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Nakladnik / Published by:
Javna ustanova "Park prirode Lonjsko polje"
Lonjsko Polje Nature Park Public Service
HR-44324 Jasenovac, Trg kralja Petra Svačića bb
Hrvatska / Croatia

Glavni i odgovorni urednik / Editor in chief:
Goran Gugić

Uredništvo / Editorial board:
Darko Kovačić, Radenko Deželić, Martin Schneider-Jacoby

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Adresa uredništva / Adress of the Editorial Board:
Javna ustanova "Park prirode Lonjsko Polje"
Bilten
HR-44324 Jasenovac
Trg kralja Petra Svačića bb
HRVATSKA / CROATIA

Tel./faks:
++385 (0)44 672 080

E-mail:
pp.lonjsko.polje@sk.htnet.hr

Prijevod / Translation:
Graham McMaster, Ivana Maguire

Lektor i korektor
Ivan Jindra

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UVOD

U ime Javne ustanove Park prirode Lonjsko polje pozdravljam sve vas, poštovani kolege šumari, znanstvenici, ekolozi, novinari i predstavnici lokalne uprave, mjerodavnih državnih tijela i zaštićenih područja, ovdje u Novoj Gradiški, na stručnom skupu Stanje šuma u Parku prirode Lonjsko polje, gospodarenje i očuvanje krajobrazne i biološke raznolikosti.

Mislim da je Nova Gradiška dobro izabrana za održavanje takvog skupa. Reći ću vam i zašto. Ima tome već nekoliko godina - sjećam se da se tada još nisam mogao požaliti na pojavu prvih sijedih vlasi zbog ravnateljskih briga - otkako sam, u potrazi za podacima o području današnjega Parka prirode, pronašao ratni arhiv u Beču. U hrpi knjiga, koje mi je uručio arhivar, bila je i jedna naslovljena "Forsteinrichtungswerk für das Neu-Gradischkaner Regiment", u prijevodu "Šumskogospodarska osnova za novogradišćansku pukovniju", izdana godine 1882. Onome tko tu osnovu zna čitati, otvara se fascinantan uvid u stanje, strukturu i povijest nizinskih poplavnih šuma u donjem dijelu današnjega Parka prirode.

Nizinske poplavne šume, ne samo što su same po sebi neprocjenjiva biološka i krajobrazna vrijednost, ne samo što znače nešto po čemu je Hrvatska prepoznatljiva na međunarodnoj razini nego se u nizinskim poplavnim šumama ogleda velikim dijelom i povijest šumarske struke u Hrvatskoj. Želim reći: šumari su aktivno sudjelovali u stvaranju jedinstvenoga kulturnog krajobraza parka prirode Lonjsko polje. Oni i danas moraju biti njegov sastavni dio.

Iz toga proizlazi velika odgovornost sviju nas; najveća ozbiljnost i profesionalnost u našem pristupu dopustite mi takav izraz - uzgajivačko umijeće svakoga šumara koji gospodari nizinskim poplavnim šumama i - dopustite mi ponovno takav izraz - upravljačko umijeće onih koji zaštićenim područjem upravljaju kako bi se očuvala ta prekrasna drevna slika koju je Josip Kozarac godine 1888. upravo ovdje, na mjestu današnjega Parka prirode Lonjsko polje, opisao u svojoj crtici "Slavonska šuma".

S takvom svrhom želimo danas raditi na ovom stručnom skupu. Zaživjela je naša suradnja i na terenu. Ona je već dosegnula takve razmjere da sada već moramo tražiti konkretna rješenja za neke probleme, iz čega bi, po mojemu mišljenju, trebale proizaći konkretne upute našim operativcima kako bi naša suradnja bila što djelotvornija, racionalnija i što manje opterećena administrativnim postupcima.

PREFACE

On behalf of Lonjsko Polje Nature Park Public Institute I bid you welcome, distinguished fellow foresters, scientists, ecologists, ecologists, journalists and representatives of local government and the competent central government bodies and representatives of the conservation areas, here, in Nova Gradiška, at this conference concerning the Condition of the Forests in Lonjsko Polje Nature Park the Management and Preservation of Landscape and Biological Diversity.

I think that Nova Gradiška is a location very well selected for the holding of such a conference. And I can tell you why: it is now several years, and I recall that I had not at that time begun to complain about the appearance of the first grey hairs brought on by directorial cares when in search of data about the area of today's nature park I went over the military archives in Vienna. In a pile of books that I was handed by the archivist there was one the title of which was: Forsteinrichtungswerk für das Neu-Gradischkaner Regiment or the Forest Management Plan of the Nova Gradiška Regiment, dated 1882. Anyone who can read this Plan can get a fascinating insight into the state, structure and history of the lowland riparian forests in the lower part of today's nature park.

Lowland riparian forests not only inherently constitute an invaluable biological and landscape value, not only constitute something that makes Croatia recognisable at the international level, but in the lowland riparian forests a great deal of the history of the profession of forester in Croatia is reflected. By this I mean that the foresters have taken an active part in the creation of the unique cultural landscape of Lonjsko Polje Nature Park. And today too they have to be an integral part of it.

From this derives the great responsibility that we all share. It requires the maximum seriousness and professionalism in our approach, it requires, and allow me to use this kind of expression, the silviculture skills of each forester who manages the lowland riparian forests, and it seeks and forgive this expression again the management skills of those who are the stewards of the protected areas in order for us to be able to preserve the lovely, ancient picture that in 1888, Josip Kozarac, precisely here, in today's Lonjsko Polje Nature Park described in his sketch Slavonian Woods.

It is from this point of view that we would like to work today at this conference.

Zato molim predavače da se strogo drže ograničenja predviđenih programom kako bismo osigurali vrijeme za bezuvjetno potrebnu raspravu, a sudionike da se u raspravi usredotoče na konkretne i operativne prijedloge koji se odnose na područje parka prirode Lonjsko polje.

Veseli me što se Šumarski fakultet uključio kao suorganizator ovoga stručnog skupa, pa ću iskoristiti priliku da za to zahvalim predstavniku Fakulteta, dekanu prof. Zvonku Seletkoviću.

Veseli me što među nazočnima mogu pozdraviti i svoga prethodnika, šumara, gospodina Stjepana Crnka.

Napokon, svima nama želim uspjeh ovoga stručnog skupa.

Ravnatelj:

Goran Gugić

Collaboration between us in the field has come to life, too. It has assumed such dimensions already that now we have to accept the search for concrete solutions of certain problems that in my opinion should result in the finding of concrete instructions to operational staff so that our collaboration should be still more efficient, rational and to the least extent possible burdened with administrative and management procedures. For this reason I would like to ask lecturers to keep strictly to the timetable foreseen in the programme so that we should be able to provide the time for the absolutely essential discussion, and so that participants in the discussion should be able to concentrate on the concrete and operational proposals that relate to the area of Lonjsko Polje Nature Park. I am very happy that the Faculty of Forestry has joined in as co-organiser of the conference, and I would like to give special thanks to the representative of the faculty, Dean Professor Zvonko Seletković.

I am also happy to be able to see among those present my predecessor, Mr Stjepan Crnko the forester.

And now I would like to wish us all a very successfully produced conference.

Managing director

Goran Gugić

STANJE ŠUMA SREDNJE POSAVINE

Uvod

U radu je prikazano stanje šuma na području između željezničke pruge Zagreb - Slavonski Brod, na sjeveru, i rijeke Save, na jugu, od Dubrovčaka i Ivanić Grada, na zapadu, do rijeke Orljave, na istoku.
Riječ je o nizinskom području, većim dijelom u poplavnom pojasu rijeke Save. Uz Savu, bitan utjecaj na hidrološke prilike ovoga područja imaju i njezine pritoke (Orljava, Šumetlica, Sloboština, Ilova, Česma, Lonja, Pakra, Trebež). Voda kao ekološki čimbenik (oborinska, poplavna ili podzemna) presudno utječe na stanje i sastav nizinskih šuma Posavine.
Hidrotehnički i infrastrukturni zahvati promijenili su vodni režim, što znatno pridonosi nestabilnosti i propadanju šumskih ekosustava na promatranom području.
Glavnina tih šuma tvori retenciju za regulaciju visokih voda rijeke Save.
U nizinskim šumama Posavine razlikuju se tri skupine ekosustva koji se pojavljuju u različitim oblicima dolinskog mikroreljefa:

1. **Šumski ekosustavi na mikrouzvisinama (grede)**
   Predstavnik ove skupine ekosustva je šuma hrasta lužnjaka i običnoga graba *(Carpino betuli-Quercetum roboris typicum Rauš 71)*

2. **Šumski ekosustavi u mikroudubinama (nize)**
   Predstavnik ove skupine ekosustava je šuma hrasta lužnjaka i velike žutilovke s rastavljenim šašem *(Genisto elatae-Quercetum roboris caricetosum remotae Ht. 38)*

3. **Šumski ekosustavi u mokrim mikroudubinama (bare)**
   Predstavnik ove skupine ekosustava je šuma poljskog jasena s kasnim drijemovcem *(Leucoio-Fraxinetum agnustifoliae Glav. 59)*

Prikaz stanja šuma ovdje se temelji na šumskogospodarskim osnovama područja, stanje 1996. godine.

Površina šuma i šumskih zemljišta

Državne šume i šumska zemljišta na promatranom području pokrivaju 51 697 ha, a glavninom gospodari

THE CONDITION OF THE FORESTS OF CENTRAL POSAVINA

Introduction

This paper considers the state of affairs in the forests in the area between the Zagreb-Slavonski Brod railway line to the north and the Sava River to the south, from Dubrovčak and Ivanić Grad to the west, and the Orljave River to the east.
This is a lowland area, most of it in the floodplain of the Sava River. As well as the Sava, the hydrological circumstances in the area are crucially influenced by its tributaries (the Orljava, Sumetlica, Slobostina, Ilova, Česma, Lonja, Pakra and Trebež). Water is the ecological fact as precipitation, as flooding or underground water that has a crucial effect on the condition and composition of the lowland forests of Posavina.
Hydro-engineering and infrastructure operations have changed the water regime, which mainly has led in turn to instability in and dieback of forest ecosystems in the region under observation. The major part of the forest area constitutes a floodwater retention area for the regulation of high water in the Sava River.
In the lowland forests of Posavina, we can distinguish three groups of ecosystems that are inundated with various forms of valley micro-relief.

1. **Forest ecosystems on micro-elevations**
   A representative of this group of ecosystems is the common oak and hornbeam forest (Carpino betuli-Quercetum roboris typicum Raus 71)

2. **Forest ecosystems in mirco-depressions.**
   A representative of this group of ecosystems is the forest of common oak and broom with scattered reeds. Genisto elatae-Quercetum roboris caricetosum remotae Ht.38)

3. **Forest ecosystem in wet micro-depressions (pools)**
   A representative of this group of ecosystems is the forest of narrow-leaved ash with snowflake (Leucoio-Fraxinetum agnustifoliae Glav.59).

An account of the condition of the forests is given, according to the forest management plan of the area, as of 1996.

Area of forests and forest lands.

The total area of state-owned forests and forest lands in the area under observation comes to 51,697

poduzeće “Hrvatske šume” d.o.o. (49 941 ha), manjom površinom državnih šuma gospodare Šumarski fakultet (513 ha) i Hrvatske vode (1243 ha). Privatne šume u tom području zauzimaju između 10 i 20% površina državnih šuma. Dakle, dok su sada šume srednje Posavine pretežno u državnom vlasništvu, prije Drugoga svjetskog rata u državnom vlasništvu bilo je oko 42% šuma, imovne općine su gospodarile sa 34% ukupnih površina, zemljišne zajednice sa 16%, a ostatak su bili različiti oblici privatnoga vlasništva.
Otvorenost šuma prometnicama iznosila je 1996. godine 8,9 km/000 ha.

Struktura površina šuma i šumskih zemljišta za površine kojima gospodare Hrvatske šume d.o.o. prikazana je u sljedećoj tablici:

ha, most of it being managed by the firm Croatian Forests d.o.o. (49,941 ha). A small area of the state-owned forests is managed by the Forestry Faculty (513 ha) and Croatian Water (1,243 ha). The area of private forests inside this area comes to between 10 and 20% of the area of the state-owned forests.
Thus, at the moment the forests of central Posavina are mostly state-owned, while before World War II about 42% of the forests were state-owned; corporations managed about 34% of the total area, land communities about 16%, with the rest being in various forms of private ownership.
The forests were accessible by road in 1996 in the ratio of 8.9 km/000 ha.

The structure of the areas of forests and forest lands with respect to the areas managed by Croatian Forests d.o.o. is shown in the following table:

Tablica 1.

Namjena šume	***Površine šuma i šumskih zemljišta***				
	Obraslo	Neobraslo		Neplodno	Ukupno
		Proizvodno	Neproizvodno		
	ha				
Gospodarska	42.938	3.999	1.209	1.372	49.518
Zaštitna				01	01
Posebna	417	00	01	04	422
Ukupno	43.355	3.999	1.210	1.377	49.941

Table 1.

Purpose of forests	***Forest and forest land areas***				
	Covered	Not covered		Unfertile	Total
		Productive	Non productive		
	ha				
Commercial	42.938	3.999	1.209	1.372	49.518
Protective				01	01
Special	417	00	01	04	422
Total	43.355	3.999	1.210	1.377	49.941

U parku prirode Lonjsko polje nalazi se oko 29 000 ha državnih šuma ili 58% nizinskih šuma na području srednje Posavine.

Drvna zaliha i prirast

Drvna zaliha iskazana je na površini od 34 418 ha sastojina starijih od prvog dobnog razreda; hrast lužnjak i jasen tvore 88% drvne zalihe.

Within Lonjsko Polje Nature Park there are about 29,000 ha of state-owned forests, or about 58% of the lowland forests in the area of Central Posavina.

Timber reserves and increment

Timber reserves are expressed on the area of 34,418 of stands older than the first cohort, common oak and narrow-leaved ash making up 88% of the timber reserves.

Tablica 2.

Vrsta drveća	*Drvna zaliha*		*Prirast*	
	m^3	*%*	*m^3*	*%*
Lužnjak	6.648.113	55,89	163.587	48,79
Bukva	6.946	0,06	323	0,09
P. jasen	3.825.924	32,16	120.634	35,99
A. jasen	13.573	0,11	978	0,29
O. grab	622.829	5,23	19.356	5,77
Klen	46.883	0,39	1.801	0,54
N. brijest	66.038	0,55	2.913	0,87
O. voće	1.710	0,01	48	0,01
OTB	135.659	1,14	5.477	1,63
M. lipa	98	0	3	0
C. joha	340.019	2,86	12.581	3,75
O. vrba	18.265	0,15	1.002	0,3
D. topole	53.611	0,45	1.913	0,57
EA. topole	75.597	0,63	3.038	0,9
OMB	36.665	0,3	1.306	0,39
OC	3.528	0,03	262	0,08
UKUPNO	11.895.458	100	335.222	100
m^3/ha	346		9,7	

Table 2.

Tree species	*Timber rese ves*			
	m^3	*%*	*m^3*	*%*
Oak	6.648.113	55,89	163.587	48,79
Beech	6.946	0,06	323	0,09
NL Ash	3.825.924	32,16	120.634	35,99
A. Ash	13.573	0,11	978	0,29
Hornbeam	622.829	5,23	19.356	5,77
Common maple	46.883	0,39	1.801	0,54
Lowland Elm	66.038	0,55	2.913	0,87
Common Fruit	1.710	0,01	48	0,01
Other hardleaf	135.659	1,14	5.477	1,63
SL. Lime	98	0	3	0
Black Alder	340.019	2,86	12.581	3,75
Willow	18.265	0,15	1.002	0,3
Domestic Poplar	53.611	0,45	1.913	0,57
E/A Poplar	75.597	0,63	3.038	0,9
Other softleaf	36.665	0,3	1.306	0,39
Other conifer	3.528	0,03	262	0,08
TOTAL	11.895.458	100	335.222	100
m^3/ha	346		9,7	

Namjena šuma i uređajni razredi

Purpose of Forests and Management Classes

Tablica 3.

Namjena	*Uređajni razred*	*Površina, ha*
Gospodarske šume	Sjemenjača lužnjaka	25.234
	Sjemenjača p. jasena	13.252
	Sjemenjača o. graba	6
	Sjemenjača c. johe	824
	Sjemenjača d. topola	143
	Sjemenjača b. vrbe	55
	Ostale sjemenjače	32
	Panjača lužnjaka	350
	Panjača p. jasena	76
	Panjača o. graba	38
	Panjača crne johe	156
	Panjača bijele vrbe	4
	Plantaža EA. topole	647
	Obični bor	1
	Ostala crnogorica	25
	UKUPNO GOSPODARSKE ŠUME	**40.843**
Posebne namjene	Znanstvena istr.- sjemenjača p. jasena	2
	Znanstvana istr.-ostale sjemenjače	8
	Sjemenska sastojina- hrast lužnjak	280
	Sjemenska sastojina- crna joha	9
	Sjemenska sastojina- ostale sjemenjače	40
	Posebni rezervat-sjemenjača lužnjaka	55
	UKUPNO POSEBNA NAMJENA	**394**
SVEUKUPNO		**41.237**

Table 3.

Purpose	*Management class*	*Area, ha*
Industrial forest	Common oak, seed trees	25.234
	Narrow-leaved ash, seed trees	13.252
	Hornbeam, seed trees	6
	Black alder, seed trees	824
	Domestic poplar, seed trees	143
	White willow, seed trees	55
	Other seed trees	32
	Oak coppice	350
	NL ash coppice	76
	Hornbeam coppice	38
	Black alder coppice	156
	White willow coppice	4
	E/A poplar plantations	647
	Common pine	1
	Other conifers	25
	TOTAL FOR INDUSTRIAL WOODS	**40.843**
Special purpose	NL Ash – scientific research	2
	Other seed trees – scientific research	8
	Common oak seed stands	280
	Black alder – seed stand	9
	Seed stands – other seed trees	40
	Special reserve – common oak seed trees	55
	TOTAL FOR SPECIAL PURPOSES	**394**
GRAND TOTAL		**41.237**

Dobna struktura i normalitet

S obzirom na to da uređajni razredi sjemenjača hrasta lužnjaka i sjemenjača poljskog jasena čine više od 93% ukupnih obraslih površina, pokazat ćemo njihove dobne strukture i normalitet sastojina. Šumskogospodarskom osnovom područja propisani etat glavnog prihoda za I/1 gospodarsko polurazdoblje na površini od 1901 ha za uređajni razred hrasta lužnjaka (N=3605 ha) i 2619 ha za uređajni razred poljskog jasena (N=3313 ha) usmjeren je na postizanje normalne dobne strukture sastojina, što je, naravno, dugoročna zadaća.

Zdravstveno stanje šuma

Zdravstveno stanje šuma na promatranom području najbolje oslikava podatak o udjelu suhih i oštećenih stabala hrasta lužnjaka u ukupnom etatu za razdoblje 1996. - 2002. koji iznosi 35%.

Ocjena stanja i prijedlozi za poboljšanje

Stanje šumskih ekosustava na promatranom području u pogledu proizvodnosti, ekološke stabilnosti i biološke raznolikosti nije najbolje.

Uzroke takvom stanju vidimo u sljedećim čimbenicima:

1. Infrastrukturnim i hidrotehničkim zahvatima promijenjen je vodni režim, područje je pretvoreno u periodičku retenciju, što se višestruko nepovoljno odražava na stabilnost ekosustava:
- površine u retenciji postaju vlažnije, na površinama uz duboke kanale snizuje se razina podzemne vode
- slijeganje leda nakon povlačenja zimskih poplava savija i lomi mlada stabalca
- s obzirom na to da je prosječno godišnje trajanje poplave u retenciji tijekom vegetacijskoga razdoblja oko 23 dana, dolazi do propadanja ponika i pomladka šumskih vrsta drveća i grmlja
- za vrijeme poplave, stoka, koja bez nadzora boravi u šumi, divljač i glodavci migriraju na preostale nepoplavljene površine, kojih bude oko 10%, gdje počine znatne gospodarske i ekološke štete
- zbog dugotrajnih poplava vrlo su ograničene mogućnosti izvođenja sječe glavnoga prihoda u propisanim vremenskim razmacima, a zbog raskvašenoga tla nastaju znatne štete na tlu prilikom privlačenja drvnih sortimenata.

2. Početkom prošloga stoljeća šumama na ovom

Age Structure and Even-Age Distribution

Since the management classes of common oak seed trees and narrow-leaved ash seed trees constitute over 93% of the total of covered areas for those management classes, we give a review of the age structure and the even-age distribution of the stands. In the forest management plan of the area the prescribed felling cut for the I/1 management half-period on an area of 1901 for the management class of common oak (N=3605 ha) and 2619 ha for the management class of narrow-leaved ash (N=3313 ha) is aimed at the achievement of an even-aged structure of the stands, which is, of course, a long-term assignment.

The health of the forests

The health of the forests in the area under consideration is best imaged by the figures concerning the proportion of dead and damaged common oak trees in the total permissible cut for the period of 1996-2002, which comes to 35%.

An evaluation of the state of affairs and proposals for improvements

The situation of the forest ecosystems in the area observed with respect to productivity, ecological stability and biological diversity is not optimal.

The causes of this state of affairs can be ascribed to the following factors:
1. Infrastructure operations and hydro-engineering have changed the water regime; the area has been turned into an occasional floodwater retention area, which reflects unfavourably upon the stability of the ecosystem in several ways:
- the areas in the retention area become more humid, in the areas along the deep channels the level of underground water drops;
- the settling of ice after the withdrawal of the winter floods breaks and bends the young trees;
- since the average annual duration of the flooding in the retention area during the vegetation area is about 23 days, the shoots and young trees of forest trees and shrubs decay;
- during the time of the floods, the livestock roams without control in the forest, the game and rodents migrate to the non-inundated areas, about 10%, doing considerable economic and ecological damage;
- because of the long-term floods, there are very limited opportunities for carrying out the logging operations for the main cut in the prescribed intervals of time, and because of the waterlogged ground, damage necessarily is incurred by the ground while the wooden assortments are being hauled.

području počela se širiti biljka *Amorpha fruticosa L.* (divlji bagrem ili čivitnjača) koja od prirode dolazi na području Floride. Ta biljka, čije se sjeme uglavnom širi vodom za vrijeme poplava, vrlo agresivno zauzima sloj grmlja u nizinskim šumama i onemogućuje prirodnu obnovu sastojina te, potiskujući biljke koje tvore sloj grmlja i prizemnog bilja u ovim šumama, znatno sužava biološku raznolikost;

3. Polovicom prošloga stoljeća holandska bolest brijesta, čiji je uzročnik gljiva (*Ophiostoma ulmi*), uzrokovala je intenzivno sušenje i nestajanje nizinskog ili poljskog brijesta (*Ulmus carpinifolia*) iz nizinskih šuma. Udio nizinskog brijesta, koji je do tada činio i do 30% drvne zalihe nizinskih šuma, smanjen je ispod 1%, što također loše utječe na ekološku stabilnost i biološku raznolikost šuma ovoga područja.

Predlažemo zajedničko sudjelovanje šumarske struke i zaštite prirode na popravljanju utvrđenoga stanja, i to sljedećim aktivnostima:

- istraživanjem i predlaganjem modela najpovoljnijega vodnog režima srednje Posavine
- razradom standarda i pravila za ispašu stoke na šumskim površinama (broj grla po jedinici površine, obveze vlasnika, površine na kojima nije dopuštena ispaša i sl.)
- izradom standarda o ekološki prihvatljivom broju divljači u šumskim ekosustavima i obvezom lovozakupnika u pogledu naknade štete koju divljač uzrokuje
- suradnjom na izradi projekata ekološki prihvatljivog otvaranja šuma šumskim prometnicama, čime bi se smanjile štete koje nastaju privlačenjem drvnih sortimenata
- istraživanjem ekološki prihvatljivih metoda za iskorjenjivanje čivitnjače iz nizinskih šumskih ekosustava i participiranje u troškovima
- izradom i zajedničkim provođenjem projekta revitalizacije nizinskog brijesta.

2. At the beginning of the last century, the plant *Amorpha fruticosa L* (bastard indigo occurring naturally in Florida) began to spread in the area. This plant, the seeds of which are mainly disseminated by water during the time of flooding, very aggressively occupies the shrub layer in the lowland forests and precludes the natural regeneration of stands and suppresses plants that make up the epigeal growth and shrug layer, thus considerable reducing biological diversity in these forests.

3. In the middle of the 20th century, the Dutch elm disease, the etiologic agent of which is the fungus *Ophiostoma ulmi*, caused the intensive withering and disappearance of the smooth leaf elm, *Ulmus carpinifolia*, from the lowland forests. The proportion of lowland elm up to that time had constituted up to 30% of the timber reserves of the lowland forests, but was reduced to less than 1%, which has left further negative consequences on the ecological stability and biological diversity of the forests of this region.

We propose a joint approach between the forestry profession and nature conservation to remedy the situation as established, through the following activities:

- research and proposal for a model for the optimisation of the water regime of Central Posavina
- elaboration of standards and rules for the grazing of livestock in the forest areas (number of head per unit of area, obligations of owners, areas in which grazing is not allowed, and so on);
- drawing up a standard for the ecologically acceptable numbers of game in the forest ecosystems and the obligations of game leases with respect to the damage caused by game;
- collaboration on the elaboration of projects of ecologically acceptable opening up of the forests with forest roads, thus reducing the damage resulting while hauling timber;
- research into ecologically acceptable methods for the eradication of bastard indigo from the lowland forest ecosystems and participation in the costs;
- elaboration and joint implementation of a project for the revitalisation of the lowland elm.

Mr.sc. Ivica Milković
Hrvatske šume d.o.o.
Služba za Uređivanje šuma
Lj. Farkaša Vukotinovića 2, 10000 Zagreb

ISKAZ POVRŠINA I STANJE ŠUMA NA PODRUČJU PARKA PRIRODE LONJSKO POLJE KOJIM GOSPODARI UPRAVA ŠUMA, PODRUŽNICA NOVA GRADIŠKA

SCHEDULE OF AREA AND CONDITION OF FORESTS IN THE AREA OF THE LONJSKO POLJE NATURE PARK MANAGED BY THE NOVA GRADIŠKA FOREST DISTRICT

1. Stanje površina šuma i šumskog zemljišta

Gospodarska jedinica	Obraslo	Neobraslo		Neplodno	Ukupno
		Proizvodno	Neproizvodno		
Žabarski bok	776,64	23,81	15,01	46,37	861,83
Krapje đol	1460,38	122,46	31,96	42,84	1657,64
Trstika	1508,12	1,90	32,86	16,48	1559,36
Grede-Kamare	3896,16	663,31	109,01	183,52	4852,00
Zelenika	3241,07	290,50	57,28	88,79	3677,64
Međustrugovi	2135,62	84,38	43,16	138,35	2401,51
U K U P N O :	13016,99	1186,36	289,28	516,35	15008,98

1. Condition of area of forests and forest land

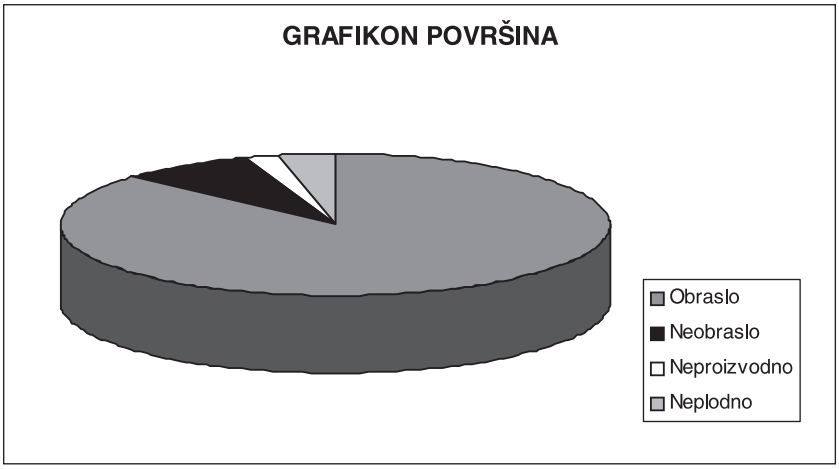
Management unit	Covered	Not covered		Not fertile	TOTAL
		Productive	Not productive		
Žabarski bok	776,64	23,81	15,01	46,37	861,83
Krapje đol	1460,38	122,46	31,96	42,84	1657,64
Trstika	1508,12	1,90	32,86	16,48	1559,36
Grede-Kamare	3896,16	663,31	109,01	183,52	4852,00
Zelenika	3241,07	290,50	57,28	88,79	3677,64
Međustrugovi	2135,62	84,38	43,16	138,35	2401,51
TOTAL	13016,99	1186,36	289,28	516,35	15008,98

1.a. Minirane površine šuma i šumskog zemljišta

Gospodarska jedinica	Obraslo	Neobraslo		Neplodno	Ukupno
		Proizvodno	Neproizvodno		
Grede - Kamare	586,1	105,35	6,95	8,08	710,69
Krapje đol	337,0	4,10	4,57	14,91	360,58
Zelenika	521,07	74,99	8,21	5,4	609,68
UKUPNO:	1444,38	188,44	19,73	28,40	1680,95

1.a. Mined areas of forest and forest land

Management unit	Covered	Not covered		Not fertile	Total
		Productive	Not productive		
Grede-Kamare	586,1	105,35	6,95	8,08	710,69
Krapje đol	337,0	4,10	4,57	14,91	360,58
Zelenika	521,07	74,99	8,21	5,4	609,68
TOTAL:	1444,38	188,44	19,73	28,40	1680,95


GRAFIKON POVRŠINA
Obraslo
Neobraslo
Neproizvodno
Neplodno

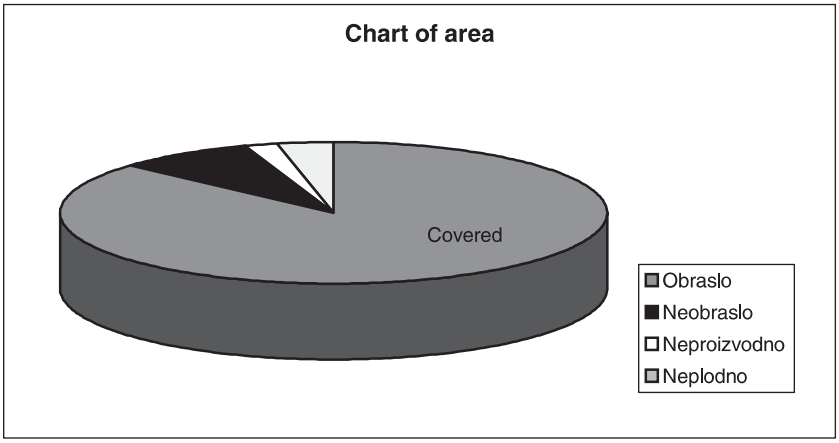
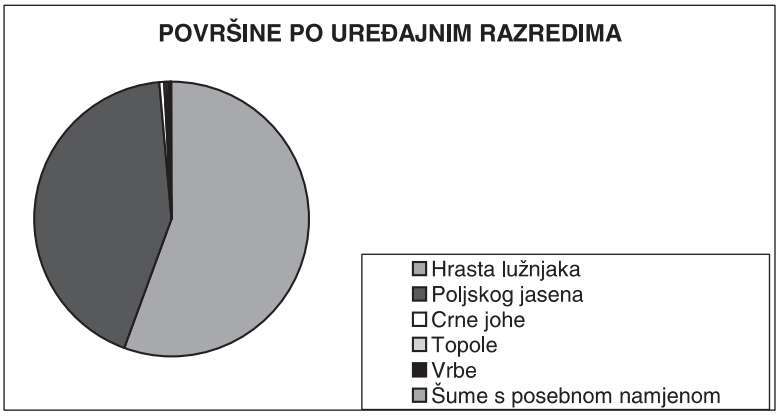


Chart of area
Covered
Obraslo
Neobraslo
Neproizvodno
Neplodno

2. Površina uređajnih razreda

2. Areas of management classes

Uređajni razred	Površina	Udjel %
hrasta lužnjaka	7.218,22	55
poljskog jasena	5.625,27	43
crne johe	62,99	1
topole	51,16	1
vrbe	12,82	
šume s posebnom namj. – sj. sast.	45,97	
Ukupno obraslo zemljište:	**13.016,99**	**100**
Neobraslo proizvodno zemljište		
- za pošumljavanje	118,91	10
- za lovstvo	1.067,45	90
Ukupno neobraslo zemljište:	**1.186,36**	**100**

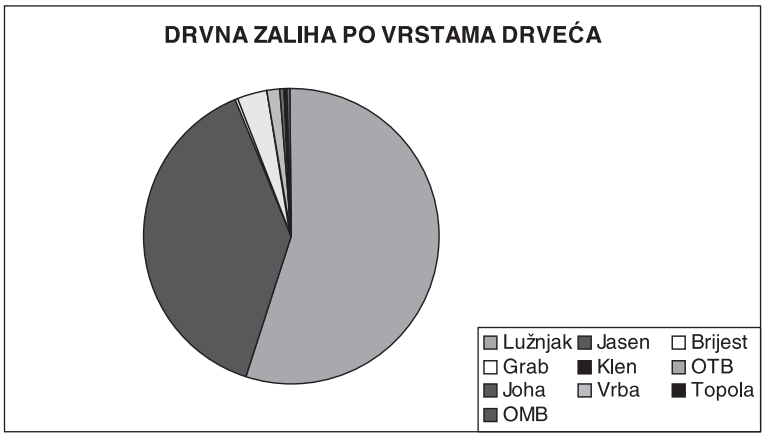


Management class	Area	Percentage
common oak	7.218,22	55
narrow leaved ash	5.625,27	43
black alder	62,99	1
poplar	51,16	1
willows	12,82	
special purpose – seed	45,97	
Total land covered	**13.016,99**	**100**
Productive land not covered		
for afforestation	118,91	10
for chase	1.067,45	90
Total land not covered	**1.186,36**	**100**

3. Drvna zaliha po vrstama drveća

Vrsta	Ž.bok	Kr.đol	Trstika	Gr.-Kam.	Zelen.	Međust.	Ukupno	%
lužnjak	153.533	424.564	315.590	485.293	339.536	402.914	2.121.430	55
jasen	67.688	93.313	163.650	459.655	382.998	350.920	1.518.224	39
brijest	944	962				2.301	4.207	
grab	8.898	11.008	30.711	68.148	5.312	11.240	135.317	4
klen			197	82			279	
OTB	2.347	3.118	13.565	14.770	11.417	4.342	49.559	1
joha	695	1.170	7.846	2.981	6.824	9	19.525	1
vrba	607	515		980	1.198	171	3.471	
topola	396	1.042	328	5.709	1.994	2.372	11.841	
OMB	276	1.155	3.190	1.950	4.281		10.852	
Ukupno	**235.384**	**536.847**	**535.077**	**1039.568**	**753.560**	**774.269**	**3.874.705**	**100**
Prirast	**5.061**	**10.573**	**12.420**	**24.198**	**24.062**	**17.130**	**93.440**	**2,4**

3. Timber reserves per species of tree

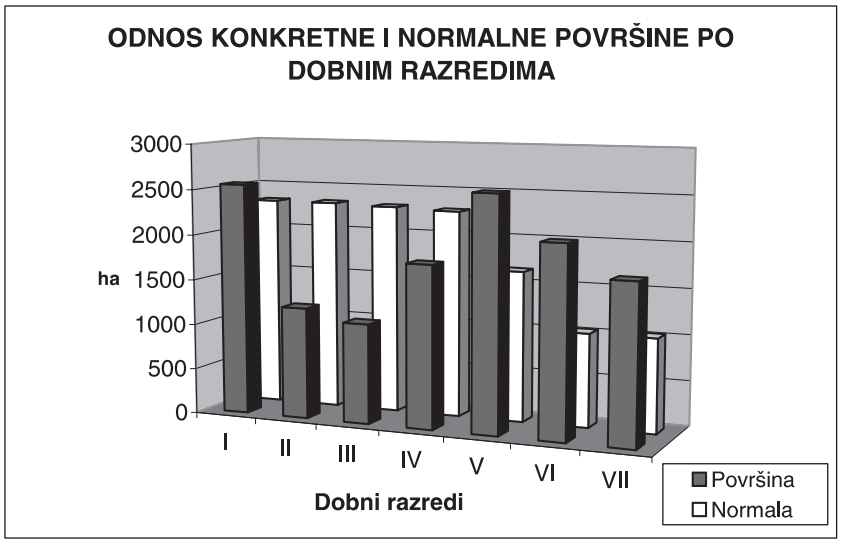


Species	Ž.bok	Kr.đol	Trstika	Gr.-Kam.	Zelen.	Međust.	Total	%
oak	153.533	424.564	315.590	485.293	339.536	402.914	2.121.430	55
ash	67.688	93.313	163.650	459.655	382.998	350.920	1.518.224	39
elm	944	962				2.301	4.207	
hornbeam	8.898	11.008	30.711	68.148	5.312	11.240	135.317	4
f. maple			197	82			279	
hard leaf	2.347	3.118	13.565	14.770	11.417	4.342	49.559	1
alder	695	1.170	7.846	2.981	6.824	9	19.525	1
willow	607	515		980	1.198	171	3.471	
poplar	396	1.042	328	5.709	1.994	2.372	11.841	
conifer	276	1.155	3.190	1.950	4.281		10.852	
Total	**235.384**	**536.847**	**535.077**	**1039.568**	**753.560**	**774.269**	**3.874.705**	**100**
Increment	**5.061**	**10.573**	**12.420**	**24.198**	**24.062**	**17.130**	**93.440**	**2,4**

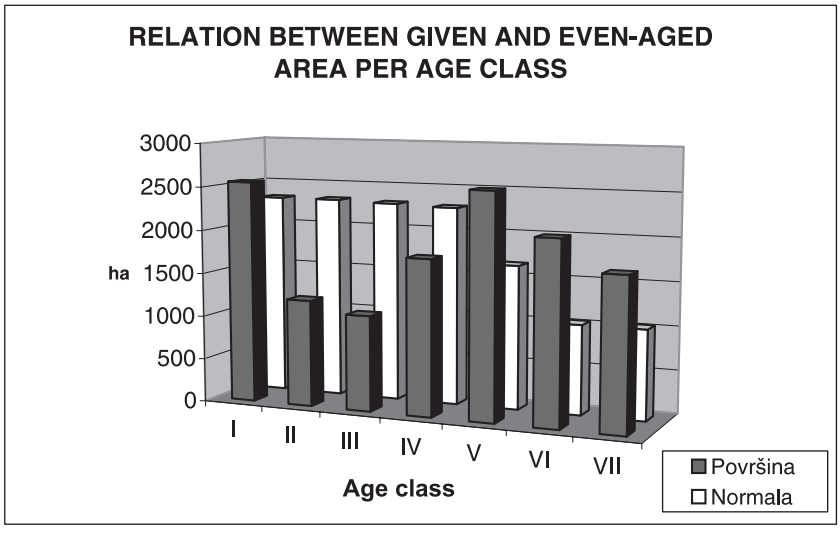
4. Tablica dobnih razreda

4. Table of age classes

Gosp. jedin.	Dobni razredi							
	I	II	III	IV	V	VI	VII	Ukupno
Ž.bok	125,79	137,09	146,20	105,59	145,89	39,72	76,36	776,64
K.đol	78,42	48,34	101,14	382,83	411,21	258,23	180,21	1.460,38
Trstika	379,47	290,25	124,85	251,46	6,70	115,13	340,26	1.508,12
Gr.-Kam.	979,45	196,90	297,32	447,88	753,44	392,68	828,49	3.896,16
Zelen.	837,81	444,66	336,33	517,52	663,60	172,93	268,22	3.241,07
Međust.	152,88	106,24	90,52	75,13	577,14	1.099,70	34,01	2.135,62
Ukupno	**2.553,82**	**1.223,48**	**1.096,36**	**1.780,41**	**2.557,98**	**2.078,39**	**1.727,55**	**13.016,99**



MU	Age classes							
	I	II	III	IV	V	VI	VII	Total
Ž.bok	125,79	137,09	146,20	105,59	145,89	39,72	76,36	776,64
K.đol	78,42	48,34	101,14	382,83	411,21	258,23	180,21	1.460,38
Trstika	379,47	290,25	124,85	251,46	6,70	115,13	340,26	1.508,12
Gr.-Kam.	979,45	196,90	297,32	447,88	753,44	392,68	828,49	3.896,16
Zelen.	837,81	444,66	336,33	517,52	663,60	172,93	268,22	3.241,07
Međust.	152,88	106,24	90,52	75,13	577,14	1.099,70	34,01	2.135,62
Total	**2.553,82**	**1.223,48**	**1.096,36**	**1.780,41**	**2.557,98**	**2.078,39**	**1.727,55**	**13.016,99**



5. Ukupno propisani etat

5. Total permissible cut

Gospodarska jedinica	Glavni prihod		Prethodni prihod	
	Površina	Drvna masa	Površina	Drvna masa
Žabarski bok	24,09	16.620	554,78	23.360
Krapje đol	98,66	26.583	913,88	32.497
Trstika	143,73	51.186	706,93	29.543
Grede-Kamare	387,69	167.976	2.058,05	66.091
Zelenika	436,27	235.284	1.673,17	46.967
Međustrugovi	428,44	125.846	1.361,01	52.298
UKUPNO:	**1.518,88**	**623.495**	**7.267,82**	**250.756**

MU	Main cut		Preliminary cut	
	Area	Wood mass	Area	Wood mass
Žabarski bok	24,09	16.620	554,78	23.360
Krapje đol	98,66	26.583	913,88	32.497
Trstika	143,73	51.186	706,93	29.543
Grede-Kamare	387,69	167.976	2.058,05	66.091
Zelenika	436,27	235.284	1.673,17	46.967
Međustrugovi	428,44	125.846	1.361,01	52.298
TOTAL:	**1.518,88**	**623.495**	**7.267,82**	**250.756**

6. Ukupno propisani uzgojni radovi

6. Total prescribed silviculture works

Uzgojni radovi JBR

Vrsta rada	Ž.bok	Kr.đol	Trstika	Gr.-Kam.	Zelen.	Međust.	Ukupno
Ukl.podr. i gr.	24,09	133,39	104,02	703,84	764,86	435,43	2.165,63
Sjetva i sadnja	24,88	42,29	78,25	342,68	436,76	155,40	1.080,26
Njega pomlatka	67,12	84,51	223,81	555,75	503,34	434,73	1.870,26
Njega mladika	43,85	0,60	35,37	403,19	290,52	11,20	784,73
Čišćenje	30,48	58,92	240,55	389,30	500,99	70,00	1.290,24

Silviculture works

Kind of work	Ž.bok	Kr.đol	Trstika	Gr.-Kam.	Zelen.	Međust.	Total
Removal of	24,09	133,39	104,02	703,84	764,86	435,43	2.165,63
Sowing, planting							
Tending shoots	24,88	42,29	78,25	342,68	436,76	155,40	1.080,26
Tending young	67,12	84,51	223,81	555,75	503,34	434,73	1.870,26
trees	43,85	0,60	35,37	403,19	290,52	11,20	784,73
Clearing							
	30,48	58,92	240,55	389,30	500,99	70,00	1.290,24

Radovi PBR

Vrsta rada	Ž.bok	Kr.đol	Trstika	Gr.-Kam.	Zelen.	Međust.	Ukupno
Pripremni radovi		14,03	11,58	80,31	40,62	67,72	214,26
Pošumljavanje		14,03	11,58	80,31	40,62	67,72	214,26
Njega pomlatka		13,03	11,58	80,31	40,62	67,72	214,26

Works of PBR

Kind of work	Ž.bok	Kr.đol	Trstika	Gr.-Kam.	Zelen.	Međust.	Total
Preparatory		14,03	11,58	80,31	40,62	67,72	214,26
Afforestation		14,03	11,58	80,31	40,62	67,72	214,26
Care of shoots		13,03	11,58	80,31	40,62	67,72	214,26

IZVRŠENI ETAT U PROŠLIH 10 GODINA

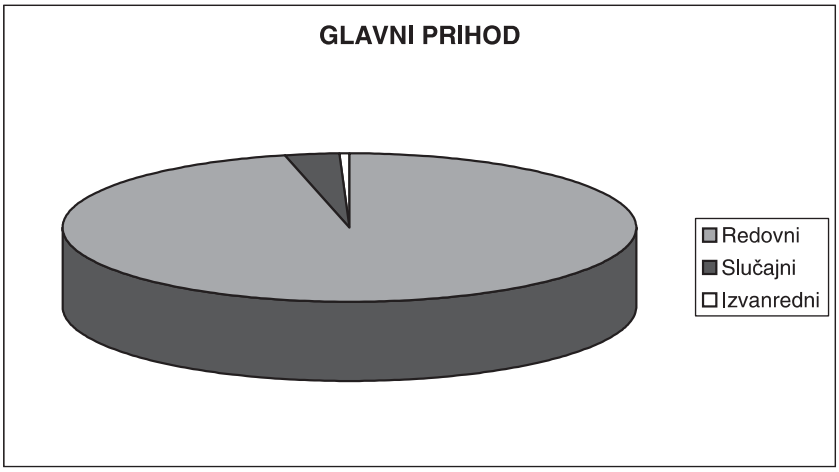
GLAVNI PRIHOD

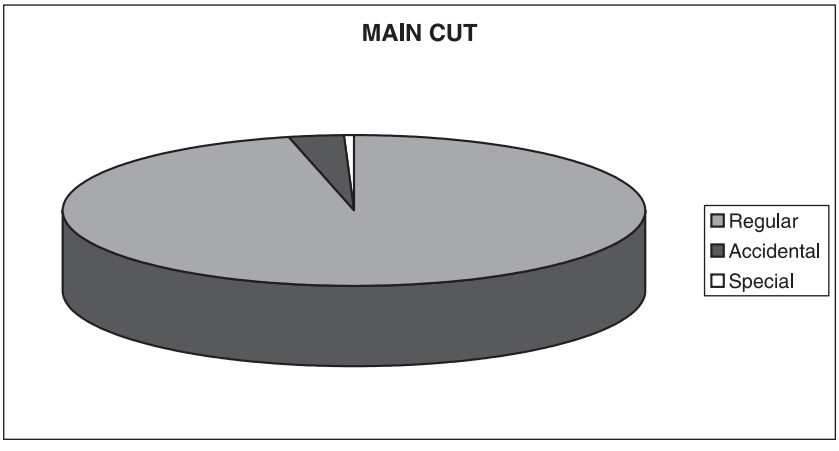
Redoviti	453 230
Slučajni	14 164
Izvanredni	2 174

PERMISSIBLE CUT EXECUTED IN THE LAST TEN YEARS

MAIN CUT

Regular	453 230
Accidental	14 164
Special	2 174



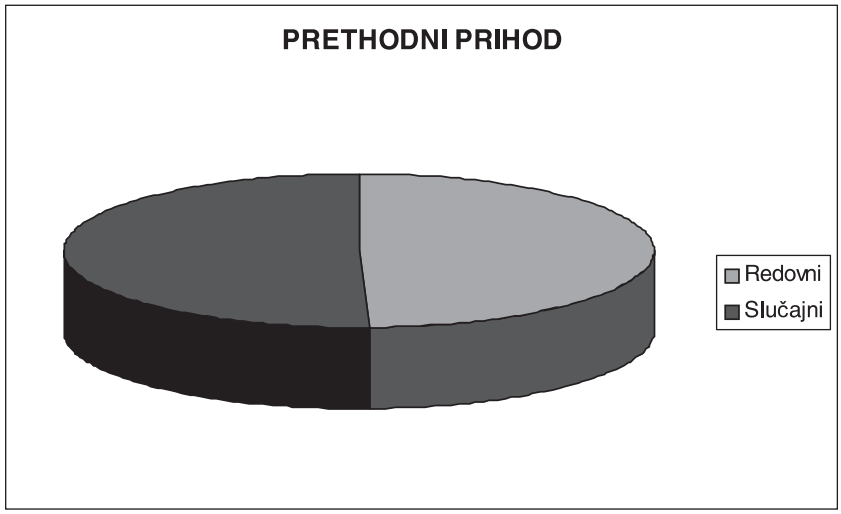


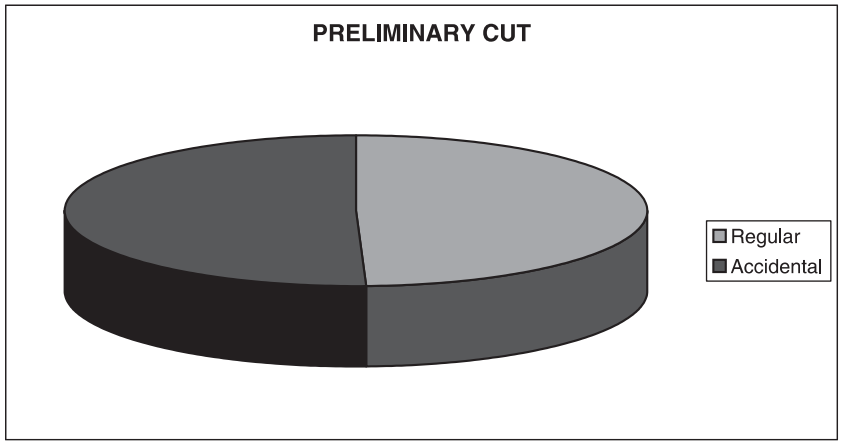
PRETHODNI PRIHOD

Redoviti	163 193
Slučajni	167 496

PRELIMINARY CUT

Regular	163 193
Accidental	167 496





Ivan Štanfar, dipl. ing. šum.
Hrvatske šume d.o.o.
Podružnica Nova Gradiška
Služba za Uređivanje šuma
Strossmazerova 11, 35400 Nova Gradiška

STANJE I PROBLEMATIKA ŠUMA NA PODRUČJU PARKA PRIRODE LONJSKO POLJE

Uprava šuma, Podružnica Zagreb gospodari sa 79 630 ha državnih i 75 800 ha privatnih šuma. Posebnost Podružnice je u tomu da gotovo 30% površine državnih šuma kojima gospodari zauzimaju tri parka prirode: Medvednica - 8200 ha, Žumberak-Samoborsko gorje - 5100 ha i, najviše, Lonjsko polje - 9700 ha. Osim više manjih površina šuma posebne namjene, raspoređenih na cijelom području, želim istaknuti i dvije gospodarske jedinice: park-šuma, i to na području Grada Samobora, G. J. "Tepec-Palačnik-Stražnik" od 345 ha, i park-šume Grada Zagreba, površine 360 ha.

Uprava šuma Podružnica Zagreb među prvima je - što je dokaz dosadašnjega kvalitetnog i pravilnog gospodarenja - dobila FSC-certifikat, i to za područje Šumarije Krapina 17. 12. 2000., a za područje cijele Podružnice 21. 6. 2001.

Uprava šuma Podružnica Zagreb na području parka prirode Lonjsko polje gospodari sa 9700 ha šuma i šumskog zemljišta, što je raspoređeno na tri šumarije: Popovača, Kutina i Lipovljani, a koje obuhvaćaju tri gospodarske jedinice "Popovačke nizinske šume", "Kutinske nizinske šume" i "Josip Kozarac". Unatoč tomu što se nalaze u području parka prirode, sadašnji zakonski i podzakonski propisi tretiraju ih kao normalne gospodarske šume. No tu tvrdnju pobijaju ograničenja u uvjetima zaštite prirode, dobivena od Ministarstva kulture, primjerice, da oplodnu sječu treba provoditi u što duljem vremenskom razdoblju, zatim zabranu uporabe kemijskih sredstava, osim uz posebnu dozvolu Ministarstva, uputu da treba ostavljati zaštitne zone oko gnijezda ptica te pojedinačnih stabala na sječinama. Uz ova i ostala ograničenja, prema Zakonu o zaštiti prirode, proizlazi da to nisu normalne gospodarske šume.

Prema podacima iz "Osnova gospodarenja" na ovom području najzastupljenije su sastojine uređajnog razreda hrasta lužnjaka - ophodnje 140 godina - 64%, te poljskog jasena - ophodnje 80 godina - 23%. Od ostalih uređajnih razreda, koji ukupno zauzimaju 13%, a zastupljeni su u malom postotku, navodim uređajne razrede graba, crne johe, bijele vrbe i topola (domaće i euroameričke).

Stanje zastupljenosti po vrstama drveća je sljedeće: hrast lužnjak je zastupljen sa 55%, poljski jasen 33%, a slijedi grab 5%, joha 3%, dok su sve ostale vrste drveća zastupljene s preostalih 4%.

Stanje sastojina na ovom području prema dobnim razredima je sljedeće: najzastupljeniji je I. dobni razred - 25%, zatim V. - 19%, VI. - 15%, VII. - 13%,

THE CURRENT STATE OF AND PROBLEMS CONNECTED WITH THE FORESTS IN THE AREA OF LONJSKO POLJE NATURE PARK

The Forest Administration Zagreb Branch manages 79,630 ha of state-owned and 75,800 ha of privately-owned forests. The particularity of this branch is that almost 30% of the area of the state-owned forests that it manages is occupied by three nature parks: Medvednica, 8200 ha; Žumberak-Samobor Hills, 5,100 ha; and the largest, Lonjsko Polje, 9,700 ha. Apart from several smallish areas of special purpose forests distributed over the whole area, I would like to make particular reference to two economic units of forest park, the 345 ha Tepec-Palačnik-Stražnik park in the area of the city of Samobor; and the Forest Park of the city of Zagreb, on an area of 360 ha.

The Forest Administration Zagreb Branch was among the first to obtain an FSC certificate as evidence of the high quality and proper management to date, for the area of the Krapina Forest Unit, in December 2000, and for the area of the branch as a whole in June 2001.

The Forest Administration Zagreb Branch manages 9,700 ha of forest and forest land in the area of Lonjsko Polje Nature Park, distributed over three forest units: Popovača, Kutina and Lipovljani, covering three economic units: Popovača lowland Forests, Kutina lowland forests, and Josip Kozarac. In spite of the fact that they are in the nature park, the current statutory and byelaw regulations affect to treat them as normal industrial forests. This however is contradicted by the constraints in the conditions of nature protection sent down by the Ministry of Culture, of which I would like to highlight the seeding cut having to be carried out in as long a period as possible, the ban on the use of chemical preparations except with the special permission of this ministry, leaving a buffer zone around the nests of birds and given trees in the felling areas. From these and other constraints according to the Nature Protection Law, it can be seen that these are not actually normal industrial or commercial forests.

According to data from the General Management Plan, in this area the most highly represented are stands of the management class of common oak, 140 year rotation, 64%; and of narrow-leaved ash, rotation 80 years, 23%. Of the other management classes, which occupy all told 13%, and are represented in small percentages, I would refer to the management classes of hornbeam, black alder, white willows, and poplars (domestic and European and American).

The composition of the forests according to tree species is as follows. Common oak accounts for 55%, narrow-leaved ash for 33%, and then comes hornbeam, with 5%, alder with 3%, and all the other

zatim slijede sastojine III. i IV. dobnog razreda - 9%, te II. sa 8% i VIII. sa 2%. Od ukupne drvne zalihe koja iznosi 2 500 000 m^3 sječe se prosječno godišnje 2,2% ili 81% od prirasta. Od ukupno sječom realizirane drvne zalihe preko 23% drvne zalihe realizirano je u sušcima, što znatno utječe na normalno gospodarenje ovim sastojinama i znatno smanjuje prihod iz ovih šuma.

Dosadašnjim istraživanjima ekosustava poplavnih područja, a u svezi s pojavom sušenja domaćih vrsta drveća (lužnjak, jasen, brijest), utvrđena je međusobna ovisnost razvoja biljnih zajednica, tla i voda. Program rješavanja vodnog režima ovog područja započinje 1963., nakon poplave u gradu Zagrebu, kada započinje regulacija toka rijeke Save i njezinih pritoka na području srednje Posavine, izgradnja odteretnih kanala (Lonja - Strug, Sava - Odra, Zelina - Česma). Uz veće, izgrađen je i cijeli niz manjih kanala i jaraka, koji također imaju veliki utjecaj na vodni režim. Osim kanala na vodni režim, veliki utjecaj ima i mnogo javnih i šumskih prometnica izgrađenih u tom razdoblju.

Svi spomenuti radovi narušili su dotadašnji prirodni režim poplava ovog područja, a područje služi kao retencioni prostor, odnosno područje na koje se kontrolirano izlijeva voda radi sprječavanja poplave na području koje se želi zaštititi.

Stvaranjem retencije znatno je poremećena dotadašnja dinamika dotoka, zadržavanja i otjecanja poplavnih voda, a tijekom godine mijenja se i struktura tla, uz sve veću akumulaciju štetnih tvari. Posljedica dugog zadržavanja vode u retencionom polju je zagrijavanje vode i gubitak kisika u vodi i tlu, što, uz već spomenutu povećanu koncentraciju štetnih tvari u tlu, uzrokuje propadanje i odumiranje korijena.

Dalje, treba reći da je tim radovima na regulaciji vodotoka narušen vodni režim i u ostalom dijelu godine, i to u onom najvažnijem segmentu, a to je razina podzemnih voda, koje su najvažnije za opstanak sastojina. Spuštanje razine podzemnih voda glavni je razlog sušenja sastojina na ovom području, a procijenjeno je da je od 1963. do danas sušenjem oštećeno oko 500 000 m^3 drvne zalihe.

Osim lošeg utjecaja na razvoj i opstanak starih sastojina, na ovom području pojavljuju se veliki problemi obnove sastojina. Dalje zadržavanje vode u retencionom polju tijekom proljeća i u ljetnom razdoblju utječe na propadanje sjemena i, osobito, ponika i pomlatka u sastojinama koje su u procesu obnove, pa čak i u onima kojima je početna faza obnove završena, izvršen dovršni sjek. Zimi, zaleđivanjem tih površina, nastaju novi problemi: led obuhvati mlade biljke i ako poraste razina vode, iščupa ih iz zemlje, odnosno ako razina vode opadne, pritiskom nastaju prelomi i oštećivanja mladih biljaka. Osim spomenutih šteta, led oštećuje i ograde

kinds of tree account for the remaining 4%.

The situation of the stands in this area, according to cohort, is as follows: the most highly represented is the 1st age class, 25%; then the 5th, 19%; the 6th, 15%; the 7th, 13%; then come stands of the 3rd and 4th cohort, 9%; the 2nd, with 8%, and the 8th, 2%. Of the total timber stocks that come to 2,500,000 cubic metres, the average annual cut is 2.2% or 81% of the increment. Of all the timber stocks realised through felling, over 23% is realised in dead trees, which considerably affects normal management of these stands and considerably reduces the earnings from these forests.

Investigation to date into the ecosystems of the riparian area, in connection with the phenomenon of the dying of the domestic species of trees (oak, ash, elm) has shown the interrelationship between the development of the plant communities, the soil and the water. The project to resolve the water regime of this region started in 1963, after the flooding in the city of Zagreb, when the course of the Sava River started be straightened and embanked, as did its tributaries in the area of Central Posavina; relief channels were constructed (Lonja-Strug, Sava-Odra, Zelina-Česma). Along with these major channels, a whole series of smaller channels and ditches were constructed, which also had a major effect on the water regime. Apart from the channels, the great number of public and forest roads built in the period also had a great impact.

All these works distorted the previous natural regime of flooding of the area, and the area began to be used as a retention basin, i.e., an area into which water was released in a controlled way for the purpose of protecting the flooding of areas to be protected. The creation of this retention area considerably disturbed the previous dynamics of inflow, standing and drainage of the flood waters, and over time there were changes in the structure of the soil, with an ever greater accumulation of detrimental substances. The consequences of the long retention of the water in the retention field was the heating of the water and the loss of oxygen in the water and soil, which, alongside the previously mentioned concentration of detrimental substances in the soil, led to the decay and death of the roots.

By the watercourse engineering works already mentioned, the water regime was deranged the rest of the year, in the most important segment, that is, the level of the underground waters, which are most important for the continued survival of stands. The dropping of the levels of the underground waters is the main reason for the mortalitz of the stands in this area, and it is estimated that since 1963, some 500,000 cubic metres of timber stocks have been affected by mortality.

Apart from the development and survival of the old stands there are big problems in the area with the regeneration of the stands. Further standing of the water in the retention field during spring and in the

podignute u svrhu zaštite pomlađenih površina od divljači i stoke.
Iz izloženog možemo zaključiti da je gospodarenje sastojinama znatno otežano, od nemogućnosti planiranja sječa i uzgojnih radova u "Osnovama gospodarenja", do provođenja propisanih radova. Ovo potvrđuje i intenzivnim sušenjem uvjetovana potreba promjene propisa "Osnova gospodarenja" u tijeku jednog polurazdoblja, tako da su za područje G.J. "Josip Kozarac" u tijeku polurazdoblja izrađene dvije izvanredne revizije.
U idućem razdoblju mogu se očekivati veliki problemi, uzrokovani sušenjem stabala, a nastat će i problem obnove, pogotovo sastojina uređajnog razreda jasena i sastojina lužnjaka u kojim je jače zastupljen jasen.
Sušenjem uzrokovano smanjenje kakvoće drvnih sortimenata, smanjit će prihode, a problemi u obnovi dodatno će povećati troškove gospodarenja ovim sastojinama.
Svi ovi problemi evidentirani su i u ostalim nizinskim šumama na području Uprave šuma Podružnica Zagreb, od kojih ističemo G. J. "Žutica" na području Šumarije Novoselec, te G. J. "Turopoljski lug" na području Šumarije Velika Gorica.
Sve podrobnije informacije o sastojinama na području Uprave šuma Podružnica Zagreb možete dobiti na Web stranici / http://www.zagreb.hrsume.hr Uprave šuma Podružnica Zagreb.

summer period means that the seed rots and decays, and the shoots and young trees in the stands, which are in the process of regeneration, even in those in which the initial phase of regeneration has been completed, and the final cut has been accomplished.
In the winter period, when the areas freeze, a new problem arises; the ice takes hold of the young plants, and if there is a rise in the level of the water, it will rip them from the soil, and if the waters drop, the pressure of the sinking ice will lead to the young plants being damaged and broken.
Apart from this kind of damage, ice does damage by breaking the fences put up to protect the regenerated area from domestic livestock and game.
From all this we can conclude that management of the stands is made much more difficult; from the impossibility of planning cuts and silviculture operations in the General Management Plan, to the implementation of such works as have been prescribed. This is also confirmed by the need to change, because of the intensive withering, the regulations of the Management Plan during a single half-period, in such a way that for the area of the Josip Kozarac area, during a half-period, two extraordinary reviews were made. In the coming period it can be expected that there will be big problems brought about by the dying of trees, and the problem of regeneration, particularly of the management class of ash, and of stands of oak in which ash also figures in a major way.
The reduction in the quality of the timber brought about by mortality will lead to reduction in revenue, and problems in regeneration will put up the costs of managing these stands.
All these problems are recorded for the other lowland forests in the area of the Forest Administration Zagreb Branch, of which we could refer particularly to the Žutica Management Unit in the area of the Novoselec Forest Unit, and the Turopoljski lug Management Unit in the area of the Velika Gorica Forest Unit.

All further information about stands in the area of the Forest Administration Zagreb Branch can be found at http://zagreb.hrsume.hr.

Dubravko Janeš, dipl. ing. šum.
Hrvatske šume d.o.o.
Služba za Uređivanje šuma
Podružnica Zagreb,
Ul. Vladimira Nazora 7, 10000 Zagreb

Uprava šuma Podružnica Sisak

NIZINSKE ŠUME

Gospodarska jedinica	Važenost osnove	šifra	površina	zaliha	prirast	etat			POVRŠINE		
						glavni	prethodni	ukupno	obraslo	neobraslo	neplodno
			ha			m^3				ha	
Belčićev gaj - Šikara	1999-2008	379	2380,54	554535	17255	23517	36146	59663	2047,28	298,80	34,46
Brezovica	1997-2006	380	2144,38	494759	19650	38173	34777	72950	1973,45	103,94	66,99
Letovanički lug	1995-2004	386	1591,76	333258	9273	27324	27793	55117	1513,83	36,46	41,47
Leklan	2003-2012	402	538,82	111538	3526	18324	6453	24777	507,54	26,47	4,81
Šumarija Sisak		gospodarske	6655,50	1494090	49704	107338	105169	212507	6042,10	465,67	147,73
Brezovica		park prirode	2031,49	558412	18592	68176	31665	99841	1845,03	160,45	26,01
Šumarija Sisak		ukupno	8686,99	2052502	68296	175514	136834	312348	7887,13	626,12	173,74

Gospodarska jedinica	Važenost osnove	šifra	površina	zaliha	prirast	etat			POVRŠINE		
						glavni	prethodni	ukupno	obraslo	neobraslo	neplodno
			ha			m^3				ha	
Kalje	1999-2008	383	2412,77	506070	17418	24500	45020	69520	2366,03	26,53	20,21
Pešćenica - Cerje	1995-2004	390	3811,68	1040413	29136	139372	47656	187028	3717,48	62,19	32,01
Šumarija Lekenik		gospodarske	6224,45	1546483	46554	163872	92676	256548	6083,51	88,72	52,22

Gospodarska jedinica	Važenost osnove	šifra	površina	zaliha	prirast	etat			POVRŠINE		
						glavni	prethodni	ukupno	obraslo	neobraslo	neplodno
			ha			m^3				ha	
Pet. lug - Piškornjač	2003-2012	389	736,66	165605	4012	0	10056	10056	653,32	71,47	11,87
Šumarija Petrinja		gospodarske	736,66	165605,00	4012,00	0,00	10056,00	10056,00	653,32	71,47	11,87

Gospodarska jedinica	Važenost osnove	šifra	površina	zaliha	prirast	etat			POVRŠINE		
						glavni	prethodni	ukupno	obraslo	neobraslo	neplodno
			ha			m^3				ha	
Lonja 387	1999-2008	park prirode	2121,74	500180	20769	80716	32672	113388	1634,19	436,96	50,59
Posavske š 395	1999-2008	gospodarske	4841,06	933007	28004	113109	50650	163759	4025,24	760,27	55,55
Šumarija Sunja		ukupno	6962,80	1433187	48773	193825	83322	277147	5659,43	1197,23	106,14

Gospodarska jedinica	Važenost osnove	šifra	površina	zaliha	prirast	etat			POVRŠINE		
						glavni	prethodni	ukupno	obraslo	neobraslo	neplodno
			ha			m^3				ha	
Posavske šume	1999-2008	395	5157,50	1392714	41550	98649	83067	181716	4781,37	186,78	189,35
Šumarija Hr.Dubica		gospodarske	5157,50	1392714	41550	98649	83067	181716	4781,37	186,78	189,35

Uprava šuma Sisak		park prirode	4153,23	1058592	39361	148892	64337	213229	3479,22	597,41	76,60
		gospodarske	23615,17	5531899	169824	482968	341618	824586	21585,54	1572,91	456,72
		ukupno	27768,40	6590491	209185	631860	405955	1037815	25064,76	2170,32	533,32

mr.sp. Tihomir Pejnović
Hrvatske šume d.o.o.
Podružnica Sisak
Služba za Uređivanje šuma
Runjaninova 12, 44000 Sisak

Sisak Forest Administration

LOWLAND FORESTS

Management Unit	Period of Management	Code	Area	Stocks	Increment	permissible cut			AREAS		
						main	preliminary	total	covered	not covered	not fertile
			ha			m^3				ha	
Belčićev gaj - Šikara	1999-2008	379	2380,54	554535	17255	23517	36146	59663	2047,28	298,80	34,46
Brezovica	1997-2006	380	2144,38	494759	19650	38173	34777	72950	1973,45	103,94	66,99
Letovanički lug	1995-2004	386	1591,76	333258	9273	27324	27793	55117	1513,83	36,46	41,47
Leklan	2003-2012	402	538,82	111538	3526	18324	6453	24777	507,54	26,47	4,81
Šumarija Sisak		commercial	6655,50	1494090	49704	107338	105169	212507	6042,10	465,67	147,73
Brezovica		Nature Park	2031,49	558412	18592	68176	31665	99841	1845,03	160,45	26,01
Šumarija Sisak		total	8686,99	2052502	68296	175514	136834	312348	7887,13	626,12	173,74

Management Unit	Period of Management	Code	Area	Stocks	Increment	permissible cut			AREAS		
						main	preliminary	total	covered	not covered	infertile
			ha			m^3				ha	
Kalje	1999-2008	383	2412,77	506070	17418	24500	45020	69520	2366,03	26,53	20,21
Pešćenica - Cerje	1995-2004	390	3811,68	1040413	29136	139372	47656	187028	3717,48	62,19	32,01
Šumarija Lekenik		commercial	6224,45	1546483	46554	163872	92676	256548	6083,51	88,72	52,22

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						main	preliminary	total	covered	not covered	infertile
			ha			m^3				ha	
Pet. lug - Piškornjač	2003-2012	389	736,66	165605	4012	0	10056	10056	653,32	71,47	11,87
Šumarija Petrinja		Commercial	736,66	165605,00	4012,00	0,00	10056,00	10056,00	653,32	71,47	11,87

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Lonja 387	1999-2008	Nature Park	2121,74	500180	20769	80716	32672	113388	1634,19	436,96	50,59
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Šumarija Sunja		Total	6962,80	1433187	48773	193825	83322	277147	5659,43	1197,23	106,14

Management Unit	Period of management	Code	Area	Stocks	Increment	permissible cut			AREAS		
						main	preliminary	total	covered	not covered	infertile
			ha			m^3				ha	
Posavske šume	1999-2008	395	5157,50	1392714	41550	98649	83067	181716	4781,37	186,78	189,35
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Sisak Forest Administration		Nature Park	4153,23	1058592	39361	148892	64337	213229	3479,22	597,41	76,60
		Commercial	23615,17	5531899	169824	482968	341618	824586	21585,54	1572,91	456,72
		total	27768,40	6590491	209185	631860	405955	1037815	25064,76	2170,32	533,32

mr.sp. Tihomir Pejnović
Hrvatske šume d.o.o.
Podružnica Sisak
Služba za Uređivanje šuma
Runjaninova 12, 44000 Sisak

ZAGREBAČKA ŠKOLA UZGAJANJA ŠUMA I GOSPODARENJE NIZINSKIM ŠUMAMA

UVOD

Često se prigovara šumarima kako svojim postupcima »krče« šumu, »uništavaju« stabla, ne postupaju »ekološki«, traži se zaštita šuma od šumara i sl. Pri tome se zaboravlja činjenica da je Hrvatska jedna od najbogatijih europskih zemalja po prirodnim šumama. Naime, približno 95% naših šuma je prirodnoga karaktera. To znači da su nastale prirodno i da se prirodno razvijaju. Izmjena generacija teče u skladu s prirodnim načelima. Prirodan način njihova postanka, prirodnost strukture, stupanj biološke raznolikosti, ekološka i socijalna vrijednost tome također govore u prilog.
Postavlja se pitanje kako je moguća takva slika naših šuma kad znamo da su većinom gospodarskoga karaktera. Istodobno, kako je moguće da je površina šuma u Hrvatskoj i unatoč gospodarenju ostala gotovo nepromijenjena u posljednjih stotinjak godina? Odgovori su sažeti u činjenici da je šumarstvo u Hrvatskoj tradicionalno ustrojeno prema načelima prirodnoga pristupa šumskom ekosustavu. Taj se pristup gotovo dva i pol stoljeća razvija pod nazivom Zagrebačka škola uzgajanja šuma i primjenjuje se u svim, pa i u nizinskim šumama. Svrha je ovoga članka razjasniti što je Zagrebačka škola uzgajanja šuma i kako se njezina načela primjenjuju u praksi gospodarenja nizinskim šumama. Šume u parku prirode Lonjsko polje dobar su primjer za to, s obzirom na činjenicu da je u njima radio jedan od najznačajnijih predstavnika te škole, veliki hrvatski šumar i književnik Josip Kozarac.

ŠUMARSTVO, UZGAJANJE ŠUMA, GOSPODARENJE ŠUMOM

Objasnit ćemo na početku tri pojma koji su značajni za razumijevanje teksta: šumarstvo, uzgajanje šuma i gospodarenje šumom. Treba napomenuti da se već iz toga može podosta zaključiti o pristupu hrvatskoga šumarstva šumskom ekosustavu.
Šumarstvo je znanost, struka i umijeće gospodarenja i očuvanja šuma i staništa, odnosno čitavoga šumskog ekosustava za trajnu dobrobit društva, okoliša i privrede. Ono se brine o uravnoteženom i potrajnom gospodarenju šumama i drvnim zalihama,

THE ZAGREB SCHOOL OF SILVICULTURE AND THE MANAGEMENT OF LOWLAND FORESTS

INTRODUCTION

There are frequently expressed criticisms of forestry workers who, during their procedures, “clear” the woods and do not behave “ecologically”, while protection of the forests against the foresters is sought, and so on. But the critics, the while, lose sight of the fact that Croatia is one of the richest of European countries in terms of natural forests. About 95% of all our forests are of a natural character. In other words, they were created and have developed naturally. The alternation of generations is carried out in accordance with natural principles. The natural manner of their genesis, the naturalness of the structure, the degree of biological diversity, and the ecological and social value are also witnesses to this.
The question arises as to how this kind of image of our forests is possible when they are mostly commercial in character. At the same time, how is it possible for the area of the woods in Croatia, even in conjunction with management, to have remained almost unchanged in the last hundred years or so? The answers are summed up in the fact that forestry in Croatia is traditionally organised according to the principles of a natural approach to the forest ecosystem. This approach has developed for almost two and a half centuries under the name of the “Zagreb School of Silviculture” and is applied in all the woods, including those in the lowlands. The objective of this paper is to explain what the “Zagreb School of Silviculture” is, and how its principles are employed in the practice of managing the lowland forests. The forests within Lonjsko Polje Nature Park are a good example of this, because of the fact that in them once worked one of the most important representatives of the school, that great Croatian forester and writer Josip Kozarac.

FORESTRY SILVICULTURE FOREST MANAGEMENT

To begin with we shall explain three concepts that are important for the understanding of this article: forestry, silviculture and forest management. It should be said that from this it will already be possible to draw conclusions about the approach of the Croatian forestry to the forest ecosystem.
Forestry is the science, profession and art of managing and conserving forests and habitats, that is, the whole of the forest ecosystem, for the lasting benefit of society, the environment and the economy. It is concerned with a balanced and enduring management of the forest and timber reserves, maximal yields and optimal regeneration,

o najvećim prinosima i najboljem pomlađivanju, o trajnoj stabilnosti šumskih ekosustava, a istodobno o bujnom životinjskom svijetu, obilnim i trajnim pričuvama pitke vode, privlačnom i rekreacijskom okolišu kako u prirodnim tako i u urbanim sredinama te o raznovrsnim uslugama i proizvodima.
Uzgajanje šuma je znanstvena i stručna disciplina koja se bavi osnivanjem, njegom i pomlađivanjem šumskih sastojina kako bi najbolje i trajno ispunjavale gospodarske i općekorisne funkcije. Uzgajanje šuma izučava procese i šumskouzgojne postupke kojima je u najkraćem razdoblju, uz što manje troškove i očuvanje staništa, moguće osnovati, podići te oblikovati šumsku sastojinu koja će najpovoljnije i trajno pružati gospodarske, ekološke i socijalne blagodati.
Primjenjujući šumskouzgojne postupke ostvarujemo gospodarenje šumom, odnosno postizanje i održavanje ciljeva gospodarenja. Život šume od nastanka do zrelosti i konačne sječe, kao i istodobna izmjena generacija moraju teći u skladu s prirodnim zakonitostima, onako kako teku u »najprirodnijoj šumi«, tj. prašumi. Šumskouzgojni postupci trebaju podupirati i usmjeravati prirodni razvoj šuma uz najveće uvažavanje svih procesa koji se zbivaju u inače složenu i osjetljivu šumskom ekosustavu. Jer »*najbolji je onaj šumar koji zna kako pustiti prirodu da ide svojim ciljevima«* (Leibundgut, 1959.).

U skladu s tim izraženi su i današnji strateški ciljevi gospodarenja šumama u Hrvatskoj:
1. osiguranje stabilnosti ekosustava
2. održavanje i poboljšavanje općekorisnih funkcija šuma
3. potrajno gospodarenje
4. iskorištavanje šuma i šumskih zemljišta na način i u takvoj mjeri da se održava njihova biološka raznolikost, produktivnost, sposobnost obnavljanja, vitalnost i potencijal
5. ispunjavanje, sada i u budućnosti, bitnih gospodarskih, ekoloških i socijalnih funkcija na lokalnoj i globalnoj razini, a da to ne šteti drugim ekosustavima.

Kako vidimo, u strateškim ciljevima gospodarenja šumama u Hrvatskoj naglašeno je očuvanje šumskoga ekosustava i njegovo potrajno iskorištavanje. Posljednje dvije točke identične su definiciji pojma potrajno gospodarenje šumama (istozn. održivo gospodarenje šumama).
Nijedan od spomenutih ciljeva nije dar prirode i ne može se postići ako se šuma prepusti samo spontanim, prirodnim procesima (Matić i dr., 2003., Pintarić, 1969.). Ti se ciljevi mogu postići i, što je još

in conjunction with the lasting stability of forest ecosystems, taking account at the same time of the flourishing animal world, the abundant and lasting reserves of potable water, an attractive and recreational surrounding but in natural and in urban milieus, and also concerned with various products and services.
Silviculture is a scientific and professional discipline concerned with the establishment, care and regeneration of forest vegetation units [stands], in such a way that that they permanently and optimally fulfil their economic and general use functions. Silviculture studies the processes and forest-cultivation procedures that will, in the shortest period of time, with the lowest costs and with the conservation of the habitats, allow a forest vegetation unit to be established, raised and shaped to provide various economic, ecological and social benefits, optimally and lastingly.
Through the implementation of silviculture procedures, we put forest management into practice, that is achieve and maintain the objectives of forest management. The life of the forest, from creation to maturity and final felling, and the simultaneous succession of generations, must unfold in accordance with the laws of nature, in the same way that it unfolds in the most natural forest of all, in a virgin forest, that is. Silviculture procedures should support and channel the natural development of the forests, with the maximum degree of respect being paid to all the process that unfold in the actually very complex and sensitive forest ecosystem. Because *"the best forester is he who knows how to let nature go on towards its own objectives"* (Leibundgut 1959).
In accordance with this, today's strategic objects for forest management in Croatia have been expressed as follows:
1. ensuring the stability of the ecosystem(s)
2. maintaining and improving the general use functions of the forests
3. lasting management
4. use of forests and forest lands in a manner and to such an extent that their biological diversity, productivity, capacity to regenerate, vitality and potential are maintained
5. meeting, now and in the future, essential economic, ecological and social needs at the local and global level, without detriment thereby to other ecosystems.

As we can see, in the strategic objectives of forest management in Croatia, the preservation of the forest ecosystem and its lasting use are stressed. The last two points are identification to the definition of the concept of lasting forest management (or sustainable forest management, which is the same thing).
None of these objectives is a gift of nature, and cannot be achieved only if the forest is left exclusively to spontaneous natural processes (Matić et al, 2003; Pintarić, 1969). These objectives can be achieved, and what is even more important,

bitnije, trajno održati jedino ako se u šumi obavljaju šumskouzgojni postupci. Dakle, šuma ne može najbolje i trajno ispunjavati ekološke, socijalne i gospodarske funkcije bez šumskoga gospodarenja. Međutim, šumsko gospodarenje mora biti usmjereno na postizanje i trajno održavanje tih funkcija.

ZAGREBAČKA ŠKOLA UZGAJANJA ŠUMA

Razlikuju se prirodni i umjetni pristup uzgajanju šuma (Korpel, 1991.). Prirodna (tradicionalna, klasična) škola uzgajanja šuma gleda na šumu kao na ekosustav. To znači da se u prirodnom pristupu pazi na sve sastavnice šumskoga ekosustava. Predstavnici te škole zagovaraju uzgajanje i trajno očuvanje prirodnih šuma. Protiv su uporabe «stranih» vrsta drveća. Zagovaraju prilagodbu šumskouzgojnih postupaka prirodnome razvoju šume i prirodno pomlađivanje (Korpel i Saniga, 1995.; Otto, 1998.). Ciljevi gospodarenja obuhvaćaju, osim gospodarskoga, i općekorisni aspekt (ekološke i socijalne funkcije šume). Danas je klasična škola uzgajanja šuma prepoznatljiva pod nazivom *close-to-nature silviculture* ili *naturalistic silviculture* (prirodi blisko uzgajanje šuma, prirodno uzgajanje šuma, uzgajanje prirodnih šuma).

Umjetnu (tehničku) školu uzgajanja šuma obilježavaju: pristup šumi kao gospodarskom objektu, šumskouzgojni postupci prilagođeni jedino gospodarskim ciljevima, pomlađivanje čistim sječama, umjetno pomlađivanje. Zagovornici te škole nisu protiv uporabe »stranih« vrsta drveća ako to nalažu zakoni tržišta. Zalažu se za uzgajanje onih vrsta drveća koje se u danom trenutku isplate. Ostale sastavnice šumskoga ekosustava uzimaju se u obzir samo ako se njihovom prodajom može ostvariti dobit.

Usporedit ćemo dva primjera iz njemačkoga šumarstva 19. stoljeća, iz kojih se vide opisani pristupi uzgajanju šuma i šumarstvu uopće. U svom udžbeniku o uzgajanju šuma, godine 1817., Heinrich Cotta, prvi i dugogodišnji ravnatelj Šumarske akademije u Tharandtu, piše: »*…uzgajanje šuma je slično poljoprivredi. Ono izučava kako osnovati i njegovati šumu te iskoristiti drvo«*. Bilo je to doba kada je u Njemačkoj vladao koncept koji je poistovjećivao šumarstvo s poljoprivednom proizvodnjom: čista sječa - sadnja - čista sječa (žetva sjetva žetva). Općekorisne uloge šume (tlo, voda, klima, kisik, šumski plodovi, ljekovito bilje, gljive, životinje, zaštita od erozija, vjetra, lavina, zdravstvena uloga, estetska uloga …) nisu uzimane u obzir. Zbog takvoga je pristupa šumarstvu u većem dijelu Europe (ne i u Hrvatskoj!) obavljena pretvorba autohtonih prirodnih šuma u šume tada rentabilnijih

maintained indefinitely only if silviculture procedures are carried out in the forest. A forest, that is, cannot optimally and permanently perform its ecological, social and economic functions without forest management. However, forest management has to be directed towards the achievement and lasting maintenance of these functions.

THE ZAGREB SCHOOL OF SILVICULTURE

There are differences between the natural and the artificial approaches to silviculture (Korpel, 1991). The natural (traditional, classical) school of silviculture looks upon the forest as an ecosystem. This means that in the natural approach, care is taken of all the components of the forest ecosystem. Proponents of this school champion the cultivation and permanent conservation of natural forests. They are against the use of foreign species of trees. They stand up for the adjustment of silviculture procedures to the natural development of the forest and natural regeneration (Korpel and Saniga, 1995; Otto, 1998). The objectives of management include, as well as the economic, the general use aspect as well (the ecological and social functions of the forest). Today the classical school of silviculture is identifiable by the names *close-to-nature silviculture* or *naturalistic silviculture*.

The artificial or technical silviculture school is characterised by: an approach to the forest as to an economic facility, silviculture procedures adjusted exclusively to economic goals, regeneration by clear-cutting, artificial regeneration. Those who stand for this school are not against the use of foreign species of tree, if the laws of the market insist upon it. They champion the culture of those species of tree that are profitable at the current moment. Other vegetation units of the forest ecosystem are taken into consideration only if a profit can be made by the sale of them.

We shall compare two examples from German forestry of the 19th century, from which the approaches to silviculture and forestry in general can be perceived. In his silviculture manual of 1817, Heinrich Cotta, the first and a long-time director of the Forestry Academy in Tharandt writes "*silviculture is like agriculture. It studies how to establish, tend and make use of trees*". This was the time when Germany was dominated by the concept that equated forestry with agricultural production: clear-cutting planting clear-cutting (harvesting sowing harvesting). The general use roles of the forest (to do with the soil, water, climate, oxygen, forest fruits, medicinal herbs, fungi, animals, protection against erosion, winds, avalanches, the role in the preservation of health, and the aesthetic role) were not taken into consideration. Because of this kind of approach, in most of Europe (but not in Croatia) there was a transformation of the indigenous natural forests into forests of species of trees that were profitable at the time. Apart from that, through sudden exploitation, the natural development of the forests was very largely

vrsta drveća. Osim toga, naglim iskorištavanjem poremećen je u većoj mjeri prirodni razvoj šuma. Nastale su »umjetne šume«, odnosno šumske kulture koje i danas pokrivaju dobar dio šumskih zemljišta. S druge strane, Karl Gayer, profesor uzgajanja šuma u Münchenu, razvijao je misao o mješovitim šumama raznolike strukture koje se prirodno pomlađuju. Naglašavao je kako je bitno nad tlom sačuvati stalan šumski pokrov i isključiti čiste sječe. Njegov je pristup bio: »*prihvatimo da je priroda naš najbolji učitelj*«.
Zagrebačka škola uzgajanja šuma dio je prirodne škole uzgajanja šuma. Rezultat je gotovo dva i pol stoljeća dugoga cjelokupnog usmjerenja, znanstvenoga i obrazovnoga pristupa te praktičnoga postupanja u gospodarenju hrvatskim šumama, uz ozakonjenja takvih spoznaja i aktivnosti.

Njezine su temeljne značajke:
- gospodarenje prirodnim šumama
- potrajnost u gospodarenju šumama
- pomlađivanje pod zastorom krošanja
- prirodno pomlađivanje
- umjetno pomlađivanje po načelima prirodnoga
- održanje strukture i stabilnosti šume njegom
- šumskouzgojni postupci obavljaju se tako da usmjeravaju razvoj sastojine prema načelima razvoja prašume, ali na temelju kriterija koji proizlaze iz ciljeva gospodarenja.

Povijest Zagrebačke škole uzgajanja šuma uklopljena je u razvoj šumarske struke i znanosti u Hrvatskoj. Prema Matiću i dr. (2001.) i Klepcu (1998., 1997.), svemu je prethodilo osnivanje i uređenje Vojne krajine (1702. - 1746.) te zapovijed Marije Terezije godine 1762. kojom je zabranila izvoz hrastovine za brodogradnju iz svoje zemlje. Naredila je podroban opis, premjer i izradu karata šuma, sastavljanje šumskoga reda (danas osnova gospodarenja) te postavljanje stručnoga osoblja za gospodarenje šumama. Zato su od 1764. do 1765. izrađene prve gospodarske osnove s kartama i osnovane prve šumarije. Šumarska služba bila je uređena uredbama sa zakonskom snagom i zakonima o šumama. Šumarski stručnjaci najprije su se školovali na Šumarskoj akademiji u Mariabrunnu. Godine 1898. u Zagrebu je osnovana Šumarska akademija, preteča današnjega Šumarskoga fakulteta. Time je započela visokoškolska nastava šumarstva u Hrvatskoj. Tako je na načelima Zagrebačke škole uzgajanja šuma do danas obrazovano 106 naraštaja inženjera šumarstva.
Načelo potrajnosti u gospodarenju šumama poznato je od 18. stoljeća i do danas je ostalo jedini pravi

distorted. Artificial forests were created, that is forest cultures that today cover a large part of the forest land. On the other hand, Karl Gayer, professor of silviculture in Munich, developed a way of thinking about mixed forests of a varied structure that would be naturally regenerated. He stressed that it was essential to maintain a permanent forest cover over the ground and to avoid clear-cutting. His approach was: "*let us accept the fact that nature is our best teacher*".
The Zagreb Silviculture School is part of the natural school of silviculture. It is the outcome of an almost two and a half century long overall orientation, of a scientific and educational approach, and practical procedure in the management of Croatian forests, and the legislation of such cognition and activity.

The fundamental characteristics of it are:

- managing natural forests
- persistence in managing the forests
- regeneration under the canopy screen
- natural regeneration
- artificial regeneration along the lines of natural regeneration
- maintenance of forest structure and stability by care
- silviculture procedures are carried out in such a way that they direct the development of a vegetation unit (a stand) after the principles of the virgin forest, but pursuant to criteria that derive from management goals.

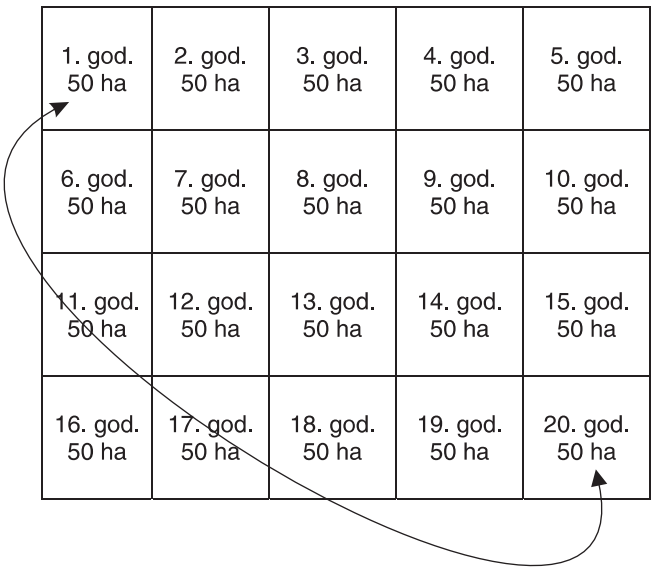
The history of the Zagreb Silviculture School fits in with the development of the forestry profession and forestry science in Croatia. According to Matić et al (2001) and Klepac (1998, 1997), this was all preceded by the foundation and organisation of the Vojna Krajina, the Military Border (1702-1746) and the edict of Maria Theresa of 1762 forbidding the export of oak for shipbuilding outside the country. The empress ordered a detailed description, survey and the elaboration of forest maps, the composition of the "forest order" (today the forest management plan) and the appointment of qualified men to manage the forests. That is why in the 1764-1765 the first economic plans with maps were drawn up and the first forest management units were founded. The forest service was organised by edicts with the effect of legislation as well as by Forest Statutes. Forestry experts were first of all educated at the Forestry Academy in Mariabrunn. In 1898 the Forestry Academy was established in Zagreb, the forerunner of today's Forestry Faculty. This started the tertiary level teaching of forestry in Croatia. Thus 106 generations of forestry engineers have been trained to date along the principles of the Zagreb Silviculture School.
The principle of sustainability in forest management has been known since the 19th century, and has remained the only real example of sustainable development to the present day (Glavac 1999). In

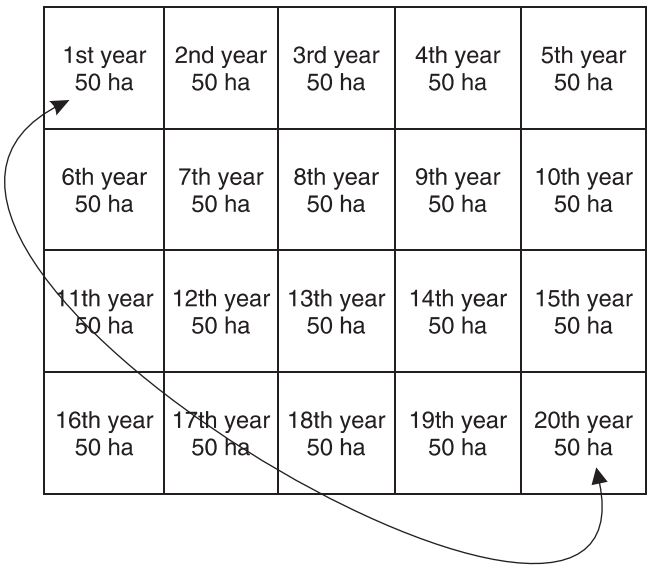
primjer održivoga razvoja (Glavač, 1999.). U Hrvatskoj je to načelo uvedeno već 1769. kada je objavljena »Zakonska uredba o šumama«. Ta se uredba smatra prvim hrvatskim šumarskim zakonom, prvom instrukcijom za uređivanje šuma i prvim udžbenikom šumarstva (Meštrović, 1995.).
Prema uredbi bila je propisana metoda razdiobe šuma na godišnje sječine. Metoda se sastoji u tome da se površina šume razdijeli na onoliko podjednakih dijelova (sječina) koliko ophodnja (vijek šume na nekoj površini od nastanka do zrelosti) broji godina. Svake se godine siječe jedan dio. Tako je na koncu ophodnje cijela šuma posječena. Sječa je mogla ponovno započeti na istome mjestu kao na početku ophodnje (Klepac, 1998.). Načela te uredbe ugrađena su u prve zakone o šumama (1852., 1894.), na temelju kojih je bilo organizirano šumsko gospodarenje.
Godine 1846. osnovana je staleška udruga Hrvatsko-slavonsko šumarsko društvo, preteča današnjega Hrvatskoga šumarskog društva. Na prvoj skupštini raspravljalo se o temi Kako treba gospodariti u starim hrasticima prašumske strukture da bi se kvalitetno pomladili?

Slika 1. Shematizirani prikaz potrajnoga šumskoga gospodarenja: šuma površine 1000 ha podijeljena je na 20 jednakih dijelova jer ophodnja traje 20 godina. Svake se godine siječe 1/20 šume, a na kraju ophodnje sječa se vrati na mjesto odakle je počela. Do danas je taj sustav u Hrvatskoj usavršen u višenamjensko progresivno potrajno gospodarenje.

Croatia this was introduced as far back as 1769 when the Legislative Ordinance [Edict] Concerning the Forests was published. This ordinance is considered the first Croatian forestry law, the first set of regulations for managing the forests, and the first forestry manual (Mestrovic, 1995).
According to this ordinance, the method of dividing the forest for annual felling was prescribed. This method consists of the area of the forest being divided into as many equal parts (felling areas) as the rotation (the age of a forest in some area from origin to maturity) has years. Each year, one part is felled. Thus at the end of the rotation, the whole of the forest has been felled. Felling can be recommenced in the same place as at the beginning of the rotation (Klepac 1998). The principles of this ordinance were incorporated into the first Forest Laws (1852, 1895), pursuant to which forest management was organised.
In 1847 the professional association called the Croatian and Slavonian Forestry Association was founded; this was the forerunner of today's Croatian Forestry Association. At the first annual assembly, the topic of discussion was: How should old oak stands of a virgin forest structure be managed in such a way as to ensure high quality regeneration?

Figure 1. Diagrammatic view of sustainable forest management: a forest of an area of 1000 ha is divided into 20 equal parts, because a rotation comes to 20 years. Each year one twentieth of the forest is felled, and at the end of the rotation the felling returns to the spot it started off from. By the present age, this system has been perfect in Croatia into multi-purpose progressive sustainable management.





Godine 1852. donesen je prvi zakon o šumama. U drugom članku toga zakona piše »*da se nijedno šumsko zemljište ne smije oduzeti niti pretvoriti u drugu kulturu*«. U devetom članku stoji da »*se šume ne samo trebaju uzdržavati nego valja neprestano primjerenim načinom njihovo stanje poboljšavati*«. Tim je zakonom naglašena potreba očuvanja površine šuma i šumskog zemljišta, a posebice potreba da se stanje šuma poboljša. Tako je utemeljeno višenamjensko progresivno potrajno gospodarenje. Dodajmo tome i 1894. godinu kada je donesen sljedeći zakon o šumama. U njemu je ponovno istaknuto načelo potrajnosti jer u trećem članku piše: »u šumah obćinskih ima se zavesti potrajno gospodarenje (Nachaltiger Betreib)«.

I danas su šume i šumska zemljišta prepoznati kao dobra od interesa za Hrvatsku, pa imaju njezinu osobitu zaštitu (prema članku 52. Ustava Republike Hrvatske). U prvom članku Zakona o šumama šume i šumska zemljišta definirani su kao specifično prirodno bogatstvo te s općekorisnim funkcijama šuma čine posebne prirodne i gospodarske uvjete rada.

NAČELA GOSPODARENJA NIZINSKIM ŠUMAMA

Nizinske šume Hrvatske prostiru se sjeverno od Karlovca, uglavnom u prostoru omeđenom rijekama: Dravom na sjeveru, Dunavom na istoku i Savom na jugu, u nizinskom (planarnom) vegetacijskom pojasu, na nadmorskim visinama između 80 i 150 metara.
Površina nizinskih šuma zauzima približno 290 000 ha. Od toga 205 000 ha pokrivaju šume hrasta lužnjaka, 27 000 šume poljskog jasena, 17 000 šume crne johe, 11 500 ha šume domaćih vrba, ponajprije bijele vrbe, 6000 ha šume domaćih topola, ponajprije bijele i crne topole, a 16 000 ha šumske kulture i plantaže euro-američkih topola dok su na 6500 ha šume ostalih vrsta drveća (Vukelić i Rauš, 2001.).
Temeljni je ekološki čimbenik, koji regulira funkcioniranje nizinskih šumskih ekosustava, voda, bilo poplavna (značajna za šume vrba i topola), podzemna (značajna za šume hrasta lužnjaka) ili obje (značajno za šume poljskog jasena i crne johe).
Postanak i razvoj nizinskih šuma načelno se događa prema Slici 2. Obešumljenu, golu površinu najprije naseljavaju pionirske vrste drveća koje oblikuju pionirsku šumu. U posavskim šumama najvažniji pionir je poljski jasen (*Fraxinus angustifolia*). Pod zastorom krošanja pionirske šume mijenjaju se ekološke prilike u usporedbi s golom površinom: nema mikroklimatskih ekstrema, nema suše, tlo je pod zasjenom, kemizam prostirke i humusnoga sloja drugačiji su nego na goloj površini…

In 1852 the first Forests Act was passed. Article 2 says that "*no piece of forest land may be appropriated or turned into some other kind of crop*". Article 9 says that "*the forests need not only maintaining but, through some appropriate manner, their condition needs improving.*" This law highlights the need to preserve the forest areas and the forest land, and in particular the need to improve the condition of the forests. Thus the foundations were set for multi-purpose progressive sustainable management were laid. We might add to this that in 1894 the next Forests Law was passed. It also, once again, highlighted the principle of sustainability, for Article 3 writes: "in the public forests sustainable management (nachaltiger Betreib) is to be introduced."

Today too the forests and forests lands are recognised as assets that are of interest to the state, and which have the particular protection of the state (according to Article 52 of the Constitution of the Republic of Croatia). In Article 1 of the Forests Law, the forests and forest lands are defined as a specific kind of natural riches, and with their general use functions of the forests, constitute special natural and economic conditions of work.

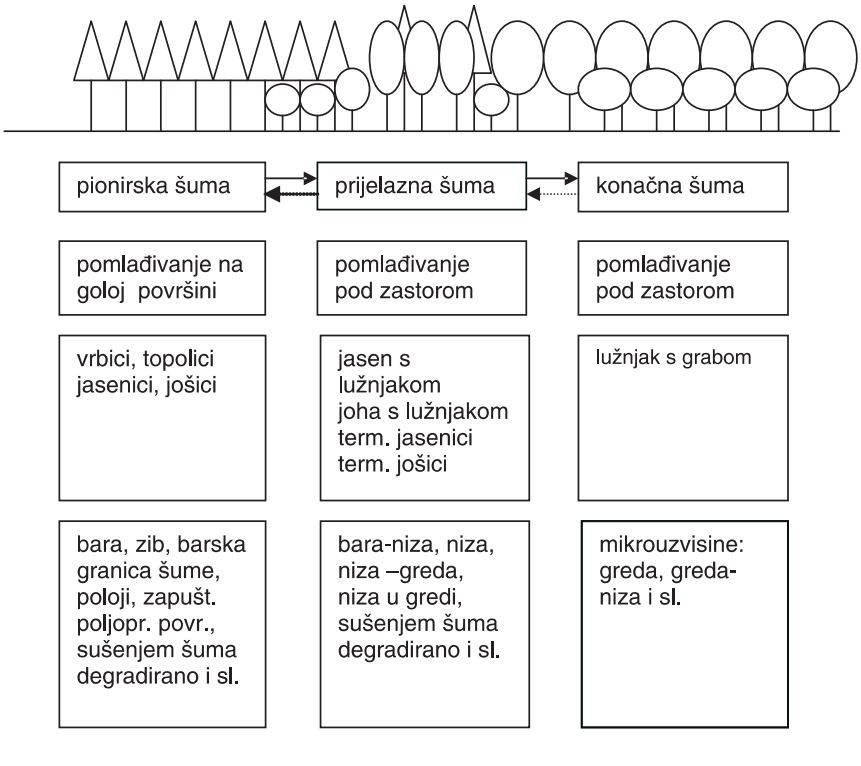
THE PRINCIPLES FOR MANAGING THE LOWLAND FORESTS

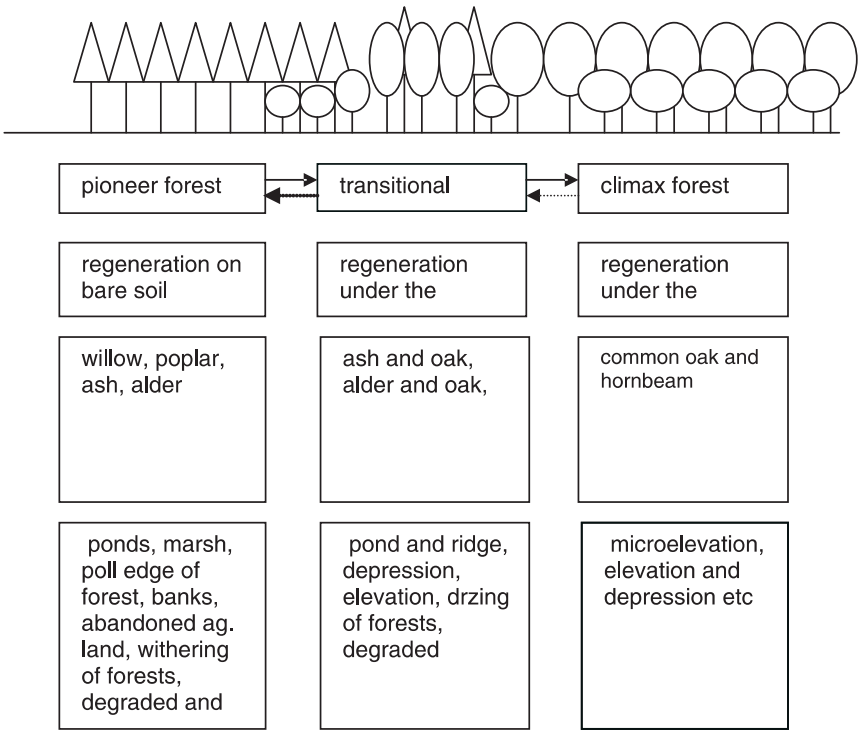
The lowland forests of Croatia stretch from north of Karlovac, mainly in the area bordered by the rivers Drava in the north, Danube in the east and the Sava in the south, in the lowland or plain vegetation zone, at heights above sea level of 80 to 150 m.
The area of the lowland forests comes to about 290,000 hectares. Of these, 205,000 ha are common oak forests, 27,000 ha narrow-leaved ash, 17,000 forests of black alder, 11,500 forests of willows, mainly white willows, 6,000 ha of forests of domestic poplars, mainly white and black poplars, 16,000 ha are covered with forest cultures and plantations of European and American poplars, and 6,500 ha are forests of other kinds of trees (Vukelić and Raus, 2001).
The fundamental ecological factor that regulates the functioning of the lowland forest ecosystems is water, whether floodwater (important for the poplar and willow woods), underground water (important for common oak forests) or both (important for the ash and alder forests).
The origin and development of lowland forests in principle follows a cycle depicted in Figure 2. A deforested bare area is first of all colonised by pioneering kinds of tree that form the pioneering forest. In the forests of Posavina the most important pioneer is *Fraxinus angustifolia*, the narrow-leaved ash. Under the canopy of the treetops of the pioneering forest, the ecological conditions change as compared with those of the forest-free area. There are no such microclimatic extremes, there are no droughts, the ground is shaded, and the

Slika 2. Shema sukcesije nizinskih šuma s naznakama načina pomlađivanja, vrstama šumskih sastojina i staništa
Takvi uvjeti više ne pogoduju pomlađivanju pionirskih vrsta, nego pomlađivanju polusvjetloljubivih, polusjenoljubivih i sjenoljubivih vrsta drveća. Tako

chemistry of the cover and the humus layer are different than they are on the bare surface…

Figure 2. A diagrammatic sketch of the succession in the lowland forests, with indications of the manner of regeneration, the kinds of forest vegetation units, and habitats.





postupno nastaje prijelazna šuma. Ako se želi zaustaviti prirodni tijek sukcesije i ostati pri pionirskoj šumi, primijenit će se zato čista sječa. Čistom sječom uklanjamo odjednom sva stara stabla. Njome se oponašaju ekološki uvjeti obešumljenoga staništa na kojemu se ponovno oblikuje pionirska šuma.
Treba napomenuti kako su čiste sječe u Hrvatskoj Zakonom o šumama zabranjene. Inače je obveza dobroga šumskoga gospodara usmjeravati šumski ekosustav prema progresivnoj sukcesiji, a ona se ne može postići čistom sječom. Čista sječa degradira stanište i zaustavlja prirodni tijek progresije šumskoga ekosustava.
Prijelazna šuma je poveznica između pionirske i konačne šume. U njoj se pod krošnjama pionirskih vrsta drveća (poljskog jasena, crne johe, vrba, topola) pomlađuju brijestovi, grabovi, javori, lipe, šumske voćkarice i vrste konačne šume, poglavito hrast lužnjak (*Quercus robur*). Prijelazna je nizinska šuma, primjerice, miješana šuma poljskoga jasena i hrasta lužnjaka ili poplavna lužnjakova šuma.
Konačna šuma (klimaks-šuma, klimatogena šuma) relativno je ustaljen završetak prirodnoga razvoja šumskoga ekosustava. Tvore je konačne (klimatogene) vrste drveća. U nizinskim šumama konačna je vrsta drveća hrast lužnjak, a konačni oblik šume je miješana šuma hrasta lužnjaka i običnoga graba. Međutim, i taj je ekosustav dinamičan. Bitno je shvatiti da je svaka šuma »živi organizam« koji nastaje, raste, stari, odumire, raspada se i istodobno pomlađuje po određenim zakonitostima. Zadatak je šumara prilagoditi se tim procesima po načelima dobrih gospodara.
Pomlađivanje prijelazne i konačne šume zbiva se pod zastorom krošanja starih stabala (Slika 3). Jedino se tako uspijeva stvoriti i održati nova generacija šume. Naime, nju tvore vrste drveća koje nemaju značajke pionirskih vrsta, posebice glede svjetla. To je razlog zbog kojega se prijelazne i konačne šume pomlađuju pod zastorom krošanja starih stabala, postupkom poznatim pod nazivom prirodno pomlađivanje oplodnim sječama. Oplodnim sječama se postupno, u 2 - 3 navrata, sijeku stara stabla. Sjekovi se zovu pripremni, naplodni i dovršni. U hrastovim se šumama sjekovi obavljaju u približnim vremenskim razmacima, svake 2 - 3 godine, pa čitav postupak pomlađivanja može potrajati do 8 godina. Tim se sjekovima stara stabla potiču na pojačani urod sjemena, tlo se naplođuje tim sjemenom, ono klija, a nova generacija raste u skladu s potrebama za svjetlom koje se dozira uz pomoć oplodnih sječa. Tako se na najbezbolniji i najprirodniji način obavlja postupna izmjena generacija šume, bez šoka i degradacije staništa.

Such conditions no longer favour the regeneration of the pioneering species, rather the regeneration of species of trees that favour shady, semi-shady and light habitats. Thus a transitional kind of forest comes into being. This is the reason why, if one wants to halt the natural course of the succession and stick with the pioneering forest, clear-cutting is used. Clear-cutting removes at once all the old trees. This is used to imitate the ecological conditions of the deforested habitat in which the pioneering forest can once again be formed.
It should be mentioned here that pure felling is forbidden in the Croatian Forests Law. It is actually the obligation of a good forest steward to direct the forest ecosystem towards the progressive succession, and this cannot be achieved with the clear-cutting. Clear cutting degrades a habitat and halts the natural course of the progression of a forest ecosystem.
A transitional forest is a link between a pioneering and a climax forest. In it, under the crowns of the pioneering species (narrow-leaved ash, alder, willow, poplar), the regeneration comes in the form of elms, hornbeams, maples, limes, forest fruit trees and species of the climax forest, particularly the common oak, *Quercus robur*. A transitional lowland forest, for example, is a mixed forest of narrow-leaved ash and common oak or a riparian common oak forest.
The final or climax forest, the climax forest, is a relatively settled conclusion of the natural development of the forest ecosystem. It is made by the climax (climatogenic) species of tree. In the lowland forest the climax species of tree is the common oak, and the climax form of forest is mixed forest of common oak and common hornbeam. However, this ecosystem too is dynamic. It is essential to understand that every forest is a living organism that comes into being, grows, ages, dies and decays and is at the same time regenerated according to certain laws. It is the task of the forester to adjust to these processes according to principles of good stewardship.
Regeneration of the transitional and climax forest takes place under the canopy of the crowns of the old trees (Figure 3). Only in this way is it possible to create and maintain the new generation of the forest. For it is made by tree species that do not have the characteristics of the pioneering species, particularly with respect to light. This is the reason why the transitional and climax forests are rejuvenated under the cover of the crowns of the old trees by the procedure known under the name of the natural regeneration by regenerative felling. In regenerative felling, gradually, on two or three occasions, the old trees are felled. These cuts are called preparatory, seeding and final. In oak forests the cuts are carried out in approximate intervals of every two to three years, and the whole process of regeneration can last up to eight years. With such fellings the old trees are provoked to producer increased seed, the ground is seeded with these seeds, the seed sprouts, and the new generation

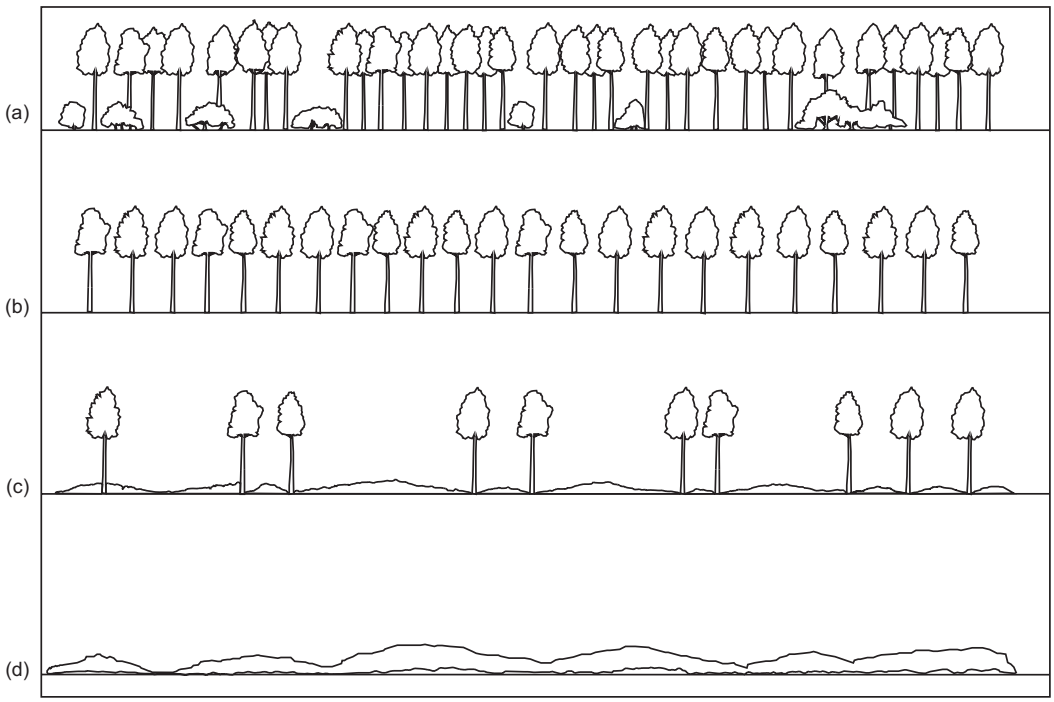
Slika 3. Proces pomlađivanja šumske sastojine oplodnim sječama: a) izgled sastojine prije početka pomlađivanja; b) izgled sastojine nakon pripremnoga sijeka. Njime su razmaknute krošnje i izazvan je pojačan urod sjemena preostalih, najkvalitetnijih stabala. Istodobno, tim se sijekom stanište priprema za prihvat i klijanje sjemena; c) sastojina nakon naplodnoga sijeka. Tim se sijekom dozira svjetlo novoj generaciji koja raste pod krošnjama. Intenzitet toga sijeka ovisi o potrebama za svjetlom nove generacije; d) nova generacija nakon dovršnoga sijeka. Taj sijek se izvodi kada novoj generaciji više ne treba zaštita krošanja starih stabala.

Treba istaknuti da se ovim načinom oponaša proces pomlađivanja koji se inače događa u prašumi, u fazi njezina raspadanja (Prpić i Seletković, 1996.; Korpel, 1989.; Leibundgut, 1978.; Matić i dr., 1979.). U prašumi stara stabla postupno odumiru i raspadaju se kada dosegnu svoju fiziološku zrelost. Istodobno, ona zasiju okolnu površinu svojim sjemenom. Proces njihova raspadanja i istodobnoga nastanka nove generacije sličan je pomlađivanju pod zastorom krošanja u gospodarskim šumama.

Naravno da proces prate mnogobrojni problemi. Spomenut ćemo najvažnije koji utječu na uspjeh pomlađivanja hrasta lužnjaka (Matić, 1996.; Matić i dr., 1979.):

- štetnici i gljivična oboljenja žira i mladoga hrasta

Figure 3. The process of regenerating a forest vegetation unit with seeding cuts: a) the appearance of a stand before the beginning of regeneration; b) the appearance of a stand after the preparatory cut. This provides greater distance between crowns and an increased production of seed among the other, high quality, trees is stimulated. c) the stand after the regeneration cut. This cut is used to adjust the light for the new generation growing beneath the crowns. The intensity of this cut depends on the new generation's need for light. d) the new generation after the final cut. This cut is done when the new generation no longer needs the protection of the canopy of the older trees.



It is worth mentioning that this manner copies the manner of regeneration that occurs in the virgin forest in the phase of its decay (Prpić and Seletković, 1996; Korpel 1989; Leibundgut 1978a; Matić et al 1979). In the virgin forest the old trees gradually die off and decay when they reach their physiological maturity. At the same time, they sow the surrounding area with their seeds. The process of decay and the simultaneous creation of a new generation are similar to regeneration under a canopy of crowns in commercially managed forests.

Of course, the process is associated with many

- nedovoljan urod žira
- vlaga i temperatura tla u fazi klijanja žira
- trajanje proljetne poplave, posebice u fazi početnoga rasta biljčica
- intenzitet osvjetljenja biljčica u prvih 3 - 5 godina razvoja
- konkurencija ostalih vrsta drveća, grmlja i prizemoga rašća
- stanje populacije štetnika, posebice šumskih glodavaca
- stanje populacije divljih svinja i žirenje.

Može se dogoditi da u tijeku pomlađivanja nema dovoljno biljaka nove generacije ili čak da nova generacija bude uništena. Zbog toga se služimo postupkom sjetve ili sadnje sjemena ili sadnica. Postupak se obavlja jednako kao i prirodno pomlađivanje. Razlika je u tome što biljke nove generacije nisu nastale iz sjemena s krošanja starih stabala, nego iz posijanoga ili posađenoga sjemena ili sadnica.

Tijekom života šuma se njeguje. Pod njegom šuma podrazumijevaju se oni uzgojni postupci kojima se nastoji stvoriti takva šumska struktura koja će osiguravati njezinu stabilnost, produktivnost, vitalitet, bioraznolikost i, na kraju života, mogućnost kvalitetnoga prirodnog pomlađivanja.

Njegom usmjeravamo razvoj šume u skladu s prirodnim zakonitostima, najbolje iskorištavajući stanišne uvjete, biološka svojstva i ekološke zahtjeve vrsta drveća. Na taj način podupiremo i održavamo šumu u najboljim strukturnim uvjetima gdje su stabilnost, produktivnost i biološka raznolikost temeljni pokazatelji optimalnoga stanja. Mogućnost prirodnoga pomlađivanja tako njegovanih šuma logičan je slijed i korak koji vodi njihovoj vječnosti. Njegom se ne utječe toliko na količinu koliko na kakvoću šume (Matić i dr., 2003., Leibundgut, 1978., Lang, 1982., Koestler, 1952., Pintarić, 1969.).

Njega šuma i stabala utemeljena je na činjenici da je fenotip rezultat genotipa i utjecaja okoliša, odnosno stanišnih uvjeta. Njegom se utječe na fenotip i stanište. Njome se spontano odabiranje stabala u šumi zamjenjuje odabiranjem temeljenim na šumskouzgojnim načelima. Razlikuju se pozitivno i negativno odabiranje. Negativnim odabiranjem uočavaju se i uklanjaju sve nepoželjne jedinke do one dobi kada se počinju uočavati stabla budućnosti. Nakon toga prelazi se na postupke pozitivnoga odabiranja kojima se iz šume uklanja ono što ometa razvoj uočenih stabala budućnosti. Pri tome se mora voditi računa da sastojina ne izgubi bitna obilježja: prirodnu strukturu, suvislost, proizvodnost, stabilnost, raznolikost i mogućnost prirodne obnove (Matić i dr., 2003.).

problems. We shall mention a few of the most important that affect the success of regenerating common oak forests (Matic 1996; Matic et al 1979):

- pests and fungal conditions of the acorn and young oak
- insufficient yield of acorns
- continuation of spring flooding, particularly in the initial growth phase of the plant
- intensity of illumination of the young plant in the first three to five years of development
- competition from other species of trees, bushes and epigeal growth
- state of population of pests, particularly rodents
- condition of the population of wild boar and foraging.

It can happen that during regeneration there are not enough plants of the new generation and even that the new generation is destroyed. Because of this the procedure of sowing or planning seeds or plants is resorted to. The procedure is done in a manner identical to natural regeneration. The difference is that the plants of the new generation have not been created from the seeds that came down from the crowns of the old trees, but from sown or planted seeds or plants.

During its lifetime the forest has to be tended. Tending of the forest implies all those cultivation procedures by which an endeavour is made to form such a structure of forest as to ensure its stability, productivity, vitality, biodiversity and at the end of its life, the capacity for high-quality natural regeneration.

Through this care we direct the development of the forest in line with the natural laws, making optimum use of the conditions of the habitat, the biological conditions and ecological requirements of the species of trees. In this way we support and maintain the forest in the optimum structural conditions, in which stability, productivity and biological diversity are the basic indicators of an optimum condition. The possibility of natural regeneration of forests care for in this way is the local consequence and step that leads to their eternity. Through care both the quantity and the quality of the forest are affected (Matić i dr. 2003, Leibundgut 1978, Lang 1982, Koestler 1952, Pintarić 1969).

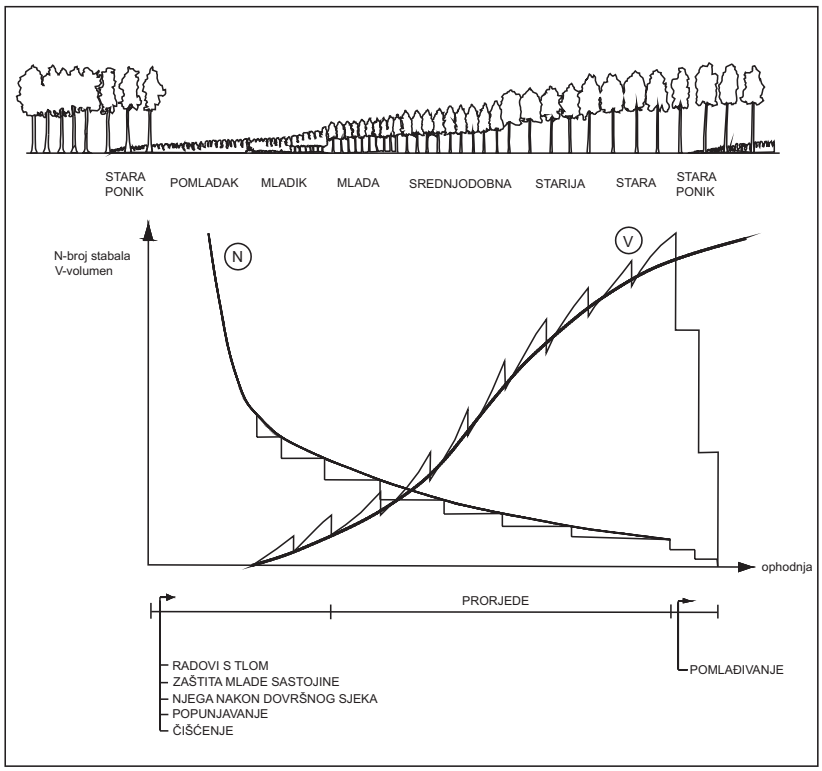
Care of forests and trees is based on the fact that the phenotype is the result of the genotype and the influence of the environment, that is of the conditions of the habitat. Through care, the phenotype and the habitat are affected. The spontaneous selection of plants in the forest is replaced with a selection based on silvicultural principles. Positive and negative selection are distinguished. through negative selection, all the undesirable individuals are perceived and removed, up to the age when the trees of the future start being discerned. After this, one goes over to procedures of positive selection, by which everything is removed from the forest that hinders the development of the perceived trees of the future. But in so doing, one must be careful that

Prorjeđivanjem šume održava se njezina higijena i pomaže razvoj najboljih stabala. Oblikuju se krošnje, njeguju se debla stabala koja ostaju u šumi. U prašumi se također događa odabiranje stabala. Međutim, prašuma ima svoja načela odabira po kojima pobjeđuju biološki i ekološki jače vrste. Hrast lužnjak po svojim je bioekološkim osobinama najslabija vrsta među drvećem nizinskih šuma (»osjetljivi kralj šume«). Zato, kada ne bi bilo stručne njege i pomlađivanja, ne bi bilo glasovitih slavonskih hrastika već grabika, vrbika, jošika ili bi hrastici bili nekvalitetni, skloni sušenju i bolestima.

Slika 4. Shema razvoja šume hrasta lužnjaka, s naznakom vrste uzgojnih postupaka te krivuljama broja stabala i obujma šume. U razdoblju od 140 godina, koliko najmanje iznosi ophodnja gospodarske hrastove šume s grabom u nas, broj stabala hrasta lužnjaka se smanji od približno 50 000 kom/ha, koliko ih ima u ranoj mladosti, do približno 100 kom/ha, koliko ih ima u 140. godini. Tih 100 stabala imaju zavidne dimenzije i ljepotu, na njima je kumulirano preko 600 m^3/ha najkvalitetnije, glasovite slavonske hrastovine.
Ako uzmemo da je životni vijek šume hrasta lužnjaka određen s najmanje 140 godina, jasno je da su potrebna 3 - 4 naraštaja šumarskih stručnjaka kako bi se podigla jedna slavonska hrastova šuma. Danas šumarstvo Hrvatske gospodari s prvom, drugom,

the stand does not lose the essential features: the natural structure, the cohesion, productivity, stability, diversity and ability to regenerate naturally (Matic et al, 2003).
Through the thinning of a forest, its hygiene is maintained, and the development of the best trees is helped. The crowns are formed, the trunks of the trees that remain in the forest are cared for. In the virgin forest, the selection of trees also occurs. But the virgin forest has its own principles of selection, in which the biologically and ecologically stronger species win. In bioecological features, the common oak is the weakest species among the trees of the lowland forests (the vulnerable king of the forest). Thus, if there were no expert care and regeneration, there would be none of the famed Slavonian oak forests, rather stands of hornbeam, willow, alder, and the oak groves would be of low quality, apt to sickness and withering.

Figure 4. Diagram of the development of a common oak forest, with an indication of the kinds of cultivation procedure and the curves of numbers of trees and volume of the forest. In a period of 140 years, which is the shortest period which a cohort of oak and hornbeam forest in this country lasts, the number of trees of common oak is reduced from approximately 50,000 to an acre, as there are in early youth, to about 100 a hectare, which there are in the 140th year. These 100 trees have remarkable dimensions and beauty, and they have accumulated over 600 cubic metres per hectare of the finest celebrated Slavonian oak wood.



ponegdje s trećom generacijom nizinskih hrastovih šuma. Prve je hrastike, prašume hrasta lužnjaka, počeo pomlađivati Josip Kozarac, nekadašnji upravitelj šumarije Lipovljani. Danas šumari pomlađuju one hrastike koje je on osnovao (druga generacija).
Svojedobno je Kozarac (1896.) poručio kolegama iz Njemačke: »*Napokon i to: nemojte gospodo njemački šumari hodočastiti jedino u Spessart, nije to prava Mekka plemenite Quercus pedunculate; nego izvolite zaviriti i u Slavoniju, pa ja kriv, ako mnogi od vas će prestati odgajati hrast ondje, gdje mu mjesta nema*«. Ova je rečenica aktualna i danas kada mnogi praktičari i znanstvenici šumarstva dolaze na ekskurzije u hrvatske hrastove šume vidjeti gospodarenje po načelima Zagrebačke škole uzgajanja šuma.
Zato šumarstvu u Hrvatskoj ne treba postavljati pitanja koja Bengtsson i dr. (2000.) postavljaju europskome šumarstvu: Kako promijeniti prečesto rabljenu praksu uzgajanja šumskih monokultura? Kako procese u prirodnim šumama primijeniti na praksu gospodarenja šumama? Kako razvijati potrajno gospodarenje u gospodarskom i općekorisnom smislu? Kako povećati biološku raznolikost i stabilnost šume? Ono odgovore na ta pitanja ima.

ZAKLJUČAK

Šume Hrvatske, poglavito nizinske i gorske, najznačajnija su ekološka uporišta naše zemlje. To mislimo danas, ali treba imati na umu da su njihove vrijednosti bili svjesni i u 18. stoljeću. Nije zato slučajno šumarstvo u Hrvatskoj nastalo upravo na tim područjima. Ono se pojavilo iz straha od nestanka šuma i potrebe za očuvanjem šuma, a razvijalo se prema načelima Zagrebačke škole uzgajanja šuma. Šumarstvo je tako bilo prva »ekološka«, »zelena« struka koja je uspjela održati šume u stanju u kakvom su danas.
Gospodarenje šumama razvijalo se po načelu višenamjenske progresivne potrajnosti: uvijek na istoj površini šuma se iskorištavala koliko se mogla, a ostajala je sve bolja.
Zahvaljujući pristupu gospodarenju i zakonskim rješenjima, hrvatske su šume do danas zadržale prirodni karakter, a površina im je ostala sačuvana. Hrvatsko se šumarstvo može pohvaliti činjenicom kako vjerojatno jedino u Europi gospodari prirodnim šumama u skladu s prirodnim načelima. Shvaća li naše društvo tu prednost?

If we take the average life span of a common oak forest as being at least 140 years, it is clear that a least 3-4 generations of forestry experts are required to bring one Slavonian oak forest to maturity. Today the forestry of Croatia manages the first, second and occasionally the third generation of lowland oak forests. The regeneration of the first oak groves, the virgin forests of common oak, was started by Josip Kozarac, the one-time warden of the forest area of Lipovljani. Today foresters are regenerating those oak groves that he established (2nd generation).
Once, Kozarac (in 1896) told his German colleagues: "*Finally, this: don't, you German foresters, make pilgrimages just to Spessart, that is not the true Meca of the noble Quercus pedunculate; but go and take a look at Slavonia, and I shall be to blame, but many of you shall cease to cultivate the oak where it has no place to be*". This sentence is topical today, too, when many practical and scientific foresters go on excursions into the Croatian oak forests to see forest management according to the principles of the Zagreb Silviculture School.
Thus forestry in Croatia need not be posed the question that Bengtsson et al (2000) put to European forestry: How to change the too frequently used practice of raising forest monocultures: How to apply the processes in the natural forest to the practice of forest management? How is one to develop sustainable management in an economic and general-use sense? How can the biological diversity and stability of the forest be increased? For it has the answers to all these questions.

CONCLUSION

The forests of Croatia, particularly those in the lowlands and the highlands, are the most important ecological resource of our country. We share this opinion today, but one should bear in mind that people in the 18th century were also aware of their value. It is not accidental that forestry in Croatia came into being in these very areas. It appeared out of fear of the disappearance of the forest, and the need to preserve them, and it developed according to the principles of the Zagreb Silviculture School. Forestry was the first ecological and green profession, and managed to maintain the forests in the condition in which we see them today.
Forest management developed on the principle of multi-use progressive sustainability; always, on the same area, the forest was used as much as it could be, and was left always in a better condition.
Thanks to the approach to management and to the legislative approaches, Croatian forests have retained to this very day their natural character, and their area has remained the same. Croatian forestry can boast of being probably the only such institution in European terms that manages natural forests in accordance with natural principles. Is our society aware of this advantage?

LITERATURA

Bengtsson, J., S. G. Nilsson, A. Franc, P. Menozzi, 2000: Biodiversity, disturbances, ecosystem function and management of European forests. Forest Ecology and Management 132(1): 39 50.

Glavač, V., 1999: Uvod u globalnu ekologiju. Državna uprava za zaštitu prirode i okoliša, »Hrvatske šume« p. o. Zagreb, 211 str., Zagreb.

Klepac, D., 1998: Hrvatsko šumarstvo u XIX. i XX. stoljeću. U: Sveučilišna šumarska nastava u Hrvatskoj 1898 - 1998, knjiga II., Šumarski fakultet, str. 9 - 33, Zagreb.

Klepac, D., 1997: Hrvatsko šumarstvo u drugoj polovici XIX. stoljeća. Šumarski list CXXI (3 4): 115 126, Zagreb.

Korpel, Š., M. Saniga, 1995: Prirode blizke pestovanie lesa. TU Zvolen, 158 str., Zvolen.

Korpel, Š., 1991: Pestovanie lesa. Priroda, 465 str., Bratislava.

Korpel, Š., 1989: Pralesy Slovenska. VEDA, 322 str., Bratislava.

Kozarac, J., 1896: Njemački šumari i uzgoj hrastovine. Šum. list, str. 144 - 152, Zagreb.

Köstler, J. N., 1953: Waldpflege. Hamburg/Berlin.

Lang, E., 1982: Pflege von Buchenbästanden im Hessichen Forstamt Happenheim. Allgemeine Forstzeitschrift, 21, Muenchen.

Lebundgut, H., 1978: Die Waldpflege. Verlag Haupt, 204 str., Bern/Stuttgart.

Leibundgut, H., 1978a: Über die Dynamik europaeisher Urwaelder. Allg. Forstzeitschr. 24: 686 - 690.

Leibundgut, H., 1959: Über Zweck und Methodik der Struktur- und Zuwachsanalyse von Urwaeldern. Schwiz. Z. Forstwes.

Matić, S., I. Anić, M. Oršanić, 2003: Uzgojni postupci u bukovim šumama. Obična bukva (Fagus sylvatica L.) u Hrvatskoj, Akademija šumarskih znanosti, 340 - 369, Zagreb.

Matić, S., I. Anić, M. Oršanić, 2001: Uzgojni postupci u prebornim šumama. Obična jela (Abies alba Mill.) u Hrvatskoj, Akademija šumarskih znanosti, 407 - 443, Zagreb.

Matić, S., 1996: Uzgojni radovi na obnovi šuma hrasta lužnjaka. Hrast lužnjak (Quercus robur L.) u Hrvatskoj, Hrvatska akademija znanosti u umjetnosti i „Hrvatske šume“ p. o. Zagreb, str. 169 - 184, Zagreb.

Matić, S., B. Prpić, Đ. Rauš, A. Vranković, Z. Seletković, 1979: Ekološko-uzgojne osobine specijalnih rezervata šumske vegetacije Prašnik i Muški bunar u Slavoniji. U: Đ. Rauš (ur.), Drugi kongres ekologa Jugoslavije, Savez društava ekologa Jugoslavije, str. 767 - 823, 1979, Zagreb.

Meštrović, Š., 1995: Dvjestodvadeseta godišnjica Zakonske uredbe o šumama. Šumarski list CXIX(4): 144 - 158, Zagreb.

Otto, J. H., 1998: Practical criteria and indicators of sustainability in forests. In: 2nd International Pro Silva Congress proceedings, Pro Silva Association, str. 223 - 239, Apeldoorn.

Pintarić, K., 1969: Njega šuma. Univerzitet u Sarajevu, 187 str., Sarajevo.

Prpić, B., Z. Seletković, 1996: Istraživanja u hrvatskim prašumama i korištenje rezultata u postupku s prirodnom šumom. U: B. Mayer (ur.), Unapređenje proizvodnje biomase šumskih ekosustava, Šumarski fakultet Sveučilišta u Zagrebu i Šumarski institut, Jastrebarsko, str. 97 - 14, Zagreb.

Vukelić, J., Đ. Rauš, 2001: Lowland forests in Croatia. Floodplain forests in Europe, European Forest Institute Research Report 10, 101 125, Leiden Boston Koeln.

Doc. dr. sc. Igor Anić
Sveučilište u Zagrebu
Šumarski fakultet
Zavod za Uzgajanje šuma
Svetošimanska 25, 10000 Zagreb

STANJE I PROJEKCIJE BUDUĆEGA GOSPODARENJA I RAZVOJA DOBNE STRUKTURE U ŠUMAMA HRASTA LUŽNJAKA I POLJSKOG JASENA NA PODRUČJU PARKA PRIRODE LONJSKO POLJE

SAŽETAK

Potencijali staništa šuma hrasta lužnjaka i poljskog jasena u nizinskim šumama Hrvatske posebno su veliki, pa su dugoročne projekcije i planiranje gospodarenja tim šumama, kako na razini cijelog područja, tako i na razini manjih područja, osobito važni. Predmet ovoga rada su sastojine u uređajnim razredima hrasta lužnjaka (16 865 ha) i poljskog jasena (10 403 ha) na području parka prirode Lonjsko polje. Cilj rada je dobiti i raspraviti projekcije budućega gospodarenja i razvoja dobne strukture tih šumskih resursa. Metoda simulacije zasniva se na sustav-dinamičkom modelu regularne šume. Intenzitet obnove sastojina uzima se kao najvažniji utjecajni čimbenik budućega razvoja dobne strukture. Tri scenarija gospodarenja su definirana, s obzirom na način planiranja godišnjega površinskog etata glavnoga prihoda (na temelju ukupne površine šume, na temelju površine sastojina starijih od pola ophodnje i na temelju površine sastojina zadnjeg dobnog razreda). Osim toga, za uređajni razred hrasta lužnjaka simulirano je produženje ophodnje na 160 godina, a za poljski jasen skraćivanje ophodnje na 80 godina. Za svaki scenarij dobivene su projekcije godišnjega površinskog etata obnove, razvoja dobne strukture, kretanja drvne zalihe te godišnjih etata glavnog i prethodnog prihoda. S obzirom na početnu dobnu strukturu, s velikim udjelom zrelih sastojina i mladih sastojina prvog dobnog razreda u oba uređajna razreda, razmotren je najprihvatljiviji scenarij. Dosljedno gospodarenje definirano planiranjem godišnje obnove sastojina na temelju površine sastojina starijih od pola ophodnje moglo bi voditi postizanju prihvatljivije dobne strukture (već za 50 godina) kao i strukture i odnosa sječa glavnoga i prethodnoga prihoda. Za uređajni razred hrasta lužnjaka planiranje bi se moglo zasnivati na ophodnji od 160 godina, a za uređajni razred poljskog jasena na ophodnji od 80 godina.

Ključne riječi: regularno gospodarenje, razvoj dobne strukture, planiranje obnove sastojina, oplodna sječa, ophodnja.

THE PRESENT CONDITION AND A PROJECTION OF THE FUTURE MANAGEMENT AND DEVELOPMENT/AGE STRUCTURE IN COMMON OAK AND NARROW-LEAVED ASH FORESTS IN THE AREA OF LONJSKO POLJE NATURE PARK

ABSTRACT

The potentials of the common oak and narrow-leaved ash forest habitats in the lowland forests of Croatia are particularly significant, and so the long-term projections and planning of the management of these forests, at the level of both the entire area and small areas, are of great importance. This paper concerns stands within management classes of common oak (16865 ha) and narrow-leaved ash (10403 ha) in the area of Lonjsko Polje Nature Park. The objective of the paper is to obtain and discuss projections for the future management and development of the age structure of these forest resources. The simulation method is based on the system/dynamic model of an even-aged forest. The regeneration intensity of stands is taken as the most important causal factor of future development of the age structure. Three scenarios for management are defined with respect to manner of planning, annual area of the main cut (according to the total area of the forest, according to the area of the area of stands older than half the rotation, and according to the area of stands of the last age class). Apart from that, for the management class of common oak, the prolongation of the rotation to 160 years is simulated, and for narrow-leaved ash an abbreviation of the rotation to 80 years. For each of the scenarios, projections of the annual felling cut, the development of the age structure, trends in timber reserves, and annual preliminary and main cuts are obtained. The most acceptable scenario is considered with respect to the initial age structure, with a large proportion of mature stands and young stands of the first age class within both management classes. Consistent management defined by the planning of an annual regeneration of stands according to the area of the stands older than half a rotation could lead to attainment of acceptable age structures (in as early as 50 years), and to structures and relations of intermediate and main cuts. For the management class of common oak, planning could be based on a rotation of 160 years, and for the management class of narrow-leaved ash, on a rotation of 80 years.

Key words: regular management, development of age structure, stand regeneration planning, seeing cut, rotation

Uvod

U nizinskom području Hrvatske, sa 31% obrasle površine, vrijedne su šume hrasta lužnjaka i šume poljskog jasena. Potencijali staništa šuma hrasta lužnjaka, od 202 150 ha, i poljskog jasena, od 27 300 ha, veći su u odnosu na postojeću strukturu drvne zalihe i volumnog prirasta (Čavlović, 1999.). Zbog velikog su općega i gospodarskoga značenja dugoročne projekcije i planiranje gospodarenja nizinskim šumama, kako na razini cijelog područja, tako i na razini manjih područja, osobito važni.
U uvjetima kada postoje stalne promjene ekoloških uvjeta, razvoja i prirasta šumskih sastojina, istovremeno sa stalnim promjenama zahtjeva društva za proizvodima i uslugama šuma, pri planiranju gospodarenja šumama treba stalno usklađivati ponudu i potražnju za dobrima šume. To može biti osigurano sveobuhvatnim modelima planiranja na razini šumske uprave, područja ili cijele zemlje (Mohren, 2003.).
Simulacijski modeli imaju značajnu ulogu u procesima odlučivanja pri planiranju i gospodarenju šumama. Brojni simulacijski modeli na razini sastojine (Pretzsch, 1997; Pretzsch et al, 2002.; Lindner et al, 1997.; Robinson and Monserud, 2003.), kao i istraživanja utjecaja promjena stanišnih uvjeta na rast sastojina (Spiecker et al, 1996.; Karjalainen et al, 2002.; Kramer and Mohren, 2001.) predstavljeni su znanstvenoj javnosti.
Na razini regularne šume (uređajni razred, šumarija, Uprava šuma) tijekom dugog razdoblja, promjene u rastu, prirastu i vrijednosti šume su uvjetovane promjenom dobne strukture šume (Čavlović, 1999; Čavlović et al., 2000.). U kontekstu modeliranja na razini većeg prostora (Nabuurs et al, 1998) i dugoročnog planiranja (Nabuurs et al, 2001; Nabuurs et al, 2002; Nelson, 2003) u radu će biti prikazane projekcije budućega gospodarenja i razvoja dobne strukture šuma hrasta lužnjaka i poljskog jasena na razini parka prirode Lonjsko polje. Planiranje gospodarenja šumama ima nedjeljivu vremensko-prostornu dimenziju. U radu će težište biti više na vremenskom dugoročnom planiranju, uz razmatranje i prostorne dimenzije planiranja. Glavni cilj je utvrditi uz kakvo gospodarenje će se dobiti najprihvatljiviji razvoj dobne strukture, kretanje strukture obnove, drvne zalihe i sječa glavnog i prethodnog prihoda.

Predmet rada

Predmet rada su sastojine uređajnih razreda hrasta lužnjaka i poljskog jasena koji se nalaze u sastavu 11 gospodarskih jedinica. Gospodarske jedinice

Introduction

In the lowland area of Croatia, 31% covered with timber, there are valuable forests of common oak and of narrow-leaved ash. The potentials of the common oak forest habitats, of 202,150 ha, and of narrow-leaved ash, of 27,300, are greater than the actual existing structure of timber reserves and volume yield (Čavlović, 1999). Because of the great general and economic importance, the long-term projections for and planning of the management of the lowland forests, at the level of the area as a whole, and at the level of small areas, are of particular importance.
In conditions in which there are constant changes in the ecological conditions, the development and yield of forest stands, simultaneously with constant changes in the requirements of the society for the products and services of the forests, forest management planning needs all the time to adjust supply of and demand for the assets of the forest. This can be secured by comprehensive planning models at the level of forest unit or compartment. (Mohren, 2003).
Simulation models play an important role in decision-making in planning and managing the forests. Many simulation models at the level of stand (Pretzsch, 1997; Pretzsch et al, 2002; Lindner et al, 1997; Robinson and Monserud, 2003), as well as research into the influence of habitat conditions on the growth of stands (Speicker et al, 1996; Karjalainen et al, 2002; Kramer and Mohren, 2002), have been submitted to the scientific public.
At the level of even-aged forest (management class, forest unit, forest district) over a long period of time, changes in growth, yield and value of the forest are conditioned by changes in the age structure of the forest (Čavlović,1999; Čavlović et al, 2000). In the context of modelling over a large area (Nabuurs et al, 1998) and long-term planning (Nabuurs et al, 2001; Nabuurs et al, 2002; Nelson, 2003), the paper will show projections of the future management and development of the age structure of forests of common oak and narrow-leaved ash at the level of Lonjsko Polje Nature Park. The planning of forest management constitutes a single indivisible dimension of time and space. The emphasis in the work will be on temporal long-term planning, with a consideration of the spatial dimension of planning as well. The main goal is to determine what kind of management will lead to the most acceptable development of the age structure, the trend in regeneration structure, timber reserves and first and felling cuts.

The subject of the paper

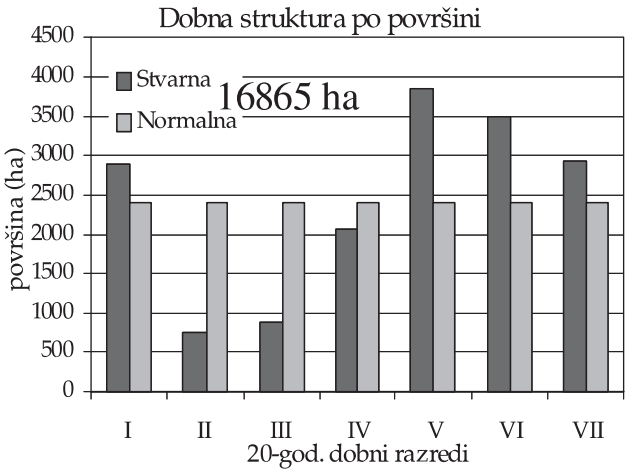
The subject of the paper is stands of management classes of common oak and narrow-leaved ash that are in 11 management units. The management units

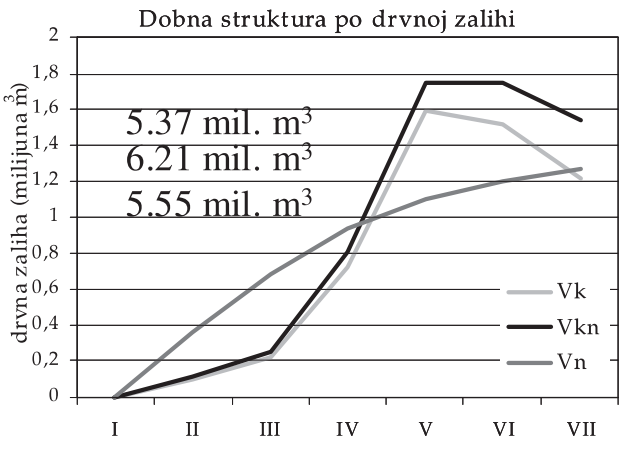
Žabarski bok, Trstika I, Grede-Kamare, Međustrugovi, Lonja, Brezovica, Kutinske nizinske šume, Popovačke nizinske šume, Zelenika, Josip Kozarac i Krapje đol se u potpunosti ili najvećim dijelom nalaze na području Parka prirode Lonjsko polje. Za potrebe ovoga rada nisu utvrđivani dijelovi gospodarske jedinice (odsjeci) koji se ne nalaze unutar granica Parka prirode, pa se podaci uređajnih razreda hrasta lužnjaka i poljskog jasena ne mogu uzeti kao potpuno točni. Isto tako, dobna struktura uređajnih razreda na razini područja svih 11 gospodarskih jedinica nije utvrđena na temelju trenutačne starosti svake pojedine sastojine, nego na temelju postojeće dobne strukture unutar svake pojedine gospodarske jedinice. Dobna struktura unutar pojedine gospodarske jedinice se odnosi na godinu obnove ili revizije osnove gospodarenja. Kako unutar navedenih 11 gospodarskih jedinica postoji normalna dinamika uređivanja šuma, može se reći da se dobivena dobna struktura prosječno odnosi na stanje prije pet godina.
Dobna struktura uređajnih razreda hrasta lužnjaka i poljskog jasena po površini i drvnoj zalihi, te odnos prema normalnoj dobnoj strukturi prikazan je slikom 1 i slikom 2. Podaci prikazani slikama pokazuju početno stanje projekcije budućeg razvoja dobne strukture.

Slika 1. Odnos dobne strukture po površini i drvnoj zalihi za uređajni razred hrasta lužnjaka u istraživanom području

of Zabarski bok, Trstika I, Grede-Kamare, Međustrugovi, Lonja, Brezovica, Kutinske nizinske šume, Popovačke nizinske šume, Zelenika, Josip Kozarac and Krapje-Đol are totally or mostly in the area of Lonjsko Polje Nature Park. For the purposes of this work, the parts of a management unit (compartments) that are not within the borders of the Nature Park are not determined, and the data of the management classes of oak and ash cannot be considered totally accurate. Similarly, the age structure of the management classes at the level of the areas of all the 11 management units has not been determined pursuant to the current age of every individual stand, but on the basis of the existing age structure within each individual management unit. The age structure within an individual management unit relates to year or regeneration or review of the management plan. Since inside these 11 management units there is a normal dynamics of forest management, it can be said that the age structure obtained refers on average to the situation of five years back.
The age structure of the management classes of common oak and narrow-leaved ash, according to area and timber reserves, and the ratio towards the normal age structure, in shown in Figures 1 and 2. The data shown in the figures are the initial state of the projection of the future development of the age structure.

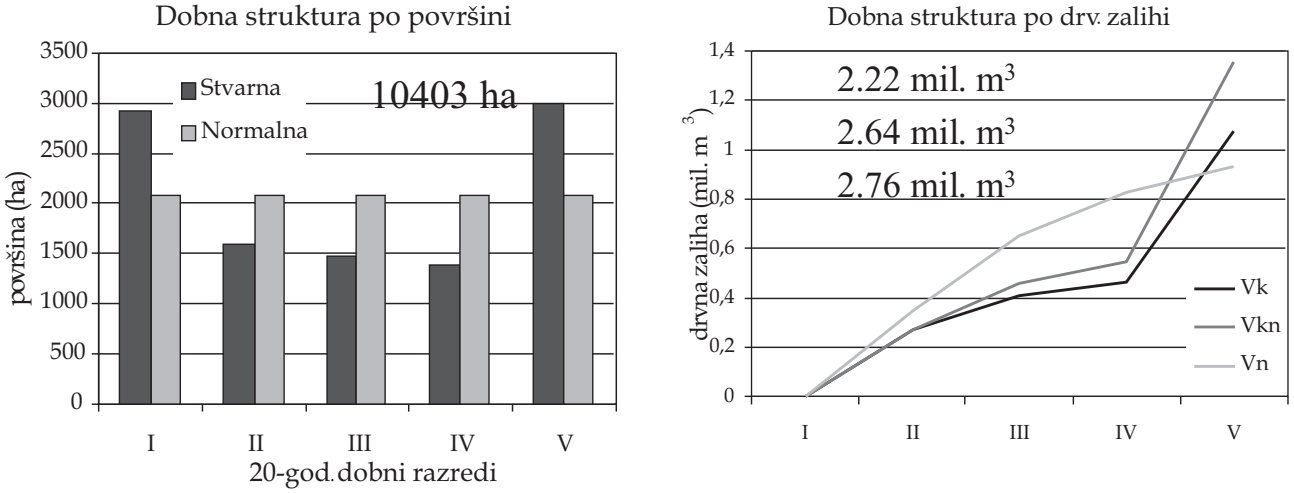
Figure 1. Ratio of age structure in terms of area and timber reserves for the management class of common oak inside the research area.





Slika 2. Odnos dobne strukture po površini i drvnoj zalihi za uređajni razred poljskog jasena u istraživanom području

Figure 2. The ratio of age structure per area and timber reserves for the management class of narrow-leaved ash inside the research area



Metoda projekcije budućeg razvoja dobne strukture

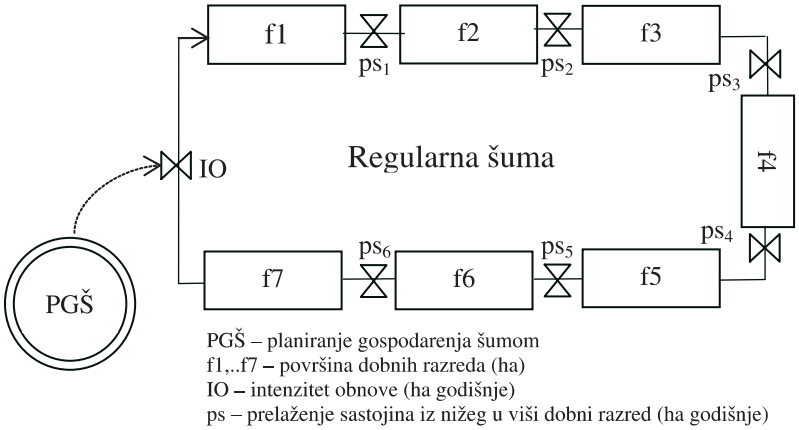
Metoda se zasniva na sustav-dinamičkom modelu regularne šume (Čavlović, 1996.). Slika 3. pokazuje sustav regularne šume koji se sastoji od sedam dobnih razreda, s obzirom na 140-godišnju ophodnju i širinu dobnih razreda od 20 godina. To je zatvoreni sustav unutar kojega se tijekom vremena odvija prelaženje sastojina između dobnih razreda. Prelaženje sastojina (površine) u sljedeći dobni razred ovisi o površini dobnog razreda i širini dobnog razreda. Prelaženje sastojina iz zadnjeg u prvi dobni razred uvjetovano je s površinom obnove sastojina (planiranje gospodarenja), pa se na taj način može utjecati na buduće kretanje dobne strukture. Buduće kretanje količine i strukture drvne zalihe, prirasta i sječa u neposrednoj je vezi s kretanjem dobne strukture po površini.
U modelu je pretpostavljeno linearno postizanje normalnoga prosječnog volumena po ha (normalni obrast sastojina) prema PPT (Špiranec, 1975.) za pojedini dobni razred u definiranom vremenu.

Method of projection of future development of the age structure

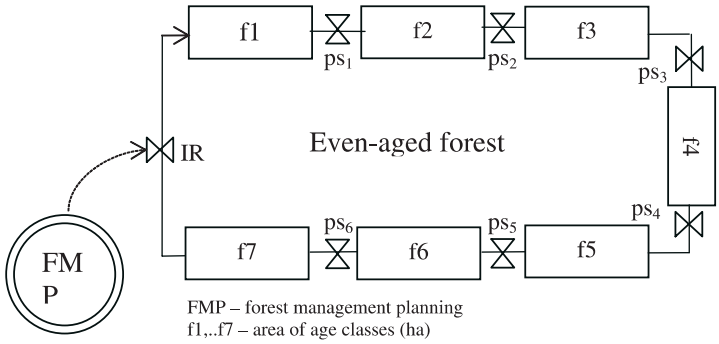
This method is based on the system-dynamic model of even-aged forest (Čavlović, 1996). Figure 2 shows the system of an even-aged forest that consists of 7 age classes, with reference to the 140 year rotation and the breadth of age classes of 20 years. This is a closed system within which over time the transition of stands between the age classes takes place. The transition of stands (areas) into the next age class depends on the area of the age class and the width of the age class. The transition of the stands from the last to the first age class is conditioned by the area of regeneration of stands (planned management) and in this way can affect the future trends in the age structure. The future trend in the volume and structure of timber reserves, yield and harvest is in direct relation with the trend in the age structure according to area.
The model assumes a linear achievement of the normal average volume per hectare (normal cover of stands) according to PPT (Spiranec, 1975) for a given age class inside the defined time.

Slika 3. Sustav-dinamički model regularne šume hrasta lužnjaka uz ophodnju od 140 godina

Figure 3. The system-dynamic model of normal forest of common oak with a rotation of 140 years.



PGŠ – planiranje gospodarenja šumom
f1,..f7 – površina dobnih razreda (ha)
IO – intenzitet obnove (ha godišnje)
ps – prelaženje sastojina iz nižeg u viši dobni razred (ha godišnje)



FMP – forest management planning
f1,..f7 – area of age classes (ha)
IR – intensity of regeneration (ha p a)
ps – stands moving from a lower to a higher age class (ha p a)

Kao što je već rečeno, regularno gospodarenje je zasnovano na 140-godišnjoj ophodnji i 10-godišnjem razdoblju oplodne sječe. Kako intenzitet obnove po površini najviše utječe na buduće kretanje dobne strukture, za projekciju budućega gospodarenja primijenjena su tri scenarija definirana sljedećim jednadžbama:

Scenarij 1: $IO_1 = \frac{F}{u}$

Scenarij 2: $IO_2 = \frac{F_M}{\frac{u}{2}}$

Scenarij 3: $IO_3 = \frac{F_z}{20}$

gdje je IO intenzitet obnove (ha/godišnje); F-ukupna površina šume; u-ophodnja; FM-površina sastojina starijih od pola ophodnje i Fz-površina zadnjeg dobnog razreda.

As was stated earlier, regular management is based on a 140 year rotation and a 10 year period of seeding cuts. Since the intensity of regeneration per area is the most important factor impacting the future trends in the age structure, for the projection of future management, three scenarios are taken, defined by the following equations:

Scenario 1: $IO_1 = \frac{F}{u}$

Scenario 2: $IO_2 = \frac{F_M}{\frac{u}{2}}$

Scenario 3: $IO_3 = \frac{F_z}{20}$

where IO is intensity of regeneration (ha/annual); F-total area of forest; u-rotation; FM area of stands older than half a rotation and Fz the area of the last age class.

Rezultati projekcije razvoja dobne strukture

Temeljem izvršenoga simuliranja dobivene su projekcije kretanja godišnjega površinskog etata glavnog prihoda (intenziteta obnove), razvoj dobne strukture, kretanje drvne zalihe, kao i godišnjeg etata glavnoga i prethodnoga prihoda za svaki od prethodno definirana tri scenarija.
Za uređajni razred hrasta lužnjaka pri gospodarenju uz ophodnju od 140 godina slika 4 prikazuje buduće kretanje godišnjeg površinskog etata glavnog prihoda i razvoja dobne strukture.

Radi utvrđivanja utjecaja produživanja ophodnje pri gospodarenju sastojinama hrasta lužnjaka na buduće gospodarenje, izvršeno je simuliranje gospodarenja uz ophodnju od 160 godina (slika 5).
Kako se vidi iz slika 4 i 5, najveće promjene se mogu očekivati tijekom prvoga 50-godišnjeg razdoblja. U tablici 1 su prikazani sumarni rezultati očekivane obnove sastojina, etata glavnog i prethodnog prihoda za prvo 50-godišnje razdoblje unutar scenarija.

Tablica 1. Prikaz intenziteta obnove i očekivanog etata s obzirom na ophodnju i scenarij gospodarenja za prvih 50 godina projekcijskog razdoblja za uređajni razred hrasta lužnjaka.

Results of the projection of the development of the age structure

According to the simulation carried out, projections of the annul felling cut (intensity of regeneration), the development of the age structure, the trends in timber reserves, and the annual felling and intermediate cuts have been obtained for each of the previously defined scenarios.
For the management class of common oak in management pattern with a 140 year rotation, Figure 4 shows the future trends of annual felling cut and the development of the age structure.

For the sake of determining the impact of the extension of the rotation while managing common oak stands on the future management, a simulation of management with a 160 year rotation was carried out (Figure 5).
As can be seen from Figures 4 and 5, the greatest changes can be expected during the first 50 year period. Table 1 shows the summary results of the expected regeneration of the stands, the main and the intermediate cut for the first 50 year period within the scenarios.

Table 1. Review of intensity of regeneration and expected permissible cut with respect to rotation and management scenario for the first 50 years of the projection period for the common oak management class.

		Gospodarenje uz ophodnju od 140 god.			Gospodarenje uz ophodnju od 160 god.		
		Scenarij 1	Scenarij 2	Scenarij 3	Scenarij 1	Scenarij 2	Scenarij 3
Obnova	ha/50 god.	6,023	6,833	7,660	5,270	5,818	4,910
	ha/god.	120.5	136.7	153.2	105.4	116.4	98.2
Etat glavnog prihoda	mil.m^3/50 g	2.693	3.061	3.425	2.344	2.591	2.164
	m^3/god.	53,860	61,226	68,510	46,886	51,816	43,289
Etat međuprihoda	mil.m^3/50 g	2.523	2.387	2.290	2.624	2.535	2.752
	m^3/god.	50,457	47,746	45,791	52,488	50,704	55,039
Sveukupni etat	mil.m^3/50 g	5.216	5.448	5.715	4.968	5.126	4.916
	m^3/god.	104,317	108,972	114,301	99,374	102,520	98,328

Isto kao za uređajni razred hrasta lužnjaka, dobiveni rezultati za uređajni razred poljskog jasena pri gospodarenju uz ophodnju od 100 godina prikazani su slikom 6. S obzirom na zastupljenost prezrelih sastojina jasena, starijih i od 100 godina, te propisanu ophodnju za jasen, slikom 7 je prikazan utjecaj gospodarenja uz ophodnju od 80 godina na dinamiku obnove i razvoja dobne strukture.

Najveće promjene u kretanju dobne strukture i obnove (scenarij 3) mogu se očekivati tijekom prvih 40 godina.

Just as with the common oak management class, the results obtained for the narrow-leaved oak management class, with a rotation of 100 years, are shown in Figure 6. Because of the representation of over-mature stands of ash, older than 100 years, and the prescribed rotation for ash, Figure 7 shows the effect of management with an 80 year rotation on the dynamics of regeneration and the development of the age structure.

The greatest changes in the trends in the age structure and regeneration (Scenario 3) can be expected during the first 40 years.

Tablica 2. Prikaz intenziteta obnove i očekivanog etata s obzirom na ophodnju i scenarij gospodarenja za prvih 40 godina projekcijskog razdoblja za uređajni razred poljskog jasena.

Table 2. Review of the intensity of regeneration and the expected permissible cut with respect to rotation and management scenario for the first 40 years of the projection period for the narrow-leaved ash management class.

		Gospodarenje uz ophodnju od 100 god.			Gospodarenje uz ophodnju od 80 god.		
		Scenarij 1	Scenarij 2	Scenarij 3	Scenarij 1	Scenarij 2	Scenarij 3
Obnova	ha/40 god.	4161	3993	4341	5202	5312	5878
	ha/god.	104.0	99.8	108.5	130.0	132.8	147.0
Etat glavnog prihoda	mil.m^3/40 g	1.611	1.547	1.693	1.917	1.962	2.192
	m^3/god.	40283	38673	42314	47912	49058	54811
Etat međuprihoda	mil.m^3/40 g	0.898	0.916	0.857	0.786	0.769	0.684
	m^3/god.	22441	22900	21434	19656	19235	17105
Sveukupni etat	mil.m^3/40 g	2.509	2.463	2.550	2.703	2.731	2.876
	m^3/god.	62724	61573	63749	67568	68293	71916

Zaključna rasprava

Modeliranje scenarija dugoročnog gospodarenja šumom na razini šireg prostora ima za cilj podržati prostorno i vremensko planiranje gospodarskih postupaka (Baskent et al., 2002.; Rohner and Boswald, 2001.; Ohman and Lamas, 2003.). Međutim, uključivanje prostora kao elementa planiranja pri dugoročnom planiranju može procese planiranja znatno otežati (Ohman and Lamas, 2003.). S obzirom na razinu planiranja, u ovom radu je razmotren dugoročni utjecaj tri različita scenarija gospodarenja na dinamiku buduće obnove sastojina, razvoj dobne strukture te kretanje drvne zalihe i sječa. Prostor nije neposredno uključen, međutim on je nedjeljivi element koji se razmatra u okviru cjelovitog planiranja.
Planiranje budućega gospodarenja regularnom šumom ovisno je o postojećoj (početnoj) dobnoj strukturi šume (Čavlović, 1996.; Salo and Tahvonen, 2002.). Nepravilna dobna struktura, s velikim udjelom starih i mladih sastojina te malim udjelom srednjodobnih sastojina za oba uređajna razreda,

Conclusion

The modelling of scenarios for the long-time management of forests at the level of a wider area is aimed at supporting the spatial and temporal planning of management procedures (Baskent et al., 2002; Rohner and Boswald, 2001; Ohman and Lamas, 2003). However, the inclusion of the area as an element of planning may, in the case of long-term planning, make the planning process extremely complex (Ohman and Lamas, 2003). Considering the planning level, this paper has considered the long-term impact of three different management scenarios on the dynamics of the future regeneration of stands, the development of the age structure, and trends in timber reserves and felling. The space is not included directly, but it is nevertheless an inseparable element that is considered within the framework of total planning.
The planning of the future management of an even-aged forest depends on the existing (initial) age structure of the forest (Čavlović, 1996; Salo and Tahvonen, 2002) An irregular age structure with a large proportion of old and young stands, and a small proportion of medium aged stands for both

razmotrena je kao važan utjecajni čimbenik na buduće gospodarenje (Slika 1 i Slika 2). Razmatrajući posebno važan uređajni razred hrasta lužnjaka (Slika 1), može se na prvi pogled usporediti dobna struktura po površini i drvnoj zalihi i njezin odnos prema normalnoj. Isto tako se vidi (Slika 1b) da je obrast starih sastojina manji od normalnog. Međutim, kada bi se dublje ulazilo u analizu strukture sastojina petog, šestog i sedmog dobnog razreda, vidjelo bi se da je stanje još nepovoljnije, s obzirom na udio stabala i drvne zalihe hrasta lužnjaka. S druge strane, stanje i struktura sastojina značajno zastupljenog prvog dobnog razreda nepoznate su. S obzirom na probleme i poteškoće koji postoje prilikom obnove lužnjakovih sastojina i na području Lonjskog polja, može se pretpostaviti da je struktura ovih sastojina u prvim razvojnim stadijima daleko od željene. Prema tome, to su elementi koji mogu biti ograničavajući čimbenici prilikom provedbe planiranih gospodarskih postupaka o kojima treba voditi računa. Uočljiv je i pozitivan utjecaj na brže uspostavljanje normalne dobne strukture, s obzirom na zakonitost - što je kraća ophodnja, brže je postizanje normalne dobne strukture uz dosljedno gospodarenje (Čavlović, 1996.).

Ophodnju kao vremensku i plansku veličinu u kontekstu vremenskog planiranja treba razmotriti kao posebno značajan utjecajni element. Na razini šume (uređajni razred na razini gospodarske jedinice, šumarije ili šireg područja) ophodnjom kao stalnim planskim elementom definira se broj dobnih razreda, dobna struktura, normalitet šume, uspostava normalne dobne strukture, obnova sastojina te etat glavnog i prethodnog prihoda. Utjecaj produljenja ophodnje na intenzitet buduće obnove, buduće kretanje dobne strukture i sječa vidi se iz slika 4 i 5 i tablice 1. Produljenjem ophodnje sa 140 na 160 godina za uređajni razred hrasta lužnjaka smanjio bi se godišnji intenzitet obnove sastojina za 15 do 55 ha, ovisno o scenariju, te bi se smanjio godišnji etat glavnog prihoda, a povećao etat međuprihoda, tijekom prvoga 50-godišnjeg razdoblja. Posebno je uočljiv pozitivan utjecaj produženja ophodnje na kretanje dobne strukture (Slika 5c) u okviru scenarija 2, u okviru kojega je postignuta zadovoljavajuća dobna struktura već nakon 50 godina. Skraćivanje ophodnje sa 100 na 80 godina unutar gospodarenja uređajnim razredom jasena (Slike 6 i 7, Tablica 2) utjecalo bi na povećanje godišnjeg intenziteta obnove za okruglo 30 do 40 ha, povećanje godišnjeg etata glavnog prihoda i smanjenje godišnjeg etata međuprihoda, kao i povećanje ukupnih godišnjih sječa tijekom prvog 40-godišnjeg razdoblja.

S druge strane, ovdje valja istaknuti razliku između značenja ophodnje na razini šume, koje je prethodno

management classes is considered an important factor impacting future management (Figures 1 and 2). Considering the particularly important management class of common oak (Figure 1), at a glance it is possible to compare age structure in terms of area and timber reserves and its relation towards the even aged. In addition it is possible to see (Figure 1b) that the coverage of old stands is smaller than that of the even aged stands. However, if one were to go more deeply into an analysis of the structure of the stands of the fifty, sixth and seventh age class, it would be seen that the situation is still less propitious, consider the proportion of common oak trees and timber reserves. On the other hand, the state and structure of stands of the first age class, very considerably represented, is unknown. Because of the problems that exist during regeneration of common oak stands in the region of Lonjsko Polje too, it can be assumed that the structure of these stands in the first development stages is very far from the desirable. Accordingly, these are elements that may be constraining factors during the implementation of the planned management procedures, that should be borne in mind. It is clear that there is a positive effect on the faster establishment of an even-aged structure, considering the law that the shorter the rotation, the faster the achievement of an even-aged structure assuming consistent management (Čavlović, 1996).

Rotation, as temporal and planning dimension in the context of temporal planning, needs considering as a particularly important conditioning element. At the level of the forest (management class at the level of the management unit, forest unit or larger area), through rotation, a constant element of planning, the number of age classes is defined, the age structure, the even-agedness of the forest, the establishment of an even age structure, regeneration of stands, and the felling and intermediate cuts. The impact of extending the rotation on the intensity of future regeneration, future trends in age structure and cuts can be seen from Figures 4 and 5 and Table 1. By a prolongation of the rotation from 140 to 160 years, for the management class of common oak, the annual intensity of regeneration of stands would e reduced by 15 to 55 ha, depending on the scenario, and the annual felling cut would be reduced, while the intermediate cut would be increased, during the first 50 year period. Particularly visible is the positive effect of the prolongation of the rotation on the trends in the age structure (Figure 5c) within the framework of Scenario 2, in the context of which a satisfactory age structure is achieved as early as within 50 years. Abbreviation of the rotation from 100 to 80 years within management of the ash management class (Figures 6 and 7, table 2) would have an effect on increasing the annual intensity of regeneration to a round 30 to 40 ha, increase of the annual felling cut and reduction of the annual intermediate cut, as well as increase of the total annual cuts of the first forty

opisano i na razini sastojine ili odsjeka. Na razini sastojine, ophodnja bi zapravo trebala predstavljati prosjek sječivih dobi svih sastojina unutar šume, a ne krutu vremensku veličinu kojom se definira sječiva dob svih sastojina. Fleksibilnost u odstupanju sječivih dobi sastojina od definirane ophodnje bolje će uvažavati postojeće stanje svake pojedine sastojine, rezultirat će većim uspjesima pri obnovi sastojina i vodit će popravljanju dobne strukture šume. To treba biti osigurano odgovarajućom zakonskom regulativom, podzakonskim aktima, dosljednom provedbom i kontrolom gospodarskih postupaka.

S obzirom na utjecaj postojeće dobne strukture na buduće gospodarenje šumom, ovdje treba razmotriti i utjecaj definiranih scenarija budućeg gospodarenja, odnosno načina određivanja godišnjega površinskog etata glavnoga prihoda (obnove sastojina). Na temelju slika 4-7 i tablica 1 i 2, može se općenito reći da bi gospodarenje definirano prema scenarijima 2 i 3 bolje uvažavalo postojeću dobnu strukturu šume. Intenzivnija obnova sastojina tijekom razdoblja prvih 50 godina, odnosno prvih 40 godina prema scenarijima 2 i 3 vodilo bi prihvatljivijem razvoju dobne strukture, kao i dinamici, količini i strukturi budućih sječa glavnog i prethodnog prihoda. Pri tom se gospodarenje definirano scenarijem 2 posebno izdvaja kao najprihvatljivije, s obzirom na manje oscilatorno kretanje godišnje obnove i sječa te drvne zalihe u odnosu na scenarij 3. S druge strane, manje intenzivna obnova tijekom prvog 50-godišnjeg razdoblja prema scenariju 1 dovela bi do povećanja prosječne starosti sastojina i gomilanja prezrele drvne zalihe. Schelhaas et al. (2003.) napominju da povećanje srednje starosti sastojina i drvne zalihe čini šumu manje otpornom na štete. Međutim, u šumi s velikim udjelom zrelih sastojina, gdje i pri intenzivnijoj obnovi (Scenarij 2 i 3) jedan dio zrelih sastojina treba "čekati" na red za obnovu dulje vrijeme, važno je odabrati one sastojine za obnovu kod kojih postoji najveći prioritet za obnovom od sastojina koje se mogu "konzervirati" na dulje vrijeme.

Općenito se može zaključiti da bi gospodarenje sastojinama hrasta lužnjaka definirano scenarijem 2, odnosno planiranje godišnjega površinskog etata glavnoga prihoda na temelju površine sastojina starijih od pola ophodnje bilo najprihvatljivije kako uz ophodnju od 140 tako i uz ophodnju od 160 godina. Uz pretpostavku gospodarenja uz ophodnju od 160 godina, s najintenzivnijom obnovom od prosječno 116,4 ha godišnje tijekom prvog 50-godišnjeg razdoblja, prema scenariju 2 bi se postigao najprihvatljiviji razvoj dobne strukture, te kretanje i struktura drvne zalihe i etata. Kod uređajnog razreda poljskog jasena nije se pokazao značajan utjecaj

year period.

On the other hand, it is necessary to highlight here the difference between the importance of the rotation at the level of the whole forest, as previously described, and at the level of stand or compartment. At the stand level, a rotation should represent the average of fellable ages of all stands inside the forest, and not an inflexible temporal dimension defining the fellable age of all the stands. Flexibility in deviating fellable ages of stands from the defined rotation will pay more appropriate attention to the existing condition of each individual stand, result in greater success in the regeneration fo the stands, and lead towards an improvement in the age structure of the forest. This should be provided by the relevant statutory regulation, byelaw instruments, consistent implementation and control of economic procedures.

Because of the effect of the existing age structure on future forest management, here it is necessary to consider the impact of defined scenarios of future management, that is of the manner of determining the annual felling cut (regeneration of stands). According to Figures 4-7 and Tables 1 and 2, it can be said in general that management defined according to scenarios 2 and 3 would better respect the existing age structure of the forest. More vigorous regeneration of the stands during the period of the first 50 years, or the first 40 years, according to scenarios 2 and 3, would lead towards a more acceptable development of the age structure, and a dynamics, volume and structure of future felling and preliminary cuts. Management defined by Scenario 2 stands out as the most acceptable, considering the smaller oscillations in the trends of the annual felling, and timber reserves as compared with Scenario 3. On the other hand, the less vigorous regeneration during the first 50 7ear period according to Scenario 1 would lead to an increase in the average age of the stands and the accumulation of over-mature timber reserves. Schelhaas et al., (2003) note that an increase in the average age of stands and timber reserves makes a forest less resistant to damage. However, in forests with a large proportion of mature stands, where even with more vigorous regeneration (Scenarios 2 and 3) some of the mature stands have to wait in turn for regeneration for quite a long time, it is important to choose for regeneration those stands in which there is the greatest priority for regeneration as against those stands that can be put on hold for a longer period of time.

In general it can be concluded that management of common oak stands defined by Scenario 2, that is, the planning of the annual felling cut according to the area of stands older than half the rotation, would be the most acceptable, both with a rotation of 140 and with one of 160 years. Assuming management with a rotation of 160 years, with a most vigorous regeneration of an average of 116.4 ha annually during the first 50 year period, Scenario 2 would give

različitih scenarija i skraćivanja ophodnje na buduće kretanje dobne strukture. Uz dosljedno gospodarenje, već nakon 40 godina postigla bi se zadovoljavajuća ravnoteža u dobnoj strukturi i kretanju i strukturi drvne zalihe i etata. Uz pretpostavku gospodarenja uz ophodnju od 80 godina i nešto ipak prihvatljivijega gospodarenja prema scenariju 2, godišnji intenzitet obnove tijekom prvog 40-godišnjeg razdoblja bi se povećao za oko 30 ha, povećao bi se etat glavnoga prihoda i sveukupni etat u odnosu na 100-godišnju ophodnju.

Sve projekcije budućega gospodarenja prikazane u rezultatima zasnivaju se na optimističnim pretpostavkama, ponajprije uspješne obnove sastojina na vremenski planiranim površinama, kao i postupnog postizanja normalnog obrasta i strukture sastojina. To znači da planiranu obnovu sastojina uređajnog razreda hrasta lužnjaka (116 ha godišnje) treba u prvom 10-godišnjem gospodarskom polurazdoblju započeti i uspješno ostvariti na 1160 ha u onim sastojinama ili dijelovima postojećih sastojina gdje su zahtjevi za obnovom najpreči. S obzirom na prostornu dimenziju planiranja, nužno je utvrditi optimalnu prosječnu površinu sastojina koje se obnavljaju, kao i njihov razmještaj u prostoru. Smanjivanje prosječne površina (sastojine) koja se obnavlja sa 20 ha na 10 ha ili manje značilo bi intenzivnije gospodarenje i uređivanje šuma, te kratkoročno veća ulaganja u šumu. S druge strane, postoji pretpostavka da bi to bila dobra podloga za uspješniju i kvalitetniju obnovu i njegu sastojina, što bi se na općoj i dugoročnoj razini isplatilo. Bez kvalitetnih sastojina u prvom dobnom razredu i bez kvalitetne obnove sastojina ne može se zasnivati očekivana i željena budućnost regularne šume.

the most acceptable development of the age structure, and trend and structure of timber reserves and felling. In the case of the management class of narrow-leaved ash, no significant impact of the different scenarios and the reduction of the rotation on the future trends in the age structure was shown. In conjunction with consistent management, as soon as after 40 years, a satisfactory equilibrium in the age structure, and in the trends and structure of the timber reserves and the permissible cut would be achieved. Assuming management with a rotation of 80 years and the (after all) slightly more acceptable management pattern of Scenario 2, the annual intensity of regeneration during the first 40-year period would be increased by about 30 ha, the felling cut and the overall permissible would be achieved as against a 100 year rotation.

All projections of future management shown in the results are based on optimistic assumptions, above all of successful regeneration of stands on the temporally planned areas, and the gradual attainment of even aged cover and structure of stands. This means that the planned regeneration of stands of the management class of common oak (115 ha a year) in the first 10 year management half-period should be started and successfully carried out on 1160 ha in those stands or parts of existing stands where there is the highest priority requirement for regeneration. Considering the spatial dimension of planning, it is necessary to lay down the optimum annual area of stands to be regenerated, as well as their geographical distribution. Reduction of the average area (of the stand) to be regenerated from 20 ha to 10 ha or less would mean more vigorous management of the forests, and a short-term large investment in the forest. On the other hand, it can be hypothesised that it would be a good base for more successful and higher-quality regeneration and tending of stands, which would at the general and long-term level pay. Without high-quality stands in the first age class and high-quality stand regeneration, it is impossible to found the expected and desirable future of an even-aged forest.

Literatura

Baskent, E.Z. and Jordan, G.A., 2002. Forest landscape management modeling using simulated annealing. For. Ecol. Manage. 165(1-3), 29-45.

Čavlović, J., 1996. Using system dynamics in even-aged forests management in the area of the Zagreb forest district. Glas. šum. pokuse. 33, 109-152. (in Croatian, with English abstract).

Čavlović, J., 1999. Management of floodplain and lowland forests in Croatia. Ekologia-Bratislava. 18(1), 164-176.

Čavlović, J., Božić, M. and Lukić, N., 2000. Trends in forest and timberland values in the dynamic system of an even-aged forest of pedunculate oak in the management unit "Josip Kozarac". Glas. šum. Pokuse. 37, 8393.

Karjalainen, T., Pussinen, Ari., Liski, J., Nabuurs, G.-J., Erhard, M., Eggers, T., Sonntag, M. and Mohren, G.M.J., 2002. An approach towards an estimate of the impact of forest management and climate change on the European forest sector carbon budget: Germany as a case study. For. Ecol. Manage. 162(1), 87-103

Kramer, K. and Mohren, G.M.J., 2001. Long-term effects of climate change on carbon budgets of forests in Europe. In: Kramer, K., Mohren, G.M.J. (Eds), Wageningen University and Research Centre, Alterra-report 194, 290 p.

Lindner, M., Sievänen, R. and Pretzsch, H., 1997. Improving the simulation of stand structure in a forest gap model, For. Ecol. Manage. 95(2), 183-195.

Mohren, G.M.J., 2003. Large-scale scenario analysis in forest ecology and forest management. Forest Policy and Economics. 5,103-110.

Nabuurs, G.J., Nuutinen, T., Bartelink, H., Korhonen, M. (Eds.), 1998. Forest scenario modelling for ecosystem management at landscape level. In: Nabuurs, G.J., Nuutinen, T., Bartelink, H., Korhonen, M. (Eds.), Proceedings of the International Seminar and Summer School, 26 June3 July 1997, Wageningen, The Netherlands, EFI Proceedings No. 19, 382 p.

Nabuurs, G.J., Päivinen, R., Schelhaas, M.J., Verkaik, E., Pussinen, A. and Mohren, G.M.J., 2001. Nature-oriented forest management in Europe: modeling the long-term effects. Journal of Forestry. 99, 2833.

Nabuurs, G.J., Päivinen, R., Pussinen, A. and Schelhaas, M.J., 2002. European forests until 2050a projection of forest resources and forest management in thirty countries. European Forest Institute Research Report No. 15, Leiden, Brill, 242 p.

Nelson, J., 2003. Forest-level models and challenges for their successful application. Canadian Journal of Forest Research. 33(3), 422-429.

Ohman, K. and Lamas, T., 2003. Clustering of harvest activities in multi-objective long-term forest planning. For. Ecol. Manage. 176(1-3), 161-171.

Pretzsch, H., Biber, P. and Dursky, J., 2002. The single tree-based stand simulator SILVA: construction, application and evaluation. For. Ecol. Manage. 162, 3-21.

Pretzsch, H., 1997. Analysis and modeling of spatial stand structures. Methodological considerations based on mixed beech-larch stands in Lower Saxony. For.Ecol. Manage. 97(3), 237-253. Robinson, A.P. and Monserud, R.A., 2003. Criteria for comparing the adaptability of forest growth models. For. Ecol. Manage. 172, 53-67.

Rohner, M. and Boswald, K., 2001. Forestry development scenarios: timber production, carbon dynamics in tree biomass and forest values in Germany. Silva. Fenn. 35(3), 277-297.

Salo, S. and Tahvonen, O., 2002. On the optimality of a normal forest with multiple land classes. Forest Science. 48(3), 530-542.

Schelhaas, M.J., Nabuurs, G.J. and Schuck, A., 2003. Natural disturbances in the European forests in the 19th and 20th centuries. Global Change Biology. 9(11), 1620-1633.

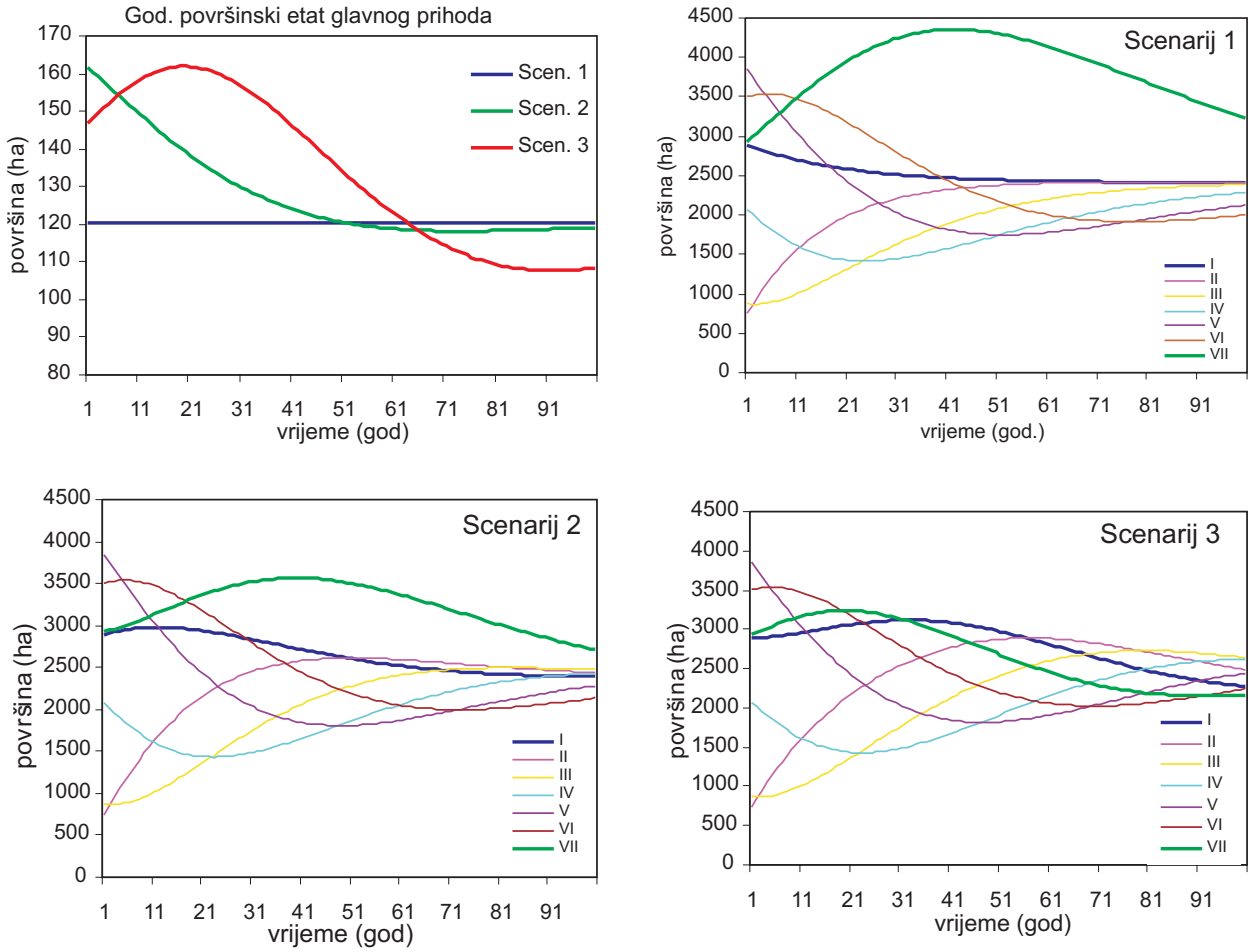
Spiecker, H., Mielikäinen, K., Köhl, M., Skovsgaard, J.P. (Eds.), 1996. Growth Trends in European ForestsStudies from 12 Countries. In: Spiecker, H., Mielikäinen, K., Köhl, M., Skovsgaard, J.P. (Eds.),

European Forest Research Report No. 5. Springer, Berlin, 372 p.

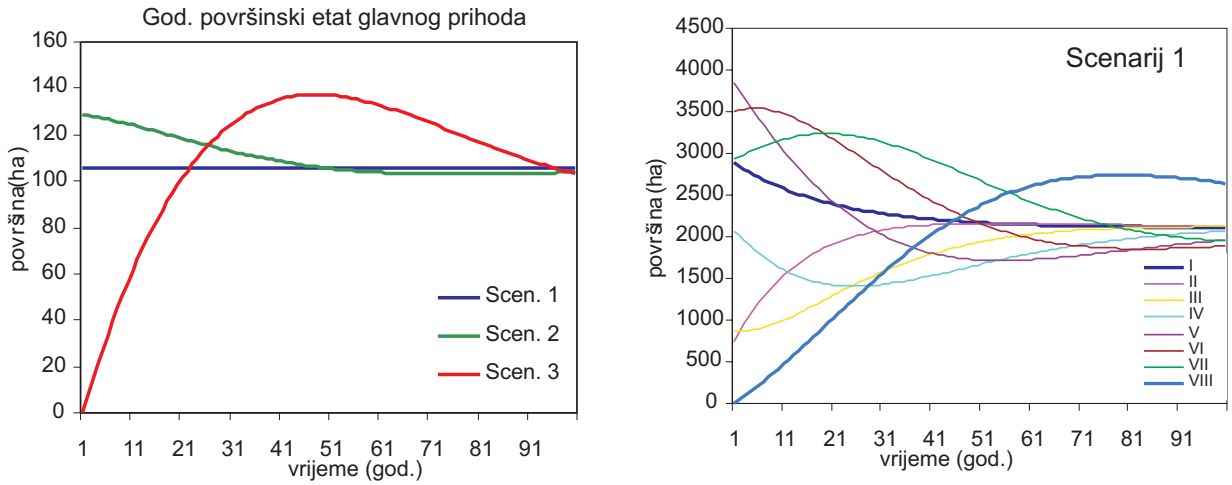
Spiranec, M. 1975: Growth-yield tables for oak, common beech, hornbeam and chestnut (Prirasno-prihodne tablice za hrastove, bukvu, obični grab i pitomi kesten). Radovi Šumar. inst, Zagreb. 25, 1-103. (in Croatian)

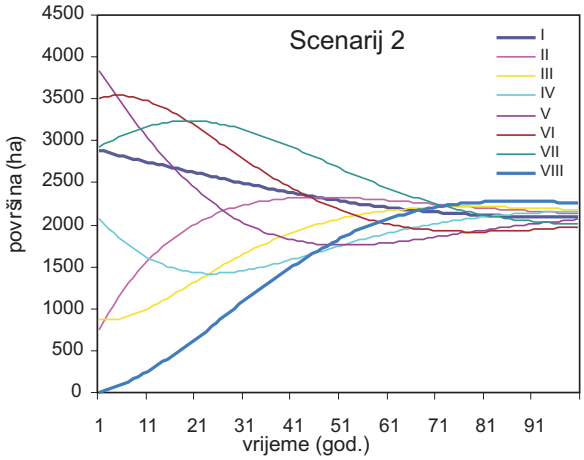
Dr. sc. Juro Čavlović
Sveučilište u Zagrebu
Šumarski fakultet
Zavod za Uređivanje šuma
Svetošimunska 25, 10000 Zagreb

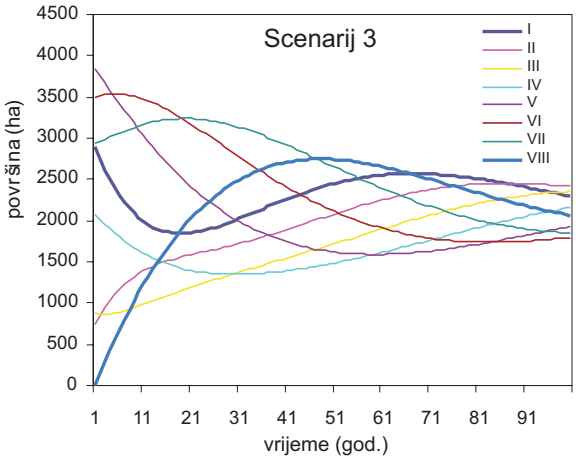
Slika 4. Projekcije godišnjeg površinskog etata glavnog prihoda (obnove) te razvoja dobne strukture za uređajni razred hrasta lužnjaka uz ophodnju od 140 godina.
Figure 4. Projections of the annual felling cut and development of the age structure for the management class of common oak assuming a rotation of 140 years.



Slika 5. Projekcije godišnjega površinskog etata glavnoga prihoda (obnove) te razvoja dobne struktur za uređajni razred hrasta lužnjaka uz ophodnju od 160 godina.
Figure 5. Projection of the annual felling cut and development of age structure for the common oak management class assuming a rotation of 160 years.

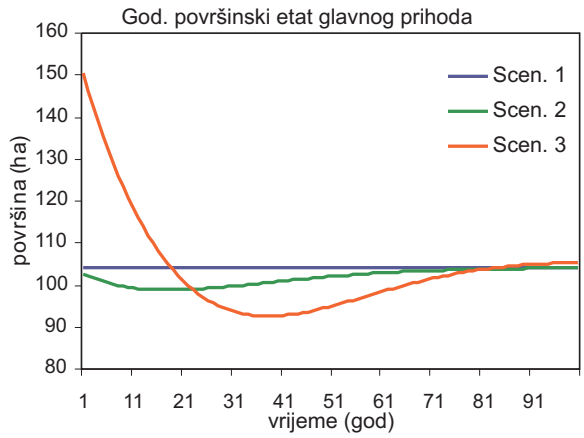


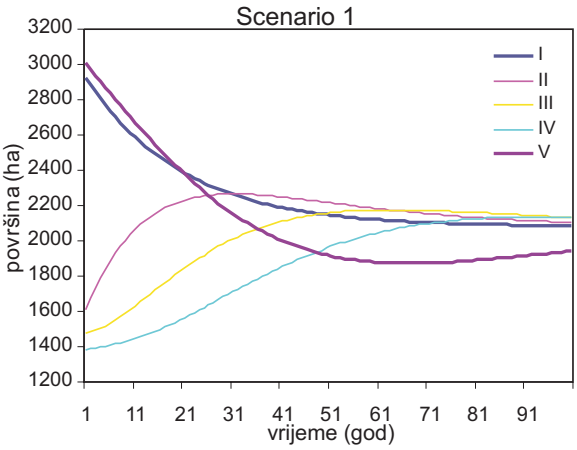


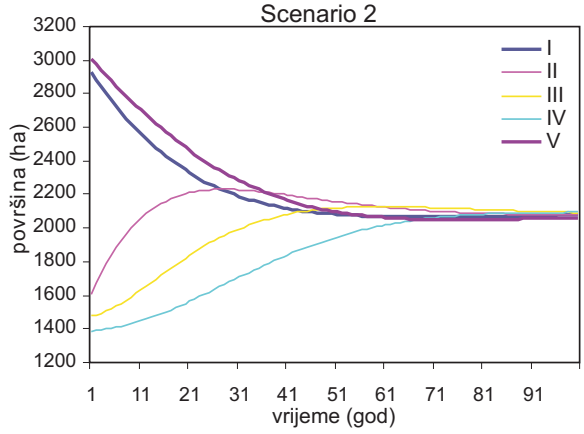


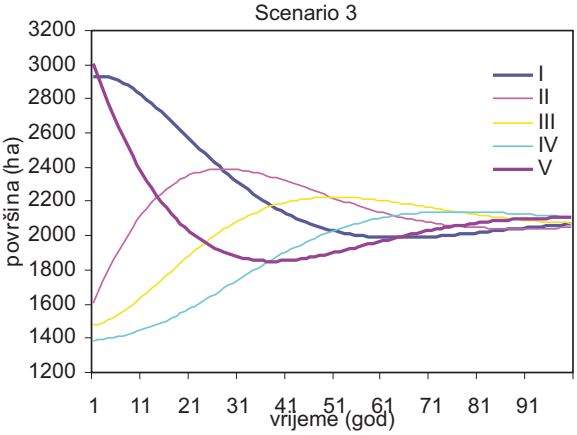
Slika 6. Projekcije godišnjeg površinskog etata glavnog prihoda (obnove) te razvoja dobne strukture za uređajni razred poljskog jasena uz ophodnju od 100 godina.

Figure 6. Projections of the annual felling cut and the development of the age structure for the narrow-leaved ash management class with a rotation of 100 years.

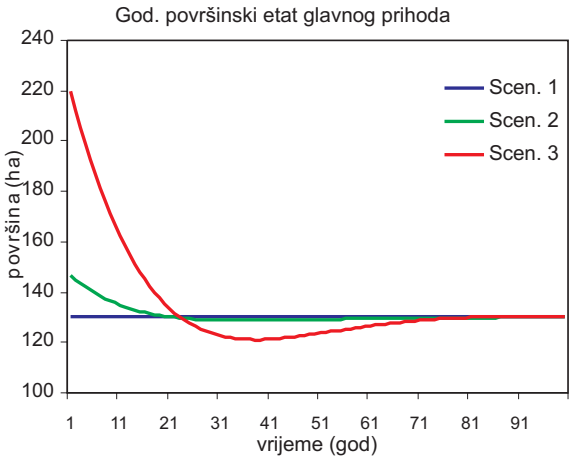


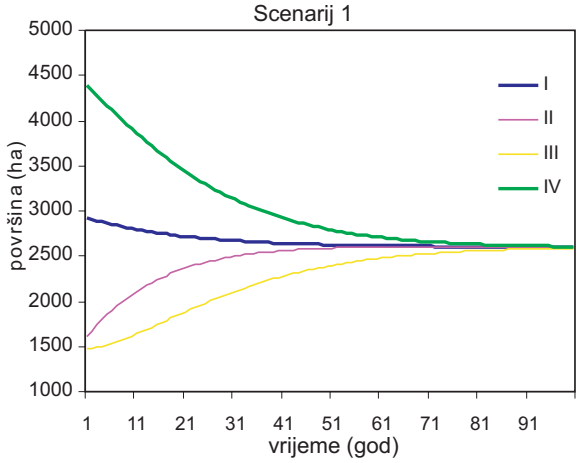


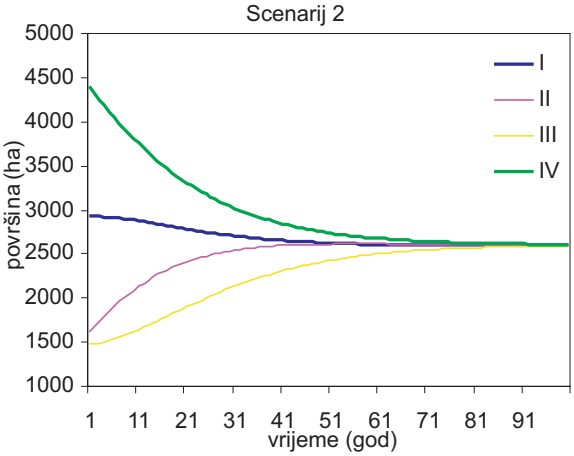


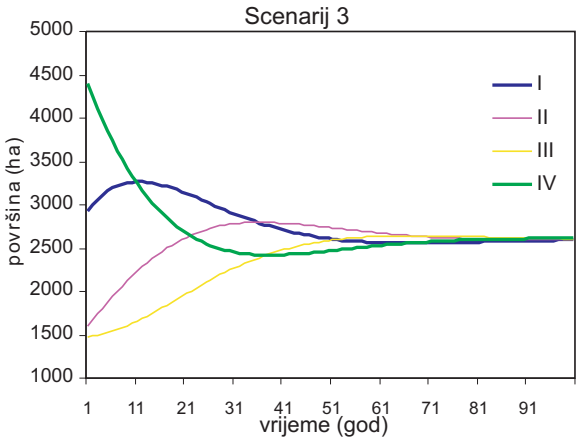


Slika 7. Projekcije godišnjeg površinskog etata glavnog prihoda (obnove) te razvoja dobne strukture za uređajni razred poljskog jasena uz ophodnju od 80 godina.
Figure 7. Projection of the annual felling cut and the development of the age structure for the narrow-leaved ash management class assuming a rotation of 80 years.

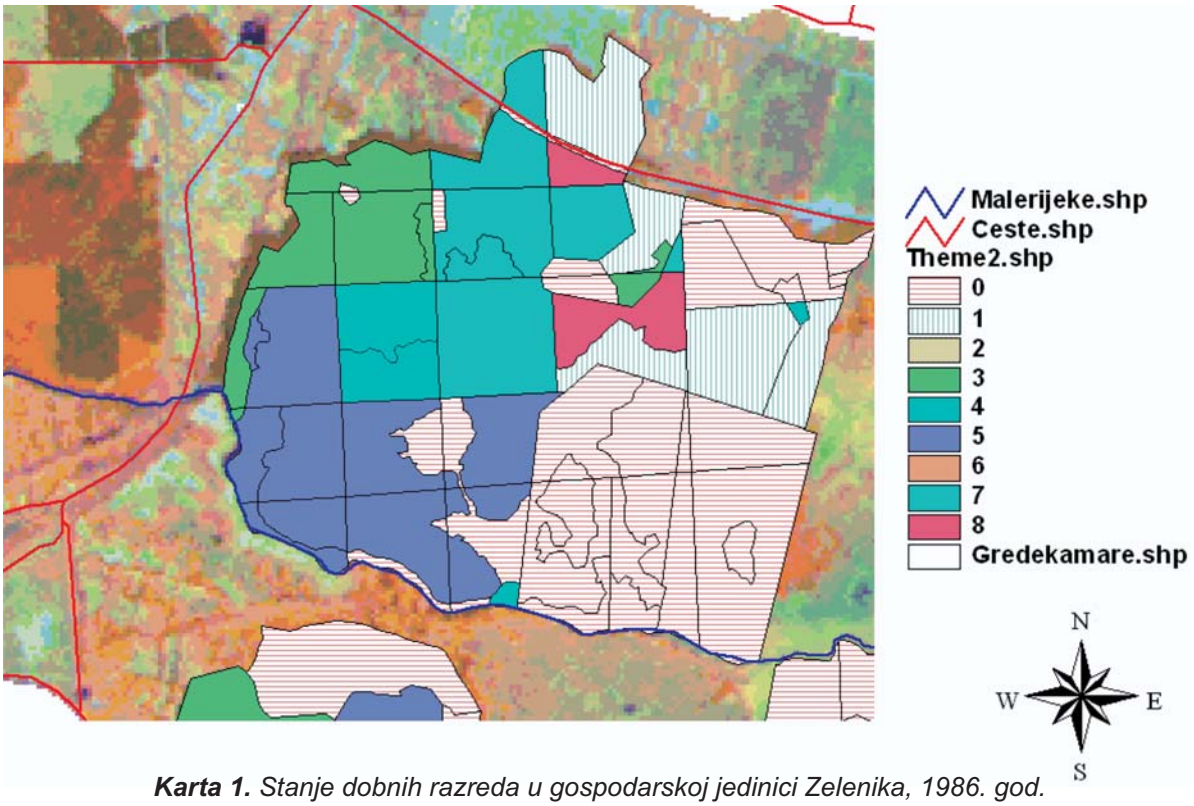






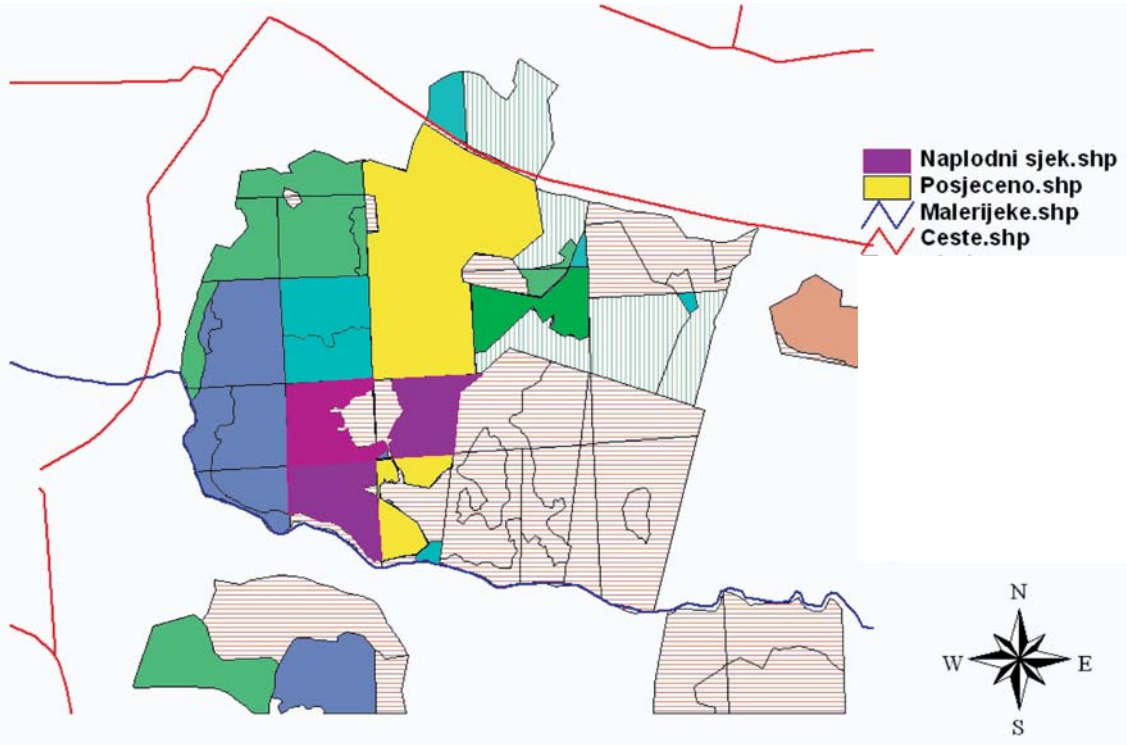


Šumski predjel Zelenika - dobna struktura 1995. godine



Karta 1. *Stanje dobnih razreda u gospodarskoj jedinici Zelenika, 1986. god.*
Map 1. *Condition of age classes in Zelenika Management Unit, 1986*

Šumski predjel Zelenika - stanje dovršnog i naplodnosjeka 2004. godine



Karta 2. *Sadašnje stanje šuma u gospodarskoj jedinici Zelenika, šumski predjel Zelenika.*
Map 2. *Current state of the forests in the Zelenika Management Unit, forest area of Zelenika.*

PRIKAZ STANJA DOBNIH RAZREDA NA PODRUČJU PARKA PRIRODE LONJSKO POLJE

Uvod

Park prirode Lonjsko polje obuhvaća površinu od 50 650 ha (odnosno 51 094 ha, temeljem GIS-podataka, Prijedlog Prostornog plana područja posebnih obilježja PPLP), a prostire se na području Lonjskog i Mokrog polja, uz lijevu obalu rijeke Save.
Taj je, s gledišta zaštite prirodne i kulturne baštine, značajni prostor najveća zaštićena močvara u Hrvatskoj, Ramsarsko močvarno područje i važno stanište ptica (Important Bird Area) te jedno od najznačajnijih zaštićenih područja u Europi.
Raspored šuma, poljoprivrednih površina, travnjaka/pašnjaka, odnosno raspored vegetacije, ovisio je o čovjekovoj aktivnosti, ali i o vrstama tala, visini podzemnih voda i trajanju plavljenja, kao i o mikroklimatskim prilikama. Preko 77% površine ovoga područja obraslo je šumom, travnjacima i ostalom prirodnom vegetacijom. Općenito se može reći da je to područje u vegetacijskom smislu prostor izuzetne biološke raznolikosti i zato savršeno stanište velikoga broja kopnenih životinjskih vrsta i ptica, a njegove su vodene i močvarne površine veoma povoljne za život mnogih riba i vodozemaca.
Tijekom posljednjih dvadesetak godina dogodile su se znatne promjene u načinu iskorištavanja zemljišta: napuštena je poljoprivredna proizvodnja, pašnjački uzgoj stoke; na djelu je zapuštanje zemljišta uopće. Taj je proces bio osobito izrazit u posljednjih desetak godina, što je posljedica ratnih razaranja. Napuštene površine, osobito pašnjačke, počela je obrastati šumska vegetacija sa svojim inicijalnim, sukcesijskim fazama. Tako se na mnogim mjestima pojavljuju šibljaci vrba, topola, johe i jasena.
Vegetacija ovoga područja pripada nizinskom vegetacijskom pojasu koji se prostire u visini od 80 do 150 metara, budući da je i sav prostor Lonjskog polja ispod nadmorske visine od 150 m. On čini početnu razinu vertikalnog pridolaska šumske vegetacije u tom području i obilježavaju ga ponajprije šume hrasta lužnjaka, poljskoga jasena, crne johe, vrba i topola, a njihov je nastanak i opstanak manje-više u svezi s površinskom i podzemnom vodom.
Odlučujući ekološki čimbenik u nastajanju i razvoju šumske vegetacije ovoga kraja je voda, bilo da je riječ o poplavnoj, kao kod topolovih i vrbovih šuma, podzemnoj (šume hrasta lužnjaka) ili su joj prijeko

A REVIEW OF THE CONDITION OF AGE CLASSES IN THE AREA OF LONJSKO POLJE NATURE PARK

Introduction

Lonjsko Polje Nature Park occupies an area of 50,650 ha (or 51,094 ha according to GIS data, Proposal of the Physical Plan of the Lonjsko Polje Nature Park Special Characteristics Area), and is located in the area of Lonjsko and Mokro Polje alongside the left bank of the Sava River.
This area, very important from the point of view of nature and cultural heritage conservation, is the largest protected wetland area in Croatia, a Ramsar Area and an Important Bird Area, and is all in all one of the most important conservation areas in Europe.
The distribution of forests, agricultural areas, grasslands and pasturelands, or alternatively the distribution of vegetation, has developed in response to human activities, as well as to the kinds of soil, the level of the underground water, the duration of floods and the microclimatic conditions. Over 77% of the area of the area is covered with forest, grasslands and other forms of natural vegetation. In general it can be said that this area is, from the point of view of vegetation, land of exceptional biological diversity that consequently constitutes an ideal habitat for a large number of terrestrial animal species and birds, while the aquatic and wetland areas constitute a very favourable resort for a large number of fish and amphibians.
During the last twenty or so years important changes in the manner of using the land relate to the neglect of agricultural production, the abandonment of pasturing in animal husbandry and the desertion of the land in general. The process was particularly marked during the last twenty years, in consequence of devastation in the war. The land that was abandoned, particularly pasture land, was begun to be overgrown by forest vegetation in its initial succession phases. Thus in many places coppices of willow, poplar, alder and ash have started to appear.
The vegetation of the area is classified into the lowland vegetation zone that covers altitudes between 80 and 150 metres, since the whole of Lonjsko Polje is actually below an altitude of 150 m. It represents the initial level of the vertical appearance of forest vegetation in the area, characterised primarily by forests of common oak, narrow-leaved ash, black alder, willow and poplar, while the occurrence and persistence of it is more or less related to the surface and underground water.
The crucial ecological factor in the origin and

potrebne i jedna i druga voda, kao što je to sa šumama u kojima prevladavaju vrste crna joha i poljski jasen.

Ukupna površina šuma i šumskog zemljišta na području Parka prirode Lonjsko polje iznosi 30 987,90 hektara (temeljem GIS podataka, Prijedlog Prostornog plana područja posebnih obilježja PPLP).

Stanje šuma prema rasporedu dobnih razreda na području PP Lonjsko polje

Normalna je ona šuma koja ima drvnu masu nužnu i dovoljnu da proizvede svake godine najpovoljniji prihod, s obzirom na postojeće stanište, vrstu drveća i oblik gospodarenja (D. Klepac, Uređivanje šuma, Zagreb 1965.). U visokim je regularnim šumama normalitet po površini definiran jednim potpunim nizom dobnih razreda jednake produktivne površine i normalnog obrasta.

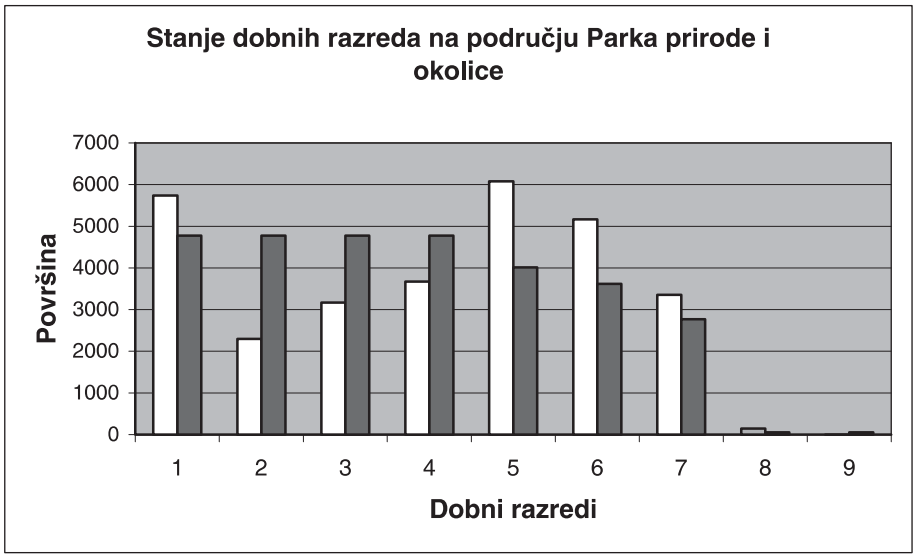
Grafikon 1. Stanje dobnih razreda po površini na području Parka prirode i okolice

development of forest vegetation in this region is water, whether it is floodwater, as is the case with the poplar and willow woods, or of underground water (the common oak forests), or whether both kinds of water are essential, as is the case in the forests in which the black alder and narrow-leaved ash are dominant.
The total area of forest and forest land in the area of Lonjsko Polje Nature Park comes to 20, 987.90 hectares (according to GIS data, Proposal of the Physical Plan of Special Features Areas of Lonjsko Polje Nature Park).

The state of the forests according to the distribution of age classes in the area of Lonjsko Polje Nature Park

The concept normal forest implies a forest that has the timber mass that is necessary and sufficient to produce the most favourable yield each year with respect to the existing habitat, kind of trees and forms of management (D. Klepac, [Forest Management], Zagreb 1965). In high even-aged forests normality per unit of area is defined by a full sequence of age classes of equal productive area and normal cover.

Graph 1. Condition of age classes per unit of area in the area of the Nature Park and surrounds



Podaci iz grafičkog prikaza (grafikon 1.) pokazuju raspored dobnih razreda gospodarskih šuma po površini u Parku prirode Lonjsko polje i okolici. U razmatranje nisu uzete površine neobraslog i neplodnog šumskog zemljišta. Podaci su dobiveni jednostavnim matematičkim metodama iz Osnova gospodarenja gospodarskim jedinicama. Iako dijelovi nekih gospodarskih jedinica nisu u sastavu Parka prirode Lonjsko polje, ipak su uzete u cijelosti.

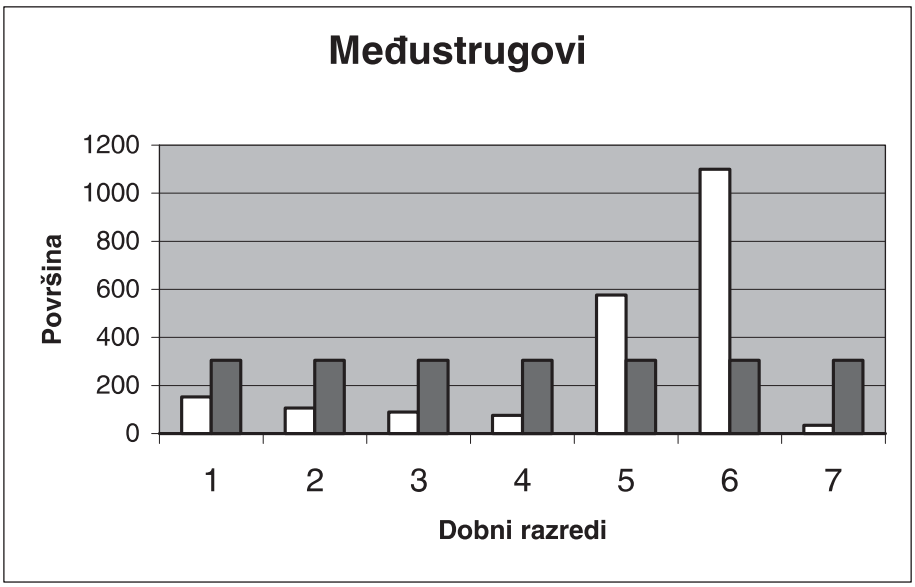
The information in the graphic display (Graph 1) shows the distribution of age classes of the commercial forests over the area of the Nature Park and environs. Areas of forest land not covered or unfertile are not taken into consideration. The data are obtained by the simple mathematical methods of the Management Plan for the management units. Since parts of some management units are not actually within the official limits of Lonjsko Polje Nature Park, they are nevertheless taken as wholes.

Grafički prikaz (grafikon 1.) jasno pokazuje nedostatak dijela mladih šuma, i to drugog dobnog razreda, u ukupnoj površini od 2478,46 ha, te dijela srednjodobnih šuma, i to trećeg dobnog razreda, u ukupnoj površini od 1608,13 ha, te četvrtoga dobnog razreda, u ukupnoj površini od 1104,12 ha.
Jedan od primjera veoma lošeg rasporeda dobnih razreda na području parka prirode Lonjsko polje nalazimo u gospodarskoj jedinici Međustrugovi.

The graphic display of Graph 1 clearly shows the insufficiency in respect of young forests, particularly of the second age class, in a total area of 2478.46 ha, and of medium age forests, in the third age class, over a total area of 1608.13 ha, and the fourth age class, in a total area of 1104.12 ha.
One example of a very poor distribution of age classes in the area of Lonjsko Polje Nature Park is the Međustrugovi Management Unit.

Grafikon 2.

Graph 2

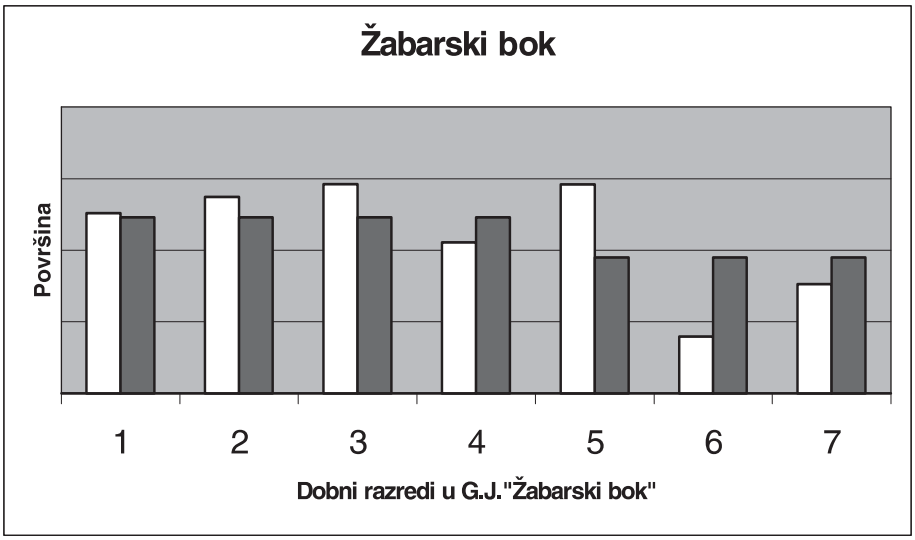


Na području te gospodarske jedinice 78,50% šuma u 5. je i 6. dobnom razredu, a samo 21,5% u svim ostalim dobnim razredima. Ako uzmemo u obzir da su šume na području te gospodarske jedinice uglavnom šume poljskog jasena, zaključujemo da se prema zakonskim odredbama za 51,48% tih šuma može propisati dovršni sjek. Osnova gospodarenja za razdoblje I/I (1998. - 2007.) propisuje dovršni sjek na ukupnoj površini od 428,44 hektara. Iz propisa Osnove gospodarenja proizlazi da je površina predviđena za obnovu veća od normalne površine dobnog razreda za 40,42% ili za 123,33 hektara.

In the area of this management unit, 78.5% of the forest is in the 5th and 6th age class, and only 21.5% of the forest in all other age classes combined. If we take into consideration the forests in this management unit being mainly of narrow-leaved ash, we can conclude that according to the currently valid legal provisions, 51.48% of this forest can be set for final cut. The currently valid Management Plan for the I/I Period (1998-2007) prescribes final cut over a total area of 427.44 hectares. From the regulations of the Management Plan it can be seen that the area set aside for regeneration is greater than the normal area of the age group by 30.42% or 123.33 ha.

Grafikon 3.

Graph 3



Žabarski bok je gospodarska jedinica koja na području PPLP ima najpovoljniji raspored dobnih razreda po površini. Samo se u 6. dobnom razredu pokazuje znatan nedostatak šuma starih od 101 do 120 godina, i to na površini od 55,18 hektara. Osnova gospodarenja propisuje obnovu, odnosno dovršni sjek u odsjecima 11a i 15a, na ukupnoj površini od 24,09 hektara. U budućnosti će se u toj gospodarskoj jedinici vrlo brzo postići normalan raspored dobnih razreda po površini.
Nepovoljan razmjer dobnih razreda ima više neželjenih posljedica. Najdrastičniji primjer štetnih posljedica za krajobraznu i biološku raznolikost zbog nepovoljnih razmjera dobnih razreda na području Parka prirode Lonjsko polje nalazimo u Gospodarskoj jedinici Zelenika, u šumskom predjelu Zelenika.

Na karti (karta 1.) uočava se da je veliki kompleks šuma iste starosti, odnosno 7. i 8. dobnog razreda. Također su odsjeci Uređajnoga razreda poljskog jasena u 5. dobnom razredu (prema karti 1.) pa samim tim pri sljedećoj reviziji Osnove sigurno ulaze u pomladno razdoblje. Odsjek 11 a dovršnim je sjekom posječen 1986. Prirodna obnova u tom je odsjeku veoma otežana zbog niza čimbenika, tako da je i u 2004. godini ovdje planirana priprema staništa i pošumljivanje na površini od nekih 11 hektara. Prema zakonskim propisima, u šumama 7. i 8. dobnoga razreda mogu se započeti radovi prirodne obnove, odnosno u zadnjoj fazi obnove sijeku se dovršnim sjekom. Pravilnik o uređivanju šuma u članku 20.(Narodne novine br.11 od 11. I. 1997.) propisuje donju granicu ophodnje, za hrast

Žabarski bok is the management unit that has the most favourable distribution of age groups over the area in the area of Lonjsko Polje Nature Park. Only in the 6th age class is there a sensible absence of forests 101-120 years old, on an area of 55.18 ha. The current Management Plan prescribes regeneration, or final cut in compartments 11a and 15a with an overall area of 24.09 ha. In the future, a normal distribution of age classes over the area in this management unit will very rapidly be achieved.

An unfavourable ratio of age classes is attended by a number of undesirable consequences. The best example of the harmful consequences for landscape and biological diversity because of the unfavourable ratio of age classes in the area of Lonjsko Polje Nature Park is in the Zelenika Management Unit in the Zelenika forest area.

From this map (Map 1) it can be seen that there is a large complex of forests of the same age, that is of the 7th and 8th age classes. Also the compartments of the management class of narrow-leaved ash are in the 5th age class (according to Map 1) and hence in the next review of the plan will certainly come into the regeneration domain. Compartment 11 was subject to final cut in 1985. Natural regeneration is very much hindered in this compartment, because of a number of factors, and hence in 2004 in this compartment habitat preparation and afforestation over an area of ca 11 ha were planned. According to current legal regulations, works on natural regeneration can be started in forests in the 7th and 8th age classes, that is, in the last phase of regeneration they are felled with final cut. The Forest Management Regulations, Article 20 (Official Gazette no. 11, January 11, 1997) prescribes the lowest level of a rotation for common oak of 140

lužnjak 140 godina, a za poljski jasen 80 godina.
Revizija Osnove gospodarenja za gospodarsku jedinicu Zelenika izvršena je 1996. i vrijedi od 1996. do 2005. Ona propisuje prirodnu obnovu, odnosno dovršni sjek u šumskom predjelu Zelenika u odsjecima 2a, 3a, 6a, 6b, 7a, 7e, 10a, 13b, 14a, 15a, 15b, 16a, 17a, 18c, kojima ukupna površina iznosi 438,83 hektara. Do 2004. izvršenjem Osnove posječeni su dovršnim sjekom odsjeci 2a, 6a, 6b, 7a, 7e, 18c, a u tijeku je sječa odsjeka 10a, koji je najveći u tom kompleksu i ima površinu od 77,31 hektar. Naplodni sjek je izvršen u odsjeku 15a i u pola odsjeka 13b, sječa na pruge izvršena je u odsjecima 14a, 16a, 17a i u polovici odsjeka 13b. U odsjeku 15b još nisu započeli radovi prirodne obnove. Osnova gospodarenja za gospodarsku jedinicu Zelenika propisuje dovršni sjek na površini od 657,34 ha. Kako normalna površina dobnog razreda iznosi 215,14 hektara, propisom Osnove gospodarenja površina za obnovu je za 205,5% ili za 442,20 hektara veća od normalne površine dobnog razreda.
Naplodni sjek je izvršen na površini od 83,29 hektara, što znači da će i te površine u vrlo kratkom vremenu, ovisno o uspjehu prirodne obnove (3 - 5 godina), biti dovršno posječene, a to je sa stajališta krajobrazne vrijednosti područja svakako loše jer je u vrlo kratkom vremenu nestalo starih hrastika na, uvjetno rečeno, velikoj površini. Kad govorimo o sječi na velikoj površini sa stajališta uzgajanja šuma, sječa na velikoj površini je sječa cijelog odsjeka.
S druge strane, nestanak tako velikog kompleksa starih šuma može uzrokovati zamočvarivanje terena jer se u velikoj mjeri smanjuje transpiracijska površina. U velikoj mjeri se narušava bioraznolikost jer s nestankom stare šume nestaju sa tog područja sve vrste koje ovise o staroj šumi, bilo da im je ona prijeko potrebna za gniježđenje (orao štekavac, crna roda, orao kliktaš, djetlovi) ili im pruža zaklon i hranilište. Velik broj vrsta šišmiša koristi se starim šumama, i to na način koji zahtijeva složenu strukturu pristupačnih stabala s dupljama, ali i mikrostanišne uvjete. Raznolikost životinjskih i biljnih zajednica, pojednostavnjeno rečeno, razmjerna je količini starih šumskih sastojina, a uz to i dodatno povećava mozaičnost staništa i postojanje dodirnih pojasa između dvaju tipova staništa.

Na karti (karta 2.) je uočljivo da je riječ o kontinuiranoj površini na kojoj nema odsjeka stare šume između posječenih površina.

years, and for narrow-leaved ash of 80 years.
The review of the management plan for Zelenika Management Unit was addressed in 1996, and the period in which this plan is valid is 1996-2005. The current Management Plan prescribes natural regeneration or final cut in the forest area of Zelenika in Compartments 2a, 3a, 6a, 6b, 7a, 7e, 10a, 13b, 14a, 15a, 15b, 16a, 17a, 18c, the total area of which comes to 438.83 ha. Up to 2004, in the implementation of the plan, compartments 2a, 6a, 6b, 7a, 7e and 18c were felled in the final cut, and the felling of Compartment 10a is under way, the largest of all the compartments in this area, with an area of 77.31 ha. Seeding cut has been carried out in Compartment 15a and in half of Compartment 13b, strip cuttinghas been carried out in Compartments 14a, 16a, 17a and in half of Compartment 13b. In Compartment 15b works on natural regeneration have not yet been started. The Management Plan for Zelenika Management Unit prescribes final cut over an area of 657.34 ha. Since the normal area of the age class comes to 215.14 hectares according the regulations of the Management Plan, the regeneration area is 205.5% or 442.2 hectares greater than the normal area of the age class.
Seeding cut has been carried out over an area of 83.29 ha, which means that the land will in a very short period of time, depending on the success of natural regeneration (2-5 years), will be subject to final cut, which is from the point of view of the landscape value of the area very bad, since in a very short time the old oak forests will have vanished on what might be called a large area. When we are talking of felling over a large area, from the standpoint of silviculture, felling over a large area is the felling of a whole compartment.
On the other hand the absence of such a large complex of old forests can lead to the marshification of the land because the transpiration of the land is reduced to a great extent. Also to a great extent, the biodiversity of the area is disturbed because when an old forest disappears, all the species that depend on old forests also vanish, whether it is essential for their nesting (sea eagle, black stork, white-tailed eagle, woodpeckers) or whether it is a refuge or feeding area. A large number of species of bats use the old forests, in a manner, what is more, that requires a complex structure of accessible hollow trees, as well as micro-habitat conditions. The diversity of animal and plant species, put in a simplified way, is proportional to the quantity of old forest stands, and also additionally increases the mosaic nature of the habitats and the existence of contact zones between two types of habitat.

Map 2 shows that this is a continuous area in which there are no old forest compartments between the felled areas.

Rasprava i zaključak

Postavlja se sljedeće pitanje:
- Kako se vidi gospodarenje u budućnosti kada te šume dođu u fazu obnove?

Grafički prikaz razmjera dobnih razreda pokazuje da su površine zadnjih dobnih razreda, šume koje će po propisima ući u fazu prirodne obnove, veće od normalnih površina dobnih razreda. To znači da će se sigurno ponoviti situacije kad Osnova gospodarenja propisuje u jednom polurazdoblju obnovu šuma na kontinuiranoj površini veličine 200 i više hektara. Takve situacije su svakako nepovoljne i sigurno imaju nesagledive posljedice za krajobraznu i biološku raznolikost i za stabilnost ekosustava.
Također treba spomenuti i gospodarski učinak smanjenja površina koje će se sjeći dovršnim sjekom u budućnosti. Smanjene površine dovršnih sjekova nužno uzrokuju smanjenu sječivu drvnu masu, a samim tim i manji financijski učinak. Kako će se u budućnosti nadomjestiti nedostatak novca zarađenog dovršnim sjekovima?
Pitanje koje se često postavlja svakako je i duljina ophodnje hrasta lužnjaka.

Lužnjakove šume u Hrvatskoj danas su zbog vrlo jakih antropogenih utjecaja:
- loše provedene regulacije vodnih tokova i melioracije (snižavanje razine podzemnih voda i promjene u prirodnom ritmu poplava)
- kazetiranja terena mrežom tvrdih cesta, s lošim propustima (zabarivanje terena)
- zatrovane i onečišćene vode Save
- opterećenosti onečišćenim zrakom (SO_2, NOx, teški metali i dr.)

i zbog raznih biotskih utjecaja:
- epidemijsko ugibanje nizinskog brijesta
- sve češća sušna razdoblja tijekom vegetacije
- slabljenjem otporne snage drveća dolazi do napada štetne entomofaune, ponajviše gubara, i biljnih bolesti, u prvom redu pepelnice
- loše gospodarenje u prošlosti (velike sječe, monokulture hrasta lužnjaka),

promijenile svoj prirodni izgled i prirodnu stabilnost. U tom svjetlu svakako treba razmotriti pitanje je li opća odredba da je ophodnja hrasta lužnjaka u Hrvatskoj 140 godina danas prihvatljiva. Treba razmotriti zamisli da se ophodnja utvrđuje prema zdravstvenom stanju i općoj vitalnosti konkretne šume, odnosno konkretnog odsjeka kao najmanje površine kojom se gospodari.
Produljenjem ophodnja zdravih i vitalnih hrastika te uspostavom normalnog razmjera dobnih razreda po površini svakako bi se pridonijelo očuvanju, zaštiti i

Discussion and Conclusion

The following question arise.
- How is management envisaged in the future in which these forests enter the regeneration phase?

The graphic display of the dimensions of the age classes shows that the area of the last age classes, of forest that according to the current regulations should come into the natural regeneration phase, are greater than the normal areas of age classes.
This means that the situation will certainly arise in which the Management Plan prescribes, in a single half-period, the regeneration of the forest over a continuous area of 200 and more hectares in area. Such situations are very unfavourable and will certainly have incalculable consequences for the landscape and biological diversity and for the stability of the ecosystems.
It is also necessary to mention the economic effect of the reduction of areas that are cut with final cuts in the future. Reduction of area of final cuts necessarily brings about a reduction of wood mass for felling, and hence the financial performance. How in the future will it be possible to make up the absence of the financial resources acquired through final cuts?
A question that is often asked is the length of the common oak rotation.

Common oak forests have certainly changed their natural appearance and natural stability because of very powerful anthropogenic factors:
- poorly executed water-course engineering and reclamation (lowering the level of the underground water and changes in the natural rhythm of flooding);
- the compartmentalisation of the land with a network of hard roads with poor permeability (the land becomes marshy);
- pollution and toxification of the Sava water;
- the burden of polluted air (SO_2, NOx, heavy metals and so on)

as well as because of various biotic influences:
- the epidemic mortality of lowland elm
- increasingly frequent periods of drought during vegetation
- weakened resistance of trees leads to harmful attacks of insect pests, primarily of the gypsy moth and plant sicknesses, primarily blight,
- bad management in the past (large cuts, common oak monoculture).

In this light one should certainly consider the question of whether the general provision that the rotation of common oak in Croatia should be 140 years is acceptable today. One should consider the ideas that the rotation should be laid down according to the state of health and the general vitality of the concrete forest, or the concrete compartment, the

povećanju vrijednosti šuma na području Parka prirode Lonjsko polje. Hrastike koji su u lošem stanju, koji se suše na većim površinama, pa se tlo prekomjerno zakorovljuje, svakako treba obnoviti i prije. Trebalo bi također razmotriti, s obzirom na novonastale stanišne uvjete u nekim šumama, je li hrast vrsta koja u njima i dalje može rasti ili ipak treba svoje mjesto prepustiti poljskom jasenu i obrnuto. I krajobrazne bi vrijednosti bile puno bolje očuvane ako bi se dovršnim sjekom sjekle manje površine u dužim vremenskim razmacima.

Prema propisanim Uvjetima zaštite prirode Ministarstva zaštite okoliša i prostornog uređenja (od 16. VIII. 2002. Ur.br.531-06/2-ŽŠ-02-4) na području Parka prirode Lonjsko polje prilikom dovršnog sjeka treba ostaviti najmanje 1 stablo po hektaru i sve voćkarice. Ti se uvjeti poštuju u gotovo svim odsjecima, ali s obzirom na to da je ovdje površina dovršnog sjeka ukupno velika, držimo da je jedno stablo po hektaru nedovoljno. U takvim slučajevima, koje u budućnosti svakako treba nastojati izbjeći, trebalo bi ostavljati nekoliko većih grupa stabala površine do 1 hektar ravnomjerno raspoređenih po površini. U tom slučaju te veće grupe služile bi kao otoci stare šume na čistinama dok se mlada šuma ne razvije, a to je razdoblje od 20 do 40 godina. Postavlja se često pitanje što sa tim stablima kada se mlada šuma razvije. Držimo da takva stabla treba prepustiti njihovu prirodnom ciklusu starenja i umiranja.

Da bi se postigao što bolji pravilan raspored dobnih razreda po površini i očuvala biološka i krajobrazna raznolikost, trebalo bi razmotriti izmjene Zakona o šumama i Pravilnika o uređivanju šuma. Izmjene bi svakako trebale obuhvatiti mogućnosti pomaka sječne dobi zdravih i vitalnih šuma i veličinu sječina u zaštićenim područjima.

smallest area that is managed.

Prolongation of the rotation of healthy and vital oak forests and the establishment of the normal dimension of the age groups over the area would certainly contribute to the conservation, protection and augmentation of the value of the forests in the area of Lonjsko Polje Nature Park. Oak woods that are in a poor state, in which mortality has occurred over large areas and in which the ground has become excessively weedy should certainly also be regenerated earlier. One should also consider the question, because of the new habitat conditions that have arisen in some of the forests, of whether the oak is a species that can continue to grow here or whether it should after all give ground to the narrow-leaved ash and vice-versa. In addition, landscape values would be much better preserved if small areas were subject to final cuts over longer periods of time. According to the regulation Nature Protection Conditions set by the Ministry of Environmental Protection and Physical Planning (August 16 2002, ref. no. 531-06/2-ZS-02-4), during final cuts in the area of Lonjsko Polje Nature Park at least 1 tree per hectare should be left, and all the fruit trees. These conditions have been respected in almost all the compartments, but considering that the area of final cut is very large here, we think that one tree per hectare is not enough. In cases of this nature, which should certainly be avoided in the future, some larger groups of trees of areas of 1 hectare evenly distributed over the land should certainly be left. In this case these larger groups would serve as islands of old forest on the cleared land, until the young forest develops, in a period from 20 to 40 years. The question also is often asked as to what should be done with such trees when the young forest has grown. We are of the opinion that such trees should be left to their natural cycle of aging and dying.

In order the better to achieve the proper distribution of age classes over the land and the preservation of biological and landscape diversity, it is necessary to consider changes in the Forests Law and the Forest Management Regulations. Modifications should certainly cover the possibility of moving the felling age of health and vital forests and the dimensions of the cut in conservation areas.

Slika 1. *Stari hrastici u Slavoniji početkom prošlog stoljeća*
Figure 1. *Old oak forests in Slavonia at the beginning of the last century.*

Literatura:

Osnova gospodarenja Gospodarskom jedinicom "Brezovica" - 1997.-2006.
Osnova gospodarenja Gospodarskom jedinicom "Popovačke nizinske šume" - 1999. -2008.
Osnova gospodarenja Gospodarskom jedinicom "Kutinske nizinske šume" - 2001.-2010.
Osnova gospodarenja Gospodarskom jedinicom "Lonja" - 1999.-2008.
Osnova gospodarenja Gospodarskom jedinicom "Josip Kozarac"-1995.-2004.
Osnova gospodarenja Gospodarskom jedinicom "Žabarski bok" - 2003.-2012.
Osnova gospodarenja Gospodarskom jedinicom "Krapje đol" - 2001.-2010.
Osnova gospodarenja Gospodarskom jedinicom "Trstika" - 2001.-2010.
Osnova gospodarenja Gospodarskom jedinicom "Zelenika" - 1996.-2005.
Osnova gospodarenja Gospodarskom jedinicom "Grede - Kamare" - 1996.-2005.
Osnova gospodarenja Gospodarskom jedinicom "Međustrugovi" - 1998.-2007.
Pravilnik o uređivanju šuma (Narodne novine br.11/97).
Zakon o šumama(Narodne novine br.52/90)
Uređivanje sastojina hrasta lužnjaka oštećenih sušenjem - terenski kolokvij
Šumarska enciklopedija
D. Klepac, Uređivanje šuma, Zagreb 1965.
Prijedlog Prostornog plana područja posebnih obilježja PPLP

Dražen Ivaštinović, dipl. ing. šum.
JUPP Lonjsko polje
Stručna služba
Trg kralja P. Svačića bb, Jasenovac

PROPADANJE STABALA I POREMETNJA STABILNOSTI NIZINSKIH ŠUMSKIH EKOSUSTAVA

SAŽETAK

U radu je obrađena problematika funkcioniranja, razvoja i postojanosti nizinskih šumskih ekosustava. Posebno su raščlanjene dosadašnje spoznaje uzroka poremetnje postojanosti tih ekosustava i prikazana je dinamika odumiranja stabala hrasta lužnjaka i poljskog jasena. Uspoređena je dinamika propadanja stabala hrasta lužnjaka s mikrostanišnim uvjetima i dobi sastojina. Na primjeru gospodarske jedinice Opeke prvi put je utvrđeno veće propadanje stabala hrasta lužnjaka na mikrouzvisini (gredi) nego na mikroudubini (nizu), kao i veća učestalost, veći intenzitet propadanja stabala V. dobnog razreda nego onih VI. dobnog razreda. U radu se raspravlja i o uzrocima propadanja stabala, s naglaskom na klimatskim ekscesima i drugim promjenama ekoloških uvjeta.

1.Uvod

Funkcioniranje šumskih ekosustava ovisi o dinamici rasta i razvoja organizama, suparništvu među vrstama i unutar vrsta u borbi za prostor, hranu i svjetlo, kao i o njihovoj prilagodbi na stalne promjene ekoloških uvjeta. Opstanak i razvoj šumskih ekosustava nadalje ovise o prirodnoj ravnoteži i otpornosti na različite nepovoljne utjecaje (Seletković i Tikvić, 1998.). Kako su šumski ekosustavi životne zajednice biljaka, životinja i mikroorganizama u kojima drveće i druga drvenasta vegetacija određuju strukturne i funkcionalne odnose na određenom staništu i pri određenim ekološkim uvjetima, promjene prirodne biološke i ekološke ravnoteže rezultiraju poremetnjom stabilnosti i degradacijom šumskih ekosustava (Tikvić, 2001.). Promjene bioloških i ekoloških uvjeta u prvom su redu uzrokovane čovjekovim djelovanjem. Posljedica tih promjena je fiziološko slabljenje i propadanje stabala hrasta lužnjaka i drugih vrsta drveća, što je osobito naglašeno u 20. stoljeću (König, 1911.; Vajda, 1968.; Prpić, 1988.).

1.1. Nizinski šumski ekosustavi

Osnovno obilježje nizinskim šumskim ekosustavima u Hrvatskoj daju hrast lužnjak, obični grab, poljski jasen i crna joha te specifični ekološki uvjeti u kojima

DIEBACK AND DISTURBANCE OF THE STABILITY OF THE LOWLAND FOREST ECOSYSTEMS

SUMMARY

This paper deals with the problems of the functions, development and stability of lowland forest ecosystems. Particular analysis is made of the knowledge gained to date into the causes of the disturbance of these ecosystems and the dynamics with which common oak and narrow-leaved ash trees die are given. The dynamics of dieback in common oak trees is considered with reference to the microhabitat conditions and the age of the stand. Using the Opeka Management Unit (MU), the greater dieback of common oak trees on the micro-elevations as against the micro-depressions was established, as well as a greater intensity of dieback of trees of the 5th cohort as against the 6th cohort. The reasons for dieback are discussed, with the emphasis on climatic extremes and other changes of ecological conditions.

1. Introduction

The functioning of forest ecosystems depends on the dynamics of growth and the development of the organisms, inter-species and intra-species competition for space, nutrients and light, and adaptation to the constant changes of the ecological conditions. The survival and development of the forest ecosystems in turn depends on the natural balance and the resistance to various deleterious impacts (Seletković and Tikvić, 1998). Since forest ecosystems are living communities of plants, animals and microorganisms, in which trees and other woody vegetation determine the structural and functional relations in a given habitat and in given ecological conditions, changes of the natural biological and ecological equilibrium result in the disturbed stability and he degradation of the forest ecosystems (Tikvić, 2001). Changes in biological and ecological conditions are primarily brought about by human activities. The consequence of these changes is the physiological decline and dieback of common oak trees and other kinds of tree species, particularly noted in the 20th century (Konig, 1911; Vajda, 1968; Prpić, 1988).

1.1 Lowland forest ecosystems

The basic characteristics of the lowland forest ecosystems in Croatia are provided by the common oak, European hornbeam, narrow-leaved ash and black alder, and by the specific ecological conditions in which some of the species are dominant. The

pojedine vrste prevladavaju. Hrast lužnjak u Hrvatskoj zauzima oko 10% šumske površine, odnosno 210 000 ha (Matić, 2000.). Dolazi u nekoliko tipičnih šumskih zajednica mješovite strukture, koje se međusobno razlikuju po hidrološkim, orografskim, edafskim, klimatskim i drugim uvjetima (Vukelić i Rauš, 1998.). Presudno utječu na razvoj tih zajednica hidrološke prilike koje znatno ovise o mikroreljefu. Hidrološki odnosi u nizinskim šumskim ekosustavima uvjetovani su dinamikom poplavne, podzemne i oborinske vode. Poplavna i podzemna voda nadalje ovise i o dvama glavnim oblicima mikroreljefa koji se pojavljuju u nizinskim šumskim ekosustavima, a to su mikrouzvisine i mikroudubine. Glavne razlike u hidrološkim prilikama tih dvaju oblika mikroreljefa su u pojavi i trajanju poplave, te u dinamici i razinama podzemne vode. Utjecaj čovjeka u posljednjih nekoliko stoljeća jedan je od najznačajnih čimbenika koji mijenja odnose u nizinskim šumskim ekosustavima, što se odražava na njihov razvoj i stabilnost (Seletković i Tikvić, 1996).

1.2. Stabilnost šumskih ekosustava

Dinamika odnosa i procesa u nizinskim šumskim ekosustavima ovisi o biotskim i abiotskim čimbenicima. Voda je najvažniji abiotski čimbenik i promjene vodnih odnosa odražavaju se na njihovu stabilnost, proizvodnost i obnovu (Prpić, 2001.; Starčević, 2003.). Stabilne vrste lako podnose određene nepovoljne utjecaje pa se razvoj ekosustava ne može znatnije poremetiti djelovanjem ekstremnih prirodnih pojava. Stabilnost prema tome ovisi o otpornosti i elastičnosti i postojanosti. Otpornost vrsta ili sustava je zadržavanje nepromijenjena stanja nakon djelovanja nepovoljnih utjecaja. Elastičnost je brzina povratka u stanje ravnoteže nakon određenih poremećaja, a postojanost vrijeme u kojem se sustav nalazi prije promjene u neki drugi sustav. Stabilnost šumskih ekosustava izražavamo zdravstvenim stanjem, vitalnošću stabala i intenzitetom propadanja stabala.
Vitalnost stabala procjenjuje se na temelju vanjskog izgleda stabala, tj. na temelju procjene osutosti krošanja i promjene boje lišća ili iglica u usporedbi s dogovorenim referentnim stanjem, odnosno utvrđuje se postotak osutosti krošanja u odnosu na normalno razvijenu krošnju iste vrste drveća u sličnim ekološkim i sastojinskim uvjetima (manual ICP-Forests, 1998.; Forest Health Monitoring, 1998.). Vitalnost stabala je pokazatelj poremetnje fiziološke aktivnosti stabala koja pod djelovanjem brojnih stresnih čimbenika odumiru.

common oak occupies about 10% of the forest area in Croatia, that is about 210,000 ha (Matić, 2000). It is found in several typical forest communities of mixed structure that are differentiated according to hydrological, orographic, edaphic, climatic and other conditions (Vukelić and Raus, 1998). A critical role in the development of such communities is played by hydrological conditions, which are in turn very dependent on the microrelief. Hydrological relations in the lowland forest ecosystems are determined by the dynamics of flood, underground and runoff waters. Flood and underground water are further dependent on two main forms of microrelief that appear in the lowland forest ecoystems, that is, micro-elevations and micro-depressions. The main differences in the hydrological conditions of these two forms of microrelief are in the occurrence and duration of the flooding, and in the dynamics and levels of the underground water. The influence of people in the last few centuries has been one of the most important factors changing the relationships in the lowland forest ecosystems, which is reflected in their development and stability (Seletković and Tikvić, 1996).

1.2 The stability of the forest ecosystems

The dynamics in the relations and processes in the lowland forest ecosystems depends on biotic and abiotic factors. Water is the most important abiotic factor, and changes in aqueous relations are reflected in stability, production and regeneration (Prpić, 2001; Starčević, 2003). Stable species easily tolerate certain adverse influences and the development of an ecosystem cannot be disturbed in a major way by the action of extreme natural phenomena. Stability accordingly depends on resistance, elasticity and persistence. The resistance of species or systems represents the maintenance of the unmodified state of affairs after the action of adverse influences. Elasticity is the speed of return to the situation of balance after given disturbances, and persistence the time in which the system exists before change to some other system. The stability of forest ecosystems is expressed by the state of health, the vitality of trees and the intensity of dieback in the trees.
The vitality of trees is estimated according to the external appearance of the tree, i.e., on the basis of the estimate of the defoliation of crowns and changes in the colour or leaf or needle as against an agreed reference state, or the percentage of defoliation of crowns as against a normally developed crown of the same kind of tree in similar ecological and stand conditions (ICP Forests Manual, 1998; Forest Health Monitoring, 1998). The vitality of the tree is an indicator of the disturbance of the physiological activity of trees that, when affected by too many stress factors, will die off.

1.3. Propadanje stabala

Problem propadanja stabala u nizinskim šumskim ekosustavima aktualan je već više od jednog stoljeća. Taj problem jednako zaokuplja šumare praktičare i znanstvenike (Kozarac, 1897.; Kovačević, 1928.; Nenadić, 1940.; Dekanić, 1972.; Androić, 1975.; Prpić, 2003.). Propadanje stabala u šumskim ekosustavima posljedica je konkurencije vrsta i individua; djelovanja različitih prirodnih pojava (klimatski ekscesi: grom, vjetar, mokar snijeg, ledena kiša, suša, dugotrajna poplava, biotski čimbenici); promjena ekoloških uvjeta (promjene hidroloških prilika, tj. snižavanja razina podzemne vode, promjena dinamike poplavne vode, zamočvarenja i isušivanja staništa, onečišćenje poplavne i oborinske vode) i nepovoljna utjecaja čovjeka. U nizinskim šumskim ekosustavima, po većini dosadašnjih spoznaja, propadanje stabala je uzrokovano u prvom redu promjenama ekoloških uvjeta i nepovoljnim utjecajima čovjeka. Kada propadanje stabala poprima velike razmjere, ono utječe na stanje šuma, njihov rast, razvoj i obnovu, odnosno gospodarske i općekorisne vrijednosti. Razlikujemo pojedinačno propadanje, propadanje skupina stabala i masovno propadanje stabala. Propadanje stabala je pokazatelj poremetnje u funkcioniranju šumskih ekosustava, naznaka kompleksnog djelovanja nepovoljnih čimbenika koji imaju kumulativni i sinergistički učinak. Ono se razlikuje i prema brzini i intenzitetu, te može biti postupno i brzo. Postoje razlike i u intenzitetu propadanja stabala, pa razlikujemo mali, značajan i katastrofalan intenzitet propadanja stabala. Propadanja stabala se izražava u apsolutnim vrijednostima (m^3, m^3/ha) i postotnoj vrijednosti odumrlih stabala u odnosu na drvnu zalihu po jedinici površine (intenzitet propadanja). Propadanje hrasta lužnjaka prema Prpiću (1974.) je značajnije u srednjodobnim i starijim sastojinama, dok su se mlađe sastojine prilagodile promjenama u staništu. Čimbenici koji izazivaju propadanje stabala su biotski, sastojinski i stanišni (Vajda, 1968.). Od biotskih čimbenika posebno su utjecajne biljne bolesti, štetni kukci i divljač; od sastojinskih čimbenika na intenzitet propadanja utječe način postanka sastojina (prirodni ili umjetni), starost stabala i struktura sastojine (čista ili mješovita). U nizinskim šumskim ekosustavima uočava se fiziološko slabljenje i propadanje stabala gotovo svih vrsta drveća (Prpić, 1996.; Matić, 2000.). Međutim, vrlo je teško razlučiti primarne od sekundarnih i tercijarnih uzroka koji dovode do propadanja, poremetnje stabilnosti i degradacije tih ekosustava.

1.3 Dieback in trees

The problem of dieback in trees in lowland forest ecosystems has been an issue for more than a century. This problem has occupied the attention of practical forestry workers and academic researchers (Kozarac, 1897; Kovačević, 1928; Nenadić, 1940; Dekanić, 1972; Androić, 1975, Prpić, 2003). The dieback of trees in forest ecosystems occurs as a result of competition of species and individuals; the action of various natural phenomena (climatic extremew such as lightning, wind, wet snow, freezing rain, drought, long-lasting floods, biotic factors), as a result of changes in ecological conditions (changes in hydrological conditions, i.e., the dropping of the level of underground water, changes in the dynamics of floodwaters, the draining of the habitat or its being turned into marshland, pollution of the flood and run-off waters) and the adverse impact of people. In lowland forest ecosystems, according to most understandings to date, dieback is caused primarily by changes in the ecological conditions and adverse anthropogenic factors. When the dieback of the trees assumes major proportions, it affects the condition of the forests, their growth, development and regeneration, or their economic and general-use values. We differentiate the dieback of individual trees, then the dieback of groups of trees and the mass dieback of the woods. The dieback of trees is an indicator of a disturbance in the functioning of forest ecosystems, a hint of the complex actions of adverse factors that have a cumulative and synergistic effect. It is further differentiated according to speed and intensity, and can be gradual and rapid. There are differences in the intensity of tree dieback, and we distinguish a small, considerable and catastrophic intensity of tree dieback. Tree dieback is expressed in absolute values (m^3, m^3/ha) and percentage value of timber stocks per unit of area (intensity of dieback). The dieback of common oak according to Prpić (1974) is more important in medium-age and older stands, while the younger stands have adapted to changes in the habitat. Factors that bring about tree dieback are biotic, stand-related and habitat-related (Vajda 1968). Particularly important in the biotic factors are plant diseases, harmful insects and game; of the stand-related factors, the following have a particular impact on the intensity of dieback: whether the stand was created artificially or naturally, the age of the trees and the structure of the stand (pure or mixed). In the lowland forest ecosystems physiological weakening and dieback of trees in almost all species can be seen (Prpić, 1996; Matić, 2000). However, it is very difficult to distinguish primary from secondary and tertiary causes leading to dieback, disturbance of the stability of and degradation of these ecosystems.

2. Područje istraživanja

Istraživanje je provedeno u nizinskim šumskim ekosustavima hrasta lužnjaka i u gospodarskoj jedinici Opeke Nastavno-pokusnog šumskog objekta (NPŠO) Lipovljani, Šumarskog fakulteta Sveučilišta u Zagrebu. Gospodarska jedinica (g. j.) Opeke s površinom od 547 ha reprezentativni je predstavnik nizinskih šuma s hrastom lužnjakom, običnim grabom, poljskim jasenom i crnom johom kao glavnim vrstama šumskoga drveća. To je područje oko 5 km južno od autoceste Zagreb - Beograd, u blizini sela Kraljeva Velika i Lipovljani, oko 15 km jugoistočno od Kutine. Hidrološke prilike tih šumskih ekosustava znatno ovise o rijeci Savi, koja teče oko 5 km južno od objekta, i njezinim lijevim pritokama (Trebež i Veliki Strug). Reljef je tipično nizinski, blago valovit, s izraženim mikrouzvisinama i mikroudubinama, nadmorske visine od 93 do 99 m. Sastojine su mješovite, s udjelom hrasta lužnjaka u omjeru smjese 60 - 70%, poljskog jasena 15 - 25%, a ostalo su druge vrste drveća. Dob sastojina je od 105 do 150 godina.

3. Metoda rada

Na temelju doznake odumrlih stabala (»sušaca«) hrasta lužnjaka i poljskog jasena u g. j. Opeke obrađeni su podaci o ukupnim drvnim masama odumrlih stabala hrasta lužnjaka i poljskog jasena za razdoblje 1986. - 2003. Kako intenziteti propadanja stabala znatno ovise o stanišnim čimbenicima, izdvojeni su iz knjižica doznake odjeli iz dva različita mikrostaništa u kojima je zabilježeno propadanje stabala s približno podjednake površine. Napravljene su analize drvne mase odumrlih stabala po jedinici površine (ha), zatim uspoređene vrijednosti ukupne drvne mase odumrlih stabala po mikrostaništima i dobnim razredima.

4. Rezultati

Drvna mase odumrlih stabala hrasta lužnjaka i poljskog jasena u g. j. Opeke NPŠO Lipovljani u godinama 1986. - 2003. značajno se mijenja. Na grafikonu 1 uočavaju se dva maksimuma odumiranja stabala, od kojih je prvi obilježen velikim odumiranjem stabala hrasta lužnjaka i poljskog jasena, dok kod drugog maksimuma prevladava sušenje hrasta lužnjaka. Prema grafikonu 5 uočavaju se promjene dinamike podzemnih voda za godine u kojima se pojavilo maksimalno odumiranje stabala, što se može dovesti u vezu s uzrokom odumiranja stabala.
Analiza drvnih masa odumrlih stabala hrasta lužnjaka na dva mikrostaništa prikazana je na grafikonima 2 i 3. Utvrđena je maksimalna količina

2. The research area

The research was carried out in lowland forest ecosystems of common oak in the Opeka MU of the Educational Experimental Forest Facility (EEFF), Lipovljani, of the Forestry Faculty, Zagreb University. The Opeka MU has an area of 547 ha, and is fairly representative of the lowland forests with common oak, European hornbeam, narrow-leaved ash and black alder as the main species of forest tree. This is an area that lies about 5 km south of the Zagreb-Belgrade motorway, close to the villages of Kraljevna Velika and Lipovljani, and about 15 km south east of Kutina. The hydrological conditions of these forest ecosystems are very dependent on the Sava River, which is about 5 km south of the facility and its left bank tributaries (Trebež and Veliki Strug). The relief is typically lowland, gently rolling, with marked micro-elevations and micro-depressions, the height above sea level being 93-99 m. The stands are mixed, with common oak accounting for 60-70% of the mix, narrow-leaved ash for 15-25%, and the rest consisting of other kinds of tree. The age of the stand is from 105 to 150 years.

3. Method of work

According to the reception of dead trees of common oak and narrow-leaved ash in Opeak MU, data were processed about the total wood mass of dead trees of common oak and narrow-leaved ash for the period 1986-2003. Since the intensity of the dieback of trees is very dependent on habitat factors, sections of two different micro-habitats in which the dieback of trees of approximately equal areas were picked out from the books. Analyses of the wood mass of dead trees per unit of area (ha) were made, and then the values of the total wood mass of dead trees per micro-habitat and age class were compared.

4. Results

The wood mass of dead common oak and narrow-leaved ash trees in Opeka MU of the EEFF Lipovljani varied considerably in the 1986-2003 period. Graph 1 shows two maximum tree mortalities, of which the first is characterised by an important mortality of common oak and narrow-leaved ash trees, while in the second maximum it is the mortality of common oak that is dominant. Graph 5 shows the changes in the dynamics of the underground water for the years in which the maximum mortality of trees occurred, which can be causally connected with the tree mortality.
Analysis of the wood mass of the dead common oak trees at the two micro-habitats is shown in Graph 2 and Graph 3. A maximum amount of dead trees were determined in 1989 at a micro-depression,

odumrlih stabala 1989. godine na mikroudubini (niza), dok je u posljednih nekoliko godina veća količina odumrlih stabala po ha utvrđena na mikrouzvisini (greda). Sličan i još naglašeniji trend većeg odumiranja stabala hrasta lužnjaka na mikrouzvisini utvrđen je kod apsolutnih vrijednosti (grafikon 3).

Prema grafikonu 4 ne postoje značajne razlike u drvnoj masi odumrlih stabala po ha s obzirom na različitu dob stabala. U posljednjih nekoliko godina uočava se veći intenzitet odumiranja stabala V. dobnog razreda na mikrouzvisini nego onih VI. dobnog razreda u istim uvjetima i stabala na mikroudubini.

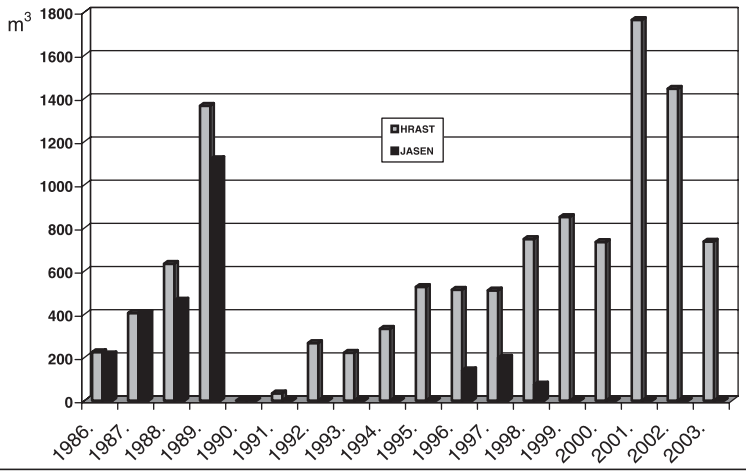
Intenziteti odumiranja stabala hrasta lužnjaka su bili veći u posljednjem desetogodišnjem razdoblju na mikrouzvisini nego na mikroudubini i kretali su se od 4 do 14% u odnosu na drvnu masu hrasta lužnjaka (tablica 1).

while in the more recent years, a greater amount of dead trees per hectare has been established on the micro-elevations. A similar though even more pronounced trend towards a greater common oak mortality on the micro-elevations has been established in the case of the absolute values (Graph 3).

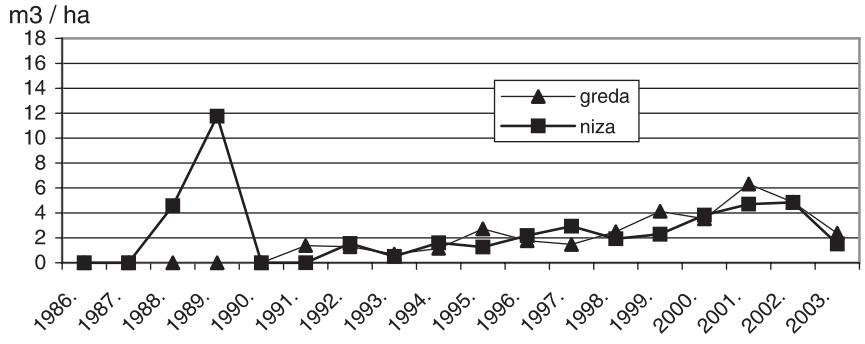
According to Graph 4 there are no important differences in the wood mass of dead trees per ha as compared with the various ages of the trees. In the last few years a greater intensity of mortality can be found in trees of the 5th cohort on the micro-elevation as compared with trees of the 6th age class in the same conditions and trees in the micro-depression.

The intensities of mortality of common oak trees were greater in the last ten year period on the micro-elevation than in the micro-depression, and ranged in the area of 4-14% as compared with the common oak wood mass (Table 1).

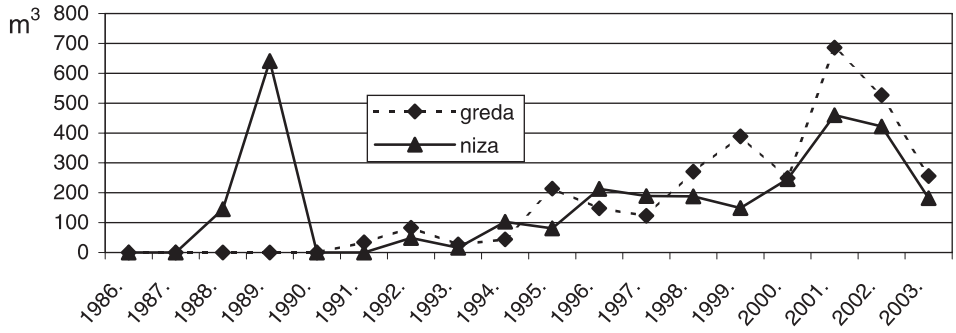
Grafikon 1 Drvna masa odumrlih stabala hrasta lužnjaka i poljskog jasena u g. j. Opeke za razdoblje 1986.-2003.



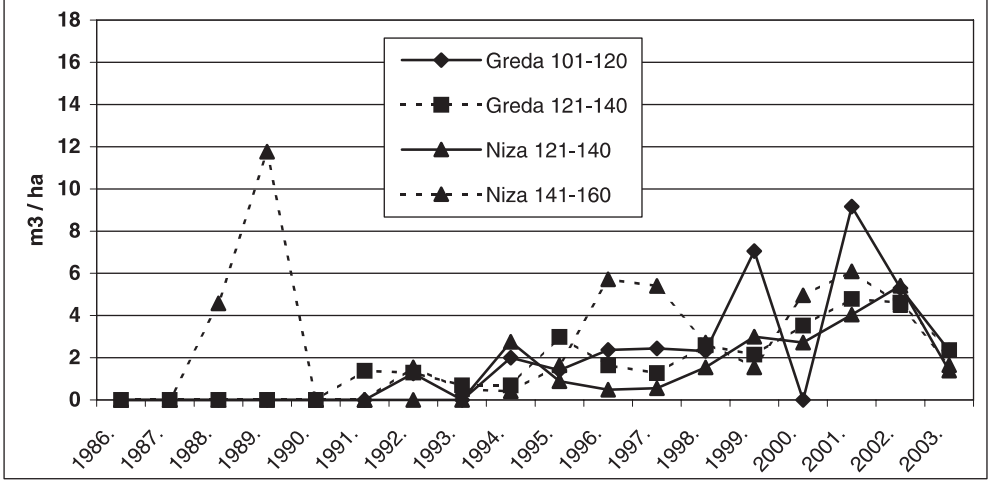
Grafikon 2 Drvna masa odumrlih stabala hrasta lužnjaka po ha u g. j. Opeke na dva različita mikrostaništa



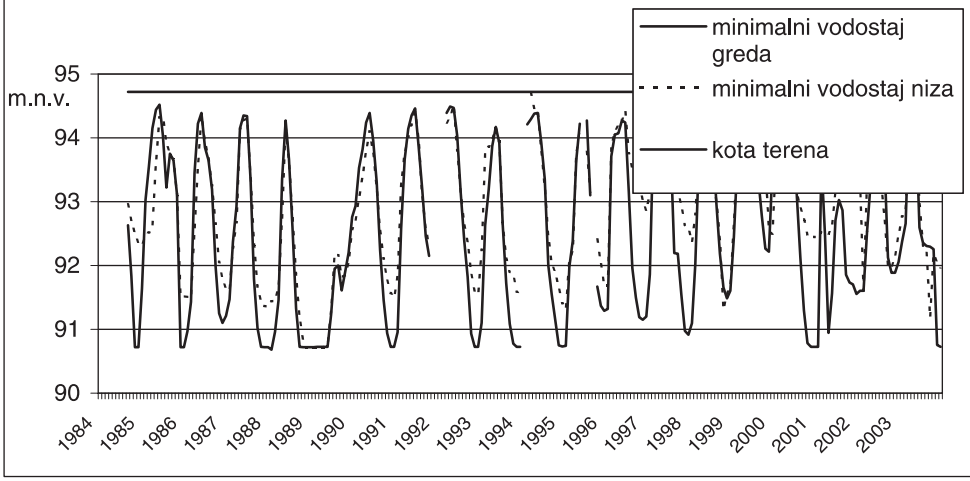
Grafikon 3 Ukupna drvna masa odumrlih stabala hrasta lužnjaka u g. j. Opeke na dva različita mikrostaništa



Grafikon 4 Drvna masa odumrlih stabala hrasta lužnjaka po ha u g. j. Opeke po dobnim razredima i mikroreljefu



Grafikon 5 Minimalne razine podzemnih voda u pjezometru dubine 4 m u g. j. Opeke na dva različita mikrostaništa



Tablica 1 Usporedba intenziteta odumiranja stabala hrasta lužnjaka u dva mikrostaništa u g. j. Opeke

	Osnova gospodarenja 1986.-1995.				Osnova gospodarenja 1996.-2005.			
	Drvna masa		Odumrla stabla		Drvna masa		Odumrla stabla	
ODJEL	Ukupno	hrast	hrasta		Ukupno	hrast	hrasta	
	m^3/ha	m^3/ha	m^3/ha	%	m^3/ha	m^3/ha	m^3/ha	%
Greda			Greda					Greda
144 b	510	376	4,7	1,24	479	368	52,1	14,15
150 a	486	246	0,0	0,00	555	291	14,5	5,00
151 c	525	300	4,6	1,54	563	342	28,6	8,37
157 a	474	284	3,3	1,16	461	264	22,3	8,44
158 a	582	358	7,5	2,11	582	342	19,3	5,65
Niza			Niza					Niza
128 a	517	397	3,6	0,92	477	373	18,3	4,92
136 a	295	213	0,0	0,00	567	373	8,3	2,22
120 a	547	427	8,1	1,89	447	368	11,4	3,11

Table 1 Comparison of intensity of morality of common oak trees in two micro-habitats at Opeke MU

	Management plan for 1986.-1995.				Management Plan for 1996.-2005.			
	Wood mass		Dead trees		Wood mass		Dead trees	
Compartment	Total	Oak	Oak		Total	Oak	Oak	
	m3/ha	m3/ha	m3/ha	%	m3/ha	m3/ha	m3/ha	%
Micro-Elevation				M-Elevation				M Elevation
144 b	510	376	4,7	1,24	479	368	52,1	14,15
150 a	486	246	0,0	0,00	555	291	14,5	5,00
151 c	525	300	4,6	1,54	563	342	28,6	8,37
157 a	474	284	3,3	1,16	461	264	22,3	8,44
158 a	582	358	7,5	2,11	582	342	19,3	5,65
Micro-Depression				M-Depression				M Depression
128 a	517	397	3,6	0,92	477	373	18,3	4,92
136 a	295	213	0,0	0,00	567	373	8,3	2,22
120 a	547	427	8,1	1,89	447	368	11,4	3,11

5. Rasprava

Stabilnost nizinskih šumskih ekosustava ovisi o brojnim čimbenicima od kojih su najjači hidrološki odnosi, biotski i klimatski utjecaji. Prema procjenama oštećenosti krošanja u Hrvatskoj, hrast lužnjak je najoštećenija listopadna vrsta drveća (Seletković i Potočić, 2004.). To je važan pokazatelj poremetnje fiziološke stabilnosti stabala. Međutim, propadanje stabala je pokazatelj poremećaja stabilnosti ekosustava. Dosadašnja istraživanja su potvrdila kompleksnost ekoloških odnosa u nizinskim šumskim ekosustavima. Propadanjem stabala hrasta lužnjaka nastaju veliki gospodarski gubici i neprocjenjiva ekološka šteta (Prpić, 2003.). Posljedice su smanjenje proizvodnosti i kakvoće drvne tvari, otežana prirodna obnova i, često, degradacija staništa. Intenzivno propadanje stabala utječe na zakorovljenje, a mjestimično na pojavu barskih uvjeta (Anić et al. 2002). Katastrofalna

5. Discussion

The stability of lowland forest ecosystems depends on numerous factors, of which the hydrological relations, biotic and climate factors are the most important. According to canopy cover damage estimates the common oak is the most damaged deciduous species of tree in Croatia (Seletković and Potočić, 2004). This is an important indicator of the disturbance of the physiological stability of the trees. However, dieback of trees is an indicator of ecosystem equilibrium disturbance. Investigations to date have confirmed the complexity of ecological relations in the lowland forest ecosystems. When oak trees undergo dieback, great economic losses and inestimable ecological damage are caused (Prpić, 2003). The consequence is the reduction of the productivity and quality of wood matter, greater difficulty in natural regeneration, and frequent habitat degradation. Intensive dieback of trees affects occurrence of weeds and in some places the appearance of marshy conditions (Anić et al. 2002).

propadanja stabala hrasta lužnjaka u šumi Žutica šumarije Novoselec zabilježena su isključivo u nizama, dok je na gredama propadanje stabala bilo mjestimično. Slično stanje stabilnosti i otpornosti pokazali su šumski ekosustavi na gredi i u drugim područjima gdje je utvrđeno propadanje stabala hrasta lužnjaka, kao što je Kalje, Turopoljski lug i Pokupski bazen (Baričević, 1999.). Propadanje stabala u g. j. Opeke NPŠO Lipovljani u razdoblju 1998. - 2003. pokazuje veći intenzitet na mikrouzvisini, dok u prijašnjem razdoblju nije bilo većih razlika u intenzitetu odumiranja stabala u različitim mikrostaništima. Te razlike su bile veće u odnosu na apsolutne vrijednosti (300 - 700 m^3 na gredi u odnosu na 200 - 450 m^3 u nizi), dok su razlike u količini odumrlih stabala po jedinici površine bile manje. Ovi rezultati upućuju na zaključak da su klimatske prilike, posebno klimatski ekscesi (suša), jedan od predisponirajućih čimbenika za pojavu odumiranja stabala hrasta lužnjaka. Važan je čimbenik i podzemna voda čija je dinamika u tim ekstremnim godinama bila poremećena u odnosu na normalno stanje prijašnjih godina. To možemo dovesti u vezu s trendom opadanja radijalnog prirasta hrasta lužnjaka od osamdesetih godina prošlog stoljeća, s izraženim padom u sušnoj 1988. godini, što prema Prpiću et al. (1994.) upućuje na dominantnost klimatskih ekscesa u procesu odumiranja stabala. Izgradnjom pregrada i brana na kanalima i vodotocima nastoji se usporiti brzo odvođenje površinskih voda iz šuma (Starčević, 2000.), što je jedna od mjera uravnoteženja poremećenih stanišnih uvjeta u nizinskim šumskim ekosustavima. Međutim, u ovom slučaju kada je klima jedan od presudnih čimbenika za stabilnost šumskih ekosustava hrasta lužnjaka, bit će potrebno intenzivirati gospodarenje i upravljanje šumskim ekosustavima kako bi se smanjile gospodarske i ekološke štete. U radu je također utvrđeno veće odumiranje stabala V. dobnog razreda od onih VI. dobnog razreda. To još više govori u prilog poremećaju stabilnosti šumskih ekosustava hrasta lužnjaka, koji na sreću još nema katastrofalne posljedice kakvih je bilo u prošlosti u nekim područjima.

6. Zaključak

1. Intenziteti propadanja nisu ovisni o starosti sastojina.
2. U odnosu na mikrostanište najveći intenzitet propadanja utvrđen je u mikroudubini (niza) 1989. godine dok je na mikrouzvisini utvrđen veći

The catastrophic diebacks of common oak trees in the forest of Žutica in the Novoselec Forest Unit were recorded only in the micro-depressions, while on the micro-elevations the dieback of the trees was occasional. A similar condition of stability and resistance were shown by the forest ecosystems on the micro-elevations in other areas where the dieback of oak trees was confirmed, as in Kalje, Turopoljski lug and Pokupski bazen (Baričević, 1999). The dieback of trees in Opeka MU, EEFF Lipovljani in the period from 1998-2003 showed a greater intensity on the micro-elevation, while in the earlier period there were no important differences in intensity of dieback of trees in the different micro-habitats. These differences were greater with reference to absolute values (300-700 cubic metres on the micro-elevation as against 200-450 cubic metres in the micro-depression), while the differences in the quantity of dead trees per unit of area were smaller. These results suggest the conclusion that climatic conditions, particularly climatic extremes (droughts) are one of the predisposition factors for the appearance of common oak mortality. An important factor too is the underground water, the dynamics of which in extreme years was disturbed as compared with the normal situation in earlier years. We can link this with the trend to the decline in radial increment of common oak from the 1980s on, with a marked drop in drought-stricken 1988, which according to Prpić et al. (1994) suggests that climatic extremes have a major role in the process of tree mortality. The construction of weirs and dams on the channels and watercourses is aimed at slowing the rapid drainage of surface waters from the forests (Starčević, 2000), and is one of the measures for restoring equilibrium to the disturbed habitat conditions in the lowland forest ecosystems. However, in this case, when the climate is one of the crucial factors for the stability of the forest ecosystems of common oak it will be necessary to enhance the management of the forest ecosystems in order to reduce the economic and ecological damage. This paper has already stated the greater mortality of trees of the 5th cohort as compared with the 6th cohort. This says still more about the disturbance of the stability of the common oak forest ecosystems, which luckily have no catastrophic consequences as yet, which did occur in the past in some areas.

6. Conclusion

1. Intensity of dieback does not depend on stand age.
2. With reference to the microhabitat, the greatest intensity of dieback was established in the micro-depression in 1989, while on the micro-elevation a greater intensity of common oak tree

intenzitet propadanja stabala hrasta lužnjaka u posljednjih nekoliko godina (1998. - 2003.).
3. Za razdoblje 1996. - 2003. intenzitet propadanja stabala hrasta lužnjaka u g. j. Opeke se kretao od 8 do 52 m^3/ha, što odgovara vrijednosti od 1,5 do 10% drvne mase sastojine.
4. U nizinskim šumskim ekosustavima utvrđeno je propadanje stabala gotovo svih vrsta drveća, što je pokazatelj poremećaja stabilnosti šumskog ekosustava.
5. Intenzitet propadanja izravno ne ovisi o starosti, strukturi i stanišnim prilikama, nego o kompleksnom djelovanju više nepovoljnih čimbenika.
6. Uzroci propadanja stabala se u prvom redu odnose na biotske, sastojinske i stanišne promjene u šumskim ekosustavima.
7. Promjene u šumskim ekosustavima posljedica su znatnog antropogenog neposrednog i posrednog utjecaja.
8. Kompleksnost odnosa i funkcija u šumskim ekosustavima zahtijeva gospodarenje cjelokupnim ekosustavima gdje će odnosi organizama (biljke, životinje, mikroorganizmi i čovjek) i stanišnih prilika biti uravnoteženi s obzirom na ciljeve gospodarenja šumskim ekosustavom.

dieback has been observed in the last few years (1998-2003).
3. For the 1996-2003 period, the intensity of dieback of common oak trees in the Opeka MU has ranged from 8 to 52 cubic metres, which corresponds to 1.5 to 10% of the wood mass of the stand.
4. In lowland forest ecosystems the dieback of trees of almost all species has been established and is an indicator of a disturbance of the stability of the forest ecosystem.
5. The intensity of dieback is not directly dependent on the age, structure and habitat-conditions, rather on the complex working of a number of unfavourable factors.
6. The causes of the dieback in trees are primarily connected with biotic, stand-related and habitat-related changes in the forest ecosystems.
7. Changes in the forest ecosystems are the consequences of important direct and indirect anthropogenic impacts.
8. The complexity of the relations and functions in forest ecosystems requires management of integrated ecosystems, where the relations of organisms (plants, animals, microorganisms and people) and habitat conditions will be brought into equilibrium with respect to the objectives of the management of the forest ecosystem.

7. Literatura

Androić, M., 1975. Prethodni rezultati timskog istraživanja uzroka sušenja hrasta u slavonskim šumama. U: Simpozij Sto godina znanstvenog i organiziranog pristupa šumarstvu jugoistočne Slavonije, JAZU Centar za znanstveni rad Vinkovci, Zagreb, pp. 59-78.

Anić, I., M., Oršanić, i M., Detelić, 2002: Revitalizacija degradiranoga ekosustava nakon sušenja hrasta lužnjaka primjer šume Kalje. Šum. list, 11-12: 575-587.

Baričević, D., 1999: Ekološko-vegetacijske promjene u šumama hrasta lužnjaka na području g. j. »Žutica«. Šum. list 1-2:17-28.

Dekanić, I., 1972. Utvrđivanje najpogodnijih vrsta drveća i metoda obnove opustošenih površina sušenjem hrasta lužnjaka (Quercus robur L.). Šum. list 4-6, 119-127.

Forest Health Monitoring, 1998: Field Methods Guide. USDA Forest Service, Washington.

ICP-Forests Manual on Methods and Criteria for Harmonized Sampling, Assessment, Monitoring and Analysis of the Effects of Air Pollution on Forests. Federal Research Centre for Forestry and Forest Products, Hamburg, Germany.

König, J., 1911. Sušenje hrastika. Šumarski list 1-2, 385-422.

Kovačević, Ž., 1928. Sušenje hrastova u Posavini sa entomološko-biološkog gledišta. Šumarski list 4, 182-185.

Kozarac, J., 1897. Šumogojstveni i drvotržni aforizmi, crpljeni na temelju prodaje posavskih hrastovih šuma u zadnjem desetgodištu 1887-1896. Šumarski list 7.

Matić, S., 2000: Oak forests (Quercus sp.) in Croatia. Glas. šum. pokuse, 37:5-13, Zagreb.

Nenadić, Đ., 1940. O posljedicama sušenja hrastovih šuma Gradiške imovne općine. Glasnik za šumske pokuse 7, 1-29.

Prpić, B., 1974. Ekološki aspekt sušenja hrastovih sastojina u nizinskim šumama Hrvatske. Šumarski list 7-9, pp. 285-290.

Prpić, B., 1988: Sušenje hrasta lužnjaka (Quercus robur L.) u Hrvatskoj u svjetlu ekološke konstitucije vrste. Glasnik za šumske pokuse 25, pp. 1-24.

Prpić, B., 1996: Propadanje šuma hrasta lužnjaka. U: Klepac, D. (ur.) Hrast lužnjak (Quercus robur L.) u Hrvatskoj, HAZU i «Hrvatske šume»; Zagreb, str. 273-298.

Prpić, B., 2001: Utjecaj vodotehničkih zahvata na stabilnost sastojina hrasta lužnjaka (Quercus robur L.) u Hrvatskoj u primjeru HE Novo Virje. Šum. list, 7-8: 379-390.

Prpić, B., 2003: Utjecaj tehničkih zahvata u prostoru na nizinske šume. Šum. list, 5-6: 230-235.

Prpić, B., Anić, I., 2000: The influence of climate and hydro-technical developments in the stability of the peduncled oak (Quercus robur L.) stands in Croatia. Glas. šum. pokuse, 37:229-239, Zagreb.

Prpić, B., Z. Seletković i M. Ivkov, 1994: Oštećenost krošanja glavnih vrsta drveća u Hrvatskoj u odnosu na radijalne priraste. Šum. list, 1-2: 3-10.

Prpić, B., Z. Seletković, i I. Tikvić, 1997: O utjecaju kanala Dunav-Sava na šumske ekosustave. Šum. list, 11-12: 579-592.

Seletković, I., Potočić, N., 2004: Oštećenost šuma u Hrvatskoj u razdoblju 1999 - 2003. godine. Šum. list, 3-4: 137-148.

Seletković, Z. I. Tikvić, 1996: Oštećenost šumskih ekosustava različitih stanišnih prilika u Republici Hrvatskoj. HŠD - Skrb za hrvatske šume od 1846. do 1996., Knjiga 2, str. 81-88, Zagreb.

Seletković, Z. i Tikvić, I., 1998: Klimatska i hidrološka funkcija nizinskih šumskih ekosustava, U: Prpić, B. (ur), Zbornik radova međunarodne konferencije Održivo gospodarsko korištenje nizinskih rijeka i zaštita prirode i okoliša, Hrvatsko šumarsko društvo, Zagreb, str. 38-43.

Seletković, Z., Tikvić, I., 1996: Oštećenost šumskih ekosustava različitih stanišnih prilika u Republici Hrvatskoj. U: Sever, S. (ur.), Zaštita šuma i pridobivanje drva, Šumarski fakultet Sveučilište u Zagrebu i Šumarski institut Jastrebarsko, str. 81-88.

Starčević, M., 2000: Utjecaj hidromelioracija na šumsku vegetaciju Varoškog luga. Šum. list, 1-2: 15-26.

Starčević, M., 2003: Utjecaj oborinske, poplavne i podzemne vode na razvoj sastojina šumskog kompleksa «Česma». Šum. list, 11-12:561-578.

Tikvić, I., 2001: Prirodne ektomikorizne zajednice na hrastu lužnjaku (Quercus robur L.) u Posavini. Disertacija, Šumarski fakultet Sveučilište u Zagrebu, str. 1-163.

Vajda, Z., 1968. Naučno istraživačke studije o sušenju hrastika. Šumarski list 2-3, pp. 122-142.

Vukelić, J., Rauš, Đ., 1998. Šumarska fitocenologija i šumske zajednice u Hrvatskoj. Sveučilište u Zagrebu, Šumarski fakultet, Zagreb.

Vukelić, J., Tikvić, I., Seletković, Z., Baričević, D., 1997: Dieback of Pedunculate Oak from the Ecological-Vegetative Aspect. IUFRO međunarodna konferencija "Advances in Research in Intermediate Oak Stands", 213-222, Freiburg.

Doc. dr. sc. Ivica Tikvić, prof. dr. sc. Zvonko Seletković
Šumarski fakultet
Sveučilište u Zagrebu,
Zavod za Uzgajanje šuma,
Svetošimunska 25, HR-10 000 Zagreb

ZAKLJUČCI SA STRUČNOG SKUPA - STANJE ŠUMA U PARKU PRIRODE LONJSKO POLJE - GOSPODARENJE I OČUVANJE KRAJOBRAZNE I BIOLOŠKE RAZNOLIKOSTI

Nova Gradiška, 18. ožujka 2004.

U suradnji Šumarskog fakulteta i Javne ustanove Park prirode Lonjsko polje pripremljen je stručni skup »Stanje šuma u parku prirode Lonjsko polje - gospodarenje i očuvanje krajobrazne i biološke raznolikosti«. Skup je održan u Novoj Gradiški 18. ožujka 2004. Na skupu su stručnjaci i djelatnici JUPPLP, Šumarskog fakulteta iz Zagreba, Hrvatskih šuma (direkcija i podružnice Zagreb, Sisak, Nova Gradiška) izlagali (9 predavanja) o stanju šuma u Parku prirode Lonjsko polje, organizaciji šumarstva, o načelima i zakonskim pretpostavkama gospodarenja šumama i o zaštiti biološke i krajobrazne raznolikosti te označili glavne postojeće probleme u šumama s područja parka i moguće putove prema poboljšanju stanja.

Na skupu je zaključeno da se osnuje radna skupina za donošenje zaključaka skupa. Izabrani su članovi radne skupine kako slijedi:

- Nives Farkaš-Topolnik, dipl. ing. - Park prirode Medvednica
- mr. sc. Petar Jurjević - Hrvatske šume d.o.o. Zagreb
- mr. sc. Ivica Milković - Hrvatske šme d.o.o. Zagreb
- dr. sc. Juro Čavlović - Šumarski fakultet Zagreb
- dr. sc. Igor Anić - Šumarski fakulet Zagreb
- Ivan Štanfar, dipl. ing. - HŠ, Podružnica Nova Gradiška
- Goran Gugić, dipl. ing. - Javna ustanova Park prirode Lonjsko polje
- mr. sc. Darko Kovačić - Javna ustanova Park prirode Lonjsko polje

Zaključci :

1. Šumama u PPLP, koje su jedna od najvažnijih sastavnica prirodnih vrijednosti područja, gospodari se na taradicionalni način uz

CONCLUSIONS OF THE CONFERENCE - THE CONDITION OF THE FORESTS IN THE LONJSKO POLJE NATURE PARK MANAGEMENT AND PRESERVATION OF LANDSCAPE AND BIOLOGICAL DIVERSITY

Nova Gradiška March 18 2004

The Forestry Faculty and Lonjsko Polje Nature Park Public Institution prepared a conference called the Condition of the Forests in Lonjsko Polje Nature Park the Management and Preservation of Landscape and Biological Diversity. The conference was held in Nova Gradiška on March 18 2004. At the conference, experts and employees of Lonjsko Polje Nature Park, the Forestry Faculty Zagreb, Croatian Forests (Main Office and Zagreb, Sisak and Nova Gradiska branches) gave X lectures concerning the condition of the forests in Lonjsko Polje Nature Park, the organisation of forestry, the principles and legal conditions for the management of forests and the protection of biological and landscape diversity, as well as marking out the main existing problems in the forests of the nature park and possible ways to improve the situation.

At the forest it was agreed to found a working group to draw up the Conclusions of the conference. The following members of the working group were elected:

- Nives Farkaš-Topolnik dipl.ing. - Medvednica Nature Park
- Petar Jurjević MSc - Hrvatske šume d.o.o. [Croatian Forests Ltd] Zagreb
- Ivica Milković MSc - Hrvatske šume d.o.o. Zagreb
- Dr Juro Čavlović - Forestry Faculty, Zagreb
- Dr Igor Anić - Forestry Faculty, Zagreb
- Ivan Štanfar dipl.ing - HŠ, Nova Gradiška Branch
- Goran Gugić dipl.ing. - Lonjsko Polje Nature Park
- Darko Kovačić MSc - Lonjsko Polje Nature Park

Conclusions:

1. The forests in Lonjsko Polje Nature Park are one of the most important constituents of the natural values of the area, managed in a traditional

podržavanje doprirodnoga stanja. Povijesne okolnosti, Domovinski rat, i prirodne pretpostavke (teška obnova zbog nepovoljne hidrološke situacije, štetnika i biljnih bolesti, utjecaja alohtonih vrsta bilja na uspješnost obnove) te dosadašnji način planiranja gospodarenja utjecale su na poželjnu strukturu šuma u parku prirode.

2. U duhu dosadašnje dobre suradnje šumarske struke i Uprave Parka prirode treba pronaći rješenja za najvažnije probleme koji se pojavljuju u gospodarenju šumama u parku i zaštiti prirodne i kulturne baštine u njemu. To su sljedeći problemi: dovođenje dobne strukture šuma što bliže normalnom stanju, smanjenje negativnog utjecaja vodnog režima na gospodarenje, posebice obnovu šuma, bolje uređenje lovstva i tradicijskog stočarenja kako bi se smanjio njihov sadašnji negativni utjecaj na obnovu šuma, rješavanje negativnog utjecaja alohtonih vrsta biljaka (Amorpha fruticosa, Fraxinus americana, Gleditschia triacanthos) na obnovu šuma i očuvanje biološke i krajobrazne raznolikosti, ponovno širenje nizinskog brijesta (Ulmus laevis), optimalna primjena mjera gospodarenja šumama u parku, koje potrajno osiguravaju njihovu stabilnost, biološku raznolikost, produktivnost i mogućnost obnove, promjene u zakonodavstvu kojim se regulira šumarska djelatnost i zaštita prirode koje bi dovele do fleksibilnijih propisa, primjerenih iznalaženju rješenja u uvjetima zaštićenog područja tipa parka prirode.

3. Poboljšanje strukture šume, a posebice dobne, u parku predlaže se postići radom na tri polja: izradom stručne podloge (stanje, mogući modeli upravljanja/gospodarenja); na zakonodavnoj razini; i izradom modela ciljanog stanja šuma u odnosu na željenu bioraznolikost.

4. Potrebno je izraditi preciznu stručnu analizu dinamike plavljenja retencijskih područja, utjecaja vodnog režima na obnovu i gospodarenje šumama (SWOT analiza; Cost/benifit analiza), model mogućih promjena u vegetaciji vezano uz planove dogradnje sustava obrane od poplava srednjeg Posavlja s kvantificiranim prikazom promjena u prostornom i vremenskom slijedu. Potrebno je osmisliti sustav uspješna utjecaja Javne ustanove i Hrvatskih šuma i šumarske znanosti na planiranje i provođenje dogradnje

manner that supports a quasi-natural state of affairs. Historical circumstances, the Homeland War and natural premises (difficulty of regeneration because of adverse hydrological conditions, pests and plant diseases, the impact of imported species of plants on the success of regeneration) and the previous manner of planning management have affected the structure of forests in the nature park.

2. In the spirit of the good collaboration to date between the forestry profession and the management of the Nature Park it is necessary to find solutions for the most important problems that occur in the management of the forests in the park and in the protection of the natural and cultural heritage within them. The problems are as follows: getting the age structure of the forests as close as possible to a normal situation, reducing the negative impacts of the water regime on management, particularly on the regeneration of the forests, the optimal arrangement of hunting and traditional animal husbandry so as to reduce their previous deleterious effect on the regeneration of the forests, the resolution of the deleterious effect of allochthonous plant species *Amorpha fruticosa, Fraxinus americana, Gleditschia triacanthos*) on the regeneration of the forests and the preservation of biological and landscape diversity, the re-dissemination of the European white elm (*Ulmus laevis*), the optimal application of measures for the management of the forests in the park, which will provide for their lasting stability, biological diversity, productivity and possibility of regeneration, changes in legislation regulating the forestry industry and the protection of nature so as to lead to more flexible regulations, more appropriate solutions in conditions of a protected area of the nature park type.

3. It is proposed to achieve improvements in the structure of the forest, particularly of the age structure, in the park by working in three fields: making a professionally based plan (condition, possible model for management); at the statutory level; and elaboration of a model of the target condition of the forests with respect to the biodiversity desired.

4. It is necessary to work out a precise expert analysis of the dynamics with which the floodwater retention areas are flooded, the effect of the water regime on the regeneration and management of the forests (SWOT analysis; Cost/Benefit Analysis), a model of possible changes in the vegetation related to plans for the further development of the flood defence system of Central Posavina with a depiction of quantified changes in the temporal and spatial sequence. It

ovog sustava na bazi suradnje s Hrvatskim vodama i drugim korisnicima prostora.

5. Radi smanjenja nepovoljnih utjecaja tradicijskoga stočarenja i uzgoja divljači na ionako otežanu obnovu šuma u plavljenom području, zainteresirane strane trebaju izraditi i provesti jasna pravila i uvjete za te djelatnosti. Pri tome treba obnovu šuma staviti kao prioritet.

6. Veliki problemi u obnovi šuma i očuvanju bioraznolikosti na šumskom i nešumskom zemljištu u parku nastaju radi širenja alohtonih biljnih vrsta (Amorpha fruticosa, Fraxinus americana, Gleditschia triacanhtos) . Potrebno je u suradnji šumarske struke i zaštite prirode oformiti istraživačke projekte i konkretne upravljačke projekte koji bi za cilj imali prihvatljivo uklanjanje alohtonih vrsta iz područja, sprječavanje njihova širenja i, posebno, smanjenja utjecaja na obnovu šuma.

7. Nestankom nizinskoga brijesta narušena je stabilnost i struktura šuma. Predlaže se razvoj programa kojim bi se pokušalo nizinski brijest vratiti u sastav šuma. Program treba imati istraživačku komponentu, aplikativni dio i program monitoringa. Treba ga ostvariti u suradnji šumarske struke (Šumarski fakultet, Šumarski institut, Hrvatske šume) i zaštite prirode (JUPPLP, Državni zavod za zaštitu prirode).

8. U gospodarenju šumskim ekosustavom u parku prirode Lonjsko polje treba primjeniti sve mjere koje osiguravaju maksimalnu razinu podržavanja i očuvanja biološke i krajobrazne raznolikosti, sukladno zakonskim propisima i mjerama prihvaćenim u Hrvatskoj i EU. Pri tome treba primijeniti pravilo da je svaki korisnik odgovoran za očuvanje bioraznolikosti, slijediti upute strateških dokumenata (Strategija šumarstva RH, Strategija očuvanja krajobrazne i biološke raznolikosti RH, FSC, EU Habitat and species direktive, EU direktive o šumama te relevantne propise o gospodarenju šumama.

9. Potrebno je iskoristiti iskustva stečena u odnosu gospodarenja šumama i zaštiti prirode u PP Lonjsko polje kako bi se utjecalo na strukturu i sadržaj zakonskih rješenja iz područja šumarstva i zaštite prirode na način da se osigura dovoljna fleksibilnost propisa. Ona je prijeko potrebna da bi se moglo na terenu i u povoljnom vremenskom

is necessary to devise a system for the application of effective influence by the Nature Park, Croatian Forests and forestry science on the planning and the implementation of the further development of this system pursuant to cooperation with Croatian Water and other users of the area.

5. For the sake of reducing the adverse impacts of traditional animal husbandry and the rearing of game on the regeneration of the forests, already hard enough, in the flooded area, interested parties should draw up and execute clear rules and conditions for the activity. In this, priority should be assigned to regeneration of the forests.

6. One great problem in the regeneration of the forests and the preservation of biological diversity in the forest and non-forest ground in the park has arisen as a result of the expansion of allochthonous plant species (*Amorpha fruticosa, Fraxinus americana, Gleditschia triacanthos*). Through collaboration between the forestry profession and nature conservation, research projects and concrete management projects ought to be set up with the aim of finding an acceptable way of ridding the area of allochthonous species, the prevention of their spread and in particular the reduction of their impact on forest regeneration.

7. The stability and structure of the forests have been disturbed with the disappearance of the European white elm. It is proposed that a programme should be developed to attempt to restore the elm to the constitution of the forests. The programme should have a research component, an application part and a monitoring programme. It should be put into practice through cooperation between the forestry profession (Forest Faculty, Forestry Institute, Croatian Forests) and nature conservation (Lonjsko Polje Nature Park and the State Institute for Nature Conservation).

8. In managing forest ecosystems in Lonjsko Polje Nature Park it is necessary to employ all measures that will ensure the maximum level of support for and preservation of biological and landscape diversity, in line with the regulations of the law and measures accepted in Croatia and the EU. In so doing one should apply the rule that every user is responsible for the preservation of biodiversity, should follow the instructions of the strategic documents (Republic of Croatia Forestry Strategy, Preservation of Landscape and Bio-Diversity of the Republic of Croatia Strategy, FSC, EU Habitats and Species Directives, EU Forests Directives and the relevant regulations concerning forest management.

razdoblju provesti mjere nužne za osiguranje poželjenog odnosa gospodarenja šumama i očuvanja biološke i krajobrazne raznolikosti.

U Zagrebu 2.7.2004.

9. It is necessary to make use of the experience acquired in the relation between forest management and nature protection in Lonjsko Polje NP, in order to affect the structure and content of legal approaches from the area of forestry and nature protection in such a way as to ensure an adequate flexibility in the regulations. This is essential so as to carry out, in the field, in a suitable period of time, measures that are essential for the achievement of a desirable relationship or ratio between forest management and the preservation of biological and landscape diversity.