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Forest plant communities and their degeneration in the urban forests of Warsaw

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Abstract

This paper presents the results of an inventory of plant communities of the urban forests in Warsaw. It covers the occurrence of forest associations and forest plant communities in individual forest complexes. Due to their location within the boundaries of a large urban agglomeration, Warsaw's city forests are particularly exposed to anthropopressure. The share of various degrees of degeneration and dominant forms of degeneration in individual complexes and over the whole surface under investigation was assessed. Possible causes of the conditions existing in the forests have been discussed; in particular, within the context of the development and use of these forests for tourism and recreation. Particular forests' distinct historical origins, forestry management, and existing forms of surface protection possess fundamental significance for the determination of their current state.

Key words

anthropopressure, forest associations, forest substitute communities, levels and forms of vegetation degeneration

Introduction

Among the European capitals, Warsaw is distinguished by the significant share of forests within the city. In its current administrative borders are 27 forest complexes with a total area of nearly 8,000 ha, which is 15% of the entire city. These complexes are located mainly on the outskirts of the capital and form a kind of forest ring around the city. About 40% of these areas belong to the board of an organizational unit of the capital city of Warsaw with the name "Urban Forests Warsaw." These forests comprise 15 complexes divided into 4 forest districts: Bielany-Młociny, Bemowo-Koło, Kabaty, and Sobieski Forest (Nowakowska and Żak 2010).

The urban forests in Warsaw are particularly vulnerable to anthropopressure, due to their presence in a large urban agglomeration. The forms of anthropopressure are quite varied. The distinct historical origins of a given forest and the forest management carried out within it are of fundamental importance. Forests in the city are also subject to more or less intense human penetration, which may be spontaneous and uncontrolled. The main manifestation of such a pressure is usually increased synanthropization of flora (Sudnik-Wójcikowska 1987a, b, 1990; Chojnacki 1990, 1991).

One of the most important ways of using these forests in the city – of great significance for the managers of their terrain – is to make them available to serve the needs of leisure, sport, and recreation and the develop-

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ment of related forms of infrastructure, including tourist trails, bicycle paths, nature trails, fitness paths, rest areas, shelters, benches, playgrounds, recreation areas, and bonfire sites (Nowakowska and Żak 2010). Urban forests must fulfil such functions; however, many of them are simultaneously covered by various forms of protection (Wojtanowicz 2005, 2009). Access to forests is associated with anthropogenic pressure and is therefore in potential conflict with those needs relating to their protection.

The aim of this research is to make inventory of the forest vegetation of urban forests and assess their state of preservation, taking into account the levels and forms of their degeneration. The study was prepared to satisfy the needs of Urban Forests Warsaw, for which the assessment of the condition of forests is of fundamental importance when making decisions regarding the management of and access to forests – in particular, within the scope of tourism and the forests' recreational use.

Research Area

Individual forest complexes within the administrative borders of Warsaw include lands with various forms of ownership. In this study, only the areas under the management of Urban Forests Warsaw were the subject of the research; topographic and administrative details of the areas in which the inventory was carried out are given in the results section. Listed below are the complexes covered by the research, with their names, locations and boundaries, the total area of individual complexes, the form of surface protection, and the details of development for tourism and recreation.

The Bielany-Młociny District includes 8 forest complexes:

1. Bielański Forest – located in Bielany district between Marymoncka, Wisłostrada, and Podleśna Streets. The total area of the forest is 151.82 ha, of which 130.35 are in the reserve. The northwest part of the forest (at Marymoncka Street) is not covered by reserve protection; however, it belongs to the Warsaw Protected Landscape Area. Numerous paths run through the forest, partly fenced to reduce the penetration of forest communities. In the southern part, there is a fairly long nature path with 12 stations. In the northern part (behind Dewajtis Street), there are 2 recreational-playground areas. There is a bicycle path along Dewajtis Street, and on the edge of the escarpment, at the end of the street, there is a recreation area in the form of a scenic viewpoint.
2. Linde Forest – located between Lindego Street, Marymoncka Street (separating it from the Bielański Forest), Twardowska Street, the buildings of the Ministry of the Interior on Barcicka Street, and Kasprowicza Street. The area of the Linde Forest is 20.77 ha. The forest, like a portion of the neighbouring Bielański Forest, is part of the Warsaw Protected Landscape Area. There is a dense network of paths in the forest and 3 recreational-playground areas.
3. Nowa Warszawa Forest – a complex bounded by the northern border of Warsaw, Pułkowa Street on the east, Kazimierza Wóycickiego and Dziekanowska Streets on the south, and Estrada Street on the west. These urban forests are adjacent to the forests of other properties; their total area is 146.68 ha. The forest area belongs to the buffer zone of the Kampinos National Park and is located within the boundaries of the Warsaw Protected Landscape Area, and is a fragment of the Warsaw Escarpment – within which, it is not permitted to disturb the area's natural relief or destroy the ecosystem's vegetation. The forest lacks typical urban recreational areas like playgrounds; a bicycle trail runs along a forest path.
4. Młociny Forest – located between Papirusów, Pułkowa, and Dziwożony Streets and the left bank of the Vistula, at the northern border of the city, on an area of 98.09 ha. The forest is covered by the Kampinos National Park buffer zone and located within the boundaries of the Warsaw Protected Landscape Area. Przy Lesie Młocińskim is a non-forest ecological site in the southern part of the forest, with an area of 4.82 hectares, including a mid-forest meadow and five clusters of trees. In the forest, there is a wide circular road for walkers and along it an educational trail. There are also several smaller forest paths and a fitness path. In the north, by the road, is a playground and 3 recreational places adapted for bonfires. In the south, there are two more fairly extensive recreational areas, including a playground, bonfire site, and a parking lot.

5. Wydma Żerańska – located along Marywilska Street near Żerański Canal. It has a stretched shape and area of only 16.92 ha. The forest is not covered by any form of protection. There is no recreational infrastructure in the forest; there are not even any paths crossing it.
6. Białołęka Dworska – the forests of Białołęka are fragmented into many complexes, most of them very small. This study has adopted the division and boundaries that name Białołęka Dworska part of the primary, largest, and most interesting (from the natural perspective) complex between Ornecka, Wałuszewska, and Insurekcji Streets, with an area of 78.72 ha. This area is covered by the Warsaw Protected Landscape Area. There is no specially prepared tourist or recreation infrastructure in the forest, but it is crossed by numerous roads and paths.
7. Henryków – a forest that is part of the Białołęka Forests; it has an area of 57.48 ha and includes forests between Fletniowa and Papieska Streets and on both sides of Mehoffer Street. This area is covered by the Warsaw Protected Landscape Area. There is a lack of tourism and recreation infrastructure; there are also few roads and forest paths.
8. Dąbrówka – a forest directly adjacent to Henryków complex, located along Czajki Street and on both sides of Przylesie Road; it has an area of 33.33 ha. This area is covered by the Warsaw Protected Landscape Area. In the forest are only a few paths and one small playground, near Przylesie Street.

The Bemowo-Koło District includes two forest complexes:

1. Na Kole Forest – a small complex in the north-western part of Warsaw, in Wola district, in the area of Prymasa Tysiąclecia, Ostrowiecka, Dobrogniewa, and Dalibora Streets. It covers an area of 48.31 ha. The forest is not covered by any form of protection. The forest is crossed by numerous roads and paths; along one is a designated fitness path, and there are 2 playgrounds and 3 other leisure areas.
2. Bemowo Forest – a forest complex located in the western part of Bemowo and in the Stare Babice commune. It is one of the largest in Warsaw, covering 508.58 ha. This area is covered by the Warsaw Protected Landscape Area. In the Bemowo Forest (but outside the administrative borders of Warsaw), two reserves are located: Łosiowe Błota and Kalinowa Łąka. There are roads and forest paths, along which are found tourist shelters and a long designated nature path, in addition to a fitness path, 3 playgrounds, and other recreational areas, including sites for bonfires.

The Sobieski Forest District includes 4 forest complexes:

1. Sobieski Forest – located between Kościuszkowców and Czecha Streets and the city border. It has an area of 516.60 ha, of which 114.44 is occupied by the King Jan Sobieski Nature Reserve. The entire complex is part of the Mazowiecki Landscape Park. Along the forest roads are rest areas and tourist shelters, a built-up fitness path, a designated nature path, a playground, and a parking lot.
2. Matki Mojej Forest – a small complex located between Strusia, Akwarelowa, and Łysakowska Streets that has an area of 14 ha. The forest is not covered by any form of protection. In the forest, there are several roads and paths, a rest area, and a fitness path.
3. Olszynka Grochowska – a complex located along Szeroka Street; the entire area is 69.39 ha, of which 56.95 ha are included in the Olszynka Grochowska reserve. The main purpose of the reserve is to preserve, for landscape, social, and historical reasons, a fragment of the forest growing on the area of the Battle of Grochów of 1831. There are roads and paths used by walkers for recreational purposes; however, the reserve's area is not developed specifically for that purpose.
4. Bródno Forest – a complex located in Targówek between Głębocka and Kondratowicza Streets, Trasa Toruńska, and Radzymińska Street. The entire complex has an area of 138 ha. The forest is not covered by any form of protection. There are roads and paths in the forest, along which an educational path is marked. There is a vast recreational area (a playground) in the western part; also, in this region, there is a valuable historical monument (an early medieval fortified settlement) that is currently a tourist attraction.

The Kabaty District includes only one forest complex:

1. The Stefan Starzyński Memorial Kabacki Forest – located in the southern part of Warsaw, on the border of the city; it is the largest forest complex of the capital, with 924.72 ha. Almost the entire area (902.68 ha) is located in the Las Kabacki reserve named after Stefan Starzyński. The object of protection is a fragment of the Warsaw Escarpment together with oak-hornbeam forests. The buffer zone of the reserve is part of the Warsaw Protected Landscape Area. The Kabacki forest is intensively used for recreational purposes and well-furnished in that regard. There are 3 tourist routes through the forest, a cycle path, two nature paths, a playground, a bonfire site, and a parking lot.

Material and methods

In all the forest complexes, over their entire area (with the exclusion of grounds not under the management of Urban Forests Warsaw), a mapping of forest vegetation was performed. Within the forest areas, places lacking forest vegetation that are either semi-natural (e.g., meadows and grasslands) or anthropogenic (buildings, roads, etc.) have been omitted. As a basis for defining the areas, the study used the existing surface division including tree stands, for which particular objects of the study dominating in these divisions were determined. In exceptional cases, when a stand division with a large area was significantly diversified in terms of existing vegetation, an additional division was introduced corresponding to this diversity.

The inventory included three elements in its description of forests: the plant community, the level of degeneration, and the type of degeneration. The plant community is fundamental, usually defined at the rank of the association, or – for associations with a high variability of habitats – also at the sub-association level (Matuszkiewicz 2001, 2005). For completely disturbed communities, it was assumed that they constitute forest substitute communities (Jakubowska-Gabara 1989). Because the system of these communities is not uniformly developed and the communities form very different species combinations, this study introduces a division based on the dominant species in the stand.

The level of degeneration was determined in a four-grade scale based on the methodology used in the State Forests (Forest Management Manual 2012). The first three stages (referred to as A, B, and C) concern communities that have been inventoried as forest communities, while the fourth degree (D) applies to all substitute communities. The main criterion that provides the basis for distinguishing individual grades is the participation in the community of alien species, both ecologically and geographically. The permissible share of geographically alien species is always 50% lower than in the case of ecologically alien species. Thus, A – natural communities, up to 10% ecologically alien species or 5% geographically alien; B – slightly degraded, between 10–30% ecologically alien or 5–15% geographically alien; C – highly degraded, between 30–60% or 15–30% alien, respectively; D – transformed or substitute communities, > 60% or > 30% alien, respectively. For communities representing B, C or D levels of degeneration, types of forest community degeneration were adopted following Olaczek (1972). In the case of coexistence of several types of degeneration, the dominant type was adopted, based primarily on the assessment of the stand. The following types of degeneration are included:

– juvenalization – young stands, in the first or second age class;
– monotypization – this manifests itself in a uniformity of the stand's age and species, a simplification of the layer structure, and species impoverishment; it is the result of former forest management, full-scale clearings, artificial renewals, and the introduction of monocultures at felling sites or on post-agricultural lands;
– pinetization – the artificial introduction of coniferous trees (mainly pine) in excessive quantities to fertile habitats on which naturally mixed or deciduous stands should grow;
– cespitization – this is manifested by the strong development of grass in the undergrowth, with the simultaneous disappearance of dicotyledonous plants; it can be the effect of stands thinning or of other types of impacts (for example, grazing in the forest);
– fruticetization – this involves the strong development of the shrub layer as a result of the stand's overexposure to light; in the case of artificial pine stands on habitats of oak-hornbeam, it is manifested in the mass growth of blackberries;

– neophytization – the spontaneous penetration of neophytes into forest communities, or their introduction by former forest management.

For the A level of degeneration involving natural, undegenerated, or only slightly degenerated communities, the degeneration type was not given. An additional category of degeneration was provided for some partitions in which various forms of degeneration occurred in equal intensity or in which others not mentioned above were observed.

Results and discussion

The percentage share of forest associations and forest substitute communities and the area of forest communities studied in particular complexes of the Urban Forests are given in Table 1. The sizes of individual complexes are very diverse, ranging from a dozen to several hundred hectares. Also quite large – from several to a dozen or so – is the variation in the number of plant communities. It is related to the size of individual complexes as well as to the diversity of natural habitat conditions that manifests itself in the occurrence of natural forest complexes, along with anthropogenic impact, which is associated with the occurrence of forest substitute communities.

Among the established forest associations, the most numerous are mixed forests of *Querco roboris-Pinetum typicum* (about 600 ha and 23% of the forest area under study), *Tilio-Carpinetum typicum* (about 520 ha and 20%), and dry oak-hornbeam (about 340 ha and 13%). Less numerous are fresh forests from the *Dicrano-Pinion* alliance (*Peucedano-Pinetum* and *Leucobryo-Pinetum*). The remaining associations occupy areas not exceeding a 3% share. Among forest

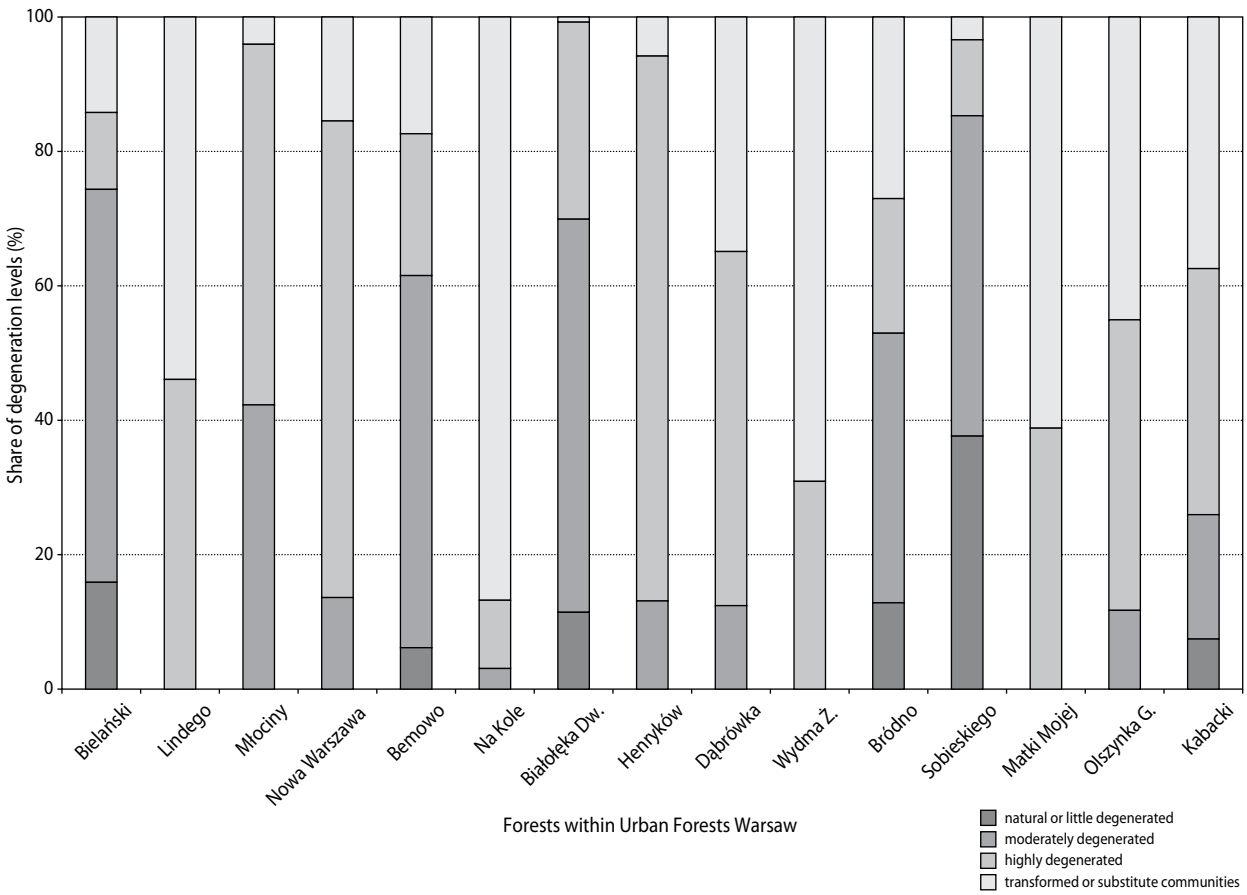

Figure 1. Degeneration levels of forest vegetation in particular forests within Urban Forests Warsaw, shown as the percentage share in the area of the forest site

Table 1. Area of forests and share of forest plant associations and communities within the constituent forests of Urban Forests Warsaw

Urban Forests	Bielański	Linde	Młociny	Nowa Warszwa	Bemowo	Na Kole	Białołęka Dw.	Henryków	Dąbrówka	Wydma Ż.	Bródno	Sobieski	Matki Mojej	Olszynka G.	Kabacki	TOTAL
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Forest area [ha]	144.98	20.77	84.99	45.51	453.99	46.29	78.72	57.48	33.33	16.92	132.25	544.32	14.01	61.19	866.95	2601.70
Forest associations [%]:																
Peucedano-Pinetum, Leucobryo-Pinetum				4.35	4.30		9.53	59.32	11.07	20.33	0.54	20.59	38.83			7.24
Querco roboris-Pinetum typicum	5.33	46.08	16.04	80.18	33.16	12.31	86.15	28.86	40.44	10.58	24.98	43.19		9.97	0.31	23.07
Querco roboris-Pinetum molinietosum					9.70						0.94				0.80	2.01
Querco roboris-Pinetum coryletosum					5.02						6.87				5.23	2.97
Potentillo albae-Quercetum												1.15				0.24
Tilio-Carpinetum calamagrostietosum	39.43		43.48			0.91		6.00	13.11		8.54	22.26		33.37	9.96	13.12
Tilio-Carpinetum typicum	20.59		15.83		3.93		3.18				2.98	9.41		7.13	45.99	20.06
Tilio-Carpinetum stachyetosum	4.32				2.76						9.01			2.26	0.29	1.33
Ficario-Ulmetum minoris	16.11		18.70													1.51
Fraxino-Alnetum					13.10		0.38		0.48		11.27			2.22		2.93
Populetum albae			1.91													0.06
Ribeso nigri-Alnetum					10.60						7.84					2.25
Forest substitute communities [%]:																
Pinus	0.63	12.28	1.31	8.44	3.80	33.94			31.89	20.69	7.86	1.30	51.75	13.37	24.84	11.68
Picea			0.45		0.08										0.12	0.07
Larix					0.68						1.41				0.31	0.29

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Betula		3.51		1.67	5.80	1.14			3.00	13.48	5.11	1.35	3.50	17.18	4.57	3.71
Quercus	1.02			5.36	2.17					1.54		0.65			5.82	2.62
Populus					0.79					17.61	1.16			1.23	1.71	0.91
Salix					0.49						4.95					0.34
Alnus					2.97					0.59	0.21			10.87		0.79
Acer					0.19											0.03
Acer negundo	0.09					2.48								0.59		0.06
Quercus rubra	0.54	17.24				2.25					3.74	0.05		1.83		0.45
Robinia Pseudoacacia	11.73	20.90	0.41		0.22	46.75	0.76	5.81		15.19			5.92		0.07	2.01
Other [%]:																
recreational areas	0.19		1.89		0.24	0.22					2.58	0.03				0.26

substitute communities, those with *Pinus sylvestris* are definitely dominant.

The level of forest associations' degeneration is very diverse in individual forest complexes (Fig. 1), but in general, it may be stated that they are degenerated to a great extent. The Sobieski, Białołęka Dworska, and Bielański Forests can be mentioned among the relatively least degenerated forest complexes. Meanwhile, the most distorted are Na Kole, Wydma Żerańska, Matki Mojej, and Linde Forests.

The total share of individual degradation levels calculated for the whole forest area under examination shows that the least numerous are category A (natural areas); the most abundant are category B (moderately degenerated) and category C (strongly degenerated). The share of category D (forest substitution communities) is close to 1/4th of the studied area (Fig. 2).

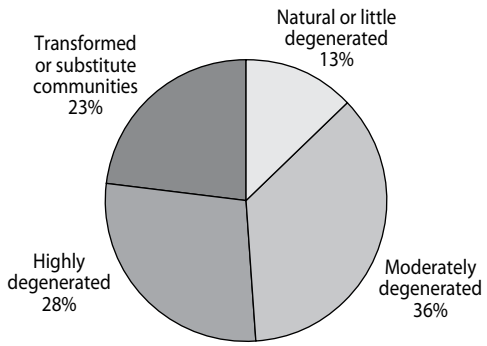

Figure 2. Total share of degeneration levels of forest vegetation within Urban Forests Warsaw

The dominant forms of degeneration in individual complexes are presented in Figure 3, with the total share of individual forms of degradation in Figure 4. The largest number of communities throughout the study area comprises those where monotypization is the most important degradation, followed by pinetization and juvenalization, as well as communities with other or different forms of degradation. The distribution of degradation in individual complexes is varied; to a large extent, this relates to the habitats and forest communities occurring within them. Monotypization occurs most often in pine stands growing on suitable habitats of fresh and mixed forests. The share of this type of degradation is thus dominant in complexes where there are many coniferous forests habitats – namely, Nowa Warszawa,

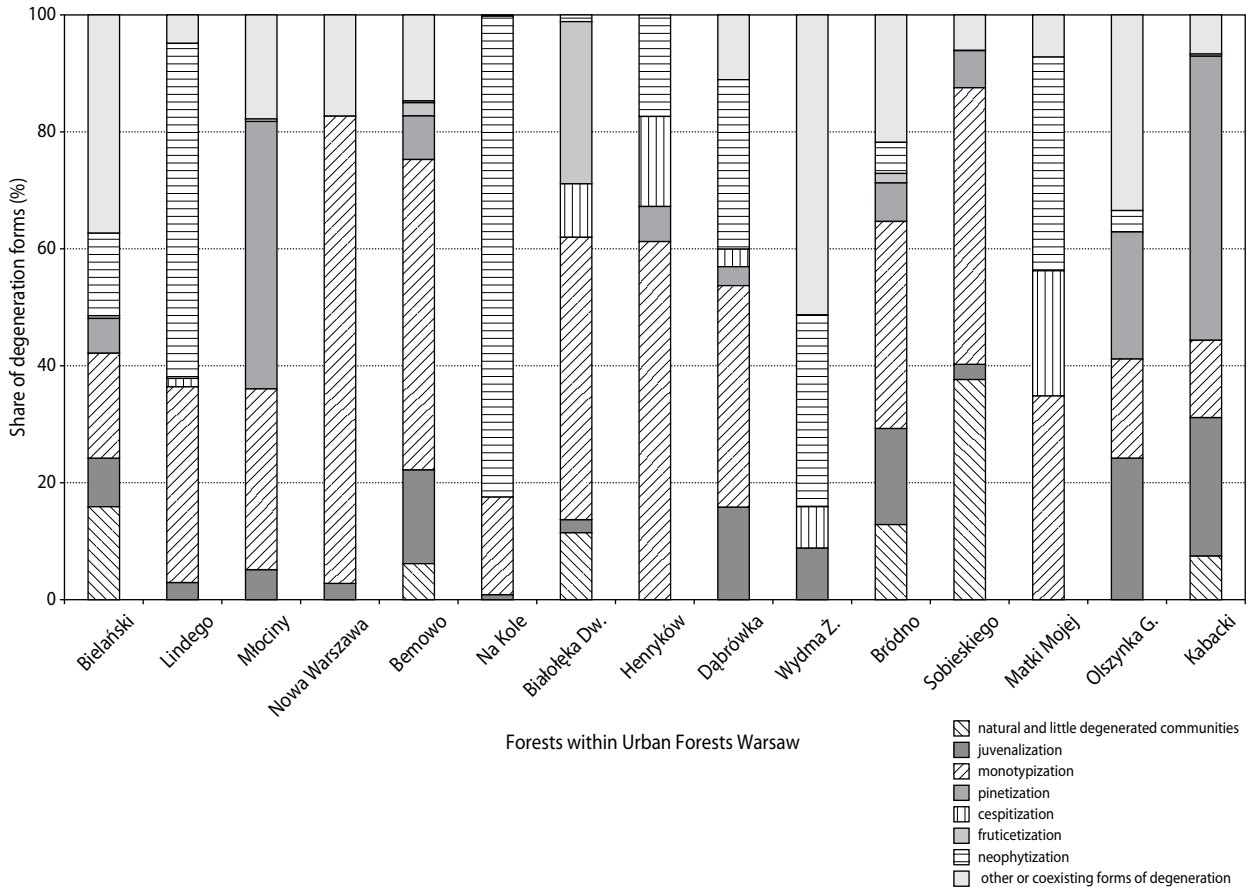

Figure 3. Degeneration types for vegetation in particular forests within Urban Forests Warsaw, shown as the percentage share in the area of the forest site

Bemowo, Białołęka Dworska, Henryków, Dąbrówka, and Sobieski Forests. Pinetization, on the other hand, concerns pine stands growing on more fertile habitats of mixed fresh forests and fresh forests, which are characteristic of oak-hornbeam forests. Such a situation occurs over the largest area in the Kabacki Forest. A relatively large share of this type of degradation is also found in the Młociny Forest.

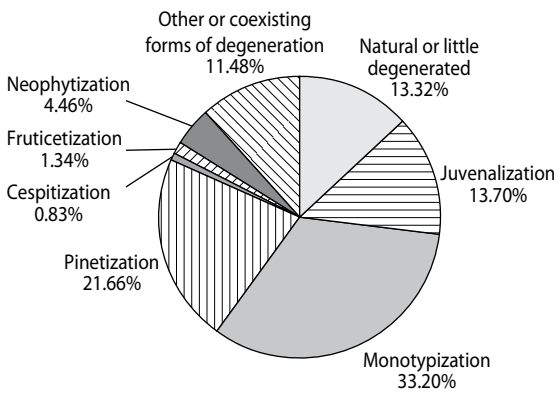

Figure 4. Total share of the degeneration types for forest vegetation within Urban Forests Warsaw

Particularly noteworthy is neophytization, one of the most dangerous types of degeneration. The share of this type in the entire forest area under study is relatively small. However, the small share results mainly from the adopted methodology, where the types of degeneration have been determined as dominant mainly in relation to the stand. Thus, neophytization has been recorded in communities in which foreign trees (i.e., woody neophytes) dominate in the forest stand, or possibly, in some cases, in the shrub layer. This approach was adopted because in the project of which this work is a part, a separate research initiative has focused on the neophytization of forest floor plants, and the results

of that research have been presented in a separate study (Obidziński et al. 2016). Warsaw's flora – with particular emphasis on its synanthropization – has already been the subject of a detailed study including both historical transformation studies and extensive documentation in the form of maps of the distribution of all vascular plants occurring within the city (Sudnik-Wójcikowska 1987a, b).

From the point of view of the neophytization of stands, an outstanding example of this phenomenon is the Na Kole Forest. Within its territory, nearly half of the area constitutes substitute communities with a stand of *Robinia pseudoacacia*, and on 1/3rd of the surface are substitute communities with *Pinus sylvestris*. However, the most important form of distortion here is not pinetization but neophytization resulting from a very large share of neophytes in the lower layers – in this case, mainly *Quercus rubra*. In total, stands dominated by woody neophytes exceed 4/5ths of the area of this forest. A high degree of neophytization also occurs in the four smallest complexes, which include Linde, Wydma Żerańska, Dąbrówka, and Matki Mojej Forests.

In the context of neophytization and other degeneration types, a separate discussion is required for the Bielański Forest, one of the most valuable objects among urban forests. Significant natural and cultural value is associated with the forest; most of the area is protected in the reserve (Baum and Trojan 1982; Luniak 2005, 2010). As is shown by the data presented, within this forest's area, both strongly deformed and substitute communities were noted, as well as a relatively high degree of neophytization and other forms of degradation. This is due to the fact that the complex includes forests that are very diverse in their history and the associated degeneration. The area covered by the reserve protection includes the remains of the former Masovian Forest. Due to significant anthropopressure, this area is not free from degradation. However, compared to other complexes, it stands out positively, especially in the lower eastern part where there are riparian forests and moist oak-hornbeam forests. These areas are typically the subject of the numerous scientific studies of this location. However, the complex in the management of the Urban Forests also includes the western part located between the reserve and Marymoncka Street. In this area, which formerly belonged to the Culture Park in Bielany, the communities are very much degenerated. On most surfaces are stands with neophytes: that is, the dominant *Robinia pseudoacacia* and, to a lesser extent, also *Quercus rubra* and *Acer negundo*. Taking this area into consideration, the substitute communities dominated by neophytes occupy about 1/5th of the entire forest complex in Bielany.

The oldest nature reserve in Warsaw is the King Jan Sobieski Reserve, which occupies 28% of the area of the Sobieski Forest (Zielony 2005). The whole complex is the least degenerated among the studied objects, largely because in the portion outside the reserve, the dominant habitats are coniferous forests, mainly mixed fresh forests, in which appear pine stands that are typical and suitable for the habitats. The reserve itself is dominated by habitats of mixed fresh forest and fresh forest with old oak stands. Currently, there are mainly oak-hornbeam forests in this area, in places well preserved or slightly degenerated. The greatest natural worth of the reserve and adjacent areas was once found in the oak-thermophilous forests *Potentillo albae-Quercetum*, which form very valuable and species-rich communities covered by habitat protection but are unfortunately rapidly disappearing over the country's entire range (Kwiatkowska 1996; Jakubowska-Gabara et al. 2004). In historical materials dating back to the pre-war years, the occurrence of this community together with the rich flora of the floor is documented (Kobendza 1933, 1950). Still at the end of the 1970s and beginning of the 1980s, this community was mapped over the largest areas in Warsaw (Chojnacki 1991). Since then, the community has almost completely disappeared; now there are two small patches, which are also poorer than in the past in terms of floristics (Ciurzycki et al. 2015).

As evidenced by the presented materials, all of the forests are more or less changed; communities are characterized by various forms of degeneration. The condition of the forests and degree of their transformation is very diverse. The most valuable forests in terms of nature include Bielański and Sobieski Forests, as well as Młociny, Bemowo, Bródno, Kabacki, and Białołęka Forests. The most transformed forests are Wydma Żerańska, Linde, Na Kole, and Matki Mojej Forests. Higher degree of naturalness and protected status of forest is usually related to a greater abundance of dead wood. This was also the subject of research at the urban forests of Warsaw, where this dependence is apparently confirmed in the case of the Bielański Forest, showing

the highest amount of dead wood. In this respect, Kabacki, Młociny and Bemowo Forests as well as Bródno and Olszynka Grochowska are outstanding. Among the well-preserved forests, the relatively low amount of dead wood is characteristic for the Sobieski Forest, which results from the high percentage of coniferous forest habitats where less deadwood was found than in fertile dominant habitats, for example, in the Bielański Forest (Skwarek and Bijak 2015).

Warsaw's municipal forests have a very diverse history and origins (Orzełek 1990). Contemporary forests that possess continuity with historical forests are among the exceptions. Only a few complexes (and even there, not over their whole surface) have the character of so-called "old forests," or forests existing since at least the middle of the 19th century (Dzwonko and Loster 2001). Taking into account the age of tree stands, it can be concluded that on average, Warsaw's forests are relatively young. The majority of forest stands come from around the middle of the 20th century. Among them are forests that are the result of spontaneous succession; however, most are the result of post-war afforestation. Established long before the introduction of multifunctional forestry, they are thus often artificial stands unsuitable for the habitat conditions – monocultures most often of pine, sometimes of other species. Scots pine was planted both on fresh habitats suitable for this species as well as on more fertile habitats. Hence, among the dominant types of degeneration, monotypization, pinetization and juvenalization can be mentioned. Most of the dominant forms of degeneration of vegetation affecting their degree of naturalness, phytosociological status, and physiognomy of communities do not result, therefore, from tourist or recreational use but from their origins and the history of forest management conducted in individual complexes.

When considering the level of tourist and recreational accessibility of individual forests, it is possible to identify forests that are distinctive in this respect. There are very different forms of development in their area: tourist trails, bicycle paths, educational paths, fitness paths, rest areas, shelters, benches, playgrounds, recreation areas, or bonfire sites. Among the forests with such development can be mentioned Bielański, Młociny, Bemowo, Bródno, Sobieski, and Kabacki Forests (Nowakowska and Żak 2010). The above mentioned forests are also relatively well preserved in terms of vegetation. Also, on their terrain are reserves belonging to the largest and most valuable in the Warsaw area. On the other hand, one can identify forests with less tourist development, such as Linde, Na Kole, Dąbrówka, and Matki Mojej Forests; these complexes are simultaneously among the most distorted ones. A prominent example here is Wydma Żerańska, where there are no designated tourist and recreational facilities; this is the forest with the highest degree of degradation.

The use of the infrastructure prepared by Urban Forests Warsaw in the form of trail paths and rest areas is certainly not the only anthropopressure that forests undergo. Each path or trail is a potential route on which people move; moreover, parts of the forest are penetrated deep into communities independently of existing communication routes. The eutrophication and synanthropization of flora are related to this. A problem in many forests is littering, including unauthorized rubbish dumps. It seems that in regard to the state of forests, such spontaneous and uncontrolled presence of people in the forests has a greater adverse effect than people accessing them for tourist or recreational purposes in designated places. It should thus be asserted that within urban conditions, the practical possibilities for the Urban Forests institution to influence the location and intensity of anthropopressure are limited to a large extent.

Conclusions

1. Among the established forest communities, the most numerous are fresh mixed forests, typical hornbeam forests, and dry oak-hornbeam forests. Fresh forests are less numerous. The remaining associations occupy areas not exceeding 3% of the entire area. Among forest substitute communities, the dominant ones are those with *Pinus sylvestris*.
2. In terms of the degree of degeneration, the natural surfaces of category A are least numerous; most numerous are the moderately degenerated category B and strongly degenerated category C. The share of category D, that is, the forest substitute communities, is close to 1/4th of the surface studied.
3. The relatively least degenerated complexes include Sobieski, Białołęka Dworska and Bielański Forests. Meanwhile, the most degenerated are Na Kole, Wydma Żerańska, Matki Mojej, and Linde Forests.

4. Most numerous are communities in which the most important degradation type is monotypization, followed by pinetization and juvenalization, as well as communities with other or coexisting forms of degeneration. The distribution of degeneration types in individual complexes is varied.
5. Most of the dominant types of vegetation degeneration affecting the degree of degeneration in particular complexes are related to the origin of the forests and the history of their management. Forests are also subject to anthropopressure in a spontaneous form, as the presence of people is not controlled along roads and paths or in the depths of communities, irrespective of existing communication routes. This is usually associated with eutrophication, littering, and the synanthropization of flora.
6. The accessibility of forests in the form of trails, paths, and leisure spots is ordered and limited to points or lines, so using the infrastructure prepared by Urban Forests Warsaw should not have such a negative impact on the condition of the forests as the abovementioned factors.

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