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FLORISTIC DIVERSITY OF ARTIFICIALLY ESTABLISHED STANDS OF DIFFERENT CONIFEROUS SPECIES IN THE AREA OF KOSMAJ (SERBIA)

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Abstract: *One of the causes of decrease of species diversity of forest ecosystems could be inadequate selection of tree species for afforestation and ameliorations. It is known that by establishing new forest ecosystem habitat conditions change, and thus, edaphic and hydrological conditions and light regime also change, which directly or indirectly reflects on plant species. The research included four artificially established stands (pure or mixed) in the area of Kosmaj, where various coniferous species were introduced in the process of substitution of autochthonous forests of Hungarian oak and Turkey oak. The largest total number of plant species was recorded in artificially established stand of common spruce, Atlas cedar, and Douglas-fir (41). The highest Shannon-Wiener diversity index was recorded in stand of Douglas-fir (3.22), and the lowest in pine stands (2.95-2.97). It was determined by cluster analysis that stand of Austrian pine and stand of Austrian pine and Scots pine have the largest degree of mutual floristic similarity.*

Keywords: Substitution, plant diversity, floristic similarity, Kosmaj, Serbia

FLORISTIČKI DIVERZITET VEŠTAČKI PODIGNUTIH SASTOJINA RAZLIČITIH VRSTA ČETINARA NA PODRUČJU KOSMAJA (SRBIJA)

Sažetak: *Jedan od uzroka smanjenja specijskog diverziteta šumskih ekosistema može biti neadekvatan izbor vrsta drveća za pošumljavanje i melioracije. Poznato je da se uspostavljanjem novog šumskog ekosistema menjaju stanišni uslovi, a samim tim bivaju promenjeni edafski i hidrološki uslovi i režim svetlosti, što se neposredno ili posredno manifestuje na biljne vrste. Istraživanjem su obuhvaćene 4 veštački podignute sastojine (čiste ili mešovite) na području Kosmaja, gde su u postupku supstitucije autohtonih šuma sladuna i cera unešene različite vrste četinara. Najveći ukupan broj vrsta biljaka registrovan je u veštački podignutoj sastojini smrče, atlaskog kedra i duglazije (41). Najveći Shannon-Wiener indeks diverziteta konstatovan je u veštački podignutoj sastojini duglazije (3.22), a najmanji u sastojinama borova (2.95-2.97). Klaster analizom je utvrđeno da najveći stepen međusobne florističke sličnosti imaju veštački podignuta sastojina crnog bora i sastojina crnog i belog bora.*

Ključne reči: Supstitucija, diverzitet biljaka, floristička sličnost, Kosmaj, Srbija

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1. INTRODUCTION

The previous criteria for introduction of various coniferous species in the belt of oak and beech forests in the territory of Serbia, in the middle of last century were largely based on the strategy of introduction of coniferous species. Introduction of coniferous species into conditions most frequently inadequate for them, influenced the resistance of these stands to various disturbances, such as extreme weather disasters, insects, fungi, and the like, thus also occurrence of die-back and decline of these cultures. Die-back of coniferous cultures in Serbia is recorded especially in the period following 2011, and the most affected were artificially established stands of Scots pine, Austrian pine, common spruce, Douglas-fir and fir, whereby the causes of die-back were very complex and include a large number of biotic and abiotic factors. (Tabaković-Tošić et al., 2016).

By changing tree species in the amelioration procedures of coppice and degraded forests, the habitat conditions are changed simultaneously. That reflects directly or indirectly on plant species, so in the majority of cases a change and significant decrease of number of species of ground vegetation occur, i.e. decrease of species diversity. At the same time, in some cases a number of invasive species increases. Changes that occur are very fast especially in the first years after the felling. In reforested forests the intensity of light is increased (Levine & Feller, 2004), and also the influence of anthropogenic factor (Decker et al., 2012) as well as the quantity of nutrients in the soil caused by accelerated decomposition of litterfall (Huebner and Tobin, 2006). In such changed conditions, in the first steps of succession increase of species diversity takes place, and only after prolonged action of negative factors significant decrease of number of species occurs in the newly created ecosystems (Lakušić, 2005).

The proper selection of tree species in afforestation or amelioration of degraded forests, along with the adequate management methods, provides the improvement of biological diversity, and simultaneous preservation of endangered and rare plant species. Therefore, the object of this paper is to determine to what extent the establishing of coniferous plantation in the researched area of Kosmaj had an impact on their floristic composition, mutual differences and diversity of these forests in general.

2. MATERIAL AND METHODS

Kosmaj is low and in terms of area relatively small mountain situated 40 km southeast from Belgrade. Larger part of this mountain has been protected as an area of outstanding natural landscape since 2005. In the protected area of Kosmaj in amelioration procedures of coppice forest various species of conifers were used in the previous period. They were most frequently planted in different combinations, sometimes mixed with deciduous trees and on very small areas.

This research includes four artificially established stands of various species of conifers:

a) common spruce (*Picea abies* (L.) Karst), Atlas cedar (*Cedrus atlantica* (Endl.) Carrière) and Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco);

b) Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco);

c) Austrian pine (*Pinus nigra* Arnold);
d) Austrian pine *(Pinus nigra* Arnold) and Scots pine (*Pinus sylvestris* L.)

For the analysis of the floristic composition of the researched stands relevés were made according to the standard method of Braun Blanquet (Braun–Blanquet,1964). Initial phase in the statistical processing of phytocoenological data was presented by conversion of values for relative abundance and coverage of the species in stands from alphanumeric Braun-Blanquet scale to numeric Van Der Maarel scale (1979). For calculation of diversity index (*Shannon-Wiener* diversity index) and evenness index (*Evenness*) program for data processing in phytocoenology Juice 7.0 (Tichý, 2002) was used. The cluster analysis was done by means of a program package for ecological research Biodiversity Pro (McAleece et al., 1997), where the similarity in floristic composition between the researched stands of conifers was determined using hierarchical classification analysis and the Bray-Curtis similarity index.

3. RESULTS

The researched artificially established stands of conifers are located in similar environmental conditions – on elevations from 360 to 462 m, on different exposures and slopes from 11 to 19º (Table 1). The parent rock are flysch formations, and the soil is eutric cambisol in all cases. Based on the analysis of floristic composition it has been determined that all of them are established on the habitat of Hungarian oak and Turkey oak - *Quercetum frainetto-cerridis* Rudski 1949.

Table 1. *Basic ecological characteristics of the habitat*

Artificially established stands	Age (years)	Elevation (m)	Exposure	Slope (°)	Parent rock	Soil
Picea abies, Cedrus atlantica Pseudotsuga menziesii	40-45	462	SW	19	Flysch	Eutric cambisol
Pseudotsuga menziesii	40	433	W	16	Flysch	Eutric cambisol
Pinus nigra	66	444	N	12	Flysch	Eutric cambisol
Pinus nigra Pinus sylvestris	65-30	360	NE-E	11	Flysch	Eutric cambisol

3.1. Floristic composition

The floristic composition of the researched stands is presented in Table 2. In the tree layer, in addition to the artificially introduced species of conifers (*Picea abies*, *Cedrus atlantica*, *Pseudotsuga menziesii*, *Pinus nigra*, *Pinus sylvestris*) and pedunculate oak (*Quercus robur* L.), 10 more woody species are present. In the shrub layer, whose coverage amounts from 0.1 to 0.3, 15 species in total can be found of various shrubs and the most represented are *Prunus avium* L., *Crataegus monogyna* Jacq. and *Fraxinus ornus* L.

The ground flora layer is relatively rich, especially in thinned stands, and the total number of ground flora species that were found amounts to 79. The coverage of ground flora in the researched stands ranges from 0.6 to 0.8.

Table 2. *Floristic composition of artificially established stands of conifers*

Species	Family	*Picea abies, Cedrus atlantica, Pseudotsuga menziesii*	*Pseudotsuga menziesii*	*Pinus nigra*	*Pinus nigra Pinus sylvestris*
Acer campestre	*Aceraceae*	+	+	+	+
Acer pseudoplatanus	*Aceraceae*	+	+		
Acer tataricum	*Aceraceae*				+
Ajuga reptans	*Lamiaceae*	+			
Alliaria petiolate	*Brassicaceae*				+
Aremonia agrimonoides	*Rosaceae*			+	
Arum maculatum	*Araceae*	+			
Astragalus glycyphyllos	*Fabaceae*		+		
Betula pendula	*Betulacea*		+		
Bilderdykia convolvulus	*Polygonaceae*				+
Brachypodium sylvaticum	*Poaceae*	+	+	+	+
Calamintha vulgaris	*Lamiaceae*	+	+		
Campanula persicifolia	*Campanulaceae*		+		
Cardamine bulbifera	*Brassicaceae*	+		+	
Carex pendula	*Cyperaceae*			+	
Carex sylvatica	*Cyperaceae*	+	+	+	
Cedrus atlantica	*Pinaceae*	+	+		
Chamaecytisus supinus	*Fabaceae*		+		
Circaea lutetiana	*Oenotheraceae*	+		+	
Clematis vitalba	*Ranunculaceae*	+	+	+	
Cornus mas	*Cornaceae*				+
Cornus sanguinea	*Cornaceae*		+	+	
Crataegus monogyna	*Rosaceae*	+	+	+	+
Danaa cornubiensis	*Apiaceae*	+			+
Dryopteris filix-mas	*Aspidiaceae*		+	+	
Euphorbia amygdaloides	*Euphorbiaceae*	+			+
Fagus moesiaca	*Fagaceae*		+	+	
Fragaria vesca	*Rosaceae*	+	+		
Fraxinus ornus	*Oleaceae*		+	+	+
Galeopsis speciose	*Lamiaceae*			+	+
Galium aparine	*Rubiaceae*	+		+	
Galium schultesii	*Rubiaceae*	+			+
Geranium robertianum	*Geraniaceae*	+	+	+	+
Glechoma hirsute	*Lamiaceae*	+	+	+	
Hedera helix	*Araliaceae*	+	+		+
Helleborus odorus	*Ranunculaceae*	+	+	+	+
Hieracium sabaudum	*Asteraceae*		+		
Hypericum hirsutum	*Hypericaceae*	+			
Inula conyza	*Asteraceae*		+		
Juglans regia	*Juglandaceae*		+	+	
Lathyrus niger	*Fabaceae*				+
Lathyrus venetus	*Fabaceae*	+			+
Ligustrum vulgare	*Oleaceae*			+	+
Lilium martagon	*Liliaceae*	+			
Lonicera caprifolium	*Caprifoliaceae*	+	+		+
Lysimachia punctate	*Primulaceae*				+
Melica uniflora	*Poaceae*		+	+	+
Moehringia trinervia	*Caryophyllaceae*	+		+	+
Mycelis muralis	*Asteraceae*	+	+	+	+
Ornithogalum pyrenaicum	*Liliaceae*	+			

Species	Family	*Picea abies, Cedrus atlantica, Pseudotsuga menziesii*	*Pseudotsuga menziesii*	*Pinus nigra*	*Pinus nigra Pinus sylvestris*
Picea abies	*Pinaceae*	+			
Pinus nigra	*Pinaceae*			+	+
Pinus sylvestris	*Pinaceae*				+
Polygonatum odoratum	*Asparagaceae*	+	+		
Potentilla reptans	*Rosaceae*		+		
Prunella vulgaris	*Lamiaceae*		+		
Prunus avium	*Rosaceae*	+	+	+	+
Prunus spinosa	*Rosaceae*			+	+
Pseudotsuga menziesii	*Pinaceae*	+	+		
Quercus cerris	*Fagaceae*	+	+	+	+
Quercus farnetto	*Fagaceae*			+	+
Quercus petraea	*Fagaceae*		+		
Quercus robur	*Fagaceae*				+
Rosa arvensis	*Rosaceae*		+		
Rubus caesius	*Rosaceae*		+		
Rubus hirtus	*Rosaceae*	+	+	+	+
Sambucus nigra	*Sambucaceae*	+	+		
Scrophularia nodosa	*Scrophulariaceae*			+	
Scutellaria altissima	*Lamiaceae*		+		
Scutellaria columnae	*Lamiaceae*				+
Stachys alpine	*Lamiaceae*	+			
Stachys sylvatica	*Lamiaceae*			+	+
Stellaria media	*Caryophyllaceae*	+			
Tamus communis	*Dioscoreaceae*	+	+	+	+
Tilia tomentosa	*Tiliaceae*	+			+
Ulmus minor	*Ulmaceae*			+	+
Vicia dumetorum	*Fabaceae*	+			
Viola alba	*Violaceae*			+	
Viola sylvestris	*Violaceae*	+			

3.2. Species richness and diversity

The largest species richness was found in mixed stand of common spruce, Atlas cedar and Douglas-fir (41), while slightly smaller number was found in the stand of Douglas-fir (40). In pine stands total number of species ranged from 34 to 35.

Table 3. *The average values of diversity parameters of the researched stands*

Species	Species number	Shannon-Wiener diversity index	Evenness
Picea abies, Cedrus atlantica, Pseudotsuga menziesii	41	3.19	0.83
Pseudotsuga menziesii	40	3.22	0.84
Pinus nigra	34	2.95	0.77
Pinus nigra, P. Sylvestris	35	2.97	0.78

The largest Shannon-Wiener diversity index was found in artificially established stand of Douglas-fir (3.22), slightly smaller in the mixed stand of common spruce, Atlas cedar and Douglas-fir (3.19), and the smallest in pine stands (2.95-2.97). Evenness index (*Evenness*) was largest also in Douglas-fir stand (0.84), and somewhat smaller in the mixed stand of common spruce, Atlas cedar and

Douglas-fir (0.83). The smallest values were recorded in artificially established stands of pine (0.77-0.78).

3.3. Floristic similarity

By cluster analysis according to Bray-Curtis (Figure 1) the largest degree of floristic similarity (more than 40%) is found in artificially established stand of Austrian pine and stand of Austrian pine and Scots pine.

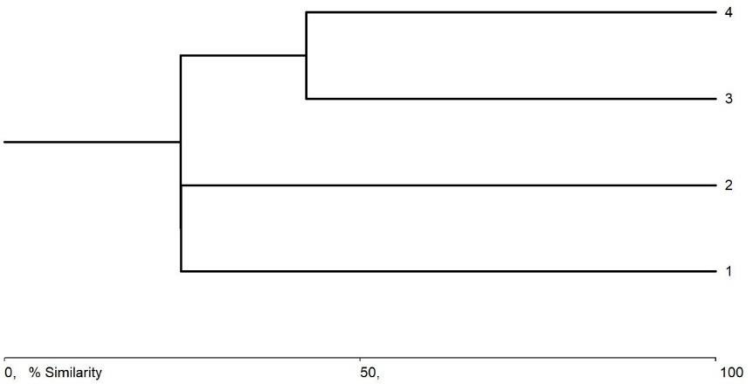

Figure 1. *Dendrogram (Bray-Curtis) of floristic similarity of the researched artificially established stands*

Legend: 1 – *Picea abies, Cedrus atlantica, Pseudotsuga menziesii; 2 – Pseudotsuga menziesii;3 – Pinus nigra; 4 – Pinus nigra, Pinus sylvestris*

In all other cases the degree of floristic similarity between stands of conifers is low (below 20%).

4. DISCUSSION

It is known that the replacement of autochthonous forest with a new tree species can reflect to ground flora and decrease of floristic diversity (Atauri et al., 2005). The artificially established stands on the researched site were exposed to different anthropogenic influence and they reacted differently to microhabitat conditions, which reflected significantly to floristic composition and diversity of these forests. Also, in recent years, there was intensive die-back of conifers in this area (Stajić, 2016). The opening of the canopy in the researched stands (due to the factors of biotic and abiotic nature) which has caused an increased inflow of light, has led to the increase of number and coverage of species, both in shrub layer and in ground flora layer. In artificially established stand of Austrian pine, as well as in mixed stand of Austrian pine and Scots pine blackberry (*Rubus hirtus* Waldst. & Kit.) formed weed coverage which indicated certain degradation of habitat, and the presence of invasive species *Alliaria petiolata* (Bieb.) Cavara & Grande was also recorded.

Species richness in natural forests of Hungarian oak and Turkey oak in this area according to a research (Stajić et al., 2021) ranged from 20 to 49 (35 in average), which was within the limits of recorded values also for the researched stands of

conifers. The value of the Shannon-Wiener diversity index (H´) in autochthonous forests of Hungarian oak and Turkey oak of this area according to Stajić et al. (2021) ranged from 2.48 to 3.39 (3.04 in average). This indicated that the floristic diversity of artificially established stands of conifers slightly decreased compared to natural forests in cases where species *Pinus nigra* and *P. sylvestris* were introduced, and increased in cases of other coniferous species. Evenness index of these stands was within the limits of the values recorded for Hungarian oak and Turkey oak forests of this area (0.77 do 0.89).

Decrease of abundance and plant diversity in pine stands partly is a consequence of openning of the canopy (due to various abiotic and biotic factors), which caused certain habitat degradation and increased coverage in blackberry in ground flora layer of vegetation. The age of these stands should be taken into consideration, since the number of species and diversity decrease with the maturity of the stands.

The research of floristic diversity in artificially established stands of conifers on wider area of Serbia shows that in some cases impoverishment in floristic composition occurs, so in the stands of the species like Douglas-fir, eastern white pine, larch or common spruce many plant species characteristic of natural forests are absent (Cvjetićanin & Bjelanović, 2007; Stajić et al., 2011). At the same time, in artificially established stands of Austrian pine the increase of floristic diversity is recorded. (Novaković-Vuković *et al*., 2013). The results of the research of influence of tree species substitution on floristic diversity are quite different, both worldwide and in Serbia. What can be concluded and used as recommendation in establishing of artificially stands is partial retention and restoration of autochthonous vegetation where this is possible, as well as establishing of mixed stands using several different tree species (Horák et al., 2019).

5. CONCLUSION

By introducing coniferous species in the area of Kosmaj the landscape of this forest complex has been refined, not only from an aesthetic point of view, but also due to significantly wider multifunctional values, which is very significant since Kosmaj is a protected area. However, the significant participation of artificially established stands represents potentially strong threatening factor to stability of this forest complex since there has been intensive die-back of conifers in this area in recent years due to the influence of various biotic and abiotic factors.

The researched artificially established stands of conifers reacted differently on microhabitat conditions, which reflected to their floristic composition. The studies showed that the introduction of coniferous species did not have significant effect on floristic composition, plant species richness and diversity in this area. The largest *Shannon-Wiener* diversity index is registered in the artificially established stands of Douglas-fir. The decrease of diversity compared to the natural forests of this area was recorded in artificially established stand of pines. The artificially established stand of Austrian pine and a stand of Austrian pine and Scots pine showed the largest degree of floristic similarity. In other cases, this degree was low (below 20%), which was expected considering ecological-biological characteristics of introduced species.

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REFERENCES

Atauri JA, de Pablo CL, de Agar PM, Schmitz MF, Pineda FD (2004). Effects of management on understory diversity in the forest ecosystems of northern Spain. *Environmental Management, 34(6),* 819-828. Doi: 10.1007/s00267-004-0180-0.

Braun-Blanquet, J. (1964). Pflanzensoziologie. *Grundzüge Der Vegetationskunde (3rd ed, 1-865)*. Springer Verlag, Vienna.

Cvjetićanin, R., Bjelanović, I. (2007). *Promene florističkog sastava u veštački podignutim sastojinama četinara na staništu planinske šume bukve na području Bukova.* In V. Ranđelović (Ed.), Proceedings of 9th Symposium on Flora of Southeastern Serbia and Neigbhbouring Regions (pp. 199–204). Department for Biology and Ecology of The Faculty of Sciences and Mathematics, Niš. Cvjetićanin, R., Bjelanović, I. (2007). *Changes of floristic composition in artificially established stand of conifers on the habitat of mountainous beech forest in the area of Bukovo* In V. Ranđelović (Ed.), Proceedings of 9th Symposium on Flora of Southeastern Serbia and Neigbhbouring Regions (pp. 199–204). Department for Biology and Ecology of The Faculty of Sciences and Mathematics, Niš.]

Decker, K. L., Allen, C. R., Acosta, L., Hellman, M. L., Jorgensen, C. F., Stutzman, R. J., Unstad, K. M., Williams, A., Yans, M. (2012). Land use, landscapes and biological invasions. *Invasive Plant Science and Management, 5(1):*108–116. Doi:10.1614/IPSM-D-11-00007.1

Horák, J., Brestovanská, T., Mladenović, S., Kout, J., Bogusch, P., Halda, J., Zasadil, P. (2019). Green desert?: Biodiversity patterns in forest plantations. *Forest Ecology and Management, 433,* 343-348. Doi:10.1016/j.foreco.2018.11.019

Huebner, C.D., Tobin, P.C. (2006). Invasibility of mature and 15-year-old deciduous forests by exotic plants. *Plant Ecology,* 186, *57–68.* Doi:10.1007/s11258-006-9112-9

Lakušić, D. (2005). Odnos specijskog i ekosistemskog diverziteta. In M. Anđelković (Ed.), *Biodiverzitet na početku novog milenijuma* (Volume 2, pp. 75-104). Srpska akademija nauka i umetnosti, Beograd. [Lakušić, D. (2005). The relation between species diversity and ecosystem diversity. In M. Anđelković (Ed.), *Biodiversity in the beginning of the new millennium* (Volume 2, pp. 75-104). Serbian Academy of Sciences and Arts, Belgrade]

Levine, M. T., Feller, I. C. (2004). Effects of forest age and disturbance on population persistence in the understory herb, Arisaema triphyllum (Araceae). *Plant Ecology, 172,*73-82. Doi: 10.1023/B:VEGE.0000026036.32013.7a

McAleece, N., Gage, J. D. G., Lambshead, P. J. D., Paterson, G. L. J. (1997). BioDiversity Professional statistics analysis software. *Jointly developed by the Scottish Association for Marine Science and the Natural History Museum, London.*

Novaković-Vuković, M., Cvjetićanin, R., Perović, M. (2013). Uporedne karakteristike florističkog sastava šume balkanskog kitnjaka (*Quercus daleschampii* Ten.) i veštački podignute sastojine crnog bora (*Pinus nigra* Arnold) na kitnjakovom staništu na Suvoboru.

Šumarstvo, 3-4, 39-54. [Novaković-Vuković, M., Cvjetićanin, R., Perović, M. (2013). Comparative characteristics of floristic composition of Dalechamp's oak (*Quercus daleschampii* Ten.) forest and artificially established stand of Austrian pine (*Pinus nigra* Arnold) on sessile oak habitat on Suvobor. *Šumarstvo, 3-4*, 39-54]

Pattison, R., Goldstein, G., Ares, A. (1998). Growth, biomass allocation and photosynthesis of invasive and native Hawaiian rainforest species. *Oecologia, 117*, 449-459.

Stajić, S., Čokeša, V., Miletić, Z., & Rakonjac, Lj. (2011). Promene sastava prizemne flore u veštački podignutim sastojinama borovca, duglazije i ariša na staništu sladuna i cera sa grabom. *Sustainable Forestry, Collection, 63-64,* 17-26. [Stajić, S., Čokeša, V., Miletić, Z., & Rakonjac, Lj. (2011). Change in composition of ground flora in artificially established stands of eastern white pine, Douglas-fir and larch on the habitat of Hungarian oak and Turkey oak with hornbeam. *Sustainable Forestry, Collection, 63-64*, 17-26]

Stajić, S. (2016). *Determination of forest phytocoenoses of mt. Kosmaj by combining the standard phytosociological method with photointerpretation*. Doctoral dissertation, Faculty of Forestry, Belgrade. National Repository of Dissertations in Serbia. https://nardus.mpn.gov.rs/

Stajić S., Cvjetićanin R., Čokeša V., Miletić Z., Novaković-Vuković M., Eremija S., Rakonjac Lj. (2021). Plant species richness and diversity in natural beech and oak dominated forests of Kosmaj protected area (Serbia). *Applied Ecology and Environmental Research 19(4),* 2617-2628. Doi 10.15666/aeer/1904_26172628

Tabakaković-Tošić, M., Milenković, I.,Radulović, Z. (2016). The coniferous anthropogenic and natural forests decline in Serbia driven by different abiotic and biotic factors. *Sustainable Forestry, Collection 73-74,*49–57.

Tichý, L. (2002). JUICE, software for vegetation classification. *Journal of Vegetation Science,13*,451-453. Doi:10.1111/j.1654-1103.2002.tb02069.x

Van der Maarel, E. (1979). Transformation of cover-abundance values in phytosociology and its effects on community similarity. *Vegetatio, 39*, 97–114. Doi:10.1007/BF00052021

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Summary

The selection of tree species in forest management can have long-term economic and environmental consequences. By replacing the autochthonous forest with new tree species, habitat conditions change. Therefore, edaphic and hydrological conditions and light regime also change. This reflects on plant species directly or indirectly – in majority of cases change of floristic composition and plant diversity occurs. The main objective of this research has been to determine how have certain coniferous species influenced the floristic composition and diversity parameters (species richness and Shannon-Wiener diversity index) of artificially established stands in the protected area of Kosmaj (Serbia).

The research included four artificially established stands of various coniferous species: a) common spruce (*Picea abies*), Atlas cedar (*Cedrus atlantica*) and Douglas-fir (*Pseudotsuga menziesii*); b) Douglas-fir (*Pseudotsuga menziesii*); c) Austrian pine (*Pinus nigra*); d) Austrian pine and Scots pine (*Pinus nigra*, *Pinus sylvestris*). The stands are located in similar environmental conditions – at elevations between 360 and 462 m, different exposures and slopes from 11 to 19º. Parent rock is flysch, and soil is eutric cambisol in all cases.

The largest total number of species was recorded in the artificially established stand of common spruce, cedar and Douglas-fir (41). The highest Shannon-Wiener diversity index was recorded in the artificially established stand of Douglas-fir (3.22), and the lowest in pine stands (2.95-2.97). The cluster analysis confirmed that the artificially established stand of Austrian pine and stand of Austrian pine and Scots pine have the largest degree of mutual floristic similarity (more than 40%).

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Rezime

Izbor vrsta drveća u gazdovanju šumama može da ima dugoročne ekonomske i ekološke posledice. Zamenom autohtone šume novom vrstom drveća menjaju se stanišni uslovi, a samim tim bivaju promenjeni edafski i hidrološki uslovi i režim svetlosti. To se neposredno ili posredno manifestuje na biljne vrste – u najvećem broju slučajeva dolazi do promene florističkog sastava i diverziteta biljaka. Glavni cilj ovog istraživanja bio je da se utvrdi kako su pojedine vrste četinara uticale na floristički sastav i parametre diverziteta (species richness and *Shannon*-Wiener diversity index) veštački podignutih sastojina u zaštićenom području Kosmaja (Serbia).

Istraživanjem su obuhvaćene 4 veštački podignute sastojine različitih vrsta četinara: a) smrče (*Picea abies*), atlaskog kedra (*Cedrus atlantica*) i duglazije (*Pseudotsuga menziesii*); b) duglazije (*Pseudotsuga menziesii*); c) crnog bora *(Pinus nigra*); d) crnog i belog bora (*Pinus nigra*, *Pinus sylvestris*). Sastojine se nalaze u sličnim ekološkim uslovima-na nadmorskim visinama od 360 do 462 m, različitim ekspozicijama i nagibima od 11 do 19º. Geološka podloga je fliš, a zemljište eutrični kambisol u svim slučajevima.

Najveći ukupan broj vrsta registrovan je veštački podignutoj sastojini smrče, kedra i duglazije (41). Najveći *Shannon-Wiener* indeks diverziteta konstatovan je u veštački podignutoj sastojini duglazije (3.22), a najmanji u sastojinama bora (2.95-2.97). Klaster analizom je utvrđeno da najveći stepen međusobne florističke sličnosti (više od 40%) imaju veštački podignute sastojine crnog bora i sastojine crnog i belog bora.