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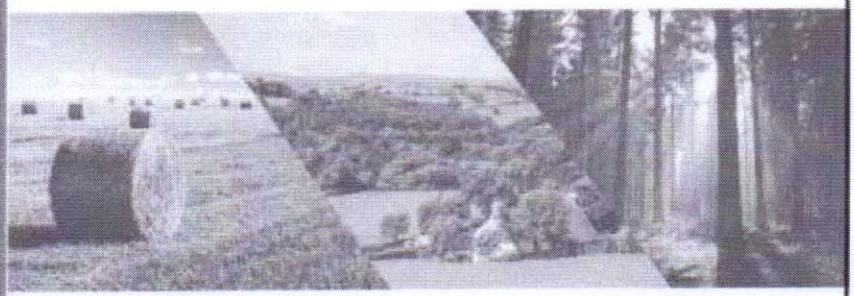

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"Agrosym 2023"

Jahorina, October 05-08, 2023

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SYSTEM MONITORING OF THE CROWN CONDITION ON ICP FORESTS SAMPLE PLOTS LEVEL I IN SERBIA WITH A SPECIAL VIEW OF BIOTIC DAMAGE ON PLOTS WITH OAK AS THE EDIFIER

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Abstract

Monitoring of plant diseases and pests represents the key element of the environmental policy, without which the standards for forests and the environment cannot be applied. Data processing and reporting inevitably follow the uniform methodologies designed in accordance with international standards. The main objective of monitoring the crown condition is provision of a periodic insight into spatial and time variations of the forest condition, relative to anthropogenic and natural stress factors in the European and national systematic networks of wide-range observation. The paper demonstrates that the database in which sample plots Level I data are collected may be used in segments, which enables the search according to tree species, diseases, pests, periods, etc. The data from the base related to specific tree species and population density of major diseases and pests, as well as other types of damage of mechanical and abiotic origin (within certain periods - time series), open broad possibilities in practical application of the research. The paper presents monitoring of biotic damage agents, some of which are quite dangerous and significant, while the most common are harmful insects – 13.7% total on all deciduous trees. Among the oak species the most endangered is Sessile oak (with 31.9% damage). The damages caused by fungi rank second and are most frequently present on coniferous trees (11.0%), whereas among the deciduous species Sessile oak is once again the most endangered (6.9%). Damages caused by anthropogenic and abiotic agents – fire, frost, local pollution, etc., are far less significant.

Key words: *sample plot, forest condition, biotic damage*

Introduction

The condition of forests, ecosystems and biodiversity have a strong mutual connection. The levels of biodiversity largely depend on the health and vitality of forests, while loss of biodiversity leads to reduced productivity and sustainability of forests (Marin et al., 2021).
The system of information on forest health condition is a result of specific activities within the framework of sustainable forest management, which is the basis of numerous international and national policies. Monitoring of plant diseases and pests represents the key element of the environmental policy, without which the standards for forests and the environment cannot be applied. Data processing and reporting inevitably follow the uniform methodologies designed in accordance with international standards. Results of the monitoring must be easily accessible and support the system of ecological indicators. Studies and monitoring are carried out by scientific institutions that prepare the database, assessments, and analyses on the national level.
The initially created database on the condition of forest trees with millions of pieces of information, which due to their subjectivity and poor specificity of international data made it difficult to compare and interpret the data (Horntvedt, 1993; Innes, 1992). Different studies used a range of various indices that are relevant only for specific species only. However, the

development of pertinent indices created an urgent need for improvement of the definitions, training, data collection and reporting (Ferretti, 1998).

The Republic of Serbia has been involved in the ICP program for forests through its National Focal Center for monitoring of the condition of forests (NFC), which in cooperation with the National Expert Group (NEG) conducts data analyses and interpretation of results, assists in scientific management of the Program, and takes part in international expert panels (IEP) and working groups (WG).

The main objective of monitoring the crown condition is provision of a periodic insight into spatial and time variations of the forest condition, relative to anthropogenic and natural stress factors in the European and national systematic networks of wide-range observation. The exposure to stress or constant attacks by insects or diseases makes forest ecosystems more susceptible to outbreaks of epiphytotic diseases (Wulff, 2011), which necessitates monitoring of the occurrence and spread of harmful biotic factors.

Materials and methods

The Manual *Visual Assessment of Crown Condition* and in the *Submanual on Visual Assessment of Crown Condition on Intensive Monitoring Plots* (Eichhorn et al., 2010) has been redesigned to enable harmonization of the data and a more flexible approach to monitoring of the crown condition, with improved and more transparent quality. All the parameters described in the latest version of the Manual have been tested in multiple countries across Europe or North America, while the values of the parameters are being continuously followed under the control of international expert panels. Any required adjustment will be recommended at the annual meetings of *ICP Forests Task Forces* in the coming years.

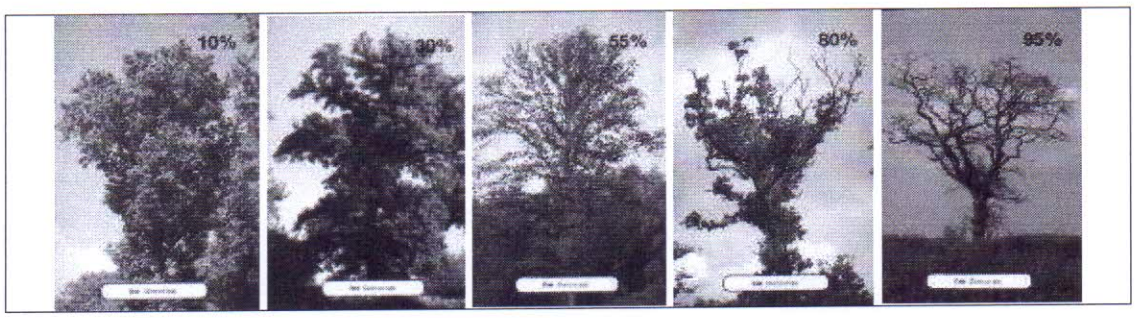
All the marked trees on the spot points are numbered clockwise, starting from the geographical north, and each tree is identified taxonomically. Damages observed in the field are noted in 5% intervals (de Lourdes Saavedra-Romero et al., 2021). Given that roughly one-fifth of the defoliation may be attributed to abiotic or biotic damages (Nevalainen et al., 2010), the assessment of chlorosis (decolorization, bleaching, i.e. color change of the leaf mass) and defoliation (branch dieback) is performed on the marked trees every year during the vegetative period. The strength of chlorosis and dieback is marked in percentages ranging from 0 to 100. In addition, injuries according to types and kinds of causal agents are noted in the manuals and marked with codes.

Besides the code, the elements noted for biotic agents of damage include Latin names of the agents of damage, development phase of the harmful agent, description of the attacked part of the plant, age of the attacked needles, etc.

Tree assessment method in practice

- Trees are assessed from multiple directions, if possible (two directions minimum).
- The distance between the assessor and the tree should be at least one height of the assessed tree.
- On a sloped terrain, the assessor should be positioned on or above the tree level.
- To exclude blinding and ensure the most relevant assessment possible, the assessor should avoid looking at the sun while conducting the assessment.

Visual determination of the percentage category of the defoliation is presented in Picture 1.



Picture 1. The visual determination of the categories of the defoliation of trees

Visual assessments of the defoliation of trees are subjective, which frequently brought the consistency of the assessment, which is the most commonly used indicator of the tree condition, into the focus of scientific critique (Haruki et al., 2011). Despite high correlations and discrepancies between the assessors, there is a possibility of occurrence of a systematic error (Eickenscheidt and Wellbrock, 2013). In order to reduce the probability of error to a minimum, efforts are made to insure that the same team visits the same locations each year to conduct the visual determination of the crown condition.

Results and discussion

On the territory of Serbia in the year 2022, the total number of all Level I sample plots amounted to 130, out of which 117 in the central Serbia and 13 in Vojvodina. The total number of points with oak as the dominant species was 69. Out of that number, there were 48 points with Turkey oak (*Quercus cerris* L.), 38 points with Hungarian oak (*Quercus frainetto* Ten.), 17 points with Sessile oak (*Quercus petraea* Matt. Liebl.), 7 points with pedunculate oak (*Quercus robur* L.), and 4 points with pubescent oak (*Quercus pubescens* Willd.).
Among the deciduous species, oak are the most widely present species on sample plots – Sessile oak, Turkey oak and Hungarian oak, all including stands of varied ages. Oak are the main species on the total of 40.9% of points (Turkey oak on 22.0%, Hungarian oak on 11.0%, and Sessile oak on 7.9%). Beech is second with presence on 31.5% of points. In the group of conifers, the most widely present species is spruce (main species on 7.9% of points), followed by ash (3.9%), white pine and fir (3.1% each).
Amongst the insects causing damage to the oak leaves, the early defoliators (Geometriadae) and leafrollers (Torticidae) appear most frequently. On sample plots dominated by Sessile and pedunculate oak, damages from attack ranging from very weak to moderate were detected, mostly by winter moth (*Operophtera brumata* L.) and mottled umber moth *Erannis defoliaria* L., then caterpillar *Alsophila* sp., (Lepidoptera: Geometridae) and lackey moth (picture 2).

Picture 2. *Malacosoma neustria* L., Sample plot Kursumlija

This year, the attack by these pests was noted as mostly weak, and moderate only on sample plot 47. Among the defoliators the Gypsy moth litters is dominant, and most damage is

usually sustained by Turkey oak forests and individual Hungarian oaks. This year it occurred individually, in the egg stage. Litters were found in August on only one sample plot in Negotin area. The majority of litters on older trees were damaged by birds. The trees were found to have sustained a moderate attack by oak leafrollers (Totricidae), with most frequent occurrences of green oak moth (*Tortix viridiana* L.), *Totrticoides alternella* Hbn., early oak leafroller and *Archips xylosteana* L. variegated golden tortrix, and the damage represented by characteristically half-rolled up leaves, most often of sessile oak. Dieback of sessile oak tops and new young shoots is also present as a consequence of the activity of a range of pests – first of early defoliators (Geometridae) and leafrollers (torticidae), followed by a chain action by leaf miners, e.g. representatives of the family (Lepidoptera, Ticheridae) with the species *Ticheria ekedlabella* Bjerk., a very common agent of damage to oak crowns across the country and on a large number of sample plots where it was found in mass, as well as *Profenusa pigmeae* (Klug, 1816) (picture), just as this year skeletal damage caused by *Caliroa annulipes* (Klug, 1816), oak slug sawfly, was frequently seen on oaks on sample plot in Forest Management Office Kraljevo.

Caterpillars of lackey moth *Malacosoma neustria* L. in higher stages of development appeared individually in the area of Forest Management Office Toplica, sample plot in Kursumlija area in early summer 2022. Gall wasps *Cynipidae* did not appear frequently this year, and the registered species included only the common ones: *Cynips quercusfolii* L., *Biorhiza pallida* (Ol.), *Andricus quercustozae* (Bosc), *Andricus caputmedusae* (Htg.). Among the galls, gall midges family Cecidomyiidae were present, but their attack intensity was weak.

Gall midges from the family Cecidomidae, specifically species *Dryomia circinnans* Girauld, frequently appear on the underside of the leaves on sample plots, as does *Janetia cerris* – these galls are similar in appearance, covered in fine hair-like setae, and are equally damaging as they cause physiological weakening of the leaves and stunt the growth of young plants due to general deformity.

The introduced oak lace bug *Corythucha arcuata* Say is present on multiple sample plots with oak, but still mainly in the vicinity of roads.

Altica quercetorum Foudr. is common on top shoots of oak trees, with characteristically deformed and finely formed leaves which are drying out, or have sustained partial or total damage. Visible pitted bite marks are evident as a consequence of the pest's action on the leaf tissue.

Dieback of sessile oak tree tops is also present as a consequence of a range of harmful factors, in addition to those mentioned above, and it may date back to damage accumulated from previous years, with the condition steadily worsening with each passing year. Snout moths *Acrobis tumidella* Zin. (Lepidoptera, Pyralidae) bite the leaves and then paste a number of leaves together on the top of the shoots. These damages were also detected on sample plots dominated by sessile oak in the year 2022.

Synantedon conopiformis Esper. (Lepidoptera, Aegeridae=Sesiidae) creates calloused creases resembling lumps or tumors in root flares of trees, sessile oak in particular, in shoot stands (sample plot Leskovac). Damage by great capricorn beetle *Cerambyx cerdo* was registered on individual felled trees.

Sporocarps of epyxilous fungi such as *Fistulina hepatica*, Schaeff appeared more rarely.

Bacterial tumor-like growths on trunks may reach great scales, but they appear individually and on unnurtured stands. On Hungarian oak trees, the presence of sporocarp of wood-decaying fungi *Coriolus versicolor* (Fr.) Pil., *Fomes fomentarius* was noted, as was the presence of brown central rot, which mostly appears on previously damaged trees. During the monitoring of the crown condition on sample plots I in 2022, several species of pathogenic fungi were found on the leaves of mature oak trees and on the regeneration growth, among

which powdery mildew *Microsphaera alphitoides* Grif.& Maubl was the most widely present (sample plot Ub).

Among other biotic agents of damage, the presence of hemiparasites was registered on individual oak branches – common mistletoe (*Viscum album* L.) and yellow mistletoe (*Loranthus europaeus* Jacq.), which cause physiological degradation of trees and make them susceptible to attack of dangerous pests and wood decay agents (sample plots Petrovac na Mlavi, Zagubica and Vrnjacka Banja).

As for abiotic factors, on sessile oak the most frequent are frost injuries on the tree bark, as well as heat damage of the leaf mass on a smaller scale. Mechanical damage to oak tree trunks, registered on roughly a dozen tested trees, was inflicted through the activity of the anthropogenic factor, i.e. during tree felling and skidding. These injuries are potentially dangerous as they may be the access point for numerous harmful insects and wood decaying fungi.

Table 1 presents the percentage of damage according to causal agents that were determined during field visits to sample plots I on trees and crowns of the marked trees.

Table 1. Damage according to causal agents determined during a field visit to sample plot I on trees and crowns of marked trees in the year 2022

	Damage							
	From insects	From fungi	From abiotic agents	From man	From forest fires	From local pollution	Other	Total
For all species %	13.1	5.0	1.5	0.4	0.0	0.0	0.2	20.2
For broad-leaved species %	13.7	3.2	0.4	0.6	0.0	0.0	0.2	18.1
For conifers %	4.7	11.0	0.0	0.0	0.0	0.0	0.0	15.7
For Turkey oak %	21.4	2.5	0.2	0.0	0.0	0.0	0.2	24.3
For Hungarian oak %	12.9	1.1	0.5	0.0	0.0	0.0	0.0	14.6
For sessile oak %	31.9	6.9	3.1	0.0	0.0	0.0	0.6	42.5

As presented in Table 1, in the year 2022 the highest percent of damage on trees on sample plots I was caused by insects, found on the total of 13.7% of broad-leaved trees. Among the oak species, the most endangered is sessile oak (with 31.9% damage). Damage caused by fungi ranked second and was most frequently present on conifers (11.0%), while among deciduous species sessile oak was once again at the highest risk (6.9%). Damage from anthropogenic and abiotic agents - fire, frost, local pollution, etc., was far less significant.

Conclusions

In the year 2022, on sample plots I the presence of several types of biotic agents of damage was registered, some of which are highly dangerous and significant, with the most common ones being harmful insects and wood-decaying fungi. In addition, there were bacterial tumor-like growths that may reach great scales on trunks, but they appear individually and on unnurtured stands. Among the abiotic factors, on Hungarian oak the frost injuries on the trunk were present on a smaller scale, whereas leaf damage from hail was striking. Mechanical damage to tree trunks of all oak species registered in 2022 was inflicted through the activity of the anthropogenic factor (tree felling and skidding), and represent potential danger and the access point for numerous harmful insects and wood decaying fungi. As presented in the paper, the database in which data from sample plots level I are collected may be used in segments, which enables search according to tree species, diseases, pests, periods, etc. The data from the base related to specific tree species and population density of major diseases

and pests, as well as other types of damage of mechanical and abiotic origin (within certain time periods), open broad possibilities in practical application of the research.

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