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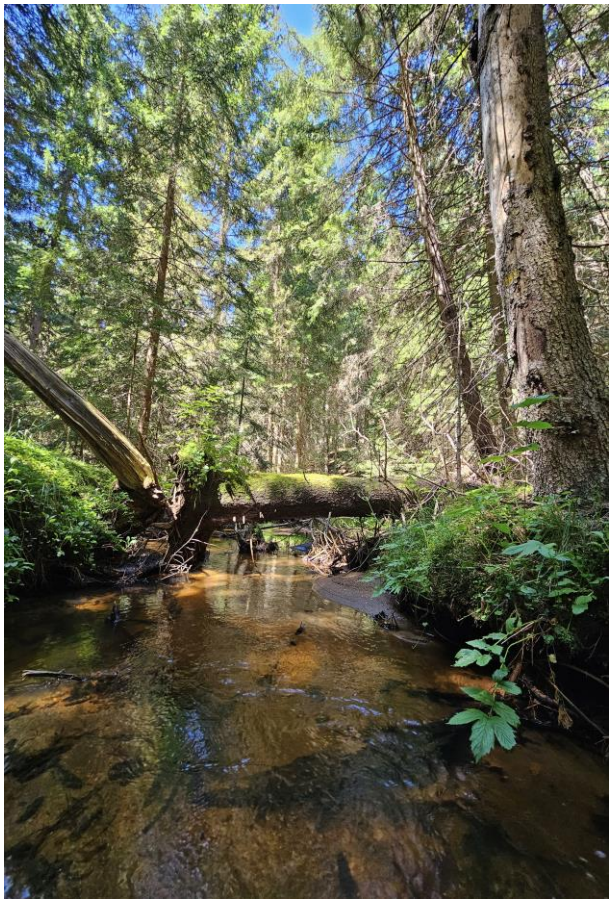

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Original scientific paper

USE OF A DATABASE FOR DETERMINING THE SPATIAL DISTRIBUTION OF PESTS AND DISEASES IN THE FORESTS OF SERBIA

Miroslava MARKOVIĆ[1], Renata GAGIĆ-SERDAR[1], Goran ČEŠLJAR[1], Suzana MITROVIĆ[1], Đorđe JOVIĆ[1], Mihajlo MARKOVIĆ[1]*

Abstract: *The paper presents the monitoring of biotic damage agents over a five-year period (from 2018 to 2022) at bio-indication point BIT I Štubik near Negotin, which includes oak trees (7/8 of all trees) and maple trees (1/8 of the total number of trees at the site). The presence of several types of biotic damage agents was recorded, some of which are very dangerous and significant. The most common were harmful insects, among which the most notable was the gypsy moth Lymantria dispar. At the end of the study in 2022, the highest number of undamaged trees was recorded (83.3%), while the most damage was present in 2019 when only 1/4 of the trees were undamaged. It can be said that the condition of the crowns is directly related to the percentage of biotic damage agents.*

Keywords: Sample plot, Defoliation, Forest pathology

KORIŠĆENJE BAZE PODATAKA NA BIT I U CILJU UTVRĐIVANJA PROSTORNOG RASPOREDA ŠTETOČINA I BOLESTI U SASTOJINAMA SRBIJE

Apstrakt: *U radu je prikazano praćenje biotičkih uzročnika šteta u petogodišnjem periodu praćenja (od 2018. do 2022. godine) na BIT I Štubik kod Negotina koja obuhvata stabla hrasta (7/8 svih stabala) i klena (1/8 od ukupnog broja svih stabala na tački). Registrovano je prisustvo više tipova biotičkih uzročnika oštećenja od kojih su neka vrlo opasna i značajna, a najčešći su štetni insekti od kojih je najznačajniji gubar Lymantria dispar. Na kraju istraživanja 2022. je zabeležen najveći broj stabala bez oštećenja (83,3%), dok je najviše oštećenja bilo prisutno 2019. godine kada je svega 1/4 stabala bila bez oštećenja. Može se reći da je stanje kruna u direktnoj vezi sa procentualnim učešćem biotičkih uzročnika šteta.*

Ključne reči: bioindikacijske tačke, defolijacija, šumska patologija

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1. INTRODUCTION

The forest health information system is the result of certain activities within sustainable forest management, which is the basis of many international and national policies (FAO, 2010; UNECE, FAO, 2011). Monitoring plant diseases and pests is a key element of ecological policy, and without it, standards for forests and the environment cannot be applied. Data processing and reporting invariably follow uniform methodologies compiled according to international standards (Gregoire and Valentine, 2008). The results of the monitoring must be easily accessible and support the system of ecological indicators. Studies and monitoring are conducted by scientific institutions that prepare the database, assessments, and analyses at the national level.

The Republic of Serbia has been involved in the ICP Forests program since 2003 through its National Focal Centre for Forest Condition Monitoring (NFC), which, in collaboration with the National Expert Group (NEG), conducts data analysis and interpretation of results, assists in the scientific management of the Program, and participates in international expert panels (IEP) and working groups (WG). The primary goal of monitoring crown conditions is to provide periodic insights into the spatial and temporal variations in forest conditions, in relation to anthropogenic and natural stress factors within European and national systematic large-scale observation networks. Exposure to stress or constant attacks by insects and diseases makes forest ecosystems more susceptible to epidemics and epiphytotics (Wulff, 2011, Gagić-Serdar *et al*, 2021), and therefore, monitoring the occurrence and spread of biotic harmful factors is imperative.

In the last year of the presented study, in 2022 in Serbia, the total number of all bio-indication points at Level I, set up in a sixteen-kilometer and a four-kilometer grid, was 130 – of which 117 were in central Serbia and 13 in Vojvodina. The total number of examined trees was 2886. The total number of points with oak as the dominant species was 69, meaning that oaks are the edifiers at almost half of all points that have been monitored for more than 20 years.

The trees examined and presented in this paper, cited as examples of the database use, belong to bio-indication point level I, no. 39 (Picture 1) located in Štubik near Negotin (coordinates: 7602947; 4907150).

Picture 1. *Location of bio-indication point 39*

The point is located on a geological substrate of gneiss, with Cambisols, Calcaric Cambi soil type, at an altitude of 330 meters, facing south. The crown cover is high at 90%, and water availability is sufficient. The trees are between 25 and 100 years old, with a pronounced multi-layered structure.

The point includes the following tree species: *Quercus cerris* - 17 trees (70.8%), *Quercus frainetto* - 4 trees (16.7%), *Acer campestre* - 3 trees (12.5%). Therefore, oaks account for a total of 87.5% (or 7/8 of all trees), and field maple accounts for 12.5% (or 1/8 of the total number of trees).

2. MATERIAL AND METHODS

The methods are described in the first Manual as Visual Assessment of Crown Condition, and in the Submanual on Visual Assessment of Crown Condition on Intensive Monitoring Plots (Eichhorn et al, 2010). The Manual has been redesigned to provide harmonized data and a more flexible approach to monitoring crown conditions, with improved and more transparent quality. All parameters described in the latest version of the Manual have been tested in several countries in Europe or North America, while the parameter values are continuously monitored under the control of international expert panels. Any necessary adjustments will be recommended at the annual ICP Forests Task Force meetings in the coming years.

All marked trees at the points are numbered in a clockwise direction, starting from geographic north, and each tree is identified taxonomically. Damages observed in the field are recorded in intervals of 5% (de Lourdes Saavedra-Romero *et al*., 2021). Considering that approximately one-fifth of defoliation can be attributed to abiotic or biotic damages (Nevalainen *et al*., 2010), the assessment of chlorosis (discoloration or color change of leaf mass) and defoliation (branch drying) is performed on marked trees every year during the vegetation period. The severity of chlorosis and drying is indicated in percentages from 0 to 100. Crown defoliation is an indicator of tree condition assessment, although the causes of defoliation can be non-specific and the result of a range harmful agents, making them difficult to quantify with certainty. Therefore, it is necessary to understand the most significant factors causing damage to trees. In addition, damages by types and causes are recorded in the manuals and marked with codes.

For biotic causes, in addition to the code, the Latin name of the damage-causing agent, the developmental stage of the harmful agent, a description of the affected part of the plant, the age of the affected needles, etc., are recorded.

Visual assessments of tree defoliation are subjective; therefore, the consistency of the assessment, which is the most commonly used indicator of tree condition, has often been the focus of scientific criticism (Nakajima et al., 2011). Despite high correlations and disagreements among observers, there is a possibility of systematic error (Eickenscheidt & Wellbrock, 2013). To minimize the possibility of error, efforts are made to have the same team visit the same sites each year for visual assessments of crown condition.

3. RESULTS

Table 1 presents the results of crown condition monitoring and the incidence of biotic damage at bio-indication point 39 over the five-year period from 2018 to 2022.

As seen from the table below, the condition of the crowns slightly varied from 2018 to 2022. The highest percentage of trees in class 1 (no drying or with very low symptoms of drying) was in 2021 (91.7%) and 2018 (54.2%), while the most trees in class 1 (drying up to 25%) were in 2019 (75.0%) and 2022 (58.3%). There were very few trees (8.3%) in class 2 (drying up to 60%), and only in 2018 and 2019, while in classes 3 and 4 (severe drying up to 100.0%) there were no trees throughout the entire study period. Generally speaking, the health condition of the examined trees has improved over time.

Table 1. *Crown condition and percentage of biotic damage on bio-indication point 39 in the period 2018 – 2022*

Defoliation (%)						
Classes of defoliation	Drying of branches	**2018**	**2019**	**2020**	**2021**	**2022**
0	0 - 10 %	**54.2**	16.7	79.2	**91.7**	41.7
1	10 - 25%	37.5	**75.0**	20.8	8.3	**58.3**
2	25 - 60 %	8.3	8.3	0.0	0.0	0.0
3	60 - 100 %	0.0	0.0	0.0	0.0	0.0
4	100 %	00	0.0	0.0	0.0	0.0
Biotic damage (%)						
Defoliators from the order Lepidoptera		8.3	16.7	0.0	0.0	0.0
Miners from family Gracilaridae		0.0	0.0	12.5	0.0	0.0
Leafrollers from family Tortricidae		8.3	0.0	0.0	0.0	0.0
Witches' brooms of species *Taphrina* sp.		0.0	4.2	0.0	0.0	0.0
Bacterial galls (*Bacterium tumefaciens*)		0.0	0.0	4.2	0.0	0.0
Branch-decay and wood-decay fungi from division Basidiomycota		12.5	20.8	4.2	12.5	0.0
Gall wasps from families Cynipidae and Cecidomydae		12.5	12.5	12.5	16.7	0.0
Neuroterus quercus baccarum		20.8	25.0	12.5	16.7	0.0
Lymantria dispar		0.0	4.2	0.0	0.0	16.7
Without agents of biotic damage		**37.5**	**25.0**	**54.2**	**58.3**	**83.3**

Regarding the incidence of biotic damage on the trees, it should be noted that multiple types and species of biotic damage were recorded on some trees. During the study period, the presence of insects from the order Lepidoptera was recorded, but only at the beginning of the study - in 2018 and 2019. Leaf miners from the family Gracillariidae were present only in 2020, while the presence of leaf rollers from the family Tortricidae was noted only at the beginning of the study, in 2018. Wood-decay fungi from the class Basidiomycota were not observed only in the last year of the study, while their highest incidence was recorded in 2019. The same applies to gall makers from the families Cynipidae and Cecidomyiidae, as well as the species *Neuroterus quercusbaccarum*, which were not recorded only in the last year of the study. Among the less significant species, witches' broom caused by *Taphrina* sp. and crown gall caused by the bacterium *Bacterium tumefaciens* were recorded. Gypsy moth (*Lymantria dispar*) egg masses were observed at a low incidence in 2019 (4.2% of trees) and at four times that incidence in the last year of

the study (16.7%) (Figures 2 and 3). It is important to note that gypsy moth egg masses have been present at this point since 2019, and their numbers have gradually increased. However, they were not recorded on the marked trees in all years, so they are not shown in the table.


Pictures 2 and 3. *Gypsy moth egg masses on bio-indication point BIT 39 (August 2022)*

At the end of the 2022 study, the highest number of undamaged trees was recorded (83.3%), while the most damage was present in 2019 when only 1/4 of the trees were undamaged. Practically, it can be said that the condition of the crowns is directly related to the percentage of biotic damage causes, and in the years with the most damage, the highest class of defoliation was also recorded.

4. DISCUSSION

Among all the observed types of biotic damage causes on the trees, the most important is the gypsy moth, as it is a gradation species and can cause extensive damage. The most damage is usually suffered by Turkey oak forests and Hungarian oak, which are dominant at the location presented in this paper. The egg masses were observed in August and were full of fertilized eggs, mostly undamaged by birds and other predators.

It is important to note that the gypsy moth in Serbia is in latency and almost nowhere has the presence of egg masses been registered. The few egg masses found throughout Serbia were located in the understory, very low, and were irregular, small, and damaged.

5. CONCLUSION

In the period from 2018 to 2022, on the examined bio-indication point 39, the presence of several types of biotic damage causes was recorded, some of which are very dangerous and significant, with the most common being harmful insects and wood-decay fungi.

Of all the observed types of biotic damage causes on the trees, the most important is the gypsy moth, given that it is a gradation species and can cause extensive damage. Considering that the gypsy moth has been in latency in Serbia in recent years and its presence has hardly been registered, special attention should be paid to oak sites near the examined area due to a high possibility of a significant

increase in its population in the coming period. In such a case, mechanical removal would be necessary to prevent more serious damage to the stands. Besides defoliation, this could cause a chain of damages and would certainly affect tree growth.

The database in which data from bio-indication points Level I is collected can be used in segments, allowing searches by tree species, diseases, pests, periods, etc. The data from the database related to a specific tree species and the population density of the most important diseases and pests, as well as other types of mechanical and abiotic damage (within a specific time period), open up wide possibilities for the practical application of these studies.

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USE OF A DATABASE FOR DETERMINING THE SPATIAL DISTRIBUTION OF PESTS AND DISEASES IN THE FORESTS OF SERBIA

Miroslava MARKOVIĆ, Renata GAGIĆ-SERDAR, Goran ČEŠLJAR, Suzana MITROVIĆ, Đorđe JOVIĆ, Mihajlo MARKOVIĆ

Summary

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In the period from 2018 to 2022, on the examined bio-indication point 39, the presence of several types of biotic damage causes was recorded, some of which are very dangerous and significant, with the most common being harmful insects and wood-decay fungi.

Of all the observed types of biotic damage causes on the trees, the most important is the gypsy moth, given that it is a gradation species and can cause extensive damage. Considering that the gypsy moth has been in latency in Serbia in recent years and its presence has hardly been registered, special attention should be paid to oak sites near the examined area due to a high possibility of a significant increase in its population in the coming period. In such a case, mechanical removal would be necessary to prevent more serious damage to the stands. Besides defoliation, this could cause a chain of damages and would certainly affect tree growth.

The database in which data from bio-indication points Level I is collected can be used in segments, allowing searches by tree species, diseases, pests, periods, etc. The data

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KORIŠĆENJE BAZE PODATAKA NA BIT I U CILJU UTVRĐIVANJA PROSTORNOG RASPOREDA ŠTETOČINA I BOLESTI U SASTOJINAMA SRBIJE

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Rezime

U radu je prikazano praćenje biotičkih uzročnika šteta u petogodišnjem periodu praćenja (od 2018. do 2022. godine) na BIT I Štubik kod Negotina koja obuhvata stabla hrasta (7/8 svih stabala) i klena (1/8 od ukupnog broja svih stabala na tački). Registrovano je prisustvo više tipova biotičkih uzročnika oštećenja od kojih su neka vrlo opasna i značajna, a najčešći su štetni insekti od kojih je najznačajniji gubar *Lymantria dispar*. Na kraju istraživanja 2022. je zabeležen najveći broj stabala bez oštećenja (83,3%), dok je najviše oštećenja bilo prisutno 2019. godine kada je svega 1/4 stabala bila bez oštećenja. Može se reći da je stanje kruna u direktnoj vezi sa procentualnim učešćem biotičkih uzročnika šteta i u godinama sa najvećim brojem oštećenja, zabeležena je i najviša klasa defolijacije.

U periodu od 2018. do 2022. godine na ispitivanoj BIT 39 godine registrovano je prisustvo više tipova biotičkih uzročnika oštećenja od kojih su neka veoma opasna i značajna, a najčešći su štetni insekti i gljive truležnice.

Od svih konstatovanih vrsta prouzrokovača biotičkih šteta na stablima, najvažniji je gubar jer spada u gradogene vrste i može izazvati štete velikih razmera. S obzirom da je gubar je u Srbiji poslednjih godina u latenci i gotovo nigde nije registrovano njegovo prisustvo, na hrastove lokalitete koji se nalaze u blizini ispitivane tačke treba obratiti posebnu pažnju jer postoji velika mogućnost da će u nastupajućem periodu tu doći do značajnog povećanja njegove brojnosti populacije. U tom slučaju bilo bi potrebno njihovo mehaničko uklanjanje, da ne bi došlo do pojave ozbiljnijih šteta u sastojinama – osim golobrsta, to bi moglo da prouzrokuje ulančavanje šteta, a svakako bi se odrazilo i na prirast stabala.

Baza u kojoj se sakupljaju podaci sa BIT Nivoa I može se koristiti po segmentima, što omogućava pretraživanje po vrstama drveća, bolestima, štetočinama, periodima itd. Podaci iz baze koji se odnose na određenu vrstu drveća i gustinu populacije najvažnijih bolesti i štetočina, kao i druge tipove oštećenja mehaničkog i abiotičkog porekla (u okviru određenog vremenskog perioda), otvaraju široke mogućnosti u praktičnoj primeni ovih istraživanja.

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