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CONSERVATION OF FOREST GENETIC RESOURCES: KEY STAKEHOLDERS' ATTITUDES IN FORESTRY AND NATURE PROTECTION

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Despite the large number of scientific papers dealing with conservation of forest genetic resources, research about the attitudes and evaluation of representatives of key stakeholders in the forestry and nature protection sectors, towards this issue, have not been sufficiently represented so far in Serbia. The aim of this paper was to study the attitudes of representatives of key public institutions (administrative and professional), enterprises, educational and research organizations in the forestry and nature protection sectors, towards the factors that threaten biodiversity, conservation methods, state of seed sources in Serbia and proposals of measures to improve forest genetic resources. The methodology used in the paper is an approach to the research on conservation of forest genetic resources which is used in the social sciences. The survey included a total number of 32 respondents in the territory of the Republic of Serbia. According to the key stakeholders' opinion, urbanization and infrastructure construction (average score 4.1) have the greatest negative impact on biodiversity; conservation of forest genetic resources in natural populations through designation of seed stands is rated as the most important *in situ* method (average score 4.60), while establishment of seed orchards and provenance trials are rated as the most important *ex situ* conservation methods (average score 4.19). From the analysis of respondents' attitudes, it can be concluded that the conservation of forest genetic resources through designation of seed stands (72%) and conservation in protected areas (63%) are methods that gave the best results in Serbia.

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However, the majority of respondents (about 60%) stated that seed sources in Serbia do not have an appropriate structure and spatial coverage. In addition to the professional activities and support from the institutions, the majority of respondents believe that it is necessary to intensify activities to promote conservation of forest genetic resources.

Key words: biodiversity, conservation methods, *ex situ*, *in situ*, survey

INTRODUCTION

Nowadays there are numerous factors (biotic and abiotic) that endanger forest genetic resources (FGR) and lead to a loss of genetic variability, which is the cause of the disappearance of a large number of species or reducing their population to critical limit. Forest trees are „*the keystone species of forest ecosystems and their continued existence is essential for many floral and faunal associations of these ecosystems*" (RAJORA and MOSSELER, 2001). According to FAO (1989), FGR can be defined as genetic variation of trees that are of potential or actual value for humans. The term *forest* refers to the habitat and populations of trees and typical associations of other woody plants; the term *genetic* includes the variability of genetic (DNA) structure at various levels: variation between species, among populations within species, and variation among individual trees within the population; the term *resources* refers to the utilization of genetic variability - in a broader sense, for the purpose of satisfying human needs (AMARAL *et al*., 2004; ŠIJAČIĆ-NIKOLIĆ and MILOVANOVIĆ, 2007, 2010). According to RAMANATHA RAO and HODGKIN (2002), biodiversity refers to variation within the living world, while genetic diversity represents the heritable variation within and between populations of organisms whose conservation is essential for present and future human well-being.

In Europe, about 99% of natural forests were modified or completely disappeared due to various anthropogenic influences (MATARUGA *et al*., 2013). Some endangered plant species have been reduced to „*so few populations and such low numbers that timely collection and storage of seed has become imperative*" (GUERRANT and PAVLIK, 1998). National Forest Inventory of Serbia (BANKOVIĆ *et al*., 2009a) recorded 49 species of trees, with dominant presence of deciduous (40) in comparison with coniferous species (nine). Out of the 49 recorded species of trees and shrubs in the forests of Serbia, according to IUCN categorization, 38 belong to relict, endemic, rare and endangered species (BANKOVIĆ *et al*., 2009b). For these reasons, there is a need for conservation and directed utilization of the available gene pool.

Conservation of FGR could be defined as a set of activities which are being implemented with the aim of ensuring the sustainable, continuous existence, evolution and availability of these resources (ŠIJAČIĆ-NIKOLIĆ and MILOVANOVIĆ, 2007; MILOVANOVIĆ *et al*., 2012). MATARUGA *et al*. (2013) under conservation include the planned utilization of genetic resources in order to give the greatest sustainable benefit to current generations while maintaining their potential to meet the needs of future generations.

An accurate (exact) insight into the state of FGR is the necessary basis for taking action on their conservation, which includes long-term and extensive scientific research on the state of these resources, and monitoring the impact of the factors that threaten them.

Activities on conservation of FGR are implemented in various directions and can be divided into several groups (ŠIJAČIĆ-NIKOLIĆ *et al*., 2016):

- research and education in the field of conservation of FGR;
- strategic, legal and institutional frameworks for conservation of FGR;

- international and inter-sectoral cooperation;
- capacity building and dissemination of information on the conservation of FGR;
- implementation of FGR conservation measures through *in situ* and *ex situ* methods.

Although, the principles of conservation of genetic variability can be regarded as identical for all living beings, the methods which are applied vary, depending on the specificity of the conservation goals and biological nature of the material that is the object of conservation (FAO, 1989; ŠIJAČIĆ-NIKOLIĆ and MILOVANOVIĆ, 2007). COHEN *et al*. (1991) stated that: „*conservation of plants diversity can be achieved in a number of complementary ways: conservation of whole plants in their native ecosystems or conservation of samples of a plant's genetic diversity and endangered species. Frequently, one method acts as a back-up to another, and the degree of emphasis placed on a particular method depends on a specific strategy developed to fulfill conservation aims and uses*". Conservation of forest genetic resources often requires simultaneous use of several methods (GRAUDAL *et al*., 1997). *In situ* (at the site) conservation methods include continuous maintenance of FGR in the surroundings where they have developed their distinctive properties (ŠIJAČIĆ-NIKOLIĆ and MILOVANOVIĆ, 2010; HEYWOOD, 2014), in natural populations (seed stands, groups of trees or individual trees) and protected areas. *Ex situ* (out of site) conservation methods include the maintenance of populations, single individuals or reproductive material of different species, outside their natural habitats (MATARUGA *et al*., 2013; ŠIJAČIĆ-NIKOLIĆ *et al*., 2014).

Conservation in protected areas presents the important aspect of *in situ* FGR conservation, because they contain large areas of forest complexes. In previous research was indicated that „*taking into account the participation of forest areas in the total area of active protection of national parks in Serbia, the diversity of forest ecosystems within them and a large number of described endemic and relict species, it is clear that national parks represent an important basis for the in situ conservation and directed utilization of forest trees gene pool, at their natural habitats*" (ŠIJAČIĆ-NIKOLIĆ *et al*., 2006a). In Serbia, there are 461 protected areas (as of November 2015), as follows: five national parks, 17 nature parks, 20 areas with specific features, 68 nature reserves, three protected habitats, 310 natural monuments, 38 areas of cultural and historical significance, but depending on the share of forest ecosystems within them, their importance in FGR conservation is different (ŠIJAČIĆ-NIKOLIĆ *et al*., 2016).

Previous research indicates that the practice of *ex situ* FGR conservation in Serbia was based on the preservation of individuals (genotypes) or a group of individuals through the establishment of field plantations (ŠIJAČIĆ-NIKOLIĆ *et al*., 2016). The clonal seed orchards of Austrian pine, Weymouth pine, Norway spruce and English oak, as well as the generative seed orchards of Serbian spruce, Austrian pine, wild cherry and Greek maple were established (ISAJEV and TUCOVIĆ, 1999). The regions of provenance of beech, sessile oak, English oak, Austrian pine, Scots pine, narrow-leafed ash, Norway spruce and European silver fir were designated (ŠIJAČIĆ-NIKOLIĆ *et al*., 2016); provenance trials of walnut, beech, Austrian pine, Norway spruce, Douglas fir, Scots pine, wild cherry, Greek maple and English oak (ISAJEV *et al*., 1999), were established and present the subjects of ongoing analysis.

A large number of progeny tests were established, within which were carried out numerous studies (ŠIJAČIĆ-NIKOLIĆ *et al*., 2014b) of various indigenous and introduced tree species, such as: Serbian spruce (TUCOVIĆ and ISAJEV, 1984, 1987; ISAJEV and ŠIJAČIĆ-NIKOLIĆ, 1994), Greek maple (VILOTIĆ *et al*., 1994), Ailanthus (ISAJEV *et al*., 1995, 1996), London plane tree (TUCOVIĆ and OCOKOLJIĆ, 1998; TUCOVIĆ and KNEŽEVIĆ, 2003; KNEŽEVIĆ and ŠIJAČIĆ-

NIKOLIĆ 2005, 2009), indigo bush (TUCOVIĆ and ISAJEV, 2000; TUCOVIĆ and VILOTIĆ, 2001; KNEŽEVIĆ and TUCOVIĆ, 2004), Austrian pine (MATARUGA *et al*., 2003), beech (ŠIJAČIĆ-NIKOLIĆ *et al*., 2006b; 2006c; 2007), ginkgo (ŠIJAČIĆ-NIKOLIĆ *et al*., 2006d; 2006e; 2009), hackberry (ŠIJAČIĆ-NIKOLIĆ *et al*., 2008), sycamore maple (ŠIJAČIĆ-NIKOLIĆ and MILOVANOVIĆ, 2006; 2009), bald cypress (POPOVIĆ *et al*., 2014), black poplar (ČORTAN and ŠIJAČIĆ-NIKOLIĆ, 2013), etc. In the territory of the Republic of Serbia, clone archives of forest tree species include collections of genotypes of fast-growing species, such as poplars, willows and acacia (ŠIJAČIĆ-NIKOLIĆ *et al*., 2016).

Despite the large number of scientific papers dealing with this issue, research on attitudes and evaluation of key stakeholders in forestry and nature protection towards FGR conservation have not been sufficiently represented so far.

Accordingly, the aim of this paper was to study the attitudes of representatives of key public institutions (administrative and professional), enterprises, educational and research organizations in the forestry and nature protection sectors, towards the factors that threaten biodiversity, FGR conservation methods, state of seed sources in Serbia and proposals of measures to improve FGR.

METHODS

The methodology used in the paper is an approach to the research on conservation of FGR which is used in social sciences. The following research methods were used: analysis, synthesis, and statistical methods. The method of analysis has been used for the interpretation of the collected data. The method of synthesis was applied for formulating the recommendations for the improvements of FGR state and for drawing the conclusions. The statistical method was used for primary data processing.

The empirical data were collected by using the research technique of questioning (NONIĆ D., 2015; NONIĆ M. *et al*., 2015, 2016). In such technique, empirical data are collected by oral or written testimonies, which are given by respondents (MILOSAVLJEVIĆ and RADOSAVLJEVIĆ, 2008). „Door to door" survey was conducted in 2015 and 2016. By applying this technique, data collection is done through a written questionnaire, so that "*respondents are asked about the facts of scientific interest (...) or about their opinion*" (MIHAILOVIĆ, 2012). Completing the questionnaire was carried out in two ways, either orally or by sending an e-mail questionnaire, after consultation with the respondents.

A judgmental sampling was used for choosing a sample, which implies that the researchers, based on their own judgment, identify representative cases so that the typical representatives of the population are chosen (MALHOTRA, 2007). This type of sample is used for focusing the research on the key stakeholders from public institutions and organizations in forestry and nature conservation (NONIĆ D., 2015), which through its activities participate in the conservation of the FGR. The survey included representatives of relevant public (administrative and professional) institutions, public enterprises for forest management and management of national parks, as well as representatives of educational and research organizations in the territory of the Republic of Serbia (without AP Kosovo and Metohija). Overview of institutions and organizations, grouped by category within the public sector of forestry and nature conservation, whose representatives participated in the survey, is shown in table 1.

Table 1. Overview of institutions/organizations and number of respondents who participated in the study

CATEGORIES AND NAMES OF THE INSTITUTIONS AND ORGANIZATIONS	NUMBER OF RESPONDENTS
Public administration in forestry and nature protection	
Ministry of agriculture and environmental protection – Forest Directorate	4
Ministry of agriculture and environmental protection – Sector for environmental protection	1
Provincial Secretariat for urban planning and environmental protection	1
Public (professional) service for nature conservation	
Institute for nature conservation of Serbia	1
Institute for nature conservation of Vojvodina Province	1
Public enterprise for state forest management	
Public enterprise „Srbijašume”	7
Public enterprise „Vojvodinašume”	3
Public enterprise for management of national parks	
Public enterprise „National park Tara”	1
Public enterprise „National park Đerdap”	1
Public enterprise „National park Kopaonik”	1
Educational and research organizations	
University of Belgrade - Faculty of Forestry	3
University of Belgrade - Biological Faculty	1
Institute for forestry, Belgrade	2
Institute of lowland forestry and environment, Novi Sad	4
Institute for Biological Research „Siniša Stanković”, Belgrade	1

The questionnaire was the combination of open, closed and Likert-scale questions. Open questions have no answers offered, but the respondent is allowed to independently formulate attitude (MALHOTRA, 2007; MIHAILOVIĆ, 2012). Closed questions have offered answers and participants have a choice (MALHOTRA, 2007; MIHAILOVIĆ, 2012). Five-point Likert scale was used: 1) very poor; 2) poor; 3) neither good nor bad; 4) well; 5) very well.

A total number of 32 respondents were included in the survey (table 1). “Face to face” data collection was done with 20 respondents, and 12 submitted a filled questionnaire electronically. The same questionnaire, which consisted of 25 questions, was used for both “face-to-face” and electronical data collection. For the purposes of this study, 16 questions were used related to the socio-demographic characteristics of respondents and their attitudes towards the factors that threaten biodiversity, FGR conservation methods, state of seed sources in Serbia and the proposal of measures to improve FGR.

When processing the data, the responses were first coded, and the database was formed, and then an analysis of the responses to the questionnaire was carried out. Descriptive statistics and frequency analysis were used for the data processing, which was carried out in the software for spreadsheet. The answers to open questions were analysed by using qualitative data analysis (content analysis).

RESULTS AND DISCUSSION

Based on socio-demographic characteristics of respondents, it can be seen that, in terms of education, the majority (90%) are experts in the field of forestry; while 10% are graduate biologists. Nearly ⅓ (28%) of respondents have a PhD in the field of forestry. Approximately ⅓ (30%) of respondents are decision-makers, and more than ⅔ (70%) are experts. Approximately ⅔ (65%) of respondents said that they have up to 10 years of work experience in the conservation of FGR.

Table 2 shows the results of the evaluation (1-the least impact, 5-the greatest impact) of anthropogenic factors that negatively affect the diversity of forest species. Anthropogenic factors are determined according to STEVANOVIĆ and VASIĆ (1995).

Table 2. Anthropogenic factors that negatively affect the diversity of forest species

FACTORS THAT NEGATIVELY AFFECT FOREST SPECIES DIVERSITY	**AVERAGE SCORE**
Agriculture (conversion of forests, steppes, valley meadows, marshes and wetlands to agricultural land)	3.7
Forestry (different types of logging, over-exploitation, reforestation)	3.2
Water management (construction of artificial reservoirs in the canyons and gorges, drying up of groundwater, exploitation of water from the source and upper flow)	3.5
Urbanization and infrastructure construction	4.1
Mining (quarries, open-pit mining of coal, overburden dumps and ash dumps)	3.5
Tourism and recreation (construction of entire settlements in the middle of natural ecosystems, large number of visitors, over-collection of berries, mushrooms, herbs)	3.3
Hunting, fishing (excessive hunting and fishing disrupt natural ecosystems)	2.5
Illegal trade in wildlife	2.8
Introduction of non-native species	3.3
Pollution of water, air and soil (different types of pollution originating from industry, large settlements, pesticides used in agriculture, soil erosion)	3.8
Other (please specify): climate changes	4

Based on these results (table 2), it can be stated that respondents believe that urbanization and infrastructure construction (average score 4.1), pollution of water, air and soil (average score 3.8), as well as agriculture (average score 3.7) have the greatest negative impact. In addition to those, several key stakeholders stated climate change as an important threatening factor.

Previous research (MATARUGA *et al*., 2013) defined the other factors that threaten FGR: deforestation and fragmentation; inappropriate use of forest reproductive material; effects of inadequate practices; spread of pests and diseases; abiotic factors (drought, forest fires, ice-breaks, avalanche, storm-breaks); water regime, etc. (ŠIJAČIĆ-NIKOLIĆ *et al*., 2016).

Considering the threatening factors, it is necessary to implement measures of FGR conservation, which are primarily: the expansion of knowledge and information on the impact of the factors that threaten FGR and development of programs with adequate measures for their control, the implementation of *in situ* and *ex situ* methods of FGR conservation in accordance with the factors of their degradation, the implementation of FGR conservation measures in relation to the spread of pests and diseases and in relation to forest fires, the implementation of

FGR conservation measures in relation to pollution (ŠIJAČIĆ-NIKOLIĆ *et al*., 2016). In this regard, the respondents rated the importance of *in situ* and *ex situ* FGR conservation methods, ranking them from 1 to 5 (1-least importance, 5-highest importance), and the results of evaluation for each method are shown in table 3.

Table 3. Evaluation of the FGR conservation methods

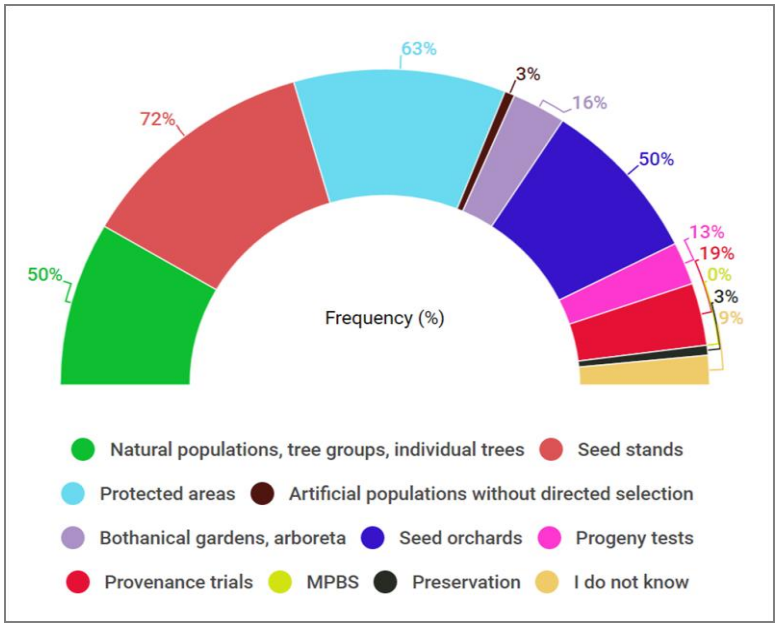
METHODS OF CONSERVATION OF FOREST GENETIC RESOURCES	SCORE
in situ methods	
Conservation of FGR in natural populations: seed stands	4.60
Conservation of FGR in natural populations: groups of trees, individual trees	4.16
Conservation of FGR in protected areas: national parks, natural reserves	4.25
Conservation of FGR in artificial populations without directed selection	2.69
ex situ methods	
Conservation of FGR in botanical gardens and arboreta	3.45
Conservation of FGR through establishment of seed orchards	4.19
Conservation of FGR through establishment of progeny tests	4.00
Conservation of FGR through establishment of provenance trials	4.19
Multiple Population Breeding System (MPBS)	4.12
Preservation – gene banks (seed, pollen, DNA), „*in vitro*“ conservation	4.16

The analysis of the responses shows that conservation of FGR in natural populations through designation of seed stands (average score 4.60) is rated as the most important *in situ* method, followed by FGR conservation in protected areas (average score 4.25) and conservation of FGR in natural populations through designation of individual trees or groups of trees (average score 4.16), while the lowest average score is recorded for the FGR conservation in artificial populations without directed selection (average score 2.69).

As for the *ex situ* methods, establishment of seed orchards and provenance trials have received the highest average score (4.19), followed by preservation (average score 4.16) and the establishment of progeny tests (average score 4.00), while the smallest importance is given to conservation of FGR in botanical gardens and arboreta (average score 3.45). The method of Multiple Population Breeding System (MPBS) is rated with the high average score (4.12), but seven of the respondents said they were not familiar with this.

From all the above *in situ* and *ex situ* FGR conservation methods, some gave good results in the previous implementation in Serbia. These methods, according to respondent's opinions are abbreviated shown in graph 1.

From the analysis of these data, it can be concluded that conservation of FGR in natural populations through designation of seed stands (72%) and conservation in protected areas (63%) are methods that gave the best results in Serbia. That is understandable, because the designation of seed stands and protected areas is financially less demanding than the *ex situ* methods, and positively affect the conservation of FGR. Designation of seed stands represents a dynamic aspect of *in situ* conservation, in which the processes of natural selection as the basis for the adaptation of species are undisturbed (ŠIJAČIĆ-NIKOLIĆ *et al*., 2016).



Graph 1. FGR conservation methods that have produced good results in Serbia

Previous research has found that *in situ* conservation in Serbia is usually implemented in natural populations that naturally regenerate in protected areas (national parks, nature parks, landscapes of exceptional characteristics, nature reserves, protected habitats, natural monuments, areas of cultural and historical significance), and in forests managed on a regular basis. FGR conservation in forests managed on a regular basis is mainly achieved through the designation of seed sources (seed stands, tree groups or individual trees). This form of FGR conservation is often the only viable one, because the funds allocated for conservation are modest (ŠIJAČIĆ-NIKOLIĆ and MILOVANOVIĆ, 2010).

For example, in the Nordic countries, there is a well-established infrastructure for conservation of genetic resources, based on multi-institutional arrangements of various categories of nature reserves, as well as a non-governmental voluntary sector (BLIXT, 1994). In Germany, conservation was meant to safeguard genetic material as a genepool for further sustainable use in production and breeding, and activities on conservation of plant genetic resources were split according to agricultural and horticultural crops, forestry species and wild species, which holds true for the formal and informal sector (BEGEMANN, 1994). Estimation of fertility variation among genotypes is also one of the important tools used in gene conservation, managing forest genetic resources, seed production programs, as well as genetic management of populations for plant breeding, based on sustainable forestry (YAZICI and BILIR, 2017).

The positive effect of *in situ* conservation is the ecosystem preservation, rather than just individual species or genes that are the subject of protection. *In situ* is the preferred form of FGR conservation in Serbia, because it enables the evolutionary process for targeted population (ŠIJAČIĆ-NIKOLIĆ *et al*., 2016).

When it comes to the structure of seed sources in Serbia, 28% of respondents are satisfied with the current state, 12% are not familiar with the situation, and the majority of respondents (60%) believe they do not have an appropriate structure. As the explanation for their attitude, they state the following:

- „*Excessive share of seed sources of conifers, given the share of coniferous forests in our country*" (representative of the Forest Directorate);

- „*Lack of seed objects of broadleaf species such as beech, sessile oak, Hungarian oak, sycamore, then wild service tree, service tree, common walnut, etc.*" (representative of PE „Srbijašume");

- „*It is necessary to pay special attention to designation and expansion of seed sources of rare and endangered species*" (representative of the Faculty of Forestry).

In addition, most respondents (60%) believe that the revision of the seed sources (many of them are not in good condition) and systematic approach to the planning of new ones are necessary.

When it comes to the spatial coverage of seed sources, 22% of respondents believe that it is appropriate, 12% are not familiar with it, while 66% of respondents believe that their coverage is inadequate. As the reasons for that, they stated the following:

- „*Insufficient area, especially for certain species, such as oaks (except for pedunculate oak), beech, spruce and others*" (representative of the Forest Directorate);

- „*The territorial distribution is inadequate, as in some parts of Serbia there are almost no seed sources*" (representative of PE „National park Đerdap");

- „*It is necessary to increase the area of seed sources, the optimum is 4 ha and they are often smaller*" (representative of PE „Srbijašume");

- „*A larger areas of ex-situ objects are needed, primarily seed orchards*" (representative of PE „Srbijašume").

From all the above, it can be concluded that seed sources do not have a satisfactory structure, spatial coverage, and current state. Therefore, a revision of the existing seed sources is needed, followed by the planned designation and establishment of new *ex situ* objects.

Previous studies also show that the current number and area of seed sources are inadequate and do not reflect the richness of the gene pool of forest tree species in our country, which should be given special attention in the coming period (ŠIJAČIĆ-NIKOLIĆ *et al*., 2014b). According to data from the Registry of the current seed sources of the Ministry of Agriculture and Environment of the Republic of Serbia – Forest Directorate (2016), in Serbia, in a total area of 1,842.89 ha, 126 seed stands are designated, with 44 stands of coniferous species, 81 stands of broadleaved species and 1 mixed seed stand. A total number of 198 objects for the production of selected reproductive material and 312 objects for the production of reproductive material of known origin are registered (ŠIJAČIĆ-NIKOLIĆ *et al*., 2016).

Since the introduction of non-native species represents a certain threat to the FGR conservation, the key stakeholders' attitude toward the need for the reintroduction of indigenous

forest species is significant. A number of respondents (13%) believe that reintroduction is not necessary because indigenous species are not greatly affected so far, but one should take appropriate measures to prevent further introduction and spread of non-native species. Additionally, in situations where indigenous species are migrated due to changing environmental conditions, one should not insist on their return. On the other hand, the majority of respondents (87%) support the partial or complete reintroduction, and give the following explanation:

- „*Indigenous species which are not receiving the attention during the restoration (e.g. supporting rare species of valuable broadleaved tree species*) *are being suppressed by fast-growing non-native species, which often have wide ecological valence*" (representative of PE "Srbijašume");

- „*During the restoration of forests it is necessary to give priority to indigenous species unless there was a change of environmental conditions*" (representative of Institute for forestry);

- „*In situations when the species (e.g. Douglas fir, black locust, Sorbus) are well adapted to specific habitats, reintroduction is not required*" (representative of Institute of lowland forestry and environment);

- „*When it comes to natural populations of endangered species, for example. black and white poplars, reintroduction is needed if environmental conditions are still appropriate*" (representative of the Faculty of Forestry);

- „*The increasing occurrence of forest desiccation happens, among other things, due to poor decisions during afforestation in the past*" (representative of the Forest Directorate).

Based on the foregoing, it can be concluded that the majority of key stakeholders considered it necessary to systematically implement the reintroduction, taking into account the course of climate change.

According to the key stakeholders' opinion, it is necessary to carry out the following professional activities, in order to improve the state of FGR:

- activities on the adoption of a national program for the conservation of FGR and provision of funds for implementation of planned activities;
- conscientiously implement management plans;
- conduct a detailed research on the changing conditions of the environment and, in this regard, species migration;
- revise the existing and designate new seed sources and establish seed orchards;
- regularly monitor the condition of seed objects and implement tending measures;
- make a conversion of coppice into high forests;
- maximum use of seed stands for the restoration of forests;
- identify rare and endangered species and study their genetic variability, assess the status of these populations;
- establish new *ex situ* objects, primarily seed orchards and provenance trials, and gene banks;

- improve the production of seedling material.

The key stakeholders believe that the following support measures would improve the current situation:

- consistent enforcement of regulations and penalty policy;
- multidisciplinary approach and better communication between institutions;
- continuous funding of activities to establish seed objects, especially *ex situ* plantations, which includes: planning, establishment, maintenance, tending and use;
- changes in the process of selecting type and origin of seed for afforestation;
- program of subsidizing the production of forest reproductive material should be adapted to the needs of conservation of forest diversity, with an emphasis on rare and endangered species.

In addition to the professional activities and support from the institutions, the majority of respondents (97%) believe that it is necessary to intensify activities to promote conservation through:

- further education of forestry professionals, and afterwards the general public about the importance of conservation and directed utilization of FGR, through debates, workshops, public meetings and lectures;
- training of forest owners and local population, as well as addressing younger population, through the establishment of professional associations.

Most of the key stakeholders (91%) want to improve knowledge about the FGR conservation and states that they require knowledge of plant breeding, application of molecular techniques, application of *ex-situ* methods, evolutionary adaptation, vegetative propagation, worldwide best practices related to the implementation of conservation methods, insight into the real situation in Serbia and recommendations of scientific institutions.

CONCLUSIONS

Based on the analysis of key stakeholders' attitudes towards the factors that threaten biodiversity, FGR conservation methods, state of seed sources in Serbia and proposals of measures to improve FGR, the following conclusions were derived:

- urbanization and infrastructure construction (average score 4.1) have the greatest negative impact on biodiversity;
- conservation of FGR in natural populations through designation of seed stands is rated as the most important *in situ* conservation method (average score 4.60);
- conservation of FGR in natural populations through designation of seed stands (72%) and FGR conservation in protected areas (63%) are methods that gave the best results in Serbia;
- the majority of respondents (60%) stated that seed sources in Serbia do not have an appropriate structure, while 66% of respondents believe that their spatial coverage is inadequate;
- establishment of seed orchards and provenance trials are rated as the most important *ex situ* conservation methods (average score 4.19), while the smallest importance is given to FGR conservation in botanical gardens and arboreta (average score 3.45);

- considering that *ex situ* conservation objects play an important role in the FGR conservation, and there is no a sufficient number of such objects in Serbia, it is necessary to provide funds for research, and then the establishment and utilization of *ex situ* conservation objects, primarily seed orchards;
- the majority of respondents (87%) support the partial or complete reintroduction of indigenous forest species;
- activities to promote FGR conservation, education and raising the awareness of forestry professionals and the general public about the importance of conservation of the forest gene pool are necessary measures for improving the state of FGR.

Based on presented conclusions, recommendations for further research and practice were made in order to improve the state of FGR. It is necessary to:

- adopt the National program of conservation and directed utilization of FGR and to provide funds for the implementation of planned activities;
- continuously monitor the state of existing seed sources and revise it, with a detailed examination of the needs for the establishment of new seed sources;
- analyze the common interests of forestry and nature conservation sectors, and work on their harmonization, in order to ensure the better cooperation of all participants in the process of FGR conservation;
- implement research on environmental changes and, in that regard, migration of species, in order to make appropriate future decisions in the selection of species for reforestation;
- work on the identification of endangered species and studying their genetic variability and the state of those populations, in order to create mechanisms for their protection.

In order to implement the activities on FGR conservation, it is necessary to provide initiatives from scientists, financial support from national and international funds and donors, as well as logistical support in the field.

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KONZERVACIJA ŠUMSKIH GENETIČKIH RESURSA: STAVOVI KLJUČNIH ZAINTERESOVANIH STRANA U ŠUMARSTVU I ZAŠTITI PRIRODE

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Izvod

Brojni biotički i abiotički faktori ugrožavaju šumske genetičke resurse, iz čega proizilazi sve veća potreba za konzervacijom raspoloživog genofonda. Uprkos velikom broju naučnih radova, u Srbiji nisu bila dovoljno zastupljena istraživanja o stavovima i ocenama predstavnika zainteresovanih strana u sektoru šumarstva i zaštite prirode, u odnosu na konzervaciju šumskih genetičkih resursa. Cilj ovog rada, bilo je utvrđivanje stavova predstavnika ključnih javnih institucija (upravnih i stručnih), preduzeća, obrazovnih i istraživačkih organizacija u sektoru šumarstva i zaštite prirode, o faktorima koji ugrožavaju biodiverzitet, metodama konzervacije, stanju semenskih objekata u Srbiji i predlozima mera unapređenja šumskih genetičkih resursa. Primenjena metodologija predstavlja istraživanje konzervacije šumskih genetičkih resursa, kroz pristup koji se koristi u društvenim naukama. U istraživanju je učestvovalo ukupno 32 ispitanika, uz primenu intervjua i anketa, kao tehnika ispitivanja. Rezultati analize stavova ispitanika ukazuju da urbanizacija i izgradnja infrastrukture imaju najveći negativan uticaj na biodiverzitet. Konzervacija šumskih genetičkih resursa kroz izdvajanje semenskih satojina je ocenjena kao najznačajnija *in situ* metoda, dok su osnivanje semenskih plantaža i provenijeničnih testova ocenjeni kao najznačajnije *ex situ* metode konzervacije. Od metoda konzervacije koje su primenjene u Srbiji, prema stavovima ispitanika, najbolje rezultati su postignuti izdvajanjem semenskih satojina (72%) i konzervacijom šumskih genetičkih resursa u zaštićenim područjima (63%). Većina ispitanika (oko 60%) je istakla da struktura i površina semenskih objekata u Srbiji nisu odgovarajuće. Kao neophodne mere unapređenja stanja šumskih genetičkih resursa, navedene su aktivnosti na promociji konzervacije, edukacija i jačanje svesti javnosti o značaju očuvanja šumskog genofonda. Izvedene su i određene preporuke za dalja istraživanja i praksu.

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