

TREE SPECIES DIVERSITY IN TWO SMALL CITIES OF KYIV REGION, UKRAINE

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Abstract

The diversity of trees is an important factor in ensuring the sustainability of urban forests, but it has hardly been studied in small towns in Ukraine. This study examines the diversity of urban tree species in two small towns in the capital region of Ukraine. The results show that the richest species composition of Vyshgorod city in the adjoining the houses territories and in mini-parks. A total of 100 species and forms of trees and shrubs have been found in the city. 27 species of trees and shrubs are represented in Ukrainka city. Spiraea vanhouttei, Syringa vulgaris and the genus Spiraea are critical for Vyshgorod city. Acer saccharinum, Pinus sylvestris, Populus pyramidalis, Betula pendula and Spiraea vanhouttei are critical for Ukrainka city. In contrast to Vyshgorod, where the distribution of trees by diameter is close to optimal, Ukrainka lacks young trees and exceeds the share of "ripening", which violates the guarantees of sustainable development of urban plantations. The methodology used in this study may allow practitioners to better assess the sustainability of urban tree plantations.

Key words: green plantings for public use, introducers, species structure, street plantings.

INTRODUCTION

The ecopotential of urban landscapes is determined by the structure of vegetation, its species composition, condition and resistance to urban factors (Ovcharenko & Zalyubovska, 2018), including the conservation of biodiversity (Caynes et al., 2016).

In urban conditions, there is a complex impact of negative factors on woody plants, which requires a differentiated approach to the selection of their species composition, taking into account the stability and categories of plantations, their purposes and natural features of the territory (Vedernikov & Bukharina, 2010). It is recognized that a quality urban environment can be achieved only through the creation of effective bio-sustainable plantings, the use of a regional range of sustainable plants, which will be based on aboriginal species that are better adapted to local eco-conditions (Buko & Volobaeva, 2008). Instead, (Gerasimchuk, 2009) found that the species composition of greenery in the towns of Ukraine, especially on the streets, is poor and does not meet modern needs.

According to Smona (2010), the diversity of urban plantations is the most important among

the factors to estimate the impact on the environment, as well as a key component of resistance to pests, diseases and climate change (Cowett & Bassuk, 2017). Rule 10-20-30 (Santamour, 2002) has become a generally accepted norm, despite the lack of scientific or empirical evidence of the values of the established restrictions, but, unfortunately, has not been introduced in Ukraine.

The Simpson diversity index or the Shannon-Wiener index are often used to assess the diversity of street trees, and the inversion of the Simpson index (SDI) is considered to be one of the best indicators of phytodiversity (Sun, 1992).

In the post-Soviet space, the species composition of green areas of large cities was mostly studied. It was found that despite the use in urban landscaping of a large number of species of woody plants, they are usually dominated by only 10-15 species (Bukharina et al., 2007).

Number of urban green space is an important determining factor of biodiversity (Lepczyk et al., 2017). Accurately extracting tree characteristics and species information can facilitate the monitoring and management of street trees, as well as aiding landscaping and

studies of urban ecology (Y. Wang et al., 2021). However, quantitative measurements of structure and morphology of urban trees are hardly exhausted so far (Bayer et al., 2018). It was noted that the expansion of species in urban greenspace leads to an increase in the similarity of the species composition of plants between remote areas (X. Wang et al., 2021). There are numerous works to study the current state of the composition of urban forests (Monteiro et al., 2019). There is almost no information about species composition of green plantings in small towns. This study aims to examine the current state of composition and stability of greenery of different functional purposes in small Ukrainian cities in the capital region.

MATERIALS AND METHODS

General characteristics of the study areas

Small city are the most common category of cities in Ukraine (as in many other countries of the world), and at the same time, the least studied. In the capital Kyiv region there are 20 (80% of the total number) small cities with a population of up to 50 thousand inhabitants. Detailed research was conducted in Vyshhorod city (forest zone - Polissya) and for comparison, in a more generalized form (only for the town as a whole) - in Ukrainka city (forest-steppe zone) (Figure 1).

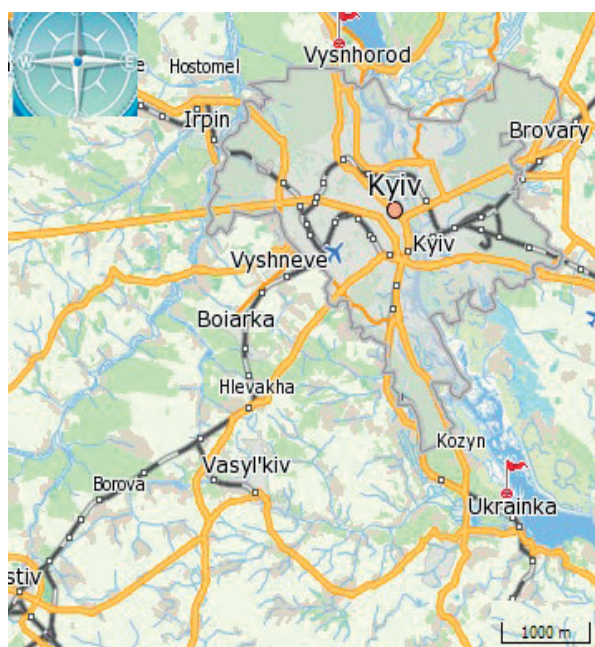


Figure 1. Location of small towns relative to Kyiv

The average annual temperature for this area is about 7°C and ranging from about -6°C in January to more than 19°C in July. The climate is temperate continental.

Vyshhorod is a historic small city founded in 946, energy in terms of industrial development, the district center, one of the closest to the capital (Kyiv), located on the picturesque hills on the banks of the Dnieper River. The town is developing rapidly and currently has of over 27 thousand inhabitants. Ukrainka is a newly built city with a population of 15.5 thousand, but also located on the banks of the Dnieper (downstream from Kyiv).

The study area covers almost the entire territory of the Vyshhorod city, which occupies 874 hectares, but, above all, its central part. The population density is about 3180 people per km². Apart from the scarce data about green areas in the Master plans and datas about area of public green spaces in the statistical form of land use, no other data on green areas were found. The Master plans provide a single indicator of landscaping - the provision of green areas for public use. It is the only directly normalized indicator in the process of urban planning of Ukrainian cities.

Methodological aspects of assessing the quality of greenery. Given that the inventory of green areas in small towns has never been conducted and currently no data on their quality are available, the research was based on our (conducted in 2012-2017) inventory of green areas (Zibtseva, 2014; 2015; 2018). Green plantings of all three functional groups in Vishhorod city were researched. The species composition and the main taxonomic indicators were determined, in particular the age and diameter of trees at a height of 1.3 meters on the territory of each research object.

The share of tree species in plantings was calculated as the ratio of the number of specimens of this species to the total number of surveyed tree plants in a given group of objects. Structural analysis of tree plantations included assessment according to the classification of species by Mikheeva (2009), where species with a high share of participation included species with a share of specimens from 5 to 10%, and with a very high share of participation - with share more than 10%. The

ratio of aboriginal and introduced species was determined.

To assess the phytodiversity, we calculated the index of diversity of tree plant species (Species Diversity Index - SDI) - the inversion of the Simpson index (Sun, 1992). An SDI value close to 20 indicates that the plantings are stable.

In general, the inventory covered greenery of all functional groups on the territory of the town, in particular: the territory of 10 squares (mini-parks), public buildings of local authorities, adjacent territories of more than 30% of apartment buildings, which are communally owned to territorial community of town, multi-storey new buildings, of a number of private sector estates in the historic part of town, three secondary schools, of a former scientific institution, recreation center, hospital, industrial zone, 14 streets and along of a suburban highway of regional importance. In addition, an inventory of trees and shrubs was conducted in Ukrainka city. The number of surveyed trees and shrubs in plantations of different functional purposes amounted to more than 3,000 specimens.

In the absence of domestic analogues, for comparison, the experience of inventory of tree plantations in a number of small US towns: Topsham, Chester and others, as well as Essex (UK). An important result of the inventory of tree plantations in American cities is the selection of critical species (which exceed the number of individuals rule 10-20-30 (Santamour, 2002) in terms of species diversity and the distribution of plants by diameter classes, the correspondence of which to the ideal (Richards, 1983) indicates the stability of urban green plantings development.

RESULTS AND DISCUSSIONS

Information in Master plans about the quality of greenery

According to the master plans of the 1970s - 1990s (later data on the species composition of green plantations are absent), the species composition of woody and shrub plants in green plantations of small towns of the region was quite limited and had up to 12 species. Common species were included *Acer negundo* L., *Robinia pseudoacacia* L., as well as

Aesculus hippocastanum L., *Acer saccharinum* L. (introduced species, currently widespread in most Ukrainian cities). It is obvious that some of these plantings have survived to this day, but have crossed the age of decorative durability and are usually represented by plantations that need to be replaced. Aboriginal species such as *Tilia cordata* Mill., *Populus nigra* L., *Betula pendula* Roth., *Alnus glutinosa* (L.) P. Gaertn., *Sorbus aucuparia* L., *Pinus sylvestris* L., *Salix alba* L., *S. caprea* L., *Quercus robur* L., *Ulmus laevis* Pall., *Fraxinus excelsior* L., *Picea excelsa* Link. In addition, the territories of small towns are characterized by large areas of orchards, which significantly influenced the formation of the urban landscape. Among the wide range of tree plant species recommended by the master plans of the 1970s and 1990s for promising urban landscaping, introduced species predominated.

Green plantings of Vyshhorod town

Public green plantings in Vyshhorod town is actually represented only by squares (mini-parks), although some of them are called parks even in official sources. In fact, they do not meet the minimum area of the park, which according to the state standard must be as minimum 2 hectares.

According to research results, the species composition of the town squares numbered 20 species and forms of tree plants. As a rule, the basis of squares are older trees of several aboriginal species, to which decorative introducers were added over time. Among the species of tree plants 11 (55%) are introducers, among shrubs - three species (or 50%).

Very high share (over 10%) is inherent to *Thuja occidentalis* L. and *Aesculus hippocastanum*. High share (5-10%) is inherent to decorative forms of *Thuja occidentalis*, *Acer platanoides* L., *Ulmus scabra* Mill., *Tilia cordata*. Figure 2 shows the distribution of species of tree plants in public gardens by age. The 10-year-old plantings, 50- and 40-year-old trees predominate in the squares of the downtown. The share of trees aged 60-70 years reaches 12.5%. Young trees are mostly decorative forms of conifers. The SDI for downtown tree plantations is 9.2 (a similar result was obtained for street plantings in Springfield, Massachusetts) (Sun, 1992).

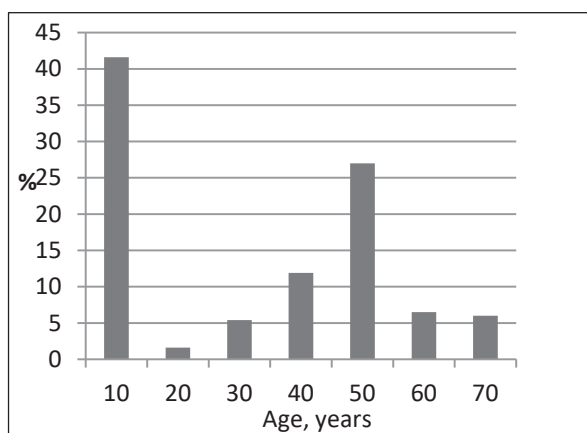


Figure 2. Age distribution of tree plantings in squares of Vyshhorod town, %

Only six species of shrubs were found in the squares of the downtown. *Spiraea japonica* L. predominates, accounting for more than half of the bush plantings.

The rapid development of the city over the last decade is accompanied by changes in landscaping, especially public greenery, new squares are appearing. On the territories of the newly created squares there are 22 species of trees and shrubs, including such exotic ones as *Aesculus carnea* 'Briotti', *Physocarpus opulifolius* f. 'Diablo', *Ginkgo biloba* L., *Catalpa bignonioides* Walt., *Potentilla fruticosa* 'Elizabeth', *Juniperus squamata* Lamb., *J. squamata* f. 'Blue Swede', *Corylus colurna* L., *Magnolia soulangeana* Soul.-Bod., *Rhus typhina* L., *Physocarpus opulifolius* f. 'Diablo'.

It was found that *Syringa vulgaris* L. occurs in all newly created parks, and 28 species occur only in one of the squares. Planting of rare exotic plants became more frequent. A total of 54 species and forms of trees and shrubs have been identified in the city's public gardens, and their species diversity index (SDI) is 10.4.

Green plantations for limited use. According to Luce (1978) green plantations of limited use are the most common category of green areas in small towns, which is explained, in particular, by large areas under residential buildings (especially private estates) and, accordingly, gardens at these areas, as well as that the green plantations of limited use are represented in all territories with any restriction of the contingent of visitors.

A significant part of the important public buildings is concentrated in Vyshhorod

downtown. The species composition of the plantations of these areas includes 14 species of woody plants, 9 of which (64%) are introducers. Species with a very high share of participation include *Picea pungens* f. *glauca*, *P. excelsa*, *Betula pendula* and *Acer platanoides* f. *globosum*.

There are 42 species of plants in the adjoining the apartment building territories of Vyshhorod downtown, including 23 species of trees, 17 species of shrubs and 2 of lianes (Figure 3).

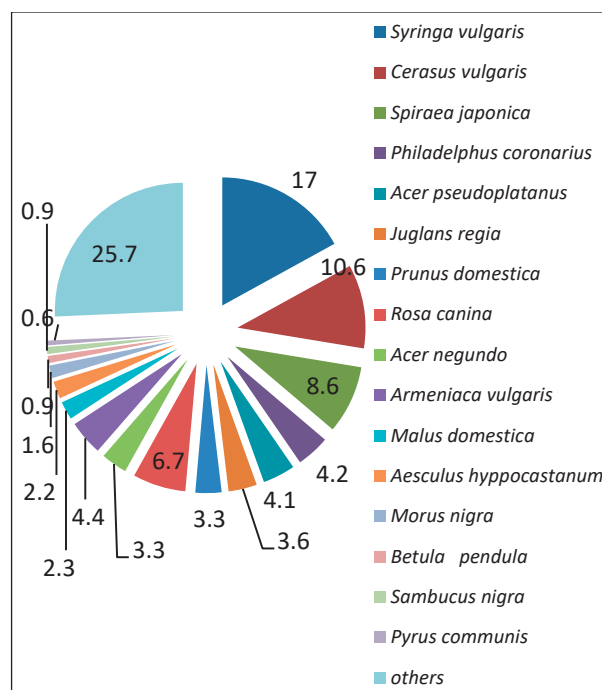


Figure 3. Species composition of green plantings on the adjoining to apartment territories in downtown Vyshhorod, %

Syringa vulgaris (17.0%), *Prunus cerasus* L. (10.6%) and *Spiraea japonica* (8.6%) have the highest share. The number of introducers reaches 67%, and fruit - ranges from 36 to 78% with an average value of 45%.

The age of tree plants ranges from a few years to 60 years or more for fruit trees). Landings under the age of 10 are available at all sites.

In the adjacent territories of multi-storey new apartment buildings, as a rule, young highly decorative plantings of trees and bushes are presented: *Juglans regia* L., *Pyrus communis* L., *Prunus cerasus*, *Malus prunifolia* (Wild.) Borkh., *Prunus persica* (L.) Batsch, *P. armeniaca* L., *Rhus typhina*, *Salix integra* 'Hakuro-nishiki', *Aesculus hippocastanum*, *Syringa vulgaris*, *Spiraea japonica*, *Berberis*

thunbergia 'atropurpurea', *Rosa canina* L. There are trees of *Betula pendula*, *Pinus sylvestris*, *Quercus robur* aged 40 and over, which grew in the area before construction. On the territory of some new buildings, no greenery or areas allocated for them were found at all. In total, 57 species and forms of woody and shrubby plants were found in apartment buildings, including new buildings. The index of species diversity for them is 18.5, ie close to optimal.

The territories of private estates in the historical part of the Vvshhorod city is characterized by plantings of mainly fruit trees: *Malus domestica* Borkh., *Prunus armeniaca*, *P. avium* (L.) L., *P. cerasus*, *Pyrus communis* L., *Juglans regia*, *Ribes nigrum* L. and others under 40 years of age.

The territories of three educational institutions in Vyshhorod downtown were studied: general secondary school No. 1, lyceum and district gymnasium "Intellect". In total, 28 species of plants are represented on the school territory, including 20 species of trees and 8 shrub species. Species with a very high share (over 10% of the total) include *Ulmus laevis* and *Populus nigra* L.; with a high share of participation - only *Ligustrum vulgare* L. Conifers are represented only by *Thuja occidentalis*. Among the species of woody plants, 55% are of aboriginal. Among the shrubs 50% are of the aboriginal species.

A total of 24 species and forms were found on the lyceum territory: 16 species of trees and 9 species of shrubs. 44% of the trees are aboriginal species. Among the bushes there is only one aboriginal species. Species with a very high share include *Thuja occidentalis* and *Platycladus orientalis*; with high - five species of shrubs. Dominated by 10-year-old trees (26.5%), the number of trees and shrubs under 15 years is 35.7%, older (50 years or more) - 0.6%, the number of others in 5-year-olds varies within from 1.8 to 4.2%.

In total, 27 species were found on the gymnasium territory: 16 trees and 11 shrubs. Only *Spiraea thunbergii* Sieb.; belongs to the species with a very high share of participation; with a high share of participation belong seven species. Among woody plants 56% are aboriginal species, one of them is coniferous.

Among the bushes only 18% are aboriginal species, no conifers.

Eight species of trees are common to these three territories. The index of species diversity of SDI trees for the school territory is 5.75; for the territory of the lyceum - 11.52; for the territory of the gymnasium - 16.22, ie approaching the optimal one.

The analysis of the age structure of plantations showed that on the territory of school No. 1 30- and 60-year-old tree plants predominate (Figure 4), which account for more than 75% of the specimens. On the territory of the lyceum and gymnasium young plantings up to ten years old predominate (32 and 39% of plants, respectively).

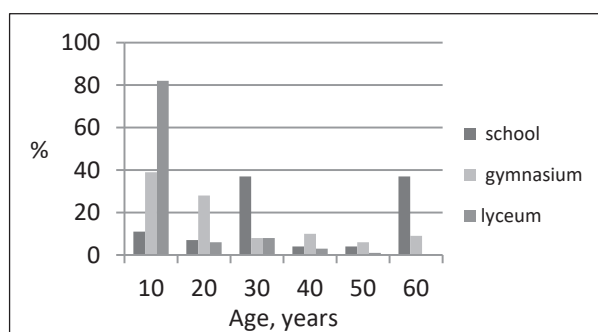


Figure 4. Distribution of tree plantings by age on the territory of educational institutions

The number of species and forms of trees and shrubs in plantations on the territory of educational institutions ranges from 24 to 28. Among the trees are almost equally represented aboriginal and introduced species, and among the shrubs are dominated by introducers. In particular, on the territory of school № 1 aboriginal species make up 55% of woody plants and 50% of shrubs; lyceum - respectively 47.3 and 11.1%; gymnasiums - 56% and 27%. In total, 45 species and forms of trees and shrubs were found on the territory of educational institutions. The Species Diversity Index (SDI) for the school grounds is 5.75; for the territory of the lyceum - 11.52; for the territory of the gymnasium - 16.22, ie only in the latter case is it approaching the optimal one. On the territory of Vyshhorod hospital 28 species of woody and shrub plants were found in the amount of 270 specimens (Figure 5). Only two species are characterized by a very high share of participation: *Tilia cordata* and *Betula pendula*, high share of participation -

three species: *Pyrus communis*, *Ligustrum vulgare*, *Prunus armeniaca*. The age of plants varies from 3-5 to more than 50 years. The index of species diversity of plants in this area is 7.79.

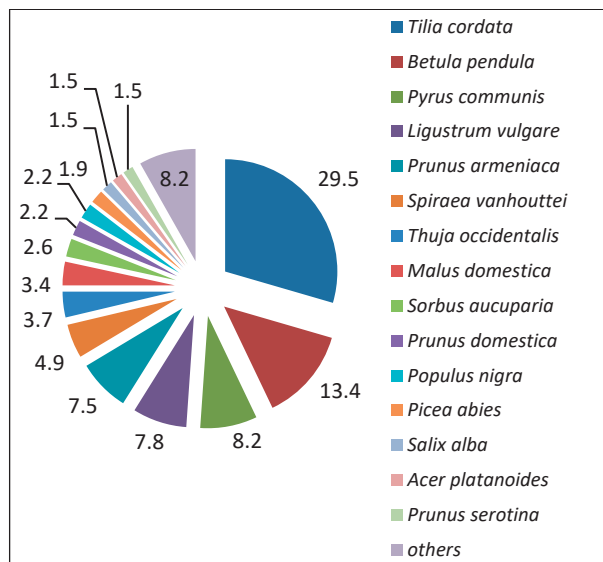


Figure 5. Species composition of green plantings on the territory of the hospital, %

Green plantings on the territory of the industrial zone was researched. In total, 26 species of trees and shrubs were found in this area. Of these, 13 (50%) are aboriginal species, 10 introduced species and three cultivars. Quantitatively, introducers predominate. Species with a very high share include *Populus nigra* and *Acer platanoides*, with a high share – *Acer negundo*, *Juglans regia*, *Syringa vulgaris*, *Thuja occidentalis*.

Green plantings for special purposes. Green plantations of special purpose of Vyshgorod include plantations of cemeteries (one of which is located on hills in the historical northern part of the city), street landscaping, protective plantings, first of all on steep slopes. More common (by area) special purpose green spaces within the town are street landscaping (which is generally typical of the Kyiv region).

The historical network of streets in the southern part of the town was redesigned in the early 1960s, at the same time they were landscaped. Currently, the routes of the oldest streets, which are located in the historic part of the town are almost not landscaped, along their carriageway there are only a few trees. The central streets are marked by relatively better landscaping with linear tree plantations.

According to the results of our research (Figure 6), 33 species of tree and shrubby plants are represented in the Vyshhorod street plantings. The four most common species in street plantings - *Aesculus hyppocastanum*, *Tilia cordata*, *Acer platanoides* and *Populus pyramidalis* - account for 54.8% of tree plants. Species with a very high share include *Populus pyramidalis*, *Tilia cordata*, *Aesculus hyppocastanum*; with high - *Betula pendula*. 46.2% of street trees are introducers.

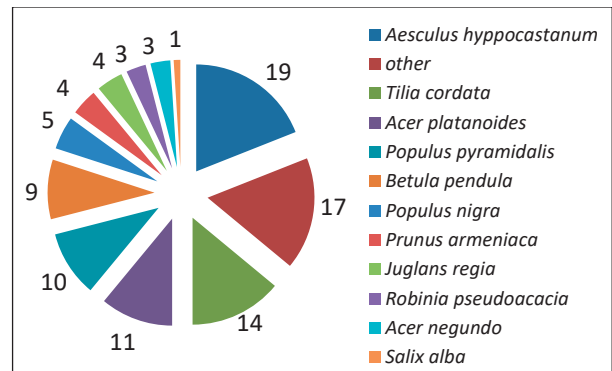


Figure 6. Share of participation of tree plant species in street plantings of Vyshhorod

The oldest species are *Salix alba*, *Populus nigra* and *P. pyramidalis* (average age 63 and 61 years, respectively) (Figure 7), the youngest species are *Juglans regia*, *Prunus cerasus*, *P. armeniaca* (mean age 23, 26 and 30, respectively). The weighted average age of trees in the experimental street plantations is 47 years.

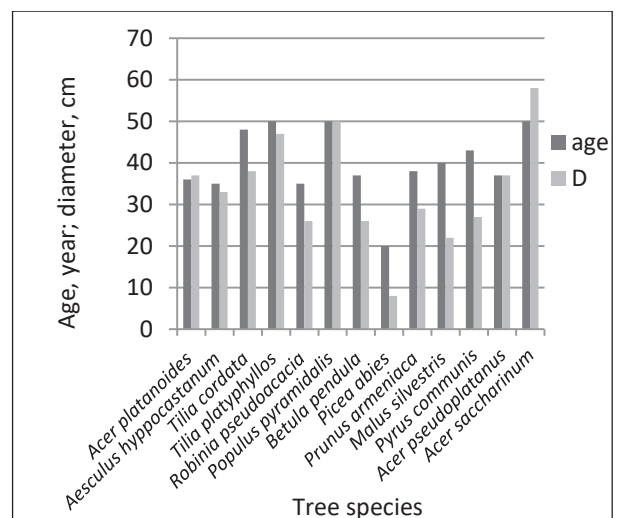


Figure 7. The average age (years) and diameter (centimeters) of tree species in the street plantings of Vyshgorod downtown

For landscaping of the road, which was carried out in the 50s - 60s of the last century, mostly aboriginal species were used. So far, 11 species of woody plants have been identified, including three introducers (27%), which represented by 10.1% of specimens. Three species - *Betula pendula*, *Tilia cordata* and *Populus pyramidalis* account for 80.8% of tree specimens. According to the proposed (Ukhvatkina and Denisov, 2010) distribution, only *Betula pendula*, which accounts for 62.2%, is classified as mass. *Tilia cordata* and *Populus pyramidalis* are included in the category of common (10.1 and 8.5%, respectively); *Populus nigra*, *Salix alba*, *Pinus sylvestris* and *Acer negundo* are rare, and *Sorbus aucuparia*, *Prunus armeniaca* are single. The total share of species of the genus *Populus* in-line plantings reaches 13.8%. The weighted average age of trees is 56 years. Trees over 60 years of age (5.9% of the studied trees) are affected by mistletoe, namely: 33.3% of *Populus nigra*, 30 % дерев *Acer platanoides*, 12.5% - *Salix alba*, 10.5% - *Tilia cordata* and 1.7% - *Betula pendula*. Affected by mistletoe among the trees of *Populus pyramidalis* were not detected.

Thus, at present, the homesteads and squares are distinguished by a wider species composition. In total, 100 species and forms of woody and shrubby plants were found in Vyhorod. The index of species diversity of urban plantations was 25.6, which should nominally guarantee their stability.

Green plantings of Ukrainka city and comparison of two cities.

The recommended ratio of trees and bushes is also not observed in the landscaping of the city of Ukrainka: trees predominate, compared to which the number of bushes is four times smaller. However, this picture is typical for landscaping of cities, especially small ones.

The species composition of the urban tree plantings is limited. Less than half (41%) of them are aboriginal species, which make up 49% of the total number of plants. A total of 21 species of trees, 5 species of shrubs and 1 species of liana were found in the study area.

The predominant species among the trees are *Acer saccharinum*, *Pinus sylvestris*, *Populus pyramidalis*, *Betula pendula*, *Aesculus hippocastanum*, *Tilia platyphyllos* Scop. and *Acer platanoides*, the total number of which is 80.5% of the total number of woody plants. Species with a very high share of participation are *Acer saccharinum*, *Pinus sylvestris*, *Populus pyramidalis*, *Betula pendula*; species with a high share of participation are *Aesculus hippocastanum*, *Tilia platyphyllos* and *Acer platanoides*. In the diagram, the category "other" includes such species as *Prunus armeniaca*, *Fraxinus excelsior*, *Fagus sylvatica* L., *Acer pseudoplatanus*, *Quercus rubra* and *Morus alba*, the number of which is from 0.6 to 0.1%.

The SDI index is 10.7. Five species of shrubs have been found in the city, of which only *Juniperus sabina* - is a conifer. Hedges of *Spiraea vanhouttei* predominate (68.4% of the total number of shrubs).

In the absence of domestic analogues, for comparison we used, the experience of inventory of tree plantations in a number of small US towns: Middlebury, Topsham, Weston, Easton, Acton and others, as well as Essex (UK). An important result of the inventory of tree plantations in American cities is not only the selection of critical species (which exceed the number of individuals (Santamour, 2002) 10-20-30 on species diversity), but also the distribution of plants by classes of diameter, which correspond to the ideal distribution (Richards, 1983) and indicates the stability of urban plantations.

Inventoried trees in US cities are classified by diameter size at chest height (and, conjugately, by age groups). The resulting plantation structure is compared with the ideal distribution (Richards, 1983), according to which the largest share of trees (40%) should be young trees (up to 8 inches in diameter), and 10% - large trees (over 24 inches). Tables 1 and 2 show generalized qualitative characteristic of green plantings - the structure of plantations of both two researched towns according to the criteria of inventory plans of US cities.

Table 1. Total characteristics of plantings in Vyshhorod and Ukrainka cities

Object	Number of species and forms	Species with a very high share of participation (critical) and high participation	SDI	The share of aboriginal species, %
Downtown squares	26	<i>Thuja occidentalis</i> , <i>Aesculus hippocastanum</i> , <i>Acer platanoides</i> , <i>Tilia cordata</i>	9.2	45
All squares	54	<i>Tilia cordata</i> , <i>Aesculus hippocastanum</i> , <i>Syringa vulgaris</i> , <i>Spiraea vanhouttei</i>	10.4	22
Apartment buildings	57	<i>Prunus cerasus</i> , <i>P. armeniaca</i> , <i>Syringa vulgaris</i> , <i>Spiraea japonica</i> , <i>Ligustrum vulgare</i>	18.5	до 20
Schools	24-28	<i>Ulmus laevis</i> , <i>Populus nigra</i> ; <i>Thuja occidentalis</i> ; <i>Spiraea Thunbergii</i>	5.8 – 16.2	44 -55
Public institutions	14	<i>Picea pungens</i> f. <i>glauca</i> , <i>P. excels</i> , <i>Betula pendula</i> , <i>Juniperus sabina</i> , <i>Spiraea vanhouttei</i>	7.9	36
Hospital	28	<i>Tilia cordata</i> , <i>Betula pendula</i>	7.9	62
Industrial zone	26	<i>Populus nigra</i> , <i>Acer platanoides</i> , <i>A. negundo</i> , genus <i>Acer</i> and <i>Populus</i>	7.3	50
Downtown streets	24	<i>Acer platanoides</i> , <i>Aesculus hippocastanum</i> , <i>Tilia cordata</i> , <i>Populus pyramidalis</i>	11.2	36
All streets	38	<i>Aesculus hippocastanum</i> , <i>Tilia cordata</i> , <i>Populus pyramidalis</i> , <i>Acer platanoides</i> , <i>Betula pendula</i>	11.8	54
Highway	11	<i>Betula pendula</i> , <i>Tilia cordata</i>	2.3	73
Vyshhorod city	100	<i>Spiraea vanhouttei</i> , <i>Syringa vulgaris</i> , genus <i>Acer</i> and <i>Spirae</i>	25.6	25
Ukrainka city	27	<i>Acer saccharinum</i> , <i>Pinus sylvestris</i> , <i>Populus pyramidalis</i> , <i>Betula pendula</i> , <i>Aesculus hippocastanum</i> , <i>Spiraea vanhouttei</i>	10.7	41

Table 2. Correspondence of the structure of Vyshhorod and Ukrainka plantings to the ideal Richards (1983) distribution

Territories	Diameter classes, cm			
	0-21	22-44	45-60	> 60
Perfect distribution	40	30	20	10
Squares	44	17	27	12
Adjoining apartment houses	75	13	10	2
School	15	10	35	40
Gymnasium	40	30	15	15
Lyceum	80	20	20	0
Industrial zone	51	30	9	20
Street downtown	38	30	28	4
All streets	10	60	10	20
Vyshhorod city	36	30	22	12
Ukrainka city	20	20	45	15

According to the results of our research, it was easy to identify critical species, as this restriction coincides with the belonging of woody plants to the category of species with a very high share (over 10%), provided by the research methodology. In the territory of Vyshhorod the most common species are *Tilia cordata*, *Acer platanoides*, *Aesculus hippocastanum*, *Prunus cerasus*, *Populus pyramidalis*, but only shrubs were critical in

number in the town as a whole: genus *Spiraea* and species *Spiraea vanhouttei*, *Syringa vulgaris*. On the territory of the settlement zone of Ukrainka, four species of trees and one species of bush are considered critical: *Acer saccharinum*, *Pinus sylvestris*, *Populus pyramidalis*, *Betula pendula* and *Spiraea vanhouttei*.

The maximum deviations from the optimal distribution of trees by diameter classes are observed in street plantations, on the embankment, in adjoining house territories, but in general the distribution of trees by diameter (and, accordingly, by age) in Vyshgorod is close to optimal. On the other hand, there are not enough young trees on the territory of Ukrainka and the share of "ripenined" (45-60 cm in diameter) is exceeded, which does not guarantee their stable development in the future.

In general, the study showed that small towns have a similar set of predominant (main) tree species. However, for the demographically and

economic more developed town the higher variety of species is inherent, mainly due to introduced decorative tree plants in adjacent to houses territories in residential areas.

DISCUSSIONS

According to the literature, in the cities of the former Soviet republics are dominated by about 10 species of trees and *Acer platanoides* is more common (Gontar et al., 2013; Molganov & Ovesnov, 2014; Zhudrik, 2016; Valetov & Ulasik, 2013), shrubs are rare. There is a positive relationship between the diversity of tree plant species and higher average minimum winter temperatures (Sjöman et al., 2012). Most species are typical for the researched cities.

As in Ukraine, there are insufficient detailed studies about the use of plants in backyards (Klepacki & Kujawska, 2018; Wysmulek et al., 2020). Like the study objects, open spaces in the United States tend to be small and difficult to manage, and are often underestimated as environmental amenities (Lynch, 2021).

In the tree plantings of USA municipalities (parks and street plantings) within the considered small towns there are from 20 to 53 species of trees. As a rule, the genus *Acer*, often *Malus*, sometimes *Thuja*, *Fraxinus*, exceeds the established standard, which causes concern for biodiversity. Although the purpose of species diversity is often at odds with aesthetic goals, where uniformity is valued, the plantations created should reduce the dominance of any species or genus, avoid pest-susceptible species and take into account future climate change. It is recommended to continue diversifying the structure of urban tree plantations (species and age composition) to prevent potential threats and challenges.

Reliable information not only on quantitative but also on qualitative indicators of green plantations, obtained as a result of their inventory, is a necessary precondition for assessing ecosystem services and ensuring ecologically balanced development of urban areas.

CONCLUSIONS

The analysis of the data of the inventory of green plantations, conducted by us in the

researched small towns, allowed to formulate the following conclusions.

The richest species composition in Vyshgorod city are typical for adjoining the apartment building territories and for squares. In total in the town 100 species and forms of tree and bush plants are found. The index of species diversity of urban plantations (including tree and shrub plants) was 25.6, which should nominally guarantee their stability.

The species composition of greenspace in the city of Ukrainka is represented by 27 species of trees and shrubs. Index of species diversity of urban plantings is 10.7.

Shrub species *Spiraea vanhouttei*, *Syringa vulgaris* and the genus *Spiraea* are critical for Vyshhorod, and *Acer saccharinum*, *Pinus sylvestris*, *Populus pyramidalis*, *Betula pendula* and *Spiraea vanhouttei* are critical for the settlement zone of Ukrainka.

In contrast to Vyshhorod, where the distribution of trees by diameter is close to optimal, in the territory of Ukrainka there are not enough young trees and the share of "ripening" trees is exceeded, which violates the guarantees of sustainable development of urban plantations.

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