val(IIf([PR1_M31]=[Handbook of species].[Code-Текст],
[KF1],
IIf([PR2_M31]=[Справочник пород].[Code-Text],[KF2],[KF3]))) AS KF,
[Handbook of species].Code AS [Code породы],
Val([KOL])*[KF]/100 AS [Amount of vigorous undergrowth]
INTO [BR - Undergrowth]
FROM [Handbook of species], [M#31]
WHERE
(
(([Handbook of species].[Code-Text])=[PR1_M31]) AND
(([M#31].PDR)="1") AND
(Not ([M#31].KF1) Is Null)
) OR
(
(([Handbook of species].[Code-Text])=[PR2_M31]) AND
(([M#31].PDR)="1") AND
(Not ([M#31].KF2) Is Null)
) OR
(
(([Handbook of species].[Code-Text])=[PR3_M31]) AND
(([M#31].PDR)="1") AND
(Not ([M#31].KF3) Is Null)
)
ORDER BY
[M#31].NumberObject,
Val(
IIf([PR1_M31]=[Handbook of species].[Code-Text],[KF1],
IIf([PR2_M31]=[Handbook of species].[Code-Text],[KF2],
[KF3]))
)
DESC;
```

APPENDIX 2

SQL query «BR - Biotope – List of stands», to make a list of subcompartments with main parameters for search of rare biotopes

```
SELECT
  MAINBASE.NumberObject,
  MAINBASE.LESHOS,
  MAINBASE.LESNICH,
  MAINBASE.KV,
  MAINBASE.VYDEL,
  [M#10].KS,
  [Handbook of species]. AS Species,
  [Handbook of forest types].Cipher AS [Forest type],
  Val([VOZ_M10]) AS Age,
  [M#10].order_in_object,
  [PL]/10 AS Area
FROM
  (
    (
      MAINBASE
        INNER JOIN [Handbook of forest types]
          ON
            MAINBASE.TL = [Handbook of forest types].Cipher)
        INNER JOIN [Handbook of land categories]
          ON
            MAINBASE.KZM_M1 = [Handbook of land categories].Code
    )
    INNER JOIN
      (
        [M#10]
          INNER JOIN [Handbook of species]
            ON
              [M#10].POR_M10 = [Handbook of species].[Code-Text]
      )
      ON
        MAINBASE.NumberObject = [M#10].NumberObject
WHERE
  (
    (([M#10].order_in_object)=1) AND
    ((MAINBASE.KZM_M1)=1101)
  );
```

APPENDIX 3

Biological diversity conservation measures as required by regulatory legal acts in forest sector (best practices of different countries)

Table 1 – Biological diversity conservation measures: Lithuania (excerpt)

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
List of biological diversity conservation measures	Forest protection measures. Recommendations Ministry of Environment of the Republic of Lithuania. Forest Department Vilnius 2011	Chapter 6. Biological diversity conservation measures. clause 1. When growing mixed stands with prevailing pine and spruce, groups of deciduous species shall be formed in the stand as well as single deciduous trees shall be included in general forest area.
		Раздел 6. Biological diversity conservation measures. clause 5. Some areas of special value for the conservation of remarkable environments (most preferably natural) may be exempt from improvement cuts
		Chapter 6. Biological diversity conservation measures. clause 8. Some logging waste shall be stored on the cut area to provide shelter for entomophage insects.
		Chapter 6. Biological diversity conservation measures. clause 9. During forest cuts, some rare tree species shall be preserved, i.e., apple, pear, elm, maple, linden trees, etc.
		Chapter 6. Biological diversity conservation measures. clause 10. Some old-aged large trees of oak, ash, maple, pine, linden, etc. shall be preserved in small biogroups.
		Chapter 6. Biological diversity conservation measures. clause 11. Old-aged dead trees shall be left in the cut area in the same place as prior to cutting operations.
		Chapter 6. Biological diversity conservation measures. clause 13. In stands dominated by one single species, small tree groups of other species shall be preserved.
		Chapter 6. Biological diversity conservation measures. clause 14. Small forest swamps, open spaces, glades shall be prevented from overgrowing with trees.
		Chapter 6. Biological diversity conservation measures. clause 15. Natural environment shall be conserved along small streams, springs, water bodies inside the forest.
		Chapter 6. Biological diversity conservation measures. clause 16. Trees of rare shapes shall be preserved during forest cuts.
		Chapter 6. Biological diversity conservation measures. Gradual and selective final cuts shall be carried out in wildlife corridor forests between forest tracts.
		Chapter 6. Biological diversity conservation measures. On final felling areas, key habitats shall be identified during planning stage and preserved during the

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
		forest cuts.
		Chapter 6. Biological diversity conservation measures. 7-10 old-aged trees of various species should be preserved (either in groups or evenly distributed across the area).
		Chapter 6. Biological diversity conservation measures. Tree and shrub species, which are rare for a certain area, shall be preserved.
		Chapter 6. Biological diversity conservation measures. During clear sanitary cuts, dead wood (windfall) should be preserved, the minimum amount depends on the group of forest.
		Chapter 6. Biological diversity conservation measures. Upon the selective sanitary cuts, minimum 20m^3/ha of dead-standing trees (or deciduous trees of reduced survivability) shall be preserved in group IIA forests. Minimum 5% of dead trees shall be preserved in forests of groups II and IV upon selective sanitary cuts.
Ways of forest restoration	Regulation on Forest Restoration dated 14.04.2008 (amended)	clause 5. Only natural reforestation shall be done in forests of group I.
		clause 7. Tree plantations are not allowed on cut areas, burnt-out areas, areas of damaged stands, forest lands.
		clause 8. When a site is prepared for afforestation, it shall be planted with nectar plants to attract insects, birds, etc.
		clause 11.2. During reforestation by conifers, areas larger than 1 ha shall be planted with nectar plants (minimum 1% of the reforested area).
		clause 20.2.1 и clause 20.2.2. Forest plantations or naturally reforested areas containing minimum 50% of oak (or beech) shall be fenced.
	Law «On Forests»	Ст. 18. Logged oak, maple, linden, ash and pine forests shall be restored by the same species composition (in suitable conditions).
Selection of biodiversity-vital trees, their identification and conservation measures	Order by the Head of Regional Unit (forestry enterprise). «Procedure for selection of biodiversity-vital trees, dead wood and shelterbelts».	CLAUSE 5. Biodiversity-vital trees shall be selected and marked during forest cuts.
		CLAUSE6. Biodiversity-vital trees shall be preserved during all types of final fellings.
		CLAUSE 7. The quantity of biodiversity-vital trees is: 7.1. minimum 7 living hardwood broadleaved trees per one hectare; 7.2. minimum 10 living trees of other species per one hectare.
		CLAUSE 9. Biodiversity-vital trees shall be selected on a priority basis by the following principles: 9.1. the thickest or oldest trees in a stand (minimum three trees per one hectare); 9.2. trees older or thicker than average; 9.3. trees not typical of a stand, trees with irregular tops, hollows, large nests, fruit-bearing trees larger than 30 cm.

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
		CLAUSE 10. Biodiversity-vital trees shall be preserved in the following way: 10.1. tree groups with understorey, dead wood, live soil cover and other components; 10.2. single trees (evenly or unevenly distributed); 10.3. mixed way.
		CLAUSE 11. Conservation of biogroups on the cutting areas associated with microdepressions, streams, biogroups of rare trees and shrubs, large bird nests, large ant hills, animal dens, piles of windfall, groups of undergrowth.
		CLAUSE 12. Trees of windblown species (spruce, birch, aspen) shall be preserved in groups. Spruce trees are selected in the least dense part of the stand, they shall have a most developed root system and tree top (top height shall be minimum 70% of the total height of the tree).
		CLAUSE 13. Biodiversity-vital trees shall be left on the site forever until they die and fully decompose.
		CLAUSE 14. Understorey, live soil cover, windfall and other biodiversity-vital components within the preserved tree groups shall be left untouched during any subsequent forestry operations.
Selection and conservation of dead wood.	Order by the Head of Regional Unit (forestry enterprise). «Procedure for selection of biodiversity-vital trees, dead wood and shelterbelts».	CLAUSE 15. Dead wood shall be preserved on the cutting areas forever. The most vital dead wood shall be identified and marked prior to forest cuts.
		CLAUSE 16. The preserved dead wood shall amount to minimum 5% of the total timber harvest, unless otherwise prescribed by legal acts regulating the conservation area management.
		CLAUSE 17. Dead wood shall be selected irrespective of its degradation stage on a priority basis according to the following principles: 17.1. dead-standing, broken, windblown trees within the biodiversity-vital groups of trees; 17.2. dead-standing trees with undisturbed tops (large and small branches); 17.3. dead-standing, broken, windblown trees of aboriginal species which are rare for the felling area and the forest tract; 17.4. windblown trees with diameter larger than 20 cm; 17.5. other dead-standing and windblown trees.
		CLAUSE 18. Dead wood shall be preserved as a matter of priority in the following way: 18.1. all kinds of windfall shall be left in its original condition (except for cases specified in 18.2 and 18.3); 18.2. windfall may be relocated if it creates dangers or difficulties for soil cultivation; 18.3. dangerous dead-standing trees shall be cut at the height that poses no danger for subsequent forestry operations.
		CLAUSE 19. Dead wood cannot be piled and covered with logging waste.
		CLAUSE 20. If the amount of windfall is insufficient, up to 5 biodiversity-vital trees shall be preserved on the site.

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
		CLAUSE 21. Dangerous dead-standing trees located close to population centers, roads, paths, recreational areas shall be cut and left on the cutting area until they fully decompose.
Creation of shelterbelts and buffer zones.	Order by the Head of Regional Unit (forestry enterprise). «Procedure for selection of biodiversity-vital trees, dead wood and shelterbelts».	CLAUSE 22. During clear cuts, shelterbelts shall be left around water bodies and open areas to ensure resilience of forest ecosystems and to create forest microclimate.
		CLAUSE 23. Shelterbelts and buffer zones are created: 23.1. around lakes, ponds, along rivers; 23.2. along streams recorded in the Cadastre of the Republic of Lithuania; 23.3. along boundaries of open areas larger than 1 ha.
		CLAUSE 24. The buffer zone around water bodies shall be located not more than 10 m from the shore line in summer (low-water season) (for rivers and streams – 5 m along both banks) or it may be larger if specified by the local regulatory act.
		CLAUSE 25. The buffer zone around open areas shall be located not less than 10 m.
		CLAUSE 26. The buffer zone boundaries shall be marked.
		CLAUSE 27. Buffer zone (shelterbelt) is marked on the technological map with a special note.
		CLAUSE 28. The buffer zone belongs to the general forest area, the biodiversity-vital trees in the buffer zone may be included in the total amount of biodiversity-vital trees of this particular area.
		CLAUSE 29. Trees in the buffer zone may be cut in the following events: 29.1. coniferous trees recently infested with bark beetles; 29.2. trees that pose dangers to people or property; 29.3. the highest trees may be cut to prevent their windfall.
		30. All parts of a stand (undergrowth, understorey, live soil cover, forest floor) in the buffer zone shall be preserved during forest management.

Table 2 – Biological diversity conservation measures: Poland (excerpt)

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
Preservation of forest components vital to biological diversity conservation.	Zasady hodowli lasu. Dyrekcjia Generalna Lasów Państwowych, Warszawa, 2012.	§ 28 clause 2. During forest restoration, valuable components of stands (e.g., groups of young vigorous undergrowth, seed-bearing trees, hollow trees, giant trees, tree-monuments) shall be left as desirable structural and functional components of a new stand.
		§ 31 clause 4. Clear cuts should not be carried out in the proximity of rivers, lakes, sacred places, around large old trees (natural monuments). Ecotones should be created in these places.
		§ 31 clause 5. Parts of old-aged forest with undestroyed lower layers shall be preserved in stands with a short restoration cycle (minimum 6 ares, the proportion of all preserved parts shall not exceed 5% of the total cut area) (except for windfall hazards; on cutting areas smaller than 1 ha which are

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
		planned for restoration by superior trees*).
Measures to restore natural forests	Zasady hodowli lasu. Dyrekcjia Generalna Lasów Państwowych, Warszawa, 2012.	§ 31 clause 9. Thinning, "window" cutting shall be done not later than 20 years prior to cutting of the mother stand in order to provide effective protection of the young forest against adverse weather effects.
		§ 38 clause 10. Swampy and excessively moist areas may be left for natural succession.

Table 3 – Biological diversity conservation measures: Estonia (excerpt)

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
Old-aged and hollow trees, trees with nests, snags and dead-standing trees with diameter over 25 cm shall always be left in the forest.	Temporary NEPCon standard for forest management assessment in Estonia	6.3.6 Old-aged and hollow trees, trees with bird nests, snags and dead-standing trees with diameter over 25 cm shall always be left in the forest with due account for the national health and safety requirements.
After cutting, minimum 10 largest-diameter living trees (5 deciduous trees) of various species per one hectare shall be left.	Temporary NEPCon standard for forest management assessment in Estonia	6.3.7. Minimum 10 largest-diameter biodiversity trees (5 deciduous trees) per one hectare shall be left during final felling and shall be left uncut forever (b). 6.3.8 Biodiversity trees shall be selected from a great variety of species, they shall have the largest diameter of all most biodiversity valuable and wind-resistant trees (6.3 b).
During clear cuts, 20-70 pine, birch, ash, oak, black alder, elm trees per one hectare shall be left, including old standing trees or their parts in the amount of minimum five cubic metres per one hectare.	Forest Act 01.01.2014	§ 29. Clear cuts (1) During clear cuts, all trees shall be cut within one year, except for: 1) 20-70 pine, birch, ash, oak, black alder, elm trees per one hectare, lumped or grouped, as seed-bearing trees or vigorous undergrowth; 3) old trees, i.e., trees that can promote biodiversity, or standing parts of old trees if the volume of stem wood amounts to minimum 5 cubic metres per one hectare or 10 cubic metres if the cutting area is larger than 5 ha.
Seed-bearing trees shall not be preserved if suitable trees are not available on the cutting area or if vigorous undergrowth is preserved, or if the cutting area is located close to the seed-age coniferous forest.	Forest Act 01.01.2014	§ 29. (2) Seed-bearing trees shall not be preserved if suitable trees are not available on the cutting area. If vigorous undergrowth is available on the cutting area, it shall be preserved during cuts. Seed-bearing trees may not be left in the cutting area that is closer than 30 m to the edge of a seed-age coniferous stand or closer than 50 m to the edge of any other stand.

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
Clear cuts are allowed in stands of all ages, except for pine, spruce, birch, aspen, black alder and hardwood broadleaved stands.	Rules of Forest Management 02.09.2017	(2) Clear cuts are allowed in stands of any age if the dominating species is not listed in Chapter 1.
Seed-bearing trees are cut after their seed-bearing capacity has terminated.	Rules of Forest Management 02.09.2017	§ 10. (2) Seed-bearing trees can be removed by sanitary cuts after their seed-bearing capacity has terminated.
After cutting, old trees or their available parts (minimum 5 (or 10 on cutting areas larger than 5 ha) cubic metres of stem wood per 1 ha) shall be preserved. Largest-diameter trees of various species shall be left in the forest forever, preferably hardwood broadleaved trees, pine and aspen trees, trees with outstanding features. Group of trees shall be left on large clear-cut areas.	Rules of Forest Management 02.09.2017	§ 13. (1) Old-aged growing trees or their available parts shall be preserved on the clear-cut area. The amount of the preserved stem wood shall be minimum 5 cubic metres per one hectare or minimum 10 cubic metres per one hectare if the clear-cut area is larger than 5 ha. (2) Old-aged trees are selected from the upper layer, they include largest-diameter trees of various species, preferably hardwood broadleaved trees, pine and aspen trees, trees with outstanding features, i.e., fire scars, hollows or large branches. (3) Groups of old-aged trees are preserved on large clear-cut areas. (4) Old-aged trees shall not be cut and are left in the forest forever.

Table 4 – Biological diversity conservation measures: Russia (excerpt)

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
Seed-bearing trees and tree groups shall be preserved on clear-cut final felling areas with assistance to natural reforestation. The quantity of the preserved seed-bearing trees shall be minimum 20 trees per one hectare.	Rules of timber harvest and special aspects of timber harvest at forest stations dated 01.12.2020	51. On clear-cut areas of mature and overmature stands with assistance to natural reforestation, the following components shall be preserved: single seed-bearing trees, groups of seed-bearing trees, clumps of trees, forest belts and forest edges with seed-bearing trees…
Single trees or tree groups can be left during improvement cuts to promote resilience, biodiversity and other environmental purposes.	Rules of forest care dated 30.07.2020 No. 534	18. …. An exception is single trees or tree groups that are to be left to promote resilience, biodiversity and other environmental purposes…
Dead-standing trees are not desirable during improvement cuts.	Rules of forest care dated 30.07.2020 No. 534	22. Undesirable trees to be cut are: b) trees in bad condition (dead-standing, windblown, snowbroken, badly damaged by pests or animals);
During improvement cuts, seed-bearing trees are cut after their seed-bearing capacity has	Rules of forest care dated 30.07.2020 No. 534	23. Trees that have lost their seed-bearing capacity, single trees left on the cut area (hereinafter single trees) shall be cut at first stages of

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
terminated.		improvement cuts if their preservation is not desirable.
Drainage amelioration is prohibited as it leads to the reduction and alteration of aboriginal biodiversity, loss of valuable natural ecosystems.	Rules of forest care dated 30.07.2020 No. 534	Drainage amelioration is not allowed as it leads to the reduction and alteration of aboriginal biodiversity, loss of valuable natural ecosystems.
During improvement cuts, making of non-linear skid roads is allowed in order to conserve superior trees and biodiversity objects.	Rules of forest care dated 30.07.2020 No. 534	98. During laying and making of skid roads, non-linear skid roads can be made in order to conserve superior trees and biodiversity objects.
During selective sanitary cuts, hollow tress may be left, 5-10 pcs/ha.	Rules of pest control dated 09.11.2020 No. 912	46. During selective sanitary cuts, hollow tress shall be left, 5-10 pcs/ha, to provide natural shelter for wildlife
During selective sanitary cuts and clear sanitary cuts, trees of category 5 are planned for cutting.	Rules of pest control dated 09.11.2020 No. 912	41. When planning clear and selective sanitary cuts, trees of category 5 are prescribed for cutting. Windblown and snowbroken trees belong to category 5.
During forest cuts, tree species available in the stand prior to cutting operations shall be preserved. Preservation of all available tree species is not obligatory.	National FSC forest management standard for Russian Federation	Indicator 6.8.2. The entity shall ensure preservation of tree species available in the stand prior to cutting operations. Guideline: Preservation of all available tree species is not obligatory on all cutting areas.
During clear cuts (or after the final stage of gradual cuts), mosaic-shaped forest landscape shall be left, i.e., shelterbelts and separated forest groups (minimum 10% of the cutting area), if the cutting area is larger than 15 ha.	National FSC forest management standard for Russian Federation	Indicator 6.8.4. During clear cuts (or after the final stage of gradual cuts), mosaic-shaped forest landscape shall be left, i.e., shelterbelts and separated forest groups. The proportion of the shelterbelts and separated forest groups shall be minimum 10% of the cutting area, if the cutting area is larger than 15 ha.
During forest cuts, key habitats shall be preserved, i.e., rare and endangered plants and mushrooms, old-aged trees, high conservation value trees, areas of various horizontal and vertical canopy density, dead-standing trees, windblown trees, areas with canopy windows caused by adverse weather effects, nesting habitats, small wetlands, swamps, low-moor bogs, etc.	National FSC forest management standard for Russian Federation	Indicator 6.6.2. Key habitats identified by indicator 6.6.1 shall be preserved.
Key habitats shall be preserved during all types of forest cuts.	National FSC forest management standard for Russian Federation	Indicator 10.11.3. Key habitats identified by indicators 6.6.1 and 6.6.2 shall be preserved during all types of forest cuts.

Table 5 – Biological diversity conservation measures: Ukraine (excerpt)

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
Preservation of trees and shrubs that are of exclusive value to biodiversity conservation	Rules of final felling	1.3. During timber harvest, it is not allowed to cut and damage redlisted trees and shrubs, seed-bearing trees, superior and other trees that are of exclusive value to biodiversity conservation
Cutting technology shall ensure preservation of the trees and undergrowth left.	Rules of final felling	4.5. Cutting technology shall ensure preservation of the trees and undergrowth left.
Cuts are recommended in the period from October 1 to April 1 on the cutting areas with undergrowth or planned coppice reforestation	Rules of final felling	4.7. Cuts shall be done in the period from October 1 to April 1 on cutting areas with vigorous undergrowth to promote reforestation and cutting areas planned for coppice reforestation
Silvicultural operations shall be prioritized during cleaning operations on cut areas	Rules of final felling	6.6. Clean-up operations on the cut areas prescribed for man-made reforestation shall provide for silvicultural operations (soil cultivation, planting or seeding, tending of forest plantations).
When burning logging waste on cut areas, undergrowth and trees exempt from cutting shall be preserved	Rules of final felling	6.8. When burning logging waste on cut areas, undergrowth and trees exempt from cutting shall be preserved. Burning of logging waste heaps shall be started at the edges of the cut areas and around clumps of seed-bearing trees. Clear burn is not allowed.
Preservation of vigorous undergrowth of commercially valuable species	Rules of final felling	7.2. During cuts, vigorous undergrowth of commercially valuable species shall be preserved.
Assistance to natural reforestation after the first stage of gradual and voluntary-selective cuts	Rules of final felling	7.5. If the amount of vigorous undergrowth is not available after the first stage of gradual and voluntary-selective cuts, measures to assist natural reforestation shall be taken.
Sanitary selective cuts and debris clean-up operations are not allowed, as well as cutting of hollow, dead-standing, defective trees in core zones of some SPNAs.	Sanitary rules in the forests of Ukraine	5. Sanitary selective cuts and debris clean-up operations are not allowed, as well as cutting of hollow, dead-standing, defective trees in core zones of biosphere reserves, national and regional landscape parks, natural reserves, natural monuments, reserved natural landmarks.
Sanitary selective cuts are not allowed in recreational areas, buffer zones or across the whole territory of some SPNAs.	Sanitary rules in the forests of Ukraine	5. Sanitary selective cuts are not allowed in recreational areas of national natural parks, buffer zones of biosphere reserves, all-zoological, botanical, forest, ornithological and landscape preserves.
During selective sanitary cuts, hollow trees free from fruit bodies of wood-destroying fungi shall be preserved.	Sanitary rules in the forests of Ukraine	23. Trees with fruit bodies of wood-destroying fungi shall be cut in the coniferous and valuable deciduous stands affected by stem rot fungi. Hollow trees shall be left to provide natural shelter for wildlife (for SSC)

Table 6 – Biological diversity conservation measures: Latvia (excerpt)

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
Creation of specially protected natural areas and microreserves to protect species and habitats	Promotion of FSC certification for biodiversity conservation in the forests of Latvia (2017)	Minimum 10% of the forest lands shall be allocated to legally protected areas and other biologically valuable areas that will enhance forest habitats and species in the forests of Latvia.
Protection of key biotopes and conservation of beaver habitats	Promotion of FSC certification for biodiversity conservation in the forests of Latvia (2017)	Three FSC standards require that all old beaver ponds, floodplains and wetlands with dead trees remain untouched.
Creation of buffer zones around swamps	Promotion of FSC certification for biodiversity conservation in the forests of Latvia (2017)	Three FSC standards require creation of buffer zones between 20 and 100 m around swamps, depending on the swamp area.
Preservation of growing trees with living biodiversity during forest felling	Promotion of FSC certification for biodiversity conservation in the forests of Latvia (2017)	FSC requires minimum 10 growing trees with living biodiversity per one hectare during final fellings. Trees shall be preserved in groups wherever possible. In humid deciduous forests, 30 living trees shall be preserved per one hectare during clear cuts in order to promote restoration of deciduous trees.
Preservation of all trees with nests, hollows, preservation of their surrounding undergrowth	Promotion of FSC certification for biodiversity conservation in the forests of Latvia (2017)	Both FSC and the current legislation require to preserve all trees with nests larger than 50 cm in diameter as well as the surrounding undergrowth, irrespective of its amount. The current law also prescribes to preserve all trees with hollows larger than 10 cm in diameter.
Use of local trees species and preservation of understorey	Promotion of FSC certification for biodiversity conservation in the forests of Latvia (2017)	Only local/non-invasive tree species shall be used for forest restoration. Distribution of non-local species shall be controlled and curbed. Undergrowth shall be preserved around fox's and badger's dens.
Preservation of dead trees during cuts	Promotion of FSC certification for biodiversity conservation in the forests of Latvia (2017)	During clear cuts, up to five large stems shall be preserved per one hectare. During partial cuts, minimum three large stems shall be preserved per one hectare, minimum eight stems per one hectare shall be preserved for dead timber harvest. 5 m^3 of windblown trees shall be preserved per one hectare. All stems larger than 50 cm in diameter shall be preserved, irrespective of their quantity.
Conservation of habitats and dead wood diversity in forests	Promotion of FSC certification for biodiversity conservation in the forests of Latvia (2017)	All dead trees larger than 25 cm in diameter shall be preserved in microdepressions, as well as groups of growing and dead trees in burnt forest areas older than 30 years.
Conservation of deciduous trees in forests	Promotion of FSC certification for biodiversity conservation in the forests of Latvia (2017)	The proportion of deciduous trees shall be enhanced during thinning cuts in mixed coniferous-deciduous forests, their proportion being 5%. Clear cuts are prohibited in deciduous forests.
Cutting of dead-standing,	Forest Act	Chapter III. Felling. Article 12.

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
damaged and windblown trees	dated 17.03.2000	(4) Dead-standing, damaged and windblown trees may be cut, as prescribed by the law and the felling rules.
Trees grown to the size of specially protected tress are exempt from cutting	Forest Act dated 17.03.2000	Chapter III. Felling. Article 12. (5) Trees that have achieved the size of specially protected trees, i.e., secular trees, cannot be cut, as specified by laws and regulatory acts on specially protected natural areas.
Clear cuts are not allowed	Rules of forest tree cutting No. 935 dated 01.01.2013	65. Clear cuts are prohibited: 65.1. in forest clusters (forest area smaller than 1 ha located at a distance of minimum 500 m from another forest area larger than 1 ha); 65.2. in forest stands dominated by oak, linden, maple, elm, willow or hornbeam; 65.3. in pine forests on dry mineral soils (the proportion of pine is larger than 80%) located in restricted use coastal areas of the Baltic Sea and the Gulf of Riga; 65.4. in forest stands on floodplains of water bodies and water currents – in periodically inundated valleys with typical floodplain vegetation; 65.5. in protected swampy areas; 65.6. on lake and swamp islands …
Biological diversity conservation measures during cuts	Rules of forest tree cutting No. 935 dated 01.01.2013	XI. Nature conservation requirements to felling 54. During felling, the following components are to be preserved: 54.1. minimum five growing trees per one felling hectare – trees of previous generation, or, if not available, trees with diameter larger than the average diameter of predominant species. Oak, linden, pine, ash, elm, maple, alder, aspen and birch trees are preferred for conservation as well as trees with fire scars; 54.2. trees with large (over 50 cm in diameter) bird nests, as well as tree branches and the surrounding undergrowth; 54.3. hollow trees with diameter larger than 10 cm. 55. If dry trees are available, minimum 4 thickest fallen, broken or standing dry trees shall be preserved per one hectare (primarily those larger than 50 cm in diameter). 56. During felling, all vegetation shall be preserved around springs and streams, as well as in microdepressions (with typical vegetation). 57. Trees next to anthills shall be preserved. 60. During felling, understorey of beech, juniper and other local shrubs shall be preserved... 61. Gulleys and forest edges shall remain partially overgrown…

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
		62. In coniferous stands older than 30 years with mixed deciduous species, the deciduous species shall be preserved in the proportion of minimum 5% of the total stand composition. 63. Timber is hauled from the cutting area in the way that soil cover, anthills, geomorphological formations, fallen dead trees thicker than 50 cm and conserved trees are not disturbed.
Preservation of biologically valuable forest components	Conservation forest management rules. No. 936 dated 01.01.2013	2. The following biologically valuable forest components shall be preserved during forest management: 2.1. forest stands on lake islands; 2.2. forest stands on swamp islands; 2.3. foest clusters; 2.4. forest stands in floodplains of water currents and water bodies; 2.9. biologically valuable forest stands …
Protection zones around swamps to preserve biodiversity	Law on Protection Zones dated 11.03.1997	7^{1} Art. Shelterbelts around swamps (2) The minimum width of shelterbelts around swamps is determined in the following way: 1) for areas between 10 and 100 ha – 20 m; 2) for areas over 100 ha – a 50 m zone for all forest growth conditions on dry, drained, wet mineral soils and drained peat soils; a 100 m zone for all forest growth conditions on wet peat soils.
Creation of microreserves to protect habitats	Regulation on creation and management of microreserves, their protection, identification of microreserves and their buffer zones No. 940 dated 18.12.2012	The Regulation prescribes the procedure for the creation of microreserves, their management, protection measures; it also defines microreserves and buffer zones.

Table 7 – Biological diversity conservation measures: Sweden (excerpt)

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
Preservation of trees during cuts	The 2013 National FSC Forest Stewardship Standard for Sweden	Both FSC and the current legislation require that old hollow trees and trees survived after adverse effects shall be preserved during cuts. During cuts, minimum 10 trees per one hectare shall be preserved for natural reforestation.
Conservation of dead wood during timber harvest	The 2013 National FSC Forest Stewardship Standard for Sweden	Both FSC and forest management laws require that dead wood available prior to cuts shall be preserved during timber harvest. FSC standard prescribe that minimum two broken stems (windblown trees) and three man-made high stump (timber harvest) per one hectare are preserved.

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
Identification of specially protected natural areas and key habitats	The 2013 National FSC Forest Stewardship Standard for Sweden	Minimum 55 of productive forests shall be left as a reserve.
Controlled burning	The 2013 National FSC Forest Stewardship Standard for Sweden	In compliance with FSC standard, large forest owners shall burn 5% of annual final fellingarea on dry and fresh soil. Burning creates new components in the forest, promotes diversity of plants and animals contingent on forest burnt areas.
Deciduous forest	The 2013 National FSC Forest Stewardship Standard for Sweden	Broadleaved forests shall not be replaced by other species. Forest management shall envisage that over 10% proportion of deciduous forest shall remain at the end of cutting cycle. 10% of fresh/moist forest lands shall be occupied by deciduous stands.
Environmental protection measures	Forestry Act dated 01.04.2020	Elements of naturally growing tree species shall be preserved. Shrubs, single trees, tree groups and dead trees shall be preserved during all types of cuts. Forest debris of over 0.1 ha shall be left undisturbed. Buffer zones with trees and shrubs vital to conservation of biotopes, cultural environment, water bodies, wetlands shall be preserved.

Table 8 – Biological diversity conservation measures: Finland (excerpt)

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
Habitat protection for biodiversity conservation	The 2017 National FSC Forest Stewardship Standard for Finland	Owners of FSC-certified forests shall allocate minimum 5% of the productive forest area for biodiversity conservation
Conservation of coastal areas	The 2017 National FSC Forest Stewardship Standard for Finland	Buffer zones shall be located at a distance of minimum 20 m from streams and springs with natural or almost natural bed and minimum 30 m around water bodies.
Conservation and protection of swamps	The 2017 National FSC Forest Stewardship Standard for Finland	Swampy biotopes shall be preserved in natural condition.
Species protection	The 2017 National FSC Forest Stewardship Standard for Finland	The Standard sets the requirements to the protection of nesting birds, defines the mating periods when felling is prohibited at the minimum distance from nests and breeding places of birds.
Conservation of deciduous trees	The 2017 National FSC Forest Stewardship Standard for Finland	In forests dominated by coniferous species, the proportion of deciduous species shall amount to 10%. If the proportion of deciduous trees is less than 10%, all deciduous trees shall be preserved during cuts.
Preservation of growing	The 2017 National FSC	Minimum 10 growing trees per one hectare shall be preserved during cuts (preferably large and

Biological conservation measure	RLA name, clause (if applicable)	Excerpt from RLA, if applicable
trees on felling areas	Forest Stewardship Standard for Finland	biologically valuable trees). Trees are left in biogroups, their typical microclimate is conserved. FSC requires all biologically valuable trees to be preserved on felling areas, i.e., all willow, bird cherry, rowan and black alder trees larger than 10 cm in diameter, all aspen trees larger than 40 cm in diameter, all large trees with diameter larger than 40-60 cm (depending on tree species) as well as all trees with hollows, nests of predatory birds and all pine trees with fire scars.
Conservation of dead wood	The 2017 National FSC Forest Stewardship Standard for Finland	Minimum 20 dead trees larger than 10 cm in diameter shall be preserved where available, as well as all decomposing deciduous trees.
Biomass conservation in forests	The 2017 National FSC Forest Stewardship Standard for Finland	The FSC Standard requires that minimum 30% of wood waste is left on wood biomass harvest areas; minimum 25 stumps larger than 15 cm in diameter, all small stumps, decaying stumps, standing and fallen dead trees larger than 10 cm in diameter are preserved.
Conservation of habitats for species dwelling in burnt forest areas	The 2017 National FSC Forest Stewardship Standard for Finland	Controlled burning (Forest areas larger than 200 000 ha) One forest site (the size depends on the forest area) per 200 000 ha shall be burned a year.
Biodiversity conservation and most relevant biotopes	Forest Act 12.12.1996/1093 revised	Chapter 3 Promotion of forest biodiversity § 10 Biodiversity conservation and most relevant biotopes The most relevant biotopes for biodiversity conservation are: 1) buffer zone along springs, streams, depressions with permanent ducts and small dells; 2) spruce bogs with mixed herbs, ferny spruce bogs and eutrophic bogs in the southern part of Lapland; 3) eutrophic islets of broadleaved stands; 4) small upland islets on undrained swamps; 5) gulleys and small hollows; 6) steeps and stands at their bottoms; 7) low-productive (lower than lichen type) stands on sands, rocks, stony grounds, boulder rocks, as well as lightly-forested swamps and floodable coastal areas.