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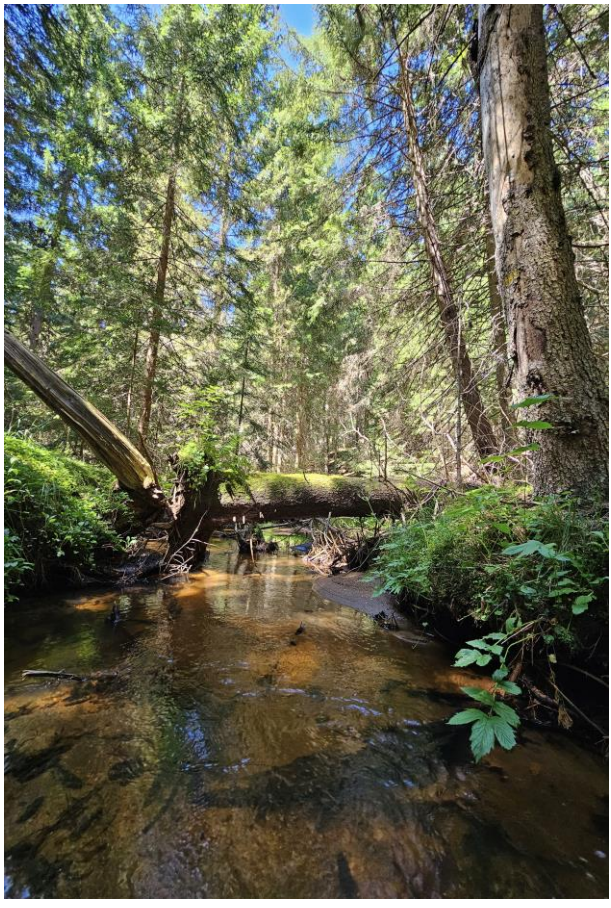

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GENEPOOL OF WOODY SPECIES IN THE STRICT NATURE RESERVE "FELJEŠANA"

Ivona KERKEZ JANKOVIĆ[1], Dragica VILOTIĆ[1], Marina NONIĆ[1], Filip MAKSIMOVIĆ[2], Mirjana ŠIJAČIĆ-NIKOLIĆ[1]*

Abstract: *Forests of primeval character in Europe usually receive the highest protection status. The importance of these ecosystems is highlighted in the BIO2023 Strategy, which outlines specific guidelines for the identification and protection of primeval forests within the European Union. Endemic ecosystems characteristic of Europe, such as pure beech forests, are facing numerous threatening factors in the context of climate change and are considered one of the most endangered habitats. Efforts to preserve and enhance forest ecosystems, as an initial step, involve conservation and long-term monitoring to gain insight into the adaptation and evolutionary strategies of the present species and ecosystems as a whole. The extremely strict protection conditions prescribed in strict reserves impose very limited human intervention, while non-invasive scientific research is considered a desirable activity. One of the first protected pure beech forests in Serbia is the Strict Nature Reserve "Felješana" which, despite being protected since 1950, has not been thoroughly and systematically studied from the aspect of woody species diversity. The aim of this paper is to provide, for the first time,data on the available gene pool of woody species in the primeval beech forest "Felješana". The field research methodology included recording woody species in the tree, shrub, and ground layers at pre-determined monitoring points and identifying and georeferencing target species. For the georeferenced individuals of the target species, height, diameter at breast height, breast circumference, and horizontal crown projection were determined. A total of 27 native woody species were recorded, with 14 species in the tree layer, 25 in the shrub layer, and 19 in the ground layer. Although beech is the dominant species across all three vegetation layers throughout the area, the recorded number of species in the shrub and ground layers indicates the potential for changes in species distribution and composition in this reserve in the future. All recorded species are of native origin, among which six species belong to one of the categories of rare, endangered, and vulnerable species in the forest fund of Serbia. Georeferencing and determining the basic characteristics of the target species individuals have provided a solid foundation for long-term monitoring of the gene pool and the conservation of woody species in SNR "Felješana".*

Keywords: old-growth forest, European beech, species diversity, monitoring, conservation.

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GENOFOND DRVENASTIH VRSTA NA PODRUČJU STROGOG REZERVATA PRIRODE „FELJEŠANA“

Sažetak: *Šume prašumskog karaktera u Evropi obično imaju najviši oblik zaštite. Značaj ovih ekosistema ističe i Strategija BIO2023, koja predviđa posebne smernice za izdvajanje i zaštitu šuma prašumskog karaktera u okvirima Evropske Unije. Endemični ekosistemi karakteristični za Evropu su i čiste bukove šume, koje se u kontekstu klimatskih promena susreću sa nizom ugrožavajućih faktora i predstavljaju jedno od najugroženijih staništa. Napori da se sačuvaju i unaprede šumski ekosistemi kao inicijalni korak podrazumevaju sprovođenje konzervacije i dugoročnog monitoringa kako bi se stvorio uvid u adaptaciju I evolucione strategije prisutnih vrsta i ekosistema u celini. Izuzetno strogi uslovi zaštite propisani u strogim rezervatima imaju veoma ograničavajuće devovanje čoveka, neinvazivna naučna istraživanja se smatraju poželjnim aktivnostima. Jedna od prvih zaštićenih čistih bukovih šuma u Srbiji je i Strogi rezervat prirode „Felješana”, koji iako je zaštićen još od 1950. godine, nije detaljno i sistematičo izučavan sa aspekta diverziteta drvenastih vrsta. Cilj ovog rada je da, po prvi put, pruži podatke o dostupnom genofondu drvenastih vrsta u bukovoj prašumi „Felješana”. Metodologija za terenska istraživanja obuhvatila je evidentiranje drvenastih vrsta u spratovima drveća, žbunja i prizemne vegetacijei na unapred određenim monitoring tačkama, kao i izdvajanje i georeferenciranje ciljnih vrsta. Georefernciranim individuama ciljnih vrsta su određeni visina, prsni prečnik, prsni obim i horizontalna projekcija krošnje. Ukupno je evidentirano 27 autohtonih drvenastih vrsta, od toga, 14 vrsta se javlja u spratu drveća, 25 u spratu žbunja, a 19 u spratu prizemne flore. Iako je bukva dominantna vrsta u sva tri sprata vegetacije na celom području, evidentirani broj vrsta u spratu žbunja i prizemne vegetacije ukazuje na mogućnost promene distribucije i sastava vrsta u rezervatu u budućnosti. Sve evidentirane vrste su autohtonog porekla, među kojima čak šest vrsta pripada jednoj od kategorija retkih, ugroženih i ranjivih vrsta šumskog fonda Srbije. Georeferenciranje i određivanje osnovnih karakteristika jedinki ciljnih vrsta pružilo je čvrstu osnovu za dugoročno praćenje genofonda i konzervaciju drvenastih vrsta u SRP „Felješana”.*

Ključne reči: prašuma, Evropska bukva, specijski diverzitet, monitoring, konzervacija.

1. INTRODUCTION

Nature reserves, as in situ conservation units, provide protected habitats for maintaining genetic diversity, understanding the adaptation and evolutionary strategy and by that represent a very important conservation units for gene pool protection (Higgs, Usher, 1980; Gray, 1996; Alexandre et al., 2006). Strict nature reserves are highly valuable conservation units worldwide, among all, for research of genetic diversity adaptation and species evolution in changing environment (Fonseca et al., 2019). According to EC 2022 (EU Commission Staff Working Document) strictly protected areas are defined as „*...legally protected areas designated to conserve and/or restore the integrity of biodiversity-rich natural areas with their underlying ecological structure and supporting natural environmental processes*.“ According to IUCN Guidelines for Applying Protected Area Management Categories (Dudley, 2008) one of the strictly protected areas is Nature Reserve (Ia) which, among all, serve as area for scientific research and monitoring.

About 3.37 percent of the EU's surface area is protected within 9,382 strict protected areas in the EU (Cazzolla Gatti et al. 2023). According to EU Biodiversity Strategy for 2030such a small percentage is planned to increase to 10% within the EU territory (EC 2020, EC 2023).One of the key commitments by 2030, according to EU BIO 2023, is addressing strict protection of all remaining EU primary and old-growth forests. Among other, one of the habitats characteristic of Europe are pure beech forests. As such, they were recognized by UNESCO and World Natural Heritage Beech Forests has been created, counting 94 forest areas in 18 states.

The European beech forest are complex ecosystems endemic to Europe which cover approximately 14-15 mil. hectares indicating ecological and economical value of these forests (EEA, 2006; Kulla et al., 2023). They are assertive and adaptable, but due to climate change belong to one of the most endangered habitats. Species and genetic composition of virgin beech forest can provide a valuable information in adaptation of species under different weather conditions in long-term chronosequence.

In Serbia, there are a total of 11 beech reserves, including 6 nature reserves with pure beech virgin (old-growth) forests: "Danilova Kosa", "Felješana", "Kukavica", "Vinatovača", "Golema reka" and "Busovata" (ZZP). Forest "Felješana" is virgin forest of European beech with trees more than 300 years old in it terminal phase. It has been declared as a strict nature reserve in 1950 by the Government of the Republic of Serbia, but even before protection there were no intensive management treatments, given the inaccessible location (Kanjevac et al., 2023).

Aim of this paper is to provide the data about available gene pool of woody species recorded in old-growth beech forest "Felješana" for the first time, as a base for long-term monitoring activities and establishing dynamic *in situ* conservation unit.

2. MATERIAL AND METHODS

2.1. Study site

The Strict Nature Reserve "Felješana" (44°20′ N; 21°53′ E) is a protected area of Category I, of national and exceptional significance. It was designated for the preservation of a unique, autochthonous stand of mountain beech with primeval forest characteristics, where trees can reach up to 300 years of age and heights exceeding 40 meters. The reserve is covering an area of 15.28 hectares located in Forest Management Unit "Crna Reka", compartment 134, subcompartment "a". Until 1960, the forest complex remained untouched and unlogged, giving it the characteristics of a primeval forest. The reserve is situated at an altitude of 520-560 meters above sea level, with a terrain slope of 20-35°, and a northern to northeastern exposure (Kanjevac *et al.,* 2023).

2.2. Terrain reconnaissance

The methodology for terrain reconnaissance included two phases: preparatory work before field visits and data collection in the field. The preparatory phase involved gathering and analyzing available literature, creating a template for recording woody species, designing monitoring points, and creating digital data (.kmz file). By overlaying the boundaries of the management unit with a satellite

image, the area of the strict reserve was delineated. The monitoring points were designed according to the methodology described by Kanjevac et al. (2023) (Figure 1).

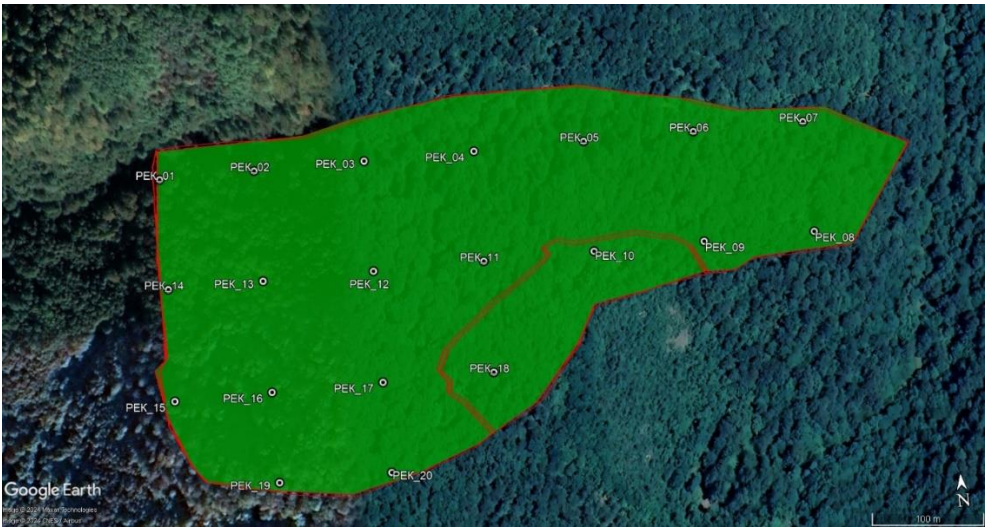

Figure 1. *Strict Nature Reserve "Felješana"with projected monitoring plots*

The data collection involved georeferencing individual trees within each monitoring point. All woody species present in the tree, shrub, and ground vegetation layer were evidented. Layers are defined by the vegetation height: ground vegetation layer up to 20 cm, shrub vegetation layer from 20 cm to 5 m height and tree vegetation layer above 5 m height. After the determination of all woody species, target species were selected based on the criteria described by Šijačić-Nikolić, Nonić (2023): vulnerability, representativeness, and scientific importance. These target species were planned to be included in monitoring and the conservation strategic planning process. For each georeferenced individual, both digital and manual data were collected. Digital data included coordinates gathered in the field, while manual data covered the dimensions of georeferenced individuals: total height [m], diameter at breast height (DBH) [cm], circumference at breast height (CBH) [cm], and maximum crown spread [m]. For georeferencing, two applications were used: UTM Geo Map (Y2 Tech.) and Google Earth Pro (Google).

2.3. Data processing

Based on the data collected during the field research, an overview of all woody species determined in the tree, shrub and ground vegetation layers in SNR "Felješana" was compiled. For each species, the following information was provided: scientific name and family of the species; origin (native or non-native); IUCN category (LC - Least Concern, stable population; NE - Not Evaluated; NT - Near Threatened; VU - Vulnerable); and the species' category in the forest inventory of the Republic of Serbia, according to Banković et al. (2009). The spatial distribution of georeferenced individuals of target species within the "Felješana" reserve was visualized using the Google Earth Pro application.

3. RESULTSAND DISCUSSION

A total of 27 woody species have been recorded in "Felješana" reserve. The species belong to the 11 families: Aceraceae, Araliaceae, Betulaceae, Cornaceae, Fagaceae, Malvaceae, Oleaceae, Rosaceae, Thymelaeaceae, Ulmaceae, and Viburnaceae. All species recorded are native. Although beech is the dominant species, the number of species recorded indicates a high level of species diversity in the reserve. Most species belong to the IUCN category "last concern" (LC), however, according to the national categorization in the forest fund of Serbia (Banković et al. 2009), six species belong to one of the categories of rare, endangered and species at risk (Table 1). All this information indicates significant species diversity in this Strict Nature Reserve, although this contradicts previous claims emphasizing low species diversity (Stojanović et al., 1999; Sekulić, Stojković, 2012).

Table 1. *Overview of the recorded woody species in the SNR "Felješana" with species endangerment status according to IUCN category: LC - last concern, stable population; NE - not evaluated; NT - near threatened; VU – vulnerable, and Republic of Serbia (RS) forest fund category (Banković et al., 2009)*

No	Family	Species	IUCN	RS
1	Aceraceae	*Acer campestre* L.	LC	-
2		*Acer platanoides* L.	LC	rare/endangered
3		*Acer pseudoplatanus* L.	LC	-
4	Araliaceae	*Hedera helix* L.	LC	-
5	Betulaceae	*Carpinus betulus* L.	LC	-
6		*Corylus avellana* L.	LC	-
7	Cornaceae	*Cornus mas* L.	NE	-
8		*Cornus sanguinea* L.	NE	-
9	Fagaceae	*Fagus sylvatica* L.	LC	-
10		*Quercus petraea* (Matt.) Liebl.	LC	-
11	Malvaceae	*Tilia cordata* Mill.	LC	-
12		*Tilia platyphyllos* Scop.	LC	-
13		*Tilia tomentosa* Moench	LC	-
14	Oleaceae	*Fraxinus excelsior* L.	NT	rare/endangered
15		*Fraxinus ornus* L.	LC	-
16		*Syringa vulgaris* L.	LC	-
17	Rosaceae	*Crataegus monogyna* Jacq.	LC	-
18		*Prunus avium* L.	LC	at risk
19		*Pyrus pyraster* (L.) Burgsd.	LC	at risk
20		*Rosa arvensis* Huds	NE	-
21		*Rosa canina* L.	LC	-
22		*Rubus fruticosus* L.	LC	-
23		*Ruscus hypoglossum* L.	LC	-
24		*Sorbus torminalis* (L.) Crantz	LC	at risk
25	Thymelaeaceae	*Daphne mezereum* L.	NE	-
26	Ulmaceae	*Ulmus glabra* Hud.	VU	rare
27	Viburnaceae	*Sambucus nigra* L.	LC	-

Among all recorded species, 14 occur in the tree layer, 25 in the shrub layer, and 19 in the ground vegetation layer (Table 2). The species present in all three layers include sycamore, field maple, Norway maple, hornbeam, beech, white ash, wild cherry, sessile oak, wild service tree, small-leaved lime, and large-leaved lime. Beech is the dominant species across all three layers throughout the entire area.

However, in warmer microclimates at higher elevations, species characteristic of drier habitats, such as lilac and wild pear, appear.

Table 2. *Overview of the recorded woody species in the SNR "Felješana" in three vegetation layers: tree, shrub and ground vegetation layer*

No	Species	Vegetation's layer		
		tree	shrub	ground
1	*Acer campestre* L.	■	■	■
2	*Acer platanoides* L.	■	■	■
3	*Acer pseudoplatanus* L.	■	■	■
4	*Carpinus betulus* L.	■	■	■
5	*Cornus mas* L.		■	■
6	*Cornus sanguinea* L.		■	
7	*Corylus avellana* L.		■	■
8	*Crataegus monogyna* Jacq.		■	
9	*Daphne mezereum* L.		■	■
10	*Fagus sylvatica* L.	■	■	■
11	*Fraxinus excelsior* L.	■	■	■
12	*Fraxinus ornus* L.	■	■	■
13	*Hedera helix* L.			■
14	*Prunus avium* L.	■	■	■
15	*Pyrus pyraster* (L.) Burgsd.	■	■	■
16	*Quercus petraea* (Matt.) Liebl.	■	■	■
17	*Rosa arvensis* Huds		■	
18	*Rosa canina* L.		■	
19	*Rubus fruticosus* L.		■	■
20	*Ruscus hypoglossum* L.			■
21	*Sambucus nigra* L.		■	■
22	*Sorbus torminalis* (L.) Crantz	■	■	■
23	*Syringa vulgaris* L.		■	
24	*Tilia cordata* Mill.	■	■	■
25	*Tilia platyphyllos* Scop.	■	■	■
26	*Tilia tomentosa* Moench		■	■
27	*Ulmus glabra* Hud.	■	■	

Among the recorded species, those belonging to the category of rare/endangered or at-risk species in the forest fund of the Republic of Serbia are particularly significant. In the studied area in tree vegetation layer, these species are represented by a very small gene pool, often consisting of individual trees or small groups of trees located in the peripheral areas of the reserve. However, in the shrub and ground vegetation layer, these species are represented in different micro-localities within the reserve. This is the reason why adult individuals of these species are also georeferenced even though they are located on the very border or even a bit outside of the reserve.

Based on vulnerability, representativeness and scientific importance criteria (Šijačić-Nikolić, Nonić, 2023), the following target species were selected: beech (*Fagus sylvatica* L.), wild pear (*Pyrus pyraster* (L.) Burgsd.), wild cherry (*Prunus avium* L.), wild service tree (*Sorbus torminalis* (L.) Crantz), white ash (*Fraxinus*

excelsior L.), sessile oak (*Quercus petraea* (Matt.) Liebl.), mountain elm (*Ulmus glabra*Hud.), maple (*Acer campestre* L.), common maple (*Acer pseudoplatanus* L.) and hornbeam (*Carpinus betulus* L.) (Table 3).

Table 3. *Overview of the target species and the criteria based on which they were selected*

Species	Criteria		
	Vulnerability	Representativeness	Scientific importance
Acer campestre L.		+	+
Acer pseudoplatanus L.		+	+
Carpinus betulus L.		+	
Fagus sylvatica L.		+	+
Fraxinus excelsior L.	+	+	+
Prunus avium L.	+	+	+
Pyrus pyraster (L.) Burgsd.	+	+	+
Quercus petraea (Matt.) Liebl.)		+	+
Sorbus torminalis (L.) Crantz	+	+	+
Ulmus glabra Hud.	+		+

3.1. Basic parameters of target species's genepool in SNR "Felješana"

In total, 20 beech individuals (notable individual trees as a population's representatives, with over 250 cm DBH), 2 white ash individuals, 7 wild pear individuals, 2 wild cherry individuals, 5 service tree individuals, 7 sessile oak individuals, 2 mountain elm individuals, 3 hornbeam individuals, and one individual each of Norway maple and field maple were georeferenced and mapped (Fig 2, Table 4).

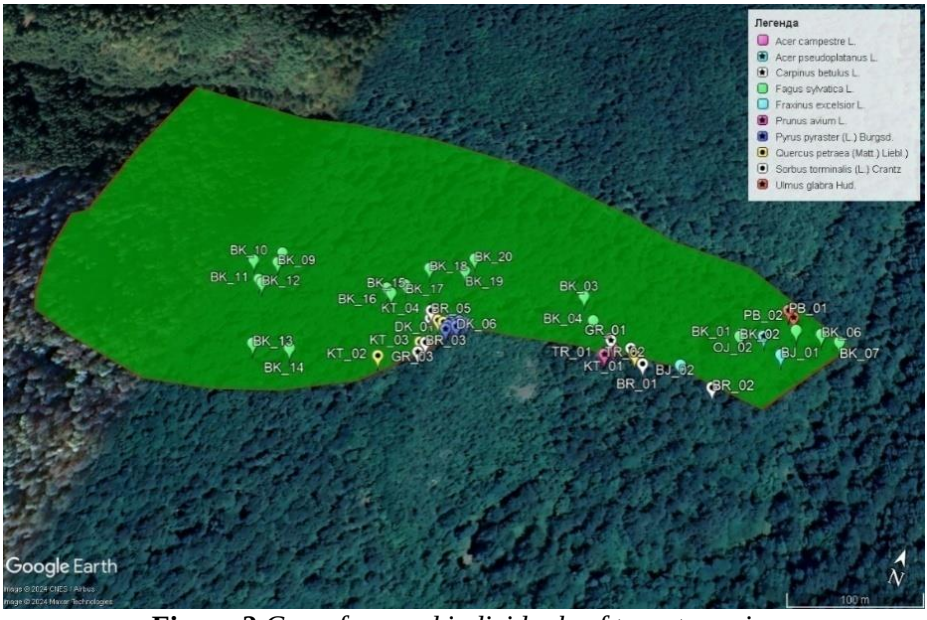

Figure 2.*Georeferenced individuals of target species*

Table 4. *Basic characteristics: HT - height, DBH - diameter at breast height, CBH - circumference at breast height, HPC - horizontal projection of the canopy, of the georeferenced individuals: BK - beech, BJ - white ash, BK - wild service tree, DK - wild pear, DT - wild cherry, KT - sessile oak*

No	Lable	HT [m]	DBH [cm]	CBH [cm]	HPC [m]
1	BK_01	40.0	79.6	250.0	9.0
2	BK_02	39.0	79.6	250.0	8.0
3	BK_03	43.0	85.4	268.0	10.0
4	BK_04	40.0	82.8	260.0	4.5
5	BK_05	41.0	79.6	250.0	8.0
6	BK_06	42.0	100.6	316.0	7.0
7	BK_07	39.0	90.8	285.0	10.0
8	BK_08	39.0	92.4	290.0	8.0
9	BK_09	37.0	82.8	260.0	6.0
10	BK_10	39.0	85.7	269.0	7.0
11	BK_11	37.0	80.3	252.0	8.0
12	BK_12	41.0	93.9	295.0	8.5
13	BK_13	40.0	89.8	282.0	8.0
14	BK_14	39.0	82.5	259.0	8.0
15	BK_15	37.0	80.6	253.0	6.5
16	BK_16	40.0	90.8	285.0	6.0
17	BK_17	38.0	86.9	273.0	8.0
18	BK_18	32.0	82.8	260.0	4.0
19	BK_19	36.0	84.1	264.0	7.0
20	BK_20	38.0	87.3	274.0	5.0
21	BJ_01	42.0	111.8	351.0	4.0
22	BJ_02	25.0	43.0	135.0	6.0
23	BR_01	11.0	24.5	77.0	4.0
24	BR_02	22.0	31.8	100.0	8.0
25	BR_03	24.0	44.3	139.0	7.0
26	BR_04	21.0	38.2	120.0	6.0
27	BR_05	10.0	15.6	49.0	6.0
28	DK_01	13.0	25.5	80.0	2.5
29	DK_02	11.0	21.3	67.0	4.0
30	DK_03	11.0	25.2	79.0	7.0
31	DK_04	8.0	31.2	98.0	5.5
32	DK_05	8.5	28.7	90.0	5.0
33	DK_06	8.0	32.2	101.0	5.5
34	DK_07	6.0	31.5	99.0	4.0
35	DT_01	20.0	19.7	62.0	5.0
36	DT_02	26.0	35.0	110.0	7.0
37	KT_01	23.0	66.9	210.0	10.0
38	KT_02	26.0	34.4	108.0	3.0
39	KT_03	20.0	36.6	115.0	5.0
40	KT_04	20.0	58.0	182.0	12.0
41	KT_05	21.0	30.9	97.0	6.0
42	KT_06	21.0	44.9	141.0	9.0
43	KT_07	19.0	86.0	270.0	16.0

Although dead trunks in various stages of decomposition and fallen trees are occasionally present (Fig 3), it can be noted that the beech population in "Felješana" is generally vital, with a good natural regeneration (Fig 4). These observations align with previous studies, which indicate that although the old-growth forest is in its terminal phase, characterized by aging and decay sub-phases, abundant regeneration appears as a sign of the initial phase (Stojanović et al., 1999; Kanjevac et al., 2023).

Figure 3. *Damaged and dead beech trees in the extinction phase in SNR "Felješana"*

Figure 4. *Natural regeneration of beech in the area of the SNR "Felješana"*

A total of 20 exceptionally healthy beech individuals were georeferenced. The height of the georeferenced trees ranged from 32 m to 43 m, with an average of 38.9 m. The diameter at breast height ranged from 79.6 cm to 100.6 cm, while the

circumference at breast height varied from 250.0 cm to 316.0 cm, respectively (Table 4). Beech is dominant species, recorded in all three vegetation layers (tree, shrub, ground), but other species occurs also, individually or in small groups. White ash is species represented by only two adult vital and in good health old-growth individuals (Table 4). Species is present in all tree vegetation layers, but occurs very rarely, naturally regenerated by individual young trees. On warm dry micro-locations on rocky terrain with exposed bedrock at very edge of SNR "Felješana", small group of wild service tree, wild pear, wild cherry and sessile oak was found (Fig 2, Table 4). Wild service tree genepool is represented by large dimensions and in good health individuals, with strong regeneration near adult trees, but also across the reserve all the wild pear, wild cherry and sessile oak individuals have damaged crowns with a significant proportion of dead, mostly upper branches. In forest fruit species no fruiting was observed. Despite the poor condition, it seems that these individuals are old-growth, implying very well adaptation of local genepools.

Beasides target species (beech, white ash, wild service tree, wild pear, wild cherry, and sessile oak), individual specimens of sycamore, Norway maple, field maple, large-leaved lime, and mountain elm were also georeferenced. These individuals were selected to enable future gene pool monitoring as part of dynamic conservation efforts.

Table 5. *Basic characteristics: HT - height, DBH - diameter at breast height, CBH - circumference at breast height, HPC - horizontal projection of the canopy, of the georeferenced individuals: OJ – common maple, ML – Norway maple, KL – field maple, LI – large-leaved lime, PB – mountain elmand and GR – common hornbeam*

No	Lable	Height [m]	DBH [cm]	CBH [cm]	HPC [m]
1	OJ_01	40.0	58.9	185.0	7.0
2	LI_01	23.0	28.7	90.0	9.0
3	KL_01	17.0	30.6	96.0	5.0
4	KL_02	18.0	32.8	103.0	3.0
5	ML_01	24.0	62.1	195.0	9.0
6	PB_01	18.0	12.1	38.0	3.5
7	PB_02	16.0	21.7	68.0	5.0
8	GR_01	19.0	24.2	76.0	4.0
9	GR_02	20.0	36.9	116.0	7.0
10	GR_03	25.0	57.6	181.0	8.0

As Serbia is located in the central part of the Balkan Peninsula, genetic hotspot for many European tree species (Zhelev, 2017; Gomory et al., 2020), more efforts should be invested in monitoring and researching nature reserves, considering species and genetic diversity. Literary sources referring to any aspect of the vegetation of the "Felješana" reserve are very limited (Stojanović et al., 1999; Ostojić et al., 2008; Sekulić, Stojković, 2012; Kanjevac et al., 2023). Most of them focus on the condition and regeneration of beech and do not address the regeneration nor condition of other species. A significant number of species in the shrub and ground vegetation layers indicates the possibility of changing the species composition of the reserve in the future. It is known that changes in the distribution of species are

expected in the context of climate change, emphasizing the need to increase proactive conservation efforts and long-term planning (e.g. Kuhn et al., 2016; Seidl et al., 2017; Liang et al., 2022; Doktor et al., 2023; Bonannella et al., 2024).Since this old-growth forest in its terminal phase (Stojanović et al., 1999) continuous monitoring of all species inthis Strict Nature Reserve can provide exact data on the regeneration and overall dynamics of the reserve. Georeferencing and determining the basic characteristics of the individuals of the target species provide a solid basis for long-term monitoring of the genepool and conservation of woody species in SNR "Felješana". Without detailed records of these species, whose genepool often represents only a small number of trees, affected by numerous factors leading to genetic erosion, species may disappear, resulting in a biodiversity loss and a significant reduction in the diversity of our forests.

4. CONCLUSION

The positioning and mapping of the target species was initiated through this research and should be continued, not only as a form of scientific research, but also through regular activities focusing on rare and endangered species. Although beech (*Fagus sylvatica* L.) is the dominant species, the number of woody species (27) in tree, shrub and ground layers indicates a high level of species diversity in the Strict Nature Reserve "Felješana". All woody species are of native origin, with six species belonging to one of the categories of rare, endangered and species at risk, including wild pear (*Pyrus pyraster* (L.) Burgsd.), wild cherry (*Prunus avium* L.), wild service tree (*Sorbus torminalis* (L.) Crantz), white ash (*Fraxinus excelsior* L.), mountain elm (*Ulmus glabra* Hud.), and common maple (*Acer pseudoplatanus* L.). Although the SNR "Felješana" is one of the oldest strict nature reserves in Serbia, this paper describes a number of woody species in detail for the first time and thus creates a knowledge base for further monitoring and conservation measures.

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REFERENCES

Banković, S., Medarević, M., Pantić, D., Petrović, N., Šljukić, B. & Obradović, S. (2009). Šumski fond Republike Srbije: stanje i problem, *Glasnik Šumarskog fakulteta, (100)*, 7-29. doi: 10.2298/GSF0900007B

Bonannella, C., Parente, L., de Bruin, S., & Herold, M. (2024). Multi-decadal trend analysis and forest disturbance assessment of European tree species: concerning signs of a subtle shift. *Forest Ecology and Management, 554*. doi: 10.1016/j.foreco.2023.121652

Cazzolla Gatti, R., Zannini, P., Piovesan, G., Alessi, N., Basset, A., Beierkuhnlein, C., Di Musciano, M., Field, R., Halley, J. M., Hoffmann, S., Iaria, J., Kallimanis, A., Lövei, G. L., Morera, A., Provenzale, A., Rocchini, D., Vetaas, O. R., & Chiarucci, A. (2023). Analysing

the distribution of strictly protected areas toward the EU2030 target. *Biodiversity and Conservation, 32 (10)*, 3157–3174. doi: 10.1007/s10531-023-02644-5

European Commission. (2020). *EU Biodiversity Strategy for 2030: Bringing nature back into our lives* (COM(2020) 380 final). European Union.

European Commission. (2022). *Criteria and guidance for protected areas designations* (Commission Staff Working Document No. SWD(2022) 23 final). Publication Office of the European Union.

European Commission. (2023). *Commission guidelines for defining, mapping, monitoring and strictly protecting EU primary and old-growth forests* (SWD(2023) 62 final). European Union.

European Environment Agency. (2006). *European forest types: Categories and types for sustainable forest management reporting and policy* (Technical Report No. 9/2006). Luxembourg: Office for Official Publications of the European Communities. ISSN 1725-2237.

Filho, J.A.F.D., & Telles, M.P.C. (2006). Optimization procedures for establishing reserve networks for biodiversity conservation taking into account population genetic structure. *Genetics and Molecular Biology, 29 (2)*, 207-214. doi: 10.1590/S1415-47572006000200004

Fonseca, E.M., Werneck, F.P., Gehara, M., Oliveira, E.F., Magalhaes, F., Lanna, F.M., Lima, G.S., Marques, R., Mesquita, D.O., Costa, G.C., Colli, G.R., & Garda A.A. (2019). The role of strict nature reserves in protecting genetic diversity in a semiarid vegetation in Brazil. *Biodiversity and Conservation, 28(11)*, 2877-2890. doi: 10.1007/S10531-019-01802-Y

Gray, A. (1996). Genetic diversity and its conservation in natural populations of plants. *Biodiversity Letters, 3(3)*, 71-80. doi: 10.2307/2999720

Gömöry, D., Zhelev, P., & Brus, R. (2020). The Balkans: a genetic hotspot but not a universal colonization source for trees. *Plant Systematics and Evolution, 306(1)*, 1-9. doi: 10.1007/S00606-020-01647-X

Higgs, A.J., & Usher M.B. (1980). Should nature reserves be large or small. *Nature, 285(5766)*, 568-569. doi: 10.1038/285568A0

Kanjevac, B., Babić, V., Stajić, S., Martać, N., Pavlović, B., Furtula, D., & Čokeša, V. (2023). Key drivers affecting the spatial heterogeneity of the regeneration process in old-growth beech forests in southeastern Europe. *Frontiers in Forests and Global Change, 6*, 1-10. doi: 10.3389/ffgc.2023.1304037.

Kuhn, E., Lenoir, J., Piedallu, C., & Gégout, J.C. (2016). Early signs of range disjunction of submountainous plant species: an unexplored consequence of future and contemporary climate changes. *Global Change Biology, 22(6)*, 2094-2105. doi: 10.1111/GCB.13243

Kulla, L., Roessiger, J., Bošeľa, M., Kucbel, S., Murgaš, V., Vencurik, J., Pittner, J., Jaloviar, P., Šumichrast, L., & Saniga, M. (2023). Changing patterns of natural dynamics in old-growth European beech (*Fagus sylvatica* L.) forests can inspire forest management in Central Europe. *Forest Ecology and Management, 529*. doi: 10.1016/j.foreco.2023.120633

Liang, Y., Gustafson, E.J., He, H.S., Serra-Diaz, J.M., Duveneck, M.J., & Thompson, J.R. (2022). What is the role of disturbance in catalyzing spatial shifts in forest composition and

tree species biomass under climate change?. *Global Change Biology, 29(4)*, 1160-1177. doi: 10.1111/gcb.16517

Ostojić, D., Jovanović, B., & Kisin, B. (2008). *Beech Virgin Reserves in Serbia*. In Proceedings of the III Congress of Ecologists of Macedonia (pp. 224-238). https://www.mes.org.mk/PDFs/3rd%20Congress%20Proceedings/12_Dragana%20Ostojic, %20Biljana%20Jovanovic%20,%20Bratislav%20Kisin.pdf

Reichmuth, A., Kühn, I., Rakovec, O., Boeing, F., Müller, S., Samaniego, L., & Doktor, D. (2023). Natura 2000 areas under climate change: Effects of tree species distribution shifts. *EGU General Assembly*, 24-28. doi: 10.5194/egusphere-egu23-17060

Seidl, R., Thom, D., Kautz, M., Martin-Benito, D., Peltoniemi, M., Vacchiano, G., Wild, J., Ascoli, D., Petr, M., Honkaniemi, J., Lexer, M.J., Trotsiuk, V., Mairota, P., Mairota, P., Svoboda, M., Fabrika, M., Nagel, T.A., & Reyer, C.P.O. (2017). Forest disturbances under climate change. *Nature Climate Change, 7(6)*, 395-402. doi: 10.1038/NCLIMATE3303

Sekulić, G., & Stojković, D. (2012). Predlog za zaštitu prirodnog dobra „Felješana“ kao strogi rezervat prirode. Zavod za zaštitu prirode, Beograd.

Stojanović, L., Krstić, M., & Bobinac, M. (1999). Stanje i razvoj bukove prašume "Felješana". *Zaštita prirode, 51(2)*, 155-164.

Stolton, S., Shadie, P. & Dudley, N. (2013). Best Practice Guidance on Recognising Protected Areas and Assigning Management Categories and Governance Types, Best Practice Protected Area Guidelines Series No. 21. In Dudley, N. (Eds.), *Guidelines for Applying Protected Area Management Categories* (pp. 1-86). IUCN.

Šijačić-Nikolić, M., & Nonić, M. 2023. Genofond drvenastih vrsta SP “Šuma Košutnjak” - konzervacija i održivo korišćenje. Univerzitet u Beogradu, Šumarski fakultet.

World Natural Heritage Beech Forests. https://www.europeanbeechforests.org/

Zavod za zaštitu priode. https://zzps.rs/opsti-rezervat-prirode-vinatovaca/

Zhelev, P. (2017). Studies on the glacial refugia of forest trees on balkan peninsula. *Sec. Nat. Math. Biotech. Sci., 38 (2)*, 129–135. doi: 10.20903/CSNMBS.MASA.2017.38.2.108

GENEPOOL OF WOODY SPECIES IN THE STRICT NATURE RESERVE „FELJEŠANA“

Ivona KERKEZ JANKOVIĆ, Dragica VILOTIĆ, Marina NONIĆ, Filip MAKSIMOVIĆ, Mirjana ŠIJAČIĆ-NIKOLIĆ

Summary

Strictly protected areas occupy 3.37% of the EU's territory, which is protected within 9,382 strict areas. It is planned to increase this proportion to 10% by 2030, including commitments to protect primary and old-growth forests. One of the most protected nature reserves are the strict nature reserves. Among all, these areas serve for scientific research. Conservation and monitoring activities provide understanding the adaptation and evolutionary strategy of species and ecosystems as a whole. Beech is one of the most important species covering large areas and forming pure forests as complex endemic

ecosystems in Europe. They are assertive and adaptable, but due to climate change belong to one of the most endangered habitats. In Serbia there are six pure beech forests protected. One of the first protected is "Felješana" declared a strict nature reserve in 1950. The aim of this paper is to provide the data about available genepool of woody species recorded in old-growth beech forest "Felješana" for the first time. The methodology for terrain reconnaissance included recording of woody species in tree, shrub and ground vegetation layers at designed monitoring points, definition and georeferencing of target species. For the georeferenced individuals, height, diameter at breast height, breast height circumference, and horizontal crown projection were determined. A total of 27 woody native species were recorded, belonging to the 11 families. Among all, 14 occur in the tree layer, 25 in the shrub layer, and 19 in the ground layer. Beech is the dominant species across all three layers throughout the entire area. The species present in all three layers include sycamore, field maple, Norway maple, hornbeam, beech, white ash, wild cherry, sessile oak, wild service tree, small-leaved lime, and large-leaved lime. A significant number of species in the shrub and ground vegetation layers indicates the possibility of changing the species composition of this Strict Nature Reserve in the future. Most of the species belong to the IUCN category "last concern" (LC), however, according to the national categorization in the forest fund of Serbia (Banković et al. 2009), six species belong to one of the categories of rare, endangered and species at risk. Georeferencing and determining the basic characteristics of the individuals of the target species provided a solid basis for long-term monitoring of the genepool and conservation of woody species in SNR "Felješana".

GENOFOND DRVENASTIH VRSTA NA PODRUČJU STROGOG REZERVATA PRIRODE „FELJEŠANA“

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Rezime

Strogo zaštićena područja zauzimaju 3,37% površine EU, sa ukupno 9.382 izdvojenih područja. Planira se povećanje ovog procenta na 10% do 2030. godine, uključujući zaštitu šuma prašumskog karaktera. Među zaštićenim područjima, najstroži uslovi zaštite se sprovode u strogim rezervatima. Među malobrojnim, naučna istraživanja su jedna od dozvoljenih i poželjnih aktivnosti. Aktivnosti konzervacije i monitoringa pružaju uvid u adaptaciju i evolucione strategije vrsta i ekosistema u celini.Bukva je jedna od najvažnijih vrsta, pokrivajući velike površine i formirajući čiste šume kao složene endemične ekosisteme Evrope. Iako su prilagodljive i otporne, bukove šume su, usled klimatskih promena, među najugroženijim staništima. U Srbiji je zaštićeno šest čistih bukovih šuma. Jedna od prvih zaštićenih je „Felješana”, koja je proglašena strogim rezervatom prirode 1950. godine.Cilj ovog rada je da pruži podatke o dostupnom genofondu drvenastih vrsta zabeleženih po prvi put u bukovoj prašumi „Felješana”. Metodologija za terenska istraživanja obuhvatila je evidentiranje drvenastih vrsta u spratovima drveća, žbunja i prizemne vegetacije na unapred određenim monitoring tačkama i georeferenciranje ciljnih vrsta. Georefernciranim individuama su određeni visina, prsni prečnik, prsni obim i horizontalna projekcija krošnje. Ukupno je evidentirano 27 autohtonih drvenastih vrsta, koje su raspoređene u 11 porodica. Od toga, 14 vrsta se javlja u spratu drveća, 25 u spratu žbunja, a 19 u spratu prizemne flore. Bukva je dominantna vrsta u sva tri sprata na celom području.Vrste prisutne u sva tri sprata su i obični javor, klen, mleč, bukva, beli i crni jasen, divlja trešnja, divlja kruška, kitnjak, brekinja, sitnolisna i krupnolisna lipa. Značajan broj vrsta u spratu žbunja i prizemne vegetacije ukazuje na mogućnost promene sastava vrsta u

ovom strogom rezervatu prirode u budućnosti. Većina vrsta,prema IUCN-u, pripada kategoriji "najmanje zabrinjavajućih" (LC), međutim, prema nacionalnoj kategorizaciji šumskog fonda Srbije (Banković i sar., 2009), čak šest vrsta pripada kategoriji retkih, ugroženih ili ranjivih vrsta. Georeferenciranje i određivanje osnovnih karakteristika jedinki ciljnih vrsta pružilo je čvrstu osnovu za dugoročno praćenje genofonda i konzervaciju drvenastih vrsta u SRP „Felješana".

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