Folia Forestalia Polonica, Series A – Forestry, 2016, Vol. 58 (4), 240–245

SHORT COMMUNICATION

DOI: 10.1515/ffp-2016-0027

Health condition of the Scots pine (*Pinus sylvestris*) in Kampinos National Park – preliminary studies

Łukasz Tyburski[1] ✉, *Paweł Przybylski*[2]

[1] Kampinos National Park, Department of Science and Nature Monitoring, Tetmajera 38, 05-080 Izabelin, e-mail: ltyburski@kampinoski-pn.gov.pl

[2] Forest Research Institute, Department of Silviculture and Genetics, Braci Leśnej 3, Sękocin Stary, 05-090 Raszyn, Poland

Abstract

In 2015 in Kampinos National Park (KNP), monitoring of tree crown condition was conducted in specimens of the Scots pine, which is the dominant tree species in the park (73.3%). The monitoring was aimed at providing information about the health of pine trees in the national park area. The monitoring was conducted on 26 plots throughout the park. The stands where the pine is not a dominant species were omitted. On each plot, 20 trees were subjected to assessment. In total, 520 pine trees were examined. The monitoring was conducted by the assessment of tree crowns based on the adapted forest monitoring methodology conducted as part of National Environmental Monitoring. On the basis of the monitoring, it was found that 75.4% of the trees are characterised by slight defoliation and 94.4% of the specimens were not found to have discoloration of the assimilation apparatus. No differences were found between areas situated closer and further from the administrative borders of Warsaw. On the basis of the monitoring, it was found that the pine trees in KNP are in a good health condition. Dendrometric measurements show that the average diameter at breast height (DBH) of the analysed trees is 26.6 cm. The average height of the trees is 20.4 m. The average age of the examined tree stands is 84. The monitoring will be continued in subsequent years in order to record the changes taking place in tree crowns.

Key words

defoliation, Kampinos National Park, Scots pine, health condition

Introduction

Kampinos National Park (KNP) was created in 1959 in order to protect the unique complex of inland dunes and the richness of flora and fauna diversity (Lubański 2009). It covers an area of 38,544 ha, out of which 28,255 ha (73.3%) are occupied by tree stands. The Scots pine (*Pinus sylvestris*, 69%), Black alder (*Alnus glutinosa*, 12.5%), oaks (*Quercus sp.*, 10.3%) and Birch (*Betula sp.*, 6.4%) are dominant species in the stands (Szczygielski 2002). A significant proportion of pine trees results from the history of shaping the stands by man and is related to the soils formed on the dunes. The stands of the Kampinos Forest were cut down in the course of overexploitation conducted by the occupants during the First and Second World War. After the war, systematic pine reforestation works were conducted (Zielony 2004). The pine was an easily

Received 5 October 2016 / 25 October 2016

accessible planting stock, which could handle adverse dune conditions well.

The area of KNP, despite its exceptional location resulting from the neighbourhood of the Warsaw agglomeration (Król and Skolimowska-Król 2004) and possible risks related to anthropogenic activity, is a place where changes occurring in the environment can still be observed.

In order to broaden the knowledge about the changes taking place in the tree stands of KNP, it is justified to conduct research and monitoring related to, inter alia, the health condition of the dominant species: Scots pine and Black alder. Monitoring of these species was carried out in 2015. The presented results expand the scarce data on the health of the trees in KNP (Tyburski 2016 a, b).

The aim of the monitoring was to evaluate the Scots pine health throughout the KNP area.

Methodology

Assessment of the pine tree crown

The assessment of the health condition of Scots pine was made by adapting the methodology of forest monitoring in the framework of National Environmental Monitoring. The assessment of trees is undertaken within the framework of Permanent Observation Areas, distributed throughout the country (www.gios.gov.pl 2015).

The assessment of the health condition in KNP was applied to defoliation, discoloration of the assimilation apparatus, biosocial position, visibility and shading of the tree crown, the number of needle sets, the length of pine needles, type of crown thinning and proportion of dead branches.

The assessment of defoliation was based on the photos from 'Atlas ubytku aparatu asymilacyjnego drzew leśnych' (Borecki and Keczyński 1992), which was provided with accuracy to the nearest 5%.

The results of defoliation and discoloration estimates have been grouped into following classes:

– class 0 – from 0% to 10% – without defoliation,
– class 1 – from 11% to 25% – slight defoliation (warning level),
– class 2 – from 26% to 60% – average defoliation,
– class 3 – more than 60–99% – strong defoliation,
– class 4 – 100% – dead trees.

The following types of crown thinning were distinguished: none (in case of defoliation below 10%), peripheral, outward-spreading from the centre, bottom-up, top-down, under-treetop, regular, gapped and foliage in clumps (Wawrzoniak and Zajączkowski 2014).

Assessment of the discoloration of the assimilation apparatus was made based on Table 1.

Table 1. Classes of the assimilation apparatus discoloration

Class	Degree of discoloration	Discoloration of the assimilation apparatus (%)
0	None	0–10
1	Slight	11–25
2	Average	26–60
3	Strong	More than 60
4	Dead tree	Dead tree

Several classes of tree stand damage were distinguished, assuming that the damage class is a combination of the defoliation class and discoloration class according to Table 2.

Table 2. Classes of tree damage (Wawrzoniak and Zajączkowski 2014)

Defoliation classes	Discoloration class				
	0	1	2	3	4
	Damage class				
0	0	0	1	2	
1	1	1	2	2	
2	2	2	3	3	
3	3	3	3	3	
4					4

0 represents no damage class, 1 warning class, 2 slight and average damage class, 3 considerable damage class and 4 dead trees.

Assessment of the biosocial position according to Kraft's classes is as follows:

1 – predominant trees
2 – dominant trees
3 – co-dominant trees
4 – suppressed trees
5 – overtopped trees

Assessment of tree crown visibility was made based on the following division: full visibility of the tree

crown, partial visibility of the tree crown, a larger part of the tree crown is visible, a smaller part of the tree crown is visible, an outline of the tree crown is visible and the tree crown is not visible.

Assessment of tree crown shading is as follows:

- the tree crown is significantly shaded (or in physical contact) from one side,
- the tree crown is significantly shaded (or in physical contact) from both sides,
- the tree crown is significantly shaded (or in physical contact) from three sides,
- the tree crown is significantly shaded (or in physical contact) from four sides,
- the tree crown with an open development space with no traces of shading impact.

Assessment of the abundance of pine needle sets was given as the dominant number of needles in the middle part of the tree crown.

Assessment of the needle length is the result of the number of dominant length pine needles in the middle of the tree crown; the following needle length types were distinguished: shortened, normal and lengthened.

In the assessment of the proportion of dead branches, the following division was distinguished: lack of dead branches, single dead branches (up to 10%), from 11% to 50% of dead branches and more than 50% of dead branches.

Causes of damage were distinguished: undamaged trees, armillaria root rot, annosum root rot, other infectious diseases, primary pests, secondary pests, wind, fire, snow (snow cap downfall), flooding, direct human activity, air pollution, multiple causative factors and unidentified ones.

The research area

Monitoring was conducted on 26 plots throughout the KNP (Fig. 1). The plots selected for the study were distributed in a way that allows for comparing plots located near the borders of Warsaw and plots situated in locations, where the impact of anthropogenic factors is significantly limited. The irregular distribution of plots results from the mosaic of dune and wetland terrain. The monitoring of wetlands was omitted because the pine in the tree stands growing in these areas is not the dominant species.

A total of 520 specimens of Scots pine were assessed. On each plot, 20 trees were subjected to assessment. The first tree in the designated area served as the central tree, around which neighbouring specimens were circularly designated. The monitoring will be implemented in subsequent years, and in the case of a tree dying on a given plot, an adjacent living tree will be selected.

The field work was carried out from April to September 2015. Dendrometric measurements were performed with the use of a calliper to measure the diameter at breast height (DBH, with an accuracy of 1 mm) and with the use of Suunto altimeter to measure the height of trees (with an accuracy of 0.5 m).

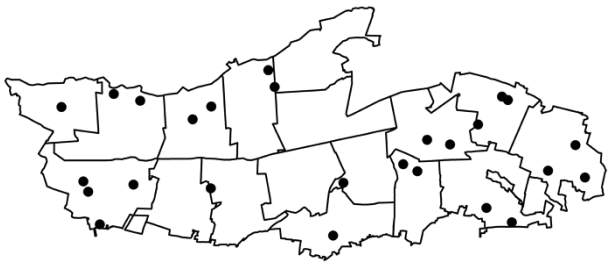

Figure 1. The distribution of research plots related to the assessment of the health condition of Scots pine in Kampinos National Park

Discussion

In the territory of KNP, monitoring of the health condition of tree stands is conducted within the framework of the Integrated Environmental Monitoring (IEM) Base Station 'Kampinos'. Three plots are analysed: two in a pine stand and one in an alder stand (Olszewski and Wierzbicki 2015). In addition, within the monitoring of fixed observation areas of the first grade (FOA I), implemented by the Forest Research Institute (FRI), there are four plots: three with the Scots pine and one with the birch (Małachowska 2015). In total, monitoring of five pine plots is conducted. Monitoring schemes implemented by the IEM Base Station 'Kampinos' and FRI are not compared. The monitoring conducted in five plots of pine stands does not allow for determining clearly what the health condition of the Scots pine in KNP is. The monitoring conducted on 26 plots allows a more comprehensive diagnosis of the health condition of the Scots pine in KNP stands.

With 520 assessed trees, it is found that the vast majority (75.4%) of specimens were characterised by light defoliation. Average defoliation affected 38.5% of

Table 3. The number of tress classified for the evaluated parameter of the health condition of Scots pine in Kampinos National Park

The estimated degree of defoliation	The type of crown thinning	The degree of discoloration	The damage class	Kraft's class	Crown visibility	Crown shading	The share of dead branches	Probable causes of damage
(0–10%) – 0 (11–25%) – 99 (26–60%) – 392 (61–99%) – 29	None – 0 Peripheral – 2 Outward from the Centre – 4 Bottom-up – 318 Regular – 136 Gaps – 55 Foliage in clumps – 5	None – 491 Minor – 5 Average – 24	Warning – 89 Minor and average damage – 388 Major damage – 43	Predominant – 113 Dominant – 300 Co-dominant – 90 Suppressed – 14 Overtopped – 3	Full – 467 Partial – 1 Larger part visible – 52	From one side – 64 From two sides – 196 From three sides – 198 From four sides – 55 With an open crown – 7	None – 10 Up to 10% – 120 (11–50%) – 387 >50% – 3	Not damaged – 95 Insects, primary pests – 9 Other infectious diseases – 4 Wind – 12 Multiple causative factors – 84 Unidentified – 316

specimens (Tab. 3). The pine is a species that practically has no specimens without defoliation below 10%. This was confirmed by the research carried out by Borecki et al. (1991), in which no trees with damage of the assimilation apparatus lower than 10% were recorded. A similar pattern of defoliation is reported in areas monitored within the framework of the IEM Base Station 'Kampinos', where the average reported defoliation was 34.8% for two analysed plots in 2015. The monitoring conducted in the KNP area by FRI in 2014 showed that the average defoliation was 21.8% – this monitoring, however, does not take into account old stands, which influences the results related to lower defoliation.

In the analysed areas, there was no discoloration or morphological changes in needles in 94.4% of trees. In 5.6% of trees, discoloration was probably associated with the multi-component weakness of the assessed specimen. In the analysed areas, 21.7% of trees had a one-year cover of needles, 74.2% had a two-year one and 4.04% had a three-year cover of needles. The endurance time for the Scots pine needles, in optimal conditions in Poland, is usually three years (Przybylski 1970). It should be borne in mind that changes in the level of surface waters (Somorowska 2011) and soils formed on dunes in the territory of KNP do not create optimal growth conditions for trees.

The analyses show that 61.2% of trees are affected by bottom-up crown thinning. Bottom-up thinning is a natural symptom related to the process of bole cleaning. The intensity of this process is dependent on, amongst others, the access of light to the lower branches of the crown. The higher the density is, the faster the tree trunks clean themselves. This process is particularly visible at the stage of the stand going through earlier growth phases: pole stage trees and young stands. In 12.7% of trees, the following were recorded: peripheral thinning (2 specimens), outward-spreading from the centre (4 specimens), gapped (55 specimens) and foliage in clumps (5 specimens). These kinds of thinning testify to the disturbed physiology of the analysed trees. It resulted from, amongst others, their low biosocial position or it could be associated with abiotic and biotic factors, which weakened the condition of the tree. The bole cleaning and crown thinning of the Scots pine are associated with the natural occurrence of dead branches. It was found that in 74.4% of trees, the proportion of dead branches is within the range of 11–50% and only in the case of 1.9% of trees, dead branches were not reported.

The presented analyses and applied methodology (Tab. 2) show that 74.6% of trees were classified as lightly and medium damaged. The results of monitoring carried out in particular years may be subject to change. It is confirmed by, amongst others, Beker's studies (2014) that the improvement of the health

condition of the examined trees, which was the effect of, amongst other things, the reduction of sulphur dioxide intake. By analysing the biosocial position, 57.7% of trees were classified as Kraft's class II (dominant trees). The biosocial structure, shaped in this way, testifies to a well-developed core of the stand (Szymański 2001).

The scientific community is not unanimous about the assessment of health condition based on defoliation. There appear statements that this assessment method is not reliable and fraught with error caused by the subjective assessment of defoliation (Lech 1995). However, in the case of KNP and the implementation of protection objectives aimed at, amongst others, ecological processes, the results of the work should be treated as informative input.

In 18.13% of the assessed trees, no damage was observed, which could have been caused by the activity of biotic and abiotic factors. In 60.8% of trees, some damage, which was difficult to verify, was recorded. The following observations were reported, amongst other things, in single specimen:

– development of a one-sided crown, which results from the competition for light between adjacent specimens,
– crown damage as a result of strong wind impact.

On the basis of 26 plots covered by monitoring, it can be established that possible human-induced pollution, in the form of gas emission and fertilising farming land, did not have any impact on the condition of the Scots pine in the recent period. The comparison of the plots, which were situated the closest and the furthest from the city of Warsaw, did not reveal any significant differences in the condition of Scots pines, which would stem from their location and the level of air pollution. The predominantly west-to-east wind direction helps to minimise the negative effects of air pollution caused by the city of Warsaw.

According to the dendrometric measurements (Tab. 4), the average DBH of the analysed trees is 26.6 cm (with a range from the average minimum diameter of 14.9 cm to the average maximum of 39.9 cm). The average height of the studied trees is 20.4 m (with a range from the average minimum height of 13.2 m to the maximum of 27.9 m). In order to analyse the changes in height and DBH, dendrometric measurements have to be conducted again in 2020. The average age of the examined tree stands is 84. The youngest stand reached 40 years in 2015 and the oldest was 122 years old.

Table 4. The average diameter at breast height (DBH) and height of Scots pines in 26 monitored areas of Kampinos National Park

Area number	Average DBH [cm]	Average height [cm]
1	29.2	18.3
2	23.9	20.2
3	28.2	21.2
4	23.9	20.2
5	33.2	24.0
6	15.8	14.3
7	19.5	19.3
8	38.7	26.9
9	23.3	18.8
10	14.9	13.3
11	39.9	22.4
12	21.5	18.3
13	22.5	22.0
14	31.6	27.9
15	31.1	21.5
16	26.5	20.7
17	20.7	19.5
18	34.5	25.1
19	35.8	24.1
20	20.6	18.5
21	25.5	23.2
22	26.9	19.6
23	20.0	17.0
24	34.9	19.5
25	15.9	13.2
26	32.7	22.5
Average	26.6	20.4

The preliminary monitoring research of 26 areas, with considerations for the specific conditions stemming from the dune-like terrain shape, reveals that the Scots pines in the KNP are in a good condition. In the future, one may expect that the health quality of the assessed specimens will undergo changes, which will be a natural behaviour, resulting from this species ecology.

The monitoring carried out in 2015 was the first stage in the evaluation of the health condition of pines in the KNP area. In the following years, these measurements will be repeated, which will allow for evaluating the

changes in the pine stands of KNP. Long-term observations will allow one to evaluate the changes in the stands and to foresee the changes associated with, for example, the disruption of seed production (Przybylski 1993).

Conclusions

The investigation of the condition of the Scots pine in the KNP in 2015 yields the following conclusions:

- – 75.4% of the Scots pine stands are slightly defoliated,
- – 94.4% of trees did not exhibit discoloration of the assimilation apparatus,
- – 61.2% of tree crowns undergo bottom-up thinning, which is a natural process in which the bole is cleaned,
- – there are no differences found between the plots, which are situated closer and further from the city of Warsaw,
- – considering the shape of the terrain and soil conditions, the Scots pine is in a good health condition.

References

Beker C. 2014. Stopień defoliacji drzewostanów sosnowych w leśnym zakładzie doświadczalnym Murowana Goślina w latach 1992–2012. *Zarządzanie Ochroną Przyrody w Lasach*, 8 (1), 7–15.

Borecki T., Miścicki S., Nowakowska J. 1991. Problemy oceny stanu zdrowotnego lasu w inwentaryzacji okresowej. *Sylwan*, 4/6, 27–33.

Borecki T., Keczyński A. 1992. Atlas ubytku aparatu asymilacyjnego drzew leśnych. Generalna Dyrekcja Lasów Państwowych, Warszawa.

Król B., Skolimowska-Król M. 2004. Kampinoski Parki Narodowy na tle kraju i regionu. In: Kampinoski Parki Narodowy. Tom 2. Społeczeństwo, przestrzeń, ekonomia (ed.: R. Andrzejewski). Kampinoski Park Narodowy, Izabelin, 7–36.

Lech P. 1995. Przydatność szacunkowej metody określania defoliacji drzew do badań stanu zdrowotnego lasu. *Sylwan*, 8, 99–107.

Lubański A. 2009. Kampinoski Park Narodowy – 50 lat. Epograf, Warszawa.

Małachowska J. 2015. Zróżnicowanie poziomu uszkodzenia monitorowanych gatunków drzew w kraju. In: Stan uszkodzenia lasów w Polsce w 2014 roku (ed.: J. Wawrzoniak). IBL, Sękocin Stary.

Olszewski A., Wierzbicki A. 2015. Uszkodzenia drzew i drzewostanów. In: Raport o stanie środowiska przyrodniczego zlewni Zintegrowanego Monitoringu Środowiska Przyrodniczego „Kampinos" w 2014 roku (ed.: A. Olszewski). Kampinoski Park Narodowy, Granica.

Przybylski T. 1970. Morfologia. In: Sosna zwyczajna (ed.: S. Białobok). PWN, Warszawa, 86–123.

Przybylski T. 1993. Autekologia i synekologia. In: Biologia sosny zwyczajnej (eds.: S. Białobok, A. Boratyński, W. Bugała). Sorus, Poznań, 255–281.

Somorowska U., Gutry-Korycka M., Lenartowicz M., Choromański J., Szporak S. 2011. Charakterystyka uwarunkowań hydrologicznych. In: Ochrona i renaturyzacja mokradeł Kampinoskiego Parku Narodowego (eds.: T. Okruszko, W. Mioduszewski, L. Kucharski). SGGW, Warszawa, 45–71.

Szczygielski M. 2002. Operat ochrony ekosystemów leśnych na okres 01.01.2002 r. – 31.12.2021 r. Volume I. Biuro Urządzania Lasu i Geodezji Leśnej, Warszawa.

Szymański S. 2001. Ekologiczne podstawy hodowli lasu. Poradnik leśniczego. PWRiL, Warszawa.

Tyburski Ł. 2016a. Sprawozdanie z monitoringu zdrowotności sosny zwyczajnej (*Pinus sylvestris*) w Kampinoskim Parku Narodowym wykonane w 2015 roku. Typescript, Izabelin.

Tyburski Ł. 2016b. Sprawozdanie z monitoringu zdrowotności olszy czarnej (*Alnus glutinosa*) w Kampinoskim Parku Narodowym wykonane w 2015 roku. Typescript, Izabelin.

Zielony R. 2004. Zarys dziejów gospodarki leśnej w Puszczy Kampinoskiej. In: Kampinoski Park Narodowy. Tom 2. Społeczeństwo, przestrzeń, ekonomia (ed.: R. Andrzejewski). Kampinoski Park Narodowy, Izabelin, 87–109.

Wawrzoniak J., Zajączkowski G. 2014. Metodyka pomiarów i obserwacji. In: Stan uszkodzenia lasów w Polsce w 2013 r. (ed.: J. Wawrzoniak). IBL, Sękocin Stary, 9–18.

www.gios.gov.pl/monlas/program.html – last access: 25.03.2016.