

& PROGRAMME

# BOOK OF ABSTRACTS

KNJIGA SAŽETAKA & PROGRAM

## FOREST PROTECTION AND TODAY'S CHALLENGES - SWITZERLAND, SLOVENIA, BOSNIA AND HERZEGOVINA, CROATIA

Zaštita šuma i izazovi  
današnjice - Švicarska,  
Slovenija, Bosna i  
Hercegovina, Hrvatska



UNIVERSITY OF ZAGREB  
FACULTY OF FORESTRY AND WOOD  
TECHNOLOGY, SVETOŠIMUNSKA 23,  
ZAGREB, CROATIA, MARCH 5TH, 2025

Sveučilište u Zagrebu  
Fakultet šumarstva i drvne tehnologije,  
Svetošimunska 23, Zagreb, Hrvatska  
5. ožujak 2025.



# FOREST PROTECTION AND TODAY'S CHALLENGES - SWITZERLAND, SLOVENIA, BOSNIA AND HERZEGOVINA, CROATIA

Zaštita šuma i izazovi današnjice - Švicarska,  
Slovenija, Bosna i Hercegovina, Hrvatska

*Scientific conference marking 260 years of  
Croatian forestry / Znanstveni skup u sklopu  
obilježavanja 260 godina hrvatskog šumarstva*



HRVATSKA KOMORA  
INŽENJERA ŠUMARSTVA  
I DRVNE TEHNOLOGIJE



HRVATSKI ŠUMARSKI INSTITUT / CROATIAN FOREST RESEARCH INSTITUTE  
AKADEMIJA ŠUMARSKIH ZNANOSTI / ACADEMY OF FORESTRY SCIENCES  
HRVATSKA KOMORA INŽENJERA ŠUMARSTVA I DRVNE TEHNOLOGIJE / CROATIAN CHAMBER  
OF FORESTRY AND WOOD TECHNOLOGY ENGINEERS  
HRVATSKO ŠUMARSKO DRUŠTVO / CROATIAN FORESTRY SOCIETY  
HRVATSKE ŠUME d.o.o. / CROATIAN FORESTS Ltd.

Forest Protection and Today's Challenges - Switzerland, Slovenia, Bosnia and Herzegovina, Croatia | University of Zagreb Faculty of Forestry and Wood Technology, Svetošimunska 23, Zagreb, March 5th - 2025  
Zaštita šuma i izazovi današnjice - Švicarska, Slovenija, Bosna i Hercegovina, Hrvatska | Sveučilište u Zagrebu Fakultet šumarstva i drvne tehnologije, Svetošimunska 23, Zagreb, 5. ožujak 2025.

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9:00 - 10:00 PARTICIPANTS REGISTRATION | REGISTRACIJA SUDIONIKA

10:00 - 10:15 OPENING OF THE CONFERENCE | OTVARANJE SKUPA

INVITED SPEAKERS | POZVANI PREDAVAČI

CHAIR: DANKO DIMINIĆ

10:15 - 10:40 **SIMONE PROSPERO: CURRENT STATUS OF THREE INVASIVE FOREST PATHOGENS IN SWITZERLAND** | DANAŠNJE STANJE INVAZIVNIH ŠUMSKIH PATOGENA U ŠVICARSKOJ

10:40 - 11:05 **BARBARA PIŠKUR: HIDDEN THREATS TO OUR FORESTS** | SKRIVENE PRIJETNJE U NAŠIM ŠUMAMA

11:05 - 11:30 **MIRZA DAUTBAŠIĆ: THE HEALTH STATUS OF FORESTS IN BOSNIA AND HERZEGOVINA** | ZDRAVSTVENO STANJE ŠUMA U BOSNI I HERCEGOVINI

11:30 - 11:55 **BORIS HRAŠOVEC: NEW CHALLENGES IN KEEPING OUR TREES AND FORESTS RESILIENT ENOUGH TO ALL THE NEGATIVE IMPACTS THEY ARE FACING TODAY** | NOVI IZAZOVI U OČUVANJU DRVEĆA I OTPORNOSTI NAŠIH ŠUMA NA SVE NEGATIVNE ČIMBENIKE KOJIMA SU DANAS IZLOŽENI

11:55 - 12:15 **COFFEE BREAK** | PAUZA ZA KAVU



## PRESENTATIONS | IZLAGANJA

CHAIRS: MILIVOJ FRANJEVIĆ, ANDRIJA JUKIĆ

- 12:15 - 12:30** **JOHANNA WITZELL, BENNO ANDREAS AUGUSTINUS, MARIELLA MARZANO, DINKA MATOŠEVIĆ\***: **URBAN TREE GUARD-SAFEGUARDING EUROPEAN URBAN FORESTS AND TREES THROUGH IMPROVED BIOSECURITY** | URBAN TREE GUARD-OČUVANJE EUROPSKIH URBANIH ŠUMA I DRVEĆA UZ POMOĆ POBOLJŠANE BIOSIGURNOSTI
- 12:30 - 12:45** **IVA FRANIĆ: PHYTOSANITARY RISK OF INTERNATIONAL TREE SEED EXCHANGE** | FITOSANITARNI RIZIK MEĐUNARODNE RAZMJENE SJEMENA DRVEĆA
- 12:45 - 13:00** **MARIN JEŽIĆ\*, MIRNA ĆURKOVIĆ PERICA, IGOR POLJAK, MARILENA IDŽOJTIĆ, LUCIJA NUSKERN, LJILJANA KRSTIN, ZORANA KATANIĆ, ZLATKO LIBER, KARLA PERANIĆ, MAJA POPOVIĆ, ANTONIO VIDAKOVIĆ: VARIABILITY IN SWEET CHESTNUT SUSCEPTIBILITY TO CHESTNUT BLIGHT DISEASE** | VARIJABILNOST U OSJETLJIVOSTI PITOMOG KESTENA NA BOLEST RAKA KORE
- 13:00 - 13:15** **TINE HAUPTMAN: NEW NON-NATIVE AMBROSIA BEETLES RECENTLY RECORDED IN SLOVENIA** | NOVE ALOHTONE VRSTE AMBROSIA KUKACA NEDAVNO ZABILJEŽENE U SLOVENIJI

## PRESENTATIONS | IZLAGANJA

CHAIRS: MILIVOJ FRANJEVIĆ, ANDRIJA JUKIĆ

- 13:15 - 13:30** **DANKO DIMINIĆ\*, JELENA KRANJEC ORLOVIĆ: COMPLEX OF PATHOGENIC AND DECAY FUNGI ASSOCIATED WITH THE DECLINE OF THE NARROW-LEAVED ASH IN CROATIA** | KOMPLEKS PATOGENIH GLJIVA I TRULEŽNICA POVEZANIH S ODUMIRANJEM POLJSKOG JASENA U HRVATSKOJ
- 13:30 - 13:45** **JELENA KRANJEC ORLOVIĆ\*, DANKO DIMINIĆ: ASH DIEBACK IN CROATIA: FINDINGS OF FUNGUS *BOTRYODIPLODIA FRAXINI* (FR.) SACC. ON NARROW-LEAVED ASH (*FRAXINUS ANGUSTIFOLIA* VAHL)** | ODUMIRANJE JASENA U HRVATSKOJ: PRONALASCI GLJIVE *BOTRYODIPLODIA FRAXINI* (FR.) SACC. NA POLJSKOME JASENU (*FRAXINUS ANGUSTIFOLIA* VAHL)
- 13:45 - 14:00** **MILIVOJ FRANJEVIĆ\*, BORIS HRAŠOVEC<sup>1</sup>, DANKO DIMINIĆ<sup>1</sup>, TOMISLAV KRCIVOJ<sup>2</sup>, DARIO KRIVIĆ, DORA BAKSA, JELENA KRANJEC ORLOVIĆ<sup>1</sup>: PHENOLOGY, ETHOLOGY AND TROPHIC CHARACTERISTICS OF *TREPTOPLATYPUS OXYURUS* (COLEOPTERA: PLATYPODIDAE) RARE SAPROXYLIYC BEETLE IN SILVER FIR (*ABIES ALBA*) FORESTS** | FENOLOGIJA, ETOLOGIJA I TROFIČKE KARAKTERISTIKE *TREPTOPLATYPUS OXYURUS* (COLEOPTERA: PLATYPODIDAE) RIJETKOG SAPROKSILIČNOG KUKCA U ŠUMAMA JELE (*ABIES ALBA*)
- 14:00 - 14:15** **DISCUSSION** | RASPRAVA
- 14:15 - 15:00** **LUNCH BREAK** | PAUZA ZA RUČAK

## PRESENTATIONS | IZLAGANJA

CHAIRS: LINDA BJEDOV, NIKOLA ZORIĆ

- 15:00 - 15:15** **MARKO VUCELJA\*, LINDA BJEDOV, MARKO BOLJFETIĆ, JOSIP MARGALETIĆ: SMALL RODENTS AND HARD TICKS IN CROATIAN FOREST ECOSYSTEMS - ECOLOGICALLY BASED INTEGRATED MANAGEMENT AND ZONOTIC RISK** | SITNI GLODAVCI I KRPELJI U ŠUMSKIM EKOSUSTAVIMA HRVATSKE - EKOLOŠKI UTEMELJENO INTEGRIRANO UPRAVLJANJE I ZONOTSKI RIZIK
- 15:15 - 15:30** **ZINA DEVETAK: DETECTION OF PINE NEEDLE PATHOGENS USING ENVIRONMENTAL DNA IN THE CASE OF *DOTHISTROMA PINI* AND *D. SEPTOSPORUM*** | DETEKCIJA PATOGENA BOROVIH IGLICA POMOĆU OKOLIŠNE DNK U SLUČAJU *DOTHISTROMA PINI* I *D. SEPTOSPORUM*
- 15:30 - 15:45** **KRISTIJAN TOMLJANOVIĆ: BARK STRIPPING, DIGGING, AND FEEDING ON FOREST SEEDS, AS WELL AS OTHER IMPACTS OF LARGE GAME ON FOREST TREES AND SHRUBS** | GULJENJE KORE, ROVANJE, ISHRANA ŠUMSKIM SJEMENOM TE OSTALI UTJECAJI KRUPNE DIVLJAČI NA ŠUMSKO DRVEĆE I GRMLJE
- 15:45 - 16:00** **ANDRIJA JUKIĆ\*, TOMISLAV KRCIVOJ, FILIP CVETKOVIĆ, DINKA MATOŠEVIĆ, NIKOLA ZORIĆ: QUARANTINE FOREST PEST MONITORING IN CROATIA** | MONITORING KARANTENSKIH ŠUMSKIH ŠTETNIKA U HRVATSKOJ

## PRESENTATIONS | IZLAGANJA

CHAIRS: LINDA BJEDOV, NIKOLA ZORIĆ

- 16:00 - 16:15**    **LUKA CAPUDER\*, TINE HAUPTMAN, FARAH KOOTSTRA, MARTIN KRIŽAJ, MARIJA KOLŠEK, MITJA FERLAN, MAARTEN DE GROOT: FELLING RESIDUE MANAGEMENT: IMPACTS ON BARK BEETLES |**  
GOSPODARENJE OSTACIMA NAKON SJEĆE: UTJECAJ NA POTKORNJAKE
- 16:15 - 16:30**    **NIKOLA ZORIĆ\*, ROBERT BOGDANIĆ: FOREST HEALTH MONITORING USING UAV-BASED TECHNOLOGIES |** NOVE TEHNOLOGIJE U MONITORINGU ZDRAVSTVENOG STANJA ŠUMA
- 16:30 - 16:45**    **DISCUSSION |** RASPRAVA
- 16:45 - 17:00**    **CLOSURE OF THE CONFERENCE |** ZATVARANJE SKUPA

# CURRENT STATUS OF THREE INVASIVE FOREST PATHOGENS IN SWITZERLAND | DANAŠNJE STANJE INVAZIVNIH ŠUMSKIH PATOGENA U ŠVICARSKOJ

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INVASIVE, NON-NATIVE PATHOGENS ARE INCREASINGLY THREATENING FOREST ECOSYSTEMS WORLDWIDE, EITHER FOLLOWING NEW INTRODUCTIONS OF RE-EMERGENCE DUE TO CLIMATE OR LAND USE CHANGES. SWITZERLAND WITH ITS CENTRAL LOCATION IN EUROPE AND IMPORTANT INTERNATIONAL CONNECTIONS IS UNFORTUNATELY NOT SAFE FROM THIS PHENOMENON. A SUCCESSFUL CONTROL OF INVASIVE PATHOGENS IS STILL PARTICULARLY CHALLENGING BECAUSE OF THE SPECIFICITIES OF BOTH THE TREE HOSTS AND THE PATHOGENS. IN MY TALK I WILL PRESENT THE CURRENT SITUATION REGARDING DISTRIBUTION, IMPACT AND CONTROL OF THREE INVASIVE DISEASES IN SWITZERLAND, NAMELY (1) INK DISEASE OF CHESTNUT CAUSED BY THE TWO OOMYCETE PATHOGENS *PHYTOPHTHORA CINNAMOMI* AND *P. X CAMBIVORA*; (2) CHESTNUT BLIGHT CAUSED BY THE ASCOMYCETE *CRYPHONETRIA PARASITICA*; AND (3) ASH DIEBACK CAUSED BY THE ASCOMYCETE *HYMENOSCYPHUS FRAXINEUS*.



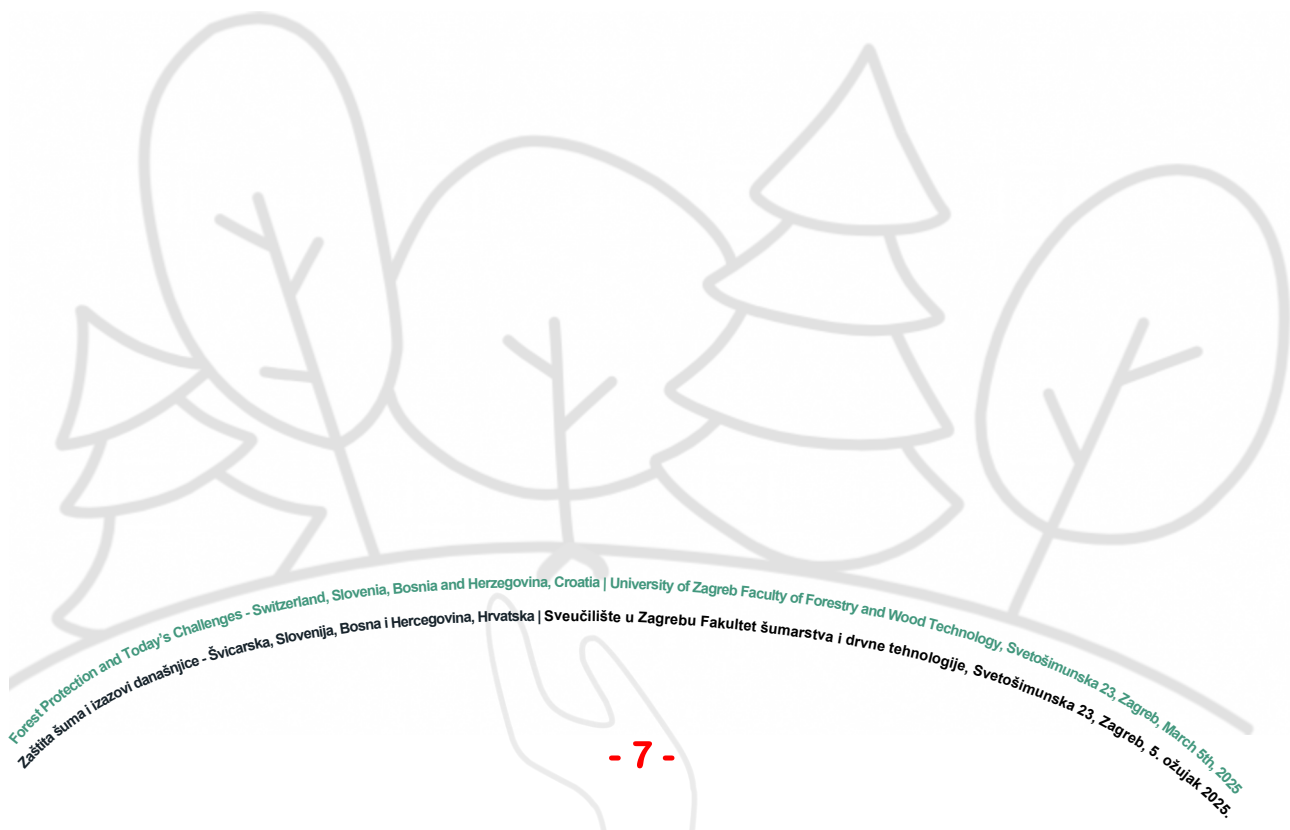
# HIDDEN THREATS TO OUR FORESTS | SKRIVENE PRIJETNJE U NAŠIM ŠUMAMA

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DISEASES, PESTS, AND CLIMATE CHANGE THREATEN THE RESILIENCE AND STABILITY OF OUR FUTURE FORESTS. WE USUALLY ASSOCIATE THESE THREATS WITH INTERNATIONAL TRADE AND THE MOVEMENT OF PEOPLE. HOWEVER, AN OVERLOOKED THREAT IS FOREST REPRODUCTIVE MATERIAL (FRM), WHICH POSES SIGNIFICANT BIOSECURITY RISKS TO FOREST ECOSYSTEMS, CLIMATE ADAPTATION, AND BIODIVERSITY. GLOBAL STUDIES INDICATE NURSERIES ARE CONTAMINATION HOTSPOTS, AND PLANTING FRM CAN INTRODUCE HARMFUL ORGANISMS, CAUSING LONG-TERM DAMAGE. PERSISTENT PATHOGENS LIKE *PHYTOPHTHORA* AND *VERTICILLIUM* CAN DEGRADE SOIL AND ENVIRONMENTAL QUALITY. GENETIC STUDIES ALSO HIGHLIGHT THE RISKS OF MOVING NATIVE SPECIES, POTENTIALLY INTRODUCING NEW POPULATIONS WITH SERIOUS ECOLOGICAL IMPACTS. EMPHASIZING THE BIOSECURITY RISKS OF FRM PRODUCTION AND PLANTING, AND RAISING AWARENESS ABOUT THESE THREATS, IS CRUCIAL.



# THE HEALTH STATUS OF FORESTS IN BOSNIA AND HERZEGOVINA | ZDRAVSTVENO STANJE ŠUMA U BOSNI I HERCEGOVINI

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VIOLATED BIOECOLOGICAL BALANCE IN A WIDER GEOGRAPHICAL AREA AND GLOBAL DISTURBANCES IN FOREST ECOSYSTEMS ARE ALSO MANIFESTED IN THE HEALTH CONDITION OF FORESTS IN BOSNIA AND HERZEGOVINA (BH). THE HEALTH CONDITION OF BH FORESTS CANNOT BE OBSERVED SEPARATELY FROM THE HEALTH STATUS OF FORESTS IN NEIGHBOURING COUNTRIES AND REGIONS. THE PAST DECADE REVEALED THE DIEBACK OF CONIFERS (SPRUCE, SILVER FIR) AS A CONSEQUENCE OF THE PROLIFERATION OF BARK BEETLES, DAMAGE CAUSED BY DEFOLIATORS *EUPROCTIS CRYSORRHOEA*, *LYMANTRIA DISPAR*, *RHYNCHAENUS FAGI*, *ARGYRESTHIA FUNDELLA*, *THEUMATOPOEA PITYOCAMPA*, DAMAGE BY FOREST FIRES, ICE AND ICE BREAKS, AS WELL AS ALIEN AND INVASIVE SPECIES. FREEZING RAIN AND LOW TEMPERATURES IN 2020 CAUSED CONSIDERABLE DAMAGE IN FORESTRY AREA "KLJUČ" (UNA-SANA CANTON) WITH THE CONSEQUENCES OF WHICH ARE STILL BEING REPAIRED TODAY. ICE BREAKS WERE FORMED ON A LARGE AREA (3,770 HA) IN THE ALTITUDE ZONE 450-750 M AFFECTING COMMON BEECH AND PINE FORESTS. TREE DISEASES RECORDED AS CAUSE OF CONSIDERABLE DAMAGE TO BH FOREST ECOSYSTEMS DURING LAST DECADE WERE *VISCUM ALBUM* SPP. *ABIETIS* ON SILVER FIR AND BLACK PINE, *HYMENOSCYPHUS FRAXINUS* ON ASH AND *CRYPHONECTRIA PARASITICA* ON SWEET CHESTNUT. THE MOST IMPORTANT BARK BEETLES THAT THREATEN FOREST ECOSYSTEMS ARE *IPS TYPOGRAPHUS* AND *PITYOGENES CHALCOGRAPHUS* ON SPRUCE, AND *PITYOKTEINES CURVIDENS* AND *P. SPINIDENS* ON SILVER FIR.

# NEW CHALLENGES IN KEEPING OUR TREES AND FORESTS RESILIENT ENOUGH TO ALL THE NEGATIVE IMPACTS THEY ARE FACING TODAY | Novi izazovi u očuvanju drveća i otpornosti naših šuma na sve negativne čimbenike kojima su danas izloženi

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THE TOPIC OF FOREST HEALTH AND TREE'S RESILIENCE TO, BOTH ABIOTIC AND BIOTIC NEGATIVE IMPACTS, HAS BEEN IN FOCUS OF RESEARCHERS CLOSE TO A CENTURY. IN FACT, AT THE BEGINNING OF 20TH CENTURY, FOLLOWING THE INSTANCES OF MORE OR LESS LOCALLY OR REGIONALLY PRONOUNCED CASES OF FOREST DECLINE, SCIENTISTS FROM VARIOUS FIELDS HAVE TRIED TO EXPLAIN THE CAUSAL CONNECTIONS AMONG THE LIKELY CULPRITS. THESE EFFORTS INTENSIFIED TOWARDS THE END OF CENTURY AND BY THE TURN OF MILLENNIA THE VOLUME OF FOREST-TREE-HEALTH-RESILIENCE RELATED RESEARCH HAS EXPLODED, AND FOR A GOOD REASON. IN THE LAST THREE TO FOUR DECADES, THE AMOUNT OF DISTURBANCES AFFECTING WORLD'S FORESTS HAS GREATLY INTENSIFIED. WHETHER IT BE RELATED TO CLIMATIC SHIFTS AND SEVERITY PLUS THE PERIODICITY OF THE EXTREMES OR IMPACTS OF IN CONNECTION WITH THE INVASIVE ORGANISMS AS A RESULT OF INTERNATIONAL TRADE AND TRAFFIC. IN ESSENCE, CLIMATE AND INTER CONTINENTALLY DISPLACED ORGANISMS CAN BE SINGLED OUT AS THE MOST PROMINENT CHALLENGING FACTORS FOR THE FOREST HEALTH TODAY. THE HISTORY OF FOREST RESEARCH WITHIN THE DISCIPLINES LIKE FOREST ENTOMOLOGY, FOREST PATHOLOGY, FOREST FIRES AND FOREST PROTECTION IN CROATIAN RESEARCH CIRCLES HAS FOLLOWED THE GENERAL EUROPEAN, AND WORLD TRENDS, ALBEIT, WITH SOME SPECIFIC TOPICS HIGHLY RELEVANT AND IN CONNECTION WITH FOREST COVER AND TREE SPECIES RELEVANT FOR CROATIAN LANDSCAPE AND OUR 260 YEAR OLD HISTORY OF FOREST MANAGEMENT. THIS PRESENTATION AIMS TO ILLUSTRATE HOW THESE CHALLENGES CHANGED THROUGH TIME AND SINGLE OUT THE MOST RECENT ONES THAT ARE PILING UP WITH UNPRECEDENTED SPEED.

# URBAN TREE GUARD-SAFEGUARDING EUROPEAN URBAN FORESTS AND TREES THROUGH IMPROVED BIOSECURITY | URBAN TREE GUARD-OČUVANJE EUROPSKIH URBANIH ŠUMA I DRVEĆA UZ POMOĆ POBOLJŠANE BIOSIGURNOSTI

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GREEN INFRASTRUCTURE, INCLUDING URBAN FORESTS, HAS BEEN PROPOSED BY THE EUROPEAN COMMISSION AS A STRATEGY TO SUPPORT CLIMATE ADAPTATION CAPACITY AND SUSTAINABLE DEVELOPMENT IN URBAN AREAS WHERE OVER 70% OF THE EU'S POPULATION LIVE. ALARMINGLY, GREEN INFRASTRUCTURE AND ESPECIALLY ITS CHARACTERISTIC ELEMENTS, TREES, ARE INCREASINGLY THREATENED BY ALIEN PESTS (INSECTS AND PATHOGENS). CURRENT BIOSECURITY SYSTEMS OFTEN FAIL TO INTERCEPT MANY ALIEN PESTS THAT OFTEN ALSO BENEFIT FROM THE ALTERED CLIMATE. THE COST ACTION URBAN TREE GUARD (CA 20132) BRINGS TOGETHER A PAN-EUROPEAN AND INTERNATIONAL NETWORK OF SCIENTISTS AND STAKEHOLDERS TO MEET THIS CHALLENGE. AS URBAN TREES HAVE BEEN RECOGNIZED AS THE FIRST POINT OF INTRODUCTION OF ALIEN FOREST PESTS, URBAN TREE GUARD HAS CREATED A PAN-EUROPEAN URBAN TREE INVENTORY COMPRISING 27 COUNTRIES, 9.6 MILLION TREES AND 2700 TREE SPECIES. OUR RESULTS HAVE SHOWN THAT EU PRIORITY QUARANTINE PESTS WILL FIND ABUNDANT HOST TREES IN EUROPEAN CITIES WHICH IS CONCERNING BECAUSE URBAN FORESTS AND TREES CAN ACT AS STEPPINGSTONES FOR FURTHER SPREAD OF ALIEN PESTS INTO FORESTS. ANOTHER IMPLICATION IS THAT URBAN AREAS CAN PROVIDE A FRONTLINE OF DEFENCE THROUGH PREPAREDNESS, SURVEILLANCE, AND OUTBREAK MANAGEMENT.

# PHYTOSANITARY RISK OF INTERNATIONAL TREE SEED EXCHANGE | FITOSANITARNI RIZIK MEĐUNARODNE RAZMJENE SJEMENA DRVEĆA

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ALTHOUGH SEVERAL SERIOUS TREE DISEASE OUTBREAKS IN FORESTS AND PLANTATIONS HAVE BEEN LINKED TO SEED-BORNE PATHOGENS, TREE SEEDS ARE CONSIDERED A LOW-RISK INTRODUCTION PATHWAY FOR PLANT PATHOGENIC FUNGI AND THEIR MOVEMENT IS MINIMALLY REGULATED. AT THE SAME TIME APPROXIMATELY 25 MILLION KILOGRAMS OF TREE SEEDS HAVE BEEN EXCHANGED BETWEEN COUNTRIES ANNUALLY AND THIS MAY INCREASE IN THE FUTURE. OUR RECENT MOLECULAR STUDIES SHOW THAT TREE SEEDS HARBOUR DIVERSE FUNGAL COMMUNITIES, INCLUDING KNOWN PATHOGENS. FURTHERMORE, SEED-BORNE FUNGAL COMMUNITIES ARE MAINLY SHAPED BY THE HOST SPECIES AND LESS BY THE ENVIRONMENT, PROBABLY DUE TO FREQUENT VERTICAL TRANSMISSION. OUR RESULTS THEREFORE SUGGEST THAT THE RISK OF INTRODUCING PATHOGENS VIA SEED TRADE IS HIGH, AS IS THE RISK OF THEIR ESTABLISHMENT IN THE NEW AREA. HOWEVER, FURTHER RESEARCH IS NEEDED TO UNDERSTAND THE IMPACT OF SEED- BORNE FUNGI IN THE NEW ENVIRONMENT AND TO DEVELOP APPROPRIATE RISK MANAGEMENT STRATEGIES.





# VARIABILITY IN SWEET CHESTNUT SUSCEPTIBILITY TO CHESTNUT BLIGHT DISEASE | VARIJABILNOST U OSJETLJIVOSTI PITOMOG KESTENA NA BOLEST RAKA KORE

MARIN JEŽIĆ<sup>1</sup>, MIRNA ČURKOVIĆ PERICA<sup>1</sup>, IGOR POLJAK<sup>2</sup>, MARILENA IDŽOJTIĆ<sup>2</sup>, LUCIJA NUSKERN<sup>1</sup>, LJILJANA KRSTIN<sup>3</sup>, ZORANA KATANIĆ<sup>3</sup>, ZLATKO LIBER<sup>4</sup>, KARLA PERANIĆ<sup>1</sup>, MAJA POPOVIĆ<sup>5</sup>, ANTONIO VIDA KOVIĆ<sup>2</sup> | MARIN.JEZIC@BIOL.PMF.HR

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<sup>3</sup>UNIVERSITY OF J. J. STROSSMAYER IN OSIJEK, DEPARTMENT OF BIOLOGY, CROATIA | <sup>4</sup>UNIVERSITY OF ZAGREB FACULTY OF SCIENCE, DEPARTMENT OF BIOLOGY, DIVISION OF BOTANY, CROATIA |

<sup>5</sup>UNIVERSITY OF ZAGREB FACULTY OF FORESTRY AND WOOD TECHNOLOGY, INSTITUTE OF FOREST ENGINEERING, CROATIA

THE CHESTNUT BLIGHT DISEASE, CAUSED BY THE FUNGUS *CYRYPHONECTRIA PARASITICA*, INTRODUCED INTO EUROPE LAST CENTURY, QUICKLY SPREAD THROUGHOUT THE SWEET CHESTNUT RANGE AND DEVASTATED MANY DECIDUOUS FORESTS OF THE CONTINENT. THE PRESENCE OF AN RNA VIRUS CAN ALLEVIATE THE SYMPTOMS OF BLIGHT DISEASE - *CHRYPHONECTRIA HYPOVIRUS 1* (CHV1), IN THE FUNGAL CYTOPLASM. BEYOND THAT, THE CHESTNUT HAS A VARIABLE DEGREE OF TOLERANCE TOWARD THE DISEASE. ASIAN CHESTNUT SPECIES ARE HIGHLY TOLERANT, WHILE EUROPEAN SWEET CHESTNUT - *CASTANEA SATIVA*, AND ESPECIALLY AMERICAN CHESTNUT - *C. DENTATA*, ARE VULNERABLE. FURTHERMORE, MANY DIFFERENT CULTIVARS HAVE BEEN RECOGNIZED OVER THE CENTURIES IN EUROPE, E.G., MARRON, RENOWNED FOR ITS FRUITS. UNFORTUNATELY, ONE OF THE MARRON VARIETIES FROM LOVRAN SHOWS MUCH LOWER TOLERANCE TOWARD THE DISEASE AND SLOWER RECOVERY, EVEN IN THE RIGHT CONDITIONS. WILD CHESTNUT TREES FROM DIFFERENT POPULATIONS EXHIBIT VARIABLE SUSCEPTIBILITY TOWARD THE DISEASE AS WELL. INDEED, IT CAN BE ASSUMED THAT GENETIC AND ENVIRONMENTAL FACTORS PROBABLY BOTH PLAY SIGNIFICANT ROLE IN THE TREES' ABILITY TO WITHSTAND THE DISEASE.

# NEW NON-NATIVE AMBROSIA BEETLES RECENTLY RECORDED IN SLOVENIA | NOVE ALOHTONE VRSTE AMBROSIA KUKACA NEDAVNO ZABILJEŽENE U SLOVENIJI

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AMBROSIA BEETLES (CURCULIONIDAE, SCOLYTINAE, XYLEBORINI) ARE OFTEN INTRODUCED TO NEW AREAS THROUGH INTERNATIONAL TRADE. DUE TO THEIR CRYPTIC LIFESTYLE, ASSOCIATION WITH SYMBIOTIC FUNGI, INBREEDING, WIDE HOST RANGE AND THEIR POTENTIAL TO ADAPT TO DIFFERENT CLIMATIC CONDITIONS, AMBROSIA BEETLES HAVE PROVEN TO BE ONE OF THE MOST SUCCESSFUL GROUPS OF INVASIVE SPECIES. BECAUSE THEY ARE ATTRACTED TO ETHANOL, AND ETHANOL IS OFTEN USED IN VARIOUS NATIONAL SURVEYS FOR THE PRESENCE OF QUARANTINE PESTS, DIFFERENT AMBROSIA BEETLES ARE REGULARLY PART OF THE BYCATCH OF THESE ACTIVITIES. DURING THE SURVEY FOR THE EARLY DETECTION OF THE QUARANTINE OAK BARK BEETLES (*PSEUDOPITYOPHTHORUS* SPP.) IN 2023 AND 2024, WE HAVE CONFIRMED THE PRESENCE OF THREE NEW NON-NATIVE AMBROSIA BEETLE SPECIES IN SLOVENIA, NAMELY *ANISANDRUS MAICHE*, *CNESTUS MUTILATUS* AND *XYLOSANDRUS COMPACTUS*. WE PRESENT DATA ON THE CURRENTLY KNOWN DISTRIBUTION OF THESE SPECIES AND DISCUSS POSSIBLE PATHWAYS OF INTRODUCTION AND DISPERSAL.

# COMPLEX OF PATHOGENIC AND DECAY FUNGI ASSOCIATED WITH THE DECLINE OF THE NARROW-LEAVED ASH IN CROATIA | KOMPLEKS PATOGENIH GLJIVA I TRULEŽNICA POVEZANIH S ODUMIRANJEM POLJSKOG JASENA U HRVATSKOJ

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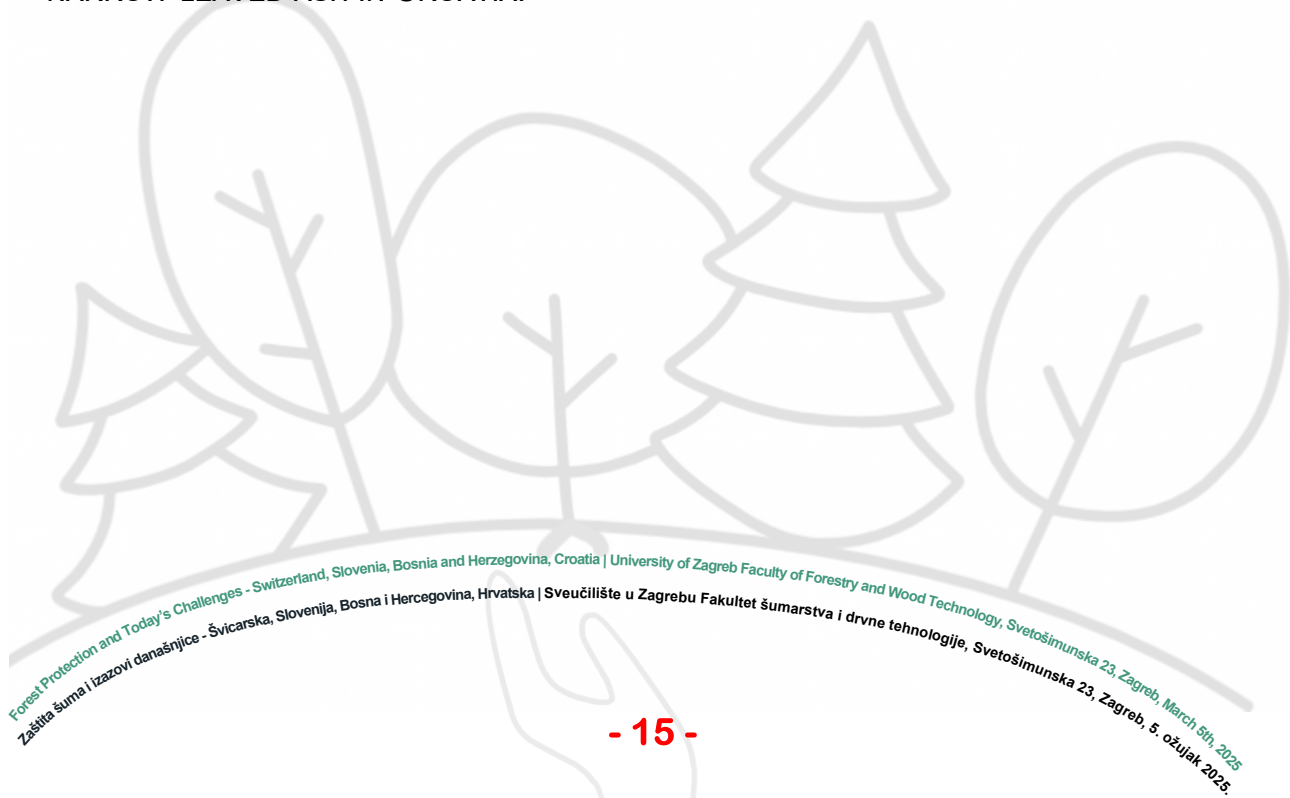
RESEARCH CARRIED OUT SINCE 2011 IN THE LOWLAND FORESTS IN CROATIA REVEALED THAT THE PRIMARY CAUSE OF THE DECLINING NARROW-LEAVED ASH (*FRAXINUS ANGUSTIFOLIA*) WAS *HYMENOSCYPHUS FRAXINEUS*. IT'S PRESENCE AND INJURIOUS IMPACT CORRELATED WITH THE HEALTH CONDITION. THE 2019 REPORT ON THE CROWN DEFOLIATION REVEALED AN ABRUPT TREND (ICP FORESTS). IN 2011, DEFOLIATION AMOUNTED TO 17% BUT REACHED 75% IN 2017. IN THE FOLLOWING YEARS, THE RATE WAS SLIGHTLY LOWER, BUT THE NUMBER OF DEAD TREES IN FOREST SITES INCREASED. ALONG WITH THE *HYMENOSCYPHUS FRAXINEUS*, A COMPLEX OF PATHOGENIC AND DECAY FUNGI WAS OBTAINED IN DECLINING NARROW-LEAVED ASH STANDS. SYMPTOMATIC AND NECROTIC TWIGS AND BRANCHES REVEALED MOST FREQUENTLY PRESENT *HYSTEROGYPHUM FRAXINI*, *DIPLODIA MUTILA*, *D. FRAXINI*, *D. SERIATA*, *DIAPORTHE ERES*, *FUSARIUM SOLANI*, AND DISCOLOURED AND DECAYED WOOD OF THE TRUNK AND ROOTS REVEALED *KRETZSCHMARIA DEUSTA*, *ILYONECTRIA ROBUSTA*, *DIPLODIA MUTILA*, *D. FRAXINI*, *D. SERIATA*, *FUSARIUM SOLANI*, *EUTYPA LATA*, *LENTINUS TIGRINUS*, *ARMILLARIA GALLICA*, *A. CEPISTIPES*, *GANODERMA RESINACEUM*, *G. ADSPERSUM*, *G. APPLANATUM*.

# ASH DIEBACK IN CROATIA: FINDINGS OF FUNGUS *BOTRYODIPLODIA FRAXINI* (FR.) SACC. ON NARROW-LEAVED ASH (*FRAXINUS ANGUSTIFOLIA* VAHL) | ODUMIRANJE JASENA U HRVATSKOJ: PRONALASCI GLJIVE *BOTRYODIPLODIA FRAXINI* (FR.) SACC. NA POLJSKOME JASENU (*FRAXINUS ANGUSTIFOLIA* VAHL)

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NARROW-LEAVED ASH, ECOLOGICALLY AND ECONOMICALLY VERY IMPORTANT SPECIES IN LOWLAND FORESTS IN CROATIA, HAS BEEN SEVERELY AFFECTED BY DIEBACK FOR MORE THAN A DECADE. AT THE BEGINNING OF THE PROCESS, PATHOGENIC FUNGUS *HYMENOSCYPHUS FRAXINEUS* WAS FOUND TO BE A PRIMARY CAUSATIVE AGENT OF CROWN DIEBACK AT MULTIPLE LOCATIONS. INVOLVEMENT OF OTHER OPPORTUNISTIC AND SECONDARY PATHOGENIC FUNGI IN THE NARROW-LEAVED ASH DIEBACK WAS CONFIRMED SINCE THAT TIME, SUCH AS *ARMILLARIA* SPP., *DIAPORTHE* SPP., *GANODERMA* SPP., AND OTHERS. IN PERIOD BETWEEN 2021 AND 2025, FUNGUS *BOTRYODIPLODIA FRAXINI* HAS BEEN RELATIVELY FREQUENTLY FOUND IN SYMPTOMATIC STEMS, BRANCHES, TWIGS AND SHOOTS OF NARROW-LEAVED ASH IN SEVERAL DIFFERENT LOCATIONS. PATHOGENICITY OF THE FUNGUS TOWARDS NARROW-LEAVED ASH WAS TESTED AND CONFIRMED ON 6-YEAR-OLD TREES IN AN OPEN-FIELD TRIAL IN THE NURSERY OF THE FACULTY OF FORESTRY AND WOOD TECHNOLOGY. THE OVERALL RESULTS INDICATE THAT THE FUNGUS CURRENTLY PLAYS AN IMPORTANT ROLE IN THE DIEBACK OF NARROW-LEAVED ASH IN CROATIA.



# PHENOLOGY, ETHOLOGY AND TROPHIC CHARACTERISTICS OF *TREPTOPLATYPUS OXYURUS* (COLEOPTERA: PLATYPODIDAE) RARE SAPROXYLIC BEETLE IN SILVER FIR *ABIES ALBA* FORESTS FENOLOGIJA, ETOLOGIJA I TROFIČKE KARAKTERISTIKE *TREPTOPLATYPUS OXYURUS* (COLEOPTERA: PLATYPODIDAE) RIJETKOG SAPROKSILIČNOG KUKCA U ŠUMAMA JELE *ABIES ALBA*

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AFTER RECENT FINDINGS OF FIR PINHOLE BORER (*TREPTOPLATYPUS OXYURUS*) (COLEOPTERA: PLATYPODIDAE) IN AFTERMATH OF SANITARY LOGGING OPERATIONS IN GORSKI KOTAR COUNTY OPPORTUNITY FOR DETAILED STUDY OF PHENOLOGY, ETHOLOGY AND TROPHIC CHARACTERISTICS WAS OBSERVED. *T. OXYURUS* SPECIMENS WERE SUSTAINED ALIVE IN WOODEN MATERIAL COLLECTED IN THE FIELD. GALLERY SYSTEMS WERE SCANNED WITH COMPUTED TOMOGRAPHY (CT) AND 3D IMAGES WERE DESCRIBED FROM COLLECTED WOODEN MATERIAL. AFTER OBSERVING PROPERTY OF STRIDULATION IN ADULT INDIVIDUALS LIVE SPECIMENS OF *T. OXYURUS* AND THEIR SOUND PRODUCTION WERE RECORDED IN SILENT ROOM. RESULTS SHOWED THAT INDIVIDUAL CORRIDORS OF *T. OXYURUS*, AS A RULE, NEVER INTERSECT, CROSS OR CONNECT. EACH FAMILY OF BEETLES (MALE, FEMALE AND THEIR OFFSPRING) LIVES SEPARATELY IN ITS CORRIDOR SYSTEM. IN ORDER TO PRESERVE THE SAPROXYLIC ENTOMOFAUNA AND TO BETTER UNDERSTAND THE TROPHIC CHARACTERISTICS OF THE FIR PINHOLE BORER, IT IS IMPORTANT TO STUDY THE PHYLOGENETIC RELATIONSHIP OF TWO SPECIES THAT COME IN CROATIA AND BELONG TO (COLEOPTERA: PLATYPODIDAE) *TREPTOPLATYPUS OXYURUS* FIR PINHOLE BORER AND *PLATYPUS CYLINDRUS* OAK PINHOLE BORER. FUNGI THAT LIVE IN SYMBIOSIS WITH THESE SAPROXYLIC INSECTS PLAY AN IMPORTANT ROLE (THEY DEVELOP IN DECAYING WOOD) AND ARE LOCATED IN A SPECIALIZED ORGAN ON THE PRONOTUM (NECK SHIELD) AND DEVELOP IN RELATION TO THE TYPE OF HOST TREE. FOR THIS PURPOSE, MOLECULAR ANALYSIS OF FUNGI IN MICANGIUM OF BOTH SPECIES IS UNDERWAY.



# SMALL RODENTS AND HARD TICKS IN CROATIAN FOREST ECOSYSTEMS - ECOLOGICALLY BASED INTEGRATED MANAGEMENT AND ZONOTIC RISK | SITNI GLODAVCI I KRPELJI U ŠUMSKIM EKOSUSTAVIMA HRVATSKE - EKOLOŠKI UTEMELJENO INTEGRIRANO UPRAVLJANJE I ZONOTSKI RIZIK

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SMALL RODENTS (MURINAE, ARVICOLINAE) - DESPITE THEIR NUMEROUS POSITIVE ECOLOGICAL IMPACTS - IMPEDE NATURAL FOREST REGENERATION DURING THE YEARS OF THEIR MASS OCCURRENCE (EVERY 3-4 YR. AVER.), CAUSING DAMAGE TO SEEDS AND SAPLINGS OF ECONOMICALLY IMPORTANT TREE SPECIES (E.G., *QUERCUS ROBUR* L.; *FRAXINUS AGNOSTIFOLIA* VAHL.) IN CROATIAN LOWLAND FOREST ECOSYSTEMS. SINCE THE EARLY 1980S, ANNUAL RODENT DAMAGE HAS BEEN RECORDED AT APPROX. 2.800 HA IN CROATIAN STATE FORESTS AND THE DOMINANT METHOD OF CONTROLLING THEIR POPULATIONS WAS, AND STILL IS, THE APPLICATION OF RODENTICIDES (8T/YR). FROM YR. 2017 RODENT MONITORING IN STATE FORESTS INCLUDES RODENT SAMPLING (TRAPPING), WHICH BECAME THE BASIS FOR APPLYING DIFFERENT PREVENTIVE OR REPRESSIVE PROTECTION METHODS (E.G., HABITAT MANAGEMENT, USE OF REPELLENTS, ARTIFICIAL BIRD PERCHES ETC.). BEING THE HOSTS AND VECTORS OF NUMEROUS ZONOTIC DISEASES (E.G. HEMORRHAGIC FEVER WITH RENAL SYNDROME, LEPTOSPIROSIS, TULAREMIA, LYME DISEASE ETC.), SMALL RODENTS, AND ALSO HARD TICKS (IXODIDAE; 23 SP. IN CROATIA!), REMAIN IMPORTANT BIOTIC FACTOR THAT NEED TO BE MONITORED AND MANAGED SYSTEMATICALLY IN OUR FOREST ECOSYSTEMS.

# DETECTION OF PINE NEEDLE PATHOGENS USING ENVIRONMENTAL DNA IN THE CASE OF *DOTHISTROMA PINI* AND *D. SEPTOSPORUM* | DETEKCIJA PATOGENA BOROVIH IGLICA POMOĆU OKOLIŠNE DNK U SLUČAJU *DOTHISTROMA PINI* I *D.*

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EARLY DETECTION REMAINS CRUCIAL FOR TIMELY RISK ASSESSMENT, ACTION PLANNING AND DELIMITING THE POTENTIAL DAMAGES CAUSED BY NOVEL INTRODUCTIONS OF PLANT PATHOGENS. UTILIZATION OF ENVIRONMENTAL DNA (EDNA), COUPLED WITH HIGH THROUGHPUT SEQUENCING, ENABLES SIMULTANEOUS DETECTION OF MULTIPLE TARGET SPECIES. WE WILL PRESENT PLANS FOR TESTING THIS METHODOLOGY ON THE CASE OF *DOTHISTROMA PINI* AND *D. SEPTOSPORUM*, CAUSAL AGENTS OF THE DOTHISTROMA NEEDLE BLIGHT. THE METABARCODING PRINCIPLE WILL BE USED TO COMPARE THE SUCCESS OF DETECTION OF THE TARGET FUNGI IN MULTIPLE SAMPLE TYPES COLLECTED IN *PINUS* SP. STANDS WITH KNOWN PRESENCE OF BOTH PATHOGENS, FOCUSING ESPECIALLY ON DETECTION THROUGH ANALYSIS OF POTENTIAL VECTORS AND RELATED SAMPLES (E.G., HONEY, POLLEN, CONSERVATION FLUID FROM TRAPS, ...). WE WILL SIMULTANEOUSLY USE MORE ESTABLISHED DETECTION METHODS (SPECIES-SPECIFIC QPCR) ON THE SAME SAMPLES AND COMPARE THE RESULTS TO THE RESULTS OF THE METABARCODING APPROACH. LAST BUT NOT LEAST, THE PROJECT WILL ENABLE US TO BROADEN THE KNOWLEDGE OF FUNGAL DIVERSITY IN *PINUS* SP. STANDS IN SLOVENIA.

# **BARK STRIPPING, DIGGING, AND FEEDING ON FOREST SEEDS, AS WELL AS OTHER IMPACTS OF LARGE GAME ON FOREST TREES AND SHRUBS | GULJENJE KORE, ROVANJE, ISHRANA ŠUMSKIM SJEMENOM TE OSTALI UTJECAJI KRUPNE DIVLJAČI NA ŠUMSKO DRVEĆE I GRMLJE**

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WILDLIFE IS MANAGED BASED ON HUNTING MANAGEMENT PLANS. IN THE PREPARATION OF THESE PLANS, CARRYING CAPACITIES ARE CALCULATED FOR EACH SPECIES. THESE CAPACITIES ARE DETERMINED IN ACCORDANCE WITH HABITAT POTENTIALS AND VARY FOR EACH SPECIES WITHIN THE SAME HUNTING AREA. WHEN DETERMINING THESE CAPACITIES, I.E. THE MAXIMUM POPULATION DENSITY PER UNIT AREA, CARE IS TAKEN TO MINIMIZE ANY NEGATIVE IMPACTS ON THE HABITAT AND THE INTERACTIONS BETWEEN DIFFERENT SPECIES. HOWEVER, IN CERTAIN YEARS, DUE TO HEAVY SNOWFALL, FLOODING, AND OTHER NEGATIVE ABIOTIC AND BIOTIC INFLUENCES, MIGRATIONS OF WILDLIFE OCCUR, LEADING TO THEIR CONCENTRATION IN SMALLER AREAS, ETC. DURING THIS TIME, THE OVERALL CAPACITY OF THE HUNTING GROUND REMAINS UNCHANGED, HOWEVER THE PRESSURE ON THE MICRO-LOCATIONS WHERE WILDLIFE CONCENTRATE IS SIGNIFICANTLY GREATER THAN USUAL. THIS OFTEN RESULTS IN SUBSTANTIAL DAMAGE TO WOODY AND HERBACEOUS VEGETATION, SEEDS, AND SOIL. MOST OFTEN IN THE EARLY WINTER PERIOD, DUE TO A LACK OF NUTRIENTS, BARK STRIPPING AND THE BROWSING OF GREEN PLANT PARTS (YOUNG SHOOTS) OCCUR. ADDITIONALLY, YOUNG TREES ARE PRONE TO UPROOTING AND BEING TORN OUT AT THE EARLIEST STAGE OF THEIR DEVELOPMENT. LARGE GAME TENDS TO CONSUME LARGE FOREST SEEDS SUCH AS ACORNS AND BEECHNUTS DURING THE AUTUMN AND WINTER PERIODS, WHICH ALSO COMPLICATES NATURAL REGENERATION.

# QUARANTINE FOREST PEST MONITORING IN CROATIA | MONITORING KARANTENSKIH ŠUMSKIH ŠTETNIKA U HRVATSKOJ

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PRESERVATION OF FOREST HEALTH AND REDUCTION OF HARMFUL IMPACTS FROM NATIVE AND INVASIVE ALIEN SPECIES ON ECOSYSTEMS ARE OF CRITICAL IMPORTANCE IN CROATIAN FORESTS. SOME OF THE NON-NATIVE INSECT AND FUNGAL SPECIES HAVE BEEN RECOGNIZED AS POTENTIALLY DANGEROUS FOREST PESTS THAT COULD HAVE DEVASTATING EFFECTS TO NATURAL FOREST ECOSYSTEMS IN CROATIA. IN THE LAST FIVE YEARS WE HAVE MONITORED A RANGE OF QUARANTINE INSECT AND FUNGAL PESTS IN VARIOUS FOREST ECOSYSTEMS ON WIDE DIVERSITY OF HOST PLANTS. THE RESULTS OF OUR STUDY PROVIDE VALUABLE INSIGHTS INTO THE NATIONAL SURVEILLANCE SCHEME FOR INVASIVE PESTS AND PATHOGENS, SPECIES OF SURVEYED PESTS AND THEIR POTENTIAL IMPACT ON FOREST HEALTH. THE STUDY HIGHLIGHTS SUCCESSFUL APPLICATION OF VARIOUS METHODS, INCLUDING VISUAL INSPECTIONS, TRAPPING USED AS EARLY WARNING SYSTEM, USE OF UAV, MORPHOLOGICAL AND MOLECULAR ANALYSES, IN DETECTING AND IDENTIFYING ALIEN INSECTS AND FUNGAL PESTS.



# FELLING RESIDUE MANAGEMENT: IMPACTS ON BARK BEETLES | GOSPODARENJE OSTACIMA NAKON SJEČE: UTJECAJ NA POTKORNJAKE

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OVER THE PAST DECADES BARK BEETLES HAVE POSED SIGNIFICANT FOREST HEALTH CHALLENGES. VARIOUS STRATEGIES FOR CONTROLLING OUTBREAKS HAVE BEEN EXPLORED, YET THE IMPACT OF FELLING RESIDUES REMAINS INSUFFICIENTLY STUDIED. AFTER TREE FELLING, SPRUCE BRANCHES ARE TRADITIONALLY GATHERED INTO PILES TO MINIMIZE THE AVAILABLE BROOD MATERIAL FOR BARK BEETLES. HOWEVER, THE EFFECTIVENESS OF THIS METHOD COMPARED TO OTHER RESIDUE MANAGEMENT APPROACHES HAS NEVER BEEN THOROUGHLY EXAMINED. OUR STUDY AIMED TO IDENTIFY THE MOST EFFECTIVE RESIDUE MANAGEMENT STRATEGY FOR CONTROLLING BARK BEETLES, CONSIDERING GEOGRAPHICAL LOCATION AND MICROHABITAT CONDITIONS. WE ESTABLISHED EXPERIMENTAL PLOTS WITH THREE TREATMENT TYPES: (1) RESIDUES IN PILES, (2) RESIDUES SCATTERED AND 3) RESIDUES REMOVED. WE MONITORED TEMPERATURE AND HUMIDITY, TRAPPED AND COUNTED BARK BEETLES ATTRACTED TO THE TREATMENTS, AND RECORDED THE NUMBER OF ENTRY HOLES IN BOTH SMALL AND LARGE BRANCHES. THE RESULTS WILL PROVIDE INSIGHTS INTO HOW SITE CONDITIONS AND CANOPY OPENNESS INFLUENCE BARK BEETLE DIVERSITY AND ABUNDANCE, CONTRIBUTING TO THE UNDERSTANDING OF FELLING RESIDUE MANAGEMENT.



# FOREST HEALTH MONITORING USING UAV-BASED TECHNOLOGIES

## | NOVE TEHNOLOGIJE U MONITORINGU ZDRAVSTVENOG STANJA ŠUMA

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FOREST PROTECTION IS CHALLENGED BY CLIMATE CHANGE, INTERNATIONAL TRADE, AND LAND-USE CHANGES, LEAVING FORESTS-CROATIA INCLUDED-VULNERABLE TO QUARANTINE PESTS. INSECTS, FUNGAL PATHOGENS, AND INVASIVE ALIEN SPECIES CAUSE SEVERE ECOLOGICAL AND ECONOMIC HARM. EFFECTIVE STRATEGIES DEMAND PREVENTION, EARLY DETECTION, AND THOROUGH PEST MONITORING. TRADITIONAL METHODS MAY BE SLOW AND COSTLY, MISSING EARLY INFESTATIONS. CONSEQUENTLY, DRONES WITH THERMAL AND MULTISPECTRAL CAMERAS (E.G., DJI MAVIC 3 MS, MAVIC 3 T) OFFER RAPID, HIGH-RESOLUTION DETECTION OF STRESS INDICATORS LIKE VEGETATION INDICES AND THERMAL ANOMALIES, SAVING TIME AND RESOURCES. HOWEVER, BATTERY CAPACITY, FLIGHT RANGE, AND EASA REGULATIONS CAN LIMIT DRONE DEPLOYMENT. NEVERTHELESS, DRONE-BASED SURVEILLANCE ADVANCES FOREST HEALTH MONITORING, ENABLING EARLIER QUARANTINE PEST DETECTION, PARTICULARLY IN DENSE FOREST VEGETATION.



## NOTES | BILJEŠKE

## NOTES | BILJEŠKE







# THANK YOU ALL FOR YOUR CONTRIBUTION!

Hvala Vam svima na doprinosu!



HRVATSKA KOMORA  
INŽENJERA ŠUMARSTVA  
I DRVNE TEHNOLOGIJE



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