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ORIGINAL SCIENTIFIC PAPER

Pan-European criteria and indicators for sustainable forest management: Institutional aspects and possibilities of application in the forestry of the Federation of Bosnia and Herzegovina

Pan-europski kriteriji i indikatori održivog gospodarenja šumama: Institucionalni aspekti i mogućnost primjene u šumarstvu Federacije Bosne i Hercegovine

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ABSTRACT

Overexploitation of natural resources have caused serious environmental issues, including climate change, biodiversity loss, habitat degradation, and soil and water pollution. The Pan-European criteria and indicators for sustainable forest management offer a tool to monitor progress and report on the sustainability of forest resources at sub-national, national, and regional levels. This paper examines the institutional aspects and possibilities of application of these criteria and indicators in the forestry sector of the Federation of Bosnia and Herzegovina (FBiH), aiming to improve forestry conditions and develop a coherent forest policy. A survey of 360 forestry experts from FBiH revealed that the majority support the positive impact of implementing the Pan-European criteria and indicators in the forestry sector. It was determined that the Ministry of Agriculture, Water Management, and Forestry of FBiH should be responsible for developing and collecting data related to these criteria and indicators. However, the primary barriers to implementation include a lack of financial resources, expertise, and commitment. While the public forest administration is formally prepared to apply these criteria, its current capacities are inadequate for effective implementation. Strengthening the capacity of the public forest administration is crucial to ensure the application of the Pan-European criteria and indicators for sustainable forest management. This would enable consistent and systematic monitoring and improvement of forest resource conditions and the overall state of the forestry sector in FBiH.

Key words: *Forestry, Sustainable Forest Management, Pan-European criteria and indicators, Application and institutional aspects.*

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INTRODUCTION – *Uvod*

U posljednje četiri decenije, koncept održivog razvoja je postao dominantni pravac u procesima usvajanja politika i donošenja odluka i predstavlja osnovu za dugoročno planiranje svih procesa koji se odnose na gospodarenje prirodnim resursima. U svojoj suštini, ovaj koncept objedinjuje različite ekonomske, ekološke, etičke, društvene, pravne i političke aspekte, a podrazumijeva uravnotežen društveno-ekonomski razvoj kroz održivo, dugoročno i odgovorno korištenje prirodnih resursa usmjereno na postizanje ekonomske, ekološke i sociološke održivosti. Potreba za ovim pristupom se javila zbog jasnih dokaza da su prirodni resursi u neposrednoj opasnosti da budu iscrpljeni ili da njihova kvaliteta bude ugrožena u smislu prijetnje za biodiverzitet i okoliš (Drexhage i Murphy, 2010). Mnogobrojni dokazi potvrđuju da je čovječanstvo, u posljednjih nekoliko decenija, neodgovornim i pretjeranim korištenjem prirodnih resursa, prije svega radi ostvarivanja ekonomske koristi uzrokovalo brojne poremećaje u prirodnoj ravnoteži (klimatske promjene, gubitak biodiverziteta, degradacija staništa, onečišćenje tla i vode, učestalost elementarnih nepogoda itd.), koje imaju negativan uticaj na kvalitet življenja cijele ljudske populacije (IPBES, 2018). Da bi se zaustavio takav „negativan trend", umanjilo iskorištavanja prirodnih resursa i samim time ugrožavanje opstanka čovječanstva i budućih generacija, razvijen je koncept održivog razvoja.

Pojam održivosti u šumarstvu je prvi put spomenut 1713. godine u knjizi *Sylvicultura oeconomica*, autora Hansa Carla von Carlowitz-a i odnosio se na održivi prinos u šumarstvu u kojoj je naglašeno: „Cilj gospodarenja šumama je trebao biti najveća moguća sječa drveta na održiv način, odnosno dosljedno i kontinuirano tijekom vremena, bez prekomjernog iskorištavanja šume" (Von Carlowitz, 1713). U današnje vrijeme, pristup gospodarenju šumama je fokusiran na ublažavanje posljedica klimatskih promjena, održavanje diverziteta biljnih i životinjskih vrsta, osiguranje drveta kao sirovine i obnovljivog izvora energije, uz istovremeno zadovoljavanje društvenih potreba za rekreacijom i osiguranjem ostalih ekosistemskih usluga. U cilju odgovora na zahtjeve za zaštitu životne sredine i očuvanje biodiverziteta na globalnom nivou, multifunkcionalno gospodarenje šumama nastoji fleksibilno reagirati na različite društvene interese i prilagoditi gospodarenje šumama lokalnim društvenim i okolišnim uvjetima, na način da pruža više opcija za odgovor na tržišne zahtjeve, trendove i promjenjive potrebe i vrijednosti društva, a ne isključuje mogućnosti korištenja za buduće generacije (Nabuurs et al, 2024).

Kao rezultat konferencije Ujedinjenih naroda o okolišu i razvoju (Rio de Janeiro, 1992. godine), došlo je do pokretanja međunarodnih procesa i inicijativa za primjenu kriterija i indikatora održivog gospodarenja šumskim resursima. Kriteriji i indikatori treba da služe kao instrumenti šumarske i okolišne politike za procjenu, monitoring i izvještavanje o primjeni koncepta održivog gospodarenja šumama na globalnom, regionalnom i nacionalnom nivou. U Europi je Ministarska konferencija za zaštitu šuma (ranije MCPFE, a sada FOREST EUROPE) bila vodeći promotor definiranja i primjene seta kriterija i indikatora održivog gospodarenja šumskim resursima. Prema definiciji Ministarske konferencije za zaštitu šuma iz 1993. godine, održivo gospodarenje šumama podrazumijeva korištenje šuma i šumskih zemljišta na način i brzinom koji održavaju njihov biodiverzitet, produktivnost, sposobnost regeneracije, vitalnost i njihov potencijal za ispunjavanje sadašnjih i budućih relevantnih ekoloških, sociolоških i ekonomskih funkcija na lokalnom, nacionalnom i globalnom nivou, na način da to ne nanosi štetu drugim ekosistemima (MCPFE, 1993). Kriteriji i indikatori održivog gospodarenja šumama su vremenom prošli kroz proces razvoja i prilagođavanja, da bi njihovo korištenje rezultiralo kreiranjem nacionalnih izvještaja o održivom gospodarenju šumama, koji su od strane FOREST EUROPE-a objedinjeni u Izvještaj o stanju europskih šuma (FOREST EUROPE, 2020).

Sagledavajući sociološku, ekološku i ekonomsku dimenziju šumarstva, koncept održivog gospodarenja šumama se istorijski posmatrano razvijao i postao nezaobilazna paradigma u modernom gospodarenju šumama (Floyd, 2002). Međutim, da bi se mogao ocijeniti napredak u postizanju održivog gospodarenja šumama bilo je potrebno definirati i razviti kriterije i indikatore održivog gospodarenja šumama (Wijewardana, 2008; Pülzl i Rametsteiner, 2009; Rametsteiner et al, 2011). Pan-europski set kriterija i indikatora je razvijen kao svojevrstan instrument šumarske politike za monitoring, evaluaciju i izvještavanje o napretka u provedbi održivog gospodarenja šumama (Barbati et al, 2013) i kao takav je istraživan kroz nekoliko međunarodnih projekata (EFI, 2013; FAO, 2016; UN, 2016). U nekoliko posljednjih decenija su kriteriji i indikatori održivog gospodarenja šumama intenzivnije istraživani, bilo da se radi o implementaciji na međunarodnom, regionalnom i nacionalnom nivou (Baycheva-Merger i Wolfslehner, 2016), kao i subnacionalnom nivou (Duinker, 2001; Hickey i Innes, 2005; Santopuoli et al, 2016), ili kroz odnos između kvalitativnih i kvantitativnih indikatora (Wolfslehner i Vacik, 2011). Pored toga, različite studije ukazuju na glavne karakteristike kriterija i indikatora, njihove nedostatke i mogućnosti primjene na različitim nivoima (Requardt, 2007; Wijewardana, 2008 ibid; Foster et al, 2010).

Kada je riječ o regionu Zapadnog Balkana i Bosni i Hercegovini (BiH), Pan-europski kriteriji i indikatori održivog gospodarenja šumama su nedovoljno istražena oblast i nisu ostvarena značajnija naučna istraživanja po pitanju njihovog razvoja, primjene i implementacije. Jedan od rijetkih radova objavljenih u regionu, koji se bavio tematikom kriterija i indikatora održivog gospodarenja šumama je imao fokus na procjenu napretka prema održivom gospodarenju šumama u Hrvatskoj kroz korištenje kvantitativnih unaprijeđenih Pan-europskih kriterija i indikatora (Lovrić et al, 2010). U BiH je, kroz stručnu analizu, dat pregled seta generičkih Pan-europskih kriterija i indikatora iz 2003. godine (Lojo, 2016), a 2023. godine su analizirani stavovi visokoobrazovanih šumarskih stručnjaka po pitanju zastupljenosti i važnosti Pan-europskih kriterija održivog gospodarenja u sektoru šumarstva FBiH (Marić et al, 2023). Pojedini autori su se bavili mogućnostima primjene FSC principa i kriterija kao eksternih standarda u procesu certificiranja (Avdibegović, 2001; Avdibegović, 2002; Avdibegović, 2004; Avdibegović et al, 2021), istraživanjem seta principa koncepta "forest governance" u šumarstvu FBiH (Mutabdžija, 2012; Avdibegović et al, 2014; Avdibegović et al, 2017) i analizom korektivnih mjera prilikom dobijanja i održavanja FSC certifikata (Avdibegović et al, 2014; Halalisan et al, 2016; Pezdevšek Malovrh et al, 2019), ali je i pored toga evidentan nedostatak naučnih radova koji bi, sa aspekta šumarske politike, bili fokusirani isključivo na problematiku Pan-europskih kriterija i indikatora održivog gospodarenja šumama u BiH. Stoga je važno na naučnim osnovama i uz korištenje odgovarajućih metoda analizirati institucionalne aspekte i mogućnost primjene seta kriterija i indikatora održivog gospodarenja šumama u sektoru šumarstva Federacije Bosne i Hercegovine (FBiH), zasnovane na utvrđivanju stavova visokoobrazovanih stručnjaka šumarstva u FBiH.

Iako u BiH postoji višedecenijska tradicija održivog gospodarenja šumskim resursima, zasnovana na principu kontinuiteta gospodarenja, trenutno u FBiH ne postoje zvanični strateški dokumenti koji sadrže sveobuhvatan i detaljno razrađen set Pan-europskih kriterija i indikatora održivog gospodarenja šumama. BiH se kao potpisnica FOREST EUROPE-a obavezala da na nacionalnom nivou implementira rezolucije usvojene na Ministarskim konferencijama. Zbog složene administrativne organizacije, u kojoj najveće nadležnosti nad javnim šumama imaju entiteti, teško je i dobiti konzistentne podatke za nivo kompletne države. Međutim, potrebno je imati u vidu da se Pan-europski kriteriji i indikatori održivog gospodarenja šumama mogu primjenjivati na nacionalnom i na subnacionalnom nivou. Cilj ovog rada je istražiti mogućnosti primjene i institucionalne aspekte Pan-europskih kriterija i indikatora u sektoru šumarstva FBiH. Primjena kriterija i indikatora održivog gospodarenja šumama, pored kontinuiranog razvoja i implementacije odgovarajućeg miksa drugih instrumenata šumarske politike, u značajnoj mjeri može doprinijeti unapređenju gospodarenja šumskim resursima, a samim tim i razvoju sektora šumarstva FBiH u ekološkom, ekonomskom i društvenom kontekstu.

MATERIALS AND METHODS – *Materijal i metode*

Set Pan-europskih kriterija i indikatora održivog gospodarenja šumama se sastoji od 6 kriterija, 34 kvantitativna i 11 općih kvalitativnih indikatora (ukupno 45 indikatora). Kvantitativni indikatori pružaju informacije o trenutnom stanju i promjenama u europskim šumama i napretku u održivom gospodarenju šumama. Promjene opisane kroz kvalitativne indikatore, tijekom vremena odražavaju odgovore donosilaca odluka u sektoru šumarstva (politike, institucije, regulatorni i finansijski instrumenti i informacije) na izazove i mogućnosti koji se odnose na šumske resurse i održivo gospodarenje šumama (Tabela 1).

Tabela 1. Set Pan-europskih kriterija i indikatora održivog gospodarenja šumama

Table 1. Set of Pan-European criteria and indicators for sustainable forest management

SET OPĆIH KVALITATIVNIH INDIKATORA		
	Br.	**Indikator**
Šumarska politika i governance[1]	1	Nacionalni šumarski program ili ekvivalent
	2	Institucionalni okvir
	3	Pravni/regulatorni okviri nacionalne i (i/ili subnacionalne) međunarodne obaveze
	4	Finansijski i ekonomski instrumenti
	5	Informacije i komunikacija

[1] Pod pojmom "šumarska politika i governance" podrazumijeva se set od 5 općih kvalitativnih indikatora koji su u setu Pan-europskih kriterija i indikatora održivog gospodarenja šumama iz 2003. godine nosili naziv "Overall policies, institutions and instruments for sustainable forest management".

SET KVANTITATIVNIH INDIKATORA		
Kriterij	**Br.**	**Indikator**
Kriterij 1 Održavanje i odgovarajuće unaprijeđenje šumskih resursa i njihovog doprinosa globalnom kruženju ugljika	K1	**Pripadajuće politike, institucije i instrumenti**
	1.1	Površina šuma
	1.2	Drvna zapremina
	1.3	Dobna i debljinska struktura
	1.4	Ugljik u šumskim resursima
Kriterij 2 Održavanje zdravlja i vitalnosti šumskih ekosistema	K2	**Pripadajuće politike, institucije i instrumenti**
	2.1	Koncentracija polutanata u zraku
	2.2	Stanje tla
	2.3	Defolijacija
	2.4	Oštećenje šuma
Kriterij 3 Održavanje i unaprijeđenje proizvodnih funkcija šuma	K3	**Pripadajuće politike, institucije i instrumenti**
	3.1	Prirast i sječa šuma
	3.2	Oblo drvo
	3.3	Nedrvni proizvodi
	3.4	Usluge
Kriterij 4 Očuvanje i odgovarajuće unaprijeđenje biodiverziteta u šumskim ekosistemima	K4	**Pripadajuće politike, institucije i instrumenti**
	4.1	Diverzitet vrsta drveća
	4.2	Podmlađivanje
	4.3	Prirodnost
	4.4	Alohtone vrste drveća
	4.5	Mrtvo drvo
	4.6	Genetički resursi
	4.7	Fragmentacija šuma
	4.8	Ugrožene šumske vrste
	4.9	Zaštićene šume
	4.10	Zajedničke šumske vrste ptica
Kriterij 5 Održavanje i odgovarajuće unaprijeđivanje zaštitnih funkcija šuma	K5	**Pripadajuće politike, institucije i instrumenti**
	5.1	Zaštitne šume-tlo, voda i druge usluge ekosistema, infrastruktura i upravljanje prirodnim resursima
Kriterij 6 Održavanje drugih sociološko-ekonomskih funkcija šuma	K6	**Pripadajuće politike, institucije i instrumenti**
	6.1	Šumski posjed
	6.2	Doprinos sektora šumarstva BDP-u
	6.3	Neto prihod
	6.4	Investicije u šume i šumarstvo
	6.5	Radna snaga u sektoru šumarstva
	6.6	Sigurnost na radu i zdravlje radnika
	6.7	Potrošnja drveta
	6.8	Trgovina drvetom
	6.9	Energija iz drveta
	6.10	Rekreacija u šumama

Izvor: (FOREST EUROPE, 2015)

Za potrebe analize institucionalnih aspekata i mogućnosti primjene Pan-europskih kriterija i indikatora održivog gospodarenja šumskim resursima od strane stručne javnosti (visokoobrazovanih šumarskih stručnjaka) u sektoru šumarstva FBiH, provedeno je istraživanje upotrebom metode anketiranja. Dizajnom upitnika je omogućen kvantitativni ili numerički opis trendova, stavova ili mišljenja ispitanika obuhvaćenih uzorkom, što je osiguralo generaliziranje zaključaka o istraživanoj populaciji na području FBiH. Sadržaj upitnika je podijeljen na nekoliko cjelina koje se odnose na socio-demografske karakteristike ispitanika (spol, starost, obrazovanje, broj godina radnog iskustva, tip institucije zaposlenja), opšte informacije o Pan-europskim kriterijima i indikatorima, institucionalne aspekte, mogućnost primjene, te doprinos Pan-europskih kriterija i indikatora održivom gospodarenju šumama sa ciljem prevazilaženja trenutnih izazova u sektoru šumarstva FBiH. Obzirom da se istraživanjem teži osigurati struktuiran i sistematičan set podataka (De Vaus, 2002), upitnik je pretestiran sa ciljem njegovog dodatnog unaprijeđenja i prilagođavanja ciljnoj populaciji.

Tabela 2. Stopa povrata upitnika po tipovima institucija i administrativnim nivoima

Table 2. Questionnaire return rate by types of institutions and administrative levels

Br.	Institucija	Administrativna jedinica	Poslano	Vraćeno	Stopa povrata (%)
1	JP "Bosansko-podrinjske šume" d.o.o. Goražde	Bosansko-podrinjski kanton	7	7	100,0
2	Kantonalna uprava za šumarstvo		1	1	100,0
3	Federalno ministarstvo poljoprivrede, vodoprivrede i šumarstva	Federacija Bosne i Hercegovine	9	6	66,7
4	ŠGD "Hercegbosanske šume" d.o.o. Kupres	Hercegbosanski kanton	99	64	64,6
5	Kantonalna uprava za šumarstvo		1	1	100,0
6	JP Šume Hercegovačko-neretvanske d.o.o. Mostar	Heregovačko-neretvanski kanton	2	2	100,0
7	Šumarstvo Prenj dd Konjic		15	10	66,7
8	Kantonalna uprava za šumarstvo		6	6	100,0
9	KJP "Sarajevo-šume" d.o.o. Sarajevo	Kanton Sarajevo	55	34	61,8
10	Kantonalna uprava za šumarstvo		10	10	100,0
11	ŠPD Srednjobosanske šume d.o.o. Donji Vakuf	Srednjobosanski kanton	92	71	77,2
12	Kantonalna uprava za šumarstvo		12	12	100,0
13	JP Šume TK dd Kladanj	Tuzlanski kanton	49	20	40,8
14	ŠPD "Unsko-sanske šume" d.o.o. Bosanska Krupa	Unsko-sanski kanton	70	45	64,3
15	JP ŠPD Zeničko-dobrojskog kantona d.o.o. Zavidovići	Zeničko-dobojski kanton	99	60	60,6
16	Kantonalna uprava za šumarstvo		11	11	100,0
	UKUPNO		**538**	**360**	**66,9**

Populacija ispitanika u ovom istraživanju su bili visokoobrazovani šumarski stručnjaci, uposlenici javnih preduzeća šumarstva i javne šumarske administracije u FBiH i primijenjen je pristup totalnog obuhvata populacije. Kao osnova za identifikaciju ispitanika poslužili su zvanični spiskovi uposlenih u pojedinim tipovima institucija, a konačan broj ispitanika u populaciji je utvrđen kontaktiranjem javnih preduzeća šumarstva i javne šumarske administracije. U Tabeli 2 je prikazana distribucija broja ispitanika po pojedinim tipovima institucija i administrativnim nivoima. Značajno je napomenuti da su svi ispitanici sa kantonalnog administrativnog nivoa, uz izuzetak uposlenika koji rade u Federalnom ministarstvu poljoprivrede, vodoprivrede i šumarstva.

Nakon dobijenih podataka za svako preduzeće šumarstva i instituciju javne šumarske administracije u FBiH, isprintan je odgovarajući broj upitnika koji su lično dostavljeni i distribuirani svim uposlenicima. U nekoliko slučajeva upitnik je poslan e-mailom, nakon telefonskog poziva, gdje su ispitanici zamoljeni da popune i pošalju nazad upitnik. Ukupno je distribuirano 538 upitnika, od kojih je 360 pravilno popunjeno i vraćeno istraživačkom timu, što je rezultiralo stopom povrata od skoro 67%. Imajući u vidu činjenicu da se radi o specifičnom tipu istraživanja, zasnovanom na metodologiji društvenih nauka, moguće je konstatovati da se radi o visokoj stopi povrata upitnika, čime je omogućeno pouzdano generaliziranje dobijenih rezultata i formuliranje zaključaka. Prikupljeni podaci su uneseni u MS Excel 2016 i obrađeni u programu za statističku analizu SPSS 22. Analizom podataka su identificirani i razmatrani sljedeći elementi primjene Pan-europskih kriterija i indikatora u šumarstvu FBiH:

a) Informiranost ispitanika o sadržaju i svrsi Pan-europskih kriterija i indikatora;
b) Institucionalni aspekti za upotrebu Pan-europskih kriterija i indikatora;

c) Kapaciteti i preduslovi za upotrebu Pan-europskih kriterija i indikatora u sektoru šumarstva FBiH;
d) Mogućnost doprinosa Pan-europskih kriterija i indikatora unaprjeđenju stanja u sektoru šumarstva FBiH.

RESULTS AND DISCUSSION – *Rezultati i diskusija*

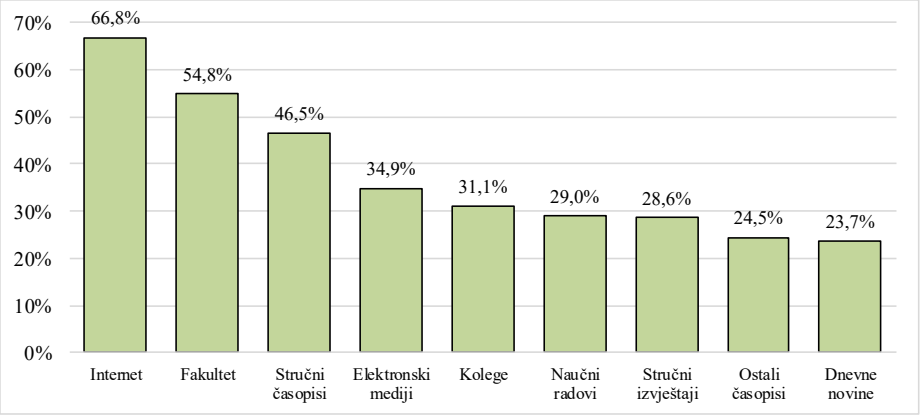
Basic information about the respondents - *Osnovne informacije o ispitanicima*

Većina ispitanika, obuhvaćenih ovim istraživanjem, su muškarci (77,8%), što ne iznenađuje imajući u vidu činjenicu da šumarstvo, na univerzitetskom nivou obrazovanja, tradicionalno privlači više muškaraca (Tabela 2). Prethodna istraživanja na ovu temu (Mutabdžija, 2012 ibid) su imala skoro identične rezultate kojima se potvrđuje više učešće pripadnika muške populacije u sektoru šumarstva FBiH. Kada je riječ o prosječnoj starosnoj dobi ispitanika, rezultati istraživanja ukazuju da ona iznosi 41 godinu, dok je najmlađi ispitanik imao 22 godine, a najstariji 65 godina. U starosnoj strukturi uposlenika najviše je zastupljeno mladih uposlenika u kategoriji od 20-40 godina (57,46%), 12,11% ispitanika je u srednjoj životnoj dobi, dok je više od 30% ispitanika u starosnoj kategoriji od 51-65 godina (30,43%). Dobijeni rezultati u ovom istraživanju su slični rezultatima do kojih se došlo u prethodnim istraživanjima (Mutabdžija, 2012 ibid). Rezultati također pokazuju da su najbrojnija grupa u uzorku inžinjeri šumarstva sa četverogodišnjim obrazovanjem (67,80%). Na drugom mjestu po zastupljenosti su Masteri šumarstva sa skoro jednom petinom ispitanika (19,70%). Na trećem mjestu se nalaze Bachelori šumarstva sa 6,90%, na četvrtom mjestu je grupa ispitanika koja pripada magistrima šumarskih nauka sa 5% i na petom mjestu su zastupljeni doktori šumarskih nauka sa 0,6%. U budućnosti se može očekivati smanjivanje broja inžinjera u ukupnom broju visokoobrazovanih šumarskih stručnjaka u FBiH, kako budu odlazili u penziju, njihova mjesta će zauzimati Masteri šumarstva, jer se četverogodišnji studij šumarstva više ne izvodi na području FBiH. Za razliku od prethodno provođenih istraživanja (Mutabdžija, 2012, ibid) važno je napomenuti da je u javnim preduzećima šumarstva broj Bachelora šumarstva u porastu. Osim toga, većina diplomiranih šumarskih stručnjaka (86,9%) zaposlena je u javnim preduzećima šumarstva u FBiH, dok je 13,1% ispitanika zaposleno u institucijama javne šumarske administracije. Prosječan broj godina radnog iskustva visokoobrazovanih šumarskih stručnjaka u sektoru šumarstva FBiH iznosi 13,7 godina, a ispitanik sa najviše godina radnog iskustva ima 38 godina radnog staža. Podaci koji se odnose na starosnu strukturu i radno iskustvo ispitanika imaju poseban značaj za planiranje obrazovne politike visokoškolskih institucija iz oblasti šumarstva u BiH. Visok procent mlađe populacije među inžinjerima/masterima šumarstva ukazuje da će u skoroj budućnosti broj dostupnih mjesta za upošljavanje biti ograničen, što može direktno uticati na broj studenata koji upisuju Šumarski fakultet, jer će se po završetku studija teže zapošljavati. Stoga je, u kontekstu planiranja daljeg razvoja sektora šumarstva i upisne politike na univerzitetskom nivou, neophodno kontinuirano analizirati broj dostupnih radnih mjesta u sektoru šumarstva FBiH, starosnu strukturu uposlenika, te potrebna znanja i vještine za provođenje aktivnosti upravljanja i gospodarenja šumskim resursima. Ovi podaci imaju višestruki značaj jer omogućavaju prilagođavanje nastavnih i naučnih aktivnosti trenutnim izazovima u gospodarenju šumama poput klimatskih promjena, povećanja rizika od katastrofa, dekarbonizacije, obnovljivih izvora energije, kao i zahtjeva za povećanje površina zaštićenih područja.

Tabela 3. Socio-demografske karakteristike ispitanika (n=360)

Table 3. Socio-demographic characteristics of the respondents (n=360)

Varijabla	Kategorija	Učešće ispitanika (%)
Spol	Muški	77,8
	Ženski	22,2
Starost	20-30 godina	21,7
	31-40 godina	35,8
	41-50 godina	12,1
	51-60 godina	27,9
	Više od 60 godina	2,5
Obrazovanje	Bachelor	6,9
	Diplomirani inžinjer	67,8
	Magistar šumarstva	19,7
	Magistar šumarskih nauka	5
	Doktor šumarskih nauka	0,6
Radno iskustvo	Do 10 godina	47,6
	11-20 godina	25,2
	21-30 godina	19,9
	Više od 30 godina	7,3
Tip institucije	Javno preduzeće šumarstva	86,9
	Javna šumarska administracija	13,1



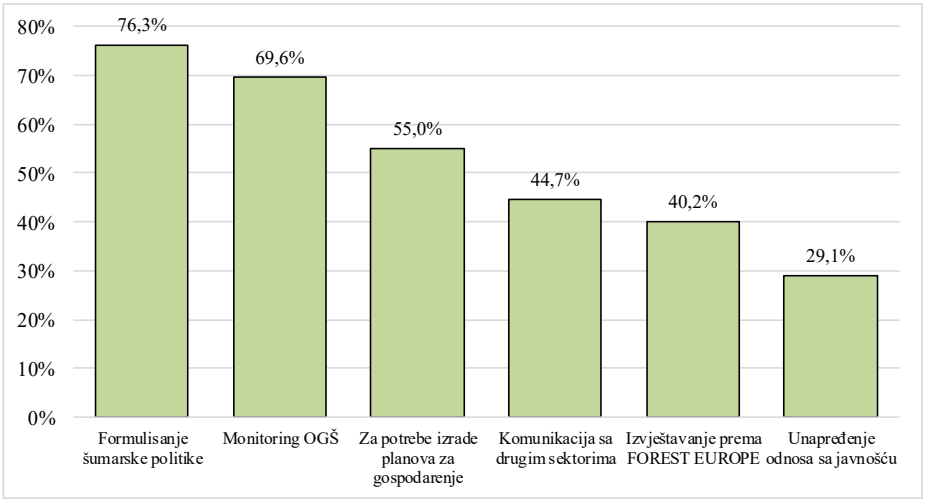
Grafikon 1. Izvori informacija o Pan-europskim kriterijima održivog gospodarenja šumama

Graph 1. Sources of information on Pan-European criteria for sustainable forest management

Respondents' awareness of the content and purpose of the Pan-European criteria and indicators - *Informiranost ispitanika o sadržaju i svrsi Pan-europskih kriterija i indikatora*

Na Grafikonu 1 je prikazana distribucija ispitanika prema načinu informiranja o Pan-europskim kriterijima održivog gospodarenja šumama. Ovdje je važno napomenuti da su ispitanici imali mogućnost odabira više ponuđenih odgovora na pitanje. Većina ispitanika (66,8%) se između ostalog, informirala o Pan-europskim kriterijima održivog gospodarenja šumama preko Internet izvora. Na drugom mjestu su ispitanici koji su se informirali o Pan-europskim kriterijima održivog gospodarenja šumama tijekom studija na fakultetu. Grupa ispitanika koja se informirala o Pan-europskim kriterijima održivog gospodarenja šumama iz stručnih časopisa zauzima 46,5%. Potom slijede ispitanici koji su se informirali iz elektronskih medija (34,9%), ispitanici koji su informacije dobili od kolega (31,1%), ispitanici koji su se informirali iz naučnih radova (29%), te ispitanici koji su se informirali iz stručnih izvještaja (28,6%), ostalih časopisa (24,5%) i preko dnevnih novina (23,7%). Uzimajući u obzir činjenicu da je Internet u današnje vrijeme dostupan svima, onda i ne iznenađuje rezultat da je najviše ispitanika do informacija o Pan-europskim kriterijima održivog gospodarenja šumama došlo putem Interneta gdje su svima dostupne informacije.

Na Grafikonu 2 su prikazani odgovori ispitanika na pitanje u koje svrhe bi se mogao koristiti set Pan-europskih kriterija i indikatora održivog gospodarenja šumama. Najviše ispitanika (76,3%) je odgovorilo da bi se set Pan-europskih kriterija i indikatora održivog gospodarenja šumama mogao koristiti za formulisanje šumarske politike, dok 29,1% ispitanika smatra da bi se set Pan-europskih kriterija i indikatora održivog gospodarenja šumama mogao koristiti za unapređenje odnosa sa javnošću. Relativno visok procent odgovora ukazuje da ovaj set ima višestruku mogućnost primjene i može poslužiti za kreiranje efektivne šumarske politike i pripadajućih upravljačko-gospodarskih aktivnosti. Prema Rametsteineru postoje dva načina korištenja indikatora održivog gospodarenja šumama: prikupljanje podataka i korištenje podataka za formulisanje politika. Glavni korisnici informacija koje se prikupljanju u okviru indikatora održivog gospodarenje šumama u kontekstu šumarske politike su vladine organizacije (javna šumarska administracija i preduzeća, institucije za zaštitu okoliša, institucije koje se bave statističkim izvještavanjem, vlasnici šuma i interesne skupine vlasnika šuma i interesne grupe koje se bave zaštitom okoliša). Sve prethodno navedene interesne grupe mogu koristiti podatke koji se prikupljaju u okviru indikatora održivog gospodarenja šumama u različite svrhe i na različitim administrativnim nivoima: međunarodni, regionalni, nacionalni, subnacionalni kao i na nivou šumsko gospodarskog područja (Rametsteiner, 2001). Glavna svrha korištenja kriterija i indikatora je bila komunikacija o napretku o održivom gospodarenju šumama unutar zajednice šumarske politike. Kriteriji i indikatori se smatraju korisnim alatom za promociju praksi održivog gospodarenja šumama kao integralni dio koncepta održivog razvoja kroz: pružanje konceptualnog okvira koji karakterizira bitne komponente održivog gospodarenja šumama, procjenu stanja šuma i njihovog gospodarenja, a kroz to procjenu napretka u postizanju održivog gospodarenja šumama, identificiranje trendova, promjena i prijetnji u gospodarenju šumama, utvrđivanje efekata gospodarenja šumama tijekom vremena, olakšavanje donošenja odluka u nacionalnim procesima šumarske politike, pružanje referentnog okvira za formulaciju i evaluaciju nacionalnih šumarskih politika i programa i identificiranje poticajnih uvjeta i mehanizama, uključujući finansijske i tehničke resurse koji utječu na nacionalnu implementaciju kriterija i indikatora (Linser et al, 2015).



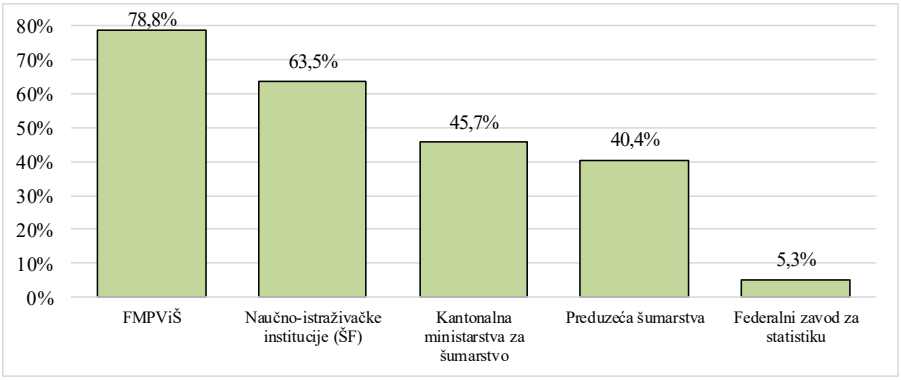
Grafikon 2. Svrha Pan-europskih kriterija i indikatora održivog gospodarenja šumama

Graph 2. The purpose of the Pan-European criteria and indicators of sustainable forest management

Institutional aspects for the use of Pan-European criteria and indicators – *Institucionalni aspekti za upotrebu Pan-europskih kriterija i indikatora*

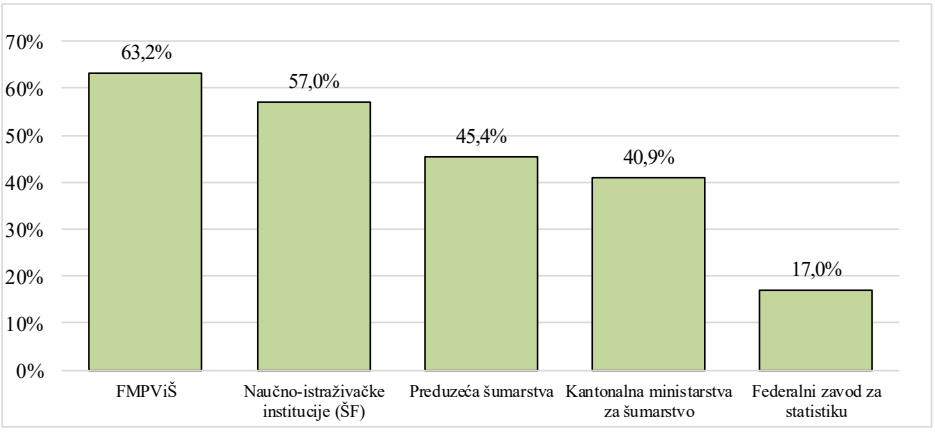
Kada je riječ o mišljenju ispitanika koja institucija bi na nivou FBiH trebala biti nadležna za razvoj seta Pan-europskih kriterija i indikatora održivog gospodarenja šumama, rezultati pokazuju da ispitanici (78,8%) smatraju da bi Federalno ministarstvo poljoprivrede vodoprivrede i šumarstva (FMPVŠ) trebalo biti nadležno za njihov razvoj (Grafikon 3). Obzirom da je istraživanje provedeno na nivou FBiH ovakvi rezultati su očekivani jer je ministarstvo nadležno za pitanja šumarstva i pozicionirano da ima nadležnosti za proces razvoja kriterija i indikatora održivog gospodarenja šumama FBiH. Sa druge strane ispitanici (63,5%) su mišljenja da u procesu razvoja seta Pan-europskih kriterija i indikatora održivog gospodarenja šumama trebaju biti uključene i naučno-istraživačke institucije kao što je Šumarski fakultet u Sarajevu. Pored prethodno navedenih institucija, u procesu razvoja seta Pan-europskih kriterija i indikatora održivog gospodarenja šumama bi trebala biti uključena i kantonalna ministarstva nadležna za šumarstvo (45,7%), preduzeća šumarstva (40,4%) koja bi imala ulogu institucija koje prikupljanju podatke i šalju ih kantonalnim ministarstvima na obradu, a nakon toga podaci bi trebali biti proslijeđeni FMPVŠ. Važno je napomenuti da su ispitanici kao jednu od institucija koja bi trebala biti nadležna u ovom procesu između ostalog, u malom procentu (5,3%) naveli i Federalni zavod za statistiku. Zanimljivo je da ispitanici nisu naveli niti jednu drugu kategoriju kao što su nevladine organizacije i profesionalna i stručna udruženja i druge institucije izvan sektora šumarstva. Zasigurno je da bi osiguranje učešća više institucija doprinijelo transparentnosti, kvalitetu i kredibilitetu seta kriterija i indikatora održivog gospodarenja šumama u FBiH, i na taj način omogućilo i unaprijedilo međusektorsku komunikaciju i saradnju.

Kao i u prethodnom pitanju ispitanici su dali dosta slične odgovore na pitanje koja bi institucija u FBiH trebala biti nadležna za prikupljanje podataka u okviru seta Pan-europskih kriterija i indikatora održivog gospodarenja šumama (Grafikon 4). Većina ispitanika (63,2%) je između ostalog odgovorila da bi to trebalo biti FMPVŠ, na drugom mjestu su naučno-istraživačke institucije (57%), na trećem mjestu su preduzeća šumarstva (45,4%), na četvrtom mjestu su kantonalna ministarstva nadležna za šumarstvo (40,9%) i na kraju se nalazi Federalni zavod



Grafikon 3. Nadležnost za razvoj seta Pan-europskih kriterija i indikatora održivog gospodarenja šumama u FBiH

Graph 3. Competence for the development of a set of Pan-European criteria and indicators of sustainable forest management in FBiH



Grafikon 4. Nadležnost za prikupljanje podataka o Pan-europskim kriterijima i indikatorima

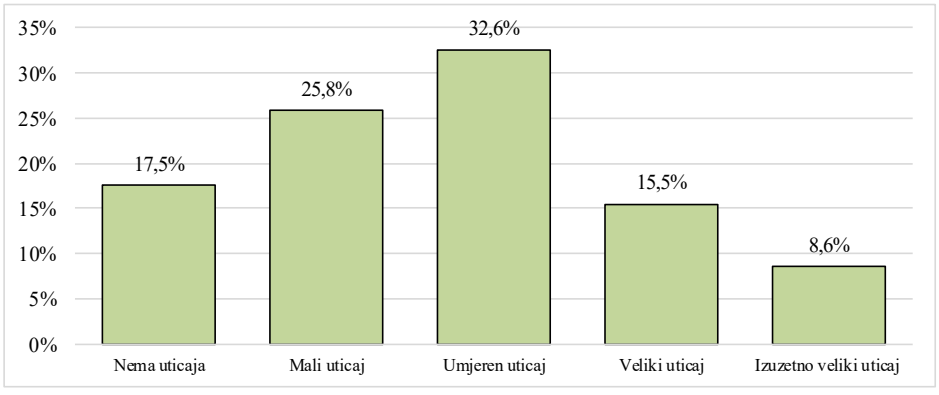
Graph 4. Competence to collect data on Pan-European criteria and indicators

za statistiku, sa 17% odgovora ispitanika. Iz prethodna dva grafikona može se zaključiti da ispitanici smatraju da bi FMPVŠ, kao krovna institucija u sektoru šumarstva FBiH, trebalo biti nadležna institucija za upravljanje procesima razvoja seta kriterija i indikatora održivog gospodarenja šumama u FBiH, te predvoditi proces prikupljanja i obrade neophodnih podataka. Ostale institucije bi trebale biti uključene u taj proces i pružati podršku prilikom prikupljanja i obrade podataka. Naravno to podrazumijeva da bi na kraju svi bili korisnici tih podataka, kako na nivou preduzeća, tako i na nivou FBiH.

Necessary capacities and prerequisites for the application of Pan-European criteria and indicators in the FBiH forestry sector - *Neophodni kapaciteti i preduslovi za primjenu Pan-europskih kriterija i indikatora u sektoru šumarstva FBiH*

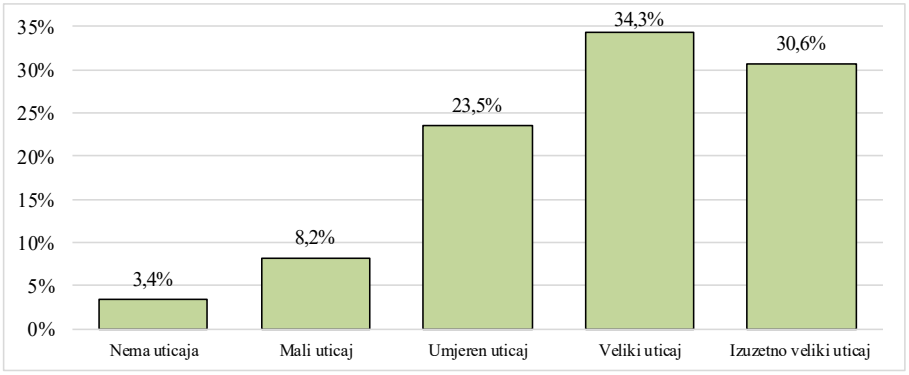
Na Grafikonu 5 su prikazani stavovi ispitanika po pitanju koliko nedostatak ljudskih resursa u FMPVŠ u smislu broja uposlenika utiče na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama. Većina ispitanika (32,6%) se izjasnila da nedostatak ljudskih resursa ima umjeren uticaj. Sa druge strane, 43,3% ispitanika smatra da nedovoljan broj uposlenika u ministarstvu nema ili ima jako mali uticaj na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama, dok skoro jedna četvrtina ispitanika (24,1%) smatra da nedovoljan broj uposlenika ima veliki i izuzetno veliki uticaj na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama. Taj negativan uticaj se ogleda u činjenici da nitko od postojećih uposlenika nema kontinuiran fokus na kriterije i indikatore održivog gospodarenja šumama na način da prati međunarodne procese i trendove u procesima primjene razvoja i implementacije kriterija i indikatora održivog gospodarenja šumama i da ih kao takve prezentira visokoobrazovanim šumarskim stručnjacima u FBiH s ciljem ukazivanja na prednosti korištenja istih.

Situacija je sasvim drugačija kada je riječ o uticaju dostupnih finansijskih sredstava na primjenu seta Pan-europskih kriterija i indikatora održivog gospodarenja šumama. Na Grafikonu 6 su prikazani odgovori ispitanika po pitanju koliko nedostatak finansijskih resursa utiče na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama. Većina ispitanika (64,9%) smatra da nedostatak finansijskih sredstava ima veliki i izuzetno veliki uticaj na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama. Skoro jedna četvrtina (23,5%) ispitanika je odgovorila da nedostatak finansijskih sredstava ima umjeren uticaj, dok 11,6% ispitanika smatra da nedostatak finansijskih sredstava



Grafikon 5. Uticaj ljudskih resursa na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama

Graph 5. The influence of human resources on the application of Pan-European criteria and indicators of sustainable forest management



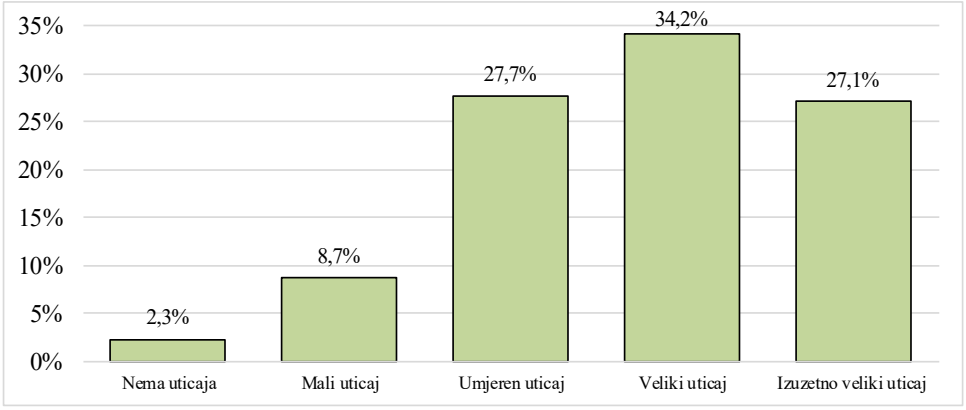
Grafikon 6. Uticaj finansijskih resursa na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama

Graph 6. The influence of financial resources on the application of Pan-European criteria and indicators of sustainable forest management

nema uticaj ili ima mali uticaj na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama. Ovakvi rezultati se mogu tumačiti na način da su ispitanici svjesni činjenice da je finansijska podloga preduvjet za implementaciju bilo kakvog procesa u sektoru šumarstva u kojem se promjene događaju uglavnom izazvane pokretačima izvana, kao što su međunarodne organizacije ili EU koje obezbjeđuju novac za implementaciju procesa bilo na nivou države ili na nivou entiteta.

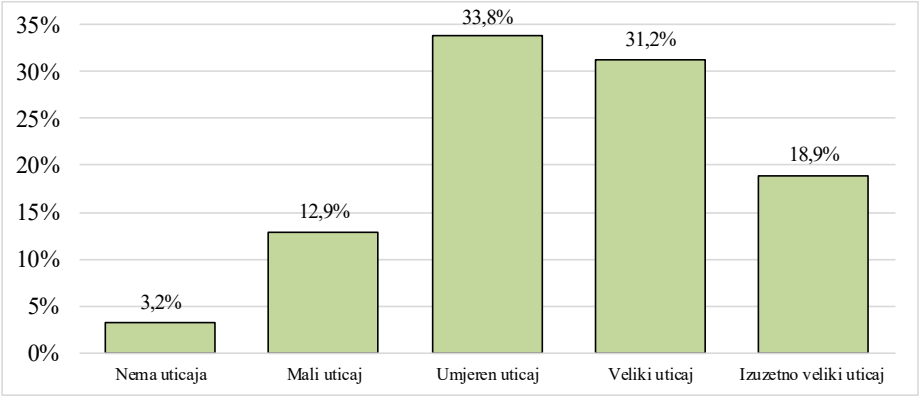
Grafikon 7 sadrži odgovore ispitanika na pitanje koliko nedostatak stručnih znanja utiče na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama. Većina ispitanika (61,3%) smatra da nedostatak stručnih znanja negativno utiče na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama na način da ima veliki i izuzetno veliki uticaj. Nešto više od jedne četvrtine ispitanika (27,7%) smatra da nedostatak stručnih znanja ima umjeren uticaj, dok 11% ispitanika smatra da nedostatak stručnih znanja nema ili ima mali uticaj na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama. Ovaj nedostatak bi se mogao otkloniti na način da se unaprijedi nastavni plan i program studija šumarstva na način da ova tematika koja se odnosi na kriterije i indikatore održivog gospodarenja šumama bude zastupljenija i da se ova dinamična materija stalno ažurira u smislu praćenja međunarodnih trendova u razvoju i evoluciji kriterija i indikatora održivog gospodarenja. Ukoliko bi se izrazio interes za prevazilaženjem ovog nedostatka, isti bi se mogao riješiti kroz cjeloživotno učenje odnosno organiziranje specijalističkih i tematskih edukacija na nivou šumarskih preduzeća i javne šumarske administracije u FBiH.

Na Grafikonu 8. su prikazani stavovi ispitanika po pitanju koliko nedostupnost podataka utiče na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama. Većina ispitanika (50,1%) smatra da nedostupnost podataka, kada je riječ o pojedinim kriterijima i njihovim pripadajućim indikatorima, ima veliki i izuzetno veliki uticaj na primjenu Pan-europskih kriterija održivog gospodarenja šumama. Više od jedne trećine ispitanika (33,8%) smatra da nedostupnost podatka ima umjeren uticaj, dok 16,1% ispitanika smatra da nema ili je mali uticaj na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama. Nedostupnost podataka se može ogledati u činjenici da se podaci za određene kriterije i njihove pripadajuće indikatore uopće ne prikupljaju ili su ti podaci ukoliko i postoje „raspršeni" na više mjesta, odnosno institucija, što otežava i smanjuje dostupnost istih. Kada bi na području FBiH imali usvojen set kriterija i indikatora održivog gospodarenja šumama, za potrebe istog bi se prikupljali podaci koji bi mogli poslužiti za procjenu napretka u procesu održivog gospodarenja šumama.



Grafikon 7. Uticaj stručnih znanja na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama

Graph 7. The influence of expert knowledge on the application of Pan-European criteria and indicators of sustainable forest management



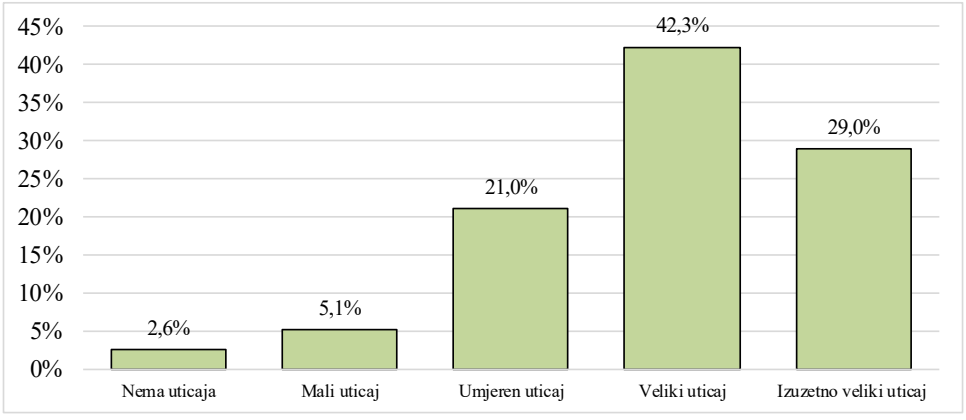
Grafikon 8. Uticaj nedostupnosti podataka na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama

Graph 8. Impact of unavailability of data on the application of Pan-European criteria and indicators of sustainable forest management

Kada je riječ o posvećenosti implementiranju Pan-europskih kriterija i indikatora održivog gospodarenja šumama na Grafikonu 9 su prikazani sljedeći odgovori: 71,3% ispitanika smatra da nedostatak posvećenosti ima veliki i izuzetno veliki uticaj na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama, nešto manje od jedne četvrtine ispitanika (21%) smatra da nedostatak posvećenosti ima umjeren uticaj, dok 7,75 ispitanika smatra da nedostatak posvećenosti nema ili ima mali uticaj na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama. U trenutnim društveno političkim realitetima FBiH, posvećenost primjeni kriterija i indikatora održivog gospodarenja šumama je na jako niskom nivou, jer većina ispitanika smatra da se mora primjenjivati samo ono što je predviđeno i propisano u zakonskim rješenjima. Prije svega, to se odnosi na nedostatak institucionalne podrške za primjenu modernih i inovativnih pristupa u upravljanju i gospodarenju šumama koji su dio praksi održivog gospodarenja šumskim resursima.

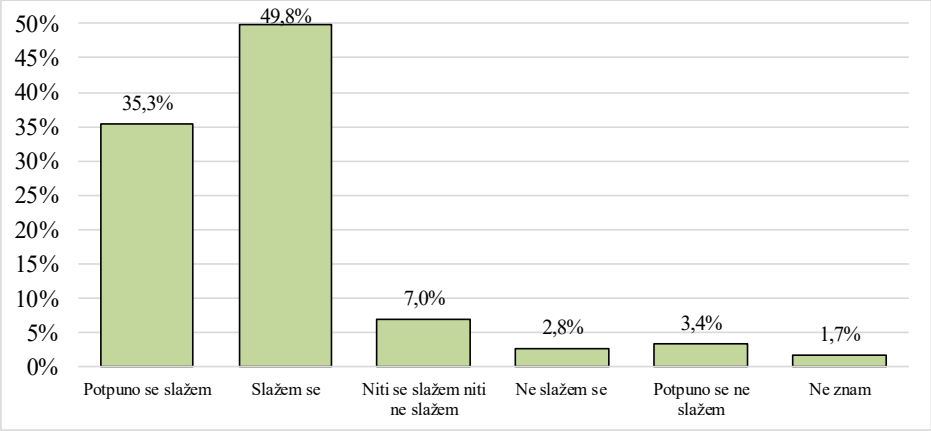
The possibility of contributing Pan-European criteria and indicators to the improvement of the situation in the FBiH forestry sector - *Mogućnost doprinosa Pan-europskih kriterija i indikatora unaprjeđenju stanja u sektoru šumarstva FBiH*

Odgovori većine ispitanika (85,1%) prikazani na Grafikonu 10 potvrđuju izjavu da primjena Pan-europskih kriterija i indikatora održivog gospodarenja šumama može doprinijeti unapređenju stanja sektora šumarstva u FBiH. Unapređenje u sektoru šumarstva FBiH ispitanici vide kroz organizirani i strukturirani način prikupljanja podataka koji se odnose na sektor šumarstva, koji se stalno ažuriraju i javno su dostupni svima na jednom mjestu. Trenutna situacija je sasvim drugačija na način da se dio podataka prikuplja i objavljuje u Informaciji o gospodarenju šumama koju na godišnjem nivou priprema FMPVŠ. Na ovaj način bi se kroz sveobuhvatno prikupljanje podataka moglo doći do realne slike u sektoru šumarstva FBiH i u skladu sa tim na odgovarajući i realan način planirati trendovi razvoja sektora šumarstva FBiH.



Grafikon 9. Uticaj nedostatka posvećenosti na primjenu Pan-europskih kriterija i indikatora održivog gospodarenja šumama

Graph 9. The impact of lack of commitment on the application of Pan-European criteria and indicators of sustainable forest management



Grafikon 10. Doprinos Pan-europskih kriterija i indikatora održivog gospodarenja šumama unapređenju stanja sektora šumarstva u FBiH

Graph 10. Contribution of Pan-European criteria and indicators of sustainable forest management to the improvement of the state of the forestry sector in FBiH

CONCLUSIONS – *Zaključci*

Pojmovi održivi razvoj i održivost su postali imperativi u svakom razvojnom procesu posljednjih nekoliko decenija. Zadovoljavanje sociooloških, ekoloških, ekonomskih, etičkih, pravnih i političkih aspekata društva i koncepta održivosti, podrazumijeva društveni i ekonomski razvoj uz odgovorno korištenja prirodnih resursa. Kroz napredak i razvoj ljudskog društva, došlo se do spoznaje da je potrebno mjeriti napredak u održivom razvoju i održivom korištenju prirodnih resursa. Zbog toga je pokrenut proces definiranja i razvoja kriterija i indikatora za održivi razvoj, a nakon toga i kriterija i indikatora održivog gospodarenja šumskim resursima. Na području Europe, Pan-europski kriteriji i indikatori održivog gospodarenja šumama su jako važni za promoviranje održivog gospodarenja šumskim resursima, a samim tim i definiranje smjernica šumarske politike. Primjenom kriterija i indikatora održivog gospodarenja šumskim resursima prikupljaju se vrijedne informacije pomoću kojih se razvija i primjenjuje šumarska politika (bilo da se radi o globalnoj, nacionalnoj ili subnacionalnoj razini), te razvijaju i primjenjuju dugoročne strategije i planovi u sektoru šumarstva.

Rezultati istraživanja su pokazali da u slučaju FBiH, nadležna institucija za razvoj seta kriterija i indikatora održivog gospodarenja šumama treba da bude FMPVŠ. Ovakvi rezultati su očekivani jer je ovo Ministarstvo nadležno za pitanja šumarstva i ima nadležnosti za proces razvoja kriterija i indikatora održivog gospodarenja šumama. Imajući u vidu potrebu osiguranja transparentnosti i participacije kompletnog procesa, ispitanici su se izjasnili da bi i druge institucije (naučno-istraživačke institucije kao što je Šumarski fakultet u Sarajevu, kantonalna ministarstva nadležna za šumarstvo, preduzeća šumarstva) trebale biti uključene u razvoj i usvajanje seta kriterija i indikatora održivog gospodarenja šumama u FBiH. Do sličnih rezultata se došlo i kada je riječ o nadležnosti institucije za prikupljanje podataka u okviru seta Pan-europskih Kriterija i indikatora održivog gospodarenja šumama. Na osnovu stavova ispitanika se može zaključiti da FMPVŠ, kao krovna institucija u sektoru šumarstva FBiH, treba biti pokretač procesa razvoja seta kriterija i indikatora održivog gospodarenja šumama. Ostale institucije (naučno-istraživačke institucije kao što je Šumarski fakultet u Sarajevu, kantonalna ministarstva nadležna za šumarstvo, preduzeća šumarstva, Federalni zavod za statistiku) bi trebale biti sudionici u tom procesu i pružati podršku prilikom prikupljanja i analize podataka koji se odnose na održivo gospodarenje šumama. U skladu s tim sve uključene institucije bi koristile prikupljene podatke, kako na nivou kantona, tako i na nivou FBiH.

Na osnovu rezultata istraživanja može se zaključiti da su najveće prepreke primjeni seta Pan-europskih kriterija održivog gospodarenja šumama u FBiH, nedostatak finansijskih resursa, nedostatak stručnih znanja i nedostatak posvećenosti primjeni Pan-europskih kriterija i indikatora održivog gospodarenja šumama. Da bi došlo do bilo kakve pozitivne promjene u sektoru šumarstva FBiH potrebna su finansijska sredstva koja se najčešće obezbjeđuju kroz angažman međunarodnih organizacija ili Europske Unije. Nažalost, još uvijek je u BiH, pa samim tim i u FBiH, praksa da neka institucija ili proces sa međunarodnog nivoa bude pokretač reformskih procesa, osigura transfer znanja, pozitivnih praksi i iskustava. Nedostatak stručnih znanja o Pan-europskim kriterijima i indikatorima održivog gospodarenja šumama bi se mogao riješiti unaprjeđenjem nastavnih planova i programa i kroz organiziranje specijalističkih i tematskih edukacija na nivou šumarskih preduzeća i javne šumarske administracije u FBiH.

U trenutnim društveno političkim realitetima u FBiH, i stanju u kojem se nalazi sektor šumarstva, posvećenost primjeni kriterija i indikatora održivog gospodarenja je

na niskom nivou. Većina ispitanika smatra da se moraju implementirati samo one aktivnosti koje su predviđene i propisane zakonskim rješenjima, i postoji relativno mala spremnost za uključivanje u proces cjeloživotnog učenja i usavršavanja. Relativno visoka opterećenost svakodnevnim obavezama u procesu gospodarenja šumama, doprinosi niskom nivou zainteresiranosti stručnjaka šumarstva za dodatno usavršavanje i usvajanje inovativnih praksi gospodarenja šumama koje su u skladu sa principima modernog održivog razvoja. Stoga se može zaključiti da je neophodno kreirati i implementirati edukativne aktivnosti kojima bi se naglasio značaj održivog gospodarenja šumama, unaprijedila znanja i stekle vještine za odgovor na trenutne okolišne i razvojne izazove kao što su klimatske promjene, povećanje rizika od katastrofa i inicijative za povećanje površina zaštićenih područja. Primjena seta Pan-europskih kriterija i indikatora održivog gospodarenja šumama u šumarstvu FBiH ovisi od spremnosti i kapaciteta javne šumarske administracije. Kroz istraživanja se došlo do zaključaka da su predstavnici javne šumarske administracije deklarativno spremni da primjene prethodno navedeni set, ali su njihovi kapaciteti, znanja i mogućnosti jako skromni po tom pitanju, što odmah onemogućuje stvarnu implementaciju u praksi. Ovo upućuje na potrebu izgradnje kapaciteta javne šumarske administracije u FBiH u budućnosti u cilju odgovarajućeg poznavanja, razumijevanja i primjene seta Pan-europskih kriterija i indikatora održivog gospodarenja šumama.

Većina ispitanika smatra da primjena Pan-europskih kriterija i indikatora održivog gospodarenja šumama može doprinijeti unapređenju stanja sektora šumarstva u FBiH. Trenutna decentralizirana organizacija sektora šumarstva ne daje mnogo mogućnosti za organizirano i sistematično prikupljanje podataka. To je posljedica nedostatka nadležnosti krovnih institucija u sektoru šumarstva FBiH i njihove nemogućnosti da prikupe osnove podatke za cijelu FBiH. Da bi se to promijenilo potrebno je da se uvede drugačiji vid organiziranog i sistematičnog načina prikupljanja podataka o održivom gospodarenju šumama u FBiH, što bi rezultirao bazom podataka koja se stalno ažurira i javno je dostupna svim šumarskim institucijama na jednom mjestu i adresi. Trenutno se dio podataka prikuplja i objavljuje u Informaciji o gospodarenju šumama koju na godišnjem nivou priprema FMPVŠ. Uspostavom sveobuhvatne i ažurirane baze podataka, osiguralo bi se prikupljanje podataka o održivom gospodarenju šumama koristeći Pan-europski set kriterija i indikatora održivog gospodarenja šumama kao okvir, a samim tim dobila realna i potpuna slika sektora šumarstva FBiH, na osnovu čega bi se na adekvatan i realan način mogli planirati strateški pravci razvoja sektora šumarstva FBiH. Primjena Pan-europskih kriterija i indikatora održivog gospodarenja u sektoru šumarstva FBiH je korisna za konzistentno i sistematsko sagledavanje stanja u sektoru šumarstva. Za primjenu ovog seta potrebno je raditi na razvijanju i usvajanju nacionalnog ili subnacionalnog seta kriterija. U cilju olakšavanja tog procesa važno je naglasiti da u BiH postoje značajna iskustva po pitanju primjene FSC Principa, kriterija i indikatora održivog razvoja šumama kojim se sektor šumarstva približio međunarodnim standardima održivog gospodarenja šumama. Neophodno je poštivanje principa transparentnosti i participacije u procesu razvoja i usvajanja seta kriterija i indikatora održivog gospodarenja šumama, na bazi lekcija naučenih iz procesa razvoja i usvajanja FSC standarda za održivo gospodarenje šumama u BiH.

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SUMMARY

In recent decades, irresponsible and excessive use of natural resources for economic profit has led to numerous environmental disturbances, including climate change, biodiversity loss, habitat degradation, and pollution of soil and water. These issues negatively impact the natural resources and entire human population. Pan-European criteria and indicators for sustainable forest management provide a tool for monitoring progress and reporting on the sustainability of forest management at subnational, national and regional levels. However, the Federation of Bosnia and Herzegovina (FBiH) currently lacks an adopted set of these criteria and indicators for sustainable forest management. This paper analyzes institutional aspects and possibilities of application of Pan-European criteria and indicators for sustainable forest management in FBiH's forestry sector. A survey of 360 forestry experts from public forest administration and public forest companies in FBiH revealed that most respondents, predominantly men averaging 41 years old with 13 years of experience, believe that applying set of Pan-european criteria and indicators can improve the forestry sector. Over 85% of the surveyed experts support their implementation. The research identified the Ministry of Agriculture, Water Management, and Forestry of FBiH as the responsible institution for developing and collecting data on these criteria and indicators for sustainable forest management. Other institutions (scientific research institutions such as the Faculty of Forestry in Sarajevo, cantonal ministries responsible for forestry, forestry companies, the Federal Bureau of Statistics) should be participants in that process and provide support during the collection and analysis of data related to sustainable forest management. Accordingly, all involved institutions would be beneficiaries of the collected data, both at the canton level and at the FBiH level.

However, significant obstacles to implementation include a lack of financial resources, professional knowledge, and commitment of forestry professonals for implementation of Pan-european criteria and indicators for sustainable forest management. Although the public forest administration shows a declarative readiness to implement the Pan-european criteria and indicators, their current capacities are insufficient for effective implementation. This highlights the need to build the capacity of the public forest administration to ensure proper knowledge, understanding, and application of the Pan-European criteria and indicators for sustainable forest management in FBiH. The application of Pan-European criteria and indicators for sustainable forest management in the FBiH forestry sector is useful for a consistent and systematic overview of the situation in the forestry sector. For the application of a set of Pan-European criteria and indicators of sustainable forest management, it is necessary to work on the development and adoption of a national or subnational set of criteria and indicators for sustainable forest management. The application of the set of Pan-European criteria and indicators of SFM can be seen as an instrument for harmonization of forest policy in BiH, and also can provide a unique framework for the collection of data and reporting on SFM in BiH in order to implement realistic planning of strategic directions for development of forest sector in FBiH.

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ORIGINAL SCIENTIFIC PAPER

Productivity of HSM 208F forwarder in selective cutting and mountainous area

Produktivnost HSM 208F forvardera u prebirnim sječama i planinskom području

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ABSTRACT

Forwarders have been used in the forest harvesting in the world for decades and are irreplaceable in the first phase of wood transportation. The use of forwarders in Bosnia and Herzegovina is still in its initial phase. Although they are used sporadically, there are still many uncertainties about the operation of forwarders in selection stands. Especially if we take into account that the current practice is that machinery in the stand is allowed to move only along pre-defined routes, trail. This practice has been used for years with winch skidders. In this research, which was carried out in selective cutting and mountainous areas, it was determined that the most important influencing factors on the productivity of the forwarder is the unloaded drive distance, loaded drive distance and distance of load collecting drive. The productivity of 7.17 m^3/h was determined for a loaded drive distance of 700 m and load collecting distance of 200 m. Forwarders require a different forest infrastructure than skidders if we want them to have competitive productivity.

Key words: *forwarder, influencing factors, productivity*

INTRODUCTION – *Uvod*

Forwarders are self-propelled vehicles intended for the transport of trees or their parts loaded in the vehicle bunk area. The development of the first forwarder started in Sweden around 1950s. Forwarders were originally used in cut-to-length timber harvesting, where the felling of trees was performed by harvester, and extracting by forwarder. In different countries, forwarders are used in difference ways. For example, in Croatian forestry forwarders are mostly used in lowland forests, particularly for the extraction of timber from shelterwood felling and late thinning (Poršinsky, 2002). From a scientific point of view, the research of forest operations includes the study of timber harvesting, ergonomics, mechanization, construction, economic aspect and planning of operations, all within the framework of a sustainable forestry development (Samset, 1992). The research of forestry operations, and hence also timber forwarding, is based on time study and on monitoring the influencing (quality and quantity) factors, data analysis, and mathematical mo-

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delling of time consumption of individual components of the working process (Samset, 1990). Similarly as other forms of timber extraction, forwarding also has the characteristics of a cyclic working process (Stankić et al., 2012). Forwarder efficiency is affected by numerous factors. The most important factors influencing the efficiency of timber forwarding is the travel distance (Sever, 1988). With the increase of the travel distance, the impact of the load volume on the vehicle productivity is also increased (Raymond, 1989). Apart from the forwarding distance, productivity is also affected by the average assortment volume, number of pieces in the load and quantity of timber on a felling site, which is more pronounced in thinning stands (Tufts and Brinker, 1993; Tufts, 1997). The highest share of time consumption in forwarder operations is related to the so-called terminal times, and namely loading and unloading of timber (Minette et al., 2004). Optimization of load volume and forwarding distance, and giving preference to downhill forwarding are the key factors for improving the productivity of forwarders (Tiernan et al., 2004). Terrain slope higher than 30% considerably decreases the productivity of forwarders because on such terrains vehicle mobility is limited (Zimbalatti and Proto, 2010). Terrain classification aimed at determining the optimum machine for timber extraction shows that in hilly-mountainous area the share of timber suitable for forwarding is considerable (Mihelič and Krč, 2008; Pentek et al., 2008). On steep terrain, up to 60%, it is possible to use forwarders with winch, the so-called cable forwarders (Kühmaier and Stampfer, 2010). The use of semi-tracks in conditions of limited soil bearing strength increases fuel consumption but provides vehicle mobility. Apart from travel distance, load volume and terrain conditions, forwarder productivity is also affected by the type of felling, length and type of assortment, driver's skill and knowledge, as well as characteristics of hydraulic crane and vehicle load space (White, 2004). The increase of the average assortment volume and terrain slope in travel direction (downhill forwarding) result in the decrease of time consumption (Ghaffarian et al. 2007). The density of secondary forest roads (forest trails) also affects the forwarding productivity (Mederski, 2006). Up to date planning methods, i.e. spatial optimization of working cycle shifts based on data on quantity and locations of assortments and possible travel areas of the felling site also increase the timber forwarding productivity (Flisberg et al., 2007). Comparative research of skidding/forwarding machines carried out in stands of small coniferous trees showed that, in terms of costs, figures speak in favour of timber forwarding, as forwarder productivity is twice higher than the productivity of the cable skidder with winch (Li et al., 2006). Forwarder efficiency depends on the type of the vehicle used, i.e. on its nominal carrying capacity, as forwarders of higher carrying capacity achieve lower costs and higher productivity per product unit (Jiroušek et al., 2007). Nowadays forwarders are not conceptually different from those of a half a century ago, but they have made serious progress in terms of environmental soundness, ergonomics and steering automation (Pandur et al., 2009). One of the ways to increase productivity is the use of dynamic system for changing the volume of the bunk area i.e. its height and width. Attaching the trailer with the loading space behind the rear end of the standard forwarder may increase the system productivity (Lindroos and Wasterlund, 2011). Investigations were performed of the use of »flats« or »swop bodies«, where timber is not unloaded from the forwarder nor loaded into the truck, as they are used with both kinds of transport, thus increasing productivity and simplifying primary transport of timber, but with increased costs.

Productivity of timber forwarding is higher than the productivity of timber skidding in lowland forests of Croatia, and the increase depends on stand and terrain conditions and ranges between 28 and 126% (Bojanin and Krpan, 1994). The operation of forwarders in Croatia, unlike the Scandinavian assortment method (CTL), makes no use of felling and processing machines. This is the effect of natural factors (natural forests, trees of large size, considerable share of broadleaved trees, etc.), but also of tradition (Bojanin and Krpan, 1997). One of the issue arising is the definition and determination of the mean distance of timber forwarding. Some authors consider that the distance of timber forwarding is the distance between the roadside landing and the point in the felling site when the bunk area is half loaded with timber (Nurminen et al. 2006). Accordingly, the mean distance of timber forwarding would be equal to the sum of travel distance of unloaded vehicle and half the travel in timber loading i.e. the travel between the loading points (Suvinen, 2006). According to Poršinsky (2002, 2005) and Stankić (2010) when investigating forwarders in Croatian lowland forests, the distance of timber forwarding was considered to be the arithmetic mean of the sum of distances travelled by fully loaded and unloaded forwarder, while the time consumption of the vehicle movement during loading process was defined depending on felling density, i.e. net timber volume per hectare. The forwarder classification is usually based on their loading capacity (payload) to light (<10 t), medium (10 t – 14 t) and heavy forwarders with the load capacity over 14 t (Brunberg, 2004).

Studies have shown also that the major determinants of forwarder productivity are extraction distance and load size (Spinelli et al., 2004; Tiernan et al., 2004; Ghaffariyan et al., 2012; Walsh and Strandgard, 2014). Other factors that have been found to impact forwarder productivity include log size (Kellogg and Bettinger, 1994; Plamondon and Pitt, 2013), log length (Gingras and Favreau, 2005), log pile size (Nurminen et al., 2006; Väätäinen et al., 2006), total wood volume (Nurminen et al. 2006) and assortment wood volume per strip road distance (Manner et al., 2013), number of assortments per load (Nurminen et al. 2006; Manner et al. 2013) and on the harvesting site, driving speed (Lileng, 2007) and slope (Tiernan et al., 2004).

Forwarders can be used on slope up to 45% (McEwan et al. 2013). The high centre of gravity restricts forwarders to operating up and down slope on steeper slopes (Visser and Stampfer, 2015) and the lack of traction restricts the maximum slope a forwarder can operate. Traction can be increased by using a forwarder with more wheels and using traction aids, such as band tracks (McEwan et al., 2013). Stangard et al. (2017) investigated performance of Valmet 890.3 on a slope terrain and cut-to-length harvesting system. They established productivity of 46 m^3/h and extraction distance and load volume as a statistically significant variable in productivity regression model. Slope did not have a significant impact on forwarder cycle time. The forwarder in this study had an 18 t nominal load capacity, and belongs to the group of heavy forwarders. That is one of the reasons for such a high productivity. Stankić et al. (2012) found that mean time consumption for heavy forwarders was 0.84 min/cycle, whereas for medium forwarders it amounted to 0.73 min/cycle. This phenomenon can be explained with the higher initial acceleration of medium forwarders. Additional time factor amounts to 1.33, or 33% of the effective time. Nurminen et al. (2006) also found extraction distance to be significantly related to travel empty time. Variation in loaded travel times was mainly due to the proportion of travel time that occurred in the stand, where travel speeds were significantly slower than on the trail. This proportion varied between cycles depending on the point in the stand at which the forwarder had collected a full load. Nurminen et al. (2006) also found that products with a lower log volume/ha had increased loading times as fewer logs were available at each loading stop. Moving during loading time has been found in some studies to be related to the loading distance, which in turn is dependent on the log concentration along the strip road (Nurminen et al., 2006; Manner et al., 2013).

The use of forwarders in Bosnia and Herzegovina is still in its initial phase. Although they are used sporadically, there are still many uncertainties about the operation of forwarders in selection stands. Especially if we take into account that the current practice is that machinery in the stand may only move along pre-defined routes, trail. This practice has been used for years with winch skidders. Forwarders require a different forest infrastructure if we want them to have competitive productivity. The goal of this research is to analyse the work of the HSM 208F forwarder that works in high forests in the mountainous area.

MATERIALS AND METHODS – *Materijal i metode*

Investigation was done in the area of municipality Ribnik, where state forests are managed by a company PFE "Šume Republike Srpske"; FA "Ribnik". Data collecting was done in compartment 10, which is located in the area of FU "Dimitor" (Table 1). The compartment has mountainous conditions, with an altitude of 1000-1300 m, a selective management system, and the dominant tree species is beech.

Table 1. Research site characteristics

Tabela 1. Karakteristike područja istraživanja

Forest Company	PFE "Šume Republike Srpske" FA "Ribnik" Ribnik
Compartment	10 FU "Dimitor"
Inclination	NW
Altitude	1000-1300 m
Soil	A combination of brown and acid brown soils on a series of silicate rocks
Stand	GK 1101 - High beech forests on deeply acidic silicate soils GK 4111 - Beech coppice forests on a series of predominantly deep limestone soils
Area	84.61 ha

The analysed forwarder is HSM 208F, owned by a private company that performs works for FA "Ribnik". HSM forwarder machines are available in various performance categories and versions. They feature a wide range of applications, long or short timber – hardwood or softwood – thick trees or thin. HSM has developed a modular system that permits the implementation of specific requirements. Medium-heavy forwarder HSM

Table 2. HSM 208F - specifications (www.hsm-forest.net)

Tabela 2. HSM 208F - specifikacije (www.hsm-forest.net)

Engine	Hydraulic system	Transmission	Loading area	Crane
VOLVO PENTA Power: 185 kW (252 HP) from 1600 rpm 1150 Nm from 1100 - 1500 rpm Max. torque: 1175 Nm at 1400 rpm Displacement: 7,7 liters	Load sensing Variable pump: flow rate: 304 l/min from 1600 rpm, pressure: up to max. 350 bar Hydraulic oil: saturated synthetic ester Panolin HLP SYNTH with Kleenoil microfiltration WGK 1	NAF 2 speed transfer gearbox; HSM High Speed Drive (series 71); speed at 1st gear 0-14 km/h	4 rungs Length: 4400 mm Cross section: 4,0 m^2 / Option 4,3 m^2 Load capacity: 11 t	EPSILON M70 F80 Lifting moment 102/68 kNm Range 8,0 m Gripper type FG43S

208F with eight wheels, has a nominal capacity of 11 t, whose overall dimensions and other characteristics are shown in the Figure 1. and Table 2. The weight distribution is such that 60% falls on the front and 40% on the rear axle. The cross-sectional area of the cargo area is 4.2 m^2, and the length is 4.4 m.

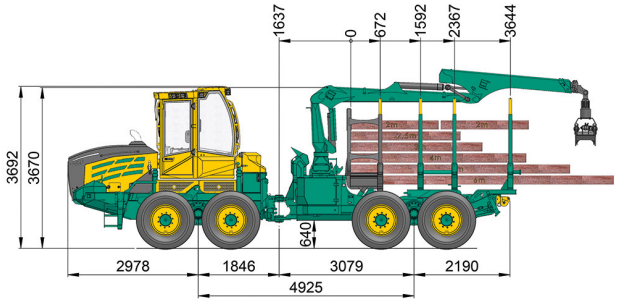


Figure 1. Dimensions of forwarder HSM 208F 11t (www.hsm-forest.net)

Slika 1. Dimenzije forvardera HSM 208F 11t (www.hsm-forest.net)

Extraction of timber by forwarders usually has the characteristics of cyclic work. Each cycle (turn) usually consists of five main work operations: unloaded drive, load collecting drive, loading, loaded drive and unloading. Other work components are added as an allowance time in the form of coefficient. The work and time study of forwarder was carried out by snapback collecting data method, using manual digital chronometer. Besides the time study, all factors influencing the work process were detected and measured. Forwarding distance was measured by hand GPS devices Garmin GPSMAP 62st.

Figure 2. Forwarder HSM 208F in the area FA "Ribnik" (Foto: Z. Bilaković)

Slika 2. Forvarder HSM 208F na području Š.G. "Ribnik" (Foto: Z. Bilaković)

RESULTS AND DISCUSSION – *Rezultati i diskusija*

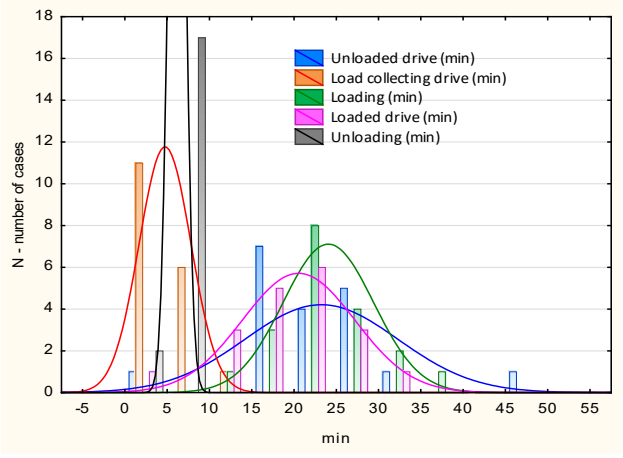
A total of 19 transport cycles were recorded. From the analysis of the work time structure, it can be seen that the work operations Unloaded drive, Loading, Loaded drive and Unloading were evidenced in all cycles and Load collecting drive was recorded in 18 cycles. In one cycle it was absent due to the fact that in that cycle the forwarder practically loaded all the timber in one place. In average, the work operation Load collecting drive took the shortest time, 4.7 min/cycle, with variations from 1 to 12.67 min. Unloading averaged 6.09 min/cycle, ranging from 4.5

Table 3. Productive work time

Tabela 3. Produktivno radno vrijeme

Work operation	N	Mean	Sum	Min	Max	Std.Dev.
Unloaded drive (min)	19	23.09	438.72	2.68	48.37	9.006
Load collecting drive (min)	18	4.70	84.53	1.00	12.67	3.050
Loading (min)	19	23.91	454.20	14.50	36.50	5.331
Loaded drive (min)	19	20.41	387.77	4.00	30.33	6.636
Unloading (min)	19	6.09	115.79	4.50	7.50	0.906
Cycle time (min/cycle)	19	77.95	1481.01	29.18	106.28	16.001

to 7.5 min. Loaded drive lasted an average of 20.41 min/cycle and Unloaded drive 23.09 min/cycle. The Loaded drive took less time than the Unloaded drive, which at first glance is contrary to expectations, but the explanation is that the movement routes did not match, as well as the fact that the Loaded drive was mostly downhill, and the Unloaded drive was uphill. Loading of wood is a work operation that lasted an average of 23.91 min/cycle, varying from 14.5 to 36.5 min (Table 3, Graph 1).

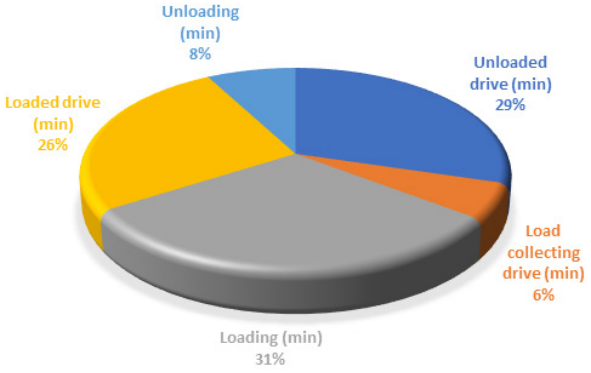


Graph 1. Distribution of duration work operations

Grafikon 1. Distribucija trajanja radnih operacija

The average productive time per cycle was 77.95 min, ranging from 29.18 to 106.28 min. The allowance time were recorded but not used for analysis due to the fact that the sample is relatively small and insufficient to objectively determine the share. For productivity calculation the coefficient 1.33, obtained in other, more extensive research under similar conditions was adopted (Stankić, 2010). However, the establishment of the allowance time factor is always subject of doubt because there are a large number of influencing factors. The higher the number of recordings, the more likely the allowance time will be credibly captured. This again contradicts the economics of conducting labor studies. A compromise is needed, where usually data from own and other researches are combined.

When looking at the relative share of work operations in productive work time, it can be seen that the largest share refers to Loading (31%), followed by Unloaded drive (29%) and Loaded drive (26%), and a significantly smaller share is spent on Unloading (8%) and Load collecting drive (6%) (Graph 2). Loading, Load collecting drive and Unloading account for 45% of working time, which is less than the 75% achieved by Manner et al., (2013), and Manner et al., (2016). The reason for that lies in the fact that in this case the wood was previously partially concentrated near the trails, with the cable skidder. Therefore, the forwarding distance is not always the main productivity factor, requiring an analysis of the factors that affect load formation and unloading (Stankić et al., 2012; Eriksson and Lindroos, 2014).



Graph 2. Relative share of work operations in productive work time

Grafikon 2. Relativni udio radnih operacija u produktivnom radnom vremenu

Table 4. Distance parameters

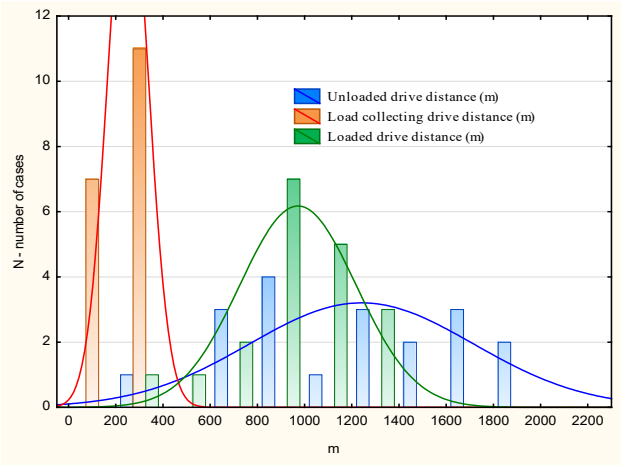
Tabela 4. Parametri distanci

Distance	N	Mean	Sum	Min	Max	Std.Dev.
Unloaded drive distance (m)	19	1234.74	23460.00	300.00	2000.00	472.915
Load collecting drive distance (m)	18	250.00	4500.00	100.00	400.00	85.612
Loaded drive distance (m)	19	966.84	18370.00	300.00	1300.00	245.471

Three forwarder movement distances were recorded, Unloaded drive distance, Load collecting drive distance and Loaded drive distance. The average distance of the Unloaded drive distance was 1234.74 m, and it varied from 300 to 2000 m. During the work operation Load collecting drive distance, the forwarder moved an average of 250 m per cycle, varying from 100 to 400 m. The Loaded drive distance was 966.84 m on average, varying from 300 to 1300 m (Table 4).

Load collecting drive distance depended on the distribution of assortments along the line of movement of the forwarder. Since the selective management system and selective cutting were used, the assortments were unevenly distributed throughout the felling site and along the lines of movement of the forwarder, so that the forwarder covered distances of 50 m and even up to 400 m to collect the full load. In most cases, the Loaded drive distance ranged from 600 to 1400 m. Essentially, these are shorter distances than the Unloaded drive due to the fact that the forwarder took routes when picking up the load and when loaded. Also, since the load was collected mostly by starting from the farthest point towards the landing site, part of the distance is covered during the collection itself, so that the distance of the Loaded drive is shortened. Distribution of distances is presented in Graph 3.

The average number of pieces in the load was 27.79, and it varied from 13 to 43. The average volume of the tour was 10.27 m^3, with a range of 8 to 12.1 m^3. The average volume of the piece was 0.4 m^3. In most cases, the load was uniform and the number of pieces ranged from 25 to 30 (Table 5).



Graph 3. Distribution of forwarder moving distances

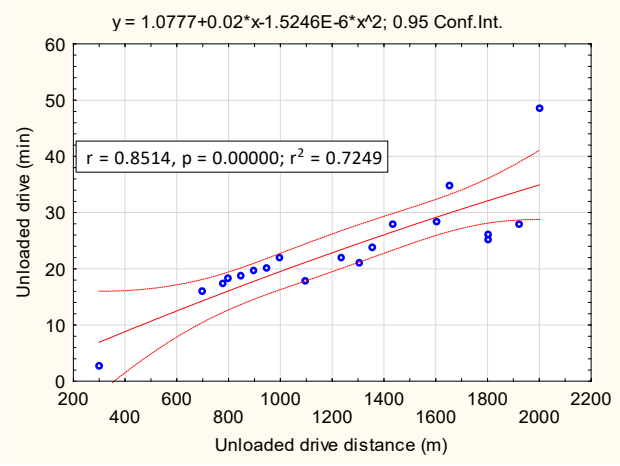
Grafikon 3. Distribucija distanci kretanja forvardera

Examination of the influence of certain factors on the duration of work operations is carried out by regression analysis. In cases where statistically significant dependence was determined, a mathematical model was defined that was used to calculate standard times, and where no impact was determined, the mean value of the time achieved for that work operation was used. Regression models, correlations and level of significance are showed in Graphs 4-7. Unloaded drive showed dependence from Unloaded drive distance, presented with quadratic equation and R = 0.85. Load collection drive showed dependence from distance only and it is presented with quadratic equation and R = 0.80. Loaded drive showed dependence from Loaded drive distance, presented with quadratic equation and R = 0.90. Loading showed dependence from volume of piece, presented with linear equation and R = 0.45. Other examined factors did not have a statistically significant influence and are not shown. Work operation Unloaded did not show dependence on any factor and the mean achieved time of 6.09 min/cycle was used for further analysis.

Table 5. Load parameters

Tabela 5. Parametri tereta

	N	Mean	Sum	Min	Max	Std.Dev.
Pieces/load	19	27.79	528.00	13.00	43.00	6.828
V (load) m^3	19	10.27	195.10	8.00	12.10	0.785
V (piece) m^3	19	0.40		0.28	0.85	0.135



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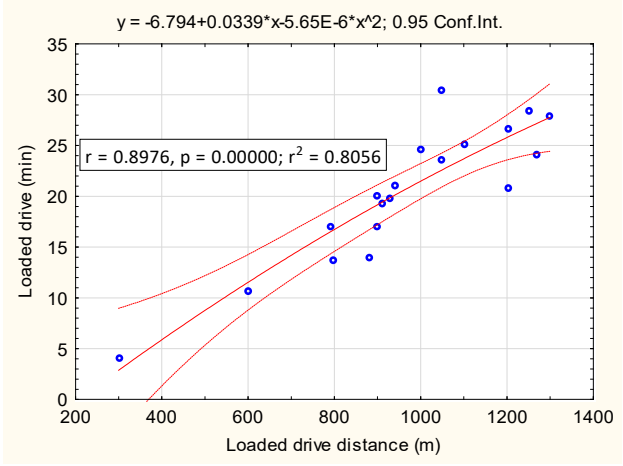

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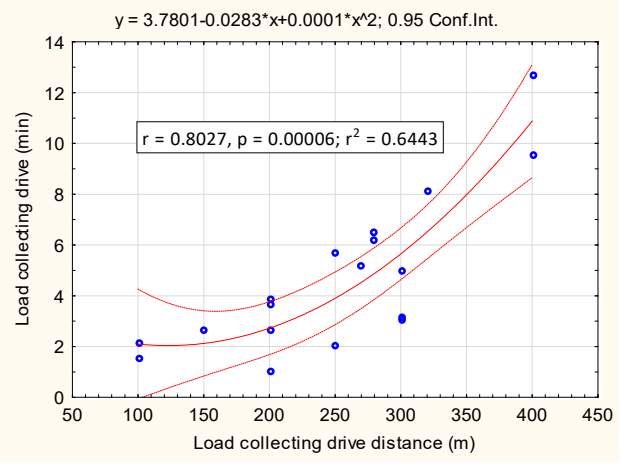

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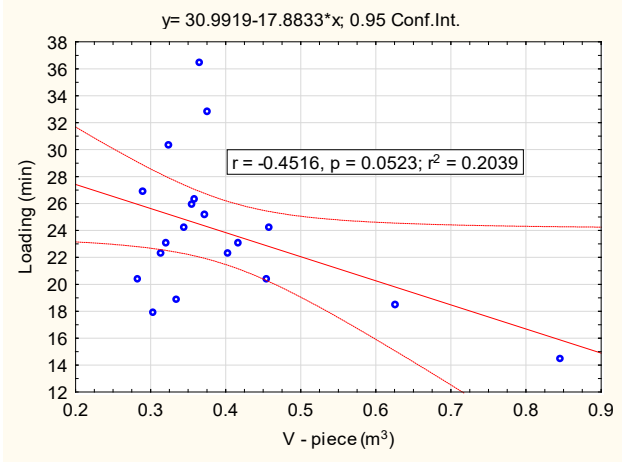
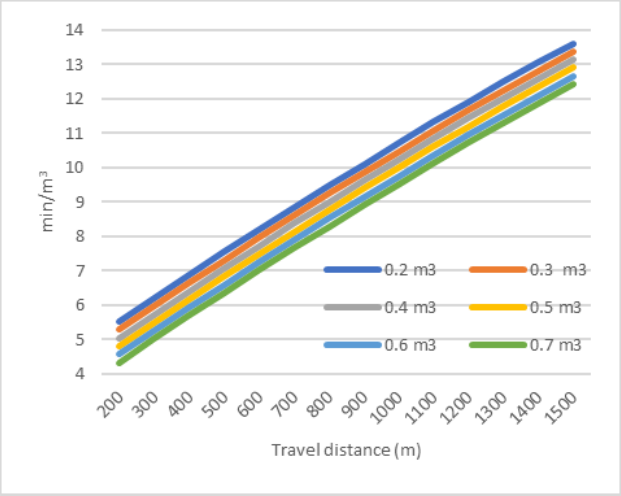


d

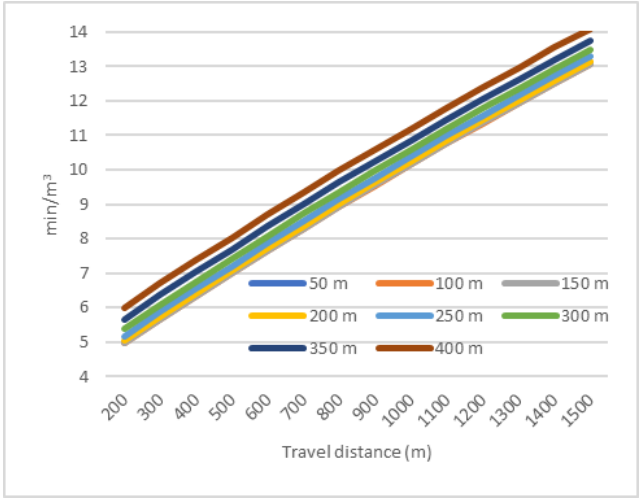
Graphs 4-7. a - Dependence of Unloaded drive from Unloaded drive distance; b - Dependence of Load collecting drive from Load collecting drive distance; c- Dependence of Loaded drive from Loaded drive distance; d - Dependence of Loading from V of piece.

Grafikoni 4-7. a - zavisnost prazne vožnje od distance prazne vožnje; b - zavisnost vožnje na prikupljanju tereta od distance vožnje na prikupljanju terete; c - zavisnost pune vožnje od distance pune vožnje; d - zavisnost utovara od V komada



Graph 8. Standard time (200 m Load collecting distance; 0.2-0.7 m³ piece size) Graph

Grafikon 8. Norma vremena (200 m distanca vožnje na prikupljanju tereta; 0.2-0.7 zapremina komada)



Graph 9. Standard time (0.4 m³ piece size; 50-400 m load collecting distance)

Grafikon 9. Norma vremena (0.4 m³ zapremina komada; 50-400 m distanca vožnje na prikupljanju tereta)

Standard time was calculated in the way that time for each work operation was calculated with regression equation for cases where significant dependence of influencing factors was established or using the average values if there was no dependence. The sum of work operation time was multiplied with allowance time coefficient and divided with the volume of transported load. Productivity is inverse value of standard time, adjusted to hourly. It was taken that the average load volume for HSM 208F is 10 m³, as determined in this research.

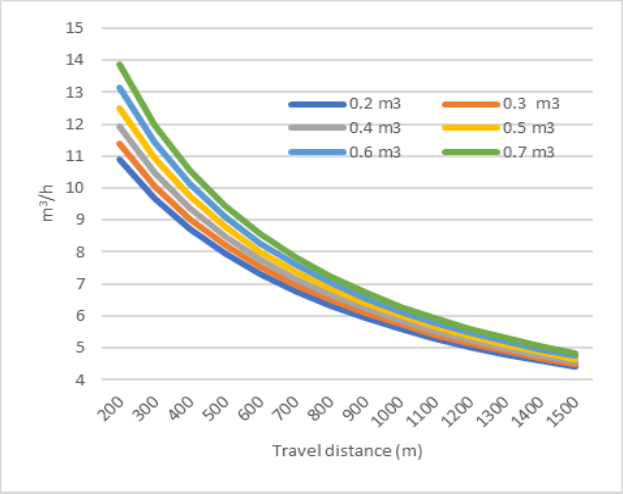
From Graphs 8-11 it can be seen that as the distances increases the time required to transport m³ of wood increases, that is, productivity declines. Mean load collecting drive distance and mean piece size also affect standard time and productivity, but to a lesser extent.

For example, for distance of 700 m and mean piece size of 0.4 m³, if the load collecting drive increase from 150 m to 400 m, productivity increase from 6.4 to 7.2 m³/h.

If we observe the change in productivity at a fixed distance of the load collecting drive (200 m) for travel distance of 700 m and at a different average volume of pieces, can be seen that productivity increases from 6.97 m³/h for 0.3 m³ piece to 7.84 m³/h for 0.7 m³ piece. Borz et al. (2021) investigated HSM 208F HVT-R2 forwarder and established for an average forwarding distance of about 1.5 km, net productivity and efficiency rates were estimated at 14.4 m³/h and 0.07 h/m³. Productivity is related to the availability of wood, and improvement is possible via better organization of tree felling and processing. Study of Proto et al. (2018) has indicated productivities in the range of 15 to 25 m³/h at extraction distance about 750 m. The same authors in case study developed in Calabria (Italy) indicated a productivity of about 15 m³/h for a John Deer 1110E, having a capacity of 12 t, that operated in selective cuts on a slope of 25%, which is comparable to this study, and for an average extraction distance of 700 m. Proto et al. (2017) have found productivities of 14.4 and 15.7 m³/h for extraction distances of approximately 300 and 600 m, respectively, for two John Deere machines (1110D and 1010D) operating on slopes of 26 and 29%, respectively. Pandur et al. (2018) found a productivity of approximately 18 m³/h on flat terrain and the extraction distance about 1.1 km. For steep terrain and an extraction distance of 0.8 km, Dinev et al. (2015) found productivities of 44–53 m³/day. For an extraction distance of 1.1 km, a payload of 12–13 m³ Slamka and Radocha (2010) found a productivity of 11 m³/h on mild to moderate slopes. Comparing the results obtained in this research with the results of other research presented here, it can be said that the productivity is comparable in some cases and in some cases, it is lower. The reason lies partly in the difficult terrain conditions, and partly in the fact that due to selective cutting and regulations, the forwarder had to move on the trails and could not search for the optimal route to the load.

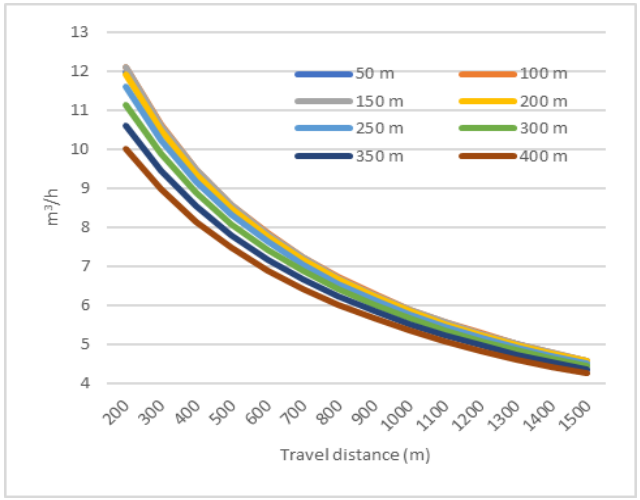
CONCLUSIONS – *Zaključak*

While the original system consisted of a harvester and a forwarder, for many reasons that affect the level of mechanization, such as the regulatory system, forest type, acceptability of practices and intensity of extracti-



Graph 10. Productivity (200 m Load collecting distance; 0.2-0.7 m^3 piece size)

Grafikon 10. Produktivnost (200 m distanca vožnje na prikupljanju tereta; 0.2-0.7 zapremina komada)



Graph 11. Productivity (0.4 m^3 piece size; 50-400 m load collecting distance)

Grafikon 11. Produktivnost (0.4 m^3 zapremina komada; 50-400 m distanca vožnje na prikupljanju tereta)

ons, in some parts of the world, forwarders are used today in partly mechanized systems that integrate motor-manual felling and processing of trees (Vusić et al. 2013). This is also the case in this research. Forwarders can successfully replace or supplement the skidders in the first phase of wood transportation, even in selective felling, but it is necessary to properly prepare the infrastructure in the compartments. In addition to the skid trails, which are the basis of the secondary opening, it is necessary to mark the lines between the skid trails that the forwarders could use to collect the wood.

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SAŽETAK

Forvarderi su samohodna vozila namjenjena za transport drveća ili njegovih dijelova utovarenih u tovarni prostor. U različitim zemljama, forvarderi se koriste na različite načine. Na primjer, u hrvatskom šumarstvu uglavnom se koriste u ravničarskim šumama, posebno za izvoz drveta iz oplodne sječe i kasnih proreda (Poršinski, 2002). Upotreba forvardera u Bosni i Hercegovini je još u početnoj fazi. Iako se koriste sporadično, još uvek postoje mnoge nejasnoće u vezi s njihovim radom u prebirnim sastojinama. Pogotovo ako se ima u vidu da je dosadašnja praksa da se mehanizacija u sastojini može kretati samo po unapred definisanim vlakama, koja se godinama koristi kod skidera sa vitlom još uvijek standardna. Forvarderima je potrebna drugačija šumska infrastruktura ako se želi postići konkurentna produktivnost. Cilj ovog istraživanja je analiza rada forvardera HSM 208F koji radi u prebirnim sastojinama u planinskom području. Istraživanje je vršeno na području opštine Ribnik, gdje državnim šumama gazduje preduzeće JPŠ "Šume Republike Srpske", ŠG "Ribnik". Prikupljanje podataka je vršeno u odjelu 10, koji se nalazi u prostoru PJ „Dimitor" (Tabela 1). Odjel ima planinske uslove rada, sa nadmorskom visinom od 1000-1300 m, prebirnim sistemom gazdovanja, a dominantna vrsta drveća je bukva. Analizirani forvarder HSM 208F je vlasništvo privatne firme koja izvodi radove za ŠG „Ribnik". Snimljeno je ukupno 19 transportnih ciklusa. Iz analize strukture radnog vremena vidi se da su radne operacije Prazna vožnja, Utovar, Puna vožnja i Istovar evidentirane u svim ciklusima, a Vožnja na prikupljanju tereta evidentirana je u 18 ciklusa. U prosjeku, radna operacija Vožnja na prikupljanju tereta trajala je najkraće, 4,7 min/ciklus, sa varijacijama od 1 do 12,67 min. Istovar je u prosjeku iznosio 6,09 min/ciklus, u rasponu od 4,5 do 7,5 min. Puna vožnja trajala je u proseku 20,41 min/ciklus, a Prazna vožnja 23,09 min/ciklus. Prosečna distanca prazne vožnje iznosila je 1234,74 m, a varirala je od 300 do 2000 m. U toku rada na prikupljanju tereta, forvarder se kretao u prosjeku 250 m po ciklusu, varirajući od 100 do 400 m. Dužina pune vožnje bila je u prosjeku 966,84 m, varirajući od 300 do 1300 m. Prosječan broj komada u teretu iznosio je 27,79, a varirao je od 13 do 43. Prosječna zapremina ture iznosila je 10,27 m^3, sa rasponom od 8 do 12,1 m^3. Prosječna zapremina komada bila je 0,4 m^3. U većini slučajeva teret je bio ujednačen i broj komada se kretao od 25 do 30 (Tabela 5). Ispitivanje uticaja pojedinih faktora na trajanje radnih operacija vršeno je regresionom analizom. Prazna vožnja je pokazala zavisnost od distance prazne vožnje, predstavljenu kvadratnom jednačinom i R = 0,85. Vožnja na prikupljanju tereta je pokazala zavisnost samo od distance i predstavljena je kvadratnom jednačinom i R = 0,80. Puna vožnja je pokazala zavisnost od distance, predstavljenu kvadratnom jednačinom i R = 0,90. Utovar je pokazao zavisnost od zapremine komada, predstavljeno linearnom jednačinom i R = 0,45. Ostali ispitani faktori nisu imali statistički značajan uticaj i nisu prikazani. Radna operacija Istovar nije pokazala zavisnost ni od jednog faktora, a za dalju analizu je korišćeno srednje postignuto vreme od 6,09 min/ciklus. Iz grafikona 8-11 se može vidjeti da se povećanjem distance povećava vrijeme potrebno za transport m^3 drveta, odnosno produktivnost opada. Srednje rastojanje za prikupljanje tereta i srednja zapremina komada takođe utiču na normu vremena i produktivnost, ali u manjoj mjeri. Forvarderi mogu uspješno zamijeniti ili dopuniti skidere u prvoj fazi transporta drva, čak i u prebirnoj seči, ali je potrebno pravilno pripremiti infrastrukturu u odjelima. Pored vlaka, koje su osnova sekundarnog otvaranja, potrebno je obilježiti linije između vlaka koje bi forvarderi mogli koristi za prikupljanje drveta.

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ORIGINAL SCIENTIFIC PAPER

Honey-bearing potential of dendroflora in Bosnia and Herzegovina

Medonosni potencijal dendroflore u Bosni i Hercegovini

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ABSTRACT

The floristic composition and ecological characteristics of the area where honey grazing is carried out directly define the botanical origin as well as the physical and chemical properties of honey. The goal of this research was to determine the potential of woody and shrubby plant species in the apiflora from Bosnia and Herzegovina (B&H) based on the qualitative-quantitative palynological analysis of honey samples. In the research, 100 different types of honey samples from B&H were collected and analyzed. The melissopalinological preparations were prepared and analyzed in accordance with the Rulebook on methods for the control of honey and other bee products of B&H, as well as the methods proposed by ICBB. After the melissopalinological analysis, 25 plant families with a total of 30,000 pollen grains were identified, of which 16 were woody or shrubby plants with 18,126 pollen grains in the preparations. In the research, the most presented honey-bearing woody plants were: black locust (*Robinia pseudoacacia*), chestnut (*Castanea sativa*) and linden (*Tilia* sp.). Each analyzed palynological profile represented a unique combination of pollen from honey-bearing plants, as a specific biological imprint of the place of honey grazing.

Key words: *Melissopalynology, honey, pollen, woody apiflora*

INTRODUCTION – *Uvod*

The honey plants include all plant species whose natural products (pollen, nectar and honeydew) are the main source of food for honey bees (*Apis mellifera*) (Dujmović Prugar & Hulina, 2007; Ljevnaić-Mašić et al, 2019). In the diet of bees, nectar is the primary source of carbohydrates, while pollen is the main source of proteins, but lipids, vitamins, minerals, and polyphenols and flavonoids also occur (Stanimirović et al, 2000; Campos et al, 2008; Bogdanov, 2012 Ljevnaić-Mašić et al, 2019).

The quantitative and qualitative properties of nectar and pollen are defined by internal (systematic affiliation and physiological properties of the plant species) and external (abiotic environmental parameters: temperature, air humidity, light, soil and wind) factors (Pešić et al, 2004). The physiological processes in bees, as well as the amount of honey production, are directly affected by the distribution of honey-bearing plant species on which bees graze (Diniz Frias et al, 2016).

The floristic composition of honey pasture is determined by ecological, biogeographic and anthropogenic factors in the area (Chiș & Purcarea, 2011; Tomczyk et al, 2019). Therefore, the selection of honey pasture, based on its floristic composition, is crucial for the creation of botanical origin and physico-chemical properties of honey (Ball, 2007; Sari & Ayyildiz, 2013; Alibabić et al, 2017; Altay et al, 2018).

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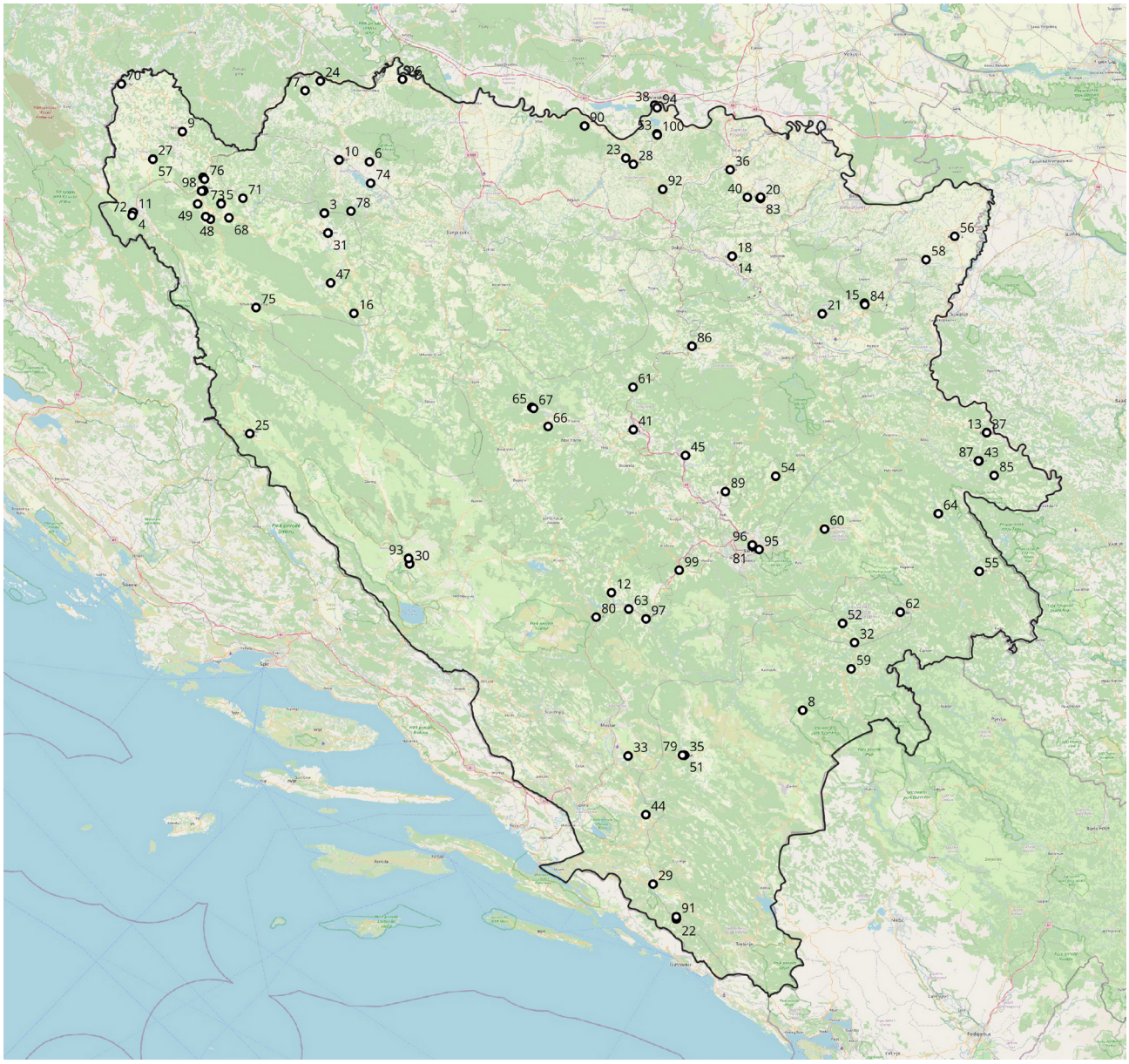


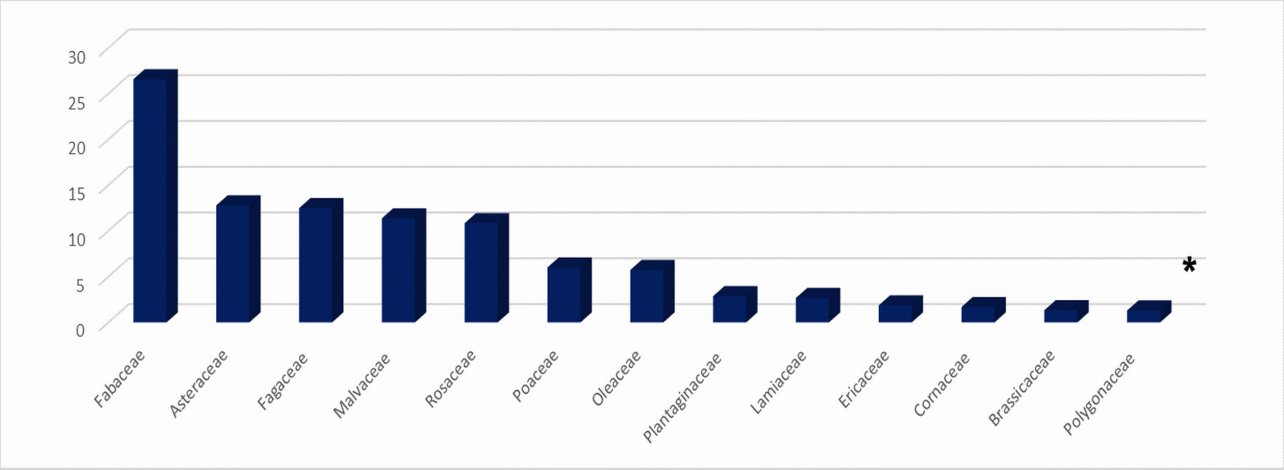
Figure 1. Map of the distribution of the analyzed samples

Slika 1. Karta distribucije analiziranih uzoraka

The aim of this research was to determine: (i) which types of woody and shrubby plants are most frequent in honey samples collected throughout Bosnia and Herzegovina (B&H), (ii) frequency and importance of woody and shrubby plants in the apiflora of B&H.

MATERIALS AND METHODS – *Materijal i metode*

As part of the research, 100 samples of different types of honey from Bosnia and Herzegovina were collected (Figure 1). The collecting of honey samples covered the entire territory of Bosnia and Herzegovina, but the availability of samples was conditioned by the distribution of apiaries and the willingness of honey producers to cooperate. The analysis included 56 monofloral and 44 polyfloral samples that were continuously collected in the period from 2015 to 2021. All analyzed samples were collected directly from honey producers with stationary apiaries. The melisopalinological preparations were made in accordance with the Rulebook (Regulation on methods for the control of honey and other bee products of B&H, Official Gazette, 37/09, 2009). The method of analysis of melissopalinological preparations was applied according to the Rulebook as well as the methods proposed by the ICBB (International Commi-



Graph 1. Families with a percentage share of pollen grains above 1% in the total sample

* Families with a percentage share of pollen grains under 1% in the total sample: Apiaceae, Boraginacea, Pinaceae, Rubiaceae, Juglandaceae, Caryophyllaceae, Viburnaceae, Simaroubaceae, Chenopodiaceae, Cupressaceae i Ranunculaceae

Grafikon 1. Porodice sa procentualnim udjelom polenovih zrna iznad 1% u ukupom uzorku

** Porodice sa procentualnim udjelom polenovih zrna ispod 1% u ukupom uzorku*: Apiaceae, Boraginacea, Pinaceae, Rubiaceae, Juglandaceae, Caryophyllaceae, Viburnaceae, Simaroubaceae, Chenopodiaceae, Cupressaceae i Ranunculaceae

ssion for Bee Botany) (Von Der Ohe et al, 2004; Rulebook on methods for the control of honey and other bee products of B&H, Official Gazette, 37/09, 2009). The melissopalynological preparations were analyzed using the Wild M20 phase-contrast microscope. The identification of plant species was based on the micromorphological elements of pollen grains (Hesse et al, 2009; Erdtman, 1943, 1952), which was followed by the qualitative-quantitative analysis of preparations. The qualitative analysis related to the inventory of honey-bearing plants identified, while quantitative analysis determined the exact number of pollen grains in the preparations. Based on the qualitative-quantitative analysis results, the melissopalynological profiles of honey samples were created.

Geographical distribution of ordinal numbers: 1-Drenova glavica, 2-Cazin, Koprivna, 3-Cazin, Koprivna, 4-Bihać, 5-Zalin, 6-Kozarac, 7-Bosanska Krupa, 8-Crno jezero, 9-Bužim, Radoč, 10-Prijedor, 11-Bihać, 12-Buturović polje, 13-Bratunac, 14-Gračanica, 15-Majevica, 16-Ključ, 17-Gračanica, 18-Gračanica, 19-Trebinje, Bobani, 20-Gradačac, 21-Tuzla, 22-Trebinje, Bobani, 23-Bosanski Dubačac, 24-Bosanska Dubica, Babinac, 25-Bosansko Grahovo, 26-Bosanka Dubica, Međeđa, 27-Cazin, 28-Bosanski Brod i Derventa, 29-Popovo polje, Ravno, 30-Livno, 31-Prijedor i Sanski Most, 32-Ustikolina, 33-Blagaj, Kamena, 34-Gradačac, 35-Nevesinje, 36-Modriča, 37-Bratunac, 38-Bosanski Brod, Svilaj, 39-Gradačac, 40-Gradačac, Novalići, 41-Zenica, 42-Bosanska Krupa, 43-Srebrenica, 44-Stolac, 45-Kakanj, 46-Sanski most, 47-Ključ, Sanica, 48-Bosanska Krupa, Suvaja, 49-Bosanska Krupa, Vranjska, 50-Bosanksa Krupa, Benkovac, 51-Nevesinje, 52-Goražde, Milanovići, 53-Derventa, Zborišta i Bosanski Brod, 54-Olovo, 55-Višegrad, 56-Bijeljina, 57-Cazin, 58-Ustiprača, Radič, 59-Foča, 60-Romanija, 61-Zenica, Nemila, 62-Goražde, 63-Čelebići, 64-Žepa, Begići, 65-Travnik, Karaula, 66-Travnik, Bijelo Buče, 67-Travnik, Karaula, Krčevine, 68-Bosanska Krupa, Jasenica, 69-Bosanskaja Krupa, Suvaja, 70-Velika Kladuša, 71-Bosanska Krupa, Veliki dubovik, 72-Bihać, 73-Bosanska Krupa, Zalin, 74-Prijedor, Petrov gaj, 75-Bosanski Petrovac, 76-Bosanska Krupa, Halkići, 77-Kostajnica, 78-Bosanska Krupa, Velika Jasenica, 79-Nevesinje, 80-Jablanica, 81-Pofalići, 82-Bosanska Krupa, 83-Gradačac, 84-Majevica, 85-Srebrenica, Brežani, 86-Zavidovići, 87-Srebrenica, Osmanovići, 88-Bosanska Krupa, 89-Breza, Bukovik, 90-Bosanski Kobaš, 91-Trebinje, Bobani, 92-Brezići, 93-Livno, 94-Bosanski Brod, 95-Sarajevo, 96-Pofalići, 97-Konjic, 98-Bosanska Krupa, 99-Tarčin i 100-Derventa i Bosanski Brod, Zborišta

RESULTS AND DISCUSSION – *Rezultati i diskusija*

After the melissopalinological analysis, a total of 30,000 pollen grains were identified. In the botanical sense, a total of 25 plant families were determined, whereby the largest number of pollen grains originated from Fabaceae (7967), Asteraceae (3832) and Fagaceae (3741) (Graph 1). By analyzing micromorphological features, 48 different types of pollen grains were identified. The ave-

Table 1. Identification of honey-bearing woody and shrubby plants in the study

Tabela 1. Identifikovne medonosne drvenaste i žbunaste biljke u istraživanju

Latin name of the species	The family	Total number of pollen grains	The number of samples in which they were detected	C*	N*	P*
Ailanthus altisima (Mill.) Swingle	Simaroubaceae	45	2	5-6	good	good
Amorpha fruticosa L.	Fabaceae	252	2	5-6	very good	very good
Calluna vulgaris (L.) Hull	Ericaceae	376	5	7-9	good	weak
Castanea sativa Mill.	Fagaceae	3659	35	6	good	excellent
Cornus mas L.	Cornaceae	500	14	2-3	weak	good
Fraxinus ornus L.	Oleaceae	422	11	4-5	weak	good
Juglans regia L.	Juglandaceae	62	3	3-5	there is none	excellent
Pinus sp.	Pinaceae	115	11			
Prunus sp.	Rosaceae	2026	49			
Quercus sp.	Fagaceae	82	8			
Robinia pseudoacacia L.	Fabaceae	6140	67	5-6	excellent	weak
Rubus sp.	Rosaceae	564	10			
Salvia officinalis L.	Lamiaceae	70	1	5-6	excellent	weak
Sambucus sp.	Viburnaceae	53	3	5-6		
Satureja sp.	Lamiaceae	354	4	7-10	excellent	good
Tilia sp.	Malvaceae	3406	53	5-7	excellent	good

C* - flowering period, *N - nectar production, *P - pollen production (Umeljić, 2013, 2015; Šilić, 1990, 2005)

rage number of honey plants per sample was seven, whereas the maximum number of 16 honey species was identified in the palynological profile from Livno.

By the analysis of melissopalynological profiles, 16 woody or shrubby plant species were identified in samples with a total of 18,126 pollen grains (Table 1). The pollen of woody or shrubby plants, in different percentages (5-100%), was identified in as many as 98 (98%) melissopalynological profiles (Graph 2). In botanical terms, a total of 11 families of woody or shrubby plants were identified (Table 1).

The woody honeydew plant with the greatest melissopalynological significance was black locust (*Robinia pseudoacacia*) with 6140 pollen grains, while the tree of heaven (*Ailanthus altisima*) with 45 pollen grains was the species with the smallest share in this research.

As part of the pollen research, black locust grains were identified in 67% of the palynological profiles as a dominant or accessory species (Graph 2). Black locust is one of the most important honey-bearing plants in Europe (Dujmović Prugar & Hulina, 2007) and is characterized by high nectar production so that the daily intake on pasture can be up to 15 kg of nectar (Umeljić, 2015). These honey-bearing properties make black locust one of the most desirable honey-bearing plants in B&H as well as in the region. So that black locust honey in Croatia (Uršulin-Trstenjak et al, 2014; Denžić Lugomer et al, 2017) and Serbia (Lazarević et al, 2012) is among the most abundant type of monofloral type, and it is also on the list of the 15 most important monofloral types of honey in Europe (Persano Oddo et al, 2004).

However, this plant species is marked as invasive in B&H and we must be extremely careful in introducing new individuals and controlling existing populations of this invasive species (Djug et al, 2019; EPPO, 2023). Given that Luigi et al (2023) determined the extremely negative effects of black locust on the growth and development of chestnut individuals, we must pay great

attention to the protection of our native species of honey plants (Luigi et al, 2023). The negative influence of black locust on the distribution of chestnuts was confirmed in the area of S Switzerland and N Italy, where it suppressed complete chestnut forests (Sabo, 2000; Sitzia et al, 2012). Black locust is characterized as a dangerous invasive species due to its invasiveness in native forest communities, and its distribution is strictly controlled in many Asian and European countries (Lazzaro et al, 2018; Lazzaro et al, 2020; Luigi et al, 2023; De Marco et al, 2023)

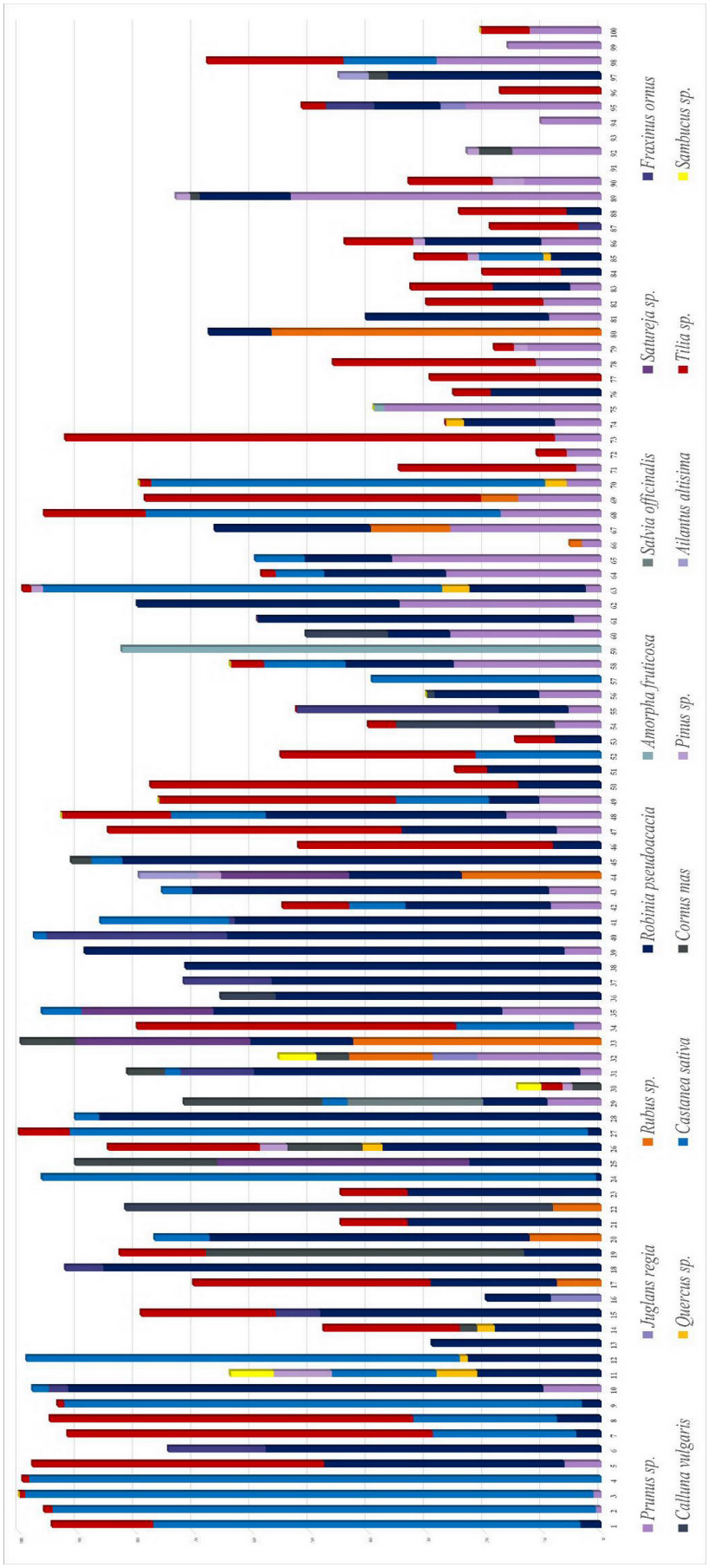
A total of 3,659 chestnut (*Castanea sativa*) pollen grains were identified within this research. Pollen grains of this honey plant were identified in 35% of the palynological profiles (Graph 2). Chestnut gives copious amounts of nectar and is specific because it gives much more pollen than any other honey plant (Umeljić, 2015). The research established that the ecological distribution of the species (Stupar et al, 2014; Milanović et al, 2015) is directly reflected through palynological profiles. Thus, the samples with the highest percentage share of this honey plant were identified in the localities where the largest natural stands of chestnut forests are located: Cazin (97%), Bihać (96%), Bužim (89%), Bosanska Krupa (75%), Buturović polje (74%), Čelebići (68%). Apart from certain regions of B&H, a significantly high proportion of chestnut pollen grains was detected in Croatia (Sabo et al, 2011), Albania (Pupuleku et al, 2016), Spain (Ramos et al, 2002) and Turkey (Temizer et al, 2018). Chestnut honey is characterized by its dark color and bitter taste (Umeljić, 2015), and due to its distinct antibacterial, antioxidant and anti-inflammatory properties (Alissandrakis et al, 2011; Avşar et al, 2016; Temizer et al, 2018; Horčinová Sedláčková et al, 2021; Güneş, 2021) is recognized as a very important monofloral type of honey in Europe (Persano oddo et al, 2004; European Commission DG Agriculture and Rural Development, 2013).

Linden (*Tilia* sp.) pollen grains were identified in 53% of the palynological profiles, a total of 3406 pollen grains of this honey-bearing plant were determined (Graph 2). Linden is one of the important honey-bearing plants of the temperate climate area of the northern hemisphere (Gašić et al, 2014) because it produces abundant amounts of nectar and pollen, so bees visit it very often (Umeljić, 2015). The honeydew pasture of linden can also carry corresponding deficiencies, mannose (Argoti, 2016), phenols, alkaloid nicotine were detected in the nectar. Linden honey pasture can also carry corresponding deficiencies, mannose (Argoti, 2016), phenols, alkaloid nicotine (Singaravelan et al, 2006; Tiedeken et al, 2014; Baracchi et al, 2015) and volatile secondary metabolites (Jacquemart et al, 2018) were detected in the nectar which can be toxic to bees after heavy consumption. However, linden honey, thanks to its specific chemical properties (Gašić et al, 2014), has strong probiotic, anticancer (Celebioglu et al, 2021) and antioxidant (Ćetković et al, 2014) effects, and is extremely important in human nutrition.

Pollen grains of the genus *Quercus* sp. were identified in the palynological spectra and *Pinus* sp. (Table 1, Chart 2). These honey-bearing species are extremely important for beekeeping, because they provide certain amounts of pollen, and after flowering, copious amounts of honeydew. Honey can be given up to four times a year, depending on the honey-bearing species on which the pasture is collected (Stanimirović et al, 2000; Dujmović Prugar & Hulina, 2007). The antibacterial effect of the honeydew of some species from the Pinaceae family has been proven, such as fir honeydew (*Abies alba* L.) inhibits the growth and adhesion of the infectious bacterium *Campylobacter jejuni* (Ramić et al, 2023).

Representatives of the Lamiaceae family are extremely important in apiflora due to the presence of essential oils, iridiodes, flavones, flavonoids, etc. (Frezza et al, 2019; Kačániová et al, 2021). As part of the research, *Salvia officinalis* pollen was identified in the paleontological profile from the locality Ravno (70 pollen grains, 23%), while the pollen of species from the *Satureja* genus was identified in the largest number at the localities Bosansko Grahovo (130, 43%), Blagaj (90, 30%) and Nevesinje (68, 22%) (Chart 2). Due to their specific characteristics, honey-bearing species from the Lamiaceae family are of great importance in honey-bearing grazing not only in the Mediterranean and sub-Mediterranean regions of Bosnia and Herzegovina, but also in regions in Croatia (Britvec, 2013), Turkey (Topal et al, 2023) and Romania (Ion et al, 2018).

As part of the research, non-native and invasive species *Amorpha fruticose* and *Ailanthus altisima* were identified (Djug et al, 2019; EPPO, 2023). Tree of heaven (*Ailanthus altisima*) and indigo bush (*Amorpha fruticosa*) have a negative allelopathic effect that can have very harmful consequences on the biodiversity of native apiflora (Gómez-Aparicio & Canham, 2008; Novak et al, 2018). Pollen of the tree of heaven was identified in the melissopalynological profiles of honey from Stolac and Konjic, where it spreads intensively in the Mediterranean and sub-Mediterranean area (Boškailo et al, 2017). While indigo bush pollen grains were detected in honey samples from the vicinity of Foča and Bosanski Petrovac. Both species are characterized by high production of nectar and pollen and low ecological requirements towards the environment (Umeljić, 2015), which makes



Graph 2. The percentage share of the researched honey-bearing species in the analyzed palynological profiles (geographical distribution of ordinal numbers of localities is indicated in Figure 1)

Grafikon 2. Procentualni udio istraživanih medonosnih vrsta u analiziranim palinološkim profilima (geografska distribucija rednih brojeva lokaliteta je označen na slici 1)

them extremely desirable in the apiflora of B&H and the region. Thus, pollen grains of these invasive species were identified in honey samples originating from Croatia (Rašić et al, 2018; Zima et al, 2018), Serbia (Nešović et al, 2020), Bulgaria (Atanassova et al, 2009; Tashev et al, 2015) and Hungary (Bodó et al, 2021).

As stated above, the knowledge of phenophases of flowering for species is most important in order to maximize its melissopalynological potential (Topal et al, 2023). Analyzing the flowering period of the identified species, we can observe that the largest number of plants express their honey-bearing potential in the period from May to July (seven species). The species that start the phenophase of flowering the earliest are dogwood (*Cornus mas*), walnut (*Juglans regia*) and species of the genus *Prunus*, the abundant production of these honey-bearing species accelerates the development of the brood and stimulates greater bee activity, which is a key phase during the spring development of the colony (Perišić et al, 2004). At the latest, during September and October, species of the genus *Satureja* and *Calluna vulgaris* bloom, which represent a very important autumn honey pasture, which provides a sufficient amount of nutrients for the unfavorable (winter) period of the year (Momirovski & Šimić, 1953; Stanimirović et al, 2000).

CONCLUSIONS – *Zaključak*

In the research, 100 melissopalynological profiles were analyzed and 30,000 pollen grains identified. A total of 48 pollen types were identified, 16 of which belong to woody and shrubby honey-bearing species. Of the total number of pollen grains identified, 60.42% (18126) belong to woody apiflora. Three species belonging to the group of invasive species were identified within the honey-bearing dendroflora. With the introduction of woody invasive species that have greater melissopalynological potential and greater economic benefit for beekeepers, we have to be careful because they may pose a biological threat to the native apiflora (Ion et al, 2018).

Based on the results, we can conclude that woody or shrubby forms of honey-bearing plants are of great importance in honey production. Also, these results point to the importance of forest ecosystems as irreplaceable grazing grounds for honey bees and the need for their conservation. Such studies aim to investigate the potential and biodiversity of apiflora as a important component of the resource potential of B&H.

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SAŽETAK

Medonosne biljke podrazumjevaju sve biljne vrste čiji su prirodni produkti (polen, nektar i medljika) glavni izvor hrane za medonosne pčele (*Apis mellifera*). U okviru istraživanja prikupljeno je i analizirano 100 uzoraka različitih tipova meda iz BiH (Slika 1). Melisopalinološki preparati izrađeni su i analizirani u skladu sa Pravilnik o metodama za kontrolu meda i drugih pčelinjih proizvoda Bosne i Hercegovine, kao i metodama koje predlaže ICBB. Nakon melisopalinologe analize 100 uzoraka meda identifikovano je ukupno 30000 polenovih zrna. U botaničkom smislu, determinisano je ukupno 25 biljnih porodica, a najveći broj polenovih zrna je konstatovan za porodice: Fabaceae (7967), Asteraceae (3832) i Fagaceae (3741) (Grafikon 1). Analizom mikromorfoloških osobenosti, identifikovano je 48 različitih tipova polena.

Analizom melisopalinoloških profila identifikovan je polen 16 drvenastih i žbunastih vrsta biljaka sa ukupno je 18126 (60,42%) polenovih zrna (Tabela 1.). Polen drvenastih i žbunastih biljaka, u različitom procentualnom udjelu (5-100%), identifikovan je u čak 98% melisopalinoloških profila (Grafikon 2). U botaničkom smislu ukupno je identifikovano 11 porodica drvenastih i žbunastih biljaka. Na osnovu rezultata možemo zaključiti da su drvenaste i žbunaste forme medonosnih biljaka imale veliki značaj u proizvodnji meda u analiziranom periodu. Takođe, ovi rezultati upućuju na značaj šumskih ekosistema kao nezamjenjive ispaše medonosnih pčela i potrebe za njihovom očuvanjem. Ovakve studije imaju za cilj proučavanje potencijala i biodiverziteta apiflore kao jednoj vrlo važnoj komponenti resursnog potencijala Bosne i Hercegovine.

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ORIGINAL SCIENTIFIC PAPER

Phytocoenological and ecological typification of the March Mushroom (*Hygrophorus marzuolus* (Fr.) Bres.) habitat in Bijambare, Sarajevo Canton

Fitocenološka i ekološka tipifikacija staništa martovke (*Hygrophorus marzuolus* (Fr.) Bres.) u Bijambarama, Kanton Sarajevo

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ABSTRACT

Biodiversity of mushrooms in FBiH is poorly researched, as well as the areas of distribution and ecological conditions under which mushrooms develop. This is also the case with the March Mushroom, so the main goal of the paper is to present the ecological conditions under which it develops. For the research, we used the Braun-Blanket (1932) method with all necessary parameters related to the selected habitat. These are: phytocenological affiliation, flora element, indicator value, and life form. The abundance of fungi was provided according to Tortić and Lisiewska (1971). Chemical analysis of the soil with basic parameters was also done. March Mushroom was detected in the *Abieti-Fagetum* in the locality of Motike within the "ZP Bijambare". This is the new site for the March Mushroom. Primary indicator values prevail in the association. Species of the order *Fagetalia* are the most numerous within the researched association. Hemicryptophytes prevail among the life forms. A total of 25 floral elements from 9 groups were determined. The largest number of species belongs to the sub-Atlantic-sub-Mediterranean group. The floral element with the largest number of determined species is subatl-smed. Fortunately, this locality is quite far from hiking trails, which is important, considering it as an extremely rich site of the March Mushroom.

Key words: *March Mushroom, biodiversity, mushrooms, Bijambare, forest*

INTRODUCTION – *Uvod*

Biodiversity of mushrooms in FBiH is poorly researched. The areas of distribution and ecological conditions under which mushrooms fructify are even less researched. The aim of the paper is to provide new data on the distribution and ecological conditions under which March Mushroom appears.

Morfological and anatomical characteristics of the March Mushroom

According to Canduso (1997) March mushrooms has the following morfological and anatomical characteristics: cap 30-120 (150) mm, convex, convex plane, waxy, hemispherical, irregular, brown, brown gray, slate-light gray to blackish. The stem is cylindrical, stocky, compre-

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ssed, gibbous, curved, firm, very irregular, full, then it has a fistulous cavity, especially at the base, pale gray or witish. The flesh is tenacious, fibrous, consistent thtoughout the carpophore, white-greyish, grey, hygrophane; it has a light smell of withered and tastes pleasant. Gills are broadly adnate, sinuous, thich, spaced apart, subdeccurent, whitish, white-greyish, grey, waxy. Spore prints are white. Spore 6,5-8 x 4-5,5 µm, elliptical, ovoidal, smooth, with large apicle. Basidi 55-70 x 6-8 µm, club-shaped, subcilindrical, tetrasporic, with very slender basidies.

Palacios et al (2011) provide data about content of phenol and the antioxidant effect in March mushroom. Sulkowska-Zlaja et al (2018) give the information that *Hygrophorus marzuolus* (Fr.) Bres., *Boletus edulis* Bull. ex Fr., *Calocybe gambosa* (Fr.) Singer ex Donk and *Lactarius deliciosus* (L. ex Fr.) S. F. Gray, contain the high content (about 15 mg/g DM) of one the most active antioxidants in mushrooms-caffeic acid.

Ecology of the March Mushroom

Cetto (2008) points out that March Mushroom fruits "on acid soil, beneath conifers, oaks, and chestnuts, hidden by the dead leaves and that it is a typical early spring mushroom". Hasanbegović (2008) states that it grows "in thinned mixed forests, near fir, beech, oak, and chestnut". Uščuplić (2012) points out that it grows in "early spring during the snow melting", and as a habitat, he points out "mountain coniferous forests, especially spruce ". According to Focht (1979), March Mushroom grows near beech and fir, in pure pine and spruce stands, and even in a mixed sweet chestnut and oak forests. According to the same author (Focht, 1990), March Mushroom grows in a period I-V month, depending on the heat and insolation.

Distribution in the world

Tkalčec et al. (2008) point out that the March Mushroom is widespread in Europe, north Africa (Morocco), and North America, and that it has not been recorded in North Europe and in the area of evergreen vegetation of the Mediterranean part of Europe. March Mushroom is spread in following countries: Italy (Bianchi, 2022), Czech (Tejklova & Kramoliš, 2017), Spain (Martinez Pena & Altelarrea, 2007), Hungary (Zajta, 2012), Switzerland (Breitenbach & Kränzlin, 1991), Germany and Austria (Hennig, 1964), Great Britain (Bingham, 2023), Greece (Psalida & Argyropoulos, 2023) Montenegro (Kasom & Miličković, 2021), North Macedonia (Karadelev & Rusevska, 2012), Serbia (Ivančević et al, 2012), Romania (Tanase & Pop, 2005), Slovakia (Lizon, 2001), Slovenia (Poler, 2018), France (Eyssartier & Roux, 2017), Turkey (Akata, 2017) and in other Europian countries. Razaq and Shahzad (2005) give a new record in Pakistan.

Distribution in BiH

Tortić (1970) mentions that the March mushroom was found in Bosnia in one locality but without specific data where. Focht (1979) mentions the Kasindol site near Sarajevo. The same author (Focht, 1992) provides information about the presence of this species also in eastern Bosnia. Hasanbegović and Ademović (2021) find it at the Nišići plateau in the *Abieti-Piceetum* forest, Hasanbegović (2022) finds it in a planted Scots pine forest at the locality of Donji Mišević.

Protection of the March Mushroom in BiH and the surrounding region

It should be emphasized that the March mushroom is a protected species in many European countries, e. g. in Croatia- it has a status of endangered species (Tkalčec et al, 2008), in Montenegro it is on the preliminary Red List (Perić et al, 2001) but Kasom and Miličković (2010) put March mashroom on the "List of protected species of Macrofungi in Montenegro", in North Macedonia has status EN (Karadelev & Rusevska, 2012), in Serbia "strictly protected fungal species" (Ivančević et al, 2012) and in Bosnia and Herzegovina it also has the status of the endangered species (Đug et al, 2013).

MATERIAL AND METHODS – *Materijal i metode rada*

Sporocarps of the target species (March Mushroom) were traced in the field during its fructifying season in the year 2021. For each collection site of the March Mushroom, a phytocoenological record was made following the Braun-Blanquete (1932) method. The floral elements, life forms, indicator values and phytocoenological affiliation of plants were provided according to Oberdorfer (2001), Raunkiaer (1937) and Pavlović-Murarspahić (1995). For determining phytocenosis, Stefanović (1986) and Barudanović et al (2015). The number of mushrooms in the table has been given according to Tortić and Lisiewska (1971): ++ few samples, and +++ many samples. The altitude has been recorded using the "Magelan eXplorist 500"GPS device. The terrain inclination has been determined with the clinometer from the "Recta DP 6 GLOBAL"compass.

The researched locality is found within the "Bijambare" protected area, in a locality called Motike, in a fir-beech

forest. It is located in the north-eastern part of the protected area, between the coordinates 18° 30' 40" and 18° 30' 42" E, and 44° 00' 82" and 44° 00'84" N. Hypsometrically, the researched area belongs to the zone of 1.000 to 1.500 m altitude (Đug et al (2008)). Geologically, the area belongs to the Lower Triassic (Čičić, 1984, Čičić & Skopljak, 2008), and, as far as tectonis is concerned, it is located in the zone of the inner Dinarides (Čičić, 1984).

Map 1. Position of the researched locality: red-1st, green-2nd, blue-3rd and yelow-4th (the map taken from Google Earth Pro)

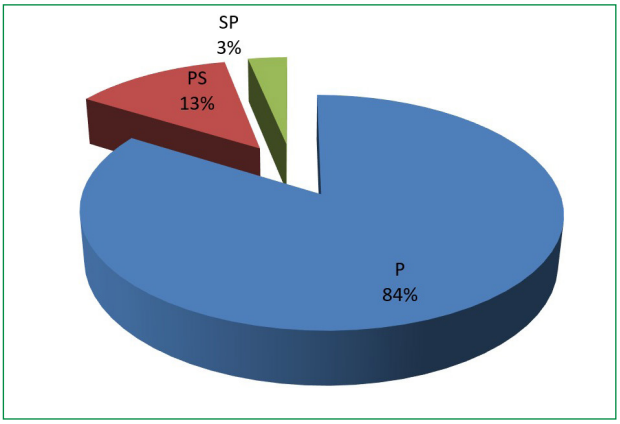
Karta 1. Položaj istraživanog lokaliteta: crveni-prvi, zeleni-drugi, plavi-treći i žuti-četvrti (karta preuzeta od Google Earth Pro)

According to Milosavljević (1970),this area is classified into the zone that during the vegetation period (March-October) has an average number of days with frost over 31, and a maximum number of days with frost (4-7) in a period when the vegetation has the most lush character (May). According to the same author (Milosavljević, 1976) this area belongs to the zone with increased air humidity. According to Đug et al (2008), the researched area belongs to the Dfbx" climate subtype which denotes humid boreal climate with warm summer and no dry period. Milosavljević (1968) points out that this area belongs to the zone with 1800-1900 hours of sunlight annualy. As far as the hydrothermal coefficient of the soil is concerned, the same author (Milosavljević, 1977), provides data on the state of soil moisture in the researched area, so it is wet during May and, moderately wet from June to September.

The soil is podzol. Chemical soil analysis were performed: pH (H2O), pH (KCl), humus (%), P2O5 and K2O (mg/100). A pH meter (ISO 10390) was used to determine the pH value. The humus content in the coil was determined by the dichromate method (ISO 14235), the reading was performed on a Thermo Spectronic Genesys 20 spectrophometer, the content of easily accessible forms K and P in the soil samples was determined by amonium lactate (AL) method (Egner et al, 1960), and, P content was determined on a Thermo Spectronic Genesys 20 spectrophometer, and K on a Microprocessor Flame photometer 671 Labtronics.

RESULTS AND DISCUSSION – *Rezultati i diskusija*

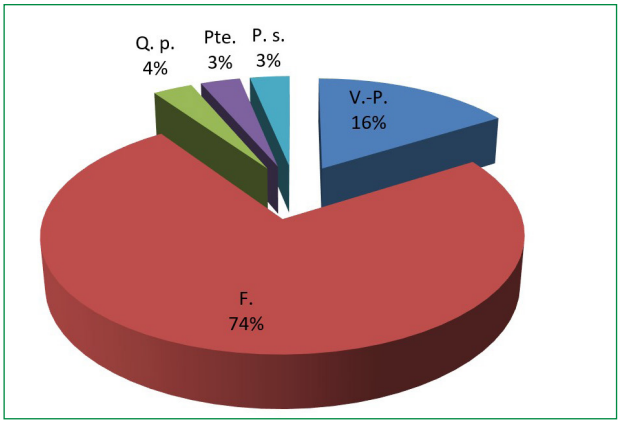
A total of 31 plant species from 25 families were found. Slightly more species, four, were found only from the family *Rosaceae*.



Graph 1. Ratio of indicator values in the researched *Abieti-Fagetum* vegetation (in %)

Grafikon 1. Odnos indikatorskih vrijednosti u istraživanoj vegetaciji Abieti-Fagetum (u %)

From the graph 1, it can be seen that the primary values far exceed the others. One could also read from the data that the anthropogenic influence is relatively small, for if it was present in a larger scale, it would be shown in the increased number of other values, and the reduced number of primary species.



Graph 2. Ratio of phytocenological affiliation in the researched vegetation

Grafikon 2. Odnos fitocenološke pripadnosti u istraživanoj vegetaciji

Table 1. Phytocoenological table of the researched vegetation

Tabela 1. Fitocenološka tabela istraživane vegetacije

Locality	**Bijambare-Motike**							
Altitude (m)	**1021**	**1032**	**1029**	**1028**				
Exposition	**W-SW**	**W-SW**	**W**	**W**				
Inclination (°)	**20**	**10**	**20**	**15**				
Geological basis	**Limestone**							
Soil type	**Brown acid soil**							
General coverage (%)	**90**	**85**	**90**	**90**				
Image size	**100 m²**							
Date	**15.V 2021.**							
Phytocenosis	Abieti-Fagetum							
Image number	**1**	**2**	**3**	**4**				
Floristic composition:								
Tree layer up to 30 m:					**I. v.**	**F. e.**	**P. a.**	**L. f.**
Abies alba Mill.	2.2	2.2	2.2	2.2	P	pralp(-smed)	V.-P.	P
Trees layer up to 20:								
Abies alba Mill.	2.2	2.2	1.1	+2	P	pralp(-smed)	V.-P.	P
Trees layer up to 5m:								
Abies alba Mill.	1.1	1.1	+2	+2	P	pralp(-smed)	V.-P.	P
Fagus silvatica L.	+1	+1			P	subatl(-smed)	F.	P
Trees layer up to 3 m:					P			
Abies alba Mill.	1.1	+2	+2	+2	P	pralp(-smed)	V.-P.	P
Fagus silvatica L.	+1	+1		+1		subatl(-smed)	F.	P
Bushs layer:								
Abies alba Mill.	1.1	1.1	1.1	2.2	P	pralp(-smed)	V.-P.	P
Rubus hirtus W. K.	1.1	1.1	1.1	1.1	PS	subatl	F.	P
Fagus silvatica L.	+2	+1			P	subatl(-smed)	F.	P
Euonymus europaeus L.	+1	+2			PS	subatl-smed	F.	P
Pyrus pyraster Burgsd	+1				P	smed (-gemässkont)	F.	P
Sorbus aucuparia L.	+1				P	no-eurassubozean	F.	P

Acer pseudoplatanus L.		+1	+1		P	subatl-smed (-pralp)	F.	P
Herbaceous plants layer:								
Galium rotundifolium L.	1.1	1.1	1.1	1.1	P	no-euras(kont), circ	V.-P.	H
Viola silvestris Lam.	1.1	1.1	+2	1.1	P	subatl-smed	F.	H
Brachypodium silvaticum (Huds.) P. B.	1.1	1.1		+2	PS	euras(subozean)-smed	F.	H
Aremonia agrimonioides	1.1		+1		P	osmed	F.	H
Asarum europaeum L.	1.1				P	euraskont	F.	H (G)
Oxalis acetosella L.	+2	+2	+2	+2	P	no-euras	F.	H (G)
Hieracium sylvaticum	+2	+2	+1	+2	P	no-subatl-smed	F.	H
Mycelis muralis (L.) Dum.	+2	+2	+2		P	subatl-smed	F.	H
Luzula silvatica (Huds.) Gaud.	+2	+2	+2		P	subatl(-smed)	V.-P	H
Epimedium alpinum L.	+2	+2			P	opralp	F.	G
Pteridium aquilinum (L.) Kuhn	+2	+1			SP	(no) eurassubozean	Pte.	G
Helleborus odorus W. K.	+2				PS	din	P. s.	H (G)
Euphorbia amygdaloides L.	+2				P	subatl-smed	F.	H
Pyrola secunda L.	+2				P	no-euraskont, circ	V.-P.	Ch
Melampyrum silvaticum L.	+2				P	no-pralp	V.-P.	T
Polypodium vulgare L.	+2				P	eurassubozean-smed, circ	F.	Ch
Anemone nemorosa L.		+2		+2	P	eurassubozean	F.	G
Athyrium filix-femina (L.) Roth		+2		+1	P	no-euras (subozean)	F.	H
Dryopteris filix-mas (L.) Schott		+2			P	eursassubozean (-smed)	F.	H
Melittis melissophyllum L.		+1			P	smed	Q. p.	H
Lamium luteum (Huds.) Krock.			+2		P	gemässkont	F.	Ch
Neottia nidus-avis L.			+2		P	euras (subozean)-smed	F.	G
Geranium roberianum L.				+2	P	eurassubozean-smed	F.	H (T)
Sanicula europaea L.				+2	P	subatl(-smed)	F.	H
Fungi								
Hygrophorus marzuolus	++	++	+++	++				

Table 2. Ratio of life forms in the researched *Abieti-Fagetum* vegetation

Tabela 2. Odnos životnih formi u istraživanoj vegetaciji Abieti-Fagetum

Life form	Total number	Σ	%	Σ %
H	12		37.2	
H(G)	3		9.3	
H(T)	1		3.1	
		16		**49.6**
P	7		21.7	
		7		**21.7**
G	4		12.4	
		4		**12.4**
Ch	3		9.3	
		3		**9.3**
T	1		3.1	
		1		**3.1**
Ukupno:	**31**	**31**	**100**	**100**

From the graph 2, it can be seen that species from the order *Fagetalia* dominate in the researched vegetation, while the other orders are represented with a significantly small number of representatives.

From the table 2, it can be seen that the largest number of species belongs to hemicryptophytes, while the other life forms have much lower values.

From table 3, it can be seen that the researched soil has a very acidic reaction, which, as a matter of fact, corresponds to fungi because "they mostly inhabit substrates with acidic reactions, i.e. they are acidophilic" (Marinović, 1972), and it is also characteristic for conifer forest ecosystems. The soil has a high content of humus (organic matter) and is poorly supplied with accessible forms P and K.

A total of 25 floral elements from 9 groups were determined. The largest number of species was recorded in the sub-Atlantic-sub-Mediterranean group, and the flo-

Table 3. The results of chemical analysis of soil samples

Tabela 3. Rezultati hemijske analize uzoraka zemljišta

Sample from the surface	pH (H_2O)	pH (KCl)	Humus (%)	P_2O_5(mg/100)	K_2O(mg/100)
1	4.9	3.6	7.3	2.3	8
2	4.1	3	12	2	5
3	4.6	3.6	10	2	5
4	5.3	4	7.2	0	2

Table 4. Spectrum of floral elements in the researched association *Abieti-Fagetum*

Tabela 4. Spektar flornih elemenata u istraživanoj asocijaciji Abieti-Fagetum

Floral element			Established number in the researched area	Σ	Percentage of participation	Total %
1.	1.	din	**1**	**1**	**3.2**	**3.2**
	2.	opralp	**1**		**3.2**	
2.	3.	pralp(-smed)	**1**	**3**	**3.2**	**9.36**
	4.	no-pralp	**1**		**3.2**	
	5.	osmed	**1**		**3.2**	
3.	6.	smed	**1**	**3**	**3.2**	**9.36**
	7.	smed(-gemässkont)	**1**		**3.2**	
	8.	subatl	**1**		**3.2**	
	9.	subatl(-smed)	**3**		**9.36**	
4.	10.	subatl-smed	**4**	**10**	**12.9**	**31**
	11.	subatl-smed(-pralp)	**1**		**3.2**	
	12.	no-subatl-smed	**1**		**3.2**	
5.	13.	euras(subozean)-smed	**2**	**2**	**6.4**	**6.4**
	14.	no-euras	**1**		**3.2**	
6.	15.	no-euras(subozean)	**1**	**4**	**3.2**	**12.9**
	16.	no-euras(kont). circ	**1**		**3.2**	
	17.	no-eurassubozean	**1**		**3.2**	
	18.	eurassubozean	**1**		**3.2**	
	19.	eursassubozean(-smed)	**1**		**3.2**	
7.	20.	eurassubozean-smed,	**1**	**5**	**3.2**	**16.1**
	21.	eurassubozean-smed,circ	**1**		**3.2**	
	22.	(no)eurassubozean	**1**		**3.2**	
	23.	euraskont	**1**		**3.2**	
8.	24.	no-euraskont, circ	**1**	**2**	**3.2**	**6.4**
9.	25.	gemässkont	**1**	**1**	**3.2**	**3.2**
			31	**31**	**100 %**	**100 %**

ral element with the largest number of determined species is subatl-smed.

At the end, having in mind that this is extremely rich site, the good thing is that this locality is far from any hiking trail.

Abbreviations:

Abbreviations for phytocoenological affiliation:

F.-*Fagetalia*, P. s.-*Prunetalia spinosae*, Pte.-*Pteridetalia*, Q. p.-*Quercetalia pubescentis*, V.-P.-*Vaccinio-Piceetalia*,

Abbreviations for indicator values:

P-primary, PS-primary secondary, S- secondary, SP-secondary primary

Abbreviations for life forms:

P-*phanerophyta*, H-*hemicriptophyta*, Ch-*chamaephyta*, G-*geophyta* and Ch (Pn)-*chamaephyta* (*nanophanerophyta*)

Abbreviations in the phytocoenological table:

I. v.-indicator value, F. e.-floral element, P. a.-phytocoenological affiliation, L. f.-life form.

Figure 2. March Mushroom (*Hygrophorus marzuolus*) from the researched area (Photo: A. Hasanbegović)

Slika 2. March Mushroom (Hygrophorus marzuolus) sa istraživanog područja (Photo: A. Hasanbegović)

Figure 3. Researched fir and beech forest *Abieti-Fagetum* (Photo: A. Hasanbegović)

Slika 3. Istraživana šuma jele i bukve Abieti-Fagetum (Photo: A. Hasanbegović)

CONCLUSIONS – Zaključci

1. This is a new locality forthe March Mushroom;
2. The locality is found within the "ZP Bijambare";
3. March Mushroomwas noted in the association of fir and beech (*Abieti-Fagetum*);
4. 31 plant species from 25 families were found in the association;
5. The *Rosaceae* familyhas the largest number of identified species;
6. Primary indicator values prevail in the association;
7. Species of the order *Fagetalia* are the most numerous ones within the researched association;
8. Hemicriptophytes predominate among life forms;
9. A total of 25 floral elements from 9 groups were determined;
10. The largest number of species belongs to the sub-Atlantic-sub-mediterranean group,
11. The floral element with the largest number of identified species is subatl-smed.
12. This locality is quantitavily extremely rich with the March Mushroom.

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SAŽETAK

Biodiverzitet gljiva FBiH je slabo istražen, kao i areali rasprostranjenosti i ekološki uslovi pod kojima se gljive razvijaju. Takav je slučaj i sa martovkom te je glavni cilj rada prikazati ekološke uslove pod kojima se martovka pojavljuje. Za istraživanje smo uzeli metod Braun-Blanketa (1932) sa svim neophodnim ostalim parametrima vezanim za odabrano stanište, kao što su: fitocenološka pripadnost, florni element, indikatorska vrijednost i životna forma. Brojnost gljiva je data prema Tortić & Lisiewska (1971). Takođe je urađena hemijska analiza tla sa osnovnim parametrima. Martovka je zabilježena u šumi *Abiet-Fagetum* na lokalitetu Motike u okviru "ZP Bijambare". Ovo je novo nalazište martovke. U asocijaciji preovaldavaju primarne indikatorske vrijednosti. Vrste reda *Fagetalia* su najbrojnije unutar istraživane asocijacije. Od životnih formi preovladavaju hemikriptofite. Ukupno je utvrđeno 25 flornih elemenata iz 9 skupina. Najveći broj vrsta pripada subatlansko-submediteranskoj skupini. Florni element sa najvećim brojem konstatovanih vrsta je subatl-smed. Sreća pa je ovaj lokalitet poprilično udaljen od bilo kojih pješačkih staza jer je riječ o izrazito bogatom nalazištu martovke.

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ORIGINAL SCIENTIFIC PAPER

The First Record of Grey Wolf (*Canis lupus*) Reproduction in Dubrovnik-Neretva County

Prvo dokumentirano razmnožavanje sivog vuka *(Canis lupus)* na području Dubrovačko-neretvanske županije

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ABSTRACT

Due to the increase in numbers and the lack of quality habitat, the wolf in the Republic of Croatia is expanding its habitat throughout the Dalmatian coast, even reaching the outskirts of settlements. What used to be a secondary habitat for the wolf, in which it only appeared occasionally, is now a primary habitat where reproduction takes place. In a wider area, until now, the occasional existence of a pack of two individuals was considered, and this case is the first documented evidence of reproduction in the investigated location.

Key words: *wolf, Dalmatian coast, secondary habitat, reproduction*

INTRODUCTION – *Uvod*

Područje republike Hrvatske, nastanjuju tri vrste velikih zvijeri: sivi vuk, smeđi medvjed i euroazijski ris.(Oković, 2010) Njen primorski dio pak kao sekundarno stanište koristi vuk i medvjed koji se povremeno pojavljuje na područjima Biokova, Dinare, Mosora i ostalih planina u neposrednom zaleđu. Sve vrste velikih zvijeri u republici Hrvatskoj su strogo zaštićene vrste sukladno Zakonu o zaštiti prirode (NN 80/13, 15/18, 14/19, 127/19) odnosno Pravilniku o strogo zaštićenim vrstama (NN 144/13). Vukovi u Hrvatskoj pripadaju dijelu velike dinarsko-balkanske populacije s brojnosti od oko 3900 jedinki i uglavnom se smatra stabilnom. (Kaczensky i dr., 2013) Po povijesnim podacima smatra se da su vukovi još 1894. bili prisutni na teritoriju cijele države, a nakon toga su počeli nestajati iz njezinog nizinskog dijela (Frković i Huber, 1992). Krajem dvadesetog stoljeća vukovi su obitavali samo u Gorskom kotaru i Lici, dok se vjerovalo da ih u Dalmaciji nema (Frković i Huber, 1992). Iako za područje Hrvatske nisu postojali podaci o odstrelu vukova a samim time i prisustvu vuka u datom periodu, istraživanja vršena na teritoriju Bosne i Hercegovine i susjedne općine Neum navode odstrele ili hvatanje vukova u periodu od 1977. do 1986. godine (Rapaić, 1989). Prvih godina ovoga stoljeća vukovi su naseljavali područja Gorskog kotara, Like, Dalmacije, Južnog Velebita, Ravnih Kotara, Splitskog zaleđa pa sve do Biokova (Kusak, 2002). U razdoblju do 2008. vukovi su ustanovili teritorije i na području Banovine kao i dijela Karlovačke županije gdje su se prije bili samo povremeno prisutni (Desnica i Oković 2007; Oković i dr., 2008; Štrbenac i dr. 2005; Desnica i Štrbenac 2006).

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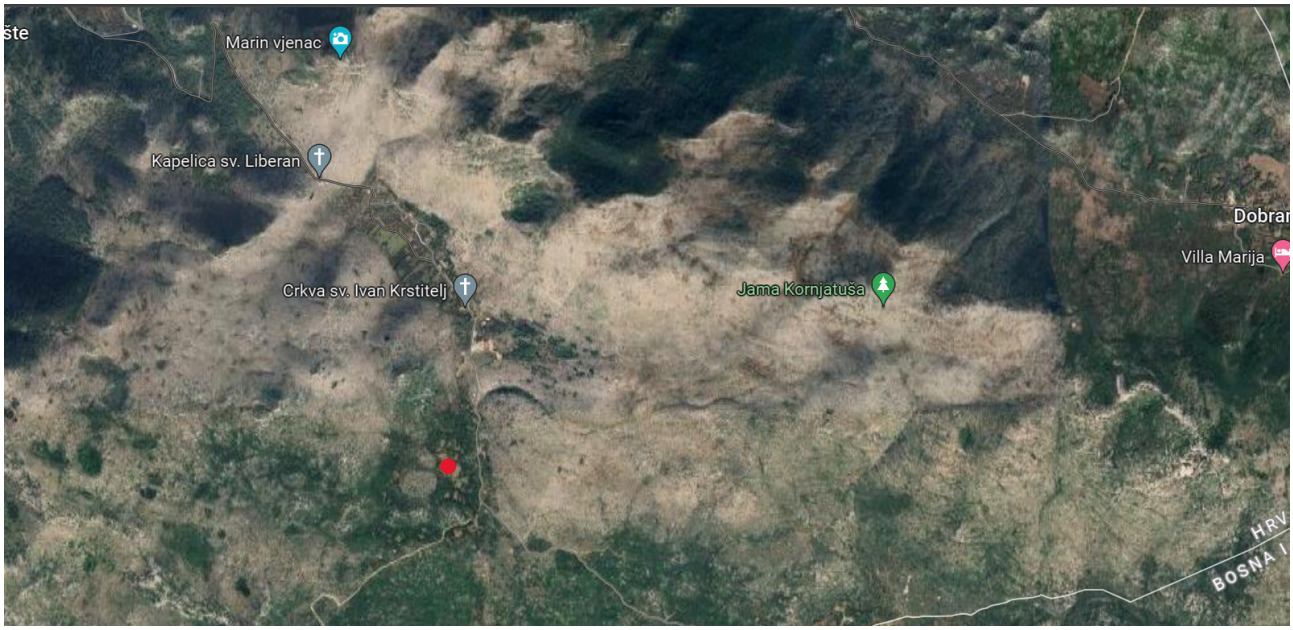


Karta 1. Šire područje istraživanja s lokacijom fotozamke (crvena točka)- podloga Google Earth;

Map 1. Wider research area with phototrap location (red dot)-Layer Google Earth;

MATERIALS AND METHODS – *Materijal i metode*

Hrvatska je sukladno svojim ekološkim obilježjima podjeljena na tri biogeografske regije: kontinentalnu, alpinsku i mediteransku (Kusak i dr., 2019.). Terenska istraživanja vršena su na području općine Zažablje, u dolini Neretve. Kao istraživano područje uzeto je selo Vidonje sa svojim zaseocima (Goračići, Ružne njive, Glavica, Galovići, Brestica) pa sve do državne granice sa Federacijom Bosne i Hercegovine, kao i cijeli dio planine Žabe koji se nalazi na teritoriju Republike Hrvatske (Karta 1.). Samo selo Vidonje je nenaseljeno (Slika 1). Monitoring je vršen fotozamkom marke SUNTEK, postavljenoj uz poznatu i aktivnu lokvu u kršu koja služi kao pojilište divljači. Lovište u kojem je istraživanje vršeno je državno lovište Mala Žaba XIX/2 kojim gospodari lovovlaštenik LD "*Liska*", Metković (*https://sle.mps.hr/contractpublic/details/1525)*. Pregledom terena i početkom monitoringa zapaženo je da vegetaciju područja sačinjavaju tipične submediteranske vrste poput crnog graba (*Carpinus orientalis*), hrasta medunca (*Quercus pubescens*), crnog jasena (*Fraxinus ornus*) uz povremen mikolokalitete u kojima se pojavljuju biljni predstavnici eumediteranskog pojasa širokolisna zelenika (*Phillyrea latifolia*), hrast crnika (*Quercus ilex*), planika (*Arbutus unedo*) i dr.

Analizirani podaci uključuju napade na domaće životinje, znakove prisutnosti (izmet, markiranje grebanjem, zavijanja, snimke automatskih kamera) kao i osobno viđenje životinja od strane ljudi. Podaci su razvrstani sukladno međunarodno korištenoj SCALP (*http://www.kora.ch/index.php?id=117)* klasifikaciji, kojom su definirane posebne kategorije nalaza. Za uspješan monitoring velikih zvijeri tako se postiže nepristranost i vjerodostojnost podataka, a time onda i povjerenje u prikupljene podatke. Opažanja se temeljem njihove provjerljivosti i kvalitete raspoređuju u tri skupine opažanja nazvane C1, C2 i C3 kategorije opažanja.

Kategorija C1 označava čvrst dokaz, odnosno dokaz koji nedvosmisleno potvrđuje prisutnost velike zvijeri (nađena mrtva, uhvaćena živa, genetski dokaz, fotografija, telemetrijska lokacija).

Kategorija C2 označava potvrđeno posredno opažanje (otisak šape, izmet, ostaci plijena i slično) koji mora biti potvrđen od iskusne osobe a na temelju prikupljene dokumentacije (fotografija tragova i/ili plijena, prikupljen uzorak izmeta). Ovdje je bitna definicija i primjena termina „iskusna osoba". Sukladno SCALP definiciji iskusna osoba je ona koja ima bogato terensko iskustvo u radu na praćenju velikih zvijeri.

Kategorija C3 označava nepotvrđeno opažanje (sva nedokumentirana viđenja, znakovi koji su prestari ili nejasni, nepotpuno dokumentirani i koji ne mogu biti provjereni). Za procjenu brojnosti vukova moguće je koristiti samo opažanja C1 i C2 kategorije. Opažanja C3 kategorije nalaza, u ovisnosti o broju takvih nalaza na nekom području, upućuje na potrebu dodatnog istraživanja, odnosno boljeg prikupljanja opažanja u kategoriji C2 ili C1 (MZOE, 2020.).

Slika 1. selo Vidonje;
Foto: Nikola Menalo;

Figure 1. Vidonje village;
Photo: Nikola Menalo

RESULTS AND DISCUSSION – *Rezultati i diskusija*

Istraživano područje u prošlosti smatrano je je teritorijem jednog čopora nazvanog Mlinište -Metković koji je brojio najviše do dvije jedinke (Jeremić i dr., 2017)

Postavljena fotozamka bila je aktivna tijekom 9 mjeseci od veljače do listopada, čime smo zaokružili dvije reprodukcijske sezone. Prvo pojavljivanje vukova registrirano je u siječnju 2023. godine. Tada je prilikom pogonskog lova na divlje svinje prijavljeno viđenje čopora od 5 jedinki na tom području. Tijekom sezone lova najmanje 3 vuka stradala su u krivolovu i lovu na Hrvatskom i Bosanskohercegovačkom teritoriju (osobni podaci autora). Nakon završetka sezone lova i smanjenih ljudskih aktivnosti u prostoru konstantno je pojavljivanje dvije odrasle jedinke sivog (Slika 2.) vuka na području Vidonja. Tijekom proljeća utvrđen je veći broj šteta, mahom na slobodno živućim krdima konja koji svakodnevno koriste podjednako područje obiju država. Tijekom travnja utvrđena je stalna prisutnost dvije jedinke sivog vuka na mikro lokalitetu zaseoka Goračići. O velikoj šteti na domaćim životinjama koja se dogodila u lipnji iste godine izvještavale su i lokalne i državne medijske plaforme (https://www.klikploce.com.hr/vukovi-u-dolini-neretve-zaklali-dvadedet-ovaca-a-sedam-ozlijedili-nijedna-nece-prezivjeti/). U starijim zapisima (Knežević i Knežević,

Slika 2. Prvo registrovanje dva odrasla vuka (reproduktivni par);
Fotozamka: Nikola Menalo;

Figure 2. First record of two adult wolves (apha pair);
Phototrap by:Nikola Menalo

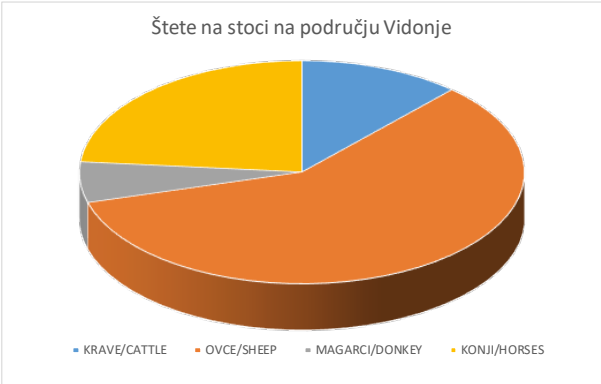
Slika 3 i 4. Domaće životinje kao vučji plijen; Foto: Nikola Menalo;

Figure 3 and 4. Livestock as wolves prey; Photo:Nikola Menalo;

1956) navodi se kako u tom periodu godine vučica na svijet donosi štence, s toga je opravdana ova pojava vjerojatno pojačanom potrebnom količinom mesa za hranjenje štenaca.

Prvo bilježenje tri šteneta pomoću fotozamke napravljeno je 20.srpnja kada je primijećen jedan štenac pri pijenju vode na obližnjoj lokvi. Kasnijim sustavnim monitoringom primijećen je veliki broj lešina stradalih domaćih životinja (Graf 1. i Slika 3).

Prvo bilježenje sa jasno vidljiva tri šteneta, pomoću fotozamke, dogodilo se 5.kolovoza, (Slika 5.) dok je zadnje bilježenje sva tri štenca bilo 28.kolovoza. Nakon toga sustavno su bilježena preostala 2 štenca i 2 odrasla vuka.



Grafikon 1. Štete od vukova na stoci tokom istraživanog razdoblja;

Graph 1. Damage at livestock by Wolwes during research period

Slika 5.Vučji štenci u istraživanom području; Fotozamka: Nikola Menalo;

Figure 5. Wolf's puppies in research area; Phototrap by: Nikola Menalo

Nejasan je razlog nestanka trećeg štenca s tim da se kao najvjerojatniji uzrok smatra krivolov. Preostali čopor od dvije odrasle i dvije juvenilne jedinke prisutan je i kroz lovnu sezonu 2024/2025. Tijekom prvih mjeseci 2024. godine lovačko društvo Jadran Neum organiziralo je hajke na vukove sa neuspješnim ishodom (https://neum.online/foto-lovacka-udruga-jadran-organizirala-hajku-na-vuka/). Po prijavama mještana i lovaca primijećen je čopor od 15 jedinki, što bez važećih dokaza ne možemo smatrati relevantnim podatkom. Nedostatak aktivnog monitoringa na području Bosne i Hercegovine i bez pojačanih aktivnosti novoosnovanog Interventnog tima za velike zvijeri brojnost ove zvijeri ostati će nejasna do daljnjeg. Prije spomenutim podacima ovaj čopor nije postojao na području općine Neum, moguće je da je uslijed izgradnje magistralnog puta Stolac-Neum i uslijed već započetih radova na kooridoru Vc migrirao na ovo područje (Menalo, 2022). Kao što je već i prije bilo spomenutu prilikom izgradnje ovih prometnih pravaca nisu izgrađeni zeleni mostovi ili prolazi za divlje životinje.

CONCLUSION – *Zaključak*

Ovim podacima jasno se ukazuje na širenje sve prisutne vrste sivog vuka širom dalmatinskog zaleđa na područjima gdje se u prošlosti samo povremeno pojavljivao (Frković i Huber, 1992.). Sukcesija staništa, raseljavanje stanovništva i veliki broj slabo čuvanih domaćih životinja pružaju idealne uvjete ovoj vrsti za stalno obitavanje. Porast prirodnog plijena manifestira se kroz rastuću populaciju srne obične (*Capreolus capreolus*) koja se lako prilagodila stanišnim uvjetima, dok je populacija divlje svinje (*Sus scrofa*) u stagnaciji. Tijekom provođenja istraživanja primijećeno je učestalo praćenje vučjeg čopora nad izoliranim jedinkama divljih svinja, mahom razreda mladih- nazimaca. U susjednom lovištu *XIX/118 Norin* u proljeće, prije pojave jednog od vučjih čopora iste godine, zabilježene su suprasne krmače dok se tijekom daljeg monitoringa divljači nije ustanovilo niti jedno prase okoćeno u tekućoj lovnoj godini (Ivan Senta, perss comm). Ovim radom po prvi puta dokumentirano je i potvrđeno razmnožavanje vuka na području Dubrovačko-neretvanske županije, čime smo ovu županiju nakon dugog niza godina ne provođenja sustavnog monitoringa od strane resornog Ministarstva svrstali u stalno područje prisutnosti sivoga vuka u Republici Hrvatskoj koje ujedno postaje i njegovo novo području reprodukcije. Broj štenaca u leglu pak u ovom području neznatno je manji od Hrvatskog prosjeka od 4 štenca (Štrbenac i sur.2005.) ili pak starijih podataka od 4,65 štenaca po ženki (Rapaić, 1989.).

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SUMMARY

Due to the unclear status of the population size and due to the increasingly visible increase in numbers and appearance in new habitats, the wolf in Croatia is expanding its area of reproduction and permanent residence. We conducted our research in a wider area of Vidonje village, part of Žaba mountain next to the border with Bosnia and Herzegovina. Using the proven methodology used in the monitoring of populations of large animals (SCALP), using photo traps, the appearance and permanent residence of a gray wolf pack in the locality of Vidonja was registered (Figure 1). During the monitoring, two reproductive seasons were covered, in which the population was monitored with the help of photo traps and damage to domestic animals (Graph 1). In the 2023/24 season, the reproductive pair had a litter of three puppies (Figure 4), while the reproductive pair and two of last year's puppies are present in the current season. This is the first documented breeding of the gray wolf in this area, which is now classified as an area of permanent residence and breeding territory of a border pack.

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