Journal of Forests
2014 Vol. 1, No. 1, pp. 11-19
ISSN(e): 2409-3807
ISSN(p): 2413-8398

URBAN AREA - REVIEW OF PROTECTIVE FOREST MANAGEMENT

Fran Poštenjak[1]* --- Karmelo Poštenjak[2]

[1]*Cert. ETW, Croatia, Matije Gupca , Jastrebarsko, Croatia*

[2]*PhD, Croatia, Matije Gupca , Jastrebarsko, Croatia*

ABSTRACT

Protective forests are areas, primarily used for wood production in the past, where forests gradually attain different roles based on its purpose and management plan. Forests are significant factors in karst management where over time devastated forest areas have been cultivated with conifers. One of those areas is camp (N 43°55', E 15°30') in small coastal city- Pakoštane, where we've conducted our research. It is almost a century old Aleppo pine culture which spreads over 25 hectare, on limestone based brown and red soil with more than 45 % stony surface. Holm oak forest is community (Orno – Quercetum ilicis H-ić 1957.) with mostly dense canopy, normal density and no silvicultural work in past few decades. The forest has following structure- number of trees: Aleppo pine 346/ha, Holm oak 261/ha, evergreen deciduous bushes (< 2,5m height) 1047/ha or in total 1654/ha; - basal area: Aleppo pine 26,47 m^2/ha, Holm oak 3,23 m^2/ha, evergreen deciduous bushes 4,33 m^2/ha or in total 34,03 m^2/ha. In contrast to normal ecological-management type (EMT) III-L-10 [1] significant differences have been detected. Absence of necessary silvicultural interventions is visible considering relevant indications of present state: average crown transparency "2", short and thin canopy, great number of deadwood: Aleppo pine 432/ha and Holm oak 148/ha, appearance of fungus fruiting body on 60 trees/ha, construction work mechanical damage of both trunk and root system 140 trees/ha and lastly Aleppo pine tree marking conducted by non-professional forester- resulted in wrong selection of trees that are meant to be fallen in future maintenance period. Natural forest degradation that is taking place in this woodland, due to anthropological influence on stand, unfortunately led the forest of this auto-camp in troublesome state.

Keywords: Protective forest, Aleppo pine, Silviculture, *Phellinus pini* (Thore), Urban park governance, Holm oak, Pollution pressure.

Contribution/ Originality

This study contributes to urban forestry- arboriculture, as urban park research on protective forests management and user safety in private parks. It contributes in the existing literature on urban park-protective forest, governance and as a current practice review it points out the ongoing problems and malpractice occurring in urban forestry.

† Corresponding author

1. INTRODUCTION

Forest science in Croatia, as well as legislative, differs three categories of forests and forest stands: managerial forests and protective and special forests. Managerial forest primary use, along the stand conservation, is hsigh quality wood mass production in prescribed period of time. By its definition protective forests have completely different role and managerial goals and other than wood production main purposes of protective forests are:

- preservation of biological diversity of different ecosystems (different protection categories: nature park, national park, regional park, strict nature reserve etc.);
- *in situ* production of forest reproductive material (selected seed stands);
- objects for scientific research and education, protection of erosion degraded area, protection of military industrial and other objects;

Every forest with different primary duty has unique management plans which can in different period produce different amount of primary traditional forest product- wood mass. Forestry of today and in the future will need to turn its attention to "secondary forest products" (clean air, water retention, pollutant particle removal, soil erosion prevention, health and recreational effects etc.) which start to play an indispensable role in everyday economy and society in general, so they are the focal point of successful management. This is particularly important in the karst area of Submediterranean and Eumediterranean region, where mostly destructive human influence on forests has been taking place for centuries and it redefined, reshaped and degraded large areas of natural forest ecosystems which, despite all the recent efforts, remained in some stage of forest degradation even nowadays. Karst area were areas deficient with agriculture lands and in order to produce food mankind needed to cut down woodlands and replace them with vineyards, olives plantations, orchards etc. Land was reforested with mostly pine or cypress trees which gave the local inhabitants a cozy oasis and shelter from the hot weather and sunshade. The protection and conservation of these areas were of high importance and there we can witness the beginning of tree care in karst regions (preservation from devastation, felling trees and especially fire).

Modern society and demand influenced local population and which switched their economy focus from agriculture to tourism and every path of the land, especially near the coastline, is invaluable and is pressured in order to be converted into a commercial lots. That pattern pushed protective forests to the very edge and proper care is a necessity if we are to preserve the current landscape. To make situation even worse protective forests are more and more influenced by air pollution, traffic pollution, soil compaction and other means of devastation that can be linked with urbanization and tourism development.

According to Martinović [2] lowest acid pollutant pressure (S and N) can be tolerated by terra rossa and Calcocambisol soil in *Quercus pubescens* and *Carpinus orientalis* forest community Nearby, on Vransko lake, on experimental plots established in 1970, data shows excess of S for 111,15 % and N 112,01 % while heavy metal concentration on limestone terra rossa is more than normal (for Cu 32,7 mg/kg, Zn 265,0 mg/kg, Pb 401,5 mg/kg and Cd <0,5 mg/kg). Also soil compaction, due to intensive transgression, leads to decrease in soil infiltration capability (5 - 10 times) what results in increased erosion processes, it rises pH and dissolved phosphorus, and decreases humus dissolved potassium and total nitrogen. All stated negative processes indicate on weakened biological processes in the soil as a result of toxic pollution influence.

Every living organism seeks attention- care, and conservation during its existence and forests are no different. So if proper care and intervention is not conducted, in the area heavily influenced with negative processes, it will start to deteriorate even to the point when further intervention will be pointless. Many authors have been examining silvicultural influence on pine stand/culture growth and development in Submediteranean and Eumediterranean [3] [4] [5] [6] [1] [7] [8] [9] [10] [11] [12].

Everything stated can indicate that nowadays care for protection forests, time of great ecological changes and environmental pressure, needs to be given over to the adequately educated professional personnel who know how to bear with problems in integral forest management. Unfortunately in the camp where our research was conducted deterioration took massive swing and proper care was not done on time, what resulted in a complex situation almost past the point of no return. Therefore the current camp insightful management attempt and engagement of professional arborists gives us hope that negative trends of vegetation regression can be stopped and reversed and in time protective forest in motor camp can maybe be rehabilitated.

2. METHODS AND RESEARCH AREA

Camp site where our research has been conducted is situated next to the coastline, west from Pakoštane city center (Pakoštane are situated 7 km south from Biograd n/m), covering the area of 25 hectares. Pakoštane is a small tourist city situated on Adriatic coast 30 km southern from Zadar. Campsite is in function for more than four decades.

In the camp area Aleppo pine trees have been growing with autochthon understory vegetation which belong to ecological managerial type (EMT) III-L-10 [3]. Soil is based on limestone with 25-90% stone surface, shallow to skeletal and it develops mostly brown limestone soils and terra rossa. Camp area is situated on 0-40 MAMSL, with incline ranging from 5-30^0 and southwestern exposition.

Forest culture established 100 years ago, with *Pinus halepensis* as dominating species (95%), on the coastal line some *Pinus pinea* and *Cupressus sempervirens* trees can be found. Understory vegetation mostly consists of: *Arbutuus unedo, Phillyrea media, Phillyrea latifolia, Lonicera implexa, Lonicera etrusca, Laurus nobilis, Pistacia lentiscus, Viburnum tinus, Myrtus commmunis, Rhamnus alaternus, Erica arborea, Smilax aspera, Aspatagus acutifolius* etc. [4].

In the motor camp area three temporary research plots have been established in order to collect relevant measurement data. Experimental plots are all established on different micro localities regarding terrain inclination, percentage of stony surface, scattered canopy surface and were rectangular shape, 100 m by 50 m, right angle was established with prism, and length was measured with steel tape- length 30 m.

Young growth and shrubs are sorted under height classes (<0,25 m, 0,26 - 0,50 m, 0,51 – 0,75 m, 0,76 – 1,00 m, 1,01 – 1,20 m) and measured with tape measure- length 3 m. Trees are measured with tree caliper, with centimeter accuracy (0,1 – 40 cm), tree height and trunk length were measured with universal forestry instrument ("Splošna finomehanika"- Ljubljana) with 0,25 m accuracy, while canopy spread is measured with plastic tape line- accuracy 0,1 m. Crown damage percentage (0, 1a, 1b, 2a, 2b, 3a, 3b, 4) was conducted according to European Forest Institute (EFI) directive. Stand age was determined by counting age rings of freshly fell trees (trees were cut due to trunk breakage, tree sprawl etc.).

All literature used for making this paper is cited.

3. RESULTS AND DISCUSSION

Clear picture of stand structure can be established with usage of distribution of stand elements of holm oak and Aleppo pine on hectare. It shows an array of significant data about the culture: stand development flux, normal or disturbed structure, regeneration, on time carried out silvicultural treatments, growth dynamics, increment etc. When this structure is compared to normal structure of adequate ecological managerial type (EMT) we can get an insight on current stand state, forest perspective in the future- good or bad, and approximate time frame which is needed so normal state is accomplished.

Table-1. Aleppo pine culture structure

Height class (m)	**aleppo pine**			**holm oak**			**shrubs**		
	N	G (m^2)	V (m^3)	N	G (m^2)	V (m^3)	N	G(m^2)	V (m^3)
1	2	3	4	5	6	7	8	9	10
< 0,25							62		
0,26 – 0,50							81		
0,51 – 0,75							157		
0,76 – 1,00							1		
1,01 – 1,20							57		
∑							499		
Diameter class (cm)									
0 - 5				61	0,29	0,04	548	4,33	0,03
6 - 10				19	0,03	0,86			
11 - 15				123	1,51	3,69			
16 - 20				58	1,40	5,80			
21 - 25	38	1,51	9,12						
26 - 30	116	6,89	45,24						
31 - 35	114	9,46	68,40						
36 - 40	78	8,61	67,86						
∑ 0 – 10				*80*	*0,32*	*0,90*	*548*	*4,33*	*0,03*
∑ 11 – 40	*346*	*26,47*	*190,62*	*181*	*2,91*	*9,49*			
∑ 0 – 40	*346*	*26,47*	*190,62*	*261*	*3,23*	*10,39*	*548*	*4,33*	*0,03*
Total	*346*	*26,47*	*190,62*	*261*	*3,23*	*10,39*	*1047*	*4,33*	*0,03*
All species total	1654	34,03	201,04						
Norm. III-L-10	437	39,70	348,00						

Tree phenotype characteristics can indicate the genetic origin- provenance of seeds and seedlings of Aleppo pine which were used for reforestation.

In following table some relevant measured taxative parameters per hectare and normal parameters of adequate EMT III-L-10 of Aleppo pine culture in motor-camp are shown.

In Table 1 we can see significant differences between current Aleppo pine culture structure and normal structure of relevant EMT III-L-10. Smallest difference is between wood stock 55 %, and the biggest in number of trees 79%, while difference between basal areas is 66%.

Next table shows values of some average relevant measured parameters and phenotype parameters per hectare of Aleppo pine culture.

Table-2. Aleppo pine and holm oak measured parameters and phenotype parameters

	crown			**trunk**					
Diameter class (cm)	transparency	height (m)	width (m)	length (m)	fork <½ Ld	fork ½ Ld	fork >½ Ld	mechanical damage	fungi fruiting bodies
					N trees	N trees	N trees	N trees	N trees
1	2	3	4	5	6	7	8	9	10
holm oak									
0 - 5	1a	1,85	1,25	1,35	4	2			
6 - 10	1a	2,25	1,60	1,95	1	2			
11 - 15	1a	2,75	1,85	3,50	6	11		14	
16 - 20	1a	3,35	2,95	4,30			9	11	
∑					**11**	**15**	**9**	**25**	
average	**1a**	**2,64**	**1,93**	**3.23**					
Aleppo pine									
21 - 25	2b	2,85	3,95	10,50				21	6
26 - 30	2b	3,45	4,65	10,80		25		27	19
31 - 35	2a	4,60	5,45	10,80			23	43	24
36 - 40	1b	5,45	6,55	10,90			36	24	11
∑						**25**	**59**	**115**	**60**
average	**2b/2a**	**4,21**	**5,26**	**10,59**					

Table 2. indicates the following measured data:

- holm oak crown has average transparency 1a, its 2,64 m high and 1,93 m wide. Its trunk is 3,23 m long, lower 1/3 fork has 4,2 % of trees, fork on 1/2 trunk length has 5,7 % of trees and fork in upper 1/3 of trunk has 3,4 % of trees. Mechanical damage is visible on 9,6 % of trees per hectare;
- Aleppo pine crown has average transparency 2b/2a, its 4,21 m high and over 5,26 m wide, its trunk is 10,59 m long, fork on 1/2 trunk length has 7,2 % of trees and fork in upper 1/3 of trunk has 17,1 % of trees. Mechanical damage is visible on 33,2 % of trees and visible fungi fruiting bodies are on 17,3 % of trees per hectare;

Table 3. shows data measured on aleppo pine and holm oak stumps (data are calculated so they represent average values per hectare). Data are collected on stumps from trees fallen up to 10 years ago in the auto camp area.

Table-3. Aleppo pine and holm oak average number of dead tree per hectare

Diameter class (cm)	Alepo pine		holm oak		Total	
	N/ha	%	N/ha	%	N/ha	%
1	2	3	4	6	6	7
0 - 5						
6 - 10			91	480	91	480
11 - 15	153		57	46	210	171
16 - 20	148				148	255
21 - 25	57	150			57	150
26 - 30	36	31			36	31
31 - 35	21	18			21	18
36 - 40	17	22			17	22
Total	432	125	148	57	557	92

Table 3 shows us following parameters:

- Aleppo pine culture number of dead trees coincide with number of naturally extracted thinner trees (DBH 11-20 cm and 21-25 cm) of third height grade and high crown transparency (3^{rd} transparency degree), number of dead wood is significant and it indicates that necessary silvicultural treatments were not conducted;
- understory of holm oak shows similar dead trees occurrence as in Aleppo pine, and there are many influences that cause such trend: shallow skeletal soil with large percentage of stone surface, great number of stump shoots that 1-2 were supposed to be chosen and the rest was supposed to be estranged, continuous overshadow and mechanical obstruction of aleppo pine crown, vitality disturbance (crown transparency around 2^{nd} degree), appearance of secondary pests and plant diseases and lastly not conducted silvicultural treatments (individual Aleppo pine that block growth of evergreen oak removal);

When relevant measured parameters of established research planes are compared with normal of EMT III-L-10 and in analysis include the researched pollution data, from the 1970. done in the vicinity of Biograd n/m [2] regarding local acid pollution deposition and transportation soil pollution following facts can be stated:

- the least load of acid deposition can tolerate terra rossa and Calcocambisol soil: nitrogen 7,2 kg/ha/annually and sulphur 11,25 kg/ha/annually;
- near Vransko lake allowed amount of pollution is exceeded: nitrogen 112,01 %, sulphur 111,15 %:
- heavy metal concentration in limestone- terra rossa soil: Cu 32,7 mg/kg, Zn 265,0 mg/kg, Pb 401,5 mg/kg and Cd <0,5 mg/kg;
- due to intensive transgression soil infiltration capacity is decreased (5-10 times) what results in increased erosion- soil surface water outflow. On plots in Biograd in soil pH and dissolved phosphorus raised while humus dissolved potassium and total nitrogen decreased;

- soil on parking lots have heavy metal concentration in upper horizon (0-7 cm) and in humus layer (1-2 cm) significantly higher than surrounding soil, what results in lower biological soil activity (also affected with soil compaction and pollutant deposition);

In Table 1 visible differences are shown in current Aleppo pine culture and normal forest structure EMT III-L-10, smallest difference is between wood stock (55 %), the biggest in number of trees (79%), while difference between basal areas is (66%) what directly indicates that silvicultural treatments in the past were not conducted but also soil degradation caused by higher pollution pressure due to urbanization (tourism, auto camp, parking lots, significantly higher traffic intensity). Data in Table 2 shows lack of silvicultural treatments in the past what can be seen on Holm oak phenotype characteristics. Almost all measured parameters indicate on stagnation in forest development (crown transparency, crown and trunk parameters) and urgent necessity of professional tree care works in the future so current state can be brought to normal.

Aleppo pine phenotype indicates that the forest culture is in the last stage of its development, trees with very long trunk and *Phellinus pini* (Thore) fungi fruiting bodies can be found on great number of trees in the stand. Fungi causes the white trunk rot and consequences of such rot are trunk breaking due to strong wind and wood deterioration [13] . *Phellinus pini* (Thore) is a fungi that spreads with the wind, and its spores infect trees old dried branches from where it growth spread into the trunk. This indicates the necessity of pruning old dried wood from the tree, what was not been done in the past. In order to minimize the area of potential infection it is crucial that cuts are the smallest possible. The fungi has massive infection potential in older stands with great inclination and shallow ground [14]. With that in mind, as this is protection forest, it is recommended that rotation period is shorten because younger trees, if properly taken care of are less prone to infection thus safer for the camp visitors. Critical breaking height of infected trees on site was 2-4 m. In the whole campsite area it is of most importance to identify and make a full diagnostic tests of dangerous trees so further damage can be prevented. Infected trees if properly maintain can still be safe for the environment for several more years (rot progression must be monitored every 1-2 years). Data in Table 3 state that number of dead trees of Aleppo pine coincide with number of naturally extracted thinner trees (DBH 11-20 cm and 21-25 cm) of third height grade and high crown transparency (3^{rd} transparency degree), number of dead trees is significant and it indicates that necessary silvicultural treatments were not conducted. In underwood layer of Holm oak stand similar dead trees appearance can be seen, and there are several stated causes for that. In the whole campsite area we have seen Aleppo pine trees marked for felling but closer analysis showed that they are not critical trees. Annual inspection has to be conducted in order to preserve visitor safety. Stated fact indicate bad practice during felling tree selection- amissed forest management. Severe root damages caused with heavy digging mechanization was also noticed in the camp what shows low tree preservation priority during construction work planning and execution. Motor camp management was informed on that matter but they decided to keep these, clearly unsafe and hazardous, trees.

4. CONCLUSIONS

According to conducted research, and literature research, which relate onto the research object and discussed facts we can conclude the following:

- Aleppo pine culture in motor camp in Pakoštane covers the area of 25 hectare, it is situated in the zone of EMT III-L-10, on 0-40 MAMSL, with incline ranging from 5-30° and southwestern exposition, brown limestone bedrock soil- Calcocambisol and terra rossa;
- soil degradation influenced by higher pollution pressure and land allocation;
- significant differences are identified between current Aleppo pine culture structure and structure of EMT III-L-10, where the most significant differences per hectare was in number of trees 79% and least difference was in wood stock per hectare 55% - direct indication of lack of quality forehand silvicultural treatments;
- holm oak phenotype shows neglectance in conduction the silvicultural intervention, almost all measured parameters indicate stagnation in forest development and necessity of quality tree care in the future period;
- Aleppo pine phenotype indicates that the forest culture is in the last stage of its development, trees with very long trunk, high crowns and *Phellinus pini* (Thore) fungi fruiting bodies can be found on great number of trees in the stand. Fungi causes the white trunk rot and consequences of such rot are trunk breaking due to strong wind and wood deterioration;
- dead trees appearance coincide with number of naturally extracted thinner trees and great crown transparency (3rd transparency degree), number of dead wood is significant and it indicates that necessary silvicultural interventions were not conducted during Aleppo pine culture development;
- understory of Holm oak stand similar deadwood appearance can be seen, and there are several stated causes for that (shallow skeletal soil with large percentage of stone surface, great number of stump shoots that 1-2 were supposed to be chosen and the rest was supposed to be estranged, continuous overshadow and mechanical obstruction of Aleppo pine crown, vitality disturbance (crown transparency around 2nd degree), appearance of secondary pests and plant diseases and lastly not conducted silvicultural treatments (individual Aleppo pine that block growth of Holm oak removal);
- although there are several positive biases towards preservation of protective forest, with current state of Aleppo pine culture in mind, camp management must alter their attitude towards camp greenery, particularly trees, if they want to prevent possible damage caused by in the past poorly maintained trees in the camp area;

REFERENCES

[1] D. Cestar, V. Hren, Z. Kovačević, J. Martinović, and Z. Pelcer, *Ekološko gospodarski tipovi šuma dijela Gorskog kotara i hrvatskog primorja*. litografirano, Zagreb: Institut Za Tipološka Istraživanja, 1971.

[2] J. Martinović, *Gospodarenje šumskim tlima u Hrvatsko*. Zagreb: Šumarski Institut, Hrvatske Sume Zagreb, 2003.

[3] J. Balen, *Naš goli krš*. Zagreb: Tisak Zaklade Tiskare Narodnih Novina u Zagrebu, 1931.

[4] J. Bilandžija, "Prof. D. Klepac o kombiniranom gospodarenju mediteranskim šumama i brdskim ekosustavima na tečaju održanom 1988. U Channi," *Šumarski list, Zagreb*, vol. 112, pp. 55-57, 1998.

[5] Z. Bubalo, "Rast i prirast šumskih kultura crnog bora (Pinus Nigra J.F.Arnold) na području šumarije Imotski," Master Thesis, Zagreb, 2011.

[6] Z. Đurđević, "Šumskouzgojne osobine kultura crnog bora (Pinus Nigra Arn.) na području Imotskog," Master Thesis, Zagreb.

[7] M. Gradečki, Z. Pelcer, and K. Poštenjak, "Ekološko gospodarski tipovi šuma NP Paklenica s posebnim osvrtom na šume crnog bora (Pinus Nigra Arn.). I obnovu šuma na kršu," presented at the NP Paklenica 45th Anniversary Syposium, Paklenički Zbornik, Starigrad Paklenica, 1995.

[8] Š. Meštrović, "Utjecaj bodovih kultura na čistoću zraka u kliško-solinskom bazenu," PhD Thesis, Zagreb, 1976.

[9] S. Orlić, "Njega mladih borovih sastojina proredom," *Šumarski list, Zagreb*, vol. 114, pp. 369-381, 1990.

[10] V. Skorup, "Uređivanje šuma crnog bora (Pinus Nigra Arn.) Na padinama Velike kapele i velebita," Master Thesis, Senj, 1998.

[11] J. Šafar, "Problem proizvodnosti kultura crnog bora u submediteranskoj zoni," *Šumarski list, Zagreb*, vol. 1-2, pp. 32-40, 1962.

[12] D. Cestar, V. Hren, Z. Kovačević, J. Martinović, and Z. Pelcer, "Istraživanje ekološko gospodarskih tipova šuma eumediternaskog i submediternaskog područja," *Šumarski List, Zagreb*, vol. 3-4, pp. 168-171, 1971.

[13] C. Tomiczek, D. Diminić, T. Cech, B. Hrašovec, H. Krehan, M. Pernek, and B. Perny, *Bolesti i štetnici urbanog drveća*. Zagreb: Sveučilište U Zagrebu, 2007.

[14] D. Diminić, "Utjecaj fitopatogenioh gljiva u zdravstvenom stanju kultura crnog bora u Hrvatskoj," *Znanost U Potrajnom Gospodarenju Hrvatskim Sumama, Zagreb*, vol. I, pp. 269-276, 2001.