UDC 581.9
DOI: 10.15587/2519-8025.2024.312550

ANALYSIS OF THE MODERN FOREST FUND

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The article is dedicated to the study of the forests in the southern part of Kyiv. The article presents data on the projective cover, distribution, vitality, frequency of occurrence, and other data, obtained from 10 geobotanical descriptions in the Holosiivskyi district of Kyiv. The further actions were made with the data observed, and as a result, the graph of similarity was created. Nowadays the territories of cities expand, causing the enhanced tempo of urbanization and this study checks whether the forest is hugely affected or not. Some evaluations could set the pattern and help to estimate the influence on forestry in the very near future.

The aim of the study *is to inventory the modern forest fund in Kyiv and observe data to determine the influence of the urbanization on forest in the future.*

Materials and methods. *Among of the methods for the observation were used geobotanical descriptions, monitoring and various computing methods, including the sorting, creating plots to make evaluations, GPS fixation, and the programme to create a map for the more thorough description of quadrants.*

Results. *The vegetation in the analyzed areas is very diverse, with 68 species identified. Among the dominant species, Quercus robur was found in the tree layer, and Molinia caerulea along with Convallaria majalis in the herbaceous layer. The Betula pendula and Quercus robur formations have the highest species diversity, with 24 species each. The vegetation classes Querco-Fagetea and Vacinio-Piceateae were analyzed.*

Conclusions. *The forest, in which the research was conducted, is mildly affected by urbanization. This inference may be made by the common species on this latitude, based on the previous researches*

Keywords: *geobotany, phytocoenosis, projective cover, graph of similarity, vitality, geobotanical description, Jaccard coefficient*

How to cite:
Lutskiv, M. (2024). Analysis of the modern forest fund. ScienceRise: Biological Science, 2 (39), 9-16. http://doi.org/10.15587/2519-8025.2024.312550

1. Introduction

With climate rapidly changing in recent times, there is also an effect on the vegetation in Ukraine. For the study, ten separate forest areas in the Holosiivskyi district of Kyiv were selected to determine the species composition and compare it using mathematical methods. Overall, many factors influence living organisms, but climate change and urbanization are the most significant. Human settlement and development of forest areas, along with a significant increase in the average annual temperature, are altering the biological rhythms of plants, affecting soil quality and air purity, which, in turn, is a key indicator for groups of organisms with narrow ecological valence.

Among the sources there were used several scientific web pages regarding the physiology and life of plants [1, 2]. These sources gave the opportunity to build up foundation facts for the further inferences.

During the past decade there was a group of scientists that have significantly advanced in descriptions of modern forestry. The best example is V. Onyshchenko, whose researches were used as a data to compare with. Mr. Onyshchenko made substantial amount of articles and resources in geobotany, among which there are monographies from years 2013 and 2011, numerated [3] and [4] respectively.

To advance further in the applied Math in Biology, the article [5] was used. Despite the fact that the Jaccard coefficient was found many years ago, it still has wide variety of possible appliances nowadays. One of them is evaluating the similarity between geobotanical descriptions, which was applied in this work.

Also, to visualise the difference between vertical forest layers and age of trees, the source [6] was used. It is one of possible ways to determine age depending on the height of the tree, in the forests with certain indexes.

The inventory of forest resources is an important component for a general understanding of modern ecological trends. This study provides the key parameters of forest vegetation in July 2024, allowing for a comparison with the corresponding indicators of forests in the same latitude and climate ten years later to draw conclusions about the changes that have occurred. Over the past 13 years, three studies have been conducted in Ukraine, and comparison will be made with them.

The aim of the study was to analyze the phytocoenoses in the Concha-Zaspa forestry in the Holosiivskyi district, to inventory them, determine and assess the impact of urbanization on the forests in Kyiv, and to compare the vegetation data in the defined classes of this study with other data.

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2. Materials and Methods

To obtain data for the study, an adapted scheme for geobotanical description was created, which was then used for each site.

For the geobotanical description of the forest phytocoenosis, 10x10 m² plots were selected, but to determine the class of formation and the formation itself, a detailed survey of a larger area, greater than 50x50 m², was conducted. To determine abundance, an adapted Braun-Blanquet [7] abundance scale was used. For areas smaller than 1 m², calculations were made in stages: the first stage involved determining the approximate linear dimensions of the plant using the iPhone Measure app, then the results were multiplied to find the area. Additionally, soil pH was determined using vegetation indicators.

The research was conducted in July 2024 in Kyiv.

The Jaccard method was one of several mathematical methods used. The data was carefully formatted into tables using Excel, and the indicators, presented in Table 4 and Table 5, were calculated.

To determine the vertical distribution of plants in the phytocoenosis, a stratification approach was used [8], and for a more general characterization of the forest, conventional notations were applied.

Stages of Analysis:

1. Prepare geobotanical descriptions.
2. Analyze data on projective cover (PC).
3. Analyze vitality and distribution.
4. Determine the similarity of sites using the Jaccard formula.
5. Group phytocoenoses into complexes to determine the classification of the forest zones.

3. Results and Discussion

The research was conducted in the Holosiivskyi district in two adjacent areas: Holosiivskyi Forest and the Concha-Zaspa forestry. The main method for data collection was the geobotanical description of phytocoenoses in selected plots. Research fieldwork was carried out from July 11, 2024, to July 31, 2024. In total, over 1.5 hectares of forest vegetation were analyzed for geobotanical descriptions and on the surrounding areas to identify plant representatives within a radius of approximately 15 metres from the centre of the study plot.

Ten plots were randomly selected to capture the maximum diversity of plants in the Concha-Zaspa forestry in the Holosiivskyi district, in order to provide representative data for the inventory of flora representatives in the area (Fig. 1).

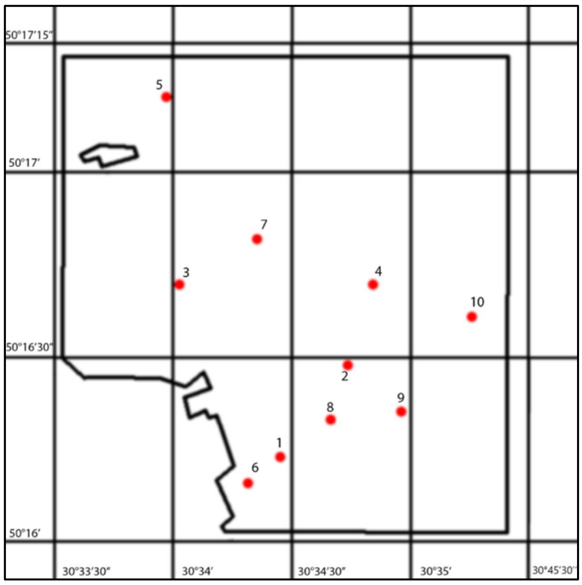

Fig. 1. Map of descriptions

Vegetation, data on projective cover and frequency of occurrence were analyzed for each plot, as shown in Table 1.

Additionally, the vitality of each species was compared using the legend, as shown in Table 3. Vitality (VT) was described on the dates of data collection and on the final day of research, July 31 to confirm the data. Species distribution was determined in the manner, indicated in Table 1. The placement of vegetation was observed and processed using the legend, shown in Table 2. This allowed to estimate and group up the species and to give more data regarding the composition of analyzed quadrants.

Table 1

Abundance of Species and the Species Frequency of Occurrence

Species	1	2	3	4	5	6	7	8	9	10	SF, %
1	2	3	4	5	6	7	8	9	10	11	12
Pinus silvestris E3/E2	9	75	80	5	50	3	3	–	3	12	90
Quercus roburE3/E2/E1	6	35	65	8	8	23	32	17	9	0,3	100
Acer platanoides E3/E2	–	10	20	–	–	–	–	–	–	–	20
Acer tataricum E3/E2/E1	3	20	15	5	0,5	2	1	4	–	14	90
Acer saccharinum E3/E2	–	5	–	–	–	–	–	–	–	–	10
Populus tremula L. E2	0,7	–	–	–	–	–	–	–	–	–	10
Betula pendula E3	–	15		10	–	12	–	3	–	30	50
Melampyrum pratense E1	3	0,8	0,2	0,4	–	10	6	0,5	8	0,7	90

Continuation of Table 1

1	2	3	4	5	6	7	8	9	10	11	12
Peucedanum oreoselinum E2/E1	–	–	–	0,3	–	0,3	0,3	0,1	0,2	5	60
Asparagus tenuifolius E1	–	–	–	1	–	0,1	0,1	2	0,1	0,1	60
Amelanchier spicata E1	0,8	–	–	0,1	–	–	–	0,2	–	–	30
Silene vulgaris E1/E0	0,4	–	–	0,7	0,3	–	–	1	0,3	0,3	60
Achillea oxyloba E1	–	–	–	0,2	–	1	–	5	0,1	2	50
Molinia caerulea E1	5	12	10	15	1	40	8	9	1	7	100
Euphorbia cyparissias E1	0,3	–	0,2	1	–	0,2	0,4	0,9	3	0,5	80
Solidago virgaurea E1	–	0,2	–	0,3	–	–	0,3	1	–	1	50
Polygonatum odoratum E1	–	0,4	–	1	0,9	0,1	5	7	–	–	60
Festuca rubra E1	–	–	20	–	–	–	9	4	–	18	40
Berberis vulgaris E2/E1	–	–	–	–	2	–	0,4	–	–	–	20
Prunus serotina E3/E2	3	20		8	–	–	–	–	20	–	40
Convallaria majalis E1	1	5	3	1	3	8	15	–	70	6	90
Caragana aborescens E2	–	–	30	–	–	–	–	–	–	–	10
Sorbus aucuparia L E2	1	20	–	–	–	9	–	–	3	1	50
Euphorbia E1	–	–	–	–	–	–	–	–	0,1	0,2	20
Silene nutans E1/E0	0,5	–	–	0,5	–	–	1	–	5	1	50
Crataegus curvisepala E2	1	3	–	–	–	–	–	–	–	–	20
Rubus saxatilis E1	–	–	–	1	–	–	–	–	–	–	10
Polygonum hydropiper E1	0,5	3	–	–	–	–	–	–	–	–	20
Juglans regia E2	–	–	–	–	–	–	–	–	–	3	10
Chamaecytisus E2	–	–	–	–	–	–	–	2	4	2	30
Lolium pratense E1	–	8	–	7	3	5	–	12	16	–	60
Lysimachia vulgaris L. E1	–	–	–	–	–	15	–	–	8	–	20
Rosa canina L. E2	–	–	–	–	–	–	0,5	–	–	–	10
Urtica dioica E1	–	–	–	–	0,2	–	–	–	–	–	10
Pteridium aquilinum (L.) Kuhn E1	–	–	–	–	–	0,7	–	–	–	3	20
Pteridium pinetorumE1	–	–	–	–	–	–	–	–	–	1	10
Dryopterix filix–mas E1	1	–	–	–	–	–	–	–	–	–	10
Anthericum ramosum E1	–	–	–	–	–	–	2	–	–	–	10
Ulmus laevis E2	–	–	–	–	–	0,3	–	–	–	–	10
Frángula álnus E2/E1	–	–	–	–	–	0,2	–	–	–	–	10
Pyrus communis E2	–	–	–	–	–	0,4	–	–	–	–	10
Teucrium chamaedrys L. E1	–	0,8	0,3	–	0,3	–	–	–	–	–	30
Impatiens parviflora E1	–	–	–	–	0,2	–	–	–	–	–	10
Ptelea trifoliata L. E1	2	–	–	–	2	–	–	–	–	–	20
Euonymus verrucosus E2/E1	–	–	5	–	5	–	–	–	–	–	20
Poa nemoralis E1	–	–	–	3	–	2	–	–	–	4	30
Robinia pseudoacacia E2	1	3	–	–	–	–	–	–	–	–	20
Fraxinus excelsior E3	–	5	–	–	–	–	–	–	–	–	10
Rubus caesius E1/E0	–	–	–	2	–	–	–	–	0,3	–	20
Prynus E2	–	–	–	–	–	–	–	0,1	–	–	10
Berberis thunbergii E2	–	–	–	–	–	–	–	–	2	–	10
Physocarpus opulifolius E2	–	–	–	–	–	–	–	–	–	2	10
Prunus padus E2/E1	–	–	–	–	–	8	–	–	–	0,3	20
Euonymus europaeus E2	–	–	3	–	–	–	–	–	–	–	10
Hieracium pilosella L E1	–	–	–	0,4	–	–	–	–	–	0,2	20
Pimpinélla saxífraga E2/E1	–	–	–	–	–	–	–	–	–	1	10
Corylus avellana L. E3	–	–	–	–	28	–	–	–	–	–	10
Mahonia aquifolium E2	1	–	–	–	–	–	–	–	–	–	10
Polytrichum piliferum E0	–	–	–	–	–	–	–	3	–	–	10
Pleurozium schreberi E0	1	4	–	0,3	0,6	–	–	3	0,5	–	60
Pylaisia polyantha E0	–	–	0,7	–	–	–	–	–	–	–	10
Lewinskya speciosa E0	–	–	0,2	–	–	–	–	–	–	–	10
Dicranum polysetum E0	0,2	–	0,7	–	–	–	–	–	–	–	20
Platygyrium repens E0	–	–	–	1	–	4	0,5	–	–	–	30
Aulacomnium androgynum E0	–	–	–	–	1	–	–	–	0,5	1	30
Ceratodon purpureus E0	–	–	–	–	–	3	–	–	–	0,7	20
Nasella tenuissima E0	–	–	–	–	4	2	–	–	–	8	30
Petrosedum E0	–	–	–	–	–	–	–	–	–	0,2	10

Additionally, the vitality of each species was compared using the legend, as shown in Table 3. Vitality (VT) was described on the dates of data collection and on the final day of research, July 31 to confirm the data. Species distribution was determined in the manner, indicated in Table 1. The placement of vegetation was observed and processed using the legend, shown in Table 2. This allowed to estimate and group up the species and to give more data regarding the composition of analyzed quadrants.

Table 2

Conventional notations of placements.

Legend	Meaning
u	Singly
gm	a group or a single patch
ga	groups or multiple patches
d	Diffusely
mc	Microcoenosis

Table 3

The Placement of Species and the Vitality of Species

Species	1	2	3	4	5	6	7	8	9	10	VT
1	2	3	4	5	6	7	8	9	10	11	12
Pinus sylvestris	u	u	u	U	u	u	u	-	u	u	3a
Quercus robur	u	u	gm	U	u	u	u	u	u	u	3
Acer platanoides	–	u	gm	–	–	–	–	–	–	–	3
Acer tataricum	u	u	gm	U	u	u	u	u	–	ga	3
Acer saccharinum	–	u	–	–	–	–	–	–	–	–	3
Populus tremula L.	u	–	–	–	–	–	–	–	–	–	2
Betula pendula	–	u	–	U	–	u	–	u	–	u	3
Melampyrum pratense	ga	u	u	U	–	d	ga	ga	ga	gm	3
Peucedanum oreoselinum	–	–	–	u	–	u	u	u	u	ga	3a
Asparagus tenuifolius	–	–	–	gm	–	u	u	gm	u	u	2
Amelanchier spicata	u	–	–	u	–	–	–	u	–	–	3
Silene vulgaris	u	–	–	gm	u	–	–	gm	u	u	3a
Achillea oxyloba	–	–	–	u	–	gm	–	d	u	d	2
Molinia caerulea	gm	mc	gm	d	gm	mc	d	d	gm	d	3
Euphorbia cyparissias	u	–	u	u	–	u	u	u	gm	u	2
Solidago virgaurea	–	u	–	u	–	–	u	u	–	d	3a
Polygonatum odoratum	–	u	–	gm	gm	u	gm	mc	–	–	3a
Festuca rubra	–	–	mc	–	–	–	ga	d	–	mc	3a
Berberis vulgaris	–	–	–	–	u	–	u	–	–	–	3a
Prunus serotina	u	gm	–	gm	–	–	–	–	gm	–	3
Convallaria majalis	gm	gm	gm	gm	gm	mc	gm	–	mc	gm	3a
Caragana aborescens	–		ga	–	–	–	–	–	–	–	3
Sorbus aucuparia L	gm	gm	–	–	–	gm	–	–	gm	u	3a
Euphorbia	–	–	–	–	–	–	–	–	u	u	2
Silene nutans	u	–	–	u	–	–	gm	–	gm	u	3a
Crataegus curvisepala	u	u	–	–	–	–	–	–	–	–	2
Rubus saxatilis	–	–	–	gm	–	–	–	–	–	–	2
Polygonum hydropiper	u	d	–	–	–	–	–	–	–	–	3a
Juglans regia	–	–	–	–	–	–	–	–	–	u	3a
Chamaecytisus	–	–	–	–	–	–	–	gm	gm	u	2
Lolium pratense	–	d	–	ga	gm	gm	–	mc	ga	–	2
Lysimachia vulgaris L.	–	–	–	–	–	d	–	–	gm	–	2
Rosa canina L.	–	–	–	–	–	–	u	–	–	–	1
Urtica dioica	–	–	–	–	u	–	–	–	–	–	2
Pteridium aquilinum (L.) Kuhn	–	–	–	–	–	u	–	–	–	u	3a
Pteridium pinetorum	–	–	–	–	–	–	–	–	–	u	3
Dryopterix filix-mas	u	–	–	–	–	–	–	–	–	–	3
Anthericum ramosum	–	–	–	–	–	–	gm	–	–	–	2
Ulmus laevis	–	–	–	–	–	u	–	–	–	–	3a
Frángula álnus	–	–	–	–	–	u	–	–	–	–	2
Pyrus communis	–	–	–	–	–	u	–	–	–	–	3a
Teucrium chamaedrys L.	–	u	u	–	u	–	–	–	–	–	1
Impatiens parviflora	–	–	–	–	u	–	–	–	–	–	1
Ptelea trifoliata L.	u	–	–	–	u	–	–	–	–	–	3
Euonymus verrucosus	–	–	u	–	u	–	–	–	–	–	2
Poa nemoralis	–	–	–	d	–	d	–	–	–	u	3a

Continuation of Table 3

1	2	3	4	5	6	7	8	9	10	11	12
Robinia pseudoacacia	u	u	–	–	–	–	–	–	–	–	3a
Fraxinus excelsior	–	u	–	–	–	–	–	–	–	–	2
Rubus caesius	–	–	–	U	–	–	–	–	u	–	1
Prynus	–	–	–	–	–	–	–	u	–	–	2
Berberis thunbergii	–	–	–	–	–	–	–	–	u	–	1
Physocarpus opulifolius	–	–	–	–	–	–	–	–	–	u	2
Prunus padus	–	–	–	–	–	gm	–	–	–	u	3a
Euonymus europaeus	–	–	u	–	–	–	–	–	–	–	2
Hieracium pilosella L	–	–	–	U	–	–	–	–	–	u	2
Pimpinélla saxífraga	–	–	–	–	–	–	–	–	–	u	2
Corylus avellana L.	–	–	–	–	u	–	–	–	–	–	3
Mahonia aquifolium	u	–	–	–	–	–	–	–	–	–	3a
Polytrichum piliferum	–	–	–	–	–	–	–	gm	–	–	1
Pleurozium schreberi	gm	d	–	Gm	gm	–	–	gm	gm	–	2
Pylaisia polyantha	–	–	gm	–	–	–	–	–	–	–	3
Lewinskya speciosa	–	–	gm	–	–	–	–	–	–	–	3a
Dicranum polysetum	gm	–	gm	–	–	–	–	–	–	–	3
Platygyrium repens	–	–	–	Ga	–	ga	gm	–	–	–	3
Aulacomnium androgynum	–	–	–	–	gm	–	–	–	gm	gm	3a
Ceratodon purpureus	–	–	–	–	–	gm	–	–	–	ga	3a
Nasella tenuissima	–	–	–	–	gm	ga	–	–	–	mc	3
Petrosedum	–	–	–	–	–	–	–	–	–	gm	3

In Table 1, an adapted species scale with precise determination of projective cover was used. The symbol "–" in Table 1 and Table 3 indicates that the species was absent in the analyzed plot.

During the survey of the plots, representatives of the Gymnosperms and Angiosperms phyla were encountered, as well as non-vascular plants, most commonly *Pleurozium schreberi* and *Platygyrium repens*. Additionally, fern species, such as *Dryopteris filix-mas*, *Pteridium pinetorum*, and *Pteridium aquilinum (L.) Kuhn*, were observed. A large number of herbs dominant in the E1 layer were also identified, such as *Molinia caerulea*, which was found in every analyzed plot. In the plots with the highest occurrence and average projective cover, *Molinia caerulea* is present, sometimes forming microcenoses. The dominance of this plant is possible due to vegetative reproduction, forming clonal nests [9]. A similar reproductive method is observed in *Festuca rubra*, sometimes forming plant clones with a diameter of up to 0.8 m.

Co-dominance of *Quercus robur* and either *Betula pendula* or *Pinus sylvestris* was primarily documented, which is characteristic of the defined classes in this area. Numerous *Betula pendula* formations were found in the west, with occasional co-dominance with *Pinus sylvestris*, while moving south and northwest, *Quercus robur* became the dominant species, frequently co-dominating with *Pinus sylvestris*.

Table 4

General characteristics of territories QF – class Querco-Fagatea, VP – class Vacinio-Piceatea.

Class of formation	QF	VP	VP	QF	VP
Description No.	1	2	3	4	5
Formation	Pineta (sylvetstris)	Pineta (sylvetstris)	Pineta (sylvetstris)	Querceta (robur)	Coryleta (avellana)
Soil pH	neutral	acidic	neutral	neutral	acidic
Ground surface	flattened	flattened	flattened	cliffy	hilly
Soil hardness	dense	dense	dense	soft	dense
Comp. of the tree strand	2P/3Q	1P/1Pr/1Q	7P/2Q/2Ca/1R	4B/2P/2Q	4P/1Q

Class of formation	QF	QF	QF	QF	QF
Report No.	6	7	8	9	10
Formation	Betuleta (pendula)	Querceta (robur)	Betuleta (pendula)	Querceta (robur)	Betuleta (pendula)
Soil pH	acidic	neutral	acidic	alcaline	neutral
Ground surface	flattened	flattened	hilly	flattened	hilly
Soil hardness	soft	soft	soft	dense	soft
Comp. of the tree strand	3Q/2B	4Q/3P	2Q/1B	3Q/1P	7B/2P

In the E1 layer, frequent sub-dominance was observed, and in description 9, even the dominance of *Convallaria majalis* with a vitality score of 3a was noted. Periodic formation of microcenoses on the described plots was also recorded. In some adjacent areas, microcenoses of *Convallaria majalis* covering over 200 m² were observed, which may be explained by the plant's shade tolerance and vegetative reproduction [10].

The plant formations were distributed relatively equally (3 – Pineta (sylvestris), 3 – Betuleta (pendula), 3 – Querceta (robur)), as seen in Table 3. In the main tree stands, *Quercus robur* predominates, leading to the conclusion that the number of sub-associations of *Quercus robur* would increase with the analysis of additional plots. Acidic soils are prevalent, as indicated by the dominance of *Molinia caerulea* [1] and several mosses species. *Acer tataricum* strongly competes for dominance in the E1 and E2 layer as a result of its root system [2], achieving this with a frequency of 90 %.

Human impact includes the direct creation of trails through the forest, which leads to the emergence of sub-dominance of edaphic plant species in the forests (*Poa nemoralis*).

The obtained data should also be compared with data from 2013 in similar formations a few kilometres north of the area, analyzed in this study. Comparing the projective cover (PC) in Fig. 2, 3, and 4 with the 2024 data in Table 1, the difference in the PC of *Acer platanoides* is visible to the naked eye. This may be a direct result of the dominance of *Quercus robur* and its ecological interactions with other plants (amensalism) due to the intertwining of root systems.

Ch Querco-Fagetea				
Acer campestre	.	+	+	.
Acer platanoides	2	+	2	+
Aegopodium podagraria	.	1	.	.
Brachypodium sylvatica	.	+	+	.
Carpinus betulus	+	+	3	.
Cerasus avium	.	+	.	.
Euonymus europaea	+	+	+	+
Euonymus verrucosa	+	.	.	+
Fraxinus excelsior	+	+	+	.
Poa nemoralis	.	.	+	.

Fig. 2. Description of past years (2011) [7]

The geobotanical descriptions indicate that, as according to Alekseev-Pohrebnyak [11], the analyzed forest is classified as a Class 1 forest, evidenced by the numerous formations of the plants *Betula pendula*, *Quercus robur*, *Pinus sylvestris*, and *Prunus padus*. Due to urbanization, a small number of species have been introduced, including *Pyrus communis* and *Rosa canina L.*, which are not typical representatives of the flora of the respective phytocoenosis classes in this forest. Additionally, it is worth noting a more significant PC for *Euonymus verrucosus* compared to previous years. There is also a noticeable difference in the occurrence of *Fraxinus excelsior* (decrease), which is a typical edaphic indicator in the plots, analyzed in the study.

This decrease may be due to competitive pressure from pines and oaks.

Ch Querco-Fagetea												
Acer campestre	.	2	.	1	+	.	2	+	+	.	1	+
Acer platanoides	.	+	3	+	+	.	.	+	+	.	.	.
Aegopodium podagraria	3	2	3	5	.	+	+	+	+	.	.	.
Brachypodium sylvatica	.	.	.	.	.	.	.	.	+	.	.	.
Corylus avellana	.	.	2	.	.	.	.	2	1	.	.	.
Euonymus europaea	+	+	.	.	+	.	+	+	+	+	.	.
Fraxinus excelsior	+	.	.	.	.	+	+	1	.	.	.	.

Fig. 3. Description of past years (2013) [4]

Ch Querco-Fagetea																								
Acer platanoides	.	+	+	+	+	+	+	58	+	+	3	+	+	+	+	.	10	+	.	42	3	+	2	1
Aegopodium podagraria	.	.	.	.	10	.	.	.	.	.	.	.	.	.	.	.	.	20	.	.	.	+	.	1
Brachypodium sylvatica	.	.	.	+	.	.	.	.	+	.	+	.	.	.	.	.	.	+	.	.	.	+	.	.
Corylus avellana	5	+	6	2	5	+	5	6	.	1	15	.	3	+	1	+	+	27	12	1	2	18	10	15
Euonymus europaea	+	13	+	+	+	.	+	+	+	2	+	3	1	+	+	.	+	+	+	.	+	+	+	+
Euonymus verrucosa	.	.	.	+	.	+	+	.	4	.	+	.	.	.	+	+	.	.	+	.	.	+	.	.
Fraxinus excelsior	.	+	+	+	.	+	+	.	+	+	+	.	.	15	.	.	+	.	+	.	+	+	.	+
Lilium martagon	.	.	.	.	.	+	.	.	.	.	.	.	.	1	.	+	.	+	+	.	.	.	.	.
Neottia nidus-avis	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Quercus robur	75	45	50	12	36	50	.	30	50	50	39	49	55	8	+	45	55	22	40	20	30	15	50	35

Fig. 4. Description of past years (2013) [4]

Table 5

Similarities of regions by K_J in QF class.

Report No.	1	4	6	7	8	9	10
1	100 %	36 %	22 %	27 %	25 %	35 %	24 %
4		100 %	45 %	46 %	54 %	50 %	42 %
6			100 %	37 %	34 %	36 %	46 %
7				100 %	38 %	31 %	34 %
8					100 %	38 %	36 %
9						100 %	42 %
10							100 %

To compare the phytocoenoses of common classes with each other, the Jaccard coefficient K_J [5], was calculated to determine the similarity between sets using Formula 1, where **a** is the total number of species in the first area, **b** is the total number of species in the second area, and **c** is the number of shared species.

$$K_J = \frac{c}{a+b-c} \qquad (1)$$

if $K_J \geq 50$ % – high similarity, 50 % < $K_J \leq 40$ % – moderate similarity, 40 % ≤ $K_J < 32$ % – sufficient similarity, and $K_J \leq 32$ % low similarity.

Table 6

Similarities of regions by K_J in QF class

Report No.	2	3	5
2	100 %	38 %	31 %
3		100 %	26 %
5			100 %

In working with the data in Table 5, pairwise comparisons of Jaccard coefficients for the phytocoenoses were conducted, and, based on this, conclusions were made regarding whether or not they should be classified into the phytocoenosis complex, as shown in Fig. 5. High similarity was observed in quadrants 4, 8, 9, and 10, and moderate or sufficient similarity was noted among other representatives of the QF class. Descriptions 1, 4, 5, 7, 8, 9, and 10 were grouped into one phytocoenosis complex.

Similar actions were taken for Table 6. The reason for the low K_J may be the large distance between the areas, described in 2, 3, and 5. Pairwise comparisons revealed sufficient similarity in only one pair (2 and 3), allowing them to be classified into one phytocoenosis complex.

Based on the data in Table 5 and Table 6, an adapted version of Kulchynskyi's graph for species[12] composition similarity was created, reformatted into a graph of the degrees of similarity among phytocoenoses. This figure visualizes the similarity of phytocoenoses within the same classes: Vacinio-Piceatea (VP) and Querco-Fagetea (QF).

Limitations of the study. In spite of the fact that most of the information was processed using computer programs, there are a few limitations regarding the observation of this data. Firstly, despite the fact that the projective cover was estimated using advanced measuring devices, the PC of big curved areas, for example big trees, were made by counting the area of a respective rectangle covering approximately the same area. Additionally, the height of the trees was not exact, as it was estimated using the simplest measuring methods. Furthermore, there might be some inaccuracies regarding the distribution and the placement of species, regarding the estimation of single and vegetation located in groups.

Prospects for further research. Among the ways to conduct further research, is the work on a data regarding projective cover. Future researches might show the changes in the analyzed aspect, consequently stating the influence of urbanization. There is also a need for inventory of the vegetation, in order to determine endangered species in the forestry.

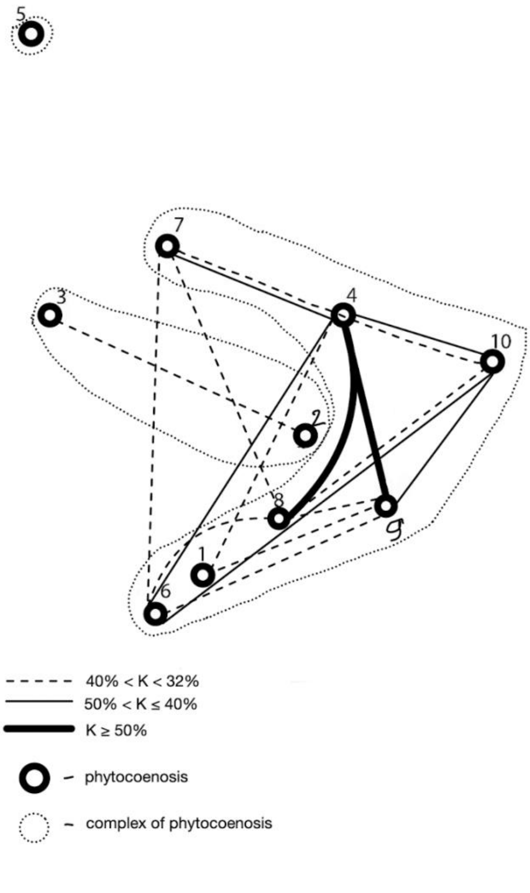

Fig. 5. Kulchynskyi graph of similarities

4. Conclusions

The analysis of the plots indicates that the Concha-Zaspa forestry has very high species diversity and is minimally impacted by urbanization. The dominant *Quercus robur* suppresses the typical representatives of the Querco-Fagetea class while hindering the spread of the Vacinio-Piceatea class, although *Pinus sylvestris* often plays a role as a sub-dominator. Notably, *Quercus alba*, a species introduced from North America, was not encountered in the analyzed area, leading to the conclusion that the species composition of edaphic indicators remains typical for the temperate latitudes of central Ukraine.

The application of Kulchynskyi's similarity graph reveals that, from the north to the southeast, the Querco-Fagetea class with broadleaf areas is predominantly spread, while the Vacinio-Piceatea class formations are found to the northwest. This work will help to establish changes in the impact of urbanization over time and subsequent generations will have access to data on distribution and vitality in phytocoenoses for comparison with the results of this study in the future.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results, presented in this article.

Funding

The study was performed without financial support.

Data availability

The manuscript has no associated data.

Acknowledgments

I want to express special thanks to Anna Shagurova, who was the first to introduce to me the ideas of Geobotany and sustained my interest; to Andy Thompson, who has helped me and taught to write in the scientific style, and to Arsen Nosenko, who assisted me with the creation of a map.

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the current work.

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Received date 16.05.2024
Accepted date 20.06.2024
Published date 30.06.2024

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