INTERNATIONAL JOURNAL OF CONSERVATION SCIENCE

ISSN: 2067-533X Volume 11, Issue 4, October-December 2020: 1051-1058 www.ijcs.ro

IN SITU CONSERVATION OF FOREST GENETIC RESOURCES FROM THE SOUTHERN CARPATHIANS

Georgeta MIHAI[1]*, Lucian DINCĂ[2]

[1] "Marin Drăcea" National Institute for Research and Development in Forestry (INCDS), Romania; București – România, 077190

[2] "Marin Drăcea" National Institute for Research and Development in Forestry (INCDS), Romania; Brașov – România, 500040

Abstract

Stands established as seed source and conservation of the forest gene-pool from the Sothern Carpathians were analyzed and described based on 13,806 stand elements. As such, the stands were analyzed from: the surface occupied on functional categories, the tree species and field exposition and slant and station types. From the total surface occupied by forests with a scientific purpose in the Southern Carpathians (sheltering gene-pool and forest eco-pool), the forests established as seed stands and conservation of forest gene-pool occupy 7,248ha (11%). The following species are predominant: European beech (Fagus sylvatica L.), Norway spruce (Picea abies L. Karst) and European silver fir (Abies alba Mill.). Also predominant are fields with large and very large slopes, with a Northeast exposition, from average and superior bonity stations, characterized by distric cambisols and eutric cambisols.Considering the importance of forest genetic resources in mitigating the negative effects of climate change on forests, the conservation strategy of these stands has to be based on a dynamic long-term conservation that maintains a high level of genetic diversity and adaptive genetic potential within tree populations.

Key words*: Seed stands, Forest genetic resources, Conservation, Southern Carpathians, Forest management plans.*

Introduction

According to the definition given by the United Nations Alimentation and Agriculture Organization (FAO), biodiversity represents "the variety of life forms, the ecologic purpose they fulfil, and the genetic diversity contained by them". Forest is one of the main components of biological diversity because it determines the stability of terrestrial ecosystems.

The scenarios of climatic changes effects claim major changes in temperature and precipitation regimes which will definitely affect the stability and production of European forest ecosystems [1, 2]. It is considered that mountain ecosystems and those located at the edges of forest species range distribution will be the most vulnerable [3].

There is an increased preoccupation at international level in regard with maintaining or restoring forest diversity as a basic precondition for evolutionary processes [4]. As such, even from the year 2003, within the Ministerial Conference on the Protection of Forests in Europe, the European ministers committed to "take further steps to maintain, conserve, restore and enhance biological diversity of forests, including their genetic resources, in Europe and also,

* Corresponding author: gmihai_2008@yahoo.com

on a global scale” (Vienna Declaration, 2003).

Furthermore, the closest collaboration at an international level between organisms such as IUFRO, FAO, and OCDE sustains the importance given to conserving biodiversity in general and forest genetic resources (FGR) in particular.

Forest genetic resources are gene funds that have a present and future economic and scientific importance [5]. In the context of climatic changes and human impact, forest genetics resources play a key role in maintaining the resilience of tree populations as they increase the forest adaptation capacity. In Romania, the conservation of forest genetic resources is realized in accordance with EU legislation and the European Forest Genetic Resources programme (EUFORGEN) through two methods: *in situ* and *ex situ*. The category of genetic resources conserved *in situ* includes: seeds stands and extremely valuable natural populations. These stands were framed in forest management plants based on the Romanian forest functional zoning in the I5 subgroup – Forests with scientific and conservation functions of valuable genetic funds.

At a national level, 39521 hectares were selected as forests designated as stands – seed sources, while 53031 ha were genetic resources conserved *in situ* [6-8].

The Southern Carpathians, also known as Transylvania’s Alps [9], host the tallest and massif Romanian mountains (Făgăraș Mountains). The diversity of ecologic conditions from this mountain region (geophysical, morphologic, topo climate) has led to a high diversity of forest vegetation. Soils from this area are specific to resinous stands [10], even though soil and forest vegetation conditions have changed lately due to climatic changes [11-16].

The main purpose of this article is to describe forests established as seeds stands and for preserving forest gene-pool, located in the Southern Carpathians, together with their adequate conservation measures.

Materials and Methods

Besides the forests whose main role is to produce wood mass (grouped in Category 2: “Forests with production and protection functions”), there is another protection forest category under the name of Group 1: “Forests with special protection functions”. This group also contains five sub-groups, with the fifth one entitles “Forest of scientific interest and for protection of gene-pool and forest eco-pool”. This contains the 1-5H functional category = “Forests established as seeds stands and for preserving forest gene-pool”. The present article analyses the characteristics of these forests located in the Southern Carpathians.

A total number of 13,806 stand elements were analyzed from the Southern Carpathians and located in the 1-5 functional groups, from which 1,491 elements were situated in the 1-5H functional category. These stand elements, together with their characteristics, were extracted from forest management plans (created at 10 years) belonging to all forest districts situated in the Southern Carpathians [17].

This vast database ensures very good data representability as well as a proper statistical insurance for the obtained results.

The stand elements extracted from the database were analyzed based on their surface occupied on functional categories, tree species, field exposition and slant and on stand types.

Adequate measures for the conservation of this forest category were identified and discussed based on these data as well as on national and EU regulations and other knowledge regarding stands destined for forest gene-pool conservation.

Results and Discussion

The characteristics and repartition in the Southern Carpathians of forests established as seeds stands and for preserving forest gene-pool.

Amongst the total surface occupied in the Southern Carpathians by forest of scientific and conservation interest (64,157ha), the forests established as seed stands or forest seed reservations and for preserving the forest gene-pool (1-5H) occupy 7,248ha, namely 11% (Fig. 1).

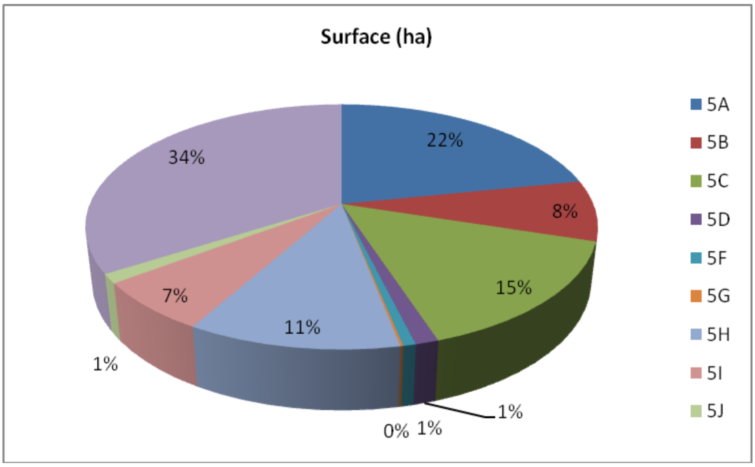

Fig. 1. Surfaces occupied by forests with a scientific and conservation interest for the gene-pool and forest eco-pool from the Southern Carpathians

In regard with tree species that comprise forests with a scientific and conservation interest regarding the gene-pool and forest eco-pool (1-5H) from the Southern Carpathians, the following were identified as preponderant: beech (*Fagus sylvatica* L.) (occupying 2,476ha), Norway spruce (*Picea abies* L., H. Karst), (2,329ha) and silver fir (*Abies alba* Mill.), (1,093 ha). Other species are also present, namely alder (*Alnus glutinosa* (L.) Gaertn.), birch (*Betula alnus* L.), sycamore maple (*Acer pseudoplatanus* L.), hornbeam (*Carpinus betulus* L.), holm (*Quercus petraea* Liebl.), and oak (*Quercus robur* L.) (Fig. 2).

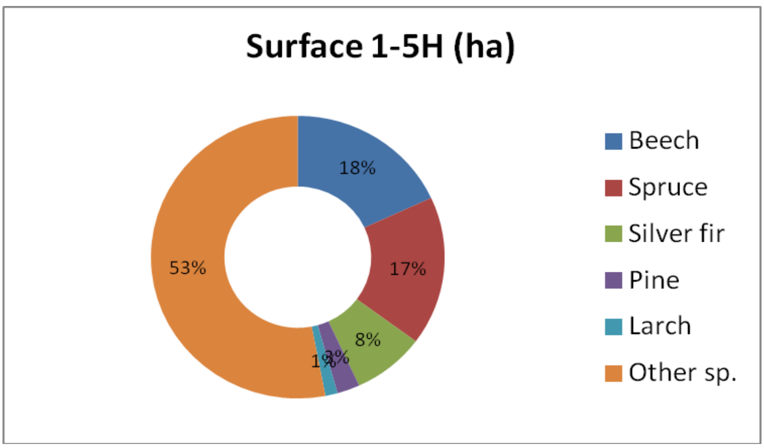

Fig. 2. Tree species from forests with a scientific and conservation interest regarding the gene-pool and forest eco-pool (1-5H) from the Southern Carpathians

As a matter of fact, common beech and Norway spruce [18] are the species from the Southern Carpathians prevailing of fields with very vulnerable substratum towards erosion and landslides. They are also present on sliding fields but accompanied in high percentages by alder, a species adapted to soil humidity excess [19].

In regard with exposition, it can be seen (Fig. 3) that the North-East exposition predominates (the forests from this category occupy 1,321ha on N-E, namely double than the surface occupied on the North exposition-644ha, or the East one - 641ha).

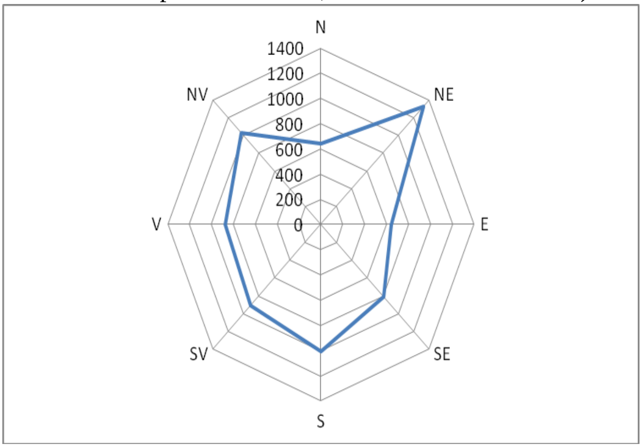

Fig. 3. The exposition of scientific and conservation interest forests regarding the gene-pool and forest eco-pool (1-5H) from the Southern Carpathians

The field inclination on which these forests are found in the Southern Carpathians, grouped on plant categories, is characterized by the dominance of fields with large slopes (200-300) - 3,655ha, followed by field with very large slopes (>300) - 1,594ha and fields with average-large slopes (110-200) - 1,437ha (Fig. 4).

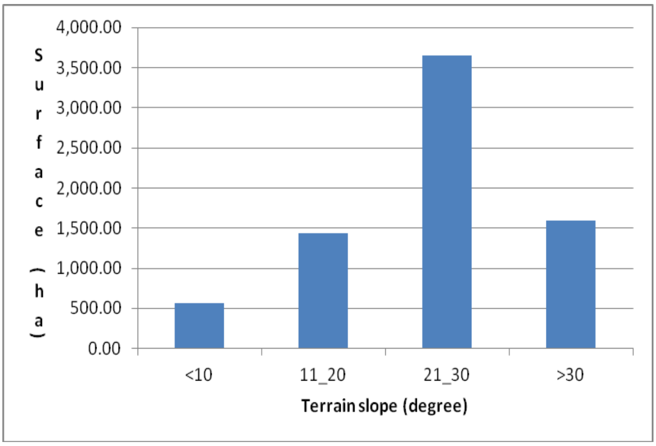

Fig. 4. Field slopes for the fields hosting scientific and conservation interest forests for protecting the gene-pool and forest eco-pool (1-5H) from the Southern Carpathians

The largest field slopes for seeds stands located in this area are present in Runcu, Maneciu, Valea Cibinului and Arpas Forest Districts.

The site types characteristic to these stands are:

2312: "Mountain Norway spruce stands, Bi podzol with edaphic raw humus, sub-average and small with *Vaccinium*" = 357ha;

2332:"Mountain Norway spruce stands, Bm dystric cambisol, average edaphic with *Oxalis-Dentaria* +- acidophil" = 294ha;

2333:"Mountain Norway spruce stands, Bs dystric cambisol and andosol, high and average edaphic with *Oxalis-Dentaria* +- acidophil" = 422ha;

3332:"Mountain mixture stands, Bm eutric cambisol, medium edaphic with *Asperula-Dentaria*" = 1266ha;

3333:"Mountain mixture stands, Bs eutric cambisol, high edaphic with *Asperula-Dentaria*" = 1895ha;

4420:"Mountain-pre-mountain common beech stands, Bm, eutric cambisol, average edaphic with *Asperula-Dentaria*" = 482ha;

4430:"Mountain-pre-mountain common beech, Bs, eutric cambisol, high edaphic with *Asperula-Dentaria*" = 527ha.

The presence of mountain and pre-mountain stations can be observed, with an average and superior bonity, characterized by dystric cambisols and eutric cambisols [20, 21], rich in humus and nutritive elements well supplied with water [22-24].

Conservation of forests genetic resources in the Southern Carpathians

The FRG *in situ* conservation strategy is based on a network of genetic conservation units which was established according to minimum pan-European requirements (EUFORGEN). The aim of this network is to maintain a high level of genetic diversity within tree populations and high variability in adaptive traits at the distribution range of tree species.

For some trees species, like *Abies alba* (Mill.), *Picea abies* (L. Karst) and *Fagus sylvatica* (L.), the Southern Carpathians represent the south-eastern part of their distribution area. This implies the fact that these populations will have to face the unprecedented warmer conditions from the future. Therefore, the conservation strategy has to consider the long-term conservation of the genetic diversity and the adaptive genetic potential of these tree populations. As the first level of biodiversity, the genetic diversity guarantees the survival, adaptation and evolution of the forest species in a changing environment. Populations with low levels of genetic variation will be more vulnerable to new pests or diseases, abiotic factors and climate changes. In this context, maintaining genetic diversity is essential because it has crucial importance for the resilience of forest ecosystems and for the adaptability to climate changes [25].

Therefore, conservation strategies have to prepare forests for the future by stimulating the process of adapting tree populations [26]. In this regard, the most suitable method for FGR *in situ* conservation is dynamic conservation.

In case of seed stands, as they have double roles, namely seed sources and preserving the valuable gene pool, the dynamic conservation must achieve the following objectives: producing local seeds with superior genetic and quality characteristics and conserving these stands (by excluding them from cutting) up to the age when the species is capable to regenerate naturally.

Conservation methods imply the selection of seed trees and the extraction of inferior phenotypic trees located inside the seed source. Based on the fact that seed trees are the ones that will transmit characters in their progenies, their selection will be achieved carefully based on productivity criteria, wood quality and resistance and adjustment towards biotic and environment factors. These selection criteria include: straightness trunk, vigorous growth over the stand’s average, highest elongate height, lack of avid branches, slim branches, narrow crown with horizontal branches, and good phyto-sanitary state [27, 28]. The number of chosen seed trees must ensure optimum conditions for crossed pollination, reducing self- pollination and maintaining a high level of intra-population genetic variability. The optimum density varies with the species and will be of 0.6 for Norway spruce and fir, 0.7 for common beech and holm, and 0.7-0.6 for oak. The stand's thinning up to the optimum density index will be realized in one or more stages, based on the species, with a periodicity of 3-5 years.

For the second category, namely, the valuable natural populations designated for preserving forest gene-pools, *in situ* dynamic conservation consists of managing populations by promoting natural regeneration through silvicultural interventions (tending, thinning, and removing poor quality individuals).

Conclusions

Forests that were designated as seeds stands and for preserving the forest gene-pool (1-5H) occupy 7,248ha in the Southern Carpathians, namely 11% of the total surface of forests with a scientific and conservation interest regarding the gene-pool and forest eco-pool (64,157ha).

The area is represented by common beech, Norway spruce and silver fir stands, situated on a North-East exposition, on fields with large slopes and on mountain and pre-mountain stations of average and superior productivity.

The conservation strategy of these stands must contain a series of silvicultural measures that can ensure a dynamic and long-term conservation of the forest gene-pool.

The conservation of forest genetic resources has to be integrated into the national forest programme and biodiversity conservation strategies through concrete actions at the practical forest management level.

Acknowledgements

This study was conducted within PN 19070303/2020 project financed by the Ministry of Education and Research in NUCLEU Programme.

References

[1] R. Bojariu, M.V. Birsan, R. Cică, L. Velea, S. Burcea, A. Dumitrescu, S.I. Dascălu, M. Gothard, A. Dobrinescu, F. Cărbunaru, L. Marin, **Schimbările climatice – de la bazele fizice la riscuri și adaptare,** Ed. Printech, Bucharest, 2015, p. 200.

[2] M. Meinshausen, S.J.H. Smit, K. Calvin, J.S. Daniel, M.L.T. Kainuma, J.F. Lamarque, K. Matsumoto, S. Montzka, S. Raper, K. Riahi, A. Thomson, G.J.M. Velders, D.P. van Vuuren, *The RCP greenhouse gas concentrations and their extensions from 1765 to 2300*, **Climatic Change, 109**, 2011, pp. 213-241.

[3] M. Lindner, M. Maroschek, S. Netherer, A. Kremer, A. Barbati, J. Garcia-Gonzalo, R. Seidl, S. Delzon, P. Corona, M. Kolstrom, M.J. Lexer, M. Marchetti, *Climate change impacts, adaptive capacity and vulnerability of European forest ecosystems*, **Forest Ecology and Management, 259**(4), Special Issue: SI, 2010, pp. 698–709. DOI: 10.1016/j.foreco.2009.09.023.

[4] * * *, *Impacts of Climate Change on European Forests and Options for Adaptation*, **AGRI-2007-G4-06. Report to the European Commission Directorate-General for Agriculture and Rural Development**, EC/2008.

[5] V. Enescu, D. Chereches, C. Bandiu, **Conservarea biodiversitatii si a resurselor genetice forestiere**, Ed. Agris, Bucuresti, 1997, p. 450.

[6] G. Mihai, **Tested Seed Sources for the Main Forest Tree Species in Romania**, Ed. Silvica, Bucharest, 2009, p. 280.

[7] Gh. Pârnuță, M. Budeanu, E. Stuparu, **Catalogul național al materialelor forestiere de reproducere**, Ed. Silvică, Bucharest, 2012, p. 334.

[8] Gh. Pârnuță, M. Budeanu, et al., **Catalogul național al resurselor genetice forestiere**, Ed. Silvică, Bucharest, 2011, p. 522

[9] E. De Martonne, **Recherches sur l'Évolution morphologique des Alpes de Transylvanie (Karpates méridionales)** Delagrave, Paris,1906.

[10] C.M. Enescu, L. Dincă, *Forest soils from Arges County*, **Current Trends in Natural Sciences, 7**(14), 2018, pp. 176-182.

[11] L. Dinca, M.D. Nita, A. Hofgaard, C.L. Alados, G. Broll, S.A. Borz, B. Wertz, A.T. Monteiro, *Forests dynamics in the montane-alpine boundary: a comparative study using satellite imagery and climate data*, **Climate Research, 73**, 2017, pp. 97-110.

[12] G. Mihai, M. Birsan, A. Dumitrescu, A.M. Alexandru, I. Mirancea, P. Ivanov, E. Stuparu, M. Teodosiu, M.L. Daia, *Adaptive genetic potential of European silver fir in Romania in the context of climate change*, **Annales of Forest Research, 61**(1), 2018, pp. 95-108.

[13] S. Davidescu, G. Murariu, L. Dinca, D. Vasile, V. Crisan, R. Cretu, L. Georgescu, S. Deca, *Growth Potential of Hybrid Black Poplar(Populus X Canadensis Moench) in Romania's East Plain,* **International Journal of Conservation Science, 11**(3), 2020, pp. 807-818.

[14] L. Dinca, G. Murariu, C. Iticescu, M. Budeanu, A. Murariu, *Norway Spruce (Picea Abies (L.) Karst.) Smart Forests from the Southern Carpathians,* **International Journal of Conservation Science, 10**(4), 2019, pp. 781-790.

[15] A.I. Semeniuc, I. Popa, *Comparative Analysis of Tree Ring Parameters Variation in Four Coniferous Species: (Picea Abies, Abies Alba, Pinus Sylvestris and Larix Decidua),* **International Journal of Conservation Science, 9**(3), 2018, pp. 591-598.

[16] G. Murariu, V. Hahuie, A.G. Murariu, L. Georgescu, M.A. Calin, D. Buruiana, I. M. Onica, G.B. Carp, *Growth Rate Modeling for White Poplar in the South Eastern Part of Romania: An Important Issue of Forest Conservation,* **International Journal of Conservation Science, 8**(2), 2017, pp. 303-316.

[17] * * *, *Amenajamentele ocoalelor silvice*: Aninoasa (2005), Arpaș (2016), Avrig (2005), Azuga (2019), Baru (2016), Bistra (1999), Brezoi (2011), Bumbești (2002), Câmpulung (2006), Cornet (2013), Cugir (2013), Domnești (2004), Făgăraș (2005), Grădiște (2004), Latorița (2014), Lupeni (2000), Mușătești (2014), Novaci (2002), Orăștie (2013), Petrila (2000), Petroșani (2001), Pietroșița (2005), Polovragi (2001), Pui (2005), Râșnov (2003), Retezat (2016), Rucăr (2016), Runcu (2000), Sinaia (2002), Șercaia (2006), Șuici (2008), Tălmaciu (2000), Teliu (2003), Valea Cibinului (2002), Valea Sadului (2002), Voila (2005), Voineasa (2013), Vidraru (2005), Zărnești (2003), Anonymous 2000-2019.

[18] R. Vlad, M. Zhiyanski, L. Dincă, C.G. Sidor, C. Constandache, G. Pei, A. Ispravnic, T. Blaga, *Assessment of the density of wood with stem decay of Norway spruce trees using drill resistance,* **Comptes rendus de l'Academie Bulgare des Sciences**, **71**(11), 2018, pp. 1502-1510.

[19] L. Dincă, F. Achim, The *management of forests situated on fields susceptible to landslides and erosion from the Southern Carpathians,* **Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 19**(3), 2019, pp. 183-188.

[20] G. Spârchez, L. Dincă, G. Marin, M. Dincă, R.E. Enescu, *Variation of eutric cambisols' chemical properties based on altitudinal and geomorphological zoning*, **Environmental Engineering and Management Journal**, **16**(12), 2017, pp. 2911-2918.

[21] C.M. Enescu, L. Dincă, I.A. Bratu, *Chemical characteristics of the forest soils from Prahova County*, Scientific **Paper Series Management, Economic Engineering in Agriculture and Rural Development, 18**(4), 2018, pp. 109-112.
[22] E.M. Edu, S. Udrescu, M. Mihalache, L. Dinca, *Research concerning the organic carbon quantity of National Park Piatra Craiului and the C/N ratio*, **Scientific Papers Serie A Agonomy, 55**, 2012, pp. 44-46.
[23] L. Dinca, O. Badea, G. Guiman, C. Braga, V. Crisan, V. Greavu, G. Murariu, L. Georgescu, *Monitoring of soil moisture in Long-Term Ecological Research (LTER) sites of Romanian Carpathians*, **Annals of Forest Research, 61**(2), 2018, pp. 171-188.
[24] A. Onet, L.C. Dincă, P. Grenni, V. Laslo, A.C. Teusdea, D.L. Vasile, R.E. Enescu, V.E. Crisan, *Biological indicators for evaluating soil quality improvement in a soil degraded by erosion processes*, **Journal of Soils and Sediments, 19**(5), 2019, pp. 2393-2404.
[25] B. Fady, J. Cottrell, L. Ackzell, R. Alía, B. Muys, A. Prada, S.C. González-Martín, *Forests and global change: What can genetics contribute to the major forest management and policy challenges of the twenty-first century?* **Regional Environmental Change, 16**(4), 2016, pp. 927–939.
[26] G. Eriksson, G. Namkoong, J. Roberds, *Dynamic gene conservation for uncertain futures*, **Forest Ecology and Management 62**, 1993, pp. 15-37.
[27] V. Enescu, **Producerea semintelor forestiere**, Ed. Ceres, Bucuresti, 1982, p. 323.
[28] G. Mihai, *Stabilirea celor mai productive şi adaptate provenienţe de molid pe baza studiilor efectuate în culturi comparative în vederea desemnării lor ca rezervaţii de seminţe*, **Anale, 47**, 2004, pp. 11 – 22.

Received: February 22, 2020
Accepted: November 5, 2020