

UDC 502.2 (58.009/58.006)

DOI: 10.31548/forest.13(1).2022.7-17

Age, Taxonomic, and Ecological Structures of Old Trees in Protected Natural and Man-Made Objects of Ukrainian Polissia

Anzhela Dzyba*

Education and Research Institute of Forestry and Landscape-Park Management
of the National University of Life and Environmental Sciences of Ukraine
03041, 19 Heneral Rodimtsev Str., Kyiv, Ukraine

Abstract. Over the past ten years, the inventory of old trees was conducted in Ukraine. The occurrence of indigenous and introduced tree species of coniferous and deciduous old trees in protected areas of Forest-Steppe, Steppe, and Ukrainian Polissia was analyzed. Currently, the issue of comparative analysis of the taxonomic and ecological structure, the frequency of occurrence of tree species from 100 years in natural and man-made protected areas of the Ukrainian Polissia is critical. The purpose of this study was to systematize the taxonomic and ecological structures, the frequency of occurrence of potentially old, old, centuries-old, and ancient trees in protected natural and man-made territories and objects of the Ukrainian Polissia. The following research methods were employed in this study: analytical, route, identification, clarification of age-related tree species according to The World Flora Online, comparative analysis. A unified scale for the distribution of old trees into four categories (potentially old (about 100 y.o.), old (100-200 y.o.), centuries-old (200-800 y.o.), ancient (800+ y.o.)) was proposed and applied, and their distribution was made. The stages of the study of potentially old, old, centuries-old, and ancient trees in the Ukrainian Polissia are given. The age structure of natural and man-made protected objects is dominated by plants from 100 to 200 years old, which is 73% and 53%, respectively. Ancient trees are represented by *Quercus robur* L., which grows in five natural sites (1% of 543 sites). Depending on the number of plants in the protected area, as well as considering the number of objects where the plants under study grow, a method has been developed for estimating their frequency of occurrence (very frequently, frequently, rarely, very rarely). It was found that potentially old, old, centuries-old, ancient trees occur very frequently – 13 taxa (21%, among which 69% are autochthonous), frequently – 13 taxa (20%, introduced (46.2%), and autochthonous (53.8 %)) and rarely – 12 taxa (19%, autochthonous species prevail 58.3%). Very rare, only on one site – 25 taxa, their number is from one to seven specimens, 76% of them are introduced. 95.2% of taxa are concentrated in man-made objects (parks-monuments of landscape art and arboretums). From 19 to 26 taxa are concentrated in four parks-monuments of landscape art created at the end of the 19th century (Vozdvizhenskyi – 19 taxa, Vahanytskyi – 22 taxa, Polonskyi – 22 taxa, Zirmenskyi – 26 taxa). 63 taxa of potentially old, old, centuries-old, ancient trees (59 species, hybrid, three varieties) belonging to 28 genera from 16 families were found in natural and anthropogenic objects in the Ukrainian Polissia. Of them, autochthonous species make up 41.3%, introduced species – 52.4%. 90.5% of potentially old, old, centuries-old, ancient trees belong to the six categories of the Red List of the International Union for Conservation of Nature, of which 69.8% are under low threat (LC category). The biomorphological spectrum of potentially old, old, centuries-old, ancient trees is represented by megaphanerophytes (47.6%), mesophanerophytes (49.2%), microphanerophytes (3.2%). The ecological spectrum mainly comprises mesotrophs (49.2%), hemiskiohytes (49.2%), and heliophytes (39.7%), mesophytes (44.4%) and mesohygrophytes (22.2%). The obtained study results will allow monitoring potentially old, old, centuries-old, ancient trees of the protected objects of the Ukrainian Polissia over time, comparing similar trees in other territories of different regions of Ukraine, supplementing the worldwide database “Monumental trees” with information about the types of ancient trees of the Ukrainian Polissia

Keywords: centuries-old, species, parks-monuments, nature reserves, nature monuments

Suggested Citation:

Dzyba, A. (2022). Age, taxonomic, and ecological structures of old trees of protected natural and man-made objects of Ukrainian Polissia. *Ukrainian Journal of Forest and Wood Science*, 13(1), 7-17.

*Corresponding author

Introduction

Centuries-old and ancient trees that have been formed over many centuries cannot be replaced by restoration or regeneration. Trees can grow and be resilient for centuries and die by accident, and therefore they need to be protected to preserve their priceless diversity [1]. The preservation of ancient trees as a cultural value periodically decreased, which is associated with a decrease in the sense of sacredness, a decrease in control over forest plantations, changes in the use of certain species, and the loss of the value of such trees in the landscape [2]. However, ancient trees are currently valuable in providing ecosystem services to humanity. As a historical link connecting different generations of people [3], they are an important object of cultural heritage [4; 5]. Ancient trees have aesthetic and cultural values and play an essential role in regulating landscape and environmental functions [6]. Large old trees are among the largest organisms on Earth, with populations rapidly declining in many parts of the world, with serious implications for ecosystem integrity and biodiversity [7]. They are also of great ecological importance, including the hydrological regime and various ecosystem processes. Large trees affect the number of individuals of a species, their distribution over a certain period of time, as well as the populations of many other plant and animal species [8]. The diameter, height, and durability of large old trees vary depending on the species and growing conditions [7; 9; 10]. Three age classes (mature, old, and ancient) create unique evolutionary diversity in complex ecological cycles. Ancient trees form an integral part of forests that take many centuries to establish [1], play a vital role in maintaining biodiversity in forest ecosystems [11], and contribute to ecosystem integrity and biodiversity in urban and suburban areas [12]. The study of ancient trees provides an opportunity to better understand natural processes, which is especially important when developing strategies to increase tree longevity and environmental value [13]. To identify the characteristics of the growth of large trees ≥ 150 years old, in Finland, their density and representation in different regions were analysed based on an inventory of forest trees for about 100 years [11]. In 198 regions of China, data were collected on trees ≥ 100 years

old, regarding the maximum age, species composition, and their density in human-dominated landscapes [14]. An inventory of old and ancient trees in Ukraine was carried out in studies [15-17]. Over the past ten years, a group of scientists has formed catalogues of old trees of the forest-steppe, steppe, and Ukrainian Polissia based on bibliographic sources and desk materials of the inventory of protected old trees [18-20]. The studies analysed the representativeness of autochthonous and introduced coniferous and deciduous species of century-old trees in administrative regions and protected areas of the forest-steppe, steppe, and Ukrainian Polissia, and provided their age structure [21-23].

However, the analysis of the taxonomic and ecological structure, the frequency of occurrence of tree species older than 100 years in the protected (natural and man-made) territories of the Ukrainian Polissia was not conducted, so this question is currently relevant.

The purpose of this study – to systematize the taxonomic and ecological structures, the frequency of occurrence of age-related, centuries-old, and ancient trees in protected natural and man-made created territories and objects of the Ukrainian Polissia.

Task: conduct an inventory of trees aged from 90 to more than 1,000 years old in the protected objects of the Ukrainian Polissia and divide them into potentially old, centenarian centuries-old, ancient trees; reveal their frequency of occurrence in natural and anthropogenic objects, establish a systematic, biomorphological, and ecological structure; distinguish dendrorarities; analyse the similarity of the dendroflora of the Ukrainian Polissia, Forest Steppe, and Steppe.

The scientific originality of the obtained study results is that for the first time a comparison of the similarity of the protected dendroflora of the old trees of the Ukrainian Polissia, Forest Steppe, and Steppe was carried out using the Serensen-Chekanovsky coefficient.

Materials and Methods

The study was conducted during 2014-2021 in four stages (Fig. 1).

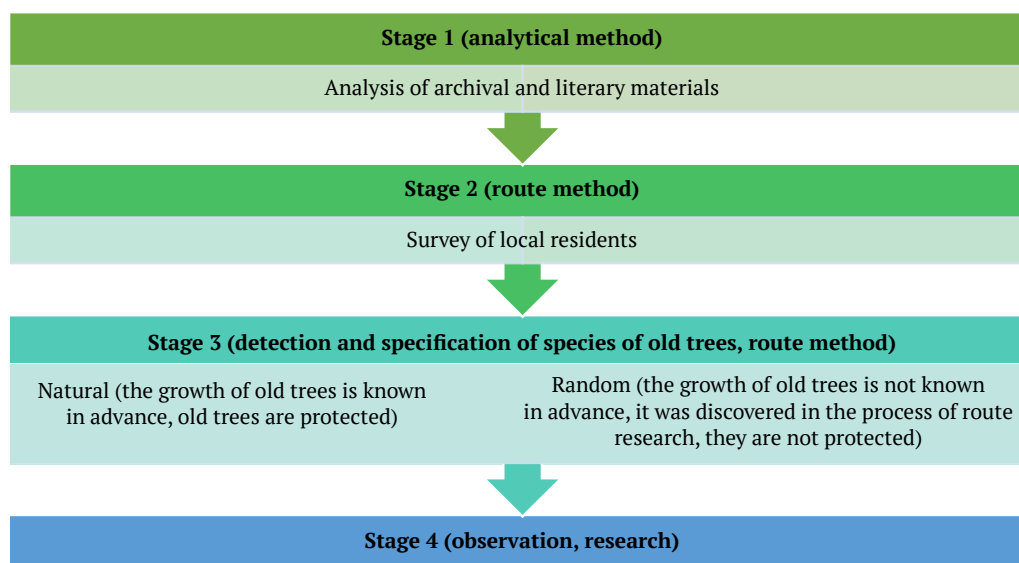


Figure 1. Scheme of the study of potentially old, centenarian, centuries-old, ancient trees

During the inventory of trees, their species [24] was identified, and the species name was specified according to the international classification [25]. Species of woody plants were verified for their pertinence to the Red List of the International Union for Conservation of Nature (IUCN Red List) [26]. The frequency of occurrence of old trees in nature reserves was determined according to the author's methodology: very rarely encountered (1-5-7 specimens encountered in a single protected area); rarely encountered (1-5-7 specimens encountered in two to four protected areas); frequently encountered (1-3-5-10 specimens encountered in five to fifteen protected areas); very frequently encountered (3 or more specimens encountered in 16 or more protected areas).

Based on the methods of V.P. Shlapak, H.I. Muzyka, V.A. Vitenko, L.I. Marno [27] (old trees were divided into categories: potentially old (age – about 100 years), old (100-200 years), centuries-old (200–1,000 years), ancient (1,000 years and older)), M.O. Sovakova, O.V. Sovakov (semi-old (up to 100 years) [28], centenarian (101-300 years), multi-century (301-500 years), ancient (501-800 years), antique (800+ years), as well as considering the morpho-physiologically equivalent life stages of trees by K. Witkoś-Gnach and P. Tyszko-Chmielowiec [13], a unified scale of tree distribution into categories: potentially old (age – about 100 years), old (100-200 years), centuries-old (200-800 years), antique (800+ years). The potentially old, old, centuries-old, ancient trees were distributed into various ecological groups, considering the requirements for the main environmental factors. Life forms were classified according to C. Raunkiaer [29].

The comparison of the similarity of protected dendroflora of old trees of Ukrainian Polissia, Forest Steppe, Steppe was carried out using the Serensen-Chekanovsky coefficient [30], which is calculated according to the formula ($Csc=2c/a+b$), where a is the number of species in one

object, b is the number of species in another object, c is the number of common species for the first and second objects. It shows the ratio of the number of species found in both objects at the same time to the average number of species in these objects. Binary coefficients are calculated based on the same received data, and take values from 0 ($Csc=0$, if the types of woody plants are completely different) to 1 ($Csc=1$, dendroflora is identical), if coefficient ($Csc\geq 0.67$) – dendroflora is considered similar.

Results and Discussion

54 parks-monuments of landscape art (PLMAs), three dendrological parks (DP), NPP Kivertsivskiyi "Tsumanska Pushcha", 18 natural monuments (NM), 9 nature reserves (NR), two protected tracts of Ukrainian Polissia were investigated, with the aim of identifying potentially old, old, centuries-old, and ancient trees. Trees were divided according to the authors' unified scale into potentially old, centenarian centuries-old, ancient, and their frequency of occurrence was established.

Based on the inventory and analysis of the list of plants [20], it was found that the age structure of natural and anthropogenic protected objects is dominated by plants aged from 100 to 200 years, which is 73% and 53%, respectively (Fig. 2), according to the number of distributions presented objects, natural – 10 times higher than anthropogenic objects. Ancient trees are represented by *Quercus robur* L., which grows only in natural objects (five in total) and accounts for 1% of their total number. The age of *Quercus robur* L. varies from 800 to 1,300 years, a 1,300-year-old specimen grows in the Yuzefinskay Dacha botanical monument of nature. Centuries-old trees within natural and anthropogenic objects make up 22% and 26%, respectively, in terms of the number of presented objects, natural ones outnumber man-made ones by more than 10 times.

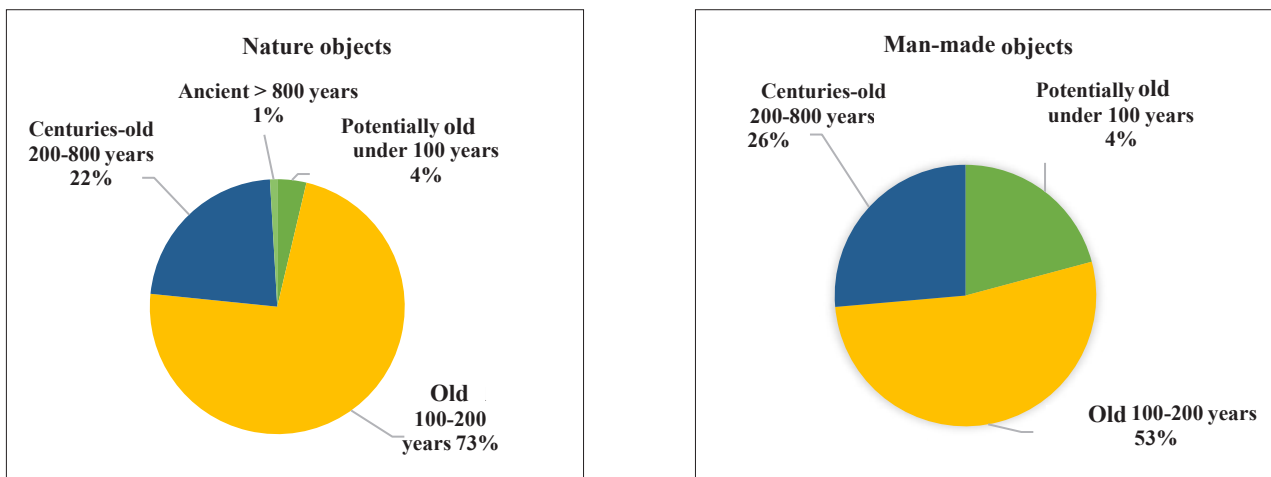


Figure 2. Age structure of potentially old, centenarian, centuries-old, and ancient trees of protected objects of Ukrainian Polissia

On the protected territories of the Ukrainian Polissia, there are very frequently (21%) – potentially old, frequently (21%) – old, rarely (19%) – centuries-old and ancient trees, a total of 38 species (Fig. 3). There are 13 species of plants that occur very frequently, among them 69% are

autochthonous. *Larix decidua* Mill. (21 objects), *Picea abies* Karst. (38 objects), *Pinus sylvestris* L. (156 objects), *Quercus robur* L. (296 objects), *Tilia cordata* Mill. (48 objects), *Acer platanoides* L. (34 objects), *Carpinus betulus* L. (29 objects), *Tilia platyphyllos* Scop. (21 objects), etc.

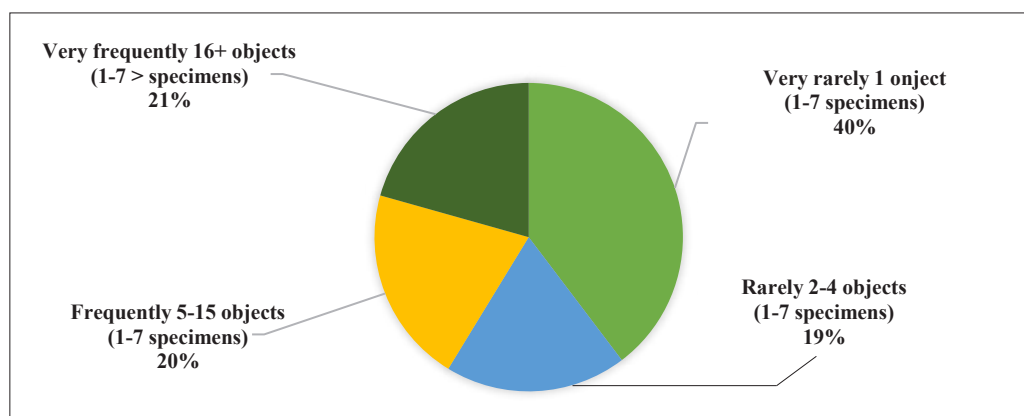


Figure 3. Frequency of occurrence of potentially old, centenarian, centuries-old, and ancient trees of protected objects of Ukrainian Polissia

Most of the old species grow in nature reserves, natural monuments and PLMAs, their number varies from 3-5-8 specimens (*Larix decidua* Mill. – Hubyn botanical reserve, Papyki forest reserve, Volyn region (Figs. 4a, 4b), PLMA Vilkhivskiyi, Zhytomyr region (Fig. 5n); *Acer platanoides* L. – Sirche landscape reserve, Volyn region (Fig. 4c), PLMA Oleksandriyskyi, Rivne region (Fig. 5d) and Dvoryshchanskyi, Zhytomyr region (Fig. 5l); *Quercus robur* L. – Hamarnia landscape reserve, Zhytomyr region (Fig. 4d), PLMA Horodotskyi, Rivne region (Fig. 5a) and Kutuzov Park, Zhytomyr region (Fig. 5f), *Tilia cordata* Mill. – PLMA Ushomyrskyi, Zhytomyr region (Fig. 5k); *Tilia platyphyllos* Scop. – Volodymyretskyi Park complex monument of

nature, Rivne region (Fig. 4h), *Carpinus betulus* L. – PLMA Mikluho-Maclay Park, Zhytomyr region (Fig. 5h)) to more than 30 specimens (*Larix decidua* Mill., Hubyn botanical reserve, Volyn region (Fig. 4a). Such species as *Larix decidua* Mill. (Modryna botanic monument of nature, (Fig. 4e), Piliava DP, Zhytomyr region), *Pinus sylvestris* L. (PLMA Vozdzhenskyi, Sumy region (Fig. 5c)), *Quercus robur* L. form pure and mixed stands, where over 50 or more specimens grow – these are mostly the remnants of natural stands based on which the sanctuaries (Hamarnia landscape reserve and others), complex monuments of nature (Antonivka Park, Volodymyretskyi park), and PLMAs (Klevanskyi Park, Vozdzhenskyi, Miklukho-Maclay Park) are created.



Figure 4. Nature reserves of the Ukrainian Polissia (author's photo)



a) *Quercus robur* L.
Horodotskyi
(Rivne Oblast)



b) *Acer negundo* L.
Tuchynskyi
(Rivne Oblast)



**c) *Pinus sylvestris* L.,
Betula obscura Kotula**
Vozdvyzhenskyi
(Sumy Oblast)



d) *Acer platanoides* L.
Oleksandriiyskyi
(Rivne Oblast)



e) *Ginkgo biloba* L.
Yu. Gagarin Park
(Zhytomyr region)



f) *Quercus robur* L.
Kutuzov Park
(Zhytomyr region)



g) *Pinus strobus* L.
Zirnenskyi
(Rivne region)



h) *Carpinus betulus* L.
Miklukho-Maclay Park
(Zhytomyr region)



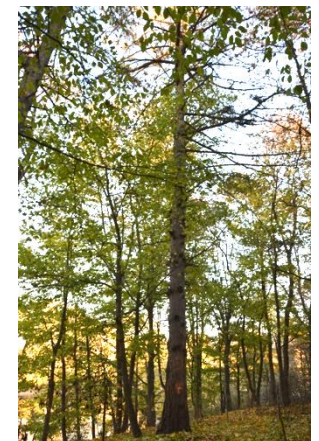
k) *Tilia cordata* Mill.
Ushomyrskyi
(Zhytomyr region)



l) *Acer platanoides* L.
Dvoryshanskyi
(Zhytomyr region)



m) *Fagus sylvatica* L.
Piliava DP
(Zhytomyr region)



n) *Larix decidua* Mill.
Vilkhivskyi
(Zhytomyr region)

Figure 5. Man-made created protected objects of the Ukrainian Polissia (PLMAs and dendrological parks) (author's photo)

Among the species that occur frequently (on 5-15 sites), introduced species and autochthons are represented by almost the same number of 6 and 7 species, respectively, and 61.5% of them were found both on natural and man-made sites. These include *Pinus strobus* L. (9 objects), including PLMA Zirnenskyi, Rivne region (Fig. 5g), *Acer negundo* L. (6 objects) – PLMA Tuchinsky, Rivne region (Fig. 5b), *Quercus petraea* (Matt.) Liebl. (9 objects), *Alnus glutinosa* (L.) Gaerth. (13 objects), *Ulmus glabra* Huds. (12 objects), *Ulmus laevis* Pall. (10 objects), *Salix alba* L. (13 objects), *Aesculus hippocastanum* L. (15 objects), *Acer pseudoplatanus* L. (7 objects), etc.

Rarely, on 2-4 objects, in the number of one to seven specimens, 12 species of potentially old, centenarian, centuries-old, and ancient trees occur, autochthonous trees predominate (58.3%), 4 species (33.3%) grow as both on natural and anthropogenic objects. These include *Acer campestre* L. (2 objects), *Betula obscura* Kotula. (3 objects), *Crataegus monogyna* Jacq. (3 objects), *Ulmus minor* Mill. (3 objects), *Salix fragilis* L. (2 objects), *Larix decidua* var. *polonica* (4 objects), *Malus sylvestris* Mill. (5 objects), *Fagus sylvatica* L. (4 objects), among them Piliava DP, Zhytomyr region (Fig. 5m), *Pinus nigra* J.F. Arnold (2 objects), including Sosna Chorna and Yuzefinska Dacha botanic monuments of nature, Rivne region (Figs. 4f, 4g), etc. In the Sosna Chorna botanic monument of nature, there is a potentially ancient plant that is represented by a mixed stand of *Pinus nigra* J.F. Arnold with an admixture of *Pinus sylvestris* L., the number of *Pinus nigra* J.F. Arnold is over 30 specimens.

Very rarely, only one object, 25 taxa occur, their number is from one to seven specimens, 76% of them are introduced species. 95.2% of taxa are concentrated in man-made objects – PLMA and dendrological parks, they include *Ginkgo biloba* L. (Yu. Gagarin Park, Zhytomyr region (Fig. 5e)), *Thuja occidentalis* L., *Pseudotsuga menziesii* (Mirb.) Franco., *Quercus rubra* L., *Liriodendron tulipifera* L., *Phellodendron*

amurense Rupr., *Celtis occidentalis* L., *Fagus sylvatica* subsp. *purpurea*, *Aesculus* × *carnea* Zeyh., etc.

In the PLMA grow between one and 26 representatives of potentially old, centenarian, centuries-old, and ancient trees. The largest number is represented in the PLMA created at the end of the 19th century, namely the Zirnenskyi PLMA (26 taxa) (*Alnus glutinosa* (L.) Gaerth., *Populus alba* L., *Quercus robur* L., *Salix alba* L., *Pinus strobus* L., *Larix decidua* Mill., *Larix decidua* var. *polonica*, *Pinus nigra* Arn., *Pinus ponderosa* Dougl., *Aesculus hippocastanum* L., *Acer saccharinum* L., *Acer negundo* L., *Robinia pseudoacacia* L., etc.), Vahanytskyi (22 taxa) (*Acer saccharinum* L., *Acer platanoides* L., *Pinus sylvestris* L., *Quercus robur* L., *Picea pungens* Engelm., *Aesculus* × *carnea* Zeyh., etc.), Vozdvizhenskyi (19 taxa) (*Tilia cordata* Mill., *Tilia platyphyllos* Scop., *Pinus sylvestris* L., *Quercus robur* L., *Pseudotsuga menziesii* (Mirb.) Franco., *Phellodendron amurense* Rupr., *Populus nigra* L., etc.), Polonskyi (22 taxa) (*Larix decidua* Mill., *Picea abies* Karst., *Aesculus hippocastanum* L., *Acer platanoides* L., *Fraxinus excelsior* L., etc.).

Thus, 63 taxa of potentially old, centenarian, centuries-old, and ancient trees (59 species, hybrid, three varieties) belonging to 28 genera and 16 families were found in the Ukrainian Polissia in natural and anthropogenic objects (Table 1). Of them, autochthonous species make up 41.3%, introduced species – 52.4%. Taxa of the *Magnoliophyta* division predominate. The family *Pinaceae* Lindl has the most species diversity (13 species). 90.5% of potentially old, centenarian, centuries-old, and ancient trees belong to the six IUCN Red List categories, of which 69.8% are represented by the LC category under low threat, 12.7% belong to the DD category, *Fraxinus pennsylvanica* Marsh. – critically endangered (CR category), *Aesculus hippocastanum* L. – vulnerable (VU), *Ginkgo biloba* L., *Larix decidua* var. *polonica* – endangered (EN), *Fraxinus excelsior* L. – near threatened (NT).

Table 1. Systematic structure of potentially old, centenarian, centuries-old, and ancient trees of protected objects of Ukrainian Polissia

Family	Genus		Species		Hybrid/variety	
	Number	%	Number	%	Number	%
<i>Ginkgoaceae</i> Adas.	1	3.6	1	1.7		
<i>Cupresaceae</i> Rich. Ex Bartl.	1	3.6	1	1.7	–	–
<i>Pinaceae</i> Lindl.	4	14.3	13	22.0	–	–
<i>Fabaceae</i> Lindl.	2	7.1	2	3.4	–	–
<i>Fagaceae</i> A.B.R.	2	7.1	5	8.5	–/1	–/33.0
<i>Juglandaceae</i> A.Rich. ex Kunt.	1	3.6	1	1.7	–	–
<i>Betulaceae</i> S.F. Gray	3	10.7	4	6.8	–	–
<i>Oleaceae</i> Lindl.	1	3.6	3	5.1	–	–
<i>Rosaceae</i> Juss.	4	14.2	7	11.9	–	–
<i>Ulmaceae</i> Mirb.	1	3.6	3	5.1	–	–
<i>Cannabaceae</i> Martinov.	1	3.6	1	1.7	–	–
<i>Salicaceae</i> Mirb.	2	7.1	6	10.1	–	–
<i>Sapindaceae</i> Juss.	2	7.1	6	10.1	1/1	100/33.0
<i>Rutaceae</i> Juss.	1	3.6	1	1.7	–	–
<i>Malvaceae</i> Juss.	1	3.6	4	6.8	–/1	–/33.0
<i>Magnoliaceae</i> Juss.	1	3.6	1	1.7	–	–
Total 16	28	100	59	100	1/3	100/100

The biomorphological spectrum of potentially old, centenarian, centuries-old, and ancient trees is represented by an almost equal number of megaphanerophytes (47.6%), mesophanerophytes (49.2%), and rare microphanerophytes (3.2%). Based on the analysis of the ecological structure of the dendroflora of potentially old, centenarian, centuries-old, and ancient trees of the protected objects of Ukrainian Polissia, it was established that there are four groups in terms of demand for soil moisture – common mesotrophs (49.2%), in terms of demand for lighting, hemiskiophytes (49.2%) and heliophytes (39.7%) prevail, to soil

fertility – mesophytes (44.4%) and mesohygrophytes (22.2%) (Fig. 6). These include are such plants as *Ginkgo biloba* L., *Larix decidua* Mill., *Carpinus betulus* L., *Populus tremula* L., *Tilia cordata* Mill., *Ulmus minor* Mill., *Malus sylvestris* Mill., *Pyrus pyraister* (L.) Burgsd., etc. The further development and stability of plants depends on the extent to which the environmental conditions of growth meet the requirements of plants. Under favourable conditions and protection, potentially potentially old, centenarian trees can pass into the group of centuries-old and ancient trees.

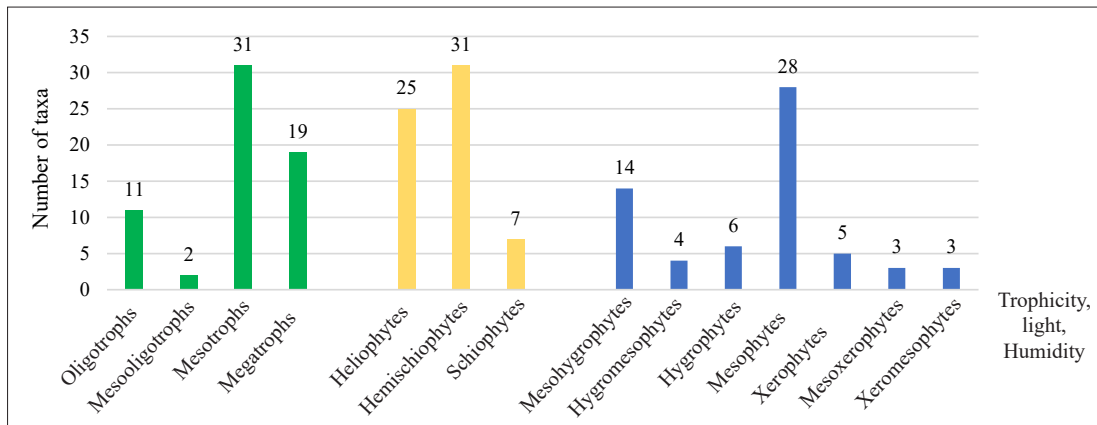


Figure 6. Ecological structure (trophicity, light, humidity) of potentially old, centenarian, centuries-old, ancient trees of protected objects of the Ukrainian Polissia

Based on own research and studies [18–20], a comparative analysis of the taxonomic composition and age structure of trees from 90 years to more than 1,000 years in three zones was carried out. The amplitude of the age of protected trees is greater in the Ukrainian Polissia (100–1,300 years) than in the Forest Steppe (100–500 years) and in the Steppe (100–250-year-old trees). In the three natural zones, age trees from 100 to 200 years prevail. 28 taxa are common to Ukrainian Polissia, Forest Steppe, and Steppe. These include *Pinus sylvestris* L., *Robinia pseudoacacia* L., *Quercus robur* L., *Quercus petraea* (Matt.) Liebl., *Juglans regia* L., *Alnus glutinosa* (L.) Gaerth., *Carpinus betulus* L., *Fraxinus excelsior* L., *Fraxinus pennsylvanica* Marsh., *Malus sylvestris* Mill., *Ulmus glabra* Huds., *Populus alba* L., *Populus nigra* L., *Acer platanoides* L., *Acer campestre* L., *Tilia cordata* Mill., etc. The number of sites in the three natural

zones is dominated by *Quercus robur* L., the largest number in the Forest Steppe (486 sites), slightly smaller – in the Ukrainian Polissia (296 sites), the smallest – in the Steppe (125 sites), which is explained by the requirements for optimal growth conditions.

The largest number of old trees, including introduced species, is concentrated in man-made created protected objects in the Ukrainian Polissia (PLMAs, dendrological parks) (95.2%) in the Forest Steppe (botanical gardens, dendrological parks, PLMAs) 97.2%, in contrast to the Steppe, where 92.9% of old trees grow in natural objects (Table 2). Less than 50% of old trees in the Ukrainian Polissia (44.4%) and in the Forest Steppe (34.9%) grow in natural objects. Representatives of the families *Pinaceae* Link., *Rosaceae* Juss., *Betulaceae* S.F.GRAY are spread in three zones.

Table 2. Representativeness of old, centuries-old, ancient dendroflora of natural and anthropogenic protected objects of the Ukrainian Polissia, Forest Steppe, Steppe

Objects	Family		Genus		Taxa	
	Number	%	Number	%	Number	%
Ukrainian Polissia						
Natural	13	81.3	20	71.4	28	44.4
Man-made (PLMAs, dendrological parks)	14	87.5	26	92.8	60	95.2
Total	16	100	28	100	63	100
Forest-Steppe						
Natural	13	44.8	24	48.0	38	34.9
Man-made (PMLA, dendrological parks, botanical gardens)	28	96,	49	98.0	106	97.2
Total	29	100	50	100	109	100
Steppe						
Natural	25	89.3	48	82.7	79	92.9
Man-made (PLMAs, dendrological parks, botanical gardens)	26	92.9	54	93.1	77	90.6
Total	28	100	58	100	85	100

An intersection-similarity matrix was used to visualise correlations between the dendrofloras of old trees of three natural zones (Ukrainian Polissia, Forest Steppe, Steppe). As the analysis showed, the value of the Serensen-Chekanovsky similarity coefficient is within the limits ($0.39 \leq Csc \leq 0.5$) average value $\Delta Csc = 0.45$, which indicates a slight similarity of dendroflora. The maximum values of

the Serensen-Chekanovsky coefficient were obtained for a pair of dendroflora: A – Ukrainian Polissia and B – Forest Steppe ($Csc = 0.5$) (Table 3). The insignificant number of common species ($Csc \leq 0.39$) and ($Csc \leq 0.45$) were influenced by both historical, ecological and geographical factors of Ukrainian Polissia, Forest Steppe, Steppe.

Table 3. Combined matrix of cross-similarity of age dendroflora of protected objects of Ukrainian Polissia, Forest Steppe, Steppe

PLMAs		A	B	C
Number of species		63	109	85
A	63	–	0.5	0.39
B	109	43	–	0.45
C	85	29	44	–

Note: A – Ukrainian Polissia; B – Forest Steppe; C – Steppe, A, B, C – compared objects, numbers – the number of taxa in the objects; on a gray background – the absolute number of shared taxa for all pairs of objects, on a white background – the value of the Serensen-Chekanovsky coefficient

In studies [21–23], the authors analysed the representation of autochthonous and introduced old woody plants within the separate natural zone of the Forest-Steppe, Steppe, and Ukrainian Polissia, according to the categories of the nature reserve areas, administrative regions and localities, the old trees were divided according to the longevity of the trees. Within the boundaries of a separate natural zone, it was found that the most common species of old introduced trees are in the dendrological parks, autochthonous – in the natural monuments. The frequency of occurrence of autochthonous and introduced species depends on the natural zone and administrative region, which confirms the above results.

Conclusions

63 taxa of semi-old, old, centuries-old, ancient, centuries-old, and ancient trees belonging to 28 genera and 14 genera grow on protected natural and anthropogenic objects of the Ukrainian Polissia. 60 taxa are concentrated in anthropogenic objects and only 28 in natural ones, introducers predominate among them (52.4%). In 40% of objects, plants are very rare – from one specimen to seven. 21% of plants are very frequent representatives of natural flora (*Betula pendula* Roth., *Quercus robur* L., *Carpinus betulus* L., *Fraxinus excelsior* L., *Populus alba* L., etc.). 25 species of woody plants grow both on natural and man-made objects, including

Pinus sylvestris L., *Pinus strobus* L., *Quercus robur* L., *Alnus glutinosa* (L.) Gaerth., *Tilia cordata* Mill., *Acer platanoides* L., etc. The ecological structure is represented mainly by mesotrophs (49.2%), hemiskiohytes (49.2%) and heliohytes (39.7%), mesophytes (44.4%) and mesohygrophytes (22.2%).

In the Ukrainian Polissia, the representatives of protected ancient trees (*Quercus robur* L.) reach the age of 1,300 years, in the Forest-Steppe – 500 years, in the Steppe – the maximum age is 250 years. The largest number of old trees is concentrated in man-made created protected objects in Ukrainian Polissia (95.2%) and in the Forest Steppe (97.2%). Historical, ecological, and geographical factors influenced the insignificant number of common species of the Ukrainian Polissia, Forest Steppe, and Steppe. Considering the value of centuries-old and ancient trees, as well as the prospects of potentially old trees (their number is the largest), it is necessary to further promote the preservation and protection of the above-mentioned trees for future generations.

Research prospects include further monitoring of potentially old, centenarian centuries-old, and ancient trees of protected objects of the Ukrainian Polissia, conducting a comparative analysis of similar trees in other territories of Ukraine, entering the received information about species into the “Monumental trees” database.

References

- [1] Cannon, C.H., Piovesan, G., & Munné-Bosch, S. (2022). Old and ancient trees are life history lottery winners and vital evolutionary resources for long-term adaptive capacity. *Nature Plants*, 8, 136–145. doi: 10.1038/s41477-021-01088-5.
- [2] Caramiello, R., & Grossoni, P. (2004). Monumental trees in historical parks and gardens and monumentality significance. In *The trees of history protection and exploitation of veteran trees* (pp. 3–8). Torino: Proceedings of the International Congress Torino.
- [3] Mahmoud, T., Gairola, S., & El-Keblawy, A. (2015). Large old trees need more conservation attention: A case of *Tamarix aphylla* in the arid deserts of the United Arab Emirates. *Journal of Asia-Pacific Biodiversity*, 8(2), 183–185. doi: 10.1016/j.japb.2015.04.006.
- [4] Camarero, J.J., Colangelo, M., Gracia-Balaga, A., Ortega-Martínez, M.A., & Büntgen, U. (2021). Demystifying the age of old olive trees. *Dendrochronologia*, 65, article number 125802. doi: 10.1016/j.dendro.2020.125802.
- [5] Huang, L., Tian, L., Zhou, L., Jin, C., Qian, S., Jim, C.Y., Lin, D., Zhao, L., Minor, J., Coggins, C., & Yang, Y. (2020). Local cultural beliefs and practices promote conservation of large old trees in an ethnic minority region in Southwestern China. *Urban Forestry & Urban Greening*, 49, article number 126584. doi: 10.1016/j.ufug.2020.126584.
- [6] Chi, X., Yang, G., Sun, K., Li, X., Wang, T., Zhang, A., Li, Y., Cheng, M., & Wang, Q. (2020). Old ginkgo trees in China distribution, determinants and implications for conservation. *Global Ecology and Conservation*, 24, article number e01304. doi: 10.1016/j.gecco.2020.e01304.

- [7] Lindenmayer, D.B., Laurance, W.F., & Franklin, J.F. (2012). Global decline in large old trees. *Science*, 338, 1305-1306. doi: 10.1126/science.1231070.
- [8] Baker, S.C., Chuter, A., Munks, S.A., & Koch, A.J. (2020). Retention of large, old trees in alternatives to clearcutting with a comparison of ground- and helicopter-based assessments. *Forest Ecology and Management*, 475, article number 118390. doi: 10.1016/j.foreco.2020.118390.
- [9] Lindenmayer, D.B., Blanchard, W., Blair, D., & McBurney, L. (2018). The road to oblivion – Quantifying pathways in the decline of large old trees. *Forest Ecology and Management*, 430, 259-264. doi: 10.1016/j.foreco.2018.08.013.
- [10] Vandekerckhove, K., Vanhellemont, M., Vrška, T., Meyer, P., Tabaku, V., Thomaes, A., Leyman, A., Keersmaeker, L.D., & Verheyen, K. (2018). Very large trees in a lowland old-growth beech (*Fagus sylvatica* L.) forest: Density, size, growth and spatial patterns in comparison to reference sites in Europe. *Forest Ecology and Management*, 417, 1-17, doi: 10.1016/j.foreco.2018.02.033.
- [11] Henttonen, H.M., Nöjd, P., Suvanto, S., Heikkinen, J., & Mäkinen, H. (2019). Large trees have increased greatly in Finland during 1921-2013, but recent observations on old trees tell a different story. *Ecological Indicators*, 99, 118-129. doi: 10.1016/j.ecolind.2018.12.015.
- [12] Wan, J.-Z., Li, Q.-F., Wei, G.-L., Yin, G.-J., Wei, D.-X., Song, Z.-M., & Wang, C.-J. (2020). The effects of the human footprint and soil properties on the habitat suitability of large old trees in alpine urban and periurban areas. *Urban Forestry & Urban Greening*, 47, article number 126520. doi: 10.1016/j.ufug.2019.126520.
- [13] Witkoś-Gnach, K., & Tyszko-Chmielowiec, P. (Eds.). (2016). *Trees – a lifespan approach. contributions to arboriculture from European practitioners*. Wrocław: Fundacja EkoRozwoju.
- [14] Liu, J., Lindenmayer, D.B., Yang, W., Ren, Y., Campbell, M.J., Wu, C., Luo, Y., Zhong, L., & Yu, M. (2019). Diversity and density patterns of large old trees in China. *Science of the Total Environment*, 655, 255-262. doi: 10.1016/j.scitotenv.2018.11.147.
- [15] Boreyko, V.E. (2001). *Protection of ancient trees. Series "Wildlife protection"* (2nd ed., Iss. 22). Kyiv: Ecological-cultural center.
- [16] Oleksiychenko, N.O., & Podolkhova, M.O. (2016). Former trees of the arboretum of Ukrainian Polissia. *Scientific Bulletin of UNFU*, 26(4), 22-27. doi: 10.15421/40260403.
- [17] Schneide, S.L., Boreyko, V.E., & Stetsenko, N.F. (2011). *500 outstanding trees of Ukraine*. Kyiv: KECC.
- [18] Popovich, S.Yu. (Ed.). (2011). *Dendrosozological catalog of the nature reserves areas of the Forest Steppe of Ukraine*. Kyiv: Agrar Media Group.
- [19] Popovich, S.Yu. (Ed.). (2014). *Dendrosozological catalog of the nature reserves areas of the Steppe of Ukraine*. Kyiv: Komprint.
- [20] Popovich, S.Yu. (Ed.). (2017). *Dendrosozological catalog of the nature reserves areas of the Ukrainian*. Kyiv: Komprint.
- [21] Popovich, S.Yu. (Ed.). (2010). *Reserved dendrososoflora of the Forest-Steppe of Ukraine*. Kyiv: Agrar Media Group.
- [22] Popovich, S.Yu. (Ed.). (2013). *Reserved dendrososoflora of the Steppe of Ukraine*. Kyiv: Comprint.
- [23] Popovich, S.Yu. (Ed.). (2017). *Reserved dendrososoflora of Ukrainian Polissya*. Kyiv: Comprint.
- [24] Spohn, M., & Spohn, R. (2011). *Cosmos tree guide Europe*. Stuttgart: Kosmos.
- [25] An online flora of all known plants. (2022). Retrieved from <http://www.worldfloraonline.org/classification>.
- [26] IUCN 2021. (n.d.). *The IUCN Red List of threatened species. Version 2021-3*. Retrieved from <https://www.iucnredlist.org>.
- [27] Shlapak, V.P., Muzyka, H.I., Vitenko, V.A., & Marno, L.I. (2011). Biometric indicators of old woody plants of the arboretum "Sofiyivka" and their distribution by age categories. *Scientific Bulletin of UNFU*, 21(5), 8-15.
- [28] Sovakova, M.O., & Sovakov, O.V. (2015). Age lindens of Kyiv. *Scientific Journal of National University of Life and Environmental Sciences of Ukraine*, 229, 333-339.
- [29] Raunkiaer, C. (1934). *The life forms of plants and statistical plant geography*. Oxford: Clarendon Press.
- [30] Leontev, D.V. (2008). *Floristic analysis in mycology*. Kharkiv: Ranok-NT.

Список використаних джерел

- [1] Cannon C.H., Piovesan G., Munné-Bosch S. Old and ancient trees are life history lottery winners and vital evolutionary resources for long-term adaptive capacity. *Nature Plants*. 2022. No. 8. P. 136–145. doi: 10.1038/s41477-021-01088-5.
- [2] Caramiello R., Grossoni P. Monumental trees in historical parks and gardens and monumentality significance. *The trees of history protection and exploitation of veteran trees: Proceedings of the international congress Torino* (Torino, April 1–2, 2004). Torino, 2004. P. 3–8.
- [3] Mahmoud T., Gairola S., El-Keblawy A. Large old trees need more conservation attention: A case of *Tamarix aphylla* in the arid deserts of the United Arab Emirates. *Journal of Asia-Pacific Biodiversity*. 2015. Vol. 8, No. 2. P. 183–185. doi: 10.1016/j.japb.2015.04.006.
- [4] Demystifying the age of old olive trees / J.J. Camarero et al. *Dendrochronologia*. 2021. Vol. 65. Article number 125802. doi: 10.1016/j.dendro.2020.125802.
- [5] Local cultural beliefs and practices promote conservation of large old trees in an ethnic minority region in Southwestern China / L. Huang et al. *Urban Forestry & Urban Greening*. 2020. Vol. 49. Article number 126584. doi: 10.1016/j.ufug.2020.126584.
- [6] Old ginkgo trees in China Distribution, determinants and implications for conservation / X. Chi et al. *Global Ecology and Conservation*. 2020. Vol. 24. Article number e01304. doi: 10.1016/j.gecco.2020.e01304.
- [7] Lindenmayer D.B., Laurance W.F., Franklin J.F. Global decline in large old trees. *Science*. 2012. Vol. 338. P. 1305–1306. doi: 10.1126/science.1231070.
- [8] Baker S.C., Chuter A., Munks S.A., Koch A.J. Retention of large, old trees in alternatives to clearcutting with a comparison of ground- and helicopter-based assessments. *Forest Ecology and Management*. 2020. Vol. 475. Article number 118390. doi: 10.1016/j.foreco.2020.118390.

- [9] Lindenmayer D.B., Blanchard W., Blair D., McBurney L. The road to oblivion – Quantifying pathways in the decline of large old trees. *Forest Ecology and Management*. 2018. Vol. 430. P. 259–264. doi: 10.1016/j.foreco.2018.08.013.
- [10] Very large trees in a lowland old-growth beech (*Fagus sylvatica* L.) forest: Density, size, growth and spatial patterns in comparison to reference sites in Europe / K. Vandekerckhove et al. *Forest Ecology and Management*. 2018. Vol. 417. P. 1–17, doi: 10.1016/j.foreco.2018.02.033.
- [11] Large trees have increased greatly in Finland during 1921–2013, but recent observations on old trees tell a different story / Henttonen H.M. et al. *Ecological Indicators*. 2019. Vol. 99. P. 118–129. doi: 10.1016/j.ecolind.2018.12.015.
- [12] The effects of the human footprint and soil properties on the habitat suitability of large old trees in alpine urban and periurban areas / J.-Z. Wan et al. *Urban Forestry & Urban Greening*. 2020. Vol. 47. Article number 126520. doi: 10.1016/j.ufug.2019.126520.
- [13] Trees – a lifespan approach. contributions to arboriculture from European practitioners / K. Witkoś-Gnach, P. Tyszkó-Chmielowiec (Eds.). Wrocław: Fundacja EkoRozwoju, 2016. 136 p.
- [14] Diversity and density patterns of large old trees in China / J. Liu et al. *Science of the Total Environment*. 2019. Vol. 655. P. 255–262. doi: 10.1016/j.scitotenv.2018.11.147.
- [15] Борейко В.Е. Охрана вековых деревьев. Серия. Охрана дикой природы. 2-е изд-во доп. Вып. 22. Киев: Эколого-культурный центр, 2001. 96 с.
- [16] Олексійченко Н.О., Подольхова М.О. Вікові дерева дендропарків Українського Полісся. *Науковий вісник НЛТУ України*. 2016. Вип. 26, № 4. С. 22–27. doi: 10.15421/40260403.
- [17] Шнайдер С.Л., Борейко В.Е., Стеценко Н.Ф. 500 выдающихся деревьев Украины. Киев: КЭКЦ, 2011. 203 с.
- [18] Дендросозологічний каталог природно-заповідного фонду Лісостепу України / С.Ю. Попович та ін.; за заг. ред. С.Ю. Поповича. Київ: Аграр Медіа Груп, 2011. 800 с.
- [19] Дендросозологічний каталог природно-заповідного фонду Степу України / С.Ю. Попович та ін.; за заг. ред. С.Ю. Поповича. Київ: ЦП «Компринт», 2014. 888 с.
- [20] Дендросозологічний каталог природно-заповідного фонду Українського Полісся / С.Ю. Попович та ін.; за заг. ред. С. Ю. Поповича. Київ: ЦП «Компринт», 2017. 466 с.
- [21] Заповідна дендросозофлора Лісостепу України / за ред. С.Ю. Поповича. Київ: ТОВ «Аграр Медіа Груп», 2010. 262 с.
- [22] Заповідна дендросозофлора Степу України: монографія / за ред. С.Ю. Поповича. Київ: ЦП «Компринт», 2013. 260 с.
- [23] Заповідна дендросозофлора Українського Полісся: монографія / за ред. С.Ю. Поповича. Київ: ЦП «Компринт», 2017. 188 с.
- [24] Spohn M., Spohn R. *Cosmos tree guide Europe*. Stuttgart: Kosmos, 2011. 303 p.
- [25] An online flora of all known plants. URL: <http://www.worldfloraonline.org/classification>.
- [26] IUCN 2021. The IUCN Red List of threatened species. Version 2021-3. URL: <https://www.iucnredlist.org>.
- [27] Шлапак В.П., Музика Г.І., Вітенко В.А., Марно Л.І. Біометричні показники вікових деревних рослин дендропарку «Софіївка» та їх розподіл за віковими категоріями. *Науковий вісник НЛТУ України*. 2011. Вип. 21, № 5. С. 8–15.
- [28] Совакова М.О., Соваков О.В. Вікові липи м. Києва. *Науковий вісник Національного університету біоресурсів і природокористування України*. 2015. № 229. С. 333–339.
- [29] Raunkiaer C. *The life forms of plants and statistical plant geography*. Oxford: Clarendon Press, 1934. 632 p.
- [30] Леонтьев Д.В. Флористический анализ в микологии. Харьков: Ранок-НТ, 2008. 110 с.

Вікова, таксономічна та екологічна структури вікових дерев заповідних природних та штучно створених об'єктів Українського Полісся

Анжела Андріївна Дзиба

Навчально-науковий інститут лісового і садово-паркового господарства
Національного університету біоресурсів і природокористування України
03041, вул. Генерала Родімцева, 19, м. Київ, Україна

Анотація. В Україні протягом останніх десяти років було проведено інвентаризацію вікових та старовікових дерев, проаналізовано репрезентативність автохтонних та інтродукованих хвойних і листяних видів вікових дерев заповідних територій Лісостепу, Степу, Українського Полісся. Наразі актуальним є питання порівняльного аналізу таксономічної та екологічної структури, частоти трапляння видів дерев від 100 років у природних та штучно створених заповідних об'єктах Українського Полісся. Метою дослідження було систематизувати таксономічну та екологічну структури, частоту трапляння вікових, багатовікових і стародавніх дерев на заповідних природних і штучно створених територіях та об'єктах Українського Полісся. Застосовано методи дослідження: аналітичний, маршрутний, виявлення, уточнення видів вікових дерев відповідно до The World Flora Online, порівняльний аналіз. Запропоновано та застосовано уніфіковану шкалу розподілу вікових дерев на чотири категорії (потенційно вікові (близько 100 років), вікові (100–200 років), багатовікові (200–800 років), та стародавні (800+ років)), зроблено їхній розподіл. Наведено етапи дослідження потенційно вікових, вікових, багатовікових та стародавніх дерев на Українському Поліссі. У віковій структурі природних і штучно-створених охоронних об'єктів переважають рослини від 100 до 200 років, що становить 73 та 53 % відповідно. Стародавні дерева представлені *Quercus robur* L., що зростає у п'яти природних об'єктах (1 % від 543 об'єктів). Залежно від кількості рослин на заповідному об'єкті, а також враховуючи кількість об'єктів, у яких зростають досліджувані рослини, розроблено методику оцінювання їхньої частоти трапляння (дуже часто, часто, рідко, дуже рідко). Встановлено, що потенційно вікові, вікові, багатовікові та стародавні дерева трапляються дуже часто – 13 таксонів (21 %, серед яких 69 % автохтони), часто – 13 таксонів (20 %, інтродуценти (46,2 %) і автохтони (53,8 %)) та рідко – 12 таксонів (19 %, переважають автохтони 58,3 %). Дуже рідко, лише на одному об'єкті, трапляється 25 таксонів, їхня кількість становить від одного до семи екземплярів, із них 76 % – інтродуценти. 95,2 % таксонів зосереджено у штучно-створених об'єктах (парки-пам'ятки садово-паркового мистецтва та дендропарки). У чотирьох парках-пам'ятках садово-паркового мистецтва, що створені у кінці XIX ст. зосереджено від 19 до 26 таксонів (Воздвиженський – 19 таксонів, Ваганицький – 22 таксона, Полонський – 22 таксона, Зірненський – 26 таксонів). На Українському Поліссі у природних та штучно-створених об'єктах виявлено 63 таксони потенційно вікових, вікових, багатовікових та стародавніх дерев (59 видів, гібрид, три різновиди), що належать до 28 родів із 16 родин. Із них автохтонні види складають 41,3 %, інтродуценти – 52,4 %. 90,5 % потенційно вікових, вікових, багатовікових та стародавніх дерев належать до шести категорій Червоного списку Міжнародного союзу охорони природи, із них 69,8 % знаходяться під невеликою загрозою (категорія LC). Біоморфологічний спектр потенційно вікових, вікових, багатовікових та стародавніх дерев представлений мегафанерофітами (47,6 %), мезофанерофітами (49,2 %), мікрофанерафітами (3,2%). Екологічний спектр – переважно мезотрофами (49,2 %), геміскіофітами (49,2 %) та геліофітами (39,7 %), мезофітами (44,4 %) та мезогірофітами (22,2 %). Отримані результати досліджень нададуть можливість проводити моніторинг потенційно вікових, вікових, багатовікових та стародавніх дерев заповідних об'єктів Українського Полісся у часі, порівнювати подібні дерева на інших територіях різних регіонів України, поповнити всесвітню базу «Monumental trees» інформацією про види стародавніх дерев Українського Полісся

Ключові слова: багатовікові, види, парки-пам'ятки, заказники, пам'ятки природи