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RESULTS OF RESEARCH OF DEFOLIATION ON BIO-INDICATOR PLOTS IN REPUBLIC OF SERBIA IN 2013

*Tomislav STEFANOVIĆ¹, Svetlana BILIBAJKIĆ¹,
Radovan NEVENIĆ¹, Ilija ĐORĐEVIĆ¹, Zoran PODUŠKA¹,
Goran ČEŠLJAR¹, Renata GAGIĆ SERDAR¹*

Abstract: *The initial symptoms of stand-level dieback of forests are defoliation and change of a tree crown color. Therefore, the defoliation, along with the color change, was accepted as the main parameter for estimation of crown condition for monitoring of forest condition. In this work were analyzed the data on defoliation as a part of the results of the monitoring of forest condition on bio-indicator plots in 2013. On plots the assessment of defoliation is performed regardless of the cause of a loss of leaves, and the results are not aiming at establishing cause-effect relationships, but only represent the defoliation condition on bio-indicator plots in 2013. Linking these results with other indicators of environmental conditions will provide more specific information and conclusions about the dependence of plant vitality on environmental conditions.*

Key words: defoliation, bio-indicator plots, assessment of crown condition

REZULTATI ISTRAŽIVANJE DEFOLIJACIJE NA BIOINDIKACIJSKIM TAČKAMA U REPUBLICI SRBIJI U 2013. GODINI

Abstract: *Početni simptomi sušenja šumskih sastojina su defolijacija i promena boje krošnji stabala. Zbog toga je defolijacija, uz promenu boje, prihvaćena kao glavni parametar procene stanja krošnji za praćenje stanja šuma. U ovom radu analizirani su podaci o defolijaciji kao deo rezultata rada na praćenju stanja šuma na bioindikacijskim tačkama u 2013. godini. Na tačkama se ocena defolijacije vrši bez obzira na uzrok gubitaka lišća, pa dobijeni rezultati nemaju za cilj utvrđivanje uzročno-posledičnih odnosa, već samo reprezentuju stanje defolijacije na bioindikacijskim tačkama u 2013. godini. Povezivanje ovih rezultata sa drugim pokazateljima uslova sredine omogućiti će konkretnija*

¹ Institute of Forestry, Kneza Visislava 3, Belgrade, Serbia

Key words: defolijacija, bioindikacijske tačke, procena stanja krošnji

1. INTRODUCTION

Forest condition monitoring project (ICP Forests) operates as an international European project in which, on the grid of bio-indicator plots, annually has been monitored the condition of forests, the data on defoliation and discoloration have been recorded and other damages on trees have been registered. The objective of this program is to collect data on the condition of forests in Europe using unique methodology and to obtain information about the spatial and temporal variation of forest condition in the countries of Europe.

On the territory of the Republic of Serbia the first record of health status, agreed with the abovementioned program was carried out in 1988. During 2003 the grid of these plots was reconstructed, with the most of bio-indicator plots that had to be re-set. In 2004 it was found that 103 reconstructed bio-indicator plots in the 16 x 16 km grid does not fully represent the state of vegetation cover in Serbia, so 27 new plots have been set in the 4 x 4 km grid. During last years in the localities of some bio-indicator plots were performed clear deforestations, so it is impossible to carry out further observations in that locations, and from two plots for technical reasons were not continuously obtained the necessary data. On all other plots the monitoring of the condition has been performed, all field data necessary for further processing have been collected, so the aforementioned program has been implemented in the continuity on the 121 bio-indicator plots.

In this paper have been analyzed the data on defoliation, as a part of the results of the monitoring of forests condition on bio-indicator plots in 2013.

2. MATERIAL AND METHOD

Within this project the crown condition is expressed by classes of leaf losses, color changes and combined classes of damages. Assessment of the crown condition has been performed every year on permanent sample plots called bio-indicator plots.

Permanent sample plot or bio-indicator plot consists of the center determined based on coordinates and metal rod clearly marked in the field. At 25 meters from the center, in the direction of the four main corners of the world the sample plots were determined and on them were selected per 6 trees labeled with numbers from 1 to 6. The selected trees are permanently marked with numbers, and the trees removed for any reason shall be replaced with new, selected trees.

Defoliation or loss of needles or leaves on the tree crown, for each tree on the permanent sample plots, in the field is estimated at intervals of 5%, and the results are grouped into five classes of unequal range (Table 1).

Table 1. Defoliation class

Class	Degree of defoliation	Percentage of leaf/needle loss
0	No defoliation	0-10 %
1	Slight	10-25 %
2	Moderate	25-60 %
3	Severe	60-100 %
4	Dead tree	100 %

In this paper were also used the data from the minute-books that researchers fill in the spot during visiting the bio-indicator plots. Based on these minute-books, the mean values of defoliation for each plot have been calculated. Mean values of defoliation for each plot were calculated based on individual values of defoliation for each tree on the plot no matter of the tree species.

Determination of the mean values of defoliation for each sample plot enabled the designing of defoliation map. By interpolation of mean values of defoliation of adjacent sample plots were obtained points with the same values of defoliation. By connecting these points, with equal values of defoliation, were formed isolines. Isolines, in this case, represent the same average annual values of defoliation on the territory of Serbia.

3. RESULTS AND DISCUSSION

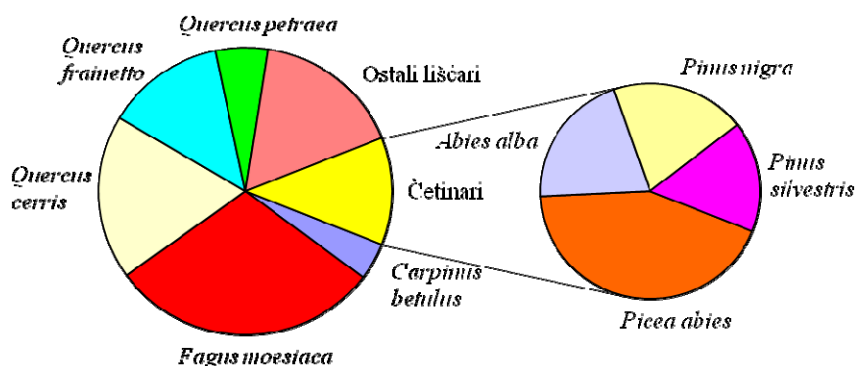
On the territory of the Republic of Serbia monitoring of the forest condition in 2013 was performed on 121 bio-indicator plots. Field work on the data collection (observations and measurements) was carried out in the period June - September.

Plots were arranged at altitudes of 75-1558 m above sea level and the largest number of plots is at altitudes of 400 - 600 m above sea level, which is a total of 27 plots (Table 2).

Table 2. - Distribution of bio-indicator plots related to altitude

Altitudes	0 - 200	200 -400	400 -600	600 -800	800 -1000	1000-1200	1200-1400	1400-1600	Total
Number of BIP	17	24	27	16	9	13	11	4	121

The assessment of defoliation was performed on 2,794 trees. The most represented tree species on bio-indicator plots are: *Fagus moesiaca* (833 trees), *Quercus cerris* (516), *Quercus frainetto* (368), *Quercus petraea* (161) and *Carpinus betulus* (117). Of conifers there are represented: *Abies alba* (69 trees), *Picea abies* (146), *Pinus nigra* (56) and *Pinus silvestris* (56) (Graph 1.).



Graph 1. Represented tree species

On all bio-indicator plots was performed the assessment of degree of defoliation and presence of defoliation processes in the most represented species of broadleaves and conifers is shown in Tables 3 and 4.

In 2013, hornbeam proved to be the most resistant species because 74.4% of the trees have no signs of defoliation, while the slight defoliation has been registered at 8.5% hornbeam trees. On beech trees defoliation does not occur in 69% of the trees, while the process of slight defoliation affected 18.9% of the trees. Species of the genus *Quercus* proved to be the most endangered and the most endangered species is Sessile oak where only 50.9% of the trees have no signs of defoliation.

Table 3. Defoliation – broadleaves in 2013

	Hornbeam	Balkan beech	Turkey oak	Hungarian oak	Sessile oak	Others
No defoliation	74.4	69	56	73.1	50.9	58.1
Slight	8.5	18.9	29.2	14.1	31.7	21.7
Moderate	7.7	8.6	10.5	8.4	13.1	13
Severe	8.5	2.9	3.7	4.1	3.1	4.8
Dead tree	0.9	0.6	0.6	0.3	1.2	2.4

Defoliation (falling of needles) in coniferous trees in 2013 was minimum presented in fir, with 92.8% of the trees with no signs of defoliation. A similar situation was registered in spruce trees (90.4%), while the Austrian pine trees are far the most endangered by these processes of all species registered in the bio-indicator plots. On only 35.8% of Austrian pine trees were not noticed signs of defoliation, while almost 50% of the trees are affected by the processes of moderate to severe defoliation.

Table 4. Defoliation – conifers in 2013

	Silver fir	Common spruce	Austrian pine	Scots pine
No defoliation	92.8	90.4	35.8	83.9
Slight	1.4	6.2	17.9	8.9
Moderate	4.4	2	34.3	0
Severe	1.4	1.4	10.5	7.2
Dead tree	0	0	1.5	0

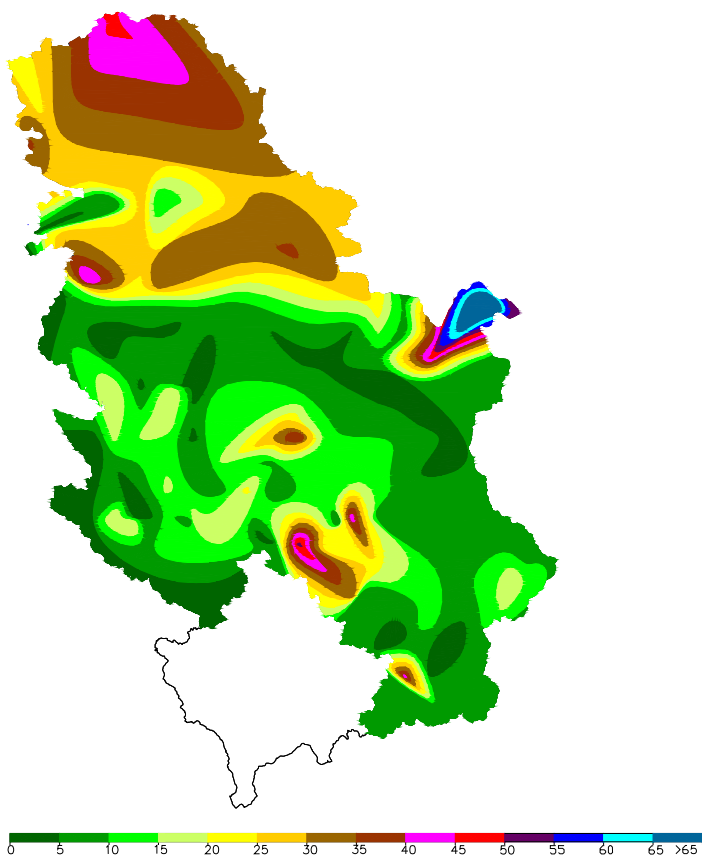
For all bio-indicator plots are calculated mean values of defoliation and the summary results per each bio-indicator plot are shown in Table 5.

Table 5. Average annual defoliation on bio-indicator plots

BIP	%	BIP	%	BIP	%	BIP	%	BIP	%	BIP	%
2	7.9	27	5.6	49	16.3	70	8.2	93	15.6	407	14.4
3	4.2	28	0.0	50	15.6	71	7.9	94	17.5	408	7.1
4	0.4	29	45.0	51	17.3	72	6.5	95	6.4	409	20.2
6	5.4	30	15.6	52	11.7	73	2.1	96	41.3	410	56.3
7	9.4	31	6.7	53	9.2	74	0.4	97	5.2	412	3.3
8	4.4	32	7.5	55	10.0	75	20.0	98	8.9	413	10.8
9	6.7	33	34.6	56	14.4	76	13.1	99	4.4	414	13.3
10	3.3	34	8.8	57	4.4	77	14.2	100	9.4	415	18.3
11	2.6	35	9.4	58	6.5	78	14.8	101	36.0	416	13.3
12	9.4	36	83.8	59	21.0	79	29.6	102	35.8	417	20.2
13	16.7	37	3.1	60	9.2	80	20.8	103	28.1	418	0.8
14	45.0	38	6.0	61	5.6	81	40.0	104	3.3	419	6.3
15	12.1	39	22.1	62	15.8	82	20.0	105	9.8	420	2.9
17	6.9	40	11.5	63	50.8	83	23.8	106	23.5	421	25.8
18	15.4	41	40.0	64	12.9	85	5.0	401	3.1	422	47.3
19	10.8	42	8.3	65	5.0	86	9.0	402	4.6	423	21.9
20	20.0	44	14.4	66	42.5	87	3.8	403	9.4	424	7.1
21	29.6	45	6.7	67	19.6	89	11.1	404	4.4	425	23.3
23	24.2	47	10.4	68	23.8	91	2.7	405	7.1	426	23.8
24	2.5	48	13.8	69	6.0	92	11.3	406	7.3	427	32.1
26	5.0										

From Table can be seen that in 2013 occurred great oscillations of mean annual values of defoliation. On plot no. 28 (Potaj Čuka, *Fagus moesiaca*) in this year there was no signs of defoliation, while on plot no. 36 (Kladovo, *Quercus cerris*, *Quercus petraea*) has been registered the severe defoliation (83.8 %). On 16 more plots the values of mean annual defoliation are in the class of moderate defoliation.

Based on values that have been shown, it was designed the Map of defoliation for the territory of Serbia. This map enables simpler review of spatial variation of defoliation values.



Picture 1. *Map of defoliation of forest tree species in the territory of Serbia*

4. CONCLUSION

Forest condition monitoring project (ICP Forests) operates as an international European project in which, on the grid of bio-indicator plots, annually has been monitored the condition of forests, the data on defoliation and discoloration have been recorded and other damages on trees have been registered.

In this paper have been analyzed the data on defoliation, as a part of the results of the monitoring of forest conditions on bio-indicator plots in 2013 on territory of the Republic of Serbia. During this year the assessment of crown condition has been performed on 121 bio-indicator plots. Field work on the data collection (observations and measurements) was carried out in the period June - September.

In deciduous species in 2013, hornbeam and beech in processes of defoliation showed to be more resistant species than oak. On bio-indicator plots in 2013 as most endangered species in broadleaves has been proved to be Sessile oak. Among conifers, fir and spruce have been shown to be more resistant species, while the Austrian pine trees are far the most endangered by these processes comparing to all species registered on the bio-indicator plots.

Calculating of mean values of defoliation for each plot allowed the

comparison of the values of defoliation and the degree of endangerment by defoliation of the individual plots.

Also, the determination of the mean values of defoliation for each sample plot enabled the designing of Map of defoliation. This map enabled simpler review of spatial variation of defoliation values.

On plots the assessment of defoliation has been performed regardless of the cause of loss of leaves, so the obtained results are not aimed at determining of cause-effect relationships, but only represent the condition of defoliation on bio-indicator plots in the studied period. The conducted researches are a baseline for monitoring changes in forest condition and connecting these results with other indicators of environmental conditions will provide more specific information and conclusions about dependence of vitality of the plants on environmental conditions.

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