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WHITE WILLOW (*Salix alba* L.) VARIABILITY IN THE LANDSCAPES OF OUTSTANDING FEATURES “GREAT WAR ISLAND” BASED ON MORPHOLOGICAL TRAITS OF THE LEAVES: A BASIS FOR ASSESSMENT OF GENE POOL

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Abstract: *The gene pool assessment of woody species has multiple significance in biotechnology. This research paper studied the morphological traits of white willow leaves in the Landscapes of Outstanding Features (LOF) “Great War Island”. The variability of leaf length, width, area, and circumference, as well as the petiole length of the white willow tested trees were determined. Different parameters show varying degrees of variability. The trees were grouped into multiple clusters based on the average distance of the tested parameters. The results provide a realistic basis for evaluating the gene pool and show great potential for the conservation and production of white willow reproductive material adapted to the changed habitat conditions in Serbia. In this way, the condition of this specific area, as well as other coastal forests in Serbia, is improved. It is possible to improve protection measures against harmful organisms, primarily pathogens of white willow leaves, by applying these findings and reducing the occurrence of certain types of harmful bacteria and fungi, which are associated with decreased vitality and poor physiological condition of trees. The results obtained in the research will facilitate the management and preservation of the white willow gene pool in these unique Landscapes of Outstanding Features.*

Keywords: white willow, variability assessment, gene pool, conservation.

VARIJABILNOST BELE VRBE (*Salix alba* L.) NA PODRUČJU PIO „VELIKO RATNO OSTRVO” PREMA MORFOLOŠKIM SVOJSTVIMA LISTOVA: OSNOVA ZA PROCENU STANJA GENOFONDA

Apstrakt: *Potreba za procenom stanja genofonda drvenastih vrsta ima višestruki značaj u biotehnologiji. Cilj ovog rada je istraživanje morfoloških karakteristika listova bele vrbe na području PIO Veliko ratno ostrvo. Utvrđena je varijabilnost u dužini, širini, površini i obimu listova, kao i dužini peteljke bele vrbe. Takođe, različiti parametri pokazuju nejednaku varijabilnost. Stabla su grupisana u više klastera na osnovu prosečne udaljenosti testiranih parametara. Dobijeni rezultati daju realnu osnovu za procenu genofonda i pokazuju da postoji veliki potencijal za konzervaciju i proizvodnju reproduktivnog materijala*

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bele vrbe prilagođenog izmenjenim stanišnim uslovima u Srbiji. Na taj način, postiže se unapređenje stanja konkretnog ispitivanog područja ali i drugih priobalnih šuma u Srbiju. Primenom ovih rezultata, moguće je unaprediti mere zaštite protiv štetnih organizama, prvenstveno patogena listova bele vrbe. Takođe, smanjuje se pojava određenih vrsta štetnih bakterija i gljiva koje su povezane sa umanjenom vitalnosti i lošim fiziološkim stanjem stabala. Rezultati dobijeni u istraživanju će olakšati upravljaču gazdovanje i očuvanje genofonda bele vrbe u ovom jedinstvenom predelu izuzetnih odlika.

Ključne reči: bela vrba, procena varijabilnosti, genofond, konzervacija.

1. INTRODUCTION

The *Salix* genus includes about 600 species in all continents except Australia (Cvjetićanin et al. 2016). The white willow (*Salix alba* L.) is one of the most widespread and well-known species of willow (Houston Durrant et al. 2016). This species is widely used in medicine to relieve pain and infections, reduce inflammation, and restore blood cells (Shara and Stohs, 2015; Maistro et al., 2019; Lin et al., 2023). Although it has limited commercial use in the wood industry, the willow plays a significant biological role in maintaining the structure of its habitat, particularly in high erosion areas, wet slopes of mountain regions with extensive drainage areas (Bosco et al., 2015), and in endangered Ramsar areas. Therefore, willow is often used in the control of erosive processes, it is an indispensable species in ecosystem restoration and for phytoremediation of polluted water and soil due to its tolerance to hypoxia and harmful agents (Urošević et al., 2024). It is also used for biomass production in short rotation conditions, thanks to its ability for simple vegetative propagation (Kovačević et al., 2010).

One of the significant challenges of the 21st century is climate change and the uncertain fate of various woody species in circumstances that test the limits of endurance. In Serbia, there are predictions of rising annual temperatures, changes in precipitation patterns, and prolonged droughts (Đurđević et al., 2018); these factors are already in force. Their influence on destabilizing the balance of existing ecosystems, soil drying, reduced water levels in rivers, and even complete riverbed drying is visible. Phylogenetic studies have identified the area of the Balkans, including Serbia, as one of the refuges ("refugium") of plant communities during the previous ice ages and the place where the subsequent recolonization of Europe began (Tzedakis, 2004). That is why the territory of Serbia is characterized by significant variability within and between populations of different plant species, which is the source and basis of adaptation to new climate changes, the fight against pathogens and diseases, pollution, and natural disasters. Considering the unpredictable nature of their habitats and variability as their constant feature, phenotypic plasticity and adaptability are some of the main characteristics of willows (Karrenberg et al., 2002). The knowledge of forests gene pool enhances the improvement of the global bio-economy (Orlović et al., 2014). A European tendency to preserve its coastal forests involves understanding the genetic diversity and environmental factors influencing trees (Alimpić et al., 2022). If trees fail to adapt to altering conditions, primarily adverse ecological factors or changed habitat conditions, the distribution range of certain tree species will decline. It is also necessary to focus on improving and preserving the current condition of various regions, especially those with exceptional environmental value. The dimensions of the leaves of woody species are very important in forestry as they indicate the trees' potential to adapt to different habitat conditions, including very warm or cold areas (Körner, 2016, Wang et al., 2019, Li et al., 2020, Liu et al., 2020, Wang et al., 2022). Leaves are the key photosynthetic organs of plants. They provide energy for other physiological processes, particularly important in stressful conditions and states of high sensitivity when the stored reserves play a vital role. Variability in leaf traits is closely linked to variations in local climatic factors, including temperature, precipitation, light, and elevation (Othón et al., 2020; Li et al., 2021). Plants demonstrate significant phenotypic plasticity, and leaves' diverse morphological and anatomical characteristics reflect their strategies for adapting to environmental conditions.

The white willow expresses morphological and anatomical variability, which allows it to adapt to various habitat conditions (Keleş 2021). Similarly, phenotypic plasticity and adaptability are the main characteristics of willows if have in mind the unpredictable nature and variability of their habitats (Karrenberg et al., 2002). The aim of this research was to investigate the variability of leaf morphological traits in different white willow trees. The results obtained will facilitate the assessment of the gene pool's condition, which serves as the basis for further efforts to enhance and protect the white willow in the LOF "Great War Island." Furthermore, these findings are the basis for additional research on genetic diversity, the beginning of species breeding, and the preservation of its gene pool.

2. MATERIAL AND METHODS

Study site

The Landscape of Outstanding Features (LOF) "Great War Island" (44° 49.826'N; 20° 25.951'E) is shaped by the Sava and Danube rivers by accumulating sand deposits and creating a sedimentary and alluvial accumulation. According to the Management Plan of the Protected Area "Great War Island" (2010), the shape and area of the island is changing due to the dynamic of rivers, with the area increasing from 167.90 hectares to 211.36 hectares between 1952 and 2006. The island is characterized by poor forest cover, with 61.6% of the thinned and 19.4% of devasted stands. Forest area occupies 59.6% (123.62 hectares), with dominant deciduous trees covering 92.6 hectares and a small portion of artificially established stands covering 7.4 hectares. (Forest Management Plan for the Management Unit "Great War Island", 2018-2027). Woody species diversity is low in this area, with 11 species in total, most of which are allochthonous. Invasive allochthonous species compete with allochthonous species, making natural regeneration and ecological restoration very challenging. According to the Management Plan of the Protected Area "Great War Island" (2010), three forest types are present on the island, of which are two dominated by white willow: the type of white willow forest (*Salicetum albae*) on beta-gley and the type of white willow forest (*Salicetum albae*) on recent, wet and layered sediment. The white willow population is located on the circle-like peripheral part of the island and is characterized by the significant presence of old, damaged trees within a significant part of dry, mostly top, branches in the crown.

Plant material

A total of twenty-six test trees, bearers of production of reproductive material in good health condition, were selected as representative individuals of the white willow population from the area of LOF "Great War Island”. Each selected tree is marked with a number, and its basic characteristics, including height (m), circumference at breast height (cm), and horizontal crown projection (m), were determined. The tree's height was measured using the Vertex III hypsometer, and the circumference was measured with measuring tape. The diameter at breast height (cm) was later calculated from the circumference using the formula $2r=O/\pi$. Additionally, the test trees were georeferenced using the UTMGeoMap mobile application and visualized using the Google Earth Pro application.

In late July 2024, fully developed undamaged leaves were sampled. From each selected tree, twenty shoots were collected from the outer, well-lit part of the crown. Two to three leaves from the central part were randomly selected from each shoot for further analysis, as these are typically the most uniform. In total, 50 leaves were collected from each tree.

Morphological analyses

After being collected, a total of 1,300 leaves (per 50 leaves from 26 trees) were herbarized and scanned to measure the morphological parameters using the specialized software LAMINA. Five phenotypic traits were selected for measurement: leaf length (LL), leaf width (LW), leaf area (LA), leaf circumference (LC), and petiole length (PL).

Statistical methods

A general linear model (GLM) was used to test the difference in the morphological parameters of white willow leaves as a dependent variable concerning selected trees (independent variable). The normality of the residuals was confirmed using the Kolmogorov-Smirnov test with Lilliefors correction. The homogeneity and linearity of the model were analyzed based on dot plots. Tukey's post hoc test determined homogeneous groups within each analyzed parameter. The dendrogram cluster analysis used the average distance method to group trees by similarity based on the tested parameters. In order to determine the variability of the observed parameters the coefficient of variability was determined. All statistical analyses were performed using the SPSS 27 software package and Statgraphics Centurion XVI.

3. RESULTS AND DISCUSSION

All twenty-six selected trees are located within compartment 1 of the LOF “Great War Island”, where the second and third degrees of protection are established (Figure 1). According to the Management Plan (2010), the area contains many clearings, agricultural and urban land, high white willow forests, high poplar forests, and high mixed poplar forests. The average height of the selected trees is 17.61 m, ranging from 6 m (BV_26) to 26.3 m (BV_14). The average diameter at breast height is 87.28 cm, while the average circumference is 273.23 cm. The tree BV_10 has the smallest circumference (47.9 cm and 150 cm, respectively), while the BV_11 tree (137.4 cm and 430 cm, respectively) has the highest (table 1). These values are consistent with the usual size characteristic of white willow trees (Houston Durrant et al., 2016). According to EUFGIS (European Information System on Forest Genetic Resources), there are only two white willow conservation units in Europe, namely in Romania. The trees selected in the area of the Great War Island could, with adequate measures, be candidates for establishing an *in situ* conservation unit to preserve, protect, and improve the available gene pool.

Table 1. *Basic characteristics of selected white willow trees in the area of LOF "Great War Island"*

Test Tree Mark	**Height (m)**	**Diameter at 1.3m (cm)**	**Circumference at 1.3m (cm)**	**Horizontal crown projection (m)**
BV_01	20.9	121.3	381	12
BV_02	22.7	118.2	370	9
BV_03	19.8	70.3	220	6
BV_04	17.9	102.2	320	8
BV_05	22.1	60.7	190	7,5
BV_06	21.7	71.9	225	12
BV_07	22.0	102.2	320	10
BV_08	20.3	115.0	360	11
BV_09	9.4	57.5	180	12
BV_10	11.6	47.9	150	11
BV_11	15.2	137.4	430	15
BV_12	17.7	95.8	300	8
BV_13	15.3	92.7	290	7
BV_14	26.3	127.8	400	11
BV_15	23.7	70.6	221	7
BV_16	13.3	70.9	222	6
BV_17	11.5	67.1	210	6
BV_18	17.0	79.9	250	9
BV_19	12.5	89.5	280	10
BV_20	20.0	89.5	280	8
BV_21	20.3	89.5	280	10
BV_22	20.0	124.6	390	10
BV_23	19.5	73.5	230	12
BV_24	14.3	55.9	175	11
BV_25	16.9	70.3	220	11
BV_26	6.0	67.1	210	10
AVERAGE	17.61	87.28	273,23	9,60
RANGE	6.0-26.3	47.9-137.4	150-430	6,0-15,0

Figure 1. *The spatial arrangement of the white willow test trees in the area of LOF "Great War Island"*

The results of one factorial analysis of variance indicate statistically significant differences ($p < 0.01$) between trees for all leaf morphological parameters analyzed: leaf length (F-value=21.53), leaf width (F-value=33.85), leaf area (F-value= 26.41), leaf circumference (F-value=28.39) and leaf petiole length (F-value=47.61) (Table 2). The result indicated a significant variability of the available gene pool, which may result from genetic factors and environmental conditions in which the trees are located. Given that the environmental conditions are relatively uniform and that the only environmental factor that can impact this area is the microlocality, it can be assumed that these are genetically distant trees.

Table 2. *Analysis of variance for measured leaf morphological traits*

Laef traits	Sum of squares	df	Mean square	F	p
Leaf length	126597.601	25	5063.904	21.530	< 0.01
Leaf width	7425.715	25	297.029	33.850	< 0.01
Leaf area	52150010.442	25	2086000.418	26.408	< 0.01
Leaf circumference	645109.275	25	25804.371	28.386	< 0.01
Leaf petiole length	2469.523	25	98.781	47.613	< 0.01

Among the analyzed morphological parameters, the leaf petiole length parameter has the highest coefficient of variability (CV=26.48%). The leaf area parameter (CV=21.57%) has a significant value of variation concerning the average value, while the other parameters - length, width, and leaf circumference have slightly lower variability (CV=13.30%, 13.60%, and 13.66%, respectively). The average value of leaf length is 75.47±10.04 mm, with the minimum value recorded for tree BV_10 (47.91±10.34 mm), while the highest value was recorded for tree BV_01 (91.65±18.91 mm). The average leaf width is 17.85±2.43 mm, with the minimum value recorded for tree BV_25 (12.98 ±1.42 mm), while the highest was recorded for tree BV_07 (21.32 ± 3.05 mm). The average value of the leaf area is 941.33±203.00 mm², where the minimum value was recorded for the tree BV_10 (462.28 ± 158.71 mm2), while the highest was recorded for the tree BV_01 (1394.76±408.26 mm2). The average value of the leaf circumference is 165.80±22.66 mm, with the minimum value recorded for tree BV_10 (104.26 ±19.94 mm), while the highest value was recorded for tree BV_01 (201.42±39.71 mm). The average value of the leaf petiole length is 5.53±1.41 mm, with the minimum average value recorded for the tree BV_18 (3.44±1.35 mm), while the highest was recorded for the tree BV_08 (8.61±1.42 mm). For most parameters, the highest average values occur for the tree BV_01 and the minimum values for the tree BV_10.

The dendrogram of cluster analysis (Figure 2) shows a grouping of two smaller and one larger clusters. The cluster distinguished at the most significant distance comprises the trees BV_5, BV_25, and BV_10. The second cluster consists of trees BV_01, BV_08, and BV12, while the third consists of all other trees. Trees BV_09 and BV_13, as well as trees BV_19 and BV_20, were grouped at the smallest distance.

Future studies regarding trees' adaptability are expected to provide more specific answers concerning the mechanisms of their adaptation to stress factors (Kijowska-Obrerc et al., 2020).

According to Ledinski's research (2020), the leaf area and leaf petiole length showed the most variation, while leaf length showed the least. The same author states that trees from warmer (Mediterranean) terrains are characterized by smaller leaves than trees that are more profound in the continent. Also, in the same research, slightly lower average values for the researched parameters were observed in the total sample compared to the values obtained in this research. The genetic foundation significantly influences the leaf traits heritability in white willow clones, with maximum heritability observed for leaf width and area, indicating that these traits are reliable for selecting and breeding this species (Singh et al., 2012). The determined variability rate is a good starting point for the conservation of the available gene pool and directed production of the reproductive material that will be used for regeneration and distribution of this population in the future. The clustering in the sample may suggest a substructure in the population, which requires further investigation using molecular markers.

It was determined that the environmental conditions significantly impact the development of leaves in willow species (*Salix* spp.) (Cunniff et al., 2015). The Salix genus is phenotypically diverse and shows remarkable phenotypic plasticity and diversity in leaf dimensions (Karp et al., 2011). The noticeable variability of the morphological leaf characteristics is important in pioneer species where the white willow belongs. It will enable faster establishment of the species and survival of individuals when they take over a new habitat. The significant morphological variability of the leaves may be due to adaptability to certain habitat conditions, such as varying water levels or different content of nutrients in the soil (Tumpa et al., 2022). Research conducted by Marcysiak (2012a, 2012b) on the related species *S.*

herbacea and *S. reticulata* proved the correlation between leaf morphometric traits and climate conditions.

The variability of phenotypic characteristics, including leaf size, was also described in the species *S. psammophila* by Hao et al. (2019). Tumpa et al. (2022) studied several populations of the related species *S. triandra* and found higher variability of traits related to leaf size between populations than within populations. They attributed this result to the most likely founder effect, where a small number of individuals participated in establishing populations, with relatively equal conditions prevailing in each population. Changes in leaf morphology are one of the main mechanisms of adaptation to different environmental conditions in plants (Radersma et al., 2020). Not all sampled trees from the investigated willow population live in identical conditions. Namely, some individuals are along the coast, while others are withdrawn inside the island, which could lead to specific changes in the soil characteristics and further cause different values of the examined characteristics. A different sunlight regime also characterized the studied trees. Larger leaves often adapt to lower insolation, higher rainfall, and warmer temperatures (Gong et al., 2023). Since the specific research was carried out in the same locality, the obtained results indicate the existence of a large genetic variability of the tested trees.

Table 3. *Descriptive statistical parameters of the analyzed leaf morphological traits*

Test tree	Leaf length (mm)	Leaf width (mm)	Leaf area (mm^2)	Leaf circumference (mm)	Leaf petiole length (mm)
BV_01	91.65 ± 18.91j	21.20 ± 3.18f	1394.76 ± 408.26i	201.42 ± 39.71j	8.21 ± 2.28k
BV_02	73.40 ± 19.40cdef	17.74 ± 3.55cd	944.05 ± 333.23ef	165.17 ± 39.72defghi	6.96 ± 1.33ij
BV_03	85.14 ± 10.94ghij	14.60 ± 1.83ab	832.32 ± 152.68cde	186.71 ± 18.49ij	4.85 ± 1.67cdefg
BV_04	78.06 ± 15.83defgh	19.67 ± 2.86def	1042.74 ± 308.77fgh	170.46 ± 32.29efghi	5.62 ± 1.53gh
BV_05	63.96 ± 10.69bc	14.91 ± 1.54ab	649.76 ± 133.36abc	146.70 ± 16.81bcd	3.61 ± 1.01a
BV_06	79.32 ± 14.23defghi	18.15 ± 2.83cd	1001.75 ± 268.71efgh	170.22 ± 26.63efghi	6.35 ± 1.38hi
BV_07	69.996 ± 14.19cd	21.32 ± 3.05f	1011.56 ± 302.60efgh	148.50 ± 31.01bcde	6.88 ± 1.34ij
BV_08	90.20 ± 17.35ij	16.59 ± 3.51bc	1042.95 ± 267.87fgh	201.24 ± 32.44j	8.61 ± 1.42k
BV_09	76.35 ± 12.98 defg	18.16 ± 3.96cd	953.27 ± 293.46ef	167.07 ± 23.11defghi	5.21 ± 1.56efg
BV_10	47.91 ± 10.34a	14.19 ± 2.68a	462.28 ± 158.71a	104.26 ± 19.94a	3.84 ± 0.81abcd
BV_11	76.90 ± 11.84defgh	13.92 ± 2.77a	716.00 ± 201.50bcd	167.56 ± 23.92defghi	6.29 ± 1.54hi
BV_12	85.38 ± 19.82ghij	19.77 ± 3.17def	1176.64 ± 365.25gh	186.91 ± 42.08ij	7.62 ± 1.89jk
BV_13	76.41 ± 23.21defg	18.54 ± 3.31cde	999.11 ± 420.17efgh	170.44 ± 47.25efghi	5.53 ± 1.25fgh
BV_14	63.63 ± 18.13bc	19.24 ± 3.23def	895.41 ± 323.70def	140.20 ± 36.38bc	5.20 ± 1.42efg
BV_15	76.32 ± 15.61defg	18.88 ± 2.94de	992.04 ± 296.00efg	166.59 ± 28.99defghi	4.90 ± 1.33defg
BV_16	63.39 ± 14.52bc	18.41 ± 4.09cde	827.90 ± 321.02cde	135.85 ± 27.08b	3.76 ± 1.41ab

BV_17	87.83 ± 15.30hij	16.66 ± 2.60bc	1014.70 ± 248.51efgh	197.30 ± 29.31j	4.48 ± 1.52abcdef
BV_18	75.59 ± 15.87defg	17.66 ± 2.07cd	948.78 ± 191.13ef	170.32 ± 23.39efghi	3.44 ± 1.35a
BV_19	78.89 ± 15.26defghi	18.21 ± 3.56cd	997.57 ± 286.80efgh	174.36 ± 31.81ghi	3.80 ± 1.30abc
BV_20	78.25 ± 15.75defh	18.89 ± 2.79de	996.41 ± 295.81efgh	171.71 ± 33.94fghi	4.36 ± 1.59abcde
BV_21	83.59 ± 13.83 fghij	20.49 ± 2.92ef	1200.73 ± 303.44hi	185.33 ± 28.50hij	4.73 ± 1.46bcdefg
BV_22	82.56 ± 17.32defghij	17.86 ± 2.38cd	998.90 ± 249.56efgh	180.84 ± 32.96hij	4.80 ± 1.39bcdefg
BV_23	71.05 ± 14.20c	21.16 ± 4.05f	1054.55 ± 339.30fgh	150.97 ± 28.23bcdef	5.17 ± 1.33efg
BV_24	71.35 ± 11.21cde	14.36 ± 2.10a	699.51 ± 142.33bcd	158.43 ± 20.57cdefg	5.21 ± 1.19efg
BV_25	58.57 ± 7.99ab	12.98 ± 1.42a	532.89 ± 102.26ab	129.15 ± 15.09b	4.37 ± 0.93abcde
BV_26	76.47 ± 14.97defg	20.47 ± 2.44ef	1087.98 ± 278.59fgh	163.16 ± 28.96defgh	4.42 ± 1.52abcde
AVERAGE	75.47±10.04	17.85±2.43	941.33±203.00	165.80± 22.66	5.53±1.41
CV %	13.30	13.60	21.57	13.66	26.48

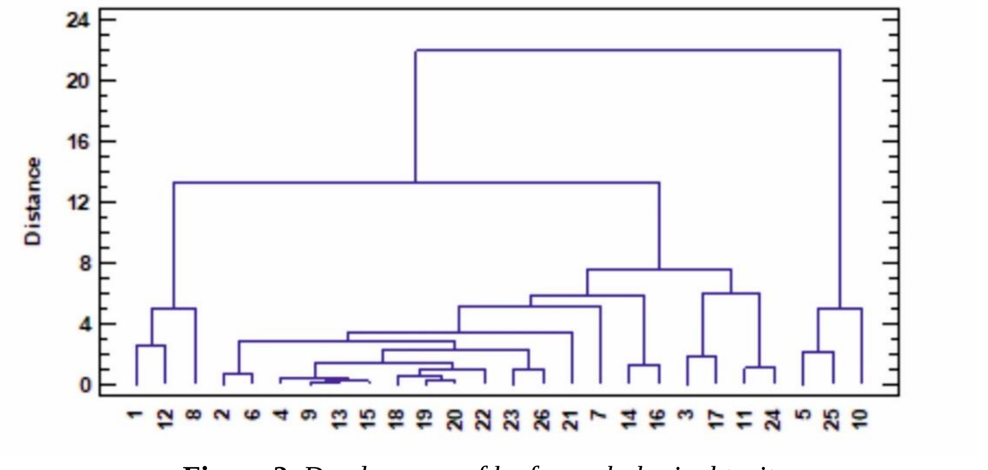

Figure 2. *Dendrogram of leaf morphological traits*

In the context of sustainable use of the available gene pool, special attention should be paid to the development and damage present on the leaves when selecting individual genotypes. In the case of white willow, inadequate adaptation of the trees to the habitat conditions can lead to an imbalance in the uptake of nutrients, resulting in bacterial diseases (De Vos et al., 2007). Besides that, high species diversity of parasitic and saprophytic fungi have been found in willow trees, mostly causing serious damage to the leaves of young individuals (Marković and Karadžić 2006), which may vary depending on the monitoring year (Pusz and Urbaniak 2017).

4. CONCLUSION

This research demonstrated a high variability rate of the studied morphological traits of the leaves of twenty-six white willow test trees which represent the population of this species in the LOF “Great War Island”. These results are the basis for further study, which is necessary to provide guidelines and recommendations for the conservation and targeted use of white willow genetic resources. The LOF "Great War Island" has the potential to preserve and produce white willow reproductive material adapted to different environmental conditions. In this way, the different biotic damages that occur due to the physiological weakening of trees in unfavorable conditions can be prevented. Furthermore, the protection measures against harmful factors deteriorating trees will give better results if the genotypes adapted to environmental conditions are used for the natural or artificial restoration of forests.

The findings on the variability within the white willow population on the Great War Island will facilitate the management and preservation of the white willow gene pool in this unique area with outstanding features.

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WHITE WILLOW (*Salix alba* L.) VARIABILITY IN THE LANDSCAPES OF OUTSTANDING FEATURES „GREAT WAR ISLAND” BASED ON MORPHOLOGICAL TRAITS OF THE LEAVES: A BASIS FOR ASSESSMENT OF GENE POOL

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Summary

Knowledge of the gene pool of trees is the basis of various works on improving the existing state of forests. To get to know the gene pool of white willow from the area "Landscape of Extraordinary Characteristics Great War Island," sampling of different trees and analysis of the morphological traits of the leaves of white willow (*Salix alba*) was carried out. Trees were sampled after the stage of full leaf development and analyzed using the LAMINA software package. The results revealed significant variability in the length and width of the leaves, including their area, circumference, and petiole length. Based on these findings, the white willow trees were categorized into distinct clusters depending on their leaf characteristics. This categorization simplifies the selection and production of reproductive material and guides further research. By better understanding the gene pool, we can enhance the white willow's adaptation to different habitat conditions, contributing to the preservation and growth of coastal forests in Serbia, particularly in response to global changes. This study also aids in improving and conserving the "Landscape of Extraordinary Characteristics Great War Island," making it easier for managers to oversee and maintain the gene pool of white willow. The findings can be applied to protect the white willow trees from various biotic and abiotic factors, ultimately enhancing their vitality and overall condition.

VARIJABILNOST BELE VRBE (*Salix alba* L.) NA PODRUČJU PIO „VELIKO RATNO OSTRVO" PREMA MORFOLOŠKIM SVOJSTVIMA LISTOVA: OSNOVA ZA PROCENU STANJA GENOFONDA

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Rezime

Poznavanje genofonda drveća predstavlja osnov različitih radova na unapređenju postojećeg stanja šuma. U cilju upoznavanja genofonda bele vrbe sa područja PIO Veliko ratno ostrvo izvršeno je uzorkovanje različitih stabala i analiziranje morfoloških karakteristika listova bele vrbe (*Salix alba*). Stabla su uzorkovana posle faze potpune razvijenosti listova i analizirana primenom softverskog paketa LAMINA. Dobijeni rezultati su pokazali veliku varijabilnost u dužini i širini listova, odnosno njihovom površini i obimu, kao i dužini peteljke. Testirana stabla bele vrbe se mogu razdvojiti u više klastera u zavisnosti od dimenzija morfoloških parametara listova. Korišćenjem ovih klastera pojednostavljuju se radovi vezani za njihovu selekciju i proizvodnju reproduktivnog materijala, odnosno dalja istraživanja. Bolja adaptiranost bele vrbe na različite stanišne uslove će doprineti očuvanju i razvoju priobalnih šuma u Srbiji, naročito usled vidljivih globalnih promena. Pre svega, ova studija omogućava unapređenje stanja i očuvanje PIO Veliko ratno ostrvo, olakšaava upravljaču gazdovanje i očuvanje genofonda bele vrbe. Primenom dobijenih rezultata olakšavaju se mere zaštite protiv pojedinih biotičkih i abiotičkih faktora koji utiču na smanjenje vitalnosti i pogoršanja opšteg stanja stabala bele vrbe.