ECO-CONFERENCE® 2013
ECOLOGICAL MOVEMENT OF NOVI SAD

Martin Bobinac[1], Siniša Andrašev[2], Milivoj Vučković[1], Branko Stajić[1]
[1] University of Belgrade -Faculty of Forestry, Belgrade, Serbia,
[2] University of Novi Sad -Institute of Lowland Forestry and Environment, Novi Sad, Serbia

PHYTOSOCIOLOGICAL REVITALIZATION OF HARDWOOD BROADLEAVED STANDS IN SNR `GORNJE PODUNAVLJE`

Abstract

The investigation, which was carried out on a permanent sample plot in an untended natural narrow-leaved ash stand within SNR `Gornje Podunavlje`, eight years after the initial thinning, included the study of the elements necessary for further phytosociological revitalization of the stand. The following stand measurements were obtained at the age of 38: $N=745\times ha^{-1}$, G=33.9 $m^2\times ha^{-1}$, V=438.0 $m^3\times ha^{-1}$, while due to thinning and natural mortality, a total of 121.7 $m^3\times ha^{-1}$ was cut in the stand. At the age of 46, the measurements were as follows: $N=483\times ha^{-1}$, G=30.9 $m^2\times ha^{-1}$, V=448.4 $m^3\times ha^{-1}$, while the current volume increment amounted to 16.5 $m^3\times ha^{-1}\times year^{-1}$. Considering the increment potential of certain categories of trees in the stand, another thinning is being considered in order to achieve phytosociological revitalization of the stand.

Key words: *Fraxinus angustifolia Vahl, SNR `Gornje Podunavlje`, stand revitalization, growth elements, thinning.*

INTRODUCTION

Special nature reserve `Gornje Podunavlje` (`Upper Danube Basin`) is a unique and compact marshland complex in the northwest of Backa in Serbia. The total protected area of "Gornje Podunavlje" amounts to 19,605 hectares and mostly encompasses the area of Monoštor and Apatin marshlands.

Regulation works and the construction of an embankment near the bed of the Danube in 1965 prevented further flooding in Monoštor marshland on an area of 6,673 hectares or 90% of the total area of the former Rit (Marshland), while the regulation of the drainage network in the pre-terraced area contributed to the drainage of the former floodplain by lowering the groundwater level. The absence of flooding has brought about significant changes in the hydrological regime of the habitats in the protected area, which have further contributed to the fragmentation of wetland habitats and the extinction of autochthonous species of willow and poplar. The remnants of wetland ecosystems are still present in the lowest parts of the marshland protected area, mainly due to the impact of groundwaters which correspond to the water level of the river Danube.

With the aim of preserving natural ecosystems, the area was put under the protection of the Special Nature Reserve `Gornje Podunavlje`, while controlled inflows of water into some sectors of the embanked area are aimed at keeping the marshland ecosystems in its `original` form (Panjković, 2000, *2000).

The prevention of flooding in 1965 has in certain parts of the former floodplains of Monoštor Marshland contributed to progressive succession of the forest vegetation and harmonization of the plant cover. Based on the reconstruction of the bioecological transect, which has fragmentary narrow-leaved ash stands preserved in Monoštor Marshland, it can be seen that before the construction of the embankment in 1965, a belt of predominantly floodplain hardwood forests was found in the areas above 84 m. a.s.l. After the construction of the embankment, narrowleaved ash stands spread and covered wetland depressions as well (Bobinac *et al.*, 2007).

The forest of narrow-leaved ash and elm (*Fraxineto-Ulmetum effusae* Slav. 1952) is the final terminal community in the development of floodplain forest vegetation. It is a hygrophyllic forest in the forest-steppe zone of Pannonian Basin, which is spatially related to the forests of willow and poplar and syndynamically to the forests of pedunculate oak with elm (*Genisto elatae-Quercetum roboris ulmetosum*) on the drier end of the ecological sequence (Tomić, 2004). According to contemporary phytocoenological and silvicultural studies, there has been a spread of the forest of narrow-leaved ash and elm in the Danube river basin due to drier site conditions. However, due to its poor surface differentiation and disturbed stand structure, this forest community has not been given any greater silvicultural significance (Vukelić *and* Baričević, 2004, Anić *et al.*, 2005).

Past research studies in natural and artificially-established stands of pedunculate oak and narrow-leaved ash, which were formed as a result of syndynamical changes on the sites of black and white poplar (*Populetum nigro-albae* Slav. 1952) and on the sites of narrow-leaved ash and elm (*Fraxineto-Ulmetum effusae* Slav. 1952) by the end of the 19th century, have pointed to the intensive development of both trees and stands and to very high production effects. On the other hand, they have also pointed to the devitalization of trees, particularly of pedunculate oak, due to the changes in hydrological conditions and inadequate stand treatment (Herpka, 1979, Simić, 1987, Bobinac *and* Vajištanac, 1989, Bobinac and Andrašev, 2008, Bobinac *et al.*, 2010, 2012, Čater *et al.*, 2008). In terms of production, these sites are also optimal for growing black poplar clones (Andrašev, 2008).

In recent years, the area of Monoštor marshland has been intended for the cultivation of Euramerican poplars. Consequently, forest management has neglected the aspects that in essence should correspond to the laws of recent succession that was brought about by the latest change in the hydrological regime. Since narrow-leaved ash has occurred together with black and white poplar and clear-felling has been applied in the process of forest management, the stands of narrow-leaved ash have not been preserved in a larger area. Today, the stands of narrow-leaved ash, of natural or artificial origin, cover less than 2.0% of the forested area (190 *ha*) in the Special Nature Reserve `Gornje Podunavlje` and they are untended in a large part. Investigations and assessments necessary for their phytosociological revitalization were carried out on permanent sample plots. The achieved effects contribute to the objectification of their production and ecological functions in the process of recent succession of vegetation and to the promotion of the protection concept of SNR `Gornje Podunavlje `.

The aim of the paper is to define the elements for further phytosociological revitalization of the narrow-leaved ash stands within SNR `Gornje Podunavlje`, based on the achieved effects of experimental tending on the permanent sample plot in the narrow-leaved ash stand.

MATERIAL AND METHODS

The subject of this investigation are natural narrow-leaved ash stands fragmentary preserved in the part of Monoštor marshland that is protected against floods. The study area is located in the north-west of Bačka, on the left bank of the Danube between 45°31'47" and 45°51'3" north latitude and 18°49'8" and 19°5'43" east longitude. According to data of the meteorological station in Sombor for the period from 1971 to 1990, the mean annual air temperature is 11.1°C and the mean temperature during the vegetation period amounts to 18.0°C. Average annual rainfall is 569 *mm*, with the tendency to fall to 337 *mm* during vegetation.

The permanent sample plot (SP-3, A = 0.325 ha) was established in the autumn 2004 in a 38-year old stand (MU Monoštor forest, compartment 53 *k*). The stand was naturally formed on the area of the former wetland depression at 83.5 m above sea level, on fluvisol (fossil meadow black soil on alluvial deposits), shortly after the construction of the embankment in 1965. The stand has had a spontaneous development with only sanitation cuttings being carried out. The first thinning was performed in the first year after the establishment, and according to the ratio of the quadratic mean diameter of the removed to the quadratic mean diameter of the remaining trees (q_d), it was characterized as low thinning (Bobinac and Andrašev, 2008). Due to thinning and natural mortality of a small number of trees, a total of 121.7 $m^3 \times ha^{-1}$ was harvested in the stand (reduced to the age of 38 years) in the following period. Eight years after the thinning, the elements for further phytosociological revitalization of the study stand were studied on the permanent sample plot.

All trees on the permanent sample plot were numbered and they had two cross diameters at breast height measured, with a degree of accuracy of 1 mm. Hypsometer Vertex III was used for the purposes of measuring tree height. During the measurements, the trees were classified according to their biological position, quality of the trunk and degree of crown position freedom into the following three-level classification:

- Biological-position (BP): dominant (1) intermediate (2); suppressed (3)
- Degree of crown position freedom (CF): free crown formed without touching the crowns of the neighboring trees or the touching area is less than 25% of the crown perimeter (1); the crown reduced on one side – the touching area is 25-50% of the crown perimeter (2); the crown is reduced on several sides – the area touching the neighboring trees is above 50% of the crown perimeter (3).
- Trunk quality (TQ): good (1); medium (2); poor (3).

Stand volume was determined by using the volume tables for narrow-leaved ash (PANTIĆ, 1996). Current (average periodic) increment of basal area and volume were determined on the basis of measurements of the same set of trees, which was left after the thinning at the age of 38 and 46.

RESULTS AND DISCUSSION

The elements of structure and growth of the investigated narrow-leaved ash stand at the age of 38 after the thinning and at the age of 46 are shown in Tables 1 and 2. The percentage of dominant trees in the structure of 38-year old stand amounts to 59% and they account for 77% of its volume. Only 22% of trees have freely formed crown and they account for 38% of the volume. After the thinning, between the age of 38 and 46, biological differentiation and phytosociological weakening of dominant and intermediate trees could be recognized, i.e. their transition into a lower storey of the stand.

Table 1. Elements of growth of the narrow-leaved ash stand after thinning at the age of 38.

Elements of structure	Total	BP			CF			TQ		
		1	2	3	1	2	3	1	2	3
N [trees·ha^{-1}]	483	286	98	98	108	200	175	123	225	135
G [m^2·ha^{-1}]	24.3	18.5	3.3	2.5	9.0	9.5	5.8	7.5	11.3	5.5
V [m^3·ha^{-1}]	316.2	244.2	41.5	30.5	121.6	122.8	71.9	98.7	147.1	70.3
N [%]	100	59.2	20.4	20.4	22.3	41.4	36.3	25.5	46.5	28.0
G [%]	100	75.9	13.7	10.4	37.2	39.1	23.7	30.8	46.5	22.7
V [%]	100	77.2	13.1	9.6	38.4	38.8	22.7	31.2	46.5	22,2

Table 2. Elements of growth of the narrow-leaved ash stand at the age of 46.

Elements of structure	Total	BP			CF			TQ		
		1	2	3	1	2	3	1	2	3
N [trees·ha^{-1}]	483	255	77	151	68	120	295	120	228	135
G [m^2·ha^{-1}]	30.9	22.6	3.8	4.5	8.3	9.7	12.8	9.9	14.4	6.5
V [m^3·ha^{-1}]	448.4	336.3	53.0	59.1	126.7	144.2	177.5	146.6	209.1	92.6
N [%]	100	52.9	15.9	31.2	14.0	24.8	61.1	24.8	47.1	28.0
G [%]	100	73.2	12.2	14.6	27.1	31.5	41.4	32.1	46.7	21.3
V [%]	100	75.0	11.8	13.2	28.3	32.2	39.6	32.7	46.6	20.7

Out of the total number of trees at the age of 46, dominant trees participated with 53%, accounted for 75% of the volume and only 14% of trees had freely formed crown and they accounted for 28% of the volume. In the stand structure, at the studied ages, about 25% of trees had good-quality trunks which accounted for 31-33% of the volume. While different trunk quality tree categories kept approximately the same percentages at the studied stand ages, the percentage of suppressed trees and trees with the crown reduced on several sides increased at the age of 46 due to biological differentiation and phytosociological weakening of dominant and intermediate trees.

Table 3 shows current increment of basal area and volume in the study stand in the period between the age of 38 and 46 for all trees, trees of different biological position, trees with different degree of crown position freedom and different trunk quality per hectare, according to the state at the age of 46. In the total increment of basal area and volume, dominant trees (53% of trees) participate with 83-84%, trees with freely formed crown (14% of trees) participate with 33-34%, and trees with good-quality trunks (25% of trees) with 38-40%. Trees with the crown reduced on several sides (61% of trees) account for 31-32% of increment, while trees with low-quality trunks (28% of trees) account for 16-17% of increment. Trees with the crown reduced on one side account for more than 35% of basal area and volume increment, and trees with the medium-quality trunk for 44%.

Table 3. Current increment of basal area and volume of narrow-leaved ash trees per hectare in the period from the 38th to the 46th year of age (SP-3).

Elements of increment	Total	BP			CF			TQ		
		1	2	3	1	2	3	1	2	3
I_G [m^2·ha^{-1}·year^{-1}]	0.82	0.69	0.08	0.05	0.28	0.29	0.25	0.33	0.36	0.13
I_V [m^3·ha^{-1}·year^{-1}]	16.52	13.73	1.62	1.17	5.48	5.80	5.24	6.32	7.41	2.79
I_G [%]	100.0	84.1	9.4	6.5	33.9	35.5	30.7	39.8	44.2	16.0
I_V [%]	100.0	83.1	9.8	7.1	33.2	35.1	31.7	38.3	44.8	16.9

Compared to the stand average, which is a common measurement of forest stand growth, dominant trees have 1.59 and 1.57 times greater average annual growth of basal area and volume for the study period from the 38th to the 46th year of the stand age. Trees with freely formed crown have 2.42 and 2.37 times greater growth and trees

with good quality trunks 1.60 and 1.54. Suppressed trees have an annual growth of the stated elements in the amount of 0.21-0.23 of the stand average (Table 4).

Increment potentials of different categories of narrow-leaved ash trees with the best characteristics (BP-1, CF-1 and TQ-1) in the study stand eight years after the thinning show that the biggest average annual growth of basal area and volume is achieved by trees with freely formed crown, in comparison to the stand average. Therefore, this element of stand structure should be the focus of attention in the process of revitalization.

Table 4. Current increment of basal area and volume of different categories of narrow-leaved trees and coefficient of growth in comparison to the stand average.

Category		i_G	i_V	i_G	i_V
		$[m^2 \cdot tree^{-1} \cdot year^{-1}]$	$[m^3 \cdot tree^{-1} \cdot year^{-1}]$	Coefficient	
All trees		0.0017	0.0340	1.00	1.00
BP	1	0.0027	0.0540	1.59	1.57
	2	0.0010	0.0210	0.59	0.62
	3	0.0004	0.0080	0.21	0.23
CF	1	0.0041	0.0810	2.42	2.37
	2	0.0024	0.0480	1.43	1.41
	3	0.0008	0.0180	0.50	0.52
TQ	1	0.0027	0.0530	1.60	1.54
	2	0.0016	0.0330	0.94	0.95
	3	0.0010	0.0210	0.57	0.60

Greater percentage of trees with good-quality trunks (25%) in comparison to trees with freely-formed crown (14%) in the stand structure after the thinning indicates that the optimal procedure for phytosociological revitalization of the stands should be further aimed at achieving their ecological and production functions within the SNR `Gornje Podunavlje`.

CONCLUSIONS

The study of the structure and the elements for phytosociological revitalization of narrow-leaved ash stands in SNR `Gornje Podunavlje` led to the following conclusions:

- At the age of 46, the following parameters were determined in the permanent sample plot (SP-3): $N=483 \times ha^{-1}$, G=30.9 $m^2 \times ha^{-1}$, V=448.41 $m^3 \times ha^{-1}$ and current volume increment 16.52 $m^3 \times ha^{-1} \times year^{-1}$, while dominant trees participated in the total number of trees with 53%, trees with freely-formed crown with 14% and trees with good-quality trunks with 25%;
- In the period between the age of 38 and 46, we observed biological

differentiation and phytosociological weakening of dominant and intermediate trees, i.e. their transition into the lower stand layer;

- Average annual growth of basal area and volume in the stand after the thinning was 1.59-1.57 times bigger in dominant trees, 2.42-2.37 in the trees with freely formed crown and 1.60-1.54 in the trees with good quality trunks in comparison to the stand average. The biggest average annual growth of basal area and volume is achieved by the trees with freely formed crown, in comparison to the stand average. Therefore, this element of stand structure should be the focus of attention in the process of revitalization;
- Average annual growth of basal area and volume in the stand after the thinning for suppressed trees was 21-23% of the stand average, for trees with the crown reduced on several sides was 50-52% of the stand average, and for trees with low-quality trunks was 57-60% of the stand average, which proves that they have secondary ecological and production significance in the stand structure.

ACKNOWLEDGEMENT

This paper was realized as a part of the project:
Establishment of Wood Plantations Intended for Afforestation of Serbia (31041) financed by the Ministry of Education and Science of the Republic of Serbia within the framework Technological development for the period 2011-2014,
`Study of the thinning effects in the narrow-leaved ash stands in Special Nature Reserve `Gornje Podunavlje` (104-401-2178/2012-05-3), financed by the Autonomous Province of Vojvodina - Provincial Secretariat for Agriculture, Water and Forestry.

REFERENCES

1. Andrašev S.: *Razvojno proizvodne karakteristike selekcionisanih klonova crnih topola (sekcije* Aigeiros *Duby) u gornjem i srednjem Podunavlju*. Doktorska disertacija, rukopis, p. 427, Šumarski fakultet, Beograd, 2008.
2. Anić I. Matić S., Oršanić M., Majer Ž.: *Pomlađivanje i njega šuma poplavnih područja*. In: Poplavne šume u Hrvatskoj, monografija (Ur. J. Vukelić), 263-276, Zagreb, 2005.
3. Bobinac, M., Vajištanac, G.: *Istraživanje razvoja i proizvodnosti sastojina poljskog jasena (*Fraxinus angustifolia *Vahl) na nekadašnjem plavnom području Bačkog Monoštora*. Glasnik Šumarskog fakulteta 71-72, Univerzitet u Beogradu-Šumarski fakultet, 203-216, Beograd, 1989/1990.
4. Bobinac M., Andrašev S., Đanić I.: *Example of recent succession of vegetation in the area of Monoštorski rit due to changes in hydrological conditions*. Internatonal conference: "Erosion and torrent control as a factor in sustainable river basin management", Proceedings-CD, 1-7, Belgrade, 2007.
5. Bobinac M., Andrašev S., Simić M.: *Growth elements of tree and stand of ash,*

oak and hornbeam in the alluvial semigley. Ed. Borz A.S., International Symposium "Forest and Sustainable Development". 19th-20th October 2012, Faculty of Silviculture and Forest Engineering, Book of abstracts. p.18, Brasov, Romania., 2012.

6. Bobinac M., Andrašev S., Simić M.: *Retrospective on the structure of dying trees in the artificially established ripening oak stands in the area of the upper Danube basin in Serbia*. First Serbian Forestry Congress-Future with Forests, 11–13th November 2010, Abstracts, p.50, Belgrade, 2010.
7. Čater M., Bobinac M., Levanič T., Simončić P.: *Water status, nutrients and radial increment of pedunculate oak (*Quercus robur *L.) in northern Serbia and comparison with selected sites in Slovenia*. Zbornik gozdarstva in lesarstva 87, 135-144, Ljubljana, 2008.
8. Vukelić J., Baričević D.: The association of spreading elm and narrow-leaved ash (*Fraxino-ulmetum laevis* Slav. 1952) in floodplain forests of the podravina and podunavlje. Hacquetia 3/1, 49-60, Ljubljana, 2004.
9. Pantić, D.: *Zapreminske tablice za poljski jasen (*F. angustifolia *Vahl.) u šumama Ravnog Srema*. Šumarstvo 1-2, 58-62, Beograd, 1996.
10. Panjković B.: *Akvatična i semiakvatična vegetacija apatinskog i monoštorskog rita*. Doktorska disertacija, rukopis, Prirodno-matematički fakultet u Novom Sadu, p. 400, Novi Sad, 2000.
11. Simić M.: *Istraživanje najpovoljnijih uzgojnih mera u različitim ekološko-proizvodnim jedinicama lužnjakovih šuma na području Sombora*. Magistarski rad u rukopisu, Šumarski fakultet u Beogradu, p.154, Beograd, 1987.
12. Tomić Z.: *Šumarska fitocenologija*. Šumarski fakultet Univerziteta u Beogradu, Beograd, 2004.
13. Herpka I.: *Ekološke i biološke osnove autohtonih topola i vrba u ritskim šumama Podunavlja*. Radovi, knj. 7, Institut za topolarstvo, p.229, Novi Sad, 1979.
14. *(2000): *Specijalni rezervat prirode Gornje Podunavlje - predlog za stavljanje pod zaštitu kao prirodnog dobra od izuzetnog značaja*, Ur. B. Kovačević, Zavod za zaštitu prirode Srbije-Odeljenje Novi Sad, p.108, 2000.

Martin Bobinac[1], Siniša Andrašev[2], Milivoj Vučković[1], Branko Stajić[1]
[1] Univerzitet u Beogradu –Šumarski fakultet, Beograd, Srbija,
[2] Univerzitet u Novom Sadu –Institut za nizijsko šumarstvo, Novi Sad, Srbija

FITOSOCIOLOŠKA REVITALIZACIJA SASTOJINA TVRDIH LIŠĆARA NA PODRUČJU SRP "GORNJE PODUNAVLJE"

Abstrakt

Na trajnoj oglednoj površini u nenegovanoj prirodnoj sastojini poljskog jasena na području SRP „Gornje Podunavlje" posle osam godina od prve prorede proučavani su elementi za dalji postupak fitosociološke revitalizacije sastojine. U starosti sastojine 38 godina utvrđeno je: $N=745\times ha^{-1}$, G=33,9 $m^2\times ha^{-1}$, V=438,0 $m^3\times ha^{-1}$, a usled prorede i prirodnog mortaliteta u sastojini je ukupno posečeno 121,7 $m^3\times ha^{-1}$. U starosti sastojine 46 godina utvrđeno je: $N=483\times ha^{-1}$, G=30,9 $m^2\times ha^{-1}$, V=448,4 $m^3\times ha^{-1}$ i tekući zapreminski prirast 16,5 $m^3\times ha^{-1}$, a prema prirastnom potencijalu pojedinih kategorija stabala u sastojini razmatra se izvođenja nove prorede u cilju fitosociološke revitalizacije sastojine.

Key words: *Fraxinus angustifolia Vahl, SRP „Gornje Podunavlje", revitalizacija sastojina, elementi rasta, prorede.*