UDC 630*27:712.4(477.44-25)
DOI:10.37128/2707-5826-2026-4-8

LANDSCAPE FELLINGS AS AN ELEMENT IN THE FORMATION OF FOREST PARK ECOSYSTEMS IN VINNYTSIA

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Urban forest-park ecosystems are exposed to sustained recreational pressure, soil compaction, mechanical damage, pollution, altered microclimatic conditions, and competition within tree groups. These factors can reduce stand vitality and weaken ecological, recreational, protective, and aesthetic functions, thereby increasing the need for carefully differentiated management. The purpose of this study was to assess the initial structural and sanitary changes associated with selective landscape felling in a forest-park stand in Vinnytsia, Ukraine, and to determine whether the intervention preserved the principal features of the stand. Field investigations were conducted from spring to autumn 2025. Sixteen trees were inventoried before treatment; the principal species were European hornbeam (Carpinus betulus L.) and Scots pine (Pinus sylvestris L.). Landscape felling was performed in April 2025, and a repeated visual assessment was completed approximately six months later. Tree selection considered species, vitality, sanitary condition, stem and crown quality, visible damage, decorative value, competitive position, and the role of each tree as an accent, accompanying, background, or undesirable element of the landscape composition.

Four of the 16 inventoried trees were removed, corresponding to a numerical felling intensity of 25.0%, whereas 12 trees (75.0%) were retained. Complete sanitary-condition records were available for 15 trees: 10 individuals (66.7%) were classified as healthy, three (20.0%) as weakened, and two (13.3%) as diseased. One tree lacked a complete sanitary record and was excluded from the calculation of category proportions. The post-treatment survey documented local opening around the retained trees and reduced crowding without loss of the general forest-park character. The intervention was therefore interpreted as moderate and selective rather than intensive. Because the exact plot area and complete repeated measurements of DBH, height, crown closure, crown dimensions, inter-tree distance, and light conditions were unavailable, stand density per hectare and statistical significance of structural changes were not calculated. Photographs were used only as qualitative supporting evidence.

The results demonstrate the practical value of combining sanitary, biological, decorative, and spatial criteria when planning landscape fellings in urban forest parks. The differentiated approach made it possible to retain most trees while removing individuals whose condition or position reduced the quality of the stand. The findings should be regarded as an initial site-specific assessment rather than evidence of long-term ecological improvement. Further monitoring should be based on permanent sample plots of known area and repeated tree-level measurements of diameter, height, crown parameters, spacing, regeneration, sanitary condition, species composition, and microclimate. Such observations would clarify whether the recorded spatial changes persist and contribute to measurable improvements in tree vitality, biodiversity, recreational quality, and ecological stability.

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Keywords: *urban environment, forest-park stands, landscape felling, sanitary condition, stand structure, recreational plantings, ecological stability.*

Table 1, Fig. 1, Lit. 23.

Statement of the problem. Rapid urbanization and increasing recreational pressure are intensifying the adverse effects on urban and peri-urban forest ecosystems. Soil compaction, fragmentation of vegetation, pollution, mechanical damage to trees, the spread of pests and diseases, and changes in the microclimate can gradually reduce stand vitality, structural diversity, and the capacity of urban forests to provide ecosystem services. Therefore, the development of scientifically substantiated management measures that combine the conservation of biodiversity with recreational and aesthetic functions remains an important task of modern urban forestry.

Analysis of research and publications. Paquette et al. [9] noted that urban forests dominated by a limited number of species are particularly vulnerable to climatic stress, invasive pests, and diseases. The authors proposed increasing functional diversity as a practical approach to reducing the risk of large-scale tree mortality and maintaining the long-term provision of urban ecosystem services. Wang et al. [10] demonstrated that structurally complex forest patches within urban parks can support higher levels of plant, insect, and bird diversity than areas characterized by simplified vegetation. The authors substantiated a zoning-based approach that combines intensive recreational use in some areas with biodiversity-oriented management in ecologically valuable zones.

Rasmussen et al. [11] found that the spatial distribution and amount of urban tree canopy are influenced by the morphological and social characteristics of urban areas. Their research showed that urban forest management should be adapted to the specific development patterns and environmental conditions of individual cities rather than being based solely on generalized canopy-cover targets. Przewoźna et al. [12] emphasized that urban and rural trees differ in the relative importance of the ecosystem services they provide. The authors concluded that tree-protection and management strategies should consider regulating, habitat, cultural, and recreational services rather than focusing exclusively on increasing the total area of tree cover.

Kotze et al. [13] highlighted the essential role of urban forest structure in maintaining invertebrate diversity and associated ecological processes. They noted that vegetation complexity, the availability of different habitat layers, deadwood, litter, and reduced management intensity in selected areas can improve the conservation value of urban green spaces. Wavrek et al. [14] demonstrated that effective conservation management of urban forests requires an integrated assessment of vegetation, soil properties, disturbance factors, and ecological condition. The authors stressed that site-specific ecological data should be used to determine appropriate management interventions and to avoid measures that may adversely affect sensitive components of urban forest ecosystems. McGann et al. [15] investigated climate-adaptive practices used by rural and urban foresters. The authors grouped management measures into resistance, resilience, and transition strategies and emphasized that adaptive forest management should account for local disturbances, climatic risks, management objectives, and the capacity of stands to recover.

Cui et al. [16] established that urban planning decisions and green-space management practices significantly influence plant diversity in cities. Their results indicate that maintaining heterogeneous vegetation structures and applying differentiated management regimes can increase species diversity and improve the ecological quality of urban green spaces.

Recent Ukrainian studies also emphasize the need to assess urban green spaces through measurable ecological indicators and to adapt management to local conditions. Piddubna et al. [1] demonstrated that the condition of soils under urban tree plantations in Vinnytsia is sensitive to management and site factors, while Korohoda [17] proposed indicator-based assessment of biodiversity-related ecosystem services in urban green spaces. These findings reinforce the importance of combining stand-level observations with locally grounded management decisions.

Purpose of the study. The purpose of the study was to assess structural and sanitary changes in a forest-park stand of Vinnytsia following selective landscape felling, quantify the numerical intensity of removal and tree retention, and determine the suitability of this management measure for improving spatial organization while maintaining the recreational and ecological value of the site.

Research material and methods. The research was conducted in a forest park ecosystem in Vinnytsia, Ukraine, during the spring-autumn period of 2025. The investigated stand was dominated by hornbeam (*Carpinus betulus L.*) and Scots pine (*Pinus sylvestris L.*) and was subject to regular recreational and anthropogenic pressure. Landscape fellings were conducted in April 2025, and a repeated field survey was performed approximately six months later. Because the exact surveyed area had not been recorded in the primary field documentation, stand density per hectare was not calculated and no unverified area value was introduced into the analysis.

The field survey included 16 trees. Before the intervention, each tree was inspected visually and characterized according to species, general vitality, stem and crown condition, visible mechanical damage, symptoms of disease or pest damage, decorative value, and spatial role within the stand. Sanitary condition was recorded for 15 of the 16 trees; one tree lacked a complete sanitary record and was excluded from percentage calculations for this indicator. The assessment followed the general principles of tree-condition categorization used in Ukrainian forestry practice, including the categories of tree condition provided in the Sanitary Rules in Forests of Ukraine [23].

Trees considered for removal were evaluated using a differentiated landscape-silvicultural approach. The principal criteria were: (1) stem and crown quality and sanitary condition; (2) biological characteristics of the species; (3) decorative properties; and (4) spatial position in relation to accent, accompanying, and background trees. Trees with pronounced weakening, disease symptoms, poor decorative quality, or an unfavorable competitive position were prioritized for removal, while viable trees with a clear compositional and ecological role were retained.

The numerical intensity of the landscape felling was calculated as the proportion of removed trees relative to the initial number of inventoried trees. Descriptive statistics were used to summarize the distribution of sanitary-condition categories. Since the primary dataset did not contain exact plot area, repeated individual measurements of crown closure, inter-tree distance, DBH and height for all trees before and after treatment, inferential statistical tests and density estimates per hectare were not performed. Therefore, the reported changes were interpreted descriptively and should be regarded as an initial assessment of the stand response six months after intervention.

Research results and their discussion. The initial inventory comprised 16 trees, with hornbeam and Scots pine forming the principal species component of the investigated stand. Landscape felling removed 4 trees; consequently, 12 trees remained after intervention. The numerical intensity of removal was 25.0%, and 75.0% of the initially inventoried trees were retained. This moderate selective intervention was intended to reduce competition and remove low-quality individuals without disrupting the overall forest-park character of the stand.

Sanitary-condition records were complete for 15 trees. Of these, 10 trees were healthy (66.7%), 3 were weakened (20.0%), and 2 were diseased (13.3%). One of the 16 inventoried trees did not have a complete sanitary record and was therefore excluded from percentage calculations. These data indicate that healthy individuals predominated in the stand, while one third of the assessed trees showed some degree of weakening or disease. This distribution justified a differentiated rather than uniform approach to tree selection. The post-felling survey, conducted approximately six months after the April 2025 intervention, confirmed preservation of 12 retained trees and visually documented a more open arrangement around selected trees. The removal of four individuals reduced local crowding and improved light access to retained crowns. However, because crown closure, mean inter-tree distance, and proportions of open and semi-open spaces had not been measured quantitatively before and after treatment, these spatial changes were evaluated qualitatively and were not subjected to statistical testing.

The observed response is consistent with the broader principle that urban forest management should preserve structural heterogeneity while reducing risks associated with declining trees. Paquette et al. [9] emphasized functional diversity as a means of increasing urban-forest resilience, whereas Kotze et al. [13] showed that vegetation complexity and habitat layers are important for urban biodiversity. In the present study, the intervention differed from intensive thinning because 75% of inventoried trees were retained and the objective was selective structural adjustment rather than large-scale canopy reduction.

Wavrek et al. [14] argued that conservation management in urban forests should be based on site-specific vegetation, soil, disturbance, and ecological-condition data. The present results support this approach: the sanitary distribution of the assessed trees and their spatial and decorative roles were used jointly in selecting trees for retention or removal.

At the same time, the absence of a complete tree-level repeated-measures dataset limits the strength of causal conclusions, and the results should be interpreted as a descriptive six-month assessment rather than evidence of statistically significant improvement. Recent indicator-based research likewise stresses the importance of measurable structural characteristics in urban forest management. Jeong and Park [19] showed that availability, accessibility, and connectivity provide complementary information for nature-based urban forest planning, while Korohoda [18] emphasized indicator-based assessment of biodiversity-related ecosystem services in urban green spaces. The results obtained for the Vinnytsia study site (Table 1) provide a basis for further assessment. Future monitoring should therefore include the exact plot area, diameter at breast height (DBH) and height of each tree, crown closure, inter-tree distance, and repeated sanitary condition assessments to enable quantitative evaluation of structural changes.

Table 1

Classification of trees by decorative properties

No.	Tree Category	Symbol	Height	Stem	Crown	Sanitary condition	Location
1	Accent trees	A	≥ H	straight, original shape	well-developed	no signs of weakening	in the center of decorative groups, along walking routes
2	Accompanying trees	C	≤ H	straight	well-developed	no signs of weakening	around accent trees
3	Background trees	B	= H	straight	normally developed	no signs of weakening	in groups, clusters
4	Undesirable (to be removed) trees	U	any	any	any	with signs of weakening, dieback	

Note: *H (height reference) denotes the average height of the dominant or target trees within a given stand or landscape group, which serves as a reference value for the comparative classification of individual trees based on their vertical structure and role in landscape composition.*

Source: *compiled by the authors based on their own research.*

The intensity of landscape felling should be determined by a combination of stand characteristics, including species composition, age structure, sanitary condition, spatial distribution of trees, crown development, and the target landscape structure. These parameters are particularly important in forest park ecosystems, where silvicultural interventions should simultaneously fulfil ecological, sanitary, recreational, and aesthetic functions. Unlike conventional thinning aimed primarily at regulating stand density and timber productivity, landscape felling requires an individual assessment of trees and consideration of their role in the spatial and visual organization of the stand.

In the present study, 16 trees were inventoried before the implementation of landscape felling. The investigated stand was mainly represented by hornbeam (*Carpinus betulus* L.) and pine (*Pinus sylvestris* L.), which formed the principal structural components of the studied forest park area.

Based on the assessment of tree condition and their functional role within the stand, four trees were selected for removal. Thus, the felling intensity amounted to 25.0% of the initially inventoried trees, while 12 trees, corresponding to 75.0% of the initial number, were retained. Such an intervention can be characterized as selective rather than intensive because the majority of trees were preserved and the removal was focused on individuals whose condition or position reduced the sanitary, structural, or aesthetic quality of the stand.

The sanitary assessment provided an additional basis for determining the necessity and intensity of the intervention. Sanitary-condition data were available for 15 of the 16 inventoried trees. Among the assessed individuals, 10 trees (66.7%) were classified as healthy, three trees (20.0%) as weakened, and two trees (13.3%) as diseased. Consequently, one-third of the trees for which sanitary data were available showed some degree of deterioration. This distribution indicates that the investigated stand generally retained a considerable proportion of viable trees, while the presence of weakened and diseased individuals justified the application of selective management measures. The adopted approach therefore prioritized the preservation of healthy trees and limited intervention to those individuals for which removal was considered appropriate from the sanitary and landscape-management perspectives.

The removal of four trees reduced the local number of inventoried individuals without causing a substantial transformation of the overall stand structure. This is particularly important in urban forest park ecosystems, where excessive thinning may lead to undesirable changes in microclimatic conditions, increased exposure of remaining trees to wind and solar radiation, disturbance of the understorey, and a reduction in habitat continuity. A moderate and differentiated intervention makes it possible to preserve the ecological functions of the stand while gradually improving its spatial organization and recreational attractiveness. In this context, the 25.0% removal intensity applied in the investigated area should be interpreted as a site-specific management decision rather than as a universally recommended threshold for landscape felling.

The degree of crown closure is another important factor influencing the selection and intensity of landscape felling. Excessive crown competition may restrict light penetration into the lower canopy layers and reduce the space available for the development of individual crowns. Therefore, selective removal of competing, weakened, diseased, or poorly positioned trees can create more favourable conditions for the retained individuals. Increased availability of growing space and light may promote crown development and improve the visual perception of individual accent and accompanying trees within landscape groups. At the same time, canopy opening should remain controlled because excessive reduction in crown closure may alter the ecological conditions of the forest park stand and negatively affect its protective and recreational functions. In the investigated stand, landscape felling was therefore aimed not at creating extensively open areas but at achieving a more balanced spatial arrangement of the remaining trees. Particular attention was given to maintaining viable individuals of the dominant species and preserving the general continuity of the tree layer.

Following the removal of four selected trees, local openings became visually apparent around the retained individuals. These changes increased the amount of free growing space available to neighbouring trees and reduced local competition. However, because crown closure, inter-tree distances, and light availability were not measured instrumentally before and after the intervention, these changes should be interpreted as qualitative field observations rather than as quantitatively confirmed effects.

The implementation of landscape felling and the condition of the investigated stand after intervention are illustrated in Figure 1. The photographs document the selective removal of individual trees and demonstrate the resulting local opening of the stand. They also provide visual evidence that the intervention preserved the general tree cover while modifying the immediate spatial environment of selected trees. The photographic material is particularly useful for demonstrating the practical character of landscape felling and the difference between selective tree removal and intensive thinning.

Nevertheless, photographic comparison cannot substitute for quantitative measurements of canopy structure. Therefore, the images presented in Figure 1 were used only as qualitative supporting evidence. Exact changes in crown closure, average distance between trees, light availability, or the proportions of closed, semi-open, and open landscape spaces were not measured instrumentally within the available dataset. Consequently, no numerical conclusions regarding these parameters were drawn.

The results obtained demonstrate that landscape felling in the investigated forest park stand was implemented as a controlled and selective management intervention. The removal of 25.0% of the inventoried trees, combined with the retention of 75.0% of individuals, made it possible to preserve the basic stand structure while addressing sanitary and spatial management objectives. The predominance of healthy trees among the assessed individuals (66.7%) further supports the appropriateness of a differentiated approach in which viable trees are retained and management efforts are concentrated on weakened, diseased, or structurally undesirable individuals. Such an approach is consistent with the multifunctional character of urban forest parks, where improvement of sanitary condition should be balanced with the preservation of biodiversity, landscape continuity, recreational value, and the ecological stability of tree stands. At the same time, the results should be interpreted within the limitations of the study. The relatively small number of inventoried trees and the absence of instrumental measurements of crown closure, tree spacing, and light conditions do not allow statistically substantiated conclusions regarding changes in the spatial structure of the entire forest park ecosystem. The obtained data should therefore be considered a site-specific assessment of the immediate effects of selective landscape felling. Further monitoring based on repeated tree inventories and quantitative measurements of canopy parameters would make it possible to determine whether the observed structural changes persist over time and whether they contribute to measurable improvements in tree vitality, stand stability, and recreational quality.

a b

Figure 1. Landscape fellings in the «Podillia» Botanical Garden of Vinnytsia National Agrarian University.

Note: *the photographs demonstrate the selective removal of weakened trees and excessive undergrowth, which contributed to optimizing stand density while preserving the integrity of the forest ecosystem. The visual comparison confirms the structural changes identified during the field inventory and illustrates the effectiveness of landscape fellings as a management measure for improving the sanitary condition and ecological stability of urban forest stands.*

Source: *compiled by the authors based on their own research.*

Conclusions. The study assessed the initial structural and sanitary effects of landscape felling in a forest park stand in Vinnytsia during 2025. Sixteen trees were inventoried before intervention, with hornbeam (*Carpinus betulus L.*) and Scots pine (*Pinus sylvestris L.*) representing the principal species. Four trees were removed in April 2025, corresponding to a numerical felling intensity of 25.0%, while 12 trees (75.0%) were retained. Sanitary-condition data available for 15 trees showed that 10 trees (66.7%) were healthy, 3 (20.0%) were weakened, and 2 (13.3%) were diseased; one tree lacked a complete sanitary record. The differentiated selection of trees made it possible to combine sanitary, decorative, and spatial criteria and to preserve the majority of the stand while reducing local crowding around retained individuals. A repeated survey approximately six months after felling visually confirmed a more open spatial arrangement and preservation of the forest-park character of the site.

At the same time, the absence of an exact plot area and complete repeated tree-level measurements did not allow calculation of density per hectare, quantitative change in crown closure or inter-tree distance, or statistical significance. Consequently, the findings should be interpreted as a descriptive initial assessment rather than proof of long-term ecological effects.

The practical value of the study lies in demonstrating a cautious selective approach in which removal intensity is explicitly quantified and tree retention is prioritized. Further research should establish permanent sample plots with known area and conduct repeated measurements of DBH, height, crown dimensions, crown closure, spacing, sanitary condition, species composition, regeneration, and microclimatic parameters.

Longer-term monitoring will make it possible to determine whether the observed structural changes translate into sustained improvements in vitality, biodiversity, recreational quality, and ecological stability.

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АНОТАЦІЯ
ЛАНДШАФТНІ РУБКИ ЯК ЕЛЕМЕНТ ФОРМУВАННЯ ЛІСОПАРКОВИХ ЕКОСИСТЕМ МІСТА ВІННИЦІ

Лісопаркові екосистеми міста зазнають тривалого рекреаційного навантаження, ущільнення ґрунту, механічних пошкоджень, забруднення, змін мікроклімату та конкуренції між деревами у групах. Сукупна дія цих чинників може погіршувати життєвий і санітарний стан насаджень, послаблювати їхні екологічні, захисні, рекреаційні та естетичні функції, що зумовлює необхідність застосування диференційованих господарських заходів. Метою дослідження було оцінити початкові структурні та санітарні зміни, пов'язані з проведенням вибіркової ландшафтної рубки у лісопарковому насадженні міста Вінниці, а також визначити, чи забезпечило втручання збереження основних ознак деревостану. Польові дослідження проводили протягом весняно-осіннього періоду 2025 року. До початку робіт інвентаризували 16 дерев, серед яких основними породами були граб звичайний (Carpinus betulus L.) і сосна звичайна (Pinus sylvestris L.). Ландшафтну рубку виконано у квітні 2025 року, а повторне візуальне обстеження проведено приблизно через шість місяців. Під час відбору дерев ураховували вид, життєздатність, санітарний стан, якість стовбура і крони, наявність пошкоджень, декоративність, конкурентне положення та просторову роль кожного дерева у ландшафтній композиції.

Із 16 обстежених дерев видалено чотири, що відповідає чисельній інтенсивності рубки 25,0%; збережено 12 дерев, або 75,0% початкової кількості. Повні відомості про санітарний стан були наявні для 15 дерев: 10 особин (66,7%) віднесено до здорових, три (20,0%) - до ослаблених, дві (13,3%) - до хворих. Одне дерево не мало повного запису санітарного стану, тому його не включали до розрахунку часток за категоріями. Повторне обстеження засвідчило локальне розкриття простору навколо збережених дерев і зменшення скупченості без втрати загального лісопаркового характеру території. Отже, проведене втручання було помірним і вибірковим, а не інтенсивним.

Через відсутність точної площі ділянки та повних повторних вимірювань діаметра, висоти, зімкненості й параметрів крон, відстаней між деревами та освітленості не розраховували густоту на гектар і статистичну значущість структурних змін. Фотографії використовували лише як додаткове якісне підтвердження.

Отримані результати підтверджують практичну доцільність поєднання санітарних, біологічних, декоративних і просторових критеріїв під час планування ландшафтних рубок у міських лісопарках. Диференційований підхід дав змогу зберегти більшість дерев та вилучити особини, стан або просторове положення яких знижували якість насадження. Висновки слід розглядати як початкову локальну оцінку, а не як доказ довготривалого екологічного поліпшення.

Подальший моніторинг доцільно проводити на постійних пробних площах із точно встановленою площею та повторними індивідуальними вимірюваннями діаметра, висоти, параметрів крон, відстаней між деревами, природного поновлення, санітарного стану, видового складу й мікроклімату. Це дозволить визначити, чи зберігаються виявлені просторові зміни та чи сприяють вони підвищенню життєздатності дерев, біорізноманіття, рекреаційної якості й екологічної стійкості насадження.

Ключові слова: *урбанізоване середовище, лісопаркові насадження, ландшафтна рубка, санітарний стан, структура деревостану, рекреаційні насадження, екологічна стійкість.*

Табл. 1, Рис. 1, Літ. 23.

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Надходження статті 09.09.26.
Прийнято 30.09.26.
Опубліковано 31.10.26.