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ASPECTS OF FUNCTIONAL LAND BASE PLANNING OF THE NULES BOTANICAL GARDEN OF UKRAINE

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We examined the ranges of differentiation of Ukraine's botanical gardens in relation to their purpose. We conducted functional zoning analysis for Ukraine's and some world's botanical gardens. Based on results of this analysis we provide recommendations for the optimization of functional land base planning of the NULES botanical garden of Ukraine.

Botanical garden, functional zoning, nature reserves of Ukraine, protected area.

According to the current legislation of Ukraine, botanical gardens are allocated to artificially created multifunctional entities within nature reserve territories of Ukraine [6]. The main objective of the functional zoning of botanical gardens is to ensure they serve the nature protection, scientific and educational functions. Based on the principles of balanced distribution of functional zones and separate components, botanical gardens should strengthen the spatial and composite expressiveness of the environment and preserve landscapes and natural integrity of the territory [12]. Botanical gardens belong to a group of limited-use or special-purpose entities with limited access.

The majority of botanical gardens of Europe, including Ukraine, arose spontaneously, without any preliminary design of their architectural and land base structure. That fact is reflected in current lay out as well as in general artistic and aesthetic look [12]. Therefore, design and construction of botanical gardens according to previously developed plan based on consideration of specific botanical and structural requirements nowadays are quite relevant.

The research objectives were to identify various types of botanical gardens of Ukraine depending on their purpose, and to analyze the functional zoning of botanical gardens' territory with the goal to improve the optimization of functional land base planning of the NULES botanical garden of Ukraine.

Materials and research methods. Differentiation of botanical gardens of Ukraine was carried out based on tasks they perform and according to a developed classification [11]. Functional zoning of botanical gardens is an obligatory part of all projects dealing with the regulation of such entities. Land protection and use in botanical gardens of Ukraine is done according to the law “About natural reserves of Ukraine”, article 32, “Land base structure and the main requirements for botanical gardens operation”. To provide a necessary mode of protection and effective use with accordance to aforementioned law, land base of botanical gardens of Ukraine is subdivided into four zones, namely reserved, scientific, -economic-administrative and demonstrative [6, 11]. For example, eco-trail in the NULES botanical garden of Ukraine was designed according to "Design methods of ecological trails in the garden" manual [9].

Research results. Botanical gardens of the world could be divided into 12 main types [11]. Currently in Ukraine there are 18 botanical gardens with varying functions [7]. Based on classification, among these 18 botanical gardens we identified three "classic" multi-purpose botanical gardens, two ornamental gardens, three historical gardens, two botanical gardens specializing strictly in plant protection, 11 university gardens, one garden combining both botanical and the zoological functions, one agro-botanical garden and a bank of the germinal plasma, two alpine or mountain gardens, three natural or "wild” gardens, two thematic gardens, and one public garden (fig. 1).

Because aforementioned classification does not perfectly fit the domestic functional allocation of botanic gardens, 8 gardens could be simultaneously placed into several categories (tab. 1).

Gardens design analysis showed that the majority of domestic botanical gardens had no concrete designs. The gardens were created in place of tree nurseries or arboretums. For example, botanical garden of the National forest engineering university of Ukraine was based on already existing tree nursery and local arboretum. Botanical garden of Uzhgorod University was organized in place of an old fruit and nut garden. Botanical garden of the department of pharmacognosy and botany of the

Lviv national medical university carrying the name of Daniil Galitsky and NULES botanical garden of Ukraine both were based on local plant nurseries.

1 . Botanical gardens belonging to several categories

№	Name of botanical garden
1.	N. N. Grishko National botanical garden of National Academy of Sciences (NAS) of Ukraine
2.	Academician O. V. Fomin botanical garden of Taras Shevchenko National University of Kyiv
3.	Botanical garden of Taurida National V.I. Vernadsky University
4.	Nikitsky botanical garden - the National science center of National Agrarian Academy of Sciences (NAAS) of Ukraine
5.	Botanical garden of Sumy State A.S. Makarenko Pedagogical University
6.	Botanical garden of Uzhgorod National University
7.	Botanical garden of I. Franko National University of Lviv
8.	Donetsk botanical garden of NAS of Ukraine

Botanical gardens which were developed following exact stage-by-stage construction program include: Donetsk botanical garden of NAS of Ukraine, N. N. Grishko National botanical garden of NAS of Ukraine, academician A.V. Fomin botanical garden of Taras Shevchenko National University of Kyiv (NUK), Kremenets botanical garden of Ministry of ecology and natural resources of Ukraine, Kryvyi Rih botanical garden of NAS of Ukraine, botanical garden of Taurida National V.I. Vernadsky University, Nikitsky botanical garden - National science center of the NAAS of Ukraine, etc.

We analyzed the functional zoning of the world's two botanical gardens (New York botanical garden [1, 12], and Tsytsin main botanical garden of Russian Academy of Sciences (RAS) [4, 12]) and two botanical gardens of Ukraine (N. N. Grishko National botanical garden of NAS of Ukraine [10, 12] and academician A. V. Fomin National botanical garden of Taras Shevchenko NUK [2, 12]). The results of the research showed that all four gardens contain four functional zones as was anticipated by the legislation. Functional zoning is important for the development of NULES botanical garden of Ukraine. Demonstrative, scientific, and economic-administrative zones were created at the initial stages of garden creation. It was necessary to create reserved zone to fulfill the requirements of current legislation.

In taxonomical aspect, reserved zone should capture sites with species highly

valued under biodiversity framework. These species are on so-called red lists (The European Red list of animals and plants which are under the threat of disappearance on a global scale; Red list of the International Union for Conservation of Nature (IUCN); Red list of Ukraine), Green book of Ukraine, as well as in conventions and international agreements.

Of a particular interest are plants growing within the boundaries of NULES botanical garden of Ukraine: two species of old-growth trees (*Juglans regia* L. and *Quercus castaneifolia* C.A.M.), 76 species from the IUCN Red list, two species from the European Red list (*Picea omorica* (Pane.) Purkyne and *Pyrus selicifolia* Pall.), and seven species from the Red List of Ukraine (*Larix polonica* Racib., *Pinus cembra* L., *Taxus boccata* L., *Syringa josikaea* Jacq., *Quercus cerris* L., *Rhododendron kotschyi* Simonk., and *Staphylea pinnata* L.) [3, 5, 8].

For the purpose of setting up the reserved zone we analyzed taxonomic structure of the species of woody plants which are on European Red list of plants, Red List of IUCN and Red List of Ukraine. Based on this analysis, we proposed to allocate for the reserved zone an area of approximately 15% of the total garden land base. Reserved zone will be placed in remote section of the garden, away from expositions and garden entrances, and outside popular visitors' routes. Such a placement will allow cultivating rare species of plants in the conditions of low anthropogenic pressure. The allocated area will include parcels 53, 56, 58.

The allocated area also encompasses the remnants of the oak grove affected slightly by anthropogenic factors. This oak grove contains individual old-growth oaks and rare species of woody plants (fig. 1).

In modern practice of landscape design, based on the type of use, the following functional sub-zones could be identified within the demonstrative zone: the cultural-educational, the sports, the children's, the walking, and the others [9].

The specifics of NULES botanical garden of Ukraine require conditional creation inside the demonstrative zone of the cultural-educational sub-zone. This sub-zone will contain the proposed eco-trail route.

We recommend creating a complex by the objectives and inter-landscape by the extent informative-educational eco-trail. It will combine all main objectives and

goals of various types of eco-trails (nature protection, informative, educational, health-improving, recreational, etc.).

2 . Taxonomic structure of species of woody plants inside the reserved zone of NULES botanical garden of Ukraine

№	Family	Genus	Species
		Division *Pinophyta*	
1.	*Pinaceae* Lindl.	*Larix* Mill.	*Larix decidua* Mill.
2.			*Larix polonica* Racib.
3.		*Picea* Diet.	*Picea pungens* Engelm.
4.		*Pinus* L.	*Pinus peuce* Griseb
5.			*Pinus strobus* L.
6.	*Cupressaceae Gray.*	*Thuja* L.	*Thuja plicata* D. Don
7.		*Platycladus* L.	*Platycladus orientalis* (L.) Franco
		Division *Magnoliophyta*	
8.	*Juglandaceae* DC ex Perleb	*Juglans* L.	*Juglans regia L.*

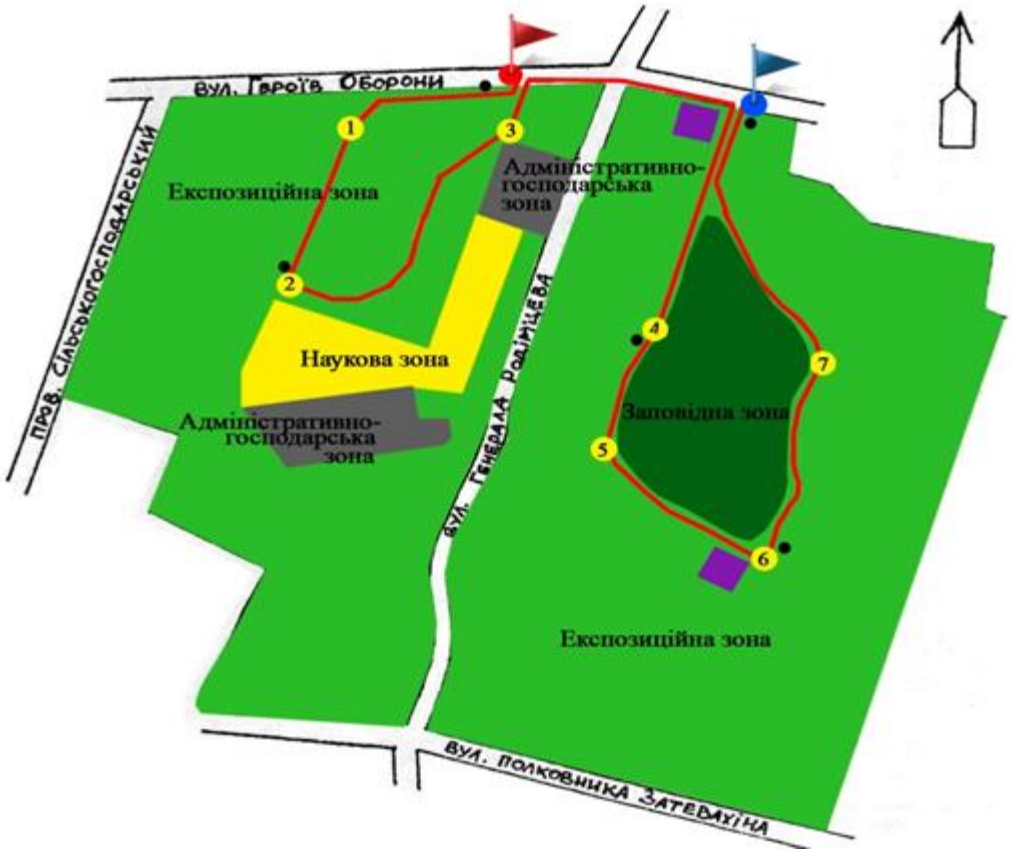
The length of this trail will be 2 km (fig. 1). Expected hiking time will be 1-1.5 hours. The trail will be intended for relatively short hikes and could be used for educational purposes in various disciplines such as dendrology, parks and recreation studies, nature conservation studies and others.

The trail route was selected based on – recreational-aesthetic and informational criteria (presence of giant trees and of landscapes of exclusive beauty). Into the account were also taken the seasonally attractive areas and natural features of the garden's territory. The trail will be easily accessible by visitors. It is located in the proximity of public transportation routes and private car parking spots. The trail was designed to bypass areas with rare plants, and avoids crossing the natural boundaries which are easily damaged and require long time to restore.

Naturally occurring landscapes along the eco-trail, in our opinion, are attractive to visitors. They amaze with species variety, beauty and exclusivity. Closed and open spaces alternate with each other. Besides natural the trail route also goes through anthropogenic landscapes. The purpose of such route planning was to show the visitors the negative effects on the environment of unrestricted human activitiest. Old burns were not covered up or regenerated on purpose to show the amount of time necessary for nature to heal its wounds.

According to eco-trail construction methods [9], we recommend creating rest spots every 500 m, whereas utilizing parcels 50 and 60 for construction of rest areas

by first cleaning the clutter and then establishing benches, trash cans, and other small architectural forms. The route will include 7 stations:



Legend:

trailhead (beginning of route)

trail's end (end of route)

eco-trail

main educational stations

information boards

rest areas

Fig. 1. Improved functional zoning distribution of NULES botanical garden of Ukraine

Station 1. Coniferous site represented by specimens of genera *Abies* Mill., *Larix* Mill., *Picea* Diet, and *Pinus* L., and *Taxus* L.

Station 2. Mixed group of woody plants. Coniferous trees (*Pinus densiflora* Siebold et Zucc., *Thujopsis dolabrata* Siebold et Zucc., *Abies holophylla* Maxim., *Abies sibirica* Ledeb., *Abies concolor* (Gordon et Glend.) Hildebr., *Pinus contorta* Douglas, and *Pinus scopulorum* Lemmon, and *Juniperus sabina* L.) here mix

perfectly with deciduous trees (*Ginkgo biloba* L., *Cercidiphyllum japonicum* Siebold et Zucc., and *Malus niedzwetzkyana* Dieck.).

Station 3. Rest stop under the majestic walnut tree.

Station 4. Old-growth oaks. At this station one could observe the majestic old-growth oaks that are over 300 years old and still have healthy appearance and are rather attractive.

Station 5. Fir stand. A 50-60-year old fir stand borders the trail on the right side.

Station 6. Larch stand. At this stop one could admire larch stand consisting of two groups, one of Polish larch (*Larix polonica* Racib.) and second one of European larch (*Larix decidua* Mill.).

Station 7. American sycamore or buttonwood (*Platanus occidentalis*).

The proposed functional planning of the botanical garden's land base is presented in figure 1.

Conclusions. Eleven types of botanical gardens have been identified in Ukraine based on their purpose. Among the botanical gardens of Ukraine there were 16 that had been designed prior to construction and 13 that were created on the basis of tree nurseries, arboretums, orchards, and fruit gardens.

Having analyzed the functional zoning of two world's botanical gardens and two botanical gardens of Ukraine and having carried out the analysis of taxonomical structure of rare woody plants at NULES botanical garden of Ukraine, we recommend to organize reserved zone within the NULES botanical garden boundaries and to create an eco-trail.

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Приведены спектры дифференциации ботанических садов Украины в зависимости от их задач. Проведен анализ функционального зонирования ботанических садов мира и Украины, на основании чего предложено оптимизировать функциональную и планировочную организацию территории ботанического сада НАУ Украины.

Ботанический сад, функциональное зонирование, заповедный фонд Украины, заповедная зона.