Received: 11.11.2022; Revised: 13.02.2023; Accepted: 26.04.2023

UKRAINIAN JOURNAL OF FOREST AND WOOD SCIENCE

UKRAINIAN JOURNAL OF FOREST AND WOOD SCIENCE

Journal homepage: https://forestscience.com.ua/en
Ukrainian Journal of Forest and Wood Science, 14(2)

UDC 630*55(436-21)
DOI: 10.31548/forest/2.2023.83

The experience of preserving ancient trees in Vienna, Austria

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Abstract. Ancient trees hold considerable aesthetic and ecological value within urban environments. The examination of ancient trees and their overall health and condition is an integral part of a comprehensive assessment aimed at preserving these trees and conserving the natural environment within urban spaces. The purpose of the study was to examine the experience of preserving valuable trees growing in urban space. General scientific theoretical methods – analysis and synthesis – were used to work with lists of tree inventory. Heritage trees grow in all districts in Vienna. It was established that ancient trees were given the status of natural monuments since 1936, the dynamics of bequests were traced, and the decades of Vienna's most active nature conservation activities were determined. The most famous heritage trees in the city were described. The species diversity of monumental trees was analysed, and their taxonomic affiliation was summarised. The heritage trees in Vienna are represented by 49 genera, most of which belong to the phylum of *Magnoliophyta*. The most common species among protected trees are *Platanus orientalis* L., *Pinus*

Suggested Citation:

Píšová, S., Tokarieva, O., & Sendonin, S. (2023). The experience of preserving ancient trees in Vienna, Austria. *Ukrainian Journal of Forest and Wood Science*, 14(2), 83-95 . doi: 10.31548/forest/2.2023.83.

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nigra J.F. Arnold, *Aesculus hippocastanum* L., *Quercus robur* L., *Taxus baccata* L., *Tilia platyphyllos* Scop. Most of heritage trees (60%) are solitary trees. It was evaluated that the general sanitary condition of protected trees is excellent; almost all trees have high vitality and play a leading role in shaping urban landscapes. Every heritage tree possesses a commendable and elevated aesthetic rating. Analysis of the existing inventory of ancient trees in Vienna, their sanitary condition and aesthetic condition will contribute to the environmental awareness of communities and the improvement of management measures for such trees. The obtained results can be used to share the experience of researchers from different countries regarding preserving ancient trees and forming European databases of heritage trees

Keywords: natural monument; status of natural monuments; woody species; city district; urban greening

Introduction

Many unique trees have survived in European cities. Identifying such natural monuments, collecting the necessary information about them, and protecting them is an extremely important issue for every city. Such trees are national property and must be protected by the government. According to I.I. Vakulyk & O.Yu. Balalaieva (2018), the majority of these trees are linked to prominent individuals, historical events, or they are ancient trees that have managed to endure and remain in excellent condition until the present time. In the investigation of aged trees, J. Dreslerová (2017) observed that it was during a scientific expedition to North America when Alexander von Humboldt, a professor at the University of Berlin, first designated ancient trees as natural monuments. Additionally, G. Piovesan *et al.* (2022) conducted studies affirming that ancient trees possess substantial educational, aesthetic, historical, and cultural worth. Nowadays, the ancient trees give the greatest expressiveness to cities.

Trees can live many centuries with sustained fecundity. C.H. Cannon *et al.* (2022) observed that only 1% of trees achieved ages that were 10-20 times greater than the median age. A quarter of all trees reached an age that was 3-4 times greater than the median age. S. Munné-Bosch (2018) pointed that there were three age classes: mature, old, and ancient. Ancient trees have developed several mechanisms to ensure their longevity, including plasticity, continuous growth, dormancy, modularity, and stress tolerance. These adaptations enable ancient trees to defy the process of ageing and sustain some level of growth capacity despite their extreme longevity. Ancient trees in cities play critical ecological roles (e.g. in carbon storage, oxygen provision, hydrological regimes, nutrient cycles, numerous ecosystem processes, and provision of wildlife habitat). Ancient trees are a real factory of oxygen. According to D.B. Lindenmayer (2017), the crown of one tree is able to provide oxygen to about 200 people a year. Merit of trees is also great as dust absorbers. The average concentration of dust where trees grow is 33% less than where these old trees do not exist. In areas where old trees are present, the level of street noise is reduced by 4-5 times compared to locations where these trees are absent. The protection and management of trees as natural monument features are essential to maintain these roles. It is important and necessary to save trees of varying ages to replace existing ancient trees as they will eventually die.

Austria has a unique beauty, a special landscape, and rare species of public interest. Heritage trees are officially designated by the nature protection authority based on their scientific or cultural value, uniqueness or rarity, the distinctive characteristics they contribute to the landscape, and the various functions they fulfil. Important is that at least one of these conditions is met. There are relevant laws regulating the protection of heritage trees in Austria. The main goal of Vienna Nature Conservation Law is the protection and care of nature in all its manifestations throughout the city, ensuring sustainable urban ecological functions by establishing the necessary measures to maintain, supplement, and renew (Landesrecht konsolidiert Wien..., 2022). According to the Law, trees, groups of trees or plant communities, and other forms of nature can be declared natural monuments. It is not allowed to interfere with protected objects, which may jeopardise or worsen their existence or appearance. Criteria for the recognition of a tree as a natural monument are age, dimensions, rarity, botanical curiosity, and connection with a legend or historical event. There is no information on the total number of natural monuments in Austria. According to official information, in 2023, there are more than 700 natural monuments in Vienna (Official website of the City Vienna..., n.d.). These include solitary trees, tree groups, alleys, groves, small reservoirs, remnants of alluvial forests, and significant rock formations with geological importance. The heritage trees in Vienna are characterised by direct aesthetic access.

The purpose is to examine the experience of preserving valuable trees growing in the urban space of Vienna. To accomplish this, it was essential to identify tree species capable of attaining significant age within the urban environment and determine the specific characteristics of their location.

Materials and Methods

The study was carried out in the territory of all 23 districts of Vienna in 2022. First, an analysis of the heritage tree inventory, which is freely available, (Official website of the City Vienna..., n.d.) and the selection of trees for the study were conducted. These were single trees, small alleys and groups of trees numbering up to 20. The total number was 723 trees. The sanitary and aesthetic condition of trees were examined and assessed. The sanitary condition of the trees involved the determination of the category according to the following gradation: I – no signs of weakening, II – weakened, III – very weakened, IV – dying, V – fresh dead trees, VI – old dead trees. The aesthetic condition of heritage trees was assessed using a scale:

1. The plant is proportionally developed, and aesthetic qualities correspond to its species and phenophase. There are no dry branches in the crown, or they can be found in small quantities, as a result of natural growth processes; mechanical damage to the trunk and branches does not affect the appearance of the plant; no visible signs of disease damage, no visible damage by pests, species do not cause negative emotions of the observer.

2. The plant has high aesthetic properties, but the first signs of a decrease in its aesthetic qualities are observed.

3. The plant has deviations in development: the inclination of the trunk, the asymmetry of the crown, the number of dry branches is more than 30%, mechanical damage to the trunk and crown, visible traces of damage by pests and diseases.

4. The plant completely lost its aesthetic qualities, which are impossible to restore.

The selected trees for research made up 90% of the general sample. Representative samples of ancient trees included all solitary trees, the vast majority of trees growing in alleys and groups.

Results and Discussion

The history of bequeathing trees in Vienna

The first nature law of Austria was the "City Law on the Protection of Nature" from 5 July 1935 (Mülleder & Kapl, 1989). The practice of preserving trees remained in all subsequent conservation laws. In 1936, trees began to be given the status of natural monuments (Tiefenbach, 1998). The bequest of ancient trees in Vienna has been going on for over 80 years. During this time, 382 places of ancient tree growth were taken under protection. Trees listed as natural monuments have a number of advantages. These trees are under special state protection in Austria. For such trees, there is a special campaign during pruning or in case of pest infestation. Nature monuments are provided with suitable signage, and each tree of such significance bears a plaque on its trunk containing a concise description of its unique qualities.

In the Vienna Nature Conservation Act of 1984, heritage trees (Sima & Büchl-Krammerstätter, 2009) were an important component because, by that time, the number of protected trees had increased considerably. The largest number of trees got the status of natural monument in the 1970s (Fig. 1). A. Schmied & W. Pillmann (2003) found that most of the laws were adopted in the 1970s due to the rising ecological awareness at that time. According to the diagram over the past 10 years, 28 trees in Vienna got this status.

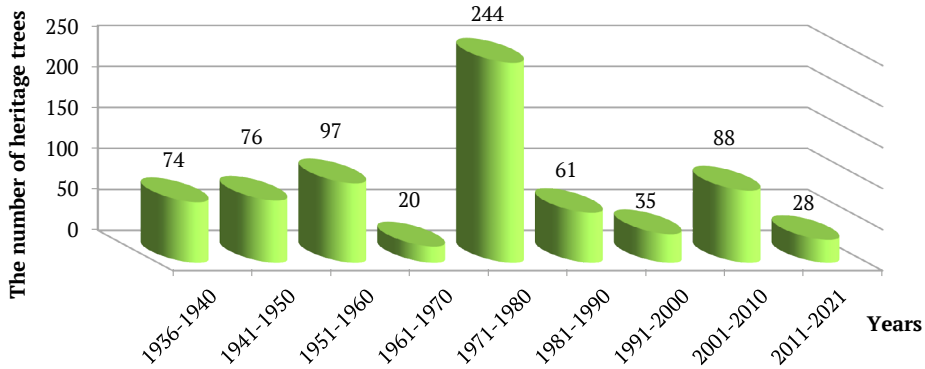

Figure 1. The history of trees bequeathing in different decades

Source: developed by the authors based on the official website of Vienna (n.d.)

The heritage trees in Vienna are found almost everywhere in the city. They are in the many historical squares, in front gardens, in courtyards, and in large parks in the middle of the city.

Each natural monument has its own uniqueness. *Taxus baccata* L. is the oldest tree in Vienna (1936 year of bequest). It is about 1000 years old, and the circumference of the trunk is 3.20 m (Sima & Büchl-Krammerstätter, 2009). This tree is one of the yew groves from Roman times.

The longest alley in Vienna, which has the status of a natural monument, leads from Schönbrunn Palace to Getzendorf Castle. Its length is 750 metres, and the trees grow in four rows, including *Aesculus hippocastanum* L., *Acer platanoides* L., *Tilia platyphyllos* Scop.

The heritage tree *Platanus orientalis* L. has been growing at Rennweg, 14 (Vienna) since the time of Wolfgang Amadeus Mozart (Fig. 2), who lived near this place (1936 year of the bequest). This tree is over 240 years old.

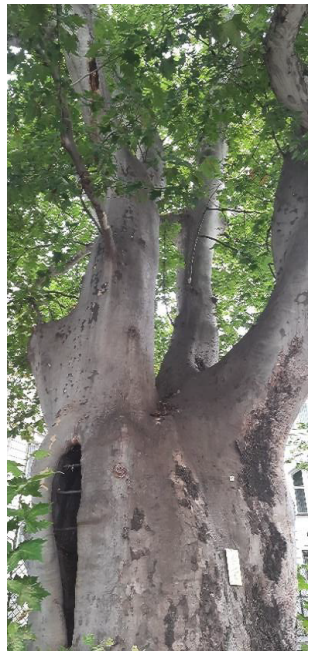

Figure 2. Mozart's plane (*Platanus orientalis* L.)

Source: developed by the authors

There is an ancient liana, which is included in the general list of natural monuments of Vienna (Fig. 3). This is *Hedera helix* L. (1950 – the year of the bequest), the branches of which spread at a distance up to 10 m and formed a crown at a height up to 7 m above the ground.

Figure 3. Ancient liana (*Hedera helix* L.)

Source: developed by the authors

Despite their rarity in urban landscapes, old trees make a disproportionate contribution to biodiversity conservation and the development of human society. For historical, urban planning, and other reasons, the distribution of ancient trees in Vienna is uneven and does not depend on the area of the district. The number of trees growing individually in the districts varies from 2 to 131. The lowest number of trees is in the following districts: Mariahilf, Margareten, Wieden, Ottakring, and the highest number is in Döbling and Hietzing (Fig. 4).

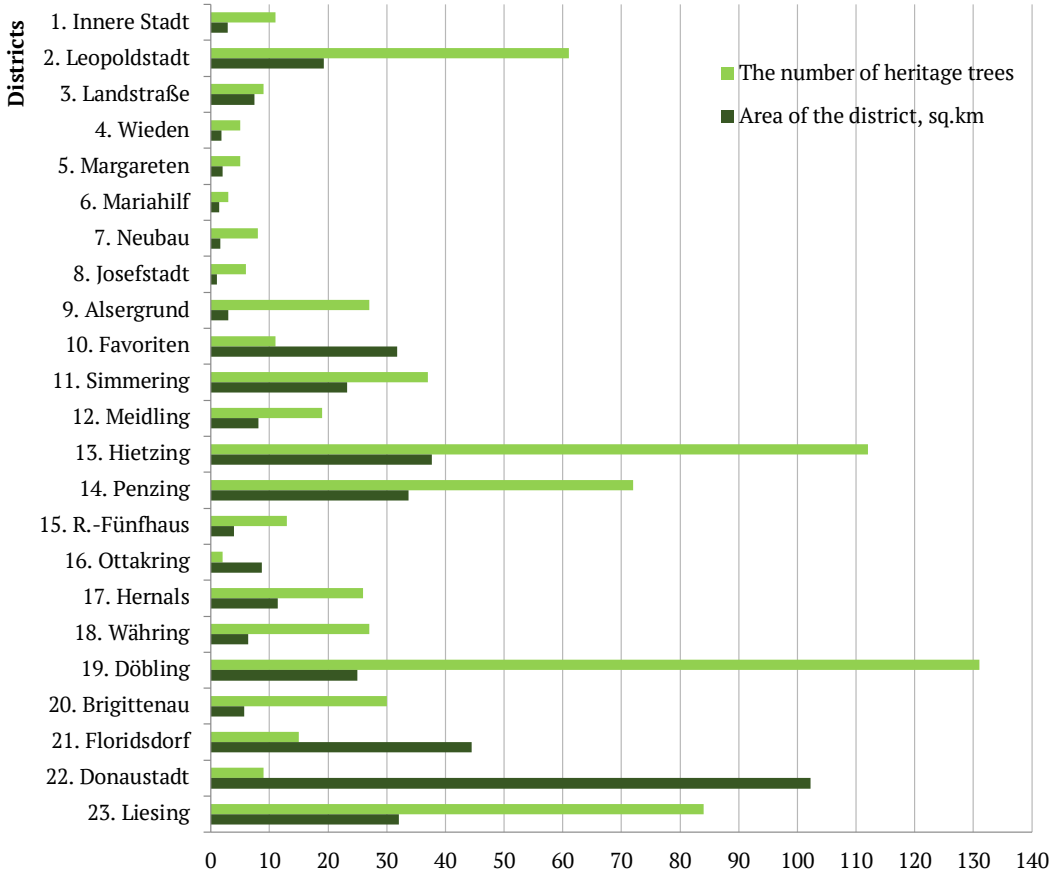

Figure 4. The number of heritage trees in districts of Vienna

Source: developed by the authors based on the official website of Vienna (n.d.)

The value of individual monumental trees is unique to each district. The presence of such trees develops the environmental awareness of the residents of the districts. Knowledge of the location of protected trees can be used to plan excursions.

Species diversity and types of plantings

In biological sciences, woody species are characterised by the longest life cycle, which can be measured in hundreds or even thousands years. Yet not all tree species can reach hundreds or even thousands of years. Dragon tree and baobab

live up to 6000 years, cypress and Lebanese cedar – to 2000 years. The oldest tree on the planet is the long-lived pine, which grows in the Sierra Nevada mountains and is 4,600 years old (Shlapak *et al.*, 2010). It is impossible to determine the exact age of ancient trees. There are known ages only of several heritage trees in Vienna.

The heritage trees in Vienna are represented by 49 genera, most of which belong to the phylum of *Magnoliophyta* (Fig. 5). The most common species among heritage trees are *Aesculus hippocastanum* L., *Pinus nigra* J.F. Arnold, *Platanus orientalis* L., *Taxus baccata* L., *Tilia platyphyllos* Scop., *Quercus robur* L.

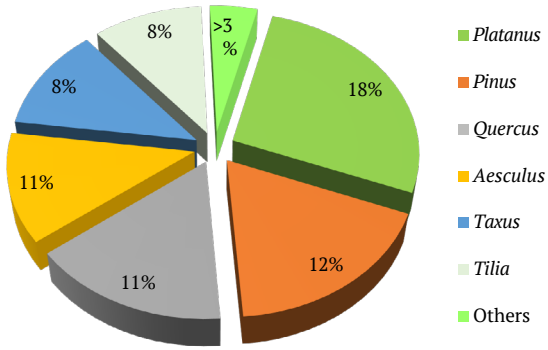

Figure 5. Distribution of heritage trees by genera in Vienna

Source: developed by the authors based on the official website of Vienna (n.d.)

Vienna is home to a diverse array of heritage trees, representing various species that exist in only one individual: *Ailanthus altissima* (Mill.) Swingle, *Buxus sempervirens* L., *Celtis australis* L., *Cornus mas* L., *Gleditsia triacanthos* L., *Hedera helix* L., *Metasequoia glyptostroboides* Hu & W. C. Cheng, *Parrotia persica* C. A. Mey., *Prunus laurocerasus* L., *Sambucus nigra* L., *Styphnolobium japonicum* (L.) Schott.

Most of the heritage trees (60%) are solitary trees (Fig. 6). Trees growing in groups make up 37% of all heritage trees. The smallest number of heritage trees (3%) grow in the alleys.

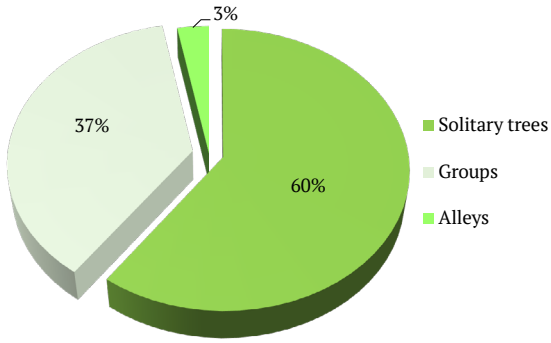

Figure 6. Distribution of heritage trees by types of planting

Source: developed by the authors based on the official website of Vienna (n.d.)

The identification and protection of natural monuments in Vienna has several features. Trees that receive the status of natural monuments would not always be ancient or historical. Quite often, in the central districts of Vienna, which do not have large areas of vegetation, promising trees are allocated to this category to preserve the green space in the area. In addition, properly shaped trees with a spreading crown, which play an important role in the formation of a particular landscape, become protected.

Sanitary and aesthetic condition of trees

Part of heritage trees are located in the immediate vicinity of buildings, in places with significant city traffic. Other trees grow in conditions that are more favourable – in parks, squares, arboretums, etc. Negative factors have a complex influence in nature on the vital state of plants (Galkin *et al.*, 2013). Ancient trees are some of the most vulnerable biotas, especially in urban environments (Dudyn, 2001). The diameter, height, and longevity of large trees vary greatly depending on their species. Such trees are vulnerable to threats ranging from droughts, pests, and pathogens, and climate change (Lindenmayer & Laurance, 2017).

Despite this, Vienna's general sanitary condition of protected trees is excellent (Table 1). Alleys growing along the roads are often threatened by their users (Pietrzak-Zawadka, 2020). Therefore, the sanitary condition of the alleys in Vienna is rated lower compared to solitary trees and groups.

Table 1. Sanitary condition of heritage trees in Vienna in 2023

Types of street plantings	Part of the trees, %	The category of tree condition
Solitary trees	93	I
	7	II
Groups	84	I
	16	II
Alleys	53	I
	47	II

Source: developed by the authors

The category of the sanitary condition of trees in the alleys was lower because of cracks, wounds, callus formation, and tree cavities. A feature of heritage tree is their exceptionally high aesthetic properties. In addition, each such tree has its own uniqueness.

Heritage trees mostly have great aesthetic properties, adequately developed. There are no dry branches in the crown, or they can be found in small quantities, visible signs of pest damage are absent. It can be concluded that trees with obvious signs of defects and the presence of pests are not distinguished as heritage trees. Therefore, the general sanitary and aesthetic condition of the heritage trees is excellent; almost all trees have a high vitality, and play a leading role in the city landscapes.

The engagement of society has an important role in the identification, and inventory of ancient trees. M. Kowalski (2020) found collaboration between society and nature protection authorities to be an essential element in the protection of ancient trees. The popularisation of information about heritage trees is an important issue, which draws social attention to the recognition of their unique value. M. Suchocka *et al*. (2022) investigated social aspects, in particular the visual perception of

old trees, and proved the unequivocal importance of such trees for people.

According M. Blicharska & G. Mikusiński (2014), in addition to providing key ecological functions, especially in cities, ancient trees are part of a social realm with numerous social and cultural benefits to people.

Residents sometimes neglect social and cultural value of heritage trees. Awareness of ancient trees as a part of cultural heritage is essential when addressing the issue of their decline worldwide. Ancient trees provide humans with aesthetic, religious, symbolic, and historic values. In many cultures, particularly ancient trees are treated with reverence.

The ancient trees can serve as a home for many representatives of the animal world, and a place for plant organisms to settle. Studies of C.Y. Jim (2017) confirm that the ancient trees create various micro-habitats to support a surprising assemblage of different organisms. Preservation of ancient trees contributes to the preservation of biodiversity. S.L. Shnayder *et al.* (2011) noted that the value of ancient trees lay not only in their historical importance, but also in the fact that they had passed the test of time and city life, and they had immunity from many pests.

All European countries have legal regulations to protect ancient trees. The issue of ancient trees has been placed in many countries and is embodied in the law of environmental protection and nature conservation. While examining the criteria applied to the trees that are the candidates to become natural monuments, J. Pietrzak-Zawadka (2016) established that they were different between countries. Currently, in the world, natural monuments are mainly trees exceptional for their age or appearance, but mostly dimensional criteria are used to determine the status. Protection and preservation of ancient and historical trees in Europe is a manifestation of culture and respect for national heritage. N. Oleksiichenko & S. Pidkhovna (2018) showed that countries with long-standing and strong nature conservation traditions (Austria, Germany, England, Poland, Lithuania, and Latvia) had been successfully engaged in the inventory and protection of ancient and other outstanding trees. In general, the tradition of bequeathing old trees is very widespread in Europe: more than 36,000 trees were bequeathed in Poland, 4,000 trees – in Italy, 22,000 trees – in Great Britain, 2648 trees – in France, 1433 trees – in Sweden, 300 trees – in Slovakia, and 1300 trees – in Czech Republic (Pietrzak-Zawadka, 2016; Zarzyński & Grzywacz, 2019). V.E. Boreiko (2010) is certain that the number of potential trees that can receive the status of natural monuments is much larger. There are 3,295 unique trees that are over a hundred years old registered in Ukraine. A.I. Kushnir & I.I. Vakuluk (2018) explored ancient trees in Ukraine, they assured that about 50 of the trees were connected by historical events, human destinies and legends. Considering research of European scientists – S.L. Shnaider *et al.* (2011), J. Dreslerová (2017), P. Zarzyński, & A. Grzywacz (2019), the most common species of heritage trees can be distinguished: *Aesculus hippocastanum* L., *Platanus orientalis* L., *Taxus baccata* L., *Tilia cordata* L., *Quercus robur* L., and others.

An important aspect of preserving ancient trees is the formation of optimal conditions for their growth and implementation of special measures to strengthen their stability. To preserve the vitality of old trees in the city, A.I. Kushnir & I.I. Vakuluk (2018) recommend the installation of openwork-style fences to reduce recreational impact on the root system, and conducting regular crown maintenance through the removal of dry, diseased, and broken branches.

Austria is a country with a long history, including in the field of landscaping, which has been preserved and adapted to modern

requirements. Specialists in other countries can use the example of the inventory of ancient trees in Vienna. This study also contributes to increase community awareness and improve the management of these unique trees.

Conclusions

Protection and preservation of ancient, rare, and historical trees in Europe is a manifestation of culture and respect for national heritage. The bequest of ancient trees in Vienna has been going on for over 80 years. The law regulates the issues of bequest rules and mechanisms. An important experience of bequeathing old trees in Vienna is open access to the cadastre of these trees. In this way, people have the opportunity to participate in research and preservation of heritage trees. Due to its rich history, Vienna has preserved extremely old treesthat are closely related to the history of the city or notable individuals of considerable ecological importance in preserving unique ecosystems within an urbanised environment. All districts of Vienna have certain number of heritage trees. However, the largest number of the trees grows in Döbling (13) and Hietzing (19) districts. The species diversity of heritage trees is diverse, but mainly represented by six genera: *Aesculus, Platanus, Pinus, Quercus, Taxus, Tilia*. Most heritage trees are solitary. Despite their respectable age, the sanitary aesthetic and condition of the trees are excellent.

The development of methods for monitoring the sanitary condition of ancient trees, the introduction of new arboriculture measures, and the promotion of a responsible attitude of the public can be among the promising areas of research on ancient and heritage trees.

Conflict of Interest

None.

Acknowledgements

None.

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Досвід збереження вікових дерев у м. Відні, Австрія

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Анотація. Вікові дерева займають важливе естетичне та екологічне місце в міському просторі. Вивчення вікових дерев, визначення їх життєвого та санітарного стану є частиною комплексної оцінки збереження цих дерев та охорони природи міського простору. Метою дослідження було вивчення досвіду збереження цінних дерев, що ростуть у міському просторі м. Відня. Для роботи з кадастром дерев-пам'яток природи м. Відня використовувалися загальнонаукові теоретичні методи – аналіз та синтез. В результаті проведеного дослідження було визначено, що історичні дерева ростуть у всіх районах м. Відня. Встановлено, що надання віковим деревам статусу пам'яток природи почали з 1936 року, була простежена динаміка заповідання, визначені періоди найбільш активної природоохоронної діяльності у Відні. Описані найбільш відомі дерева спадщини в місті. Проаналізований видовий склад пам'ятних дерев, узагальнена їхня таксономічна приналежність. Дерева спадщини у Відні представлені 49 родами, більшість із яких належить до відділу *Magnoliophyta*. Було виявлено, що серед дерев, які мають охоронний статус, найпоширенішими видами є *Aesculus hippocastanum* L., *Pinus nigra* J.F. Arnold, *Platanus orientalis* L., *Quercus robur* L., T*axus baccata* L., *Tilia platyphyllos* Scop. Більшість дерев-пам'яток природи (60 %) є солітерами. Встановлено, що загальний санітарний стан таких дерев відмінний; майже всі дерева мають високу життєстійкість і відіграють провідну

роль у формуванні міських ландшафтів. Усі дерева спадщини мають високу та добру естетичну оцінку. Аналіз існуючої інвентаризації вікових дерев у Відні, їх санітарний стан та естетичний стан сприятимуть екологічної обізнаності громад та покращенню заходів з управління такими деревами. Отримані результати можуть бути використані для обміну досвідом науковців різних країн щодо збереження вікових дерев та формування європейських баз даних дерев-пам'яток природи

Ключові слова: пам'ятка природи; статус пам'ятника природи; деревні породи; район міста; озеленення міст