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Zagrebačka 20, 71000 Sarajevo Bosna i Hercegovina

email: radovi@sfsa.unsa.ba

Tel: +387 33 812 490/491

Fax: + 387 33 812 488

www.radovi.sfsa.unsa.ba

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Wood assortment tables of Norway spruce (*Picea abies* Karst.) for Canton 10 of Federation B&H

Sortimentne tablice smrče *(Picea abies* Karst) u Kantonu 10 Federacije BiH

Ahmet Lojo[1,*], Jusuf Musić[1], Besim Balić[1], Admir Avdagić[1]

[1] University of Sarajevo, Faculty of Forestry, Zagrebačka 20, BA-71000 Sarajevo, Bosnia and Herzegovina

ABSTRACT - Sažetak

Current tables of wood assortments for the most important tree species in B&H were made almost 50 years ago. There is an indication that real forest wood assortments are different than the one derived from assortment tables in-use, both in terms of quality and dimensions. In the meantime, from the creation of the existing tables until today, the standards of production of forest wood assortments have changed, so that the fact of inaccuracy of the existing assortment tables is unquestionable.

This continually creates a variety of problems in the ongoing operations of forestry companies. The main aim of this paper is to create wood assortment tables whose assortment of wood products will correlate with the current market conditions. The research was conducted in the area of the Canton 10 in FB&H. A sample of 393 spruce trees was used as a database to produce this paper. The bucking of the sample trees was carried out in accordance with the valid norms and customer requirements with regards to the dimensions of forest wood products. Data processing was performed using methods of simple and multiple regressions, variance analysis as well as their combinations by the *Generalized Linear Models* method. Independent factors were breast diameter (DBH), technical quality class and the height of the trees. The share of wood assortments was determined through 10 different mathematical models, and it was found that all independent variables had a statistically significant influence on the dependent variables-volume of particular assortments or group of assortments. The share of logs is growing rapidly with the increase of tree diameter and decreases with decreasing of their technical quality. The influence of tree height primarily correlated with tree volume increase. Trees having better assortment quality, have tree heights higher than average for the same diameter class. The results of the research are presented in the form of tables as percentage share of wood assortment classes. The obtained results can be used as wood assortment tables in the research area.

Key words: *forest wood products, diameter, technical quality class, regressions*

INTRODUCTION - *Uvod*

Acknowledgement and evaluation of the forest quality is an essential information for establishing forestry policies and creating various plans in forestry and wood industry. Matić (1969) highlights that knowing the health condition of the forest and its technical applicability is of the same economic importance as knowing the areas of certain forest categories, their growing stocks and wood increment. He also states that perspective plans of forestry development, annual plans, development plans for certain objects of the wood industry

* Corresponding author: Ahmet Lojo a.lojo@sfsa.unsa.ba

etc. cannot be properly constructed if the assortment structure of the forest in focus cannot be determined beforehand. In reality, this can only be done by using assortment tables. Considering the huge importance of assessment (i.e. knowing the assortment structure of wood products in forest stands), numerous studies have been conducted both worldwide and locally, aiming to determine the assortment structure of the economically most important tree species. But, since all of the study results of assortment structure are greatly defined by the round-wood assortment system (standards), they often cannot be used for direct comparison due to obvious differences in classification criteria.

The first significant studies of wood assortment, and the assessing of the manner and size of certain influential factors on the assortment structure, was conducted by Flury (1916). These studies are also important because the author concluded that under the hypothesis of the same tree quality, even for the assortments that he formed (six assortment classes defined by the diameter at the thinner end and at minimum length), the tree height does not have an impact on the percentage share of these assortments in the tree volume (grown trees including bark). On the other hand, Gorskij (according to Pavlič 1973) obtained the results that confirm the impact of height on the percentage share of all assortments, concluding that tree height has an impact on the quantity of assortments. A great number of authors in Europe engaged in the research of the wood assortment structure and the creation of wood assortment tables (Mitscherlich 1939, Altherr 1953, Čermák 1982, Petráš and Nociar 1990, 1991 and many others). Nonetheless, the most interesting and the most important works definitely are the works of authors from the region of the former Yugoslavia, primarily due to the fact that they used the same round-wood normative (sorting) system.

Bojanin (1960) studied and analysed the share of some wood assortments, bark, and wood losses by diameter classes, as well as their interdependence. The author confirms a strong correlating dependence between the tree diameter at breast height and the researched characteristics, and presents the analytical expressions of these dependences.

Plavšić and Golubović (1963) studied the wood assortment share of the Silver fir (Abies alba L.) and conducted its classification based on the regulations of two standards (JUS 1955 and JUS 1962). They stated a strong correlation between the percentage share and the related diameter class for all assortments. They concluded that the change in regulation results in a significant difference between the percentage share of the most valuable assortments (1st and 2nd class sawlogs), which is 14%, according to the JUS 1955 standard, up to astounding 31% (due to the lowered quality and log thickness criteria), according to the JUS 1962 standard. These two authors stated that there were minor differences in the percentage ratio of wood assortments of the same diameter class in different height classes and different forest community, but they did not state the exact values. To finalize, they confirmed the forementioned hypothesis by Flury (1916), according to which the trees of the same diameter at breast height (DBH) and the same quality, but different heights, have the same percentage ratio of wood assortments, while their absolute values change along with the tree height.

The research in percentage share of the beech, spruce and fir assortments in monospecies and mixed stands in Bosnia and Herzegovina was conducted by Vukmirović (1971), Pavlič (1973) and Prolić (1975). As the result of those researches, the assortment tables for three economically most important tree species. Considering that a high variation of tree quality (i.e. technical usability) was determined, the authors created the so-called two-way assortment tables. The input values for the evaluation of the percentage share of assortments are the previously defined technical quality and diameter classes. As a part of this research, the impact of tree quality (expressed through technical quality classes) on percentage share of assortments is analysed for the first time. The better the tree quality, the higher the percentage share of the more valuable assortments — and vice-versa, regarding all of the researched tree species.

The assortment structure of the most important broadleaved species in Croatia was researched by Štefančić (1997, 1998). His conclusion was that tree height also affects the percentage share of wood assortments in merchantable tree volume (in addition to DBH). By analyzing this influence, he concluded that it is linear, hence, he presented the analytical expression of this dependence. The percentage share of timber rises with the increase of tree height (applies to all analyzed species), but the relation is inversely proportional for pulpwood.

Rebula (1996, 1998a, 1998b) made important contribution to knowledge of the wood assortment structure and the value of Silver fir trees. Using appropriate statistical methods, he determined the relation between the most important criteria of wood quality and its value. He concluded that tree's timber value depends on their diameter and natural defects (their amount and severity), with former being prevalent as the best individual criterion of their value.

Prka (2001, 2006a) has made intensive research on assortment structure of beech forests in Croatia determining a strong correlation between DBH and the percentage share of technical round wood i.e. stacked wood. Prka and Krpan (2007) pointed out the unreliability of the former approach of determining assortment structures of even-aged beech stands, while emphasizing the necessity of differentiating the assortment structure of stands from the assortment structure of felling method.

Koprivica et al. (2008) analysed the quality and assortment structure of tall beech stand volume in northern forest areas of Kučaj mountain range, revealing that the quality structure of the stands is extremely low. Percentage of technically applicable trees was staggering 34.7%, due to past mistakes in forest management.

In Europe, at the end of the last century, there were important changes in the field of standardization. Namely, the awareness that the diversity of national standards largely represents a serious goods trade obstacle for European industry and consumers, as well as the fact that it was obligatory to adjust national standards, led to the foundation of the European Committee for Standardization (CEN), i.e. the introduction of European Norms (EN). Efficient application of these standards requires, among others, the assortment structure research and the creation of applicable assortment tables according to the requirements regarding dimensions and quality. Therefore, numerous researches on assortment structure regarding European Norms have been conducted. (Šušnjar et al. 2005, Prka 2006b, Prka, 2008, Musić et al. 2008, Prka and Poršinsky 2009).

Latest valid assortment tables for the most economically important tree species in BiH were made almost 50 years ago, based on previous standards (JUS) from 1968 and 1969, and the former state of wood industry. With a relatively fast technical and technological development in wood processing industry and usage, this previous standard was a matter of change throughout decades, while, regardless of that, it was not synchronized with the changes in other standards. In other words, the production plans of wood assortments and their immediate production were not adjusted because they had different grounds. As time passed, these differences grew. Lipoglavšek (1996) emphasized the unseemliness of these standards 25 years ago. Regarding that, it can be concluded that the produced and traded wood assortments today are much different than the ones that were produced at the time of creation of the above-mentioned assortment tables, which continuously creates various problems in the current business. If we consider the fact that the change of regulation (standards) results in a significant difference in percentage share of wood assortments (Plavšić and Golubović 1963), the need for creating assortment tables is imposed as a priority task. These assortment tables should include the wood assortment products which will as closely as possible correspond to the demands of the current wood industry market state, and their quality and dimensions should be attuned to the valid standards in the field of forestry and wood processing.

MATERIALS AND METHODS – *Materijal i metode*

From an economical and environmental aspect, spruce (*Picea abies* Karst) is one of the most important coniferous species in Europe. In Bosnia and Herzegovina, spruce represents one of the most significant forest tree species. Its share in the total wood stock is 16.1%, which makes it (after beech and fir) the third most important tree species in our forests.

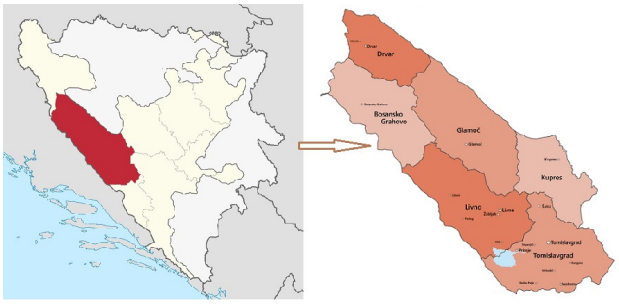

Figure 1. Research area – Canton 10 of the Federation of Bosnia and Herzegovina

Karta 1: Područje istraživanja – Kanton 10 Federacije Bosne i Hrecegovine

This research was conducted in the area of Canton 10 of the Federation of B&H (Figure 1) as part of the scientific-research project: *The creation of volume and assortment tables for fir, spruce and beech trees in the area of forests managed by FMC "Hercegbosanske šume Ltd. Kupres"*. In this canton, spruce is located at the south-western edge of its areal, in the area with the predominant moderately continental climate, in colder expositions and on higher altitudes.

The creation of assortment tables is methodologically a very complex task. In countries where the quality of assortments is influenced by other features (knots, taper, twist etc.) in addition to dimensions, assortment tables are usually created in two ways (Rebula 1996):

- Model trees are chosen using small samples (200-300 trees), based on the necessary features (dimensions and quality). Such an example can be found in *Sortimentačné tabuľky pre ihličnaté dreviny* (Hubač 1973)

and the current assortment tables in BiH (Vukmirović 1971, Pavlič 1973, Prolić 1975).
- Using large samples (1,000-1,500 trees) all the tree features are measured (dimensions and features), and then the assortment tables are computationally created by sample classification of the trees. Such an example can be found in *Sortimentačné tabuľky pre smrekovec, hrab a brezu* (Mecko et al. 1994).

Considering the huge amount of time spent for field work during data collection, as well as limited funds, the method applied in this paper is the so-called "small sample" method. Firstly, the locations for selecting model trees (representatives) were chosen in the research area, considering the fact that the chosen locations cover the forest area in Canton 10 as systematically as possible. Then the trees were selected based on DBH, height and quality. From 5 to 30 spruce trees were selected on every location depending on the spruce share in individual stands. While selecting the trees, it was taken care that the sample consisted of trees of all diameter and quality classes, whereat thicker trees were more represented since they have more variability regarding quality and potential of wood product assortment. Every selected tree had its DBH and height measured, and quality estimated. It is important to mention that some criteria of tree quality classifications (Matić 1964) were corrected or adjusted to the changes in standards and demands regarding dimensions and quality for the most important forest wood assortments (Musić and Lojo 2006). The structure of the sample trees is shown in Table 1.

Table 1. Number of trees in the sample per diameter and technical quality classes

Tabela 1. Broj stabala uzorka po debljinskim i tehničkim klasama

Diameters class (cm) *Debljinska klasa (cm)*	**No. of trees** *Broj stabala*	**Technical quality class** *Tehnička kvalitetna klasa*			
		I	**II**	**III**	**IV**
10-14.9	26	15	0	10	0
15-19.9	26	6	0	17	4
20-29.9	68	15	22	25	7
30-49.9	118	34	43	36	4
50-69.9	53	38	42	30	0
>70	44	20	15	9	1
Total	**393**	**128**	**122**	**127**	**16**

Following the felling of selected model trees, their volume was determined using the section model. Due to the irregular shape of the lower part of the stem, the volume of the first section was calculated using Ricke's formula while the volume of the other sections was calculated using Huber's formula. The diameter were measured at the middle of the section length, twice (cross-wise), with the precision of up to 1 mm, considering their average value as well. In the places where the diameter was measured, tree bark was also measured (mm). In addition, every felled tree was measured from the ground to the final terminal bud or height of the tallest branch including the height of the stump (height of tree). Following the log dimension measurement, their cutting was conducted according to the current standards for certain forest wood assortments and the current demands of the wood industry regarding the type of assortment and their dimensions, primarily the length. The dimension measurement of the produced wood assortments, with the purpose of determining their volume, was conducted according to the *JUS D.B0.022* (1984) standard with the addition of the appropriate length excess where the standard prescribes it.

Considering the crucial and dominant impact of tree diameter and quality on the percentage share of assortments, DBH and the technical quality class have to be taken as independent variables in all models, with the following two regression procedures:

1. Levelling the share of certain forest wood assortments for each quality class individually, by method of simple or multiple regression with the diameter at breast height appearing as an independent continual variable.
2. Levelling the share of certain forest wood assortments simultaneously for different quality classes and different tree diameters. This second procedure would have to combine category and continual variables simultaneously. Therefore, the use of G*eneralized Linear Models* (GLM) analysis combining variance analysis and regression is the logical procedure.

Both procedures have their drawbacks which largely depend on the quality (size) of the sample, where the first procedure requires a significantly larger sample. Namely, although the changes in the forest wood assortments regarding diameter and quality are known for the researched feature (assortment structure), thus possible inconsistencies can easily be recognized, the sample analyzed in this paper is still relatively small, hence the gained results could have a strong impact on individual models of simple regression. Due to this drawback of the first procedure, the G*eneralized Linear Models* (GLM) procedure was used in this paper. Its models are more flexible in so-

lutions and offer more logical results in cases of missing trees in the sample. For the purpose of analyzing the impact of different factors on the tree volume and the volume of certain assortment, the Fischer LSD test and variance analysis were used. Statistical program STATGRAPHICS Centurion XVII was used for the processing of the data and the interpretation of the results.

RESULTS AND DISCUSSION – *Rezultati i diskusija*

After determining the volume of certain forest wood assortments, their percentage share in the volume of merchantable wood was calculated per diameter and technical quality classes. The obtained results, with some minor deviations, show a rather clear and logical distribution of data. The better the quality and diameter, the larger the share of more valuable assortments. Only the technical class IV is missing the data for diameter classes 10 - 15 cm and 50 - 70 cm. Although the data for this class is rather logical, the number of trees of the sample was too low to derive any reliable conclusions.

Therefore, the main aim of this paper is the creation of reliable functional models for the estimate of the percentage share for the volume of certain forest wood assortments in the volume of trees.

It was stated in a lot of conducted research that the height of coniferous trees (site quality class of the stand) does not have a significant impact on the percentage share of assortments (Flury 1916, Plavšić and Golubović 1963, Pavlić 1973, Prolić 1975). This was also confirmed through our preliminary data analyses while attempting to directly level the percentage share of the forest wood assortments in the volume of spruce trees through the GLM procedure. The direct usage of the percentage share of volumes of certain assortments or assortment groups as independent variables did not yield reliable results. Therefore, the indirect approach of levelling volumes of certain forest wood assortments and large spruce wood volume was used. The percentage shares were then calculated based on the tree volumes and volumes of certain forest wood assortments. A special problem was the fact that some assortments appear only above certain DBH of trees, i.e. that the change of percentage share of certain assortments does not have a continual – constant flow which could easily be expressed through some sort of functional form. Such was the case with logs of every quality. Namely, they appear in trees above a certain DBH, their percentage share significantly rises with the increase of tree diameter, and then that increasement slows down following a declining curve.

By using the GLM method for determining the model for the estimation of volume of certain forest wood assortments in tree volume using DBH as one of the continual variables, there was no result yielding a good quality distribution of residual deviation in every individual case. Because of that, the diameter class of 5 cm was used instead of DBH as an independent category variable.

Volume of merchantable wood - V_7 (model 1) – *Zapremina krupnog drveta V_7 (model 1)*

In order to secure the best relative relation between tree volume and the volume of certain assortments, the first thing to be done in this procedure was to make a tree volume evaluation model (of merchantable wood) based on the data. The main purpose of creating such a model is precise calculation of volume share of certain assortments for the purpose of this paper. That is why the model for evaluating the volume of merchantable wood has the same factors as the models for evaluating the volume of certain assortments or groups of assortments. The regression model for ascertaining the volume of merchantable wood includes the following independent category factors:

1. DBH_{cl} – diameter class of 5 cm width, based on the measured breast diameter,
2. TQ_{cl} - technical quality class of the tree, And for the quantitative factor, the following was taken:
3. H - tree height in meters.

With the aim of optimizing the model, the transformation of the dependent variable was conducted by using the Box-Cox (1964) procedure with the determined exponent $\lambda = 0.179096$. The resulting regression model has a high coefficient of multiple determination ($R^2 = 0.9878$), and the regression results are given in Tables 2 and Tables 3.

Based on the data from Tables 2 and 3, it is noticeable that each independent factor shows a considerable impact on the size of the dependent variable, while the impact of the technical class remains the smallest. According to the sizes of the parameters of the regression model alongside the quality classes, it can be concluded that the trees are of lower quality, and those of the same diameter, are somewhat slighter taper than better quality trees. The average volumes of spruce trees by diameter classes, with intervals of least significant difference around average sizes, are presented in Figure 2.

Table 2. The analysis of variance for the volume of trees (merchantable wood) – V_7

Tabela 2. Analiza varijanse zapremine stabala (krupno drvo) - V_7

Source *Izvor*	**Sum of Squares** *Suma kvadrata*	**Df**	**Mean Square** *Sredina kvadrata*	**F-Ratio** *F-odnos*	**P-Value** *P-vrijednost*
Model	868.857	18	48.2698	1685.60	0.0000
Residual	10.7101	374	0.0286366		
Total (Corrected)	879.567	392			

Table 3. Type III Sums of Squares

Tabela 3. Suma kvadrata tip III

Source *Izvor*	**Sum of Squares** *Suma kvadrata*	**Df**	**Mean Square** *Sredina kvadrata*	**F-Ratio** *F-odnos*	**P-Value** *P-vrijednost*
TQ_{class}	0.36893	3	0.122977	4.29	0.0054
DBH_{class}	51.2513	14	3.66081	127.84	0.0000
H	9.0211	1	9.0211	315.02	0.0000
Residual	10.7101	374	0.0286366		
Total (Corrected)	879.567	392			

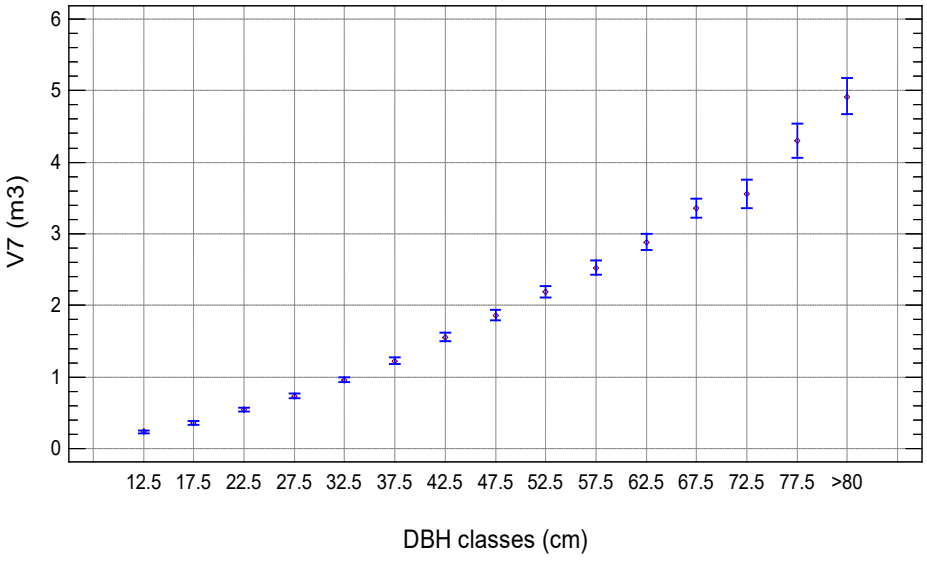

Figure 2. Average volumes of spruce trees (V_7) by diameter classes and least significant difference (LSD) intervals around average sizes

Grafikon 2. Prosječne zapremine stabala smrče (V_7) po debljinskim klasama i interval najmanjih značajnih razlika (LSD) oko prosječne vrijednosti

Analysis of residuals shows that they have no systematic deviation in any part of the domain of empirical data, with the exception of only two residuals leaving the ± 3 of the standard deviation.

The equation for the selected model is the following:

BoxCox (V_7) = -0.0958333 – 0.0267807·I1(1) + 0.0157342·I1(2) – 0.0513599·I1(3) – 2.06775·I2(1) – 1.66439·I2(2) – 1.25591·I2(3) – 0.929984·I2(4) – 0.626868·I2(5) – 0.338302·I2(6) – 0.0440483·I2(7) +

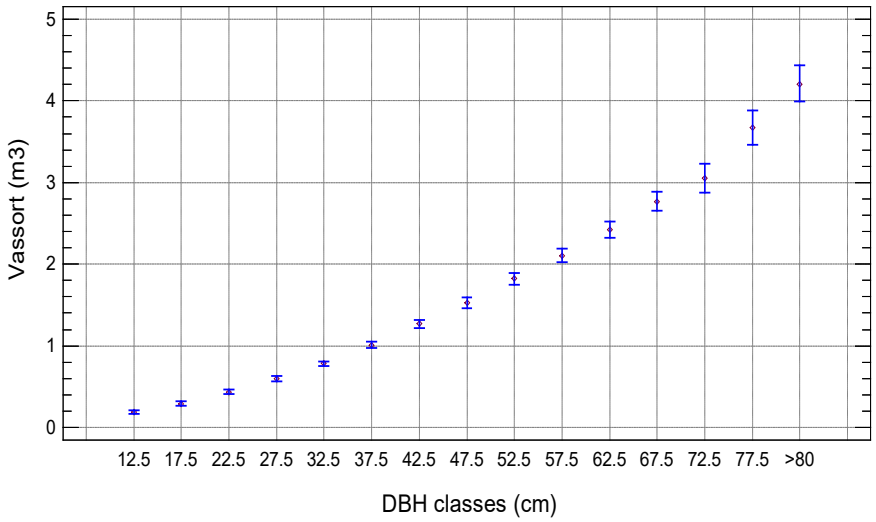

Figure 3. Average volumes of all asortments (V_{assort}) by diameter classes and least significant difference (LSD) intervals around average sizes

Grafikon 3. Prosječna zapremina svih sortimenata (V_{assort}) po debljinskim klasama i interval najmanjih značajnih razlika (LSD) oko prosječne vrijednosti

0.184114·I2(8) + 0.396691·I2(9) + 0.590793·I2(10) + 0.774412·I2(11) + 0.990616·I2(12) + 1.07565·I2(13) + 1.35434·I2(14) + 0.0661968·H

With:

BoxCox (V_7) = 1 + ($V_7^{0.179096}$-1)/(0.179096*1.20162$^{-0.820904}$)

I1(1) = 1 if TQ_{cl}=1; -1 if TQ_{cl}=4; 0 otherwise

I1(2) = 1 if TQ_{cl}=2; -1 if TQ_{cl}=4; 0 otherwise

I1(3) = 1 if TQ_{cl}=3; -1 if TQ_{cl}=4; 0 otherwise

I2(1) = 1 if DBH_{cl}=12.5; -1 if DBH_{cl}=80 and more; 0 otherwise

I2(2) = 1 if DBH_{cl}=17.5; -1 if DBH_{cl}=80 and more; 0 otherwise

I2(3) = 1 if DBH_{cl}=22.5; -1 if DBH_{cl}=80 and more; 0 otherwise

I2(4) = 1 if DBH_{cl}=27.5; -1 if DBH_{cl}=80 and more; 0 otherwise

I2(5) = 1 if DBH_{cl}=32.5; -1 if DBH_{cl}=80 and more; 0 otherwise

I2(6) = 1 if DBH_{cl}=37.5; -1 if DBH_{cl}=80 and more; 0 otherwise

I2(7) = 1 if DBH_{cl}=42.5; -1 if DBH_{cl}=80 and more; 0

Table 4. Average spruce tree height per diameter degrees for different technical quality classes

Tabela 4. Prosječne visine stabala smrče po debljinskim stepenima i tehničkim kvalitetnim klasama

Technical class *Tehnička klasa*	**Diameter of spruce trees (cm)** *Debljinski stepen (cm)*														
	12.5	**17.5**	**22.5**	**27.5**	**32.5**	**37.5**	**42.5**	**47.5**	**52.5**	**57.5**	**62.5**	**67.5**	**72.5**	**77.5**	**82.5**
	Tree height (m) *Visina stabla (m)*														
I	11.7	16.1	19.5	22.1	24.3	26.2	27.9	29.4	30.7	31.9	33.0	34.0	35.0	35.9	36.7
II	11.7	15.8	18.9	21.3	23.3	25.1	26.6	27.9	29.1	30.2	31.3	32.2	33.1	33.9	34.6
III	11.2	15.1	18.0	20.4	22.3	24.0	25.5	26.8	27.9	29.0	30.0	30.9	31.7	32.5	33.2
IV	10.4	14.0	16.5	18.4	20.1	21.4	22.7	23.7	24.7	25.6	26.5	27.3	28.0	28.7	29.3

otherwise
I2(8) = 1 if DBH_{cl}=47.5; -1 if DBH_{cl}=80 and more; 0 otherwise
I2(9) = 1 if DBH_{cl}=52.5; -1 if DBH_{cl}=80 and more; 0 otherwise
I2(10) = 1 if DBH_{cl}=57.5; -1 if DBH_{cl}=80 and more; 0 otherwise
I2(11) = 1 if DBH_{cl}=62.5; -1 if DBH_{cl}=80 and more; 0 otherwise
I2(12) = 1 if DBH_{cl}=67.5; -1 if DBH_{cl}=80 and more; 0 otherwise
I2(13) = 1 if DBH_{cl}=72.5; -1 if DBH_{cl}=80 and more; 0 otherwise
I2(14) = 1 if DBH_{cl}=77.5; -1 if DBH_{cl}=80 and more; 0 otherwise

Volumes of all assortments – V_{assort} (model 2) – *Zapremina svih sortimenata - V_{assort} (model 2)*

The volume of all assortments was determined using the same procedure and the same independent variables as in the previous case. Also, the transformation of the dependent variable was conducted with the determined exponent λ = 0.194387. Every factor showed a significant influence on the dependent variable, and the chosen regression model has a high degree of explanation of the dependent variable's size (coefficient of multiple determination R^2 = 0.9870). The equation for the chosen model, its statistical parameters and the analysis of residuals are given in the supplement to this paper. Average volumes of all spruce tree assortments by diameter classes with intervals of least significant difference around average sizes are presented in Figure 3.

Average tree heights per diameter classes (model 3) – *Prosječne visine stabala po debljinski klasama (model 3)*

A significant correlation was established between the technical quality of trees and their height (for the same DBH), which is also logical since the trees in better stands are usually taller and have better trunks due to the faster clearing of branches. For this reason, and only for the purpose of creating assortment tables in this paper, we established mathematical models for estimating average heights of spruce trees in meters (H) depending on the DBH in cm. This was done separately for each technical class, and these were determined to be the best individual models of average tree height estimate:

TQ_{cl} =1: $H = -21.679 + 13.2165 \cdot \ln(D_{1,30})$; R^2 = 94.03
TQ_{cl} =2: $H = -18.7045 + 12.0706 \cdot \ln(D_{1,30})$; R^2 = 80.76
TQ_{cl} =3: $H = -19.5113 + 12.0537 \cdot \ln(D_{1,30})$; R^2 = 85.99
TQ_{cl} =4: $H = -16.998 + 10.6301 \cdot \ln(D_{1,30})$; R^2 = 78.93

Models were used to calculate the average heights per diameter classes and technical classes (Table 4). These heights were used to calculate the volumes of merchantable wood and the volumes of certain log types while creating the assortment tables.

Utilization degree of spruce in tree wood volume – *Stepen iskorištavanja u zapremini stabala smrče*

Using regression models 1, 2 and 3 the tree volumes were established as well as the volumes of all wood assortments per diameter and technical quality classes. Based on the established volumes, the percentage share of assortments in tree volumes was calculated, i.e. the percentage of utilization of tree volume into assortments. This data is presented in Table 5. The calculation of percentage share of individual assortments or group assortments in spruce tree volume was calculated in the same manner in the rest of this paper.

Table 5. Percentage share of all assortments in spruce tree volumes (degree of utilization)

Tabela 5. Procentualni udio svih sortimenata u zapremini stabala smrče (stepen iskorištenja)

Diameters class (cm) *Debljinska klasa (cm)*	Technical quality classes *Tehnička kvalitetna klasa*			
	I	II	III	IV
	% assort	% assort	% assort	% assort
10-14	75.6		73.9	71.1
15-19	80.2		78.7	75.9
20-29	81.2	80.7	79.9	77.4
30-39	82.8	82.4	81.8	79.5
40-49	82.7	82.3	81.9	79.8
50-69	83.9	83.6	83.4	81.6
>70	85.7	85.5	85.4	83.9

Volumes of all logs - V_{logs} (model 4) – *Zapremina svih trupaca V_{logs} (model 4)*

While analyzing the log volume, we excluded the trees under 20 cm DBH since, according to current standards, logs cannot be produced from these trees. For the procedure of creating the model, 341 trees were used. The volume of all spruce logs consists of the following:

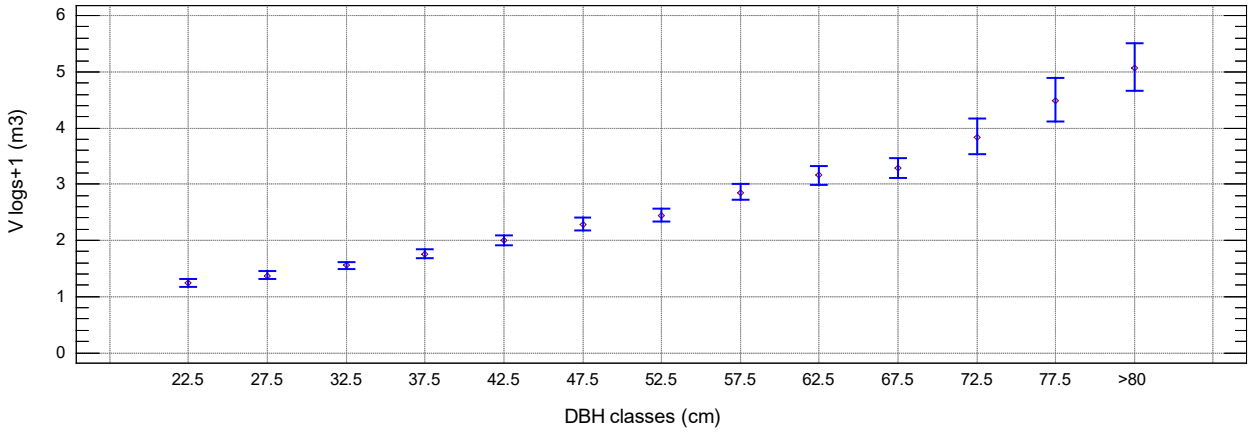

Figure 5. Average volume of all logs by diameter classes and least significant difference (LSD) intervals around average sizes

Grafikon 5. Prosječna zapremina trupaca po debljinskim klasama i interval najmanjih značajnih razlika (LSD) oko prosječne vrijednosti

VL – veneer logs
SL_1 – I class saw logs
SL_2 – II class saw logs
SL_3 – III class saw logs

It is clear that levelling the volumes of all logs is far more reliable than the direct levelling of individual log types. For this purpose, the volumes, i.e. the percentage share of log types which are the least represented in tree volumes (VL and SL_1), were calculated as the difference between the volumes (percentage) determined for all logs together and the most represented log groups (SL_2 and SL_3).

This regression model included the same independent variables as model 1. In the regression procedure itself, the dependent variable was linearly increased by 1 (m^3) for each data ($V_{logs}+1$). This was done in order to enable the model optimization by transformation according to the Box-Cox procedure (eliminating zeroes from the data), while keeping in mind that this increase in dependent variable data has no impact on the quality of regression and its statistical parameters. It is understood that in the final calculation of volume, according to this model, it is necessary to deduct 1 (m^3) from the obtained values. All independent variables had a statistically significant impact on the dependent variable, and the regression model has a high level of explanation of the dependent variable's size (multiple determination coefficient $R^2 = 0.9206$). The equation for the chosen model, its statistical parameters and the analysis of residuals are given in the supplement to this paper. The average volumes of all spruce logs are presented by diameter and quality classes in Figure 4, while the least significant difference intervals around average sizes, are presented in Figure 5.

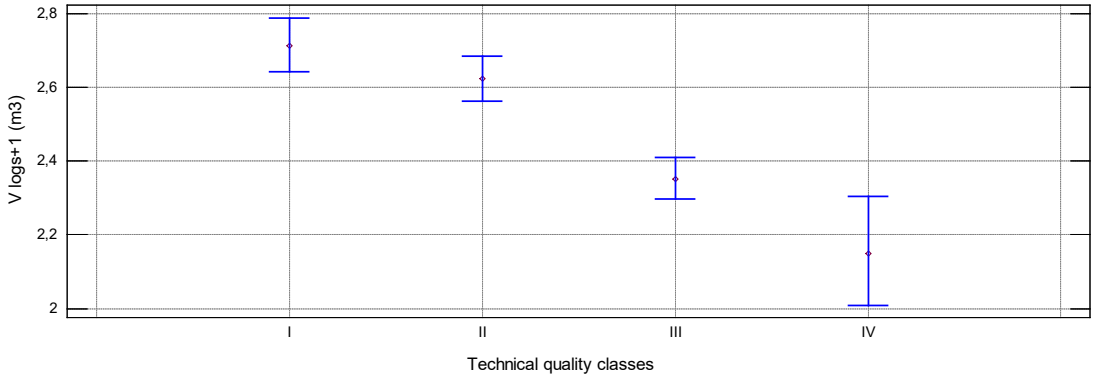

Figure 6. Average volume of all logs by technical quality classes and least significant difference (LSD) intervals around average sizes

Grafikon 6. Prosječna zapremina trupaca (V_{assort}) po tehničkim klasama i interval najmanjih značajnih razlika oko prosječne vrijednost

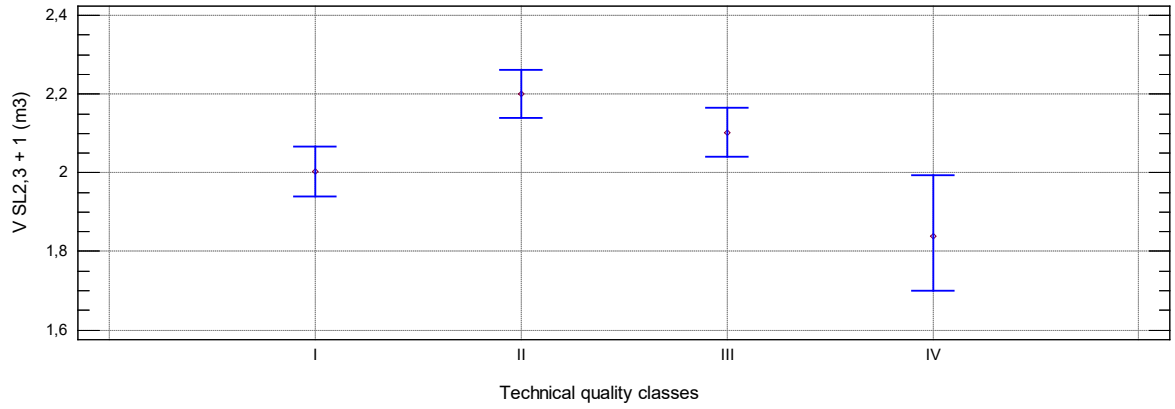

Figure 7. Average volume of sawlogs II and III class by technical quality classes and least significant difference (LSD) intervals around average sizes

Grafikon 7. Prosječna zapremina pilanskih trupaca II i III klase po tehničkim klasama i interval najmanjih značajnih razlika oko prosječne vrijednosti

Percentage log share in spruce tree volume – *Procentualni udio trupca u zapremini stabala smrče*

Based on models 1 and 4, spruce tree volumes and log volumes were calculated according to diameter classes, separately for each technical class. This procedure could not be conducted for the quality class IV since it lacks the best quality logs (VL and SL_1), thus the data obtained through the regression model in this part is unreliable. This problem will be solved by creating the model for estimating log volumes of classes SL_2 and SL_3 together. The percentage share of logs was then determined by simply dividing log volume and merchantable wood volume (both per diameter and technical classes).

Saw log volume for classes II and III - V $SL_{2,3}$ (model 5) – *Zapremina pilanskih trupaca II i III klase V $SL_{2,3}$ (model 5)*

The total share of these logs in the sample is over 50% of merchantable wood volume, with an average of 73% of all logs. In addition, this assortment group is greatly represented in all diameter classes (over 20 cm) and all technical tree classes. The conducted analysis showed that the model for determining the volume of saw logs from class II and III (combined) was more reliable (has fewer mistakes) than the model used to determine the combined volume of veneer and class I saw logs. During the optimization of the model, the Box-Cox transformation of the dependent variable with the exponent λ = -0.429777 was used. Here, just like with model 4, the dependent variable was increased by 1 (m^3) linearly for each data, for the previously explained reasons. The resulting regression model has a multiple determination coefficient of R^2 = 0.8471. The equation for the chosen model, its statistical parameters and the analysis of residuals are given in the supplement to this paper. The average volumes of analyzed logs by technical quality classes and least significant difference intervals around average sizes are presented in Figure 6.

The figure shows that the reliability interval around the average volume size of these logs in the technical class IV is significantly wider (larger) than for other classes. This points to the conclusion that the results for this class are rather unreliable, the main reason being the fact that only a few trees of this class contained logs that have been analyzed in the sample.

Saw log volume for class II - V SL_2 (model 6) – *Zapremina pilanskih trupaca II klase V SL_2 (model 6)*

In the sample tree volume, the volume of class II saw logs was larger and better distributed by diameter classes than the volume of saw logs in class III. Therefore, the model for the estimate of their volume is more reliable than the one for saw logs in class III, and that is why it is presented in this paper. Just like in previously described procedures, while creating this model, trees with DBH over 20 cm were used alongside the same independent variables (with already explained 1 (m^3) increase of the dependent variable). During the optimization of the model, the Box-Cox dependent variable transformation was applied with the exponent λ = -0.744052. The resulting regression model has a multiple determination coefficient of R^2 = 0.6309. The equation for the chosen model and its statistical parameters

are given in the supplement to this paper. The average volumes of these logs by diameter classes and least significant difference intervals around average sizes are presented in Figure 7.

The following volumes were determined based on the previous regression models: tree volumes, the volumes of all wood assortments, volumes of all logs together, combined saw log volumes for classes II and III, and volume for saw logs of class II. The obtained sizes of volumes were used to calculate the percentage share of all assortments and/or assortment groups in the spruce tree volume.

Pit timber, pulpwood and firewood – *Rudno drvo, celulozno drvo i ogrjevno drvo*

This assortment group consists of assortments such as pit timber (PT), pulpwood (PW) and firewood (FW). Firewood was represented with only 0.23% in the sample, and in the volume of this assortment group with only 2.6%. Therefore, firewood is included in the volume of pulpwood in all the analyses. In practice, pit timber and pulpwood most often substitute each other, depending on the current demand on the market. Their percentage share has already been determined by previously defined percentage share of all assortments combined and the percentage share of all logs combined, and represents their difference: $PT + PW = V_{assort} - V_{logs}$ (%). The share of pit timber has, as opposed to pulpwood, shown a clear regularity of appearance according to diameter classes, thus it was easier to make a regression model for the estimate of its volume.

Pit timber share in tree volume (model 7) – *Udio rudnog drveta u zapremini (model 7)*

While searching for the optimal model for estimating pit timber volume, i.e. its share in spruce tree volume, it was noticed that direct levelling of percentage share in tree volume yielded the model with the largest multiple determination coefficient ($R^2 = 0.536$) and the best residual distribution around the estimate line. For the creation of the model, the same independent variables were used as in all previous models, and the ponder in calculating the equation parameters was merchantable wood volume (V_7). The equation for the chosen model is given in the supplement to this paper. The average percentage share of pit timber by diameter classes with least significant difference intervals around average sizes are presented in Figure 8. Based on previous models it is easy to obtain the percentage share of pulpwood and firewood: $PW + FW = V_{assort} - V_{logs} - PT$ (%)

Veneer log share in tree volume (model 8) – *Udio furnirskih trupaca u zapremini stabala (model 8)*

The share of veneer logs in the volume of large spruce tree wood is relatively small. The percentage share of veneer and class I saw logs combined (VL and SL_I) has already been determined as the difference of the share of all logs and saw logs of classes II and III combined. These assortments do not appear in the volumes of trees thinner than 30 cm, and their total share in the sample volume was only 1.21%. Due to insufficient data

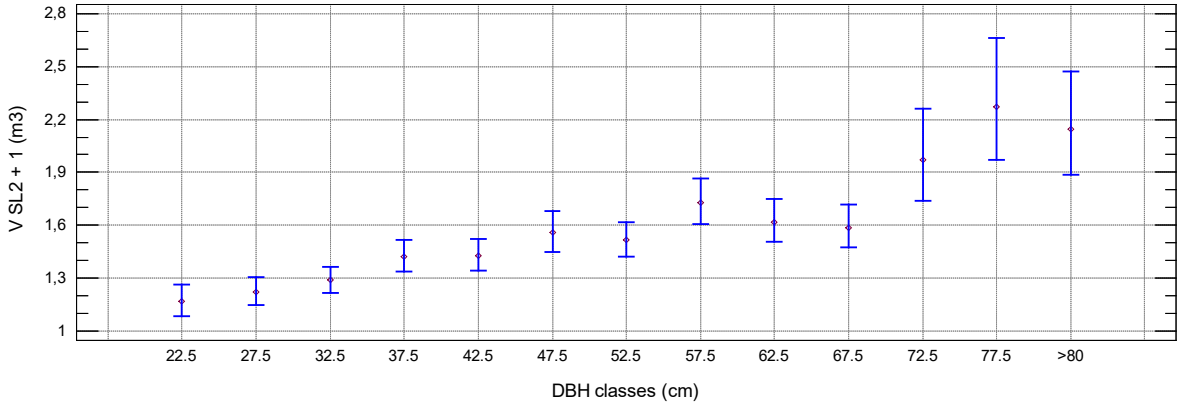

Figure 8. Average volume of class II saw logs by diameter classes and least significant difference (LSD) intervals around average sizes

Grafikon 8. Prosječna zapremina pilanskih trupaca II klase po debljinskim klasama i interval najmanjih značajnih razlika oko prosječne vrijednosti

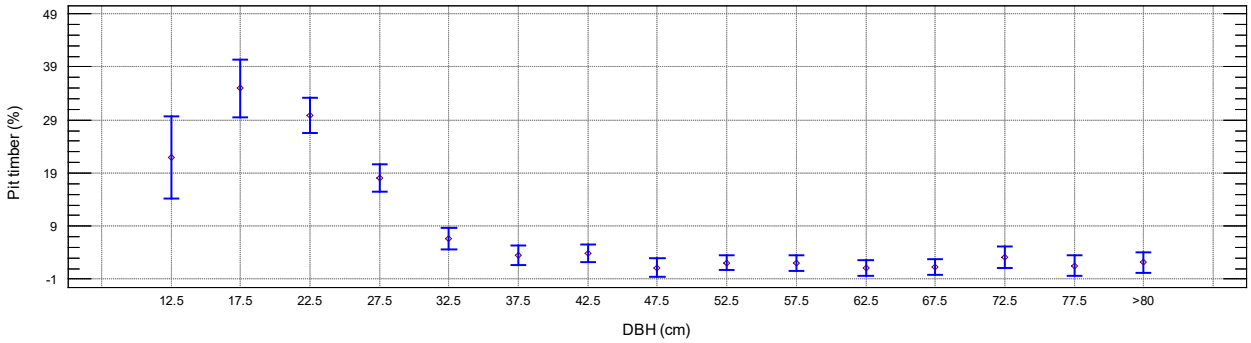

Figure 8. Average percentages of pit timber by diameter classes and least significant difference (LSD) intervals around average sizes

Grafikon 8. Prosječna procentualno učešće rudnog drveta po debljinskim klasama i interval najmanjih značajnih razlika (LSD) oko prosječne vrijednosti

and their variability by technical classes, there was no significant difference between veneer logs and saw logs of class I. Also, there were no significant differences in the percentage share of veneer logs by diameter classes. Therefore, the share of these logs in assortment tables was given together in the same group as class I saw logs (VL + SL_I) with the account of their relation by technical quality classes. The ascertained model for estimating the percentage share of veneer logs was of a very low explanation degree (only 12 %), and it is therefore not presented in this paper. The average percentages of veneer logs by diameter and quality classes, as well as the least significant difference intervals around average sizes, are given in the supplement to this paper.

The volumes of veneer and saw logs of class I - VL and SL_I (model 9) – *Zapremina furnirskih i pilanskih trupaca I klase VL and SL_I (model 9)*

Due to the regulations on minimal dimensions and quality of these logs, their share in tree volume is significantly lower than the saw logs of classes II and III, while this share increases with the increase in tree quality. For this reason, while creating the volume estimation model for these logs, only the trees over 30 cm DBH from first three diameter classes were taken into account. During the optimization of the model, the Box-Cox dependent variable transformation was applied with the exponent □ = -0.728027, as well as the linear increase in the dependent variable by 1 (m^3) for each piece of data. The equation for the chosen model and its statistical parameters is given in the supplement to this paper. The average volumes of these logs by technical quality classes and the least significant difference intervals around average sizes are presented in Figure 9.

The resulting model has an explanation degree of only 44.12% for the volume of these assortments. The main reason is their relatively small share (a lacking presence) i.e. high-volume variability by diameter classes. All the independent factors proved a significant impact on the volume of logs, but the factor of technical quality proved as most important. In other words, the volume (share) of these logs is significantly larger in better quality trees.

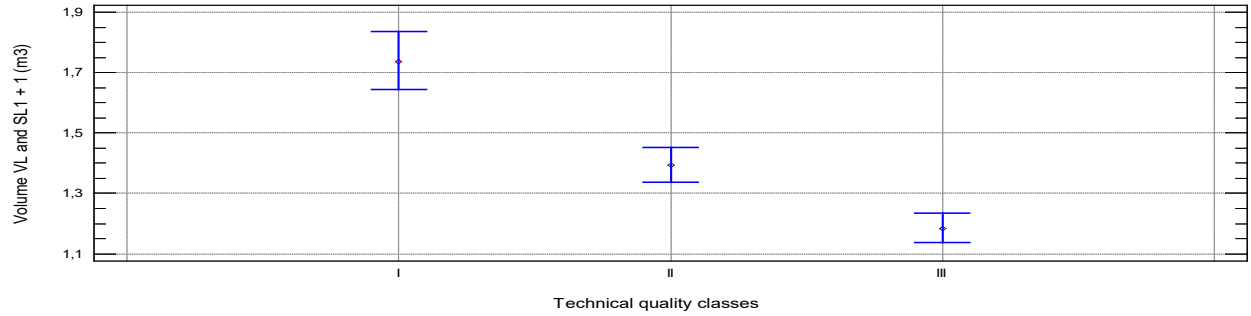

Figure 9. Average volume of veneer logs and class I saw logs per technical quality classes and least significant difference (LSD) intervals around average sizes

Grafikon 9. Prosječna zapremina furnirskih trupaca i pilanskih trupaca I klase po tehničkim klasama i interval najmanjih značajnih razlika (LSD) oko prosječne vrijednosti

Bark volume of spruce trees – *Zapremina kore stabala smrče*

Bark thickness and percentage share of bark in the volume of roundwood (section) in this area of research were already determined in the paper "Modelling bark thickness of Norway Spruce (*Picea abies* Karst)" (Musić et al. 2019). The results of this paper were used during the creation of wood assortment tables.

Percentage share of waste in spruce tree volume (W) – *Procentulani udio otpatka u zapremini stabala smrče (W)*

Waste usually consists of the following: different unproduced parts of merchantable wood and sawdust, and prescribed method of scaling round-wood, including deduction of the double bark thickness. Since the bark volume was determined in the paper, the waste share is calculated as the difference between the percentage share of merchantable wood volume (100%) and the percentage share of all assortments and bark.

Assortment tables – percentage share of assortments in the volume of spruce tree merchantable wood – *Sortimentne tablice – procentulani udio sortimenata u zapremini krupnog drveta stabala smrče*

The final data on determined percentage shares of certain forest wood assortments were obtained by correcting the data obtained using the presented regression models and the explained procedures. To clarify, it was necessary to correct the percentage shares of some assortments by diameter and technical classes in a manner that their sum matches the percentage share of all assortments combined i.e. the percentage share of merchantable wood (100%). The final results are presented in Tables 6-9.

Through the analysis of the obtained results on the percentage share of certain wood assortment and/or assortment groups, it can be stated that they are logical, and largely confirm the previously established relations (Rebula 1996, Rebula 1998a, Rebula 1998b, Plavšić and Golubović 1963, Pavlič 1973 etc.). Nonetheless, by comparing these tables with the current spruce assortment tables for spruce (Pavlič 1973), a significant increase in the most valuable assortments can be noticed (VL and SL_1), especially in the first technical and diameter class (20-30 cm). These differences are conditioned primarily by the changes in standards that have occurred in the meantime, regarding the lowering of quality criteria. Similar results can also be found in the research by Plavšić and Golubović (1963) of fir assortment share according to the regulations of two different standards. Comparisons with the results of authors from different countries, that also dealing with assortment structures, is not suitable, due to the differences in standards and classification systems of wood assortments, but it is confirmed that tree diameter and quality show a dominant impact on the percentage representation of wood assortments regardless of valid regulations and tree species.

CONCLUSIONS - *Zaključak*

Based on the acquired results from the conducted research and the discussion that followed, it is possible to select the following important conclusions:

- The influence of independent variables on all dependent variables was manifested and it is statistically significant.
- The width of the tree i.e. diameter at breast height is confirmed as a reliable indicator of tree quality i.e. its value. With the increase of the width, the share of the valuable assortments grows, and the share of less valuable assortments decreases in all technical classes, at the same time the level of wood volume usefulness increases.
- The increase in tree quality expressed through the qualification in certain technical quality classes (for the same diameters) results, principally, in a significantly larger share of the most valuable assortments.
- The influence of tree height on the volume of each assortment was, as expected, manifested through the increase in volume of trees and their belonging assortments, as well as through common influence with quality since better quality trees were of greater average height.
- The created assortment tables and their wood product assortment greatly correlate with the current state of wood industry, and they correspond to the valid standards in forestry and wood processing.

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Table 6. First technical class trees

Tabela 6. Stabla prve tehničke klase

DBH class	Veneer and saw logs I class VL + SL1	Saw logs II class SL2	Saw logs III class SL3	Saw logs II and III class SL2+SL3	All Logs	Pit timber PT	Pulp wood PW	PT+PW	All Assortments	Bark B	Waste W	Total merchantable wood
Debljinska klasa	*Furnirski i pilanski trupci prve kalse VL + SL1*	*Pilanski trupci II klase SL2*	*Pilanski trupci III klase SL3*	*Pilanski trupci II i III klase SL2+SL3*	*Svi trupci*	*Rudno drvo PT*	*Celulozno drvo PW*	*PT+PW*	*Svi sortimenti*	*Kora B*	*Otpadak W*	*Ukupno krupno drvo*
cm	%	%	%	%	%	%	%	%	%	%	%	%
10-14	0.00	0.00	0.00	0.00	0.00	25.13	50.50	75.63	75.63	11.00	13.37	100.00
15-19	0.00	0.00	0.00	0.00	0.00	37.21	43.00	80.21	80.21	11.49	8.30	100.00
20-29	34.30	10.80	9.60	20.40	54.70	19.10	7.40	26.50	81.20	10.70	8.10	100.00
30-39	34.30	24.20	9.80	34.00	68.30	3.85	10.60	14.45	82.75	10.00	7.25	100.00
40-49	31.10	26.00	14.50	40.50	71.60	0.84	10.20	11.04	82.64	9.20	8.16	100.00
50-69	28.80	26.00	17.20	43.20	72.00	0.06	11.90	11.96	83.96	8.80	7.24	100.00
70-90	30.70	25.90	22.60	48.50	79.20	0.24	6.30	6.54	85.74	8.40	5.86	100.00
	(3.0 : 97.0)											

Table 7. Second technical class trees

Tabela 7. Stabla druge tehničke klase

DBH class *Debljinska klasa*	Veneer and saw logs I class VL + SL I *Furnirski i pilanski trupci prve kalse VL + SL I*	Saw logs II class SL2 *Pilanski trupci II klase SL2*	Saw logs III class SL3 *Pilanski trupci III klase SL3*	Saw logs II and III class SL2+SL3 *Pilanski trupci II i III klase SL2+SL3*	All Logs *Svi trupci*	Pit timber PT *Rudno drvo PT*	Pulp wood PW *Celulozno drvo PW*	PT+PW *PT+PW*	All Assortments *Svi sortimenti*	Bark B *Kora B*	Waste W *Otpadak W*	Total merchantable wood *Ukupno krupno drvo*
cm	%	%	%	%	%	%	%	%	%	%	%	%
20-29	3.20	27.50	10.20	37.70	40.90	19.54	20.30	39.84	80.74	11.00	8.26	100.00
30-39	17.10	36.50	8.90	45.40	62.50	4.35	15.50	19.85	82.35	10.25	7.40	100.00
40-49	18.30	33.10	16.10	49.20	67.50	1.39	13.40	14.79	82.29	9.40	8.31	100.00
50-69	16.10	32.00	19.40	51.40	67.50	0.70	14.30	15.00	82.50	9.10	8.40	100.00
70-90	18.40	31.50	26.10	57.60	76.00	0.93	8.50	9.43	85.43	8.70	5.87	100.00
	(0.3 : 99.7)											

Table 8. Third technical class trees

Tabela 8. Stabla treće tehničke klase

BH class *Debljinska klasa*	Veneer and saw logs I class VL + SL I *Furnirski i pilanski trupci prve kalse VL + SL I*	Saw logs II class SL2 *Pilanski trupci II klase SL2*	Saw logs III class SL3 *Pilanski trupci III klase SL3*	Saw logs II and III class SL2+SL3 *Pilanski trupci II i III klase SL2+SL3*	All Logs *Svi trupci*	Pit timber PT *Rudno drvo PT*	Pulp wood PW *Celulozno drvo PW*	PT+PW *PT+PW*	All Assortments *Svi sortimenti*	Bark B *Kora B*	Waste W *Otpadak W*	Total merchantable wood *Ukupno krupno drvo*
cm	%	%	%	%	%	%	%	%	%	%	%	%
10-14	0.00	0.00	0.00	0.00	0.00	25.80	48.10	73.90	73.90	11.40	14.70	100.00
15-19	0.00	0.00	0.00	0.00	0.00	38.00	40.70	78.70	78.70	11.90	9.40	100.00
20-29	0.00	2.20	23.60	25.80	25.80	20.00	34.10	54.10	79.90	11.00	9.10	100.00
30-39	7.10	23.10	20.80	43.90	51.00	4.80	26.00	30.80	81.80	10.40	7.80	100.00
40-49	11.10	24.10	24.90	49.00	60.10	1.90	19.90	21.80	81.90	9.50	8.60	100.00
50-69	11.90	24.10	27.40	51.50	63.40	1.20	18.70	19.90	83.30	9.20	7.50	100.00
70-90	13.10	24.20	33.00	57.20	70.30	1.50	13.60	15.10	85.40	8.80	5.80	100.00
	(0.0 : 100.0)											

Table 9. Fourth technical class trees

Tabela 9. Stabla četvrte *tehničke klase*

BH class	Veneer and saw logs I class VL + SL1	Saw logs II class SL2	Saw logs III class SL3	Saw logs II and III class SL2+SL3	All Logs	Pit timber PT	Pulp wood PW	PT+PW	All Assortments	Bark B	Waste W	Total merchantable wood
Debljinska klasa	*Furnirski i pilanski trupci prve kalse VL + SL1*	*Pilanski trupci II klase SL2*	*Pilanski trupci III klase SL3*	*Pilanski trupci II i III klase SL2+SL3*	*Svi trupci*	*Rudno drvo PT*	*Celulozno drvo PW*	*PT+PW*	*Svi sortimenti*	*Kora B*	*Otpadak W*	*Ukupno krupno drvo*
cm	%	%	%	%	%	%	%	%	%	%	%	%
10-14	0.00	0.00	0.00	0.00	0.00	23.10	47.10	70.20	70.20	11.70	18.10	100.00
15-19	0.00	0.00	0.00	0.00	0.00	35.30	40.20	75.50	75.50	12.10	12.40	100.00
20-29	0.00	0.00	2.10	2.10	2.10	17.20	58.00	75.20	77.30	11.20	11.50	100.00
30-39	0.00	17.60	6.10	23.70	23.70	2.10	53.80	55.90	79.60	10.60	9.80	100.00
40-49	0.00	20.40	13.00	33.40	33.40	0.00	46.60	46.60	80.00	9.70	10.30	100.00
50-69	0.00	17.90	19.60	37.50	37.50	0.00	44.10	44.10	81.60	9.40	9.00	100.00
70-90	0.00	17.00	25.10	42.10	42.10	0.00	41.70	41.70	83.80	9.00	7.20	100.00
	(0.0 : 100.0)											

SAŽETAK

Postojeće tablice drvnih sortimenata za najvažnije vrste drveća u BiH napravljene su prije gotovo 50 godina. Postoje indikacije da se procentualno učešće šumskih drvnih sortimenata, prikazano u njima razlikuje od stvarnog, kako u pogledu kvaliteta tako i dimenzija. U međuvremenu, od stvaranja postojećih sortimentnih tablica do danas, promijenili su se standardi za proizvodnju šumskih drvnih sortimenata, tako da je neadekvatnost postojećih sortimentnih tablica neupitna.

Ta činjenica kontinuirano stvara razne probleme u operativnom poslovanju šumarskih preduzeća. Glavni cilj ovog rada je izrada sortimentnih tablica čiji će asortiman proizvoda od drveta biti u korelaciji sa trenutnim tržišnim uslovima. Istraživanje je provedeno na području Kantona 10 u FBiH. Uzorak od 393 stabala smrče korišten je kao baza podataka za izradu ovog rada. Sječa stabala izvedena je u skladu s važećim normama i zahtjevima kupaca s obzirom na dimenzije proizvoda od drveta. Obrada podataka izvršena je metodama jednostavne i višestruke regresije, analizom varijanse kao i njihovim kombinacijama metodom Generalizovanog linearnog modela. Nezavisni faktori bili su prsni prečnik stable (DBH), tehnička kvalitetna klasa i visina stabala. Udio drvnih sortimenata utvrđen je kroz 10 različitih matematičkih modela, u svakom od njih utvrđeno je da su sve nezavisne varijable imale statistički značajan uticaj na zavisne varijable - zapreminu pojedinih sortimenata ili grupe sortimenata. Udio trupaca značajno raste s povećanjem prečnika stabla, a smanjuje se smanjenjem njihovog tehničkog kvaliteta. Uticaj visine stabla na zapreminu sortimenata prvenstveno je povezan s većom zapreminom visočijih stabala istog prečnika, dok u procentualnom udjelu u zapremini stabala istog prečnika nema statistički značajan uticaj. Stabla iz uzorka, koja imaju veću zapreminu kvalitetnih sortimenata, u prosjeku imaju veću visinu stabala za istu klasu prečnika što je skriveni uticaj boniteta staništa na kvalitet stabala. Rezultati istraživanja predstavljeni su u obliku tabela za pojedine kvalitetne klase, kao procentualni udio drvnih sortimenata u pojedinim debljinskim klasama. Dobijeni rezultati mogu se koristiti kao sortimentne tablice u istraživanom području.

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Former and present habitats of Grey partridge (*Perdix perdix* L.) and Rock partridge (*Alectoris Graeca* Meisner) in Federation of Bosnia and Herzegovina

Nekadašnja i sadašnja staništa jarebice poljske (*Perdix perdix* L.) i jarebice kamenjarke-grivne (*Alectoris Graeca* Meisner) u Federaciji Bosne i Hercegovine

Saša Kunovac[1] *

[1] University of Sarajevo, Faculty of Forestry, Zagrebačka 20, 71000 Sarajevo

ABSTRACT

The main problem in small game management today is habitat loss. Agricultural development and modern techniques in crop farming have a high impact on small game populations. To present this impact in the Federation of Bosnia and Herzegovina, we analyzed and determined former and present habitats of two traditionally important gamebird species: Grey partridge (Perdix perdix L.), and Rock partridge (*Alectoris Graeca* Meisner)

Key words: *grey partridge, rock partridge, habitat*

INTRODUCTION – *Uvod*

The Grey partridge was once the main species of small feathered game in Bosnia and Herzegovina. With the development and intensification of agriculture, ie the creation of a modern agrobiotope instead of the former habitats, the number and range of this species has drastically decreased. According to statistical data (Statistical Yearbook of SRBiH 1946-1990), the harvesting of this species decreased from 15,000 birds during the 1950s, to about 5,000 during the 1960s, 4,000 and 3,000 birds during the 1970s and 1990s. According to the data of the Statistical Yearbook of the FBIH, in 2019, the harvesting of partridges amounted to only 700 birds, while the shooting of both grey partridges and rock partridges was shown together.

The Grey partridge is marked on the Red List of the Federation of BiH as NT (Low-Risk Species), ie a species that is not currently endangered and has a stable population, but for which there is a danger of population decline due to constant habitat endangerment. However, on the World Red List, this species is marked with EN, ie as an endangered species. The lack of real data and serious research in BiH has certainly affected the existing categorization of the partridge in the Federation of Bosnia and Herzegovina.

The rock partridge is also a very attractive and important autochthonous species. According to available data, it experienced the same fate as the partridge, with a similar reduction in the numbers and harvesting. On the Red List of the Federation of BiH is marked as DD (In-

* Corresponding author: Saša Kunovac, e-mail address: s.kunovac@sfsa.unsa.ba

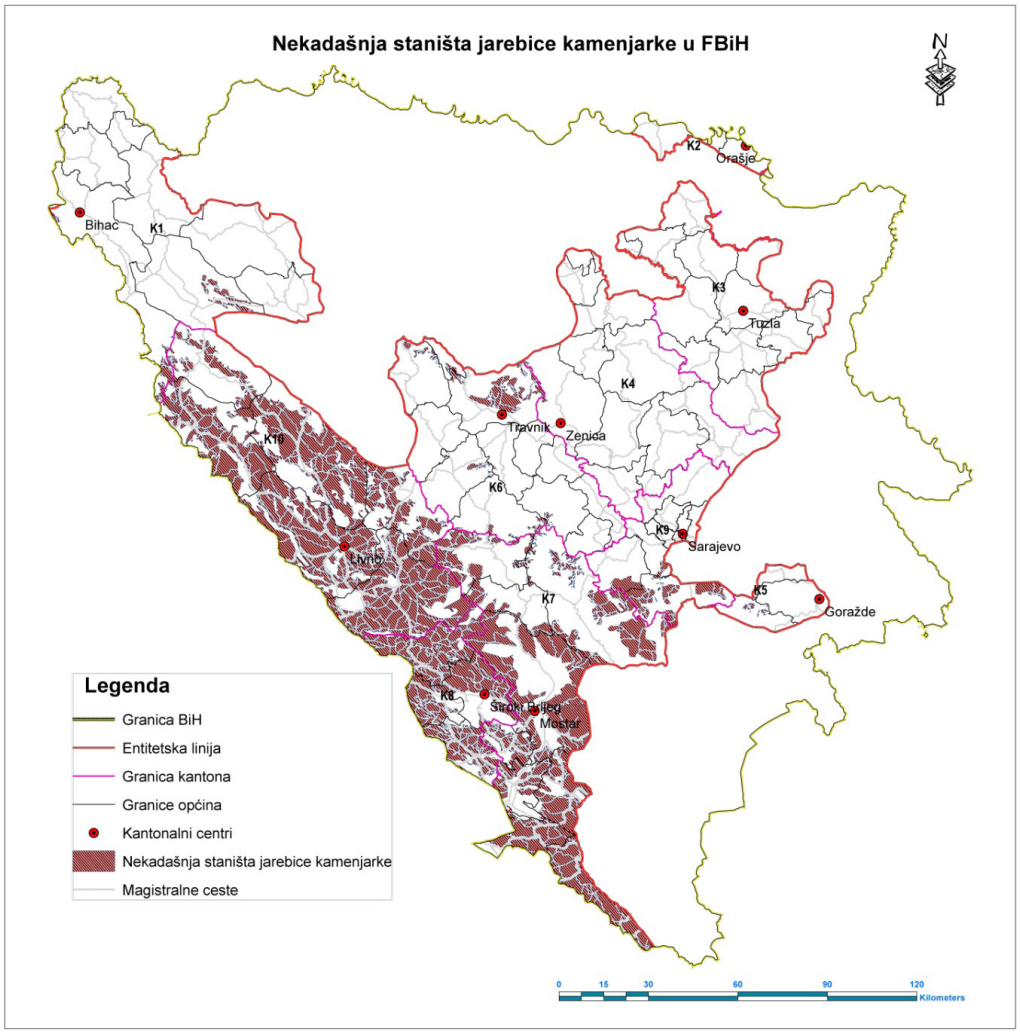


Figure 1: Former habitats of rock partridge in Federation of BiH

Karta 1: Nekadašnja staništa jarebice kamenjarke u Federaciji BiH

sufficiently known species, ie safe or probably endangered species whose categorization cannot be performed due to lack of data). Within this work, we try to provide realistic data on partridge habitats, so that, it will be possible to start developing long-term protection and management plans.

By collecting and obtaining new data on these species, a contribution will be made by EU nature protection directives, which will serve to establish the Natura 2000 network in BiH, especially when it comes to such important indigenous species.

MATERIAL AND METHODS – *Materijal i metode*

Based on available historical literary sources (Laska 1905, Dimitz 1905, Statistical Yearbook of SR BiH 1960-1992, Lovački list 6-10, 1953, 1954, 1958), we inspected the former representation of both species in Bosnia and Herzegovina and the Federation. BiH. After collecting these data, maps of former habitats of partridge and partridge in BiH, ie the Federation of Bosnia and Herzegovina, were made.

A network of 1x1 km = 100 ha (one hunting unit) was made on the identified former habitats of both species, and the structure of areas according to CORINE LAND COVER (CLC) was inspected. This network was selected following applicable legislation (Law on Hunting, Professional Basis for Rating and Determination of Hunting Productive Areas in FBiH Hunting Grounds), and because the Professional Basis for Determining Hunting Productive Areas (hereinafter LPP) and credit rating classes in FBiH hunting grounds represent the starting point for determining the framework for the

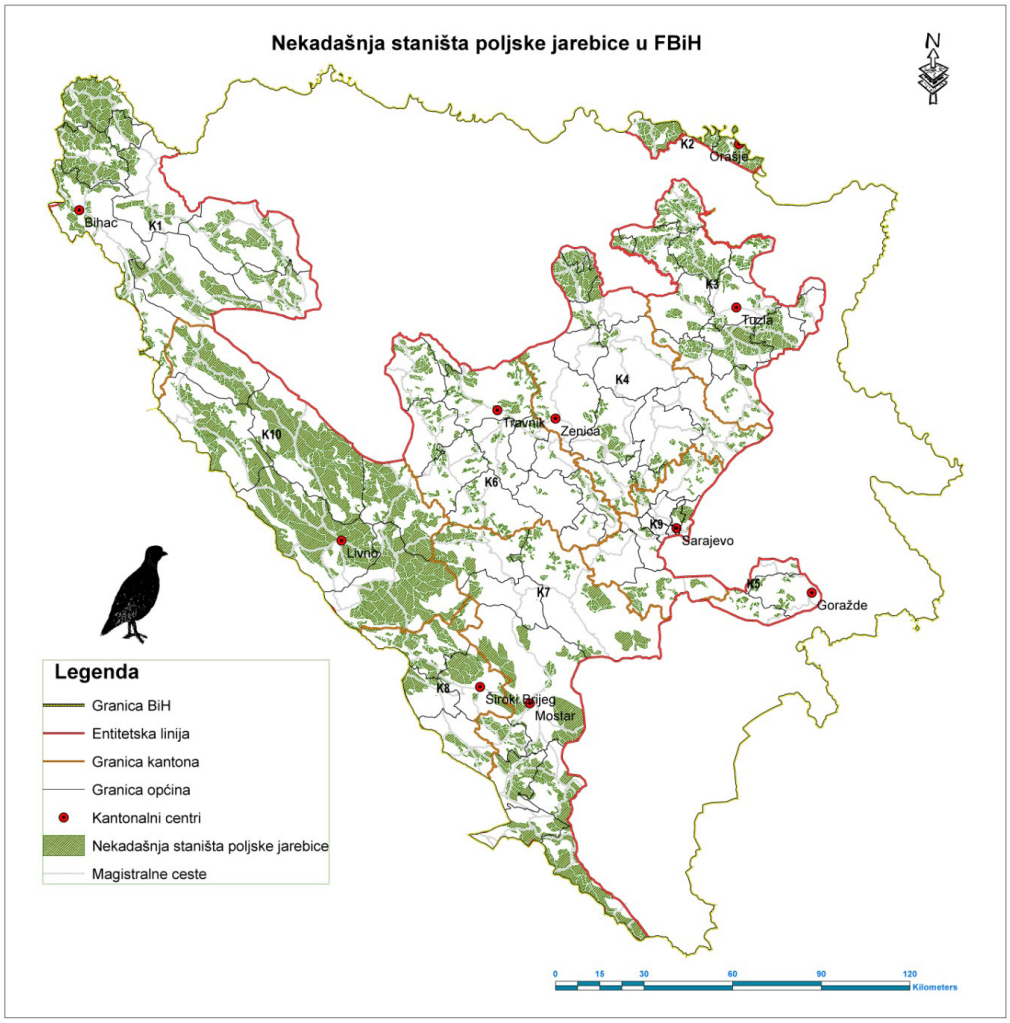


Figure 2: Former habitats of grey partridge in Federation of BiH

Karta 2: Nekadašnja staništa jarebice poljske u Federaciji BiH

management of economically important game species, which are expressed per hunting unit.

Within each canton and associated hunting grounds, the presence, counting and accurate recording of the presence of grey partridge and rock partridge were performed, according to the methodology (Kunovac 2009): Well-trained bird dogs were used, which are characterized by firm pointing. When the dogs discover the partridges and stop, the guide approaches and catch the dog so as not to further disturb or disperse the partridges. By counting the birds, the counter determines the number of individuals in the flock and enters the location on the appropriate maps. This was realized twice during the year: in the month of February-May when the partridges are in pairs and before the vegetation becomes too high and in the second half of the year, ie in the months of August-November..

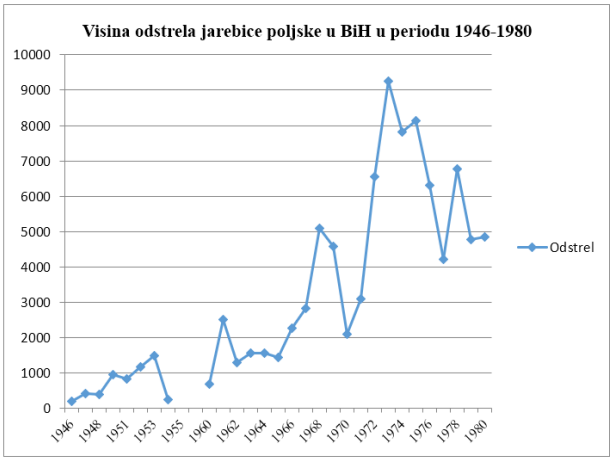
During each count, the appropriate map of the locality or area was used, and the location (coordinates) of each pair, the flock of partridges, or individual birds were entered on the appropriate map with the Mobile Mapper CE instrument. Based on the obtained data, the current habitats of partridge and rock partridge in the territory of FBiH were mapped.

RESULTS AND DISCUSSION – *Rezultati i diskusija*

After collecting historical data, maps of the former habitats of grey and rock partridge in BiH, ie the Federation of Bosnia and Herzegovina, were made, as shown on Figure 1 and Figure 2. The total area of former rock partridge habitats in the FBiH was 520,000 hectares. The total area of former grey partridge habitats in the FBiH was 729.244 hectares.

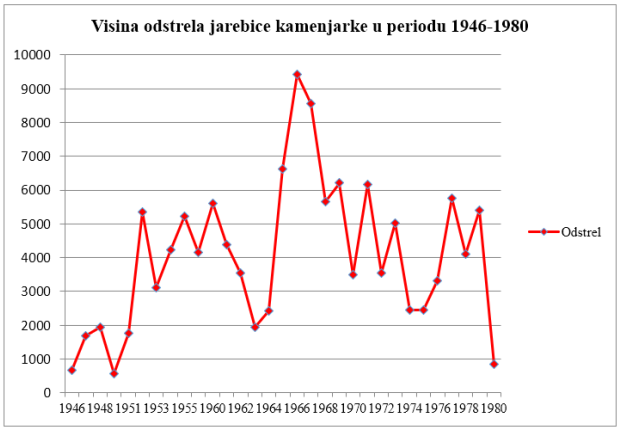
Numbers and harvesting - *Brojnost i odstrel*

Based on data presented in statistical yearbooks, made appropriate graphs for the number of grey and rock partridges, as well as graphs showing the harvesting of these two species. The data are presented in two types, considering the presentation of the same in the statistical yearbooks for SR BiH. Until 1980, shooting data were reported for both species separately, and in later periods for both species in total, which we have shown for each period separately in the following graphs:



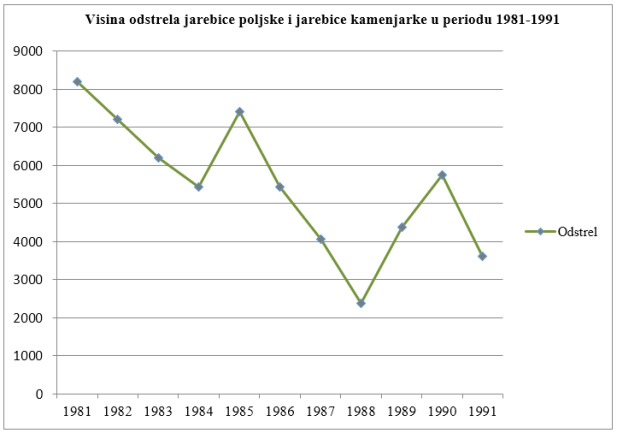
Graph1: Harvesting of grey partridge in Bosnia and Herzegovina in 1946-1980 period. (Note: data for 1955 and 1956 year are missing)

Grafikon 1:Visina odstrela jarebice poljske u Bosni i Hercegovini u periodu 1946-1980; (Napomena: nedostaju podaci za 1955 i 1956 godinu).



Graph 2: Harvesting of rock partrige in Bosnia and Herzegovina in 1946-1980 period.

Grafikon 2:Visina odstrela jarebice kamenjarke u Bosni i Hercegovini u periodu 1946-1980;



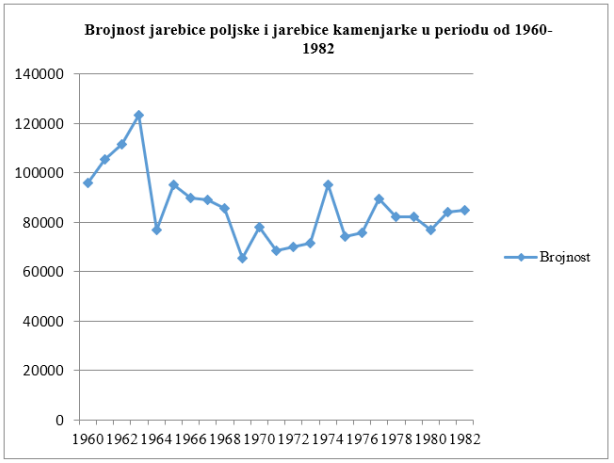
Graph 3: harvesting of both partridge species in Bosnia and Herzegovina in 1981-1991 period.

Grafikon 3:Visina odstrela obje vrste jarebica (poljska i kamenjarka) u Bosni i Hercegovini u periodu 1981-1991.

The number of these two species was also expressed together, except for the data from 1953 (Development Plan of the Association of Hunting Organizations of BiH 1953), when the following numbers were stated separately for these species:

Grey partridge – 68.000 birds

Rock partridge – 56.000 birds



Graph 4: Number of both partridge species (grey and rock) in Bosnia and Herzegovina in 1960-1982.

Grafikon 4: Brojnost obje vrste jarebica (poljska i kamenjarka) u Bosni i Hercegovini u periodu 1960-1982.

After 1982, the number of these species was not stated in the statistical yearbooks of SR BiH, but in the data of the then Hunting Association of Yugoslavia (General Guidelines for the Development of Hunting in SFRY 1990-1995), we found data for Bosnia and Herzegovina, which we compared with data for both species reported in 1953:

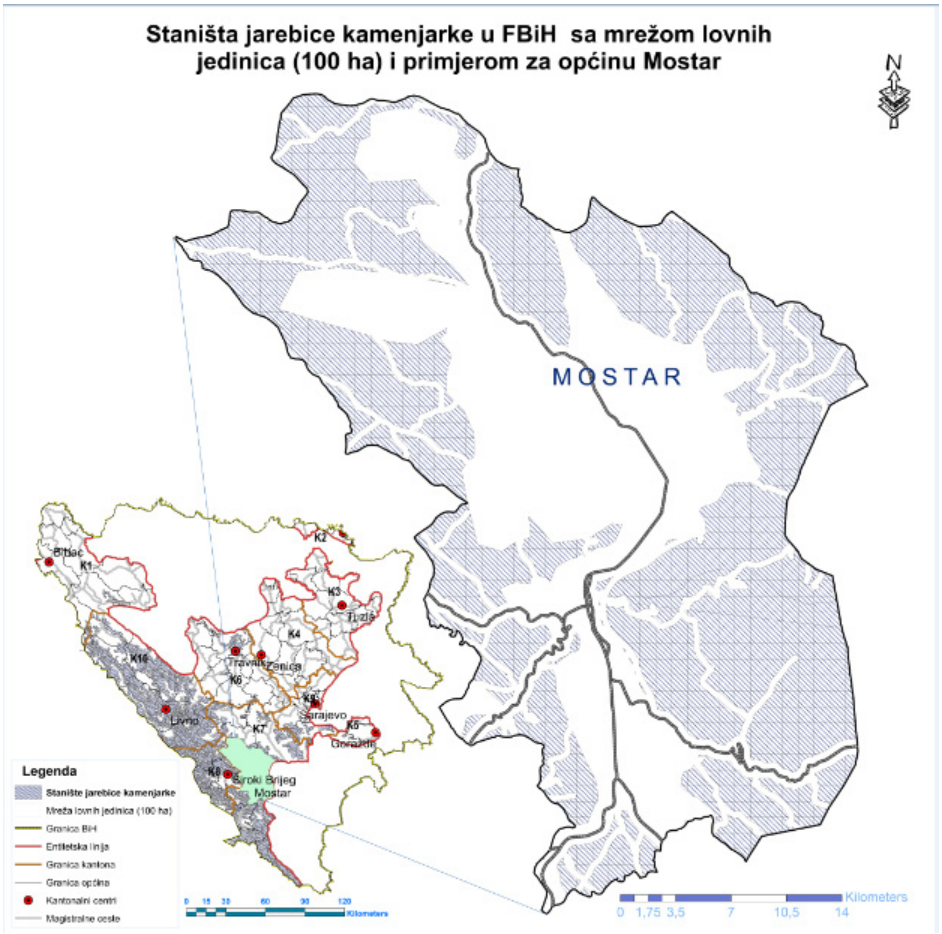


Figure 3. Rock partridge habitats in FBiH with a network of hunting units (100ha) and an example for the municipality of Mostar

Karta 3: Staništa jarebice kamenjarke u FBiH sa mrežom lovnih jedinica (100ha) i primjerom za općinu Mostar

Table 1: Comparing of numbers of grey and rock partridge in 1953 and 1990.

Tabela 1: Uporedba brojnosti jarebice poljske i jarebice kamenjarke u 1953 i 1990 godini;

Species/Vrsta	Numbers/ Brojnost 1953	Numbers/ Brojnost 1990	Differen-ce in %/ Razlika u %
Grey partridge/ Jarebica poljska	68.000	19.890	-70,75%
Rock partridge/ Jarebica kamenjarka	56.000	27.490	-50.91%

As we can see from the table, in 37 years, the number of both species in Bosnia and Herzegovina has significantly decreased, with the partridge by more than two thirds, and with the rock partridge by slightly more than half. This is in line with the data on reported culling (for both species and in total) on previous graphs, where a clear decline has been observed since the early 1980s.

Present habitats - *Sadašnja staništa*

The network of hunting units is shown is shown on Figure 3 and Figure 4 (with enlarged examples for clarity).

After a detailed search with dogs, and following the established methodology and collected data, we started making maps of the current habitats of partridges and partridges, which are shown on Figure 5 and Figure 6.

As can be seen, the current habitats of the rock partridge in the Federation of BiH have remained within the boundaries of the former ones. The reason for this is that the habitats of this species include areas mostly away from human settlements, barren and unproductive areas, and have accordingly suffered less negative anthropogenic impacts. The area of the current rock partridge habitats is 480,000 hectares (Picutre 1).

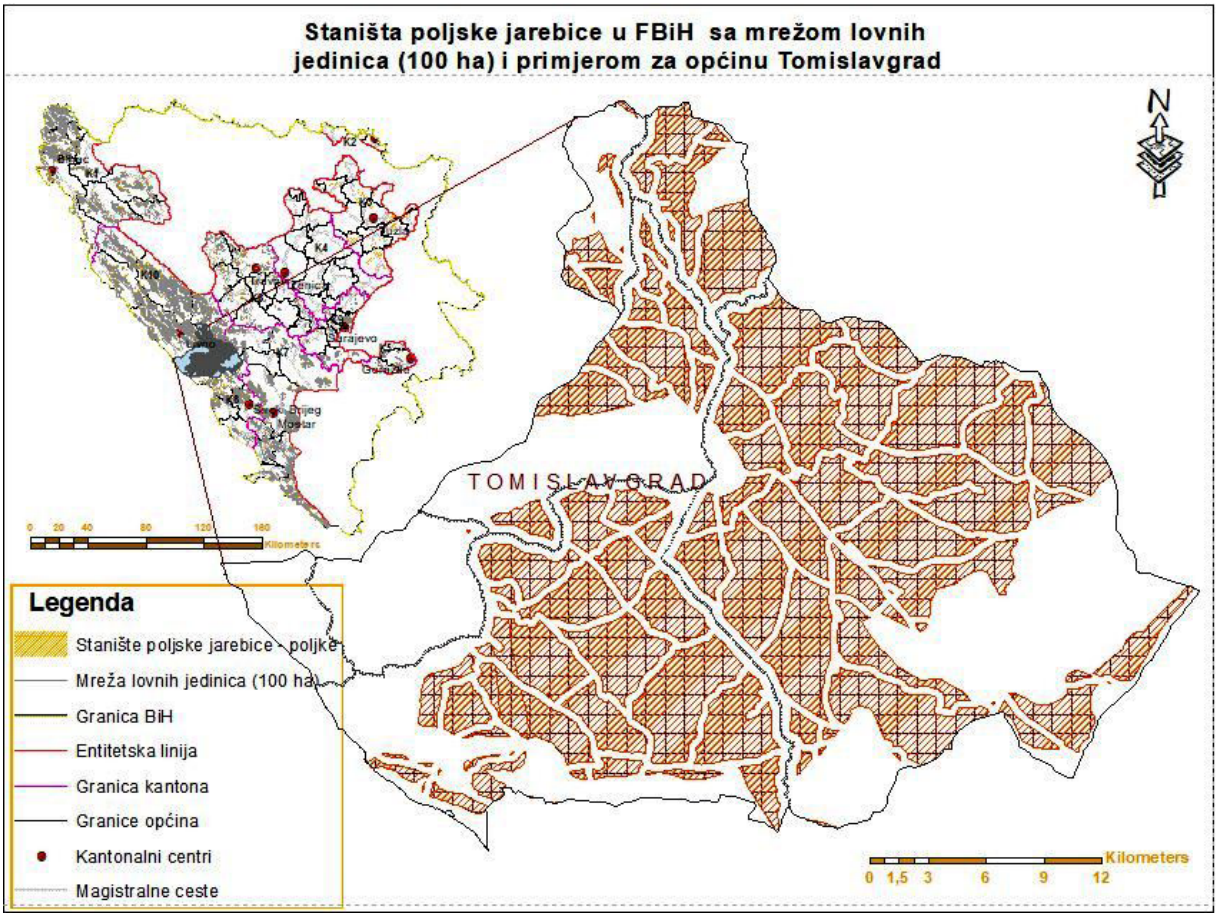


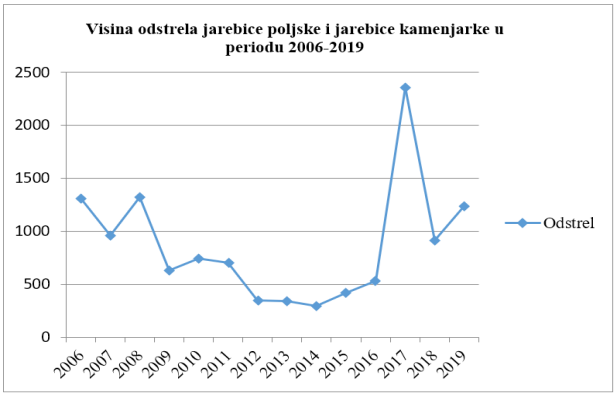
Figure 4: Grey partridge habitats in FBiH with a network of hunting units (100ha) and an example for the municipality of Tomislavgrad

Karta 4: Staništa poljske jarebice u FBiH sa mrežom lovnih jedinica (100ha) i primjerom za općinu Tomislavgrad

The current habitats of the grey partridge have been significantly reduced compared to the former. This species has also disappeared from its former best habitats, especially in the Tuzla and Posavina cantons. The reasons for this are primarily intensive agriculture with the mass use of pesticides, the lack of agricultural forest belts and hedges around arable land, as well as changes in the use of agricultural land (usually in construction). The area of current grey partridge habitats in the Federation is 467,000 hectares. The enumerated reasons have caused that today grey partridges can be found more often in the high mountains instead of in the former habitats in the lowlands, which is illustrated on Picture 2.

NUMBERS AND HARVESTING - *Brojnost i odstrel*

In the FBiH statistical yearbooks, hunting data have only been reported since 2006. Data on partridge and partridge are shown only in the amount of annual shooting, together for both species, as shown in the following graphic:



Graph 5: Harvesting of both species (grey and rock) in Federation of BiH for 2006-2019 period

Grafikon 5:Visina odstrela obje vrste jarebica (poljska i kamenjarka) u Federaciji Bosne i Hercegovine u periodu 2006-2019

Picture 1: Small parcels with different cultures (extensive agriculture) are very convenient for both species of partridges. Nowadays those parcels are predominantly represented in rock partridge habitats.

Slika 1: Male parcele sa različitim kulturama (ekstenzivna poljoprivreda) su jako pogodne za obje vrste jarebica. Danas, ovakve parcele su uglavnom zastupljene u staništima jarebice kamenjarke.

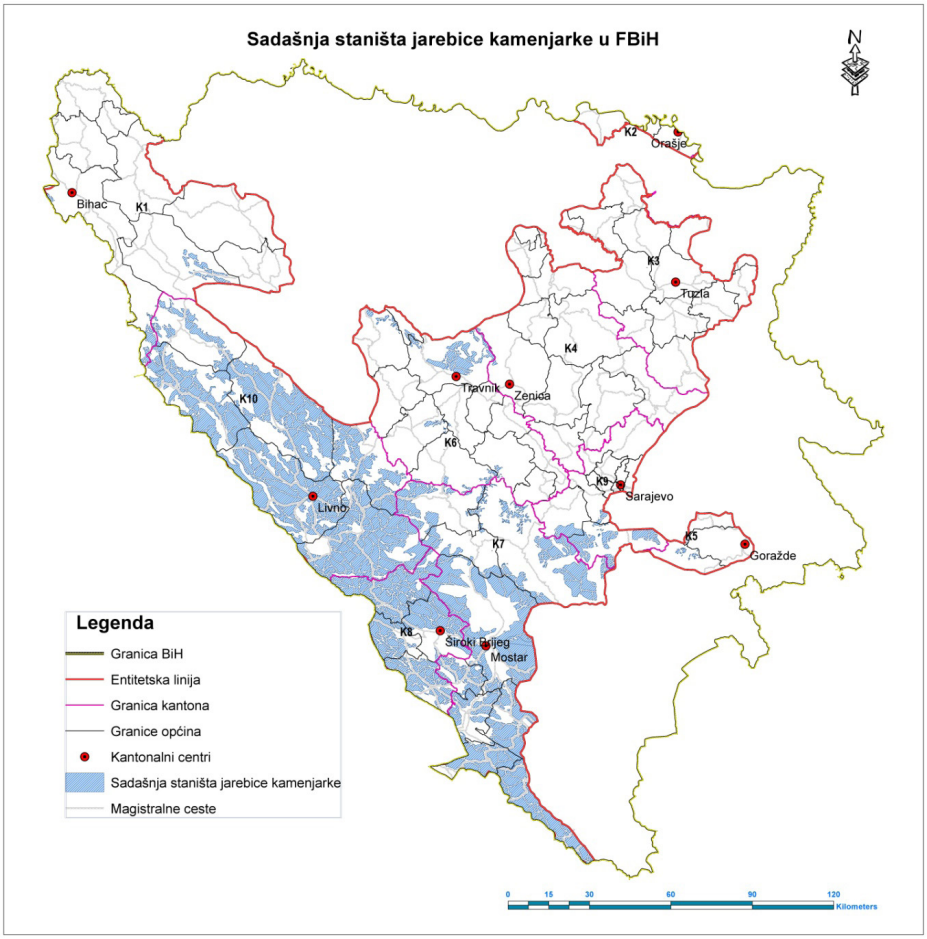


Figure 5: Present habitats of rock partridge in Federation of BiH

Karta 5: Sadašnja staništa jarebice kamenjarke u Federaciji BiH

CONCLUSIONS – *Zaključci*

In recent decades, the number of small game has been steadily declining. Hunting experts have long been looking for the causes of declining numbers in the wild itself, and not in the deterioration of living conditions, which are necessary for the survival of any species. What kind of environment does the small game need, which includes, among other species, the grey and rock partridge? Small game is by nature more of an inhabitant of open areas. The term "open" does not refer to today's open areas, primarily agricultural, where monocultures predominate.

Picture 2: The grey partridge flock at the Vlašić mountain (around 1500 m.a.s.l.)

Slika 2: Jato poljskih jarebica na planini Vlašić (oko 1500 m.n.v.)

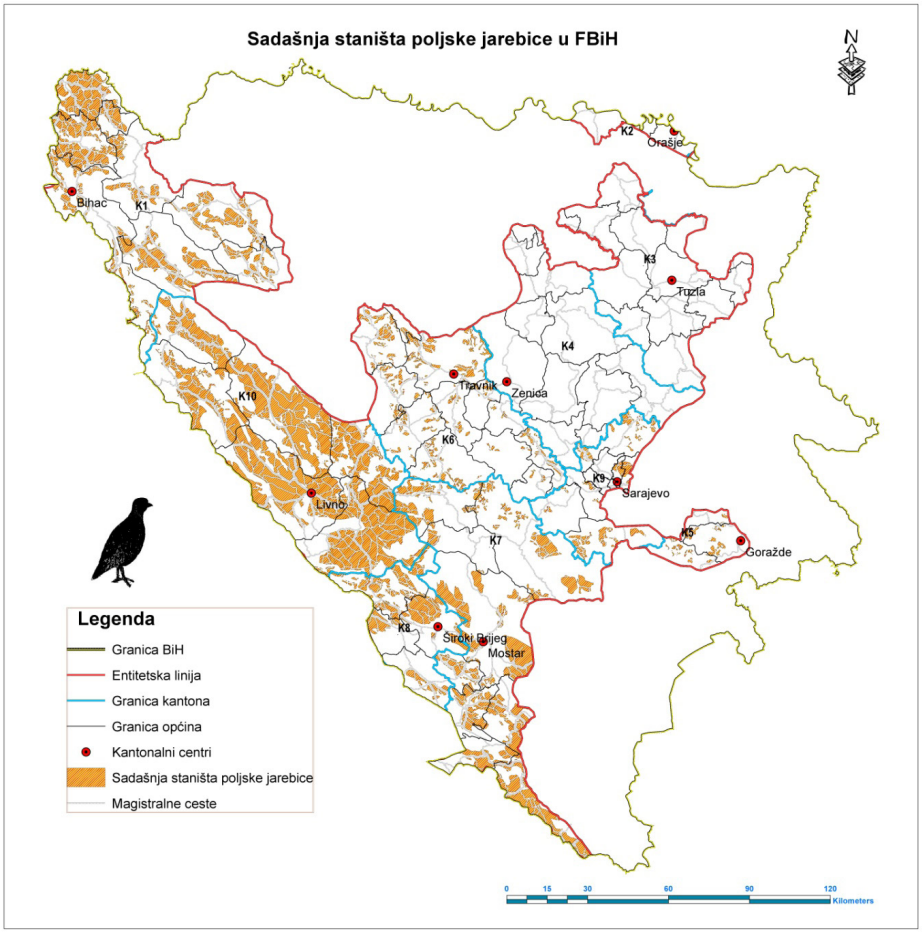


Figure 6: Present habitats of grey partridge in Federation of BiH

Karta 6: Sadašnja staništa jarebice poljske u Federaciji BiH

Living conditions for the small game began to deteriorate with the development of agriculture, the introduction of mechanization, and the use of chemicals. With the intensification of agriculture, natural shelters and suitable places for raising young people disappeared, and large areas with monocultures were created. All this does not correspond to the living conditions for small game, so in terms of preserving small game and increasing the number, of hunting grounds that cover a large number of agricultural areas, the following should be done:

- Strict compliance with the law on agricultural land and especially the provisions on the use of pesticides, maintenance of hedges, borders, and agricultural forest belts.

- in cooperation with the Federal Ministry of Agriculture, Water Management, and Forestry, start drafting a new Expert Basis for rating and capacity of hunting grounds, following the results of this work, because it is more than obvious that the existing Expert Basis does not meet the conditions in the Federation of BiH. from the Republic of Croatia.
- maintain the allowed number of predators per unit of a hunting area
- harmonize the use of the hunting-productive area with other target groups during breeding and care for raising young
- achieve a more even water supply during dry periods, ie. when achieving extreme climatic conditions by making watering places, ponds, as well as water collection points in cisterns or troughs
- building shelters for feeding in severe winter conditions with various combinations of grain foods
- enriching the food range in scarce habitats, planting fruit trees and shrubs, or supporting these species during forestry works.
- maintaining an appropriate degree of shrubby vegetation behind which it will find shade as well as shelter from predators while regulating excessive overgrowing of open areas.
- perform regular controls of hunting productive areas and continuously sanction the use of open flames on those areas by other target groups (farmers, nomads, mushroom and medicinal plant collectors, motorcyclists, mountaineers, etc.)
- conduct continuous and annual monitoring of both species with counting and control of growth
- do not hunt in areas where there is a small increase of 2 juveniles per pair of both species of partridges

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SAŽETAK

Jarebica poljska je nekada bila glavna vrsta sitne pernate divljači u Bosni i Hercegovini, Razvojem i intenziviranjem poljoprivrede, odnosno stvaranjem savremenog agrobiotopa umjesto nekadašnjih staništa, brojnost i areal ove vrste se drastično smanjio. Prema statističkim podacima (Statistički godišnjak SRBiH 1946-1990), odstrel ove vrste se smanjio od 15.000 kljunova tokom pedesetih godina prošlog vijeka, na oko 5000 tokom šezdesetih, 4000 i 3000 kljunova tokom sedamdesetih do devedesetih godina prošlog vijeka. Prema podacima Statističkog godišnjaka FBIH, u 2019 godini, odstrel jarebice iznosio je svega 700 kljunova, pri čemu je zajedno iskazan odstrel i jarebice poljske i jarebice kamenjarke.Jarebica poljska je na Crvenoj listi Federacije BiH označena kao NT (Niskorizične vrste), odnosno vrsta koja u ovom trenutku nije ugrožena i ima stabilnu populaciju, ali za koju postoji opasnost od smanjenja populacije usljed konstantnog ugrožavanja staništa. Međutim na svjetskoj Crvenoj listi, ova vrsta je označena sa EN, odnosno kao ugrožena vrsta. Nedostatak realnih podataka i ozbiljnih istraživanja u BiH, svakako je uticao na postojeću kategorizaciju jarebice poljske u Federaciji Bosne i Hercegovine.

Jarebica kamenjarka-grivna, takođe je vrlo atraktivna i značajna autohtona vrsta, a prema dostupnim podacima doživjela je istu sudbinu kao i jarebica poljska, uz slično smanjenje brojnosti i visine odstrela. Na Crvenoj listi Federacije BiH označena kao DD (Nedovoljno poznate vrste, odnosno sigurno ili vjerovatno ugrožene vrste čija se kategorizacija ne može izvršiti zbog nedostatka podataka). Realizacijom ovog rada dobiće se realni podaci o veličini staništa ove dvije vrste, pa će u skladu s tim biti moguće pristupiti izradi dugoročnih planova zaštite i gospodarenja.

Na osnovu dostupnih istorijskih literarnih izvora izrađene su karte nekadašnjih staništa ove dvije vrste, a potom je izrađena mreža 1x1 km=100 ha (jedna lovna jedinica), te izvršen uvid u strukturu površina prema CORINE LAND COVER (CLC. Potom je izvršen detaljan obilazak svih nekadašnjih staništa te utvrđivano prisustvo obje vrste u skladu sa odabranom metodologijom. Rezultati pokazuju da su se staništa obje vrste značajno smanjila, a posebno kod jarebice poljske, koja je skoro nestala sa svojih najznačajnijih nekadašnjih staništa. Takođe, analizirana brojnost i odstrel u periodima 1946-1990 i 2006-2019 godine pokazuju značajno smanjene, koje je kod jarebice poljske manje za dvije trećine u odnosu na prošli vijek. Na osnovu rezultata rada, može se zaključiti da je krajnje vrijeme da se preduzme odgovarajuća zaštita ovih vrsta, uz stalan monitoring te izradu odgovarajućih planova upravljanja.

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Interakcija između efekata genetske strukture i stanišnih uslova na rast zelene duglazije u testovima provenijencija u Bosni i Hercegovini

Interaction between the effects of genetic structure and habitat conditions on douglas fir growth in provenance tests in Bosnia and Herzegovina

Mirzeta Memišević Hodžić[1], Dalibor Ballian[1], Emina Šehović[2]

[1] University of Sarajevo, Faculty of Forestry, Zagrebačka 20, 71000 Sarajevo
[2] Šumarstvo "Ljuta" Osik 861, 71210 Ilidža

ABSTRACT

Douglas fir (*Pseudotsuga menziesii* (Mirbel) Franco) is the most important and most productive species in Europe, outside its natural range. This study aimed to examine the presence of interaction between the effects of the genetic structure of provenances from the United States and Canada and three localities of provenance tests in Bosnia and Herzegovina.

For this research, we measured diameters at breast height of all trees, and heights of 10 trees per provenance in three tests of Douglas fir at the age of plants 32 years. Four provenances are represented in all three tests and additional two provenances in two tests. We examined the variance between provenances and habitats using multivariate analysis, for four provenances in all three habitats, and six provenances in two habitats (Bosanska Gradiška and Zavidovići).

Multivariate analysis of variance for four provenances at all three localities showed that there were no statistically significant differences in diameters at breast height and heights caused by the interaction of provenances x localities. Multivariate analysis for six joint provenances at Bosanska Gradiška and Zavidovići tests showed that there were no statistically significant differences for diameter at breast height caused by interaction locality x provenance, and there were statistically significant differences caused by interactions of locality x provenances for height.

The obtained results can be used for the introduction of Douglas fir on predefined habitats that correspond to the conditions of the experimental plots, as well as for the selection of the best provenances for raising clone plantations or seed plantations.

Key words: *Douglas fir, provenances, interaction provenance x habitat*

INTRODUCTION - *Uvod*

Douglas fir is a species of rapid height and thickness growth and is very interesting for introduction to areas where the production potential of the habitat is not sufficiently used, and which are suitable for its growth. There are many such areas in Bosnia and Herzegovina, especially in the Bosna river basin, but also in the hilly part of Bosanska Posavina, and the area of Sprečko polje, and Majevica.

Douglas fir originated from the western United States and Canada and was introduced to Europe in the 19th century (Kleinshmit and Bastien 1992). It is currently one of the most important foreign tree species in Western and Central Europe, and it is the most represented in France and Germany (Bastien and Sanchez 2013; Krumm and Vitkova 2016; Konnert et al. 2018). In addition to good growth, Eilman and Rigling (2011) state that Douglas fir has a high level of resistance to long-term droughts, which was confirmed in a study conducted by Montwe et al. (2015).

As it is one of the most productive species of trees in Europe, works on its breeding have been done for a long time. The greatest attention was paid to the correct choice of provenances for raising forest plantations. These activities began at the beginning of the 20th century, and numerous provenance trials were raised in many European countries. In the territory of Bosnia and Herzegovina, the first experimental plots were raised in 1966, near Sarajevo (Batalovo Brdo and Rosulje near Rakovica) with five different provenances. In the early 1970s, a series of provenance tests were established throughout Bosnia and Herzegovina within the IUFRO program with Douglas fir. Thus, experiments were raised on the site of Crna Lokva (Bosanska Gradiška), Blinje (Kreševo), Gostović (Zavidovići), Dubrave (Visoko), which was destroyed very soon after the construction, and the largest of them on the site of Goleš (Travnik).

Previous results on experimental areas with Douglas fir in Bosnia and Herzegovina indicate very high productivity of this species (Pintarić 1973, 1979, 1989, 1991). In the experimental plot Batalovo Brdo, Ballian et al. (1999) determined the productivity of the best provenance in 37 years 235 m^3/ha. Ballian et al. (2002, 2003), Govedar et al. (2003) also defined the high productivity of provenances in experimental plots Bosanska Gradiška, Zavidovići, and Kreševo.

In this study, the interactions between the effects of the genetic structure of provenances from the United States and Canada and the locations of provenance tests in Bosnia and Herzegovina were analyzed. The results will be used in the selection of best provenances in terms of productivity for further use in wood production.

MATERIAL AND METHODS - *Materijal i metode*

For this study, the heights and diameters at breast height (DBH) of Douglas fir trees were measured in three provenance tests. Provenances are shown in Table 1, Figure 1.

Provenance tests were raised on areas based on climatic analogs of provenances, and are located in different ecological conditions, at the sites Zavidovići Gostović, Bosanska Gradiška Crna Lokva, and Kreševo Blinje (Table 2, Figure 2).

In all three provenance tests, DBH of all trees were measured, and the height of 10 trees by provenance in each block for all common provenances, at the age of plants 32 years. For the above traits, we examined the interaction between provenances and habitats using multivariate analysis, for four provenances for all three habitats and six provenances for two habitats.

RESULTS - *Rezultati*

The highest average value of DBH in all tests had the provenance of Alberni from Canada (1036), from an altitude of 150 m (Table 2). The lowest average value of DBH in Bosanska Gradiška and Kreševo had the provenance Grand Ronde from Oregon (1100) from an altitude of 170-230 m, while in Zavidovići this provenance was at the top in terms of average DBH, and the lowest value had provenance Cougar Washington (1090) from an altitude of 500-600 m.

Table 1. List of provenances with main information

Tabela 1: Lista provenijencija sa osnovnim podacima

Provenance label	Country	Locality	Latitude	Longitude	Altitude	Included in provenance tests
1029	British Columbia (Canada)	Thasis	49°47'	-126°38'	17	Bos. Gradiška, Kreševo, Zavidovići
1036	British Columbia (Canada)	Alberni	49°19'	-124°51'	150	Bos. Gradiška, Kreševo, Zavidovići
1099	Washington (USA)	Pine Grove	45°06'	-121°23'	800	Bos. Gradiška, Kreševo, Zavidovići
1100	Oregon (USA)	Grand Ronde	45°06'	-123°36'	170-230	Bos. Gradiška, Kreševo, Zavidovići
1060	Washington (USA)	Sequim	48°02'	-123°02'	33-100	Bos. Gradiška, Zavidovići
1090	Washington (USA)	Cougar	46°05'	-122°18'	500-600	Bos. Gradiška, Zavidovići

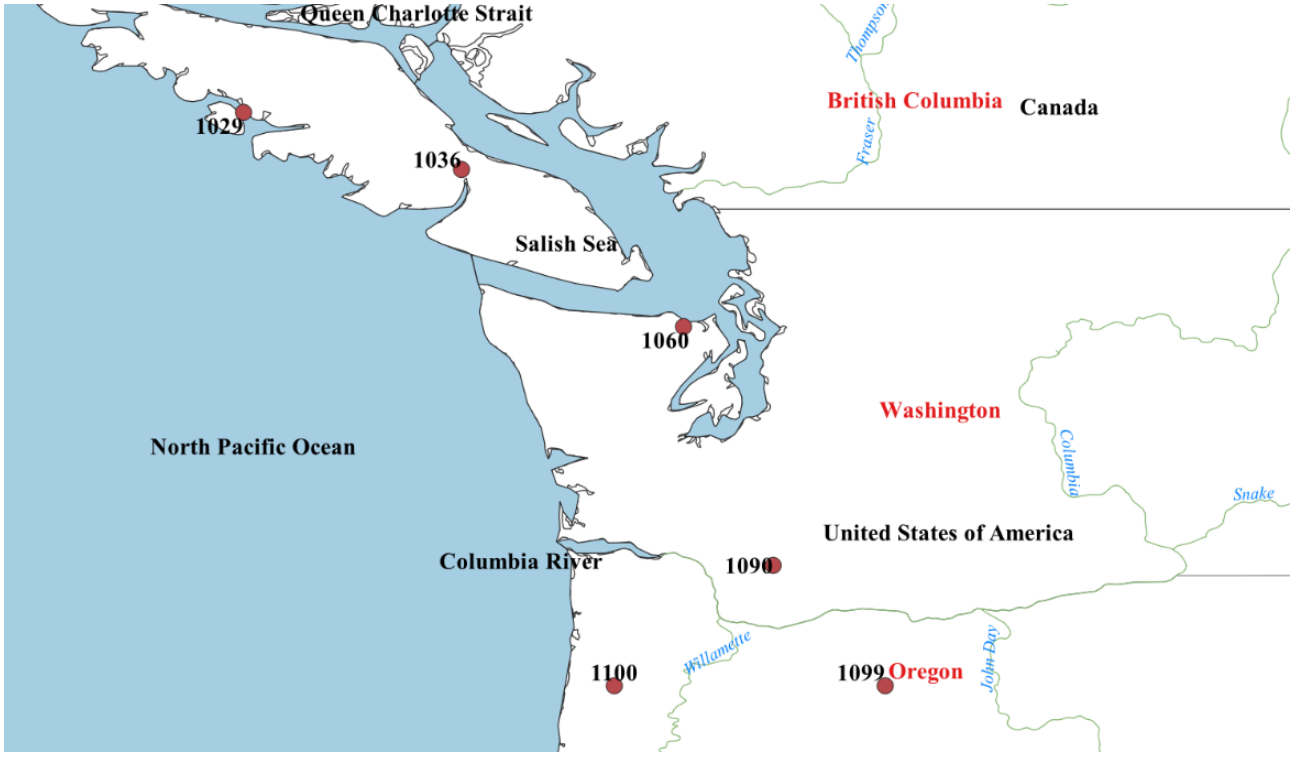

Figure 1. Distibution of researched provenances

Slika 1. Raspored istraživanih provenijencija

Table 2: Basic information on provenance test sites

Tabela 2: Osnovni podaci o lokalitetima testova provenijencija

Provenance test	Locality	Latitude	Longitude	Altitude
Bosanska Gradiška	Crna Lokva	44° 59'	16° 51'	665
Kreševo	Blinje	43° 50'	18° 03'	951
Zavidovići	Gostović	44° 23'	18° 08'	411

Figure 2: Distribution of provenance tests

Slika 2: Raspored testova provenijencija

Table 2: Average values of DBH and height by provenances and localities

Tabela 2: Prosječne vrijednosti prsnog prečnika i visine po provenijencijama i lokalitetima

Provenance	Average DBH (cm) in provenance tests			Average height (m) in provenance tests		
	B. Gradiška	Kreševo	Zavidovići	B. Gradiška	Kreševo	Zavidovići
1029	26.0	23.8	27.9	20.3	18.6	18.7
1036	27.9	25.9	29.7	22.2	20.4	19.1
1060	25.3	-	23.5	21.5	-	17.5
1090	25.7	-	23.0	21.2	-	17.6
1099	27.2	25.8	25.5	21.0	20.9	18.6
1100	25.3	23.1	27.8	21.5	19.8	20.4
Total	26.2	24.7	26.3	21.3	20.0	18.7

Table 3: Multivariate analysis for diameter at breast height (Test of Between-Subject Effects) for four provenances for three localities

Tabela 3: Multivarijantna analiza za prsni prečnik (Test of Between-Subject Effects) za četiri provenijencije za sva tri lokaliteta

Source of variability	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3798.774a	35	108.536	1.961	0.001
Intercept	421415.515	1	421415.515	7615.533	0.000
Locality	1109.427	2	554.714	10.024	0.000
Provenance	123.367	3	41.122	0.743	0.527
Locality * provenance	511.983	6	85.330	1.542	0.162

Table 4: Multivariate analysis for height (Test of Between-Subject Effects) for four provenances for three localities

Tabela 4: Multivarijantna analiza za visinu (Test of Between-Subject Effects) za četiri provenijencije za sva tri lokaliteta

Source of variability	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	928.839a	34	27.319	3.591	0.000
Intercept	134885.653	1	134885.653	17731.237	0.000
Locality	239.777	2	119.888	15.760	0.000
Provenance	65.274	3	21.758	2.860	0.037
Locality * provenance	77.082	6	12.847	1.689	0.123

The highest average value of height in Bosanska Gradiška provenance test had Alberni provenance from Canada (1036), from 150 m above sea level (Table 2). In Kreševo test, Pine Grove provenance (1099) from Washington from 800 m above sea level had the highest average height, while in Zavidovići test, Grand Ronde provenance (1100) had the highest average height. The lowest average value of height in Bosanska Gradiška and Kreševo had provenance Thasis from Canada (1029) from 17 meters above sea level). In Zavidovići, provenance Sequim Washington (1060) had the lowest average height. Multivariate analysis of variance for diameter at breast height for four provenances (1029, 1036, 1099, and 1100) and three localities (Table 3) showed that there were statistically significant differences caused by provenance test localities (Sig. = 0.000), but no significant differences caused by provenances (Sig. = 0.527), nor by interactions locality x provenance (Sig. = 0.162).

Multivariate analysis of variance for height for four provenances (1029, 1036, 1099, and 1100) and three localities (Table 4), showed that there were statistically significant differences caused by the localities of provenance tests (Sig. = 0.000), by provenances Sig. = 0.037), while there were no statistically significant differences caused by interactions locality x provenance (Sig. = 0.123).

The results of multivariate analysis for six common provenances at Bosanska Gradiška and Zavidovići (Table 5) for DBH showed that there were no statistically significant differences caused by localities (Sig. = 0.997), there were statistically significant differences caused by provenances (Sig. = 0.003), and there were no statistically significant differences caused by interactions locality x provenance (Sig. = 0.108).

The results of the multivariate analysis for height for six common provenances in Bosanska Gradiška and Zavidovići (Table 6) showed that there were statistically significant differences caused by localities (Sig. = 0.000), by provenances (Sig. = 0.005), and interactions locality x provenance (Sig. = 0.030).

The registered interaction between provenances and habitat for the trait of height is visible in the graph (Figure 3), where all provenances changed order depending on the locality where they were introduced. Thus, provenance 1036 (Alberni, British Columbia 150 m above sea level) showed better growth in height at the locality Bosanska Gradiška than provenance 1100 (Grand Ronde, Oregon 170-230 asl), while at the locality Zavidovići provenance 1100 showed better growth in height. Provenance 1060 (Sequim Washington 33-100 asl) grew better in the Bosanska Gradiška locality than

Table 5: Multivariate analysis for diameter at breast height (Test of Between-Subject Effects) for six provenances for two localities

Tabela 5: Multivarijantna analiza za prsni prečnik (Test of Between-Subject Effects) za šest provenijencija za dva lokaliteta

Source of variability	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1101.293a	11	100.118	2.362	0.008
Intercept	237179.830	1	237179.830	5595.727	0.000
Locality	0.001	1	0.001	0.000	0.997
Provenance	782.634	5	156.527	3.693	0.003
Locality * provenance	386.061	5	77.212	1.822	0.108

Table 6: Multivariate analysis for height (Test of Between-Subject Effects) for six provenances for two localities

Tabela 6: Multivarijantna analiza za svojstvo visine (Test of Between-Subject Effects) za šest provenijencija za dva lokaliteta

Source of variability	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	798.343b	11	72.577	9.443	0.000
Intercept	137404.951	1	137404.951	17878.226	0.000
Locality	589.672	1	589.672	76.724	0.000
Provenance	131.013	5	26.203	3.409	0.005
Locality * provenance	96.514	5	19.303	2.512	0.030

Provenance 1090 (Cougar Washington 500-600 m asl), 1099 (Pine Grove Washington, 800 m asl) and 1029 (Thasis British Columbia 17 m asl)), while at the Zavidovići site all these provenances preceded it in growth in height.

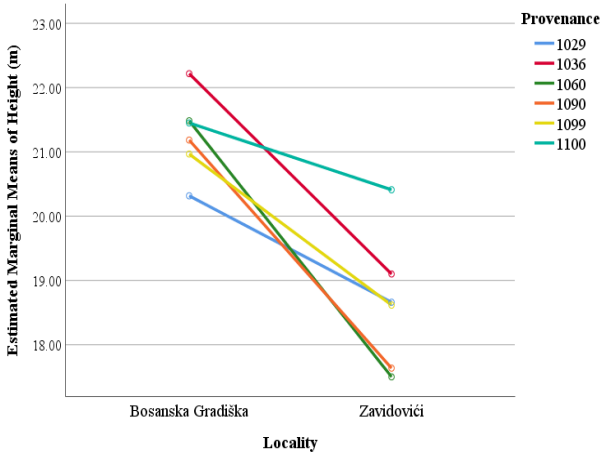

Figure 3: Estimated marginal means of height per provenances and localities

Slika 3: Procijenjene granične srednje visine po provenijencijama i lokalitetima

DISCUSSION AND CONCLUSIONS – *Diskusija i zaključci*

In this study, we did not obtain a statistically significant difference among provenances caused by the interaction of locality and provenances for the four provenances represented in all three provenance tests. This can be explained by large differences among the sites of provenance tests (Bosanska Gradiška test is located at an altitude of 665 m, Kreševo at 951 m, and Zavidovići at 411 m), and also differences arising from soil type, as well as climate. According to climatic indicators given in ecological vegetation zoning (Stefanović et al. 1983), all experimental areas are located in different areas and regions. Since the differences in heights by provenances are statistically significant, in all localities, in the future planning of raising Douglas fir plantations, provenances that grow better in these localities are recommended.

Statistically significant differences among provenances caused by the interaction provenance x locality were found for six provenances represented in the Bosanska Gradiška and Zavidovići provenance tests for the trait of height. Thus, provenance 1036 (Alberni, British Columbia 150 m asl) shows better growth in in Bosanska Gradiška than provenance 1100 (Grand Ronde, Oregon 170-230),

while in Zavidovići provenance 1100 showed better growth in height. Provenance 1060 (Sequim Washington 33-100) grew better in Bosanska Gradiška than provenance 1090 (Cougar Washington 500-600 m asl), 1099 (Pine Grove Washington, 800 m asl) and 1029 (Thasis British Columbia 17 m asl)), while in Zavidovići test all these provenances preceded it in growth in height.

The influence of interactions between the genetic structure of provenances and localities of provenance tests for Scots pine was investigated by Memišević Hodžić et al. (2020) and Memišević Hodžić and Ballian (2021). In both studies (interactions between the Kupres and Žepče provenance tests and between the Glasinac and Gostović provenance tests), statistically significant differences were found for the traits of diameter at breast height and height caused by interactions of locality x provenance.

In Bosnia and Herzegovine, the growth of different provenances of Douglas fir was investigated by Ballian et al. (1999, 2002, 2003), Govedar et al. (2003), and statistically significant differences among provenances for certain traits were found.

Research on the provenance of Douglas fir was also conducted in neighboring countries. Orlić and Ocvirek (1994), Perić et al. (2009, 2011), Orlić and Perić (2015) found statistically significant differences among provenances in provenance tests in Croatia.

Smolnikar et al. (2021), in research of fifteen Douglas fir provenances in the IUFRO provenance test established in 1966/67 in Slovenia, found significant differences among provenances in terms of survival rate, growth, and quality. They also found a positive and significant correlation between tree height in 1985 and average diameters measured in 2017. They determined that provenances from the west coast of Washington from low altitudes have the greatest potential for western Slovenia (Central Europe).

The lack of interaction between the provenances and the localities for the four common provenances for three localities is probably caused by the distance among the original populations that are larger than the differences among the localities where the provenance tests were set.

As six common provenances in the tests Bosanska Gradiška and Zavidovići showed statistically significant differences for height, it is recommended to choose provenances that grow better in height at given localities, ie localities with similar ecological conditions. Specifically, provenance 1036 should be favored at the Bosanska Gradiška locality, and 1100 at the Zavidovići locality.

The obtained results can be used for the introduction of Douglas fir on predefined habitats that correspond to the conditions of the experimental plots, as well as for the selection of best provenances for raising clone plantations or seed plantations.

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SAŽETAK

Duglazija (*Pseudotsuga menziesii (Mirbel) Franco)* je najvažnija i najproduktivnija vrsta u Evropi izvan svog prirodnog areala. Stoga je na području Bosne i Hercegovine od 1966. godine postavljeno nekoliko testova provenijencija, u cilju provjere njene proizvodnosti. Cilj ovog istraživanja je utvrditi da li postoji interakcija između efekata genetske strukture provenijencija iz Sjedinjenih Američkih Država i Kanade i lokaliteta na kojima su postavljeni testovi provenijencija. Rezultati će poslužiti prilikom selekcije najboljih provenijencija po proizvodnosti u svrhu daljeg korištenja u proizvodnji drvne mase.

Za potrebe ovog istraživanja mjerene su visine i prečnici stabala duglazije različitih provenijencija u tri provenijencijska testa, koji se nalaze u različitim ekološkim uslovima, i to na lokalitetima Zavidovići Gostović (411 m), Bosanska Gradiška Crna Lokva (665 m), Kreševo Blinje (951 m). Za procjenu interakcija za sva tri provenijencijska testa korištene su sljedeće provenijencije: 1029 (Thasis, Britanska Kolumbija, Kanada, NV 17m), 1036 (Alberni, Britanska Kolumbija Kanada, NV 150 m), 1099 (Pine Grove, Washington, USA, NV 800 m) i 1100 (Grand Ronde, Oregon, USA, NV 200 m), koje su zajedničke za sva tri testa. Za procjenu interakcija između testova Bosanska Gradiška i Zavidovići korištene su još dvije provenijencije (1060 Washington Sequim 33-100 m NV i 1090 Washington Cougar 500-600 m NV). Terenski testovi su postavljeni u proljeće 1972. godine sadnicama starosti 2 + 2 po blok sistemu sa tri ponavljanja, sa razmakom sadnje 2.5x2.5m. Na sve tri eksperimentalne površine izvršen je premjer prečnika svih stabala, te visine 10 stabala po provenijenciji u svakom bloku, za četiri zajedničke provenijencije u tri testa, te dodatno za dvije zajedničke provenijencije u dva testa. Mjerenje je vršeno pri starosti biljaka 32. godine. Za navedena svojstva pomoću multivarijantne analize ispitivane su interakcije između provenijencija i staništa, i to za četiri provenijencije na sva tri staništa, te za šest provenijencija na dva staništa.

Multivarijantna analiza varijanse za četiri provenijencije na sva tri lokaliteta pokazala je da ne postoje statistički značajne razlike u prečnicima i visinama uzrokovane interakcijom provenijencija x lokalitet.

Rezultati multivarijantne analize za šest zajedničkih provenijencija na lokalitetima Bosanska Gradiška i Zavidovići pokazali su da za svojstvo prečnika ne postoje statistički značajne razlike uzrokovane interakcijama lokalitet x provenijencija, dok za svojstvo visine postoje statistički značajne razlike.

Dobijeni rezultati mogu se koristiti pri introdukciji na unaprijed definiranim staništima koja odgovaraju uslovima koje imaju eksperimentalne plohe, kao i pri selekciji najboljih provenijencija za podizanje klonskih nasada ili sjemenskih plantaža.

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Manner and frequency of using the park heritage on the example of the Ilidža Spa Park

Način i učestalost korištenja parkovske baštine na primjeru banjskog parka Ilidža

Dino Hadžidervišagić[1,*], Jasna Avdić[2]

[1] Šumarski fakultet, Univerzitet u Sarajevu, Bosna i Hercegovina
[2] Poljoprivredno-prehrambeni fakultet, Univerzitet u Sarajevu, Bosna i Hercegovina

ABSTRACT

This paper presents manner and frequency of using park heritage on the example of Ilidža Spa Park. The aim of the research is to determine the attitudes of visitors to the Spa Park about the manner and frequency of using the park heritage, as well as the possibility of restoring some historical elements. The research was conducted through a questionnaire, quantitative type, in the period from August 23, 2017, to September 29, 2017. The total number of respondents is 246, of which 56.1% are female and 43.9% are male. As the best-rated contents (grade very good) the majority of respondents state the availability (37%) and quality of greenery (20.3%) while the worst-rated (grade very poor) cultural contents (6.5%). Most respondents have a positive attitude towards restoring the original appearance of some parts of the park (70.7%) as well as for restoring the historical elements - pavilions and old benches (72.8%). The park needs to be legally protected as a park heritage, ie a cultural and historical heritage with unchanged boundaries and a large part of the historical matrix. It needs to be renovated with the allocation of larger financial resources for maintenance and protection. The results of this research will expand the existing knowledge about the satisfaction of visitors to the Ilidža Spa Park, and contribute to experts to solve problems in finding the possibility of applying methods of restoration and restoring the original appearance of this historic park.

Key words: *manner, frequency, historical park, heritage, survey questionnaire, Ilidža*

INTRODUCTION – *Uvod*

Banjski park Ilidža kod Sarajeva je izgrađen između 1892. i 1895. godine tokom perioda austrougarske vladavine u Bosni i Hercegovini i imao je karakteristike historicističke vrtne umjetnosti kasnog XIX vijeka. U periodu od 1878. do 1918. godine izgrađeni su i uređeni termalno kupalište, kompleks hotela i niz privatnih vila, a Ilidža je postala značajna i kao kulturno-zabavno sastajalište, poznato po termalnim izvorištima. Prilikom izgradnje parka sve biljne vrste većinom su sađene u svom tipskom obliku, bez korištenja ukrasnih formi, a nakon Drugog svjetskog rata, pri obnovi banjskog parka, sađeni su i kultivari ali u malom broju primjeraka (Ljujić-Mijatović i Avdić, 2002). Inventarizacija dendroflore Banjskog parka Ilidža odnosno zastupljenost taksona,

* Corresponding author: Dino Hadžidervišagić; Faculty of Forestry, University of Sarajevo, Zagrebačka 20, 71000 Sarajevo, Bosnia and Herzegovina; e-mail address: d.hadzidervisagic@sfsa.unsa.ba

geografsko porijeklo i brojnost predstavljena je u radu Bašića i dr. (2019) dok Hadžidervišagić i Čabaravdić (2021) analiziraju važnost i strukturnu raznolikost stabala u historijskom parku. Kao i ostale zelene površine grada i Kantona Sarajevo, banjski park je djelomično izgubio svoju funkcionalnu i estetsku vrijednost, čemu je značajno doprinijelo uništavanje tokom ratnih dešavanja od 1992. do 1995. godine, zatim kasnije lošije održavanje, kao i neplanska sadnja biljnog materijala.

Sociološki aspekti parkova u Sarajevu prezentirani su u istraživanjima Hadžidervišagića (2011) dok su za "Vrelo Bosne" prikazani u istraživanjima Brajić (2011). Također, Hadžidervišagić (2018) analizira i koncept razvoja historijskog parka na Ilidži, pri čemu daje pejzažno-arhitektonsku i historijsku analizu uz inventarizaciju dendroflore. Analizu i obnovu vrtno-arhitektonskih elemenata historijskog parka su prezentovali Hadžidervišagić i Krstić (2019). Mešić i dr. (2017) istražuju zaštitu parkovske baštine na primjeru gradskog parka "Zrinjevac" u Mostaru.

Analizu estetske, rekreativne i socijalne uloge zelenih prostora grada Šibenika i Nacionalnog parka Krka koji percipira kao prirodna baština i turistička atrakcija su prikazali Stanić i Buzov (2014). Mišetić (1997) analizira socijalnu ulogu Rive u Splitu, pri čemu je posmatrana kao kompleksan urbani prostor koji određuje i definira niz komponenata. Analiza je temeljena na uvažavanju više aspekata tog prostora, kao što su arhitektonsko-urbanistička, kulturno-historijska, ekonomska, simbolička i socijalna dimenzija. Istraživanje sociooloških aspekata parka Maksimir prezentuju Vitasović Kosić i Aničić (2005), te navode da je Maksimir izgubio na kvaliteti svojih sadržaja, na estetskim aspektima i edukacionoj funkciji, kao i da li je trenutno stanje parka dovoljno za zadovoljavanje društvenih potreba. Brojni radovi vezani su uz značaj parkova na ljudsko zdravlje, sportsko–rekreativne aktivnosti na ambijentalnim prostorima i njihove dobrobiti na psihofizičko stanje čovjeka (Cooper i Barnes, 1999; Frumkin, 2001; Catlin, 2003; Davis, 2003; Godbey i Mowen, 2010; Anderson, 2011; Adevi i Lieberg, 2012; Berman i dr. 2012; Knez i dr. 2013). Gabrieli i Wilson (2010) u istraživanjima Royal parkova u Londonu prikazuju važnost privlačnih faktora kao što su: održavanje parkova, lakoća pristupa, kvalitet okoliša, mir i tišina za posjetioce, a koji su uslovljeni razlozima njihovog dolaska: šetnja, svježi zrak, boravak u miru i tišini, rekracija sa djecom, trčanje, vožnja biciklom i sl.

Cilj ovog istraživanja bio je utvrditi: (A) način i učestalost korištenja parkovske bašine na primjeru Banjskog parka Ilidža i (B) stav korisnika odnosno javnosti prema vraćanju nekih historijskih elemenata kao što su mali vrtno-arhitektonski elementi – paviljoni, stare klupe i sl.

Rezultati ovog istraživanja mogli bi pomoći u planiranju mjera zaštite i vraćanja izvornog izgleda historijskog parka u cilju unapređenja i održivosti parka, kao i boljeg ostvarenja socioloških funkcija parka, te proširenju postojećih spoznaja o načinu i učestalosti korištenja parkovske baštine u BiH.

MATHERIAL AND METHODS – *Materijal i metode*

Područje istraživanja u ovom radu je historijski Banjski park Ilidža, formiran za vrijeme austrougarske uprave u BiH. Park je smješten u blizini grada Sarajeva, na lijevoj obali rijeke Željeznice (slika 1), ima ukupnu površinu od 16,5 ha i nadmorsku visinu između 499 i 508 metara. Hrasničkom cestom je ograničen sa sjeverne i istočne strane, a tačnu granicu parka čine Banjska ulica i staza uz arheološke iskopine iz rimskog perioda koja se nastavlja do fijakerskog stajališta na zapadu. Na jugozapadnoj strani park je ograničen Ulicom VI viteške brigade. U parku počinje Velika aleja kojom je povezan sa Spomenikom prirode Vrelo Bosne, u podnožju planine Igman.

Prema podacima Federalnog hidrometeorološkog zavoda BiH prikupljenih na meteorološkoj stanici Butmir, za period 2001-2011. godine, prosječna godišnja temperatura iznosi 10,0 °C. Najtopliji je mjesec juli (20,2 °C) i august (19,9 °C), dok je najhladniji mjesec januar (-0,6 °C). Prosječna godišnja količina padavina iznosi 800 L/m^2, najviše u septembru i novembru, a najmanje u julu i februaru.

Slika 1. Orto-foto snimak istraživanog područja (izvor: Google Earth, 2017)

Figure 1. Orto-photo image of the study area (source: Google Earth, 2017)

Metodom ankete provedeno je istraživanje kvantitativnog tipa u periodu od 23.08.2017. do 29.09.2017. godine s ciljem utvrđivanja načina i učestalosti korištenja

Banjskog parka Ilidža koji su operacionalizovani kroz sociološko-demografsku strukturu ispitanika, stav ispitanika prema pojedinim sadržajima-aspektima, stav ispitanika prema vraćanju nekih historijskih elemenata i informacije o obrascu posjeta ispitanika.

U istraživanju je primijenjen kombinovani uzorak odnosno anketirane su osobe koje su zatečene u parku i koje tu obično dolaze, a potom su birane nasumično. Prilikom prikupljanja podataka metodom anketiranja poštovan je etički kodeks dobrovoljnosti i anonimnosti ispitanika, kao i nepristrasnost istraživača (De Vaus, 2002), a vođeno je računa i o ravnomjernom anketiranju radnim danima i vikendom, zatim u različito doba dana, kao i u različitim vremenskim uslovima (sunčano vrijeme, oblačno i sl.).

Dobiveni podaci su prikazani osnovnom statističkom metodom deskriptivne statistike u svrhu jasnijeg i boljeg razumijevanja, kao i donošenja odgovarajućih zaključaka.

RESULTS – *Rezultati*

U Banjskom parku Ilidža ukupno je anketirano 246 ispitanika što je prikazano kroz socološko-demografsku strukturu. Utvrđivanje sociološko-demografskih karakteristika ispitanika je jedna od osnovnih pretpostavki za razumijevanje zahtjeva posjetilaca i obrazaca ponašanja tokom njihove posjete.

Spolna struktura ispitanika iznosi 56,1% ženskih i 43,9% muških ispitanika (slika 2).

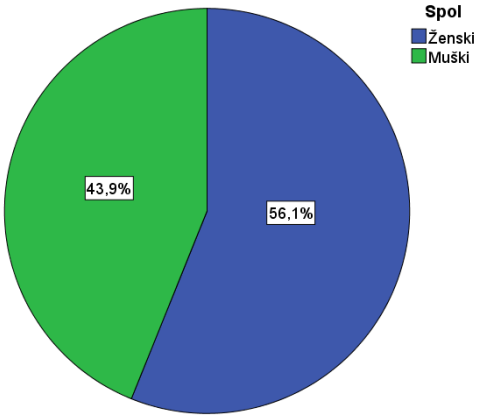
Iz obrazovne strukture anketiranih ispitanika je konstatovano da je najveći procent ispitanika sa srednjom stručnom spremom (48,4%), a najmanji procent sa osnovnom stručnom spremom (5,3%), dok 2,4% ispitanika nije htjelo odgovoriti na ovo pitanje (slika 3).

Istraživanjem starosne dobi ispitanika je konstatovano da najveći broj ispitanika pripada kategoriji posjetilaca 25-34 godine (26%), a najmanji kategoriji 75 i više godina života (1,6%), dok 0,4% ispitanika nije htjelo odgovoriti na ovo pitanje (slika 4).

U odnosu na zanimanje ispitanika konstatovano je da skoro polovina ispitanika banjskog parka pripada kategoriji uposlenika (48%), a najmanji broj pripada kategoriji turista (0,8%). Visok procent odgovora od 17,1% ispitanici su dali za kategoriju ostalo u anketnom upitniku (slika 5).

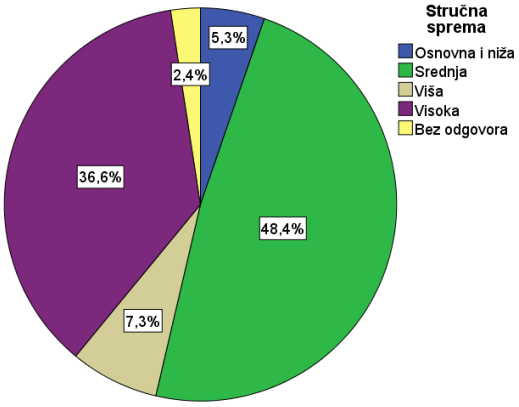
Iz podataka o mjestu prebivališta najveći broj ispitanika (62,6%) je sa područja općine Ilidža, dok je najmanji broj ispitanika sa područja Ilijaša (0,4%), Vogošće (0,8%) i Hadžića (2%; slika 6). Posjetilaca iz drugih gradova u BiH koji dolaze u banjski park je 5,3%.

Obzirom na **bračno stanje**, najveći broj ispitanika koji posjećuju banjski park nije u braku (45,9%). Međutim, ispitanici koji su u braku (41,1%) u park dolaze sa porodicom. Najmanji procent odgovora (2,8%) se odnosi na ispitanike koji nisu htjeli odgovoriti na ovo pitanje (slika 7).



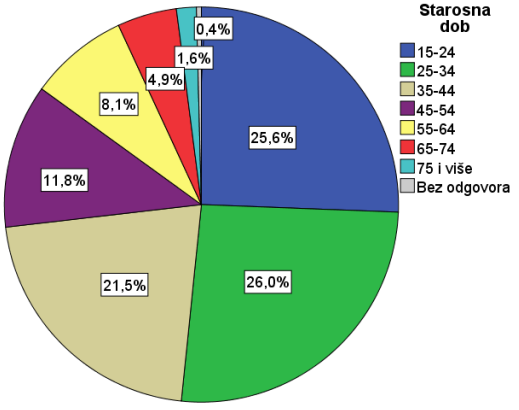
Slika 2. Spolna struktura ispitanika

Figure 2. Gender structure of respondents



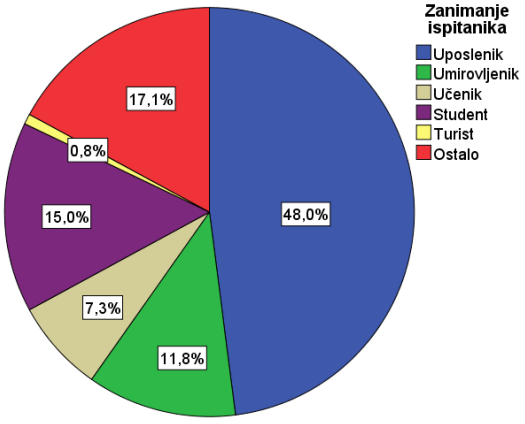
Slika 3. Obrazovna struktura ispitanika

Figure 3. Educational structure of respondents



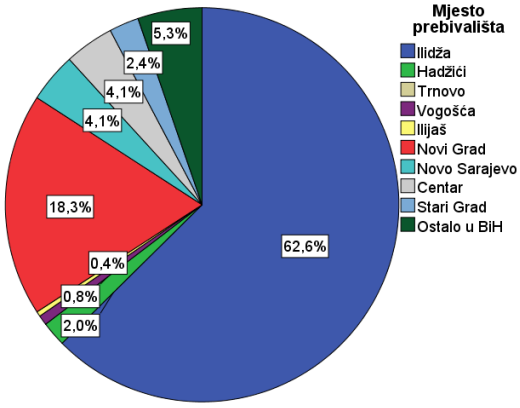
Slika 4. Starosna struktura ispitanika

Figure 4. Age structure of respondents



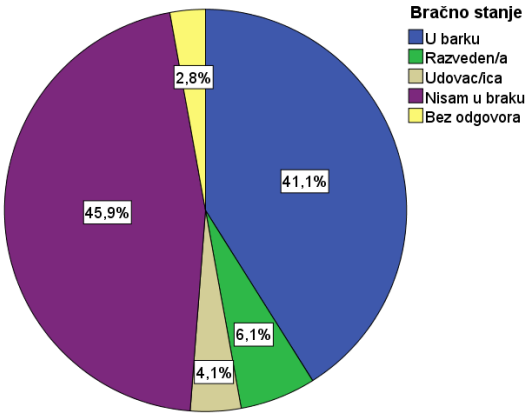
Slika 5. Zanimanje ispitanika

Figure 5. Occupation of respondents



Slika 6. Mjesto prebivališta ispitanika

Figure 6. Place of residence of the respondents



Slika 7. Bračno stanje ispitanika

Figure 7. Marital status of the respondents

Radi jednostavnijeg pregleda u tabeli 1 je prikazana raspodjela odgovora za sve istraživane sadržaje/aspekte Banjskog parka Ilidža.

Kao najbolje ocijenjeni aspekt banjskog parka (ocjena vrlo dobar) većina ispitanika je navela aspekt dostupnosti (37%) dok su kao najlošiji aspekt (ocjena vrlo loš) ispitanici naveli kulturne sadržaje (6,5%). Od ukupnog broja ispitanika, najveći procent odgovora ispitanici su naveli za aspekt kvaliteta zelenila (50%) dok su najmanji procent odgovora naveli za aspekt dostupnosti (0,4%).

Posebno važan set pitanja koji je proveden anketnim istraživanjem je vezan za stavove ispitanika prema vraćanju izvornog izgleda nekih dijelova parka, kao i na vraćanje pojedinih historijskih elemenata koji su postojali u parku (paviljoni, klupe i dr.).

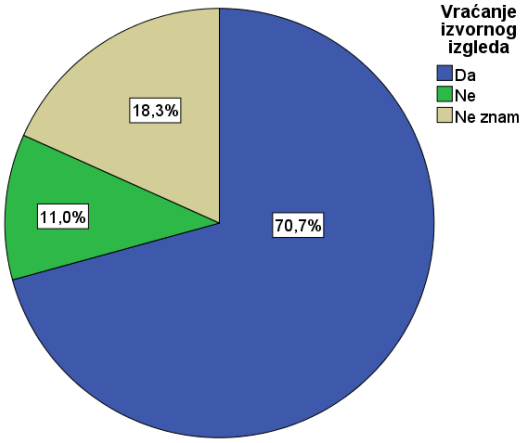
Tabela 1. Raspodjele odgovora za istraživane sadržaje/aspekte Banjskog parka Ilidža

Table 1. Distributions of answers for the researched contents/aspects of the Ilidža Spa park

Sadržaj/aspekt **Content/aspect**	**Procent raspodjele odgovora (%) Percentage of response distribution (%)**				
	Vrlo dobro **Very good**	**Dobro** **Good**	**Osrednje** **Moderately**	**Loše** **Bad**	**Vrlo loše** **Very bad**
Kulturni sadržaji *Cultural contents*	13,4	24	36,2	19,9	6,5
Čistoća *Cleanliness*	8,1	26,8	37,8	22	5,3
Infrastruktura *Infrastructure*	3,7	23,2	37,4	30,1	5,7
Parkovski mobilijar *Park furniture*	11	30,5	37	19,9	1,6
Dostupnost *Availability*	37	45,1	15	2,4	0,4
Kvalitet zelenila *Quality of greeenery*	20,3	50	22	6,5	1,2
Opći izgled parka *General appearance of park*	18,7	43,5	33,3	3,7	0,8

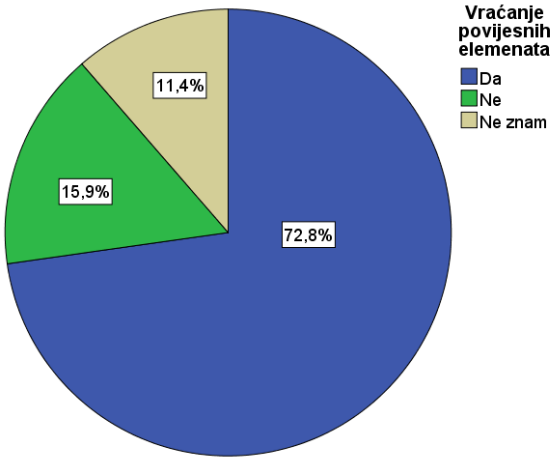
Većina ispitanika (70,7%) je stava da nekim dijelovima parka treba vratiti izvorni izgled. Negativan stav ima 11% ispitanika dok 18,3% ispitanika ne zna treba li nekim dijelovima parka vratiti izvorni izgled (slika 8).

Stav većine ispitanika (72,8%) je pozitivan u odnosu na vraćanje nekih historijskih elemenata – paviljona, starih klupa i dr. Od ukupnog broja ispitanika njih 15,9% smatra da ne treba vraćati historijske elemente, dok 11,4% ispitanika ne zna da li treba vratiti neke historijske elemente u banjski park (slika 9).



Slika 8. Stav ispitanika prema vraćanju

Figure 8.The attitude of the respondents

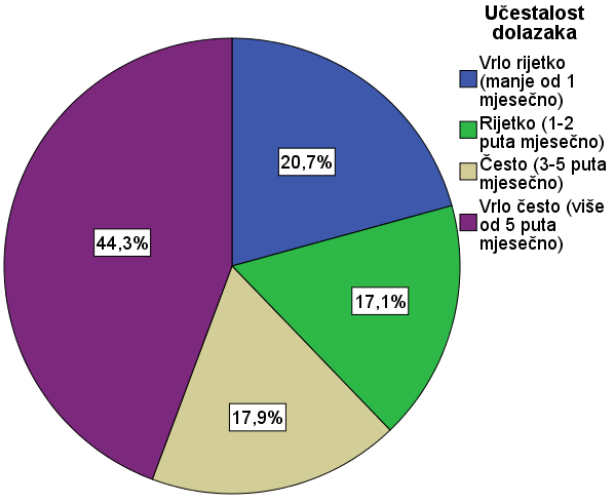


Slika 9. Stav ispitanika prema vraćanju nekih izvornog izgleda nekih dijelova parka historijskih elemenata banjskog parka

Figure 9.The attitude of the respondents towards the towards restoring the original appearance restoring of some historical elements of the Spa park of some parts of the park

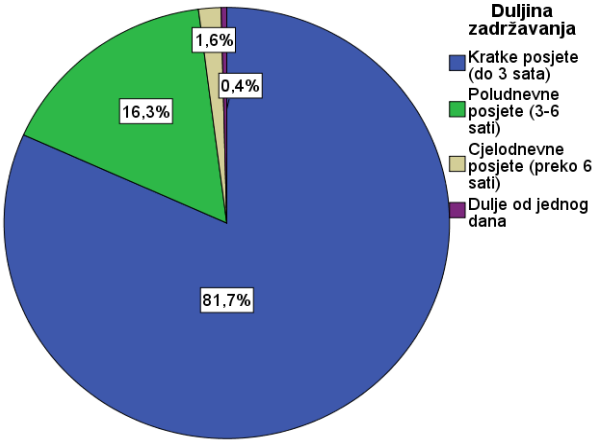
U odnosu na obrazac posjeta ispitanika učestalost dolazaka (frekvencija posjeta) izražena je kroz četiri kategorije: vrlo rijetko (manje od 1 mjesečno), rijetko (1-2 puta mjesečno), često (3-5 puta mjesečno) i vrlo često (više od 5 puta mjesečno). Najveći broj ispitanika (44,3%) u park dolazi vrlo često (više od 5 puta mjesečno), dok najmanji broj ispitanika (17,1%) u park dolazi rijetko (1-2 puta mjesečno; slika 10).

Prosječna dužina zadržavanja (boravka) u banjskom parku klasifikovana je u četiri kategorije: kratke posjete (do 3 sata), poludnevne posjete (3-6 sati), cjelodnevne posjete (preko 6 sati) i posjete duže od jednog dana. Kod ispitanika su najviše zastupljene kratke posjete do 3 sata (81,7%), a najmanji broj posjeta je za posjete duže od jednog dana (0,4%; slika 11).



Slika 10. Učestalost dolazaka ispitanika

Figure 10. Frequency of arrivals of respondents



Slika 11. Prosječna dužina zadržavanja ispitanika

Figure 11. Average lenght of detention of respondents

Stav ispitanika u odnosu na doba godine tokom kojeg dolaze u park je predstavljen u tabeli 2.

Tabela 2. Raspodjela odgovora posjeta Banjskog parka Ilidža za određeno doba godine

Table 2. Distributions of answers for visits to the Ilidža Spa Park for a certain time of the year

Doba godine *Time of year*	**Odgovori Answers**	
	Ukupno *Total*	**Procent** *Percent (%)*
Neodređeno doba godine *Indefinite time of year*	175	63,4
Proljeće *Spring*	20	7,2
Ljeto *Summer*	68	24,6
Jesen *Autumn*	11	4
Zima *Winter*	2	0,7
Ukupno *Total*	276	100

Od ukupnog broja ispitanika, svi su odabrali bar jednu kategoriju vezanu za dolazak u park tokom nekog doba godine. Najveći broj ispitanika (63,4%) je odgovorio da svoje posjete ne povezuje sa određenim godišnjim dobom.

Anketiranjem ispitanika su utvrđeni i razlozi njihovog dolaska u banjski park. Stav ispitanika u odnosu na razloge njihovog dolaska u park predstavljen je u tabeli 3.

Tabela 3. Raspodjela odgovora za razloge dolaska u banjski park

Table 3. Distributions of answers for the reasons for coming to the Spa park

Razlozi *Reasons*	**Odgovori** *Answers*	
	Ukupno *Total*	**Procent** *Percent (%)*
Rekreacija *Recreation*	57	18,6
Šetnja *Walk*	183	59,8
Zabava *Fun*	39	12,7
Liječenje *Healing*	5	1,6
Turizam *Tourism*	3	1
Ostalo *Other*	19	6,2
Ukupno Total	**306**	**100**

Svih 246 ispitanika je označilo 306 razloga što je više od jednog razloga dolaska po ispitaniku. Najčešći razlog dolaska u banjski park je šetnja (59,8%), a najrjeđi razlog dolaska ispitanici navode liječenje (1%).

DISCUSSION – *Diskusija*

Anketnim istraživanjem su utvrđeni načina i učestalosti korištenja parkovske bašine na primjeru Banjskog parka Ilidža, kao i mogućnosti vraćanja nekih historijskih elemenata (paviljoni, stare klupe i sl.). Posjetioci koji su u parku koristili neki vid aktivnosti (šetnja, trčanje, igranje sa djecom, itd.), u većoj mjeri su odbijali učestvovati u anketiranju u odnosu na korisnike čije su aktivnosti bile stacionarne (sjedenje na klupi ili stajanje u parku).

Zastupljenost posjetilaca različitog spola u parkovima prema Galečić (2016) je uslovljena intenzitetom korištenja prostora, lokalnim kontekstom, kulturom, tradicijom i mentalitetom podneblja. Prema istraživanjima Jim i Chen (2006) i Lee i Kim (2015) parkove većinom posjećuju korisnici ženskog spola u odnosu na korisnike muškog spola dok istraživanja Oguz (2000) i Derkzen (2012) navode da je u parkovima veća zastupljenost korisnika muškog spola koja je uslovljena drugačijim običajima i kulturom. Na nivou ukupnog uzorka, u Banjskom parku Ilidža je evidentiran veći broj ispitanika ženskog spola (56,1%) u odnosu na ispitanike muškog spola (43,9%; slika 2). Slične podatke o spolnoj strukturi korisnika navodi Galečić (2016) za beogradske parkove (Tašmajdan, Bele vode i Čuburski park) u kojima je evidentiran veći broj korisnika ženskog spola u odnosu na korisnike muškog spola. Dalje navodi da procentualna razlika između korisnika ženskog i muškog spola u parku Tašmajdan iznosi 5,44%, u parku Bele vode 5,21% i u Čuburskom parku 1,39% ide u korist ispitanika ženskog spola. Međutim, sa ovim podacima se ne slažu istraživanja Brajić (2011) vezana za spolnu strukturu ispitanika Spomenika prirode "Vrelo Bosne" na Ilidži koja je evidentirala neznatno veći broj ispitanika muškog spola (51%) u odnosu na ispitanike ženskog spola (49%). Prema obrazovnoj strukturi, istraživanjem je utvrđeno da najveći procent ispitanika ima srednju stručnu spremu (48,4%; slika 3). S ovim podacima se slažu istraživanja Brajić (2011) o stručnoj spremi ispitanika koja navodi da većina ispitanika Spomenika prirode "Vrelo Bosne" ima srednju stručnu spremu, kao i da je nivo stručne spreme posjetilaca Vrela Bosne znatno iznad prosjeka Federacije BiH. U odnosu na starosnu strukturu ispitanika u banjskom parku je evidentirano približno ravnomjerno učešće posjetilaca starosne kategorije od 25-34 godine (26%), kategorije od 15-24 godine (25,6%) i kategorije od 35-44 godine (21,5%) dok je starija populacija zastupljena u manjem procentu (slika 4). Na osnovu ovih podataka se može konstatovati da banjski park uglavnom posjećuje mlađa populacija. Slične podatke o starosnoj strukturi ispitanika Spomenika prirode "Vrelo Bosne" je dobila Brajić (2011), te navodi da u starosnoj strukturi ispitanika preovladava kategorija od 15-24 godine (31,3%) i kategorija od 25-34 godine starosti (21,3%). Od ukupnog broja ispitanika u

banjskom parku, u odnosu na zanimanje, gotovo polovina ispitanika (48%) pripada populaciji uposlenika (slika 5), zatim slijede ispitanici koji su kod opcije zanimanje naveli ostalo (17,1%). Relativno visok procent (15%) predstavlja i studentska populacija što se može povezati sa činjenicom da su u neposrednoj blizini banjskog parka smještena tri privatna univerziteta. Prema mjestu prebivališta, većina ispitanika (62,6%) dolazi sa područja općine Ilidža (slika 6). Iz navedenog podatka se zaključuje da blizina mjesta prebivališta ispitanika značajno utječe na obrazac posjeta banjskog parka. Slične podatke je dobila Brajić (2011) provedenim istraživanjem na Vrelu Bosne, koje je smješteno u neposrednoj blizini banjskog parka, i navodi da većina evidentiranih posjetilaca (47%) Vrela Bosne ima mjesto prebivališta na području općine Ilidža. U odnosu na bračno stanje ispitanika, većina evidentiranih ispitanika banjskog parka nije u braku (45,9%) što se povezuje sa činjenicom da park uglavnom posjećuje mlađa studentska populacija (slika 7).

U odnosu na sve istraživane sadržaje/aspekte banjskog parka (tabela 1) rezultati su pokazali da je većina ispitanika osrednje zadovoljna sa aspektima čistoće (37,8%), infrastrukture (37,4%), parkovskim mobilijarom (37%) i kulturnim sadržajima (36,2%). Na osnovu ovih rezultata se može zaključiti da značajan broj ispitanika nema jasno definisan stav po pitanju navedenih aspekata. Vezano za aspekt infrastrukture, neki od komentara ispitanika za poboljšanjem postojećeg stanja je i izgradnja javnog toaleta, čemu treba posvetiti veću pažnju i značaj. Inače, prema Schipperijn (2010) idealna parkovska površina uz dobro njegovano zelenilo, dovoljan broj udobnih klupa, fontanu i česmu treba sadržavati i javni toalet. U odnosu na aspekt dostupnosti većina ispitanika (45,1%) je stava da je ovaj aspekt dobar dok 37% ispitanika smatra da je aspekt dostupnosti vrlo dobar. Ove rezultate možemo povezati i sa činjenicom da većina ispitanika (62,6%) ima mjesto prebivališta na području općine Ilidža što značajno doprinosi visokom procentu zadovoljstva aspektom dostupnosti. Percepcija ispitanika o kvaliteti zelenila pokazuje da ukupno 50% ispitanika smatra da je kvalitet postojećeg zelenila u banjskom parku dobar. Ako se ovom rezultatu doda podatak ispitanika od 20,3% koji smatraju da je aspekt kvalitete zelenila vrlo dobar, može se konstatovati da preko 70% ispitanika izražava zadovoljstvo ovim aspektom. Visok procent zadovoljstva ispitanika kvalitetom zelenila treba uzeti sa rezervom jer su ispitanici vjerovatno poistovjetili pojam kvaliteta i kvantiteta zelenila odnosno da su odgovarali na količinsku zastupljenost jer nemaju dovoljno znanja o ovome. Ovu konstataciju u određenoj mjeri potvrđuju podaci o stručnoj spremi jer je 50,3% od ukupnog broja ispitanika sa srednjom stručnom spremom izrazilo zadovoljstvo kvalitetom zelenila. Provedenim istraživanjem je utvrđeno da većina ispitanika (43,5%) ima stav da je opći izgled banjskog parka dobar dok 18,7% smatra da je opći izgled parka vrlo dobar. Visok procent zadovoljstva općim izgledom parka se povezuje sa činjenicom da je većina ispitanika sa područja Ilidže, na kojoj je smješten banjski park, te su subjektivniji po pitanju ovog aspekta u odnosu na ispitanike iz drugih općina. Od ukupnog broja ispitanika koji su stava da je opći izgled banjskog parka vrlo dobar 65,2% ispitanika je sa područja Ilidže, 19,6% sa područja Novog Grada dok su procenti ispitanika iz drugih općina neznatni.

U odgovoru na pitanje treba li nekim dijelovima parka vratiti izvorni izgled konstatovan je pozitivan stav većine ispitanika (70,7%; slika 8). Vraćanjem izvornog izgleda dijela banjskog parka obogatila bi se turistička ponuda Ilidže, a time i povećao broj turista i posjetilaca. Od ukupnog broja ispitanika, većina je pozitivnog stava (72,8%) i u odnosu na vraćanje nekih historijskih elemenata – paviljona, starih klupa i dr. (slika 9). Pozitivan stav većine ispitanika, tj. korisnika u odnosu na vraćanje izvornog izgleda i vraćanje nekih historijskih elemenata doprinosi lakšoj i boljoj obnovi banjskog parka bez pritisaka javnosti. Izradom replika starih historijskih elemenata kao što su drveni paviljoni i klupe obogatio bi se postojeći krajolik i poboljšala atraktivnost parka.

Prema Galečić (2016) uspješnost parka se procjenjuje na osnovu njihovog redovnog korištenja. U odnosu na učestalost dolazaka odnosno frekvenciju posjeta većina ispitanika (44,3%) u banjski park dolazi vrlo često (do 5 puta mjesečno) i provodi kraće vrijeme u parku (slika 10). Ovi podaci ukazuju na postojanje stabilne populacije frekventnih posjetilaca koja uživa u banjskom parku. Dužina boravka odnosno vrijeme koje ispitanici provedu u banjskom parku ukazuje na njegovu slabiju upotrebu. Kod većine ispitanika (81,7%) preovladavaju kratke posjete sa prosječnim zadržavanjem u parku do 3 sata (slika 11). Slične podatke o dužini boravka posjetilaca dobila je Galečić (2016) za četiri gradska parka u Beogradu koja navodi da više od polovine posjetilaca u istraživanim parkovima prosječno provedu od 1-3 sata. Nagy (2002) navodi da se posjetioci parkova u Budimpešti, tokom jedne posjete, prosječno zadrže od 1-2 sata. Iz rezultata anketnog istraživanja je utvrđeno da većina ispitanika (63,4%) nema određeno doba godine vezano za posjetu banjskog parka (tabela 2) i u park dolaze tokom cijele godine. Gehl (2008) navodi da je korištenje parka tokom cijele godine pokazatelj dobrog kvaliteta parka što je utvrđeno provedenim anketnim istraživanjem. Prema Galečić (2016) upražnjavanje određenih aktivnosti predstavlja motiv, odnosno razlog zašto ljudi dolaze u park. Motivi za korištenje parka proizlaze iz potreba korisnika (Konijnendijk 2008, Galečić 2016), a upražnjavanje rekreativnih aktivnosti je poveza-

no sa unutrašnjom motivacijom koja može biti fiziološke i psihološke prirode (Živković 2015). Istraživanja u različitim sredinama pokazuju da je najčešći motiv za dolazak u park šetnja (Yilmaz i dr., 2007; Schipperijn, 2010; Lee i Kim, 2015; Galečić 2016). Shodno ovim navodima, rezultati provedene ankete također su pokazali da je šetnja (59,8%) najčešći motiv za dolazak u Banjski park Ilidža (tabela 3). Ovi podaci se slažu sa istraživanjima Brajić (2011) za Vrelo Bosne, u neposrednoj blizini, koja navodi da šetnja predstavlja najčešći motiv posjete većine ispitanika (55,7%). Slične podatke o motivima dolazaka posjetilaca za istraživane parkove u Beogradu je dobila Galečić (2016) koja isto navodi šetnju kao najčešći motiv posjete dva veća parka, Tašmajdan i Bele vode.

CONCLUSIONS AND RECOMMENDATIONS – *Zaključci i preporuke*

Banjski park Ilidža kod Sarajeva je izgrađen između 1892. i 1895. godine tokom perioda austrougarske vladavine, imao je karakteristike historicističke vrtne umjetnosti kasnog XIX vijeka i predstavlja jedan od najstarijih parkova u Bosni i Hercegovini.

Provedenim anketnim istraživanjem je utvrđeno da je prema spolnoj strukturi ispitanika zastupljenost žena 56,1%, a muškaraca 43,9%. Najveći procent ispitanika ima srednju stručnu spremu (48,4%) i pripada kategoriji starosne dobi od 25-34 godine (26%). Većina ispitanika je uposlena (48%), ima mjesto prebivališta na području općine Ilidža (62,6%) i nije u braku (45,9%).

Najbolje ocijenjeni aspekt banjskog parka (ocjena vrlo dobar) većina ispitanika je navela za aspekt dostupnosti (37%) dok su najlošiji aspekt (ocjena vrlo loš) ispitanici naveli kulturne sadržaje (6,5%). Od ukupnog broja ispitanika, najveći procent odgovora ispitanici su naveli za kvalitet zelenila (50%) dok su najmanji procent odgovora naveli za dostupnost (0,4%).

U odnosu na vraćanje izvornog izgleda banjskog parka, većina ispitanika (70,7%) ima pozitivan stav da nekim dijelovima parka treba vratiti izvorni izgled. Negativan stav ima 11% ispitanika dok 18,3% ispitanika nema jasan stav po ovom pitanju. Također, i u odnosu na vraćanje nekih historijskih elemenata kao što su paviljoni i stare klupe većina ispitanika ima pozitivan stav (72,8%).

Prema učestalosti dolazaka preovladavaju česti (više od 5 puta mjesečno) dolasci ispitanika (44,3%) sa kratkom dužinom (do 3 sata) boravka u parku (81,7%). Većina ispitanika (63,4%) je odgovorila da svoje posjete ne povezuje s određenim godišnjim dobom.

Park je potrebno zakonski zaštititi kao parkovsku baštinu odnosno kulturno-historijsko nasiđe sa nepromijenjenim granicama i većim dijelom historijske matrice. Prostorno i sadržajno ga treba obnoviti i izdvojiti veća finansijska sredstva za održavanje i zaštitu.

Dobiveni rezultati istraživanja proširit će postojeće spoznaje o načinu i učestalosti korištenja Banjskog parka Ilidža, te doprinijeti u rješavanje nekih problema vezanim za mogućnost obnove i vraćanja izvornog izgleda ovog historijskog parka odnosno parkovske baštine.

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SUMMARY

The Ilidža Spa Park near Sarajevo is a very valuable cultural and historical building built during the Austro-Hungarian rule, between 1892 and 1895, and is one of the oldest parks in Bosnia and Herzegovina. The aim of the research is to determine the attitudes of visitors to the Spa Park about the manner and frequency of using the park heritage, as well as the possibility of restoring some historical elements.

The research was conducted through a questionnaire, quantitative type, in the period from August 23, 2017, to September 29, 2017. A combined sample was applied and a code of ethics of respondents, voluntariness and anonymity was respected. Determining the socio-demographic characteristics of respondents is one of the basic prerequisites for understanding visitor requirements and behavior patterns.

The total number of respondents is 246, of which 56.1% are female and 43.9% are male (Figure 2). From the data on the place of residence, the largest number of respondents is from the area of the municipality of Ilidža (62.6%; Figure 6). In the Ilidža Spa Park, cultural contents, cleanliness, infrastructure, furniture, accessibility, quality of greenery, and general appearance of the park were investigated (Table 1). As the best-rated contents (grade very good) the majority of respondents state the availability (37%) and quality of greenery (20.3%) while the worst-rated (grade very poor) cultural contents (6.5%). Most respondents have a positive attitude towards restoring the original appearance of some parts of the park (70.7%; Figure 8) as well as for restoring the historical elements - pavilions and old benches (72.8%; Figure 9). The frequency of arrivals of respondents (frequency of visits) is most pronounced for very frequent arrivals with more than 5 times monthly visits (44.3%; Figure 10) while the average length of stay (stay) is a short visit of up to 3 hours (81.7%; Figure 11). The attitude of the majority of respondents about the time of year during which they come to the park is not related to a certain season (63.4%; Table 2). The survey of respondents also determined the reasons for their arrival in the park, and they cite walking as the most common motive for their arrival (59.8%; Table 3).

The results of this research will expand the existing knowledge about the satisfaction of visitors to the Ilidža Spa Park, and contribute to experts to solve problems in finding the possibility of applying methods of restoration and restoring the original appearance of this historic park.

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Dendroflora of the urban part of Srebrenik municipality

Dendroflora urbanog područja općine Srebrenik

Sanida Bektić[1,*], Samira Huseinović[2], Elvedin Šabanović[3]

[1] Prof. dr. Sanida Bektić, The Faculty of Natural Sciences and Mathematics, University of Tuzla, Univerzitetska 4, 75 000 Tuzla, Bosnia and Herzegovina
[2] Prof. dr. Samira Huseinović, The Faculty of Natural Sciences and Mathematics, University of Tuzla, Univerzitetska 4, 75 000 Tuzla, Bosnia and Herzegovina
[3] Mr.sc. Elvedin Šabanović, The Faculty of Natural Sciences and Mathematics, University of Tuzla, Univerzitetska 4, 75 000 Tuzla, Bosnia and Herzegovina

ABSTRACT

The results of the research on the urban dendroflora of the Srebrenik minicipality are presented in this paper. The research was conducted in the period March-August 2020-2021. In the field of research, 100 taxa were identified, which were classified into 37 families and 64 genera. The family Rosaceae stands out with the largest number of taxa, followed by Pinaceae, Aceraceae, and Cupressaceae. The analysis of the presence of deciduous and evergreen elements shows that deciduous trees predominate in the dendroflora of Srebrenik in relation to evergreen taxa. In the dendroflora of Srebrenik, allochthonous taxa (50 taxa) are more represented than autochthonous taxa (48 taxa). According to the number of taxa, angiosperms dominate (84 taxa) compared to gymnosperms (16 taxa). Allochthonous dendroflora shows the largest representation of taxa of Eurasian origin, followed by taxa from Asia, North America, Europe, while all others are represented by less than 10 taxa. The results of research on the dendroflora of Srebrenik show a lack of park areas and urban greenery, so it is necessary to pay special attention to the arrangement of existing and the formation of new green areas.

Key words: *urban dendroflora, inventory, Srebrenik*

INTRODUCTION – Uvod

Green areas in urban areas are becoming important in developing countries as they improve certain aspects of air quality (Thaiutsa et al., 2008; Pickett et al., 2008; Davies et al., 2011). The flora of urban areas usually consists of indigenous plants that are introduced from the surrounding natural and semi-natural habitats, and allochthonous plants that were introduced intentionally for the purpose of cultivation or came there by chance (Repić et al., 2013). Due to their unique role in ecosystems, urban forests and trees have been extensively studied in Malaysia (Sreetheran et al., 2006), Taiwan (Huang et al., 2009), and Germany (Strohbach and Haase, 2012). Goel & Singh (2006) collected important data on the diversity of dendroflora of the city of Delhi and identified suitable trees for expanding green areas. There are a significant number of papers dealing with the research of dendroflora of Bosnia and Herzegovina in the area of Banja Luka (Stupar, 2009), Sarajevo (Omano-

* Corresponding autor: Sanida Bektić, The Faculty of Natural Sciences and Mathematics, University of Tuzla, Univerzitetska 4, 75 000 Tuzla, Bosnia and Herzegovina, e-mail:sanida.bektic76@gmail.com

Figure 1: Satellite image of the investigated area

Slika 1: Satelitski snimak istraživanog područja

vić et al., 2012), Jajce (Hadžić et al., 2016), Tuzla (Dervišević et al., 2018), Bihać (Delić et al., 2018) and Brčko (Huseinović et al., 2020). Research on similar problems has been conducted in neighboring Croatia in the area of Šibenik (Milović, 2000), Split (Rušćić, 2002), Zadar (Milović, 2008), Omiš (Tafra, 2012) and Šibenik-Knin County (Pandža, 2016). According to the available literature data dealing with this issue, no similar research has been conducted in the municipality of Srebrenik.

The municipality of Srebrenik is located in the northeastern part of Bosnia and Herzegovina and belongs to Tuzla County. It is located at 44°42′26.7″ north latitude and 18°29′31.2″ east longitude. The area of the municipality is 249 km², and the average altitude is 199 meters. The municipality of Srebrenik is exposed to the climatic influence of the Pannonian Plain from the north and northwest, while the Dinaric Mountains from the south hinder the penetration of air masses from the Mediterranean. Depending on the natural-geographical factors in this area, a moderately warm and humid climate with a warm summer was formed (Hatunić, 2009; Zukić, 2016).

This paper aims to analyze and inventory the dendroflora of green areas in the urban part of the municipality of Srebrenik to assess the state of urban greenery. This study did not include green areas of private greenery, is private gardens, or only those parts that border public areas, such as hedges or individual trees.

MATERIAL AND METHODS - Materijal i metode

The paper inventories the dendroflora of the urban area of Srebrenik municipality (Figure 1). Dendroflora research was conducted in the period March-August 2020.-2021. years. The collected plant material was determined in the laboratory of the Faculty of Natural Sciences and Mathematics in Tuzla.

In the list of dendroflora, taxa are presented in alphabetical order. Determination of taxa was performed based on numerous literature sources: Tutin (1964-1980); Pignattti (1982); *Šilić* (1990a, 1990b); Domac (1994), Šilić (2005) and Stupar (2005, 2009). Popular names are given according to Domac (1994), Vidaković and Franjić (2004), and Idžojtić (2005a 2005b). The nomenclature of taxa in the flora list was harmonized according to Nikolić (2012). Cultivar names are listed according to an international standard (Hoffman, 2005). The following information is given for each taxon: scientific and popular name, an indication of whether the species is deciduous or evergreen, and geographical origin for non-native taxa. The distribution of taxa into deciduous (D), evergreen (E), and as well as data on geographical origin was taken from Pignatti (1982), Walters (1989); Erhardt et al. (2002). The classification of dendroflora into these categories was performed according to the established situation in the study area.

RESULTS AND DISCUSSION – Rezultati i diskusija

List of flora - Popis flore

The list of dendroflora of the urban part of Srebrenik municipality is shown in Table 1.

Table 1: List of dendroflora of the urban part of Srebrenik municipality

Tabela 1: Popis dendroflore urbanog dijela općine Srebrenik

GYMNOSPERMAE				
Number	**Botanical name**	**Popular name**	**Geografic origins**	**D/E Deciduosus/ Evergreen species**
CUPRESSACEAE				
1.	*Chamaecyparis lawsoniana* (A. Murray bis) Parl	Port Orford Cedar	North America	E
2.	*Chamaecyparis pisifera* (Siebold & Zucc.) Endl.	Cultivity of Sawara false cypress	-	E
3.	*Juniperus communis* L.	Common blueberry	Europe, Asia, Africa	E
4.	*Juniperus horizontalis* Moench	Crawling blueberry	North America	E
5.	*Juniperus virginiana* L.	Virgin's blueberry	North America	E
6.	*Platycladus orientalis* (L.) Franco	Eastern thuja	Asia	E
7.	*Thuja occidentalis* L.	American thuja	North America	E
PINACEAE				
8.	*Abies concolor* (Gordon) Lindl. ex Hildebr.	American white pine	America	E
9.	*Larix decidua* Mill.	European larch	Europe	D
10.	*Picea abies* (L.) H.Karst.	Common sprice	Europe	E
11.	*Picea pungens* Engelm.	Prickly spruce	North America	E
12.	*Pinus mugo* Turra	Dwarf mountain pine	Europe	E
13.	*Pinus nigra* J.F.Arnold	Black pine	Europe	E
14.	*Pinus silverstris* L.	White pine	Europe, Asia	E
15.	*Pinus strobus* L.	Eastern white pine	North America	E
TAXACEAE				
16.	*Taxus baccata* L.	Common jew	Europe, Asia, North Africa	E
ANGIOSPERMAE				
ACERACEAE				
1.	*Acer campestre* L.	Field maple	Europe, Asia, North America	D
2.	*Acer negundo L.*	Boxelder maple	North America	D
3.	*Acer platanoides* L.	Norway maple	Europe, Asia	D

GYMNOSPERMAE				
Number	**Botanical name**	**Popular name**	**Geografic origins**	**D/E Deciduosus/ Evergreen species**
4.	*Acer platanoides* L. "Crismon King"	-	Cult.	D
5.	*Acer pseudoplatanus* L.	Sycamore	Europe, Asia	D
6.	*Acer saccharinum* L.	Silver maple	America	D
7.	*Acer tataricum* L.	Tatarian maple	Europe, Asia	D
ADOXACEAE				
8.	*Viburnum bodnantense* Aberc. 'Dawn'	Arrowwood "Dawn"	-	D
ANACARDIACEAE				
9.	*Rhus typhina* L.	Staghorn sumac	North America	D
ARALIACEAE				
10.	*Hedera helix* L.	Common ivy	Europe, Africa, Asia	E
BERBERIDACEAE				
11.	*Berberis thunbergii* DC.	Japanese barberry	Asia	
12.	*Berberis vulgaris* L.	Common barberry	Europe, Asia	D
13.	*Mahonia aquifolium* (Pursh) Nutt	Oregon grape	North America	D
BETULACEAE				
14.	*Betula pendula* Roth.	European white birch	Europe, Asia	D
BIGNONIACEAE				
15.	*Catalpa bignonioides* Walter	Catalpa tree	North America	D
BUXACEAE				
16.	*Buxus sempervirens* L.	Boxwood	Western and Southern Europe, Northern Africa	E
CORYLLACEAE				
17.	*Carpinus betulus* L.	Common hornbeam	Europe, Asia	D
18.	*Corylus avellana* L.	Common hazel	Europe, Asia	D
19.	*Corylus maxima* Mill. Purpurea	Giant hazel	Europe, Asia	D
CANNABACEAE				
20.	*Celtis australis* L.	Mediterranean hackberry	Europe, Asia, Africa	D
CAPRIFOLIACEAE				
21.	*Lonicera caprifolium* L.	Perfoliate honeysuckle	Europe, Asia	D

GYMNOSPERMAE				
Number	**Botanical name**	**Popular name**	**Geografic origins**	**D/E Deciduosus/ Evergreen species**
22.	*Lonicera fragrantissima* Lindl. & J. Paxton	Winter-flowering honeysuckle	Asia	E
23.	*Lonicera nitida* E.H.Wilson	Box honeysuckle	Asia	E
CELASTRACEAE				
24.	*Evonymus japonicus* Thunb.	Japanese spindle	Asia	E
CORNACEAE				
25.	*Cornus sanguinea* L.	Common dogwood	Europe	D
ELAEGNACEAE				
26.	*Elaegnus angustifolia* L.	Russian olive	Asia	D
FABACEAE				
27.	*Robinia pseudoacacia* L.	Black locust	North America	D
28.	*Gleditschia triacanthos* L.	Honey locust	North America	D
FAGACEAE				
29.	*Quercus robur* L.	English oak	Europe, Asia	D
30.	*Quercus frainetto* Ten.	Hungarian oak	Europe, Asia	D
31.	*Quercus cerris* L.	Turkey oak	Europe, Asia	D
32.	*Castanea sativa* Mill.	Sweet chestnut	Europe, Asia, Africa	D
HAMAMELIDACEAE				
33.	*Liquidambar styraciflua* L	American sweetgum	North America	D
HIPPOCASTANACEAE				
34.	*Aesculus hippocastanum*	Horse chestnut	Asia	D
HYDRANGEACAE				
35.	*Hydrangea arborescens* L	Smooth hydrangea	North America	D
36.	*Philadelphus coronarius* L	Sweet mock orange	Asia	D
JUGLANDACEAE				
37.	*Juglans regia* L.	Domestic walnut	Asia	D
LYTHRACEAE				
38.	*Lagerstroemia indica var.Alba* Ram. Goyena	Crape myrtle	Asia	D
MAGNOLIACEAE				
39.	*Liriodendron tulipifera* L.	Tulip poplar	North America	D
MALVACEAE				
40.	*Hibiscus syriacus* L.	Rose of sharon	Asia	D

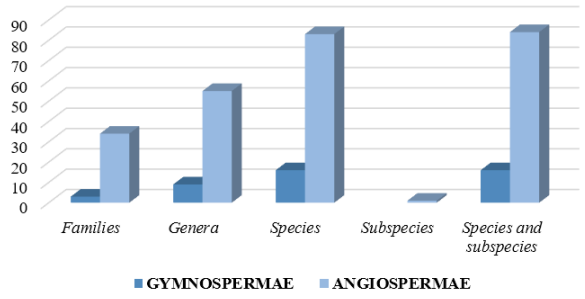
GYMNOSPERMAE				
Number	**Botanical name**	**Popular name**	**Geografic origins**	**D/E Deciduosus/ Evergreen species**
MORACEAE				
41.	*Morus nigra* L.	Black mulberry	Asia	D
42.	*Morus alba* L.	White mulberry	Asia	D
43.	*Maclura pomifera* (Raf.) C.K.Schneid.	Osage orange	North America	D
OLEACEAE				
44.	*Buddleja davidii* "Franch"	Butterfly-bush	Asia	D
45.	*Lygustrum vulgare* L.	Common privet	Europe, Asia, North Africa	D
46.	*Fraxinus pennsylvanica* Marshall	Green ash	Europe	D
47.	*Fraxinus ornus* L.	Flowering ash	Europe, Asia	D
48.	*Fraxinus excelsior* L.	European ash	Evrope, Asia	D
49.	*Fraxinus angustifolia* Vahl.	Narrow-leaved ash	Europe, Asia	D
50.	*Syringa vulgaris* L.	Lilac	Europe	D
PAULOWNIACEAE				
51.	*Paulownia tomentosa* (Thunb. Ex Murray) Steud	Princess tree	Asia	D
PLATANACEAE				
52.	*Platanus acerifolia* (Aiton) Willd.	Oriental plane	Cult.	D
POLYGONACEAE				
53.	*Reynoutria japonica* Houtt.	Japanese knotweed	Asia	D
ROSACEAE				
54.	*Chaenomeles japonica* (Thunb.) Lindl. Ex Spach	Japanese quince	Asia	D
55.	*Cotoneaster horizontalis* Decne.	Rockspray cotoneaster	Asia	D
56.	*Crataegus monogyna* Jacq.	Common hawtorn	Europe, Asia	D
57.	*Crataegus oxyacantha* L.	Hawtorn	-	D
58.	*Kerria japonica* (L.) DC.	Japanese rose	Asia	D
59.	*Malus domestica* Borkh.	Domestic apple	Evrope, Asia	D
60.	*Mespilus germanica* L.	Medlar	Asia	D
61.	*Prunus armeniaca* L.	Siberian apricot	Asia	D
62.	*Prunus avium* L.	Wild cherry	Europe, Asia	D
63.	*Prunus cerasifera* Ehrh.	Cherry plum	Europe, Asia	D

GYMNOSPERMAE				
Number	**Botanical name**	**Popular name**	**Geografic origins**	**D/E Deciduosus/ Evergreen species**
64.	*Prunus domestica* L.	Plum	Europe, Asia	D
65.	*Prunus serulatta* Lindl.	Japanese cherry	Asia	D
66.	*Pyrus communis* L.	Common pear	Europe, Asia	D
67.	*Rosa canina* L.	Dog-roose	Europe, Asia, North Africa	D
68.	*Rubus caesius* L.	European dewberry	Europe, Asia	D
69.	*Rubus fruticosus* L.	Bramble blackberry	Europe	D
70.	*Spirea x bumalda* Burv.	Japanese meadowsweet	Asia	D
71.	*Spirea x vanhouttei* (Briot.) Zabel	Vanhoute meadowsweet	Asia	D
SALICACEAE				
72.	*Salix alba* L.	White willow	Europe, Asia	D
73.	*Salix babylonica* L.	Weeping willow	Asia	D
74.	*Salix fragilis* L.	Crack willow	Europe, Asia	D
75.	*Salix integra* Thunb.	Dappled willow	Asia	D
76.	*Salix matsudana var. tortuosa* Vilm.	Corkscrew willow	-	D
77.	*Populus nigra* L.	Black cottonwood	Europe, Asia, North Africa	D
SAMBUCACEAE				
78.	*Sambucus nigra* L.	Elderberry	Europe, Asia, Africa	D
TILIACEAE				
79.	*Tilia cordata* Mill	Small-leaved lime	Europe	D
80.	*Tilia platyphyllos* Scop.	Large leaved lime	Europe	D
81.	*Tilia tomentosa* Moench	Silver lime flower	Europe, Asia	D
ULMACEAE				
82.	*Ulmus glabra* Hudson	Wych elm	Europe, Asia	D
83.	*Ulmus minor* Mill.	Field elm	Eropae, Africa, Asia	D
VITACEAE				
84.	*Vitis vinifera* L. *subsp. sylvestris* (C.C. Gmel.) Hegi	European wine greape	Europe, Asia	D

Flora analysis - Analiza flore

The analysis of the dendroflora of the urban part of the municipality of Srebrenik included 100 taxa (Table 1). The dendroflora is determined to the level of the cultivar. Taxonomic and phytogeographic analysis was performed.

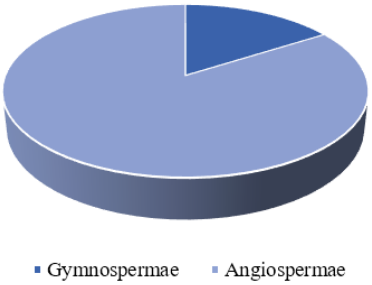
The taxonomic analysis of the dendroflora of the urban part of Srebrenik municipality included 100 taxa classified into 37 families and 64 genera (Graph 1). Out of 37 families, only one is represented by more than 10 taxa. The families Rosaceae (18 taxa; 18%), Pinaceae (8 taxa; 8%), Aceraceae (7 taxa; 7%), and Cupressaceae (7 taxa; 7%) stand out with the largest number of taxa. In their research, Tafra et al., (2012), and Huseinović et al., (2020) also list the Rosaceae family as the most represented. The most represented genus is *Acer* (7 taxa), followed by *Prunus* (5 taxa), *Pinus* (4 taxa), *Salix* (4 taxa), and the genera *Fraxinus, Juniperus, Lonicera, Quercus*, and *Tilia* (all 3 taxa).



Graph. 1: Taxonomic analysis woody plants of the urban part of Srebrenik municipality

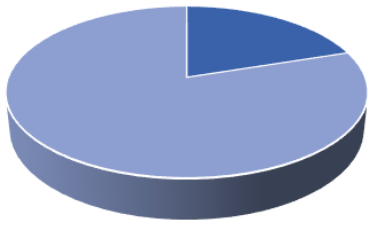
Grafikon 1: Taksonomska analiza drvenastih biljaka urbanog dijela općine Srebrenik

Out of a total of 100 taxa identified by this study, gymnosperms were represented by 16 taxa (16%), while angiosperms were more numerous and represented by 84 taxa (84%) (Graph 2). The dominance of angiosperms was also recorded in the area of the park "University City" in Banja Luka (Stupar, 2009) of the city park in Tuzla (Dervišević et al., 2017), as well as in other research areas in the region (Tafra et al., 2012; Pandža, 2016).



Graph 2: Percentage representation of Graph.

Grafikon 2: Procentualna zastupljenost Graf



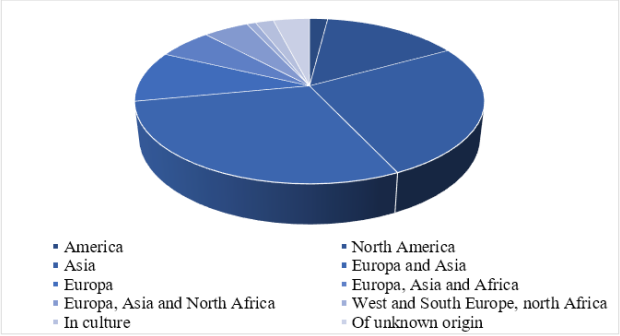
Graph 3: Percentage representation of gymnosperme and angiospermae deciduous and evergreen taxa

Grafikon 3: Procentualna zastupljenost golosjemenjača i skrivenosjemenjača listopadnih i zimzelenih svojti

The dendroflora of Srebrenik is dominated by deciduous plants with 80 taxa (80%), while 20 taxa belong to the evergreens (20%) (Graph 3). The results of our research deviate from similar research in other areas (Stupar, 2009; Dervišević et al., 2017; Delić, 2018) where evergreens were dominant in the number of taxa.

Out of the total number of taxa, 50 are allochthonous, 48 are autochthonous, while other taxa have been left out of the analysis because they are varieties or cultivars. The dominance of allochthonous plant taxa was also recorded in the flora of Vukovar (Rauš, 1969), Rijeka (Karavla et al., 1997), Omiš (Tafra et al., 2012), Knin (Dorbić et al., 2014), Mostar (Mešić et al. et al., 2017) and Brčko (Huseinović et al., 2020).

Analysis of allochthonous dendroflora by geographical origin (Graph 4) shows the highest representation of taxa of Eurasian origin (29 taxa), followed by taxa from Asia (26 taxa), North America (15 taxa), Europe (10 taxa), while all others are represented by less than 10 taxa.



Graph. 4: Representation of introduced dendro taxa in relation to their natural distribution

Grafikon 4: Zastupljenost dendrosvojti u odnosu na prirodnu distribuciju

CONCLUSION – Zaključak

From all the above, the following conclusions can be drawn:

- A survey was conducted in the urban area of Srebrenik Municipality identified 100 taxa. All taxa are classified into 37 families and 64 genera. The family Rosaceae stands out with the largest number of taxa, followed by Pinaceae, Aceraceae, and Cupressaceae.
- In the area of Srebrenik, 84 taxa belonging to angiosperms and 16 taxa belonging to gymnosperms were recorded. Of the 100 taxa in the dendroflora of Srebrenik, 50 are allochthonous and 48 autochthonous. Other taxa have been omitted from the analysis because they are cultivars.
- The analysis of the presence of deciduous and evergreen elements shows that in the dendroflora of Srebrenik deciduous prevail over evergreen taxa.
- Allochthonous dendroflora shows the largest representation of taxa of Eurasian origin, followed by taxa from Asia, North America, Europe, while all others are represented by less than 10 taxa.
- The results of this research can be useful to urban planners in selecting trees that are successfully tolerated by the urban environment. Further studies are needed on a larger scale to assess existing and future needs for green spaces, improve air, water, and other ecosystem services provided by urban biodiversity.

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SAŽETAK

U radu se iznose rezultati istraživanja urbane dendroflore općine Srebrenik. Općina Srebrenik nalazi se u sjeveroistočnom dijelu Bosne i Hercegovine i pripada Tuzlanskom kantonu. Površina općine je 249 km², a prosječna nadmorska visina je 199 metara. Istraživanje je provedeno u razdoblju ožujak-kolovoz 2020.2021. godine. Na području istraživanja identificirano je 100 svojti koje su razvrstane u 37 porodica i 64 roda. Sa najvećim brojem svojti ističe se porodica Rosaceae, zatim Pinaceae, Aceraceae i Cupressaceae. Analiza zastupljenosti listopadnih i zimzelenih elemenata pokazuje da u dendroflori Srebrenika prevladavaju listopadne u odnosu na zimzelene svojte. U dendroflori Srebrenika zastupljenije su alohtone svojte (50 svojti) od autohtonih (48 svojti). Prema broju svojti dominiraju skrivenosmjenenjače (84 svojte) u odnosu na golosjemenjače (16 svojti). Analiza alohtone dendroflore prema geografskom porijeklu pokazuje najveću zastupljenost svojti evroazijskog porijekla (29 svojti), zatim iz Azije (26 svojti), Sjeverne Amerike (15 svojti), Evrope (10 svojti), dok su ostali zastupljeni s manje od 10 svojti. Rezultati istraživanja dendroflore Srebrenika pokazuju nedostatak parkovnih površina i urbanog zelenila, pa je potrebno posebnu pažnju posvetiti uređenju postojećih i formiranju novih zelenih površina.