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Rethinking Urban Lawns: Rewilding and Other Nature-Based Alternatives

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Abstract

Ongoing urbanization, biodiversity decline, and intensifying climate change increasingly challenge the sustainability of urban green spaces (UGS) dominated by conventional, intensively maintained lawns. Although widespread across cities worldwide, lawns are criticised for their low biodiversity value and high resource demands. This paper explores nature-based solutions (NBS) as viable alternatives for enhancing resilience and multifunctionality of urban lawns. It conceptualizes lawns as intertwined ecological, design, and socio-cultural systems, and evaluates strategies for their transformation. Building on case studies from ten Eurasian cities, a narrative literature review, and the authors' inter- and transdisciplinary research experience, this study develops a typology of NBS alternatives, including urban species-rich meadows, semi-natural grasslands, naturalistic herbaceous perennial plantings, mixed-vegetation groundcovers, edible lawns, pictorial (annual) meadows, and rewilded lawns. Key interventions involve reduced mowing, multifunctional green spaces, adaptive management, and community engagement. Findings demonstrate that these approaches enhance biodiversity, ecosystem services, and climate resilience, but their success depends on local ecological conditions, landscape design, and public perceptions of urban nature. Alternative lawn designs and maintenance practices should employ native, drought- and trampling-resistant plants and context-sensitive design configurations while respecting cultural traditions of urban greening and fostering social acceptance. The paper suggests practical recommendations and directions for future research.

Keywords: urban lawns; rewilding; nature-based solutions; biodiversity; climate change; resilience; socio-cultural values of nature; Europe and Asia

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1. Introduction

Urban lawns (also known as turf) are frequently cut grasslands that represent one of the most widespread components of urban green infrastructure (UGI) globally, occurring in cities regardless of their geographical or socio-cultural context and covering up to 70% of urban green areas [1–4]. They are prevalent across a diverse range of urban green spaces (UGS), including public parks, private gardens, university campuses, sports fields, roadsides, street verges, and cemeteries, highlighting their functional and aesthetic significance within the urban landscape [5–7]. In many countries, the words "turf" and "lawn" are often used as synonyms, without recognition of their ecological differences. In our previous

paper [2], we clarified that the main distinction is that turf can refer either to natural grass in a pre-grown, ready-to-lay form (i.e., sod, making turf and sod synonymous) or to a synthetic, artificial substitute. In contrast, a lawn is a general term for any patch of land covered with maintained grass (sometimes including other herbaceous species), whether established from seed or turf.

Originally, urban lawns were primarily intended to serve aesthetic and recreational purposes (including sport), playing a central visual and cultural role in shaping urban landscapes, especially in public parks and private gardens [8]. In many cities worldwide, lawns serve as a prominent part of UGS and are widely admired for their cultural significance and visual appeal [2]. Beyond their cultural and aesthetic value, urban lawns provide a range of ecological and social benefits, including urban cooling, carbon sequestration, water filtration, habitats for urban wildlife, and spaces for sport and recreation [2,9–13]. However, these benefits come at significant environmental and economic costs, as lawns are typically intensively managed through frequent mowing, irrigation (in dry climates), and sometimes the application of fertilizers and even pesticides. Especially, in arid and semi-arid regions, despite limited water supply, recurring droughts, and the energy use as well as costs of transporting water, greening cities (e.g., in Southern China, California, Arizona) via arranging lawns and exotic plants remains a prevailing yet ecologically unsustainable practice [10,12,14–16]. Such practices lead to low biodiversity, high maintenance expenses, support of non-native plant species, and notable ecological impacts such as greenhouse gas emissions, excessive water consumption, and chemical runoff into groundwater and waterways [17–19]. Despite these negative effects and maintenance costs, urban areas covered by lawns continue to expand, not only in Western countries such as those in Europe, the United States, Australia, and New Zealand, but also in other parts of the world, such as China, Vietnam, India, Japan, and many cities in Latin America and Africa, where modernization processes have driven a recent rapid increase in the establishment of lawns [1,4,6,20,21]. This ongoing expansion, combined with increasing pressures from climate change, biodiversity loss, and urbanization, underscores the critical need to explore sustainable alternatives that fit into nature-based solutions (NBS) for urban lawns, making this an especially timely and relevant area of research.

NBS have emerged as a prominent concept and practical approach to address societal challenges such as climate change, biodiversity loss, and urban sustainability and resilience [22,23]. It is broadly recognized that NBS are an effective strategy to improve the health and well-being of the urban ecosystems and population, while simultaneously enhancing ecosystem services, supporting climate adaptation, and promoting social cohesion in urban communities [24–27]. Through their ability to leverage natural processes and functions to mitigate environmental impacts and enhance urban liveability, NBS are actively implemented across various types of urban green infrastructure, including green roofs, public parks, community gardens, and allotments, contributing to sustainable urban development and resilience. Empirical evidence suggests that NBS applied to urban rewilding can restore ecological functions, enhance biodiversity, and strengthen resilience by improving habitat connectivity and creating self-sustaining green patches. They also provide ecosystem services such as microclimate regulation and carbon sequestration, while promoting human well-being through contact with more biodiverse and natural urban landscapes [28,29].

However, despite the growing interest in NBS, there remains a notable gap in research focused specifically on their application to urban lawns, including strategies for enhancing biodiversity, ecosystem services, and climate resilience in these widely distributed green spaces. The pioneering research on lawn alternatives began in Germany in the 1980s–1990s, when the works of Müller and Schmidt [30], Müller and Wolf [31],

and Müller [32,33], demonstrated that the intensity of use and maintenance regime (e.g., mowing) can affect a lawn's plant composition, alongside climate conditions. In several cities (e.g., Augsburg, Bonn, Köln, and Munich), experimental projects were carried out to transform conventional lawns into biodiverse meadows, laying the foundation for understanding and implementing sustainable lawn alternatives. Recent studies in Europe, Asia, America, and Australia have explored several types of lawn alternatives. Among the most popular recent trends are solutions such as the intentional abandonment of green space and promoting wilderness through low-intensity management and wild bee-supportive grasslands in Germany [34,35], spontaneous vegetation and energy crops in Poland [36,37], low-maintenance and naturalized urban Mediterranean grasslands in Italy [38,39], rewilding/succession in Singapore [40], restoration of native grasslands and using low growing mixtures of native shrubs, perennials and grasses in Australian and New Zealand urban street verges, private gardens and public parks [41,42]. Another approach refers to permaculture lawns that replace traditional grass monoculture with diverse functional and sustainable systems of plants (e.g., accepting unwanted "weeds" as a part of the lawn's plant communities) to support soil quality, wildlife, and produce food, as shown by the studies on multifunctional lawns in Italy [43,44]. There are also meadows enhancing soil microbial biodiversity [45] and prairie-meadows [46,47] in the USA, grass-free meadows in Sweden [48,49], UK [50,51], and biodiversity-rich urban meadows in Germany [17,30,31,52], France [53], and other European countries (e.g., global study—[13]). Additionally, "edible" lawns (growing herbs and edible species instead of conventional lawns in courtyards, street verges, private gardens, public parks) as a part of the edible landscape approach are implemented in various cities worldwide [54–56]. Other solutions include native turfgrass polycultures (using several lawn grass species instead of one turf species in seed mixtures and some perennial species aiming to increase the diversity) in Germany [57] and native plantings including "woody meadows" in Australia [5,20,21,41,42,58]. All these options aim to redesign conventional lawns and to minimize maintenance interventions while providing multiple benefits for people and nature.

This research advances our previous investigations [2,4,20,21,41,48,59–62] of nature-based alternatives to conventional urban lawns, and explores opportunities for rewilding in European and some Asian countries. Europe is a "cradle" of lawns according to recent research, and it is a unique, specifically designed plant community that derived from modified natural or semi-natural grasslands, especially pastures and meadows [2,63]. Our understanding of the NBS concept emphasizes the importance of recognizing and respecting local contexts across different countries, while adopting a holistic approach that integrates ecological, planning, and design dimensions [2,20,64]. By analysing various NBS initiatives for urban lawns, we conceptualize urban rewilding as a complementary NBS approach for sustainable management and stewardship of urban lawns. Originally emerging in the 1970s in Germany and the 1980s in North America under the umbrella of ecological restoration and wilderness recovery, the term "rewilding" was developed as a concept within the academic community by Noss [65], Foreman et al. [66], and Soulé and Noss [67]. German urban ecologists were among the first to focus on rewilding in urban contexts. In particular, Sukopp et al. [68] identified urban wastelands as foundational spaces for urban rewilding. Kowarik [69,70] introduced the term "Verwilderung" as the German equivalent of rewilding and suggested that urban rewilding represents the potential enhancement of urban wilderness, emphasizing that it delivers cultural ecosystem services and provides both ecological and social benefits. Today, urban rewilding has been proposed as a strategy for cities worldwide to address the biodiversity crisis while also leveraging various benefits of urban nature for the well-being of residents [70–73]. Defined as a process of allowing ecosystems within cities to develop with minimal human intervention (e.g., through low- to

no-management initiative [74]), promoting self-regulating (succession) and self-sustaining systems [70], urban rewilding is often discussed as a promising direction for urban green space [29,75] and a strategy to enhance biodiversity, improve ecosystem services, and restore ecological complexity [76,77]. This includes, for example, different layers of urban forest and a reinforcing wildlife component [73]. In relation to lawns, applying the urban rewilding approach allows them to transition from intensively maintained, species-poor grass surfaces into multispecies, self-sustaining ecosystems that support biodiversity, deliver ecosystem services, and improve climate adaptation.

However, the adoption of the NBS approach, including rewilding, remains limited, as its effective implementation requires a comprehensive understanding of urban lawn not only as an ecological system but also as a socio-cultural constructed space, whose design and management must consider public acceptance, social norms and preferences, historical planning and design styles, and other local contexts.

Accordingly, the primary objective of this paper is to advance the understanding of nature-based strategies for enhancing the resilience of Eurasian urban lawns under the pressure of urbanization, globalization, biodiversity loss, and climate change. This paper builds upon our previous research [2,5,48], advancing the discussion from conceptual foundations to the practical implementation of these strategies. It focuses on the following specific research tasks:

(a) To extend the conceptual framework established earlier [2] toward the practical requirements for implementing nature-based strategies for urban lawns;
(b) To analyse selected case studies in Europe and Asia, complemented by insights from the literature review, in order to develop a comprehensive typology of NBS related to urban lawns, and identify barriers and opportunities for their implementation in diverse urban contexts;
(c) To formulate practical recommendations and a future research direction for promoting NBS alternatives to conventional lawns, including rewilding, to enhance ecological performance, social acceptance, and management adaptability.

While we are familiar with alternative nature-based solutions for lawns in cities across both the Northern and Southern hemispheres (e.g., Australia, New Zealand), this paper specifically focuses on the European and Asian contexts. Lawns in Australia and New Zealand have been introduced into ancient endemic ecosystems, and their history of development and understanding of NBS alternatives and rewilding differ substantially from those in Europe, making it more complex [5,20]. These Southern Hemisphere contexts will be addressed in follow-up research.

2. Materials and Methods

This study combines comparative case analyses and a narrative review of the peer-reviewed scientific and grey literature. The research framework comprised three phases:

1. **Phase 1: Conceptual grounding**—conduct a focused narrative review of existing literature to elaborate on the key aspects of lawn research, such as: (a) biodiversity, (b) ecosystem services and ecosystem disservices, (c) public perception, attitude, and preferences, and (d) NBS-related lawn alternatives to identify conceptual and practical gaps.
2. **Phase 2: Case study analysis**—examine ten selected case studies representing various perspectives of lawn research to investigate how they appear in practice, highlighting challenges and opportunities, while linking findings back to the literature to reinforce the theoretical foundation.

3. **Phase 3: Recommendations for practical application and future research** to support the integration of the nature-based lawn alternatives (including rewilding) into the planning, design, and management of UGS.

2.1. Literature Review

A focused narrative review of recent scientific and grey literature was conducted following Snyder's [78] approach, covering studies on biophysical, socio-cultural, planning, and design aspects of urban lawns and their nature-based alternatives (Figure 1). To ensure a broader coverage, the review used Google Scholar, Scopus, and ISI Web of Science databases to access a comprehensive range of peer-reviewed and grey literature. The following keywords were used: "urban lawns", "lawns", "urban rewilding", "lawn alternatives", "lawn nature-based solutions", "biodiverse lawns", "urban meadows", "turf grass", "turf grass lawns", "urban grassland", "sustainable lawn", "sustainable lawn practices", "sustainable lawn management", "lawn perceptions", and "lawn ecosystem services". It extends our earlier review [2] by incorporating more recent publications (from 2013 to 2025). While the majority of the included literature is in English, relevant sources in Russian and German were also considered. Most of the non-English sources included provide abstracts in English to ensure that their key findings are accessible and verifiable. In this updated review, we not only considered aspects of lawn biodiversity, ecosystem services, history, and management practices, but also placed particular emphasis on studies examining the application of the NBS approach to urban lawns. The review aimed to identify sustainable, nature-based, and rewilding-oriented alternatives to conventional lawns, as well as to explore and synthesize barriers limiting their wider adoption and the opportunities to overcome them. In total, 87 publications were selected for analysis. The studies are organized according to defined research categories (lawn research aspects) (Table 1).

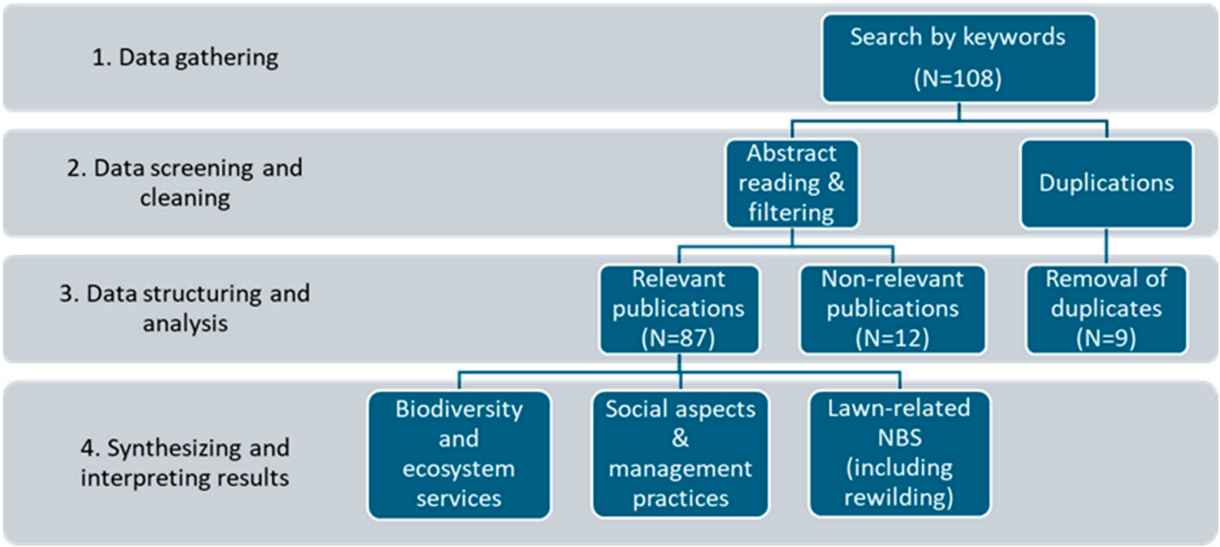


Figure 1. Literature review process.

Table 1. Literature analysis conducted within this research.

Category of Research	Research Aspect (s)	References
1. Lawn and the benefits provided	1.1. Biodiversity and vegetation aspects	Aguilera et al., 2019 [79]; Baldi et al., 2023 [58]; Beery and Lekies, 2019 [80]; Buchholz et al., 2018, 2020 [34,35]; Chollet et al., 2018 [53]; Fekete et al., 2024 [81]; Griffiths-Lee et al., 2022 [50]; Hedblom et al., 2017 [1]; Hwang et al., 2017 [40]; Ignatieva, 2017 [48]; Lhomme-Duchadeuil, 2018 [82]; Lonati et al., 2018 [39]; Müller et al., 2013 [52]; Rudolph et al., 2017 [83]; Sehrt et al., 2020 [84]; Smith and Fellowes, 2013, 2014 [51,85]; Southon et al., 2017 [86]; Trémeau et al., 2023 [87]; Wastian et al., 2016 [88]; Winkler et al., 2024 [13]; Wolfin et al., 2021 [47]; Yang et al., 2019a [4]
	1.2. Ecosystem services and disservices provided by lawns	Amani-Beni et al., 2018 [89]; Barnes et al., 2020 [90]; Bø et al., 2024 [91]; Chollet et al., 2018 [53]; Çakır and Sancar, 2022 [92]; Marcus and Sachs, 2014 [93]; Cumberbatch et al., 2025 [94]; Fekete et al., 2024 [81]; Filibeck et al., 2016 [38]; Fischer et al., 2020 [95]; Francis, 2018 [96]; Griffiths-Lee et al., 2022 [50]; Gu et al., 2015 [97]; Hedblom et al., 2017 [1]; Ignatieva and Hedblom, 2018 [61]; Ignatieva et al., 2020 [8]; Monteiro, 2017 [11]; Müller et al., 2013 [52]; Przybysz et al., 2021 [98]; Rudolph et al., 2017 [83]; Shchepeleva et al., 2019 [99]; Thienelt and Anderson, 2021 [100]; Thompson and Kao-Kniffin, 2017 [101]; Trémeau et al., 2023 [87]; Turgeon and Fidanza, 2017 [102]; van Delden et al., 2016 [103]; Wang et al., 2016 [12]; Wheeler et al., 2017, 2020 [16,104]; Winkler et al., 2024 [13]; Zhang et al., 2015 [105]
2. Lawn as a socio-cultural phenomenon	2.1. Public perception, attitude, and preferences	Barnes, 2022 [90]; Beery & Lekies, 2019 [80]; Filibeck et al., 2016 [38]; Fischer et al., 2020 [95]; Francis, 2018 [96]; Hartin et al., 2022 [15]; Hedblom et al., 2017 [1]; Hu et al., 2025 [106]; Konstantinova et al., 2025 [107]; Ignatieva, 2017 [48]; Ignatieva et al., 2020 [8]; Ignatieva et al., 2024, 2025 [41,42]; Poškus and Poškienė, 2015 [108]; Prior and Brady, 2017 [109]; Ramer et al., 2019 [46]; Southon et al., 2017 [86]; Yang et al., 2019 [4]; Yang et al., 2019 [62]; Wheeler et al., 2020 [104]; Zhang et al., 2015 [105]
	2.2. History of lawn development, management, and maintenance	Bretzel et al., 2020 [43]; Fekete et al., 2024 [81]; Hartin et al., 2022 [15]; Ignatieva, 2017 [48]; Ignatieva et al., 2018 [63]; Ignatieva et al., 2020 [2]; Ignatieva and Hedblom, 2018 [61]; Konstantinova et al., 2025 [107]; Paudel and States, 2023 [6]; Sehrt et al., 2020 [84]; Smetana and Crittenden, 2014 [110]; Smith and Fellowes, 2013, 2014 [51,85]; Trémeau et al., 2023 [87]; Turgeon and Fidanza, 2017 [102]; Yang et al., 2019 [111]; Wheeler et al., 2020 [104]; Zhang et al., 2015 [105]
3. Sustainable alternatives/ Lawn-related NBS	3.1. Nature-based alternatives to conventional lawns, lawn-related NBS, and sustainable lawn management	Baldi et al., 2023 [58]; Barnes et al., 2020 [90]; Beumer, 2018 [112]; Bonthoux and Chollet, 2024 [113]; Bretzel et al., 2020, 2023 [43,44]; Buchholz et al., 2018 [34]; Chollet et al., 2018 [53]; Çakır and Sancar, 2022 [92]; Dushkova et al., 2021, 2025a [59,60]; Fekete et al., 2024 [81]; Fischer et al., 2020 [95]; Garret, 2014 [54]; Gu et al., 2015 [97]; Hwang et al., 2017 [40]; Jiang and Tuan, 2023 [114]; Smith and Fellowes, 2014 [51]; Konstantinova et al., 2025 [107]; Ignatieva, 2017 [48]; Ignatieva and Hedblom, 2018 [61]; Ignatieva et al., 2023 [20]; Lonati et al., 2018 [39]; Mårtensson, 2017 [49]; Müller et al., 2013 [52]; Pilarchik and D'Amore, 2023 [55]; Przybysz et al., 2021 [98]; Rudolph et al., 2017 [83]; Sehrt et al., 2020 [84]; Smith and Fellowes, 2013, 2014 [51,85]; Stevens, 2020 [56]; Wolfin et al., 2021 [47]
	3.2. Lawn and rewilding	Bauer and von Atzigen, 2019 [115]; Bonthoux and Chollet, 2024 [113]; Cabon et al., 2022 [116], Carver et al., 2021 [117]; Chollet et al., 2018 [53]; Clayton, 2019 [118]; Fischer et al., 2020 [95]; Jørgensen, 2015 [119]; Hobbs and White, 2016 [120]; Hwang et al., 2017 [40]; Hu et al., 2025 [106]; Mata et al., 2025 [121]; Moxon et al., 2023 [76]; Mumaw and Bekessy, 2017 [122]; Owens and Wolch, 2019 [123]; Pettorelli and Bullock, 2023 [124]; Prior and Brady, 2017 [109]; Rotherham, 2019 [125]; Southon et al., 2017 [86]; Sikorska et al., 2021, 2023 [36,37]; Stone, 2019 [77]; Tessler et al., 2023 [45]; Trémeau et al., 2023 [87]; Turnbull et al., 2025 [126]; Wartmann and Lorimer, 2024 [127]; Webb and Moxon, 2021 [128]; Winkler et al., 2024 [13]; Zoderer, 2025 [129]; Zoderer and Wieser, 2025 [130]

2.2. Case Study

Our empirical observations were based on the analysis of collaborative inter- and transdisciplinary research projects on urban lawns and other elements of UGI conducted in 2010–2024 in ten Eurasian cities: Uppsala, Stockholm, Berlin, Leipzig, Barcelona, Rome, Moscow, St. Petersburg, Beijing, Xi'an, and Hue City. The case studies focused on urban lawns in diverse UGI settings, including public parks, private gardens, university campuses, sports fields, roadsides, and street verges, allowing for cross-cultural and climatic comparisons. These sites represent a range of geographic, ecological, and climatic conditions—from northern temperate (Uppsala, St. Petersburg), warm temperate oceanic (Berlin, Leipzig), and temperate continental (Moscow, Xi'an, Beijing) to Mediterranean (Barcelona, Rome) and tropical monsoon climates (Hue City), allowing for bioclimatic and ecological comparisons. In addition, the case studies reflect historical traditions and local cultural practices of urban greening and historical gardening, including the aesthetic and social roles of lawns in different societies. Understanding these cultural and historical contexts is crucial for interpreting lawn management strategies and assessing the potential for nature-based alternatives, including the rewilding approach. Data collection in case study cities involved a combination of field observations, questionnaire surveys, walking interviews with UGS visitors, expert interviews, and analysis of lawn management practices, with particular attention to lawn biodiversity, management intensity, and sociocultural values (Table 2). More details on the data collection procedures and analytical approach are provided in [48,63] for Stockholm and Uppsala; in [25,131] for Berlin and Leipzig, in [59,60,107,132] for Moscow and St. Petersburg; in [4,62,111] for Beijing and Xi'an; and in [21] for Hue City. Additionally, in 2023–2025, we conducted further research observations of NBS related to urban lawns in the case study sites to update and extend the data sets.

In all case studies, we detected four main types of urban lawns:

(1) *Conventional lawns* (taking the biggest area in the cities, common for most UGS), which are cut on average 8–12 times per season (or more) to a height of 3–4–10 cm according to the official municipal standards; with remaining the clipping on the area and mulching.
(2) *Sports lawns* (e.g., football fields), which are typically subject to more intensive management. They occupy the UGS of sports facilities and account for only a small proportion of the total urban lawn area.
(3) *Meadow-like lawns*, representing a lawn alternative, which are mowed one to three times per season, and the clippings removed. In European cities (especially German and Swedish), there is a rise in using this type of lawn not only in public parks, but also in other types of UGS, including private gardens, and road embankments inside or on the outskirts of cities.
(4) *Other sustainable lawn alternatives* (e.g., permaculture or edible lawns, naturalistic herbaceous plantings, grass-free lawns, lawns comprised exclusively of locally native species, pictorial meadows, and rewilding-oriented lawns) designed to reduce resource inputs and maintenance (mowing once or twice per season or not mowing at all) while enhancing biodiversity, ecosystem services, and habitat quality for urban wildlife (mostly insects); they are increasingly implemented in public parks, institutional landscapes (e.g., university campuses), and experimental urban sites.

We documented variations in lawn types, construction, plant composition, and maintenance regimes, capturing differences shaped by historical, climatic, and cultural factors. To this end, we conducted field research based on direct (landscape) observation and data collection of ecological parameters (especially biodiversity-related) in urban public open spaces (public parks, private gardens, verges, etc.) This approach allowed us to document

and measure characteristics such as plant and animal life, urban habitat/biotope features, and the presence of specific features (e.g., equipment and amenities). In most case studies, this method was combined with social science techniques such as questionnaire surveys, observational studies (non-participatory observations), walking interviews, expert interviews, and content analysis of urban planning documents related to lawn management and maintenance. Together, these methods enabled us to develop a comprehensive understanding of lawns' ecological functions, perceived value, and associated management practices.

Table 2. Case study sites and research undertaken.

Case Study	Ecological Parameters, Incl. Biodiversity Aspects	Social Aspects (Perception, Attitude, and Preferences)	Management and Maintenance Specifics
Uppsala, Stockholm (Sweden)	Direct (landscape) observation, data on plants and pollinators	on-site questionnaire survey among citizens, and observational studies of people's activities	Semi-structured interviews with experts *
Berlin, Leipzig (Germany)	Direct (landscape) observation, plant biodiversity assessment of lawns in parks, and verges	Walking interviews with park visitors, observational studies of people's activities	Semi-structured interviews with experts *
Barcelona (Spain) and Rome (Italy)	Direct (landscape) observation	Observational studies of people's activities	Analysis of documents and policies regulating lawn construction and management
Moscow, St.-Petersburg (Russia)	Direct (landscape) observation, plant biodiversity assessment of lawns in parks and private gardens	Online and on-site questionnaire survey among citizens	Analysis of documents regulating lawn construction and management
Beijing, Xi'an (China)	Landscape observation, plant and pollinator biodiversity assessment of lawns in parks, green corridors, and verges	Observational studies of people's activities, walking interviews	Semi-structured interviews with experts *
Hue City (Vietnam)	Landscape observation in public parks and private gardens (lawn as a part of green spaces).	Semi-structured interviews with experts *	Semi-structured interviews with experts *

* experts include academics, landscape architects, park managers, turf producers, and researchers responsible for the planning, design, and management of urban lawns within green spaces.

2.3. Recommendations for Practical Application

Building on the insights gained from the narrative review and comparative case analyses, phase 3 focuses on developing recommendations for integrating the NBS approach into planning, design, and management of urban lawns. This phase synthesizes empirical findings, ecological principles, and socio-cultural considerations to propose strategies that enhance biodiversity, ecosystem services, and social utility of urban lawns. Emphasis is placed on identifying practical interventions, such as alternative scientifically proven mowing regimes, species-rich plantings, multifunctional green spaces, and adaptive management practices, that can transform conventional lawns into ecologically and socially resilient landscapes.

By integrating theoretical insights with practical considerations, including barriers and opportunities for implementation of nature-based lawn strategies, this phase of the article aims to bridge the gap between academic research and urban planning, design,

and UGS management, supporting policy-makers, landscape architects, and community stakeholders in adopting lawns that deliver both ecological and social benefits.

3. Results

3.1. Lawn as a Contradictory Phenomenon

Urban lawns are widely recognized as a central component of UBGI, providing aesthetic, cultural, and recreational functions [1,2,4]. Despite their apparent simplicity, lawns traditionally represent designed nature [42]. Lawns are intentionally established plant communities composed mainly of cultivated grass species, either sown from seed or planted vegetatively, and often include spontaneously emerging herbaceous species commonly considered undesirable (called lawn weeds). This is one of a striking set of contradictions (Figure 2): while lawns are celebrated as symbols of prosperity, naturalness, and well-being, their intensive management often entails significant environmental and socio-economic costs [13,48,90]. In Sections 3.1.1–3.1.4, we discuss each of these contradictions by combining insights from our empirical research with the conceptual foundations and findings from the literature review, and suggest the typology for lawn-related NBS (Section 3.2). This approach connects the theoretical understanding of urban lawns with practical evidence, highlighting the need and critical factors for implementing nature-based and rewilding strategies, which are further elaborated in Section 3.2.

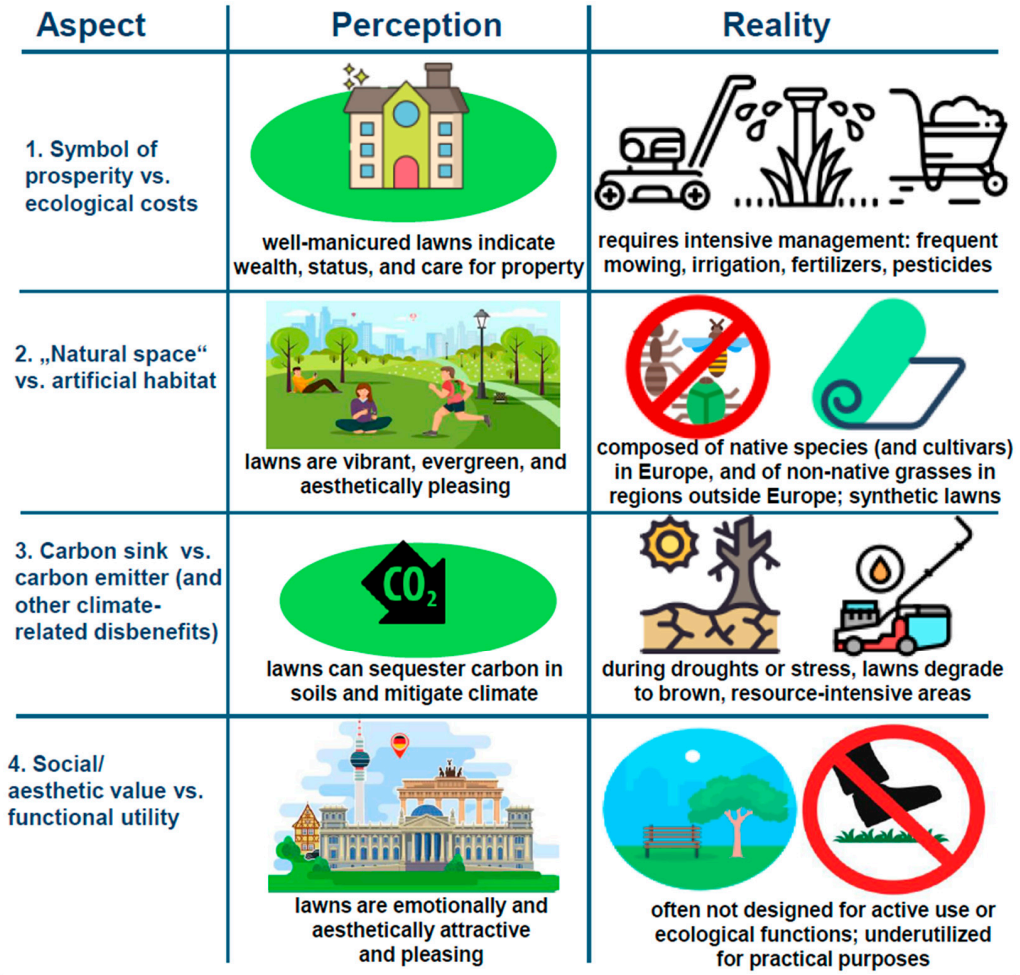


Figure 2. The contradictory nature of urban lawns (created by the authors using free images/drawings from https://www.freepik.com/ and https://icons8.ru/ accessed on 15 September 2025).

3.1.1. Symbol of Prosperity Versus High Ecosystem Disservices and Maintenance Costs

A perfectly maintained lawn has long symbolized wealth, social status, and the homeowner's dedication to order and care for their surroundings [2,86]. Historically, lawns as manicured green surfaces reflected ideals of modernity and power, representing control over nature and social aspiration [6,15]. This symbolism is evident in various case studies from classical formal European gardens (e.g., Bellevue Garden in Berlin, Catherine Palace Park in St. Petersburg, Park near the Borghese Art Gallery in Rome) to Chinese (e. g. Daming Palace National Heritage Park in Xi'an) and Vietnamese public parks as a symbol of modernity and westernisation (Figure 3). In these aristocratic and imperial parks, expansive lawns were deliberately used to convey power, refinement, and mastery over the natural environment. Such lawns also served as a tool for social differentiation, signalling wealth and cultural sophistication [86,132]. Their design and maintenance often reinforced hierarchical social structures, linking aesthetic preferences to social authority and prestige [15,48], that can still be observed in private gardens of many cities/city outskirts of the world, as well as institutional green spaces such as university campuses and governmental official green spaces (Figure 4). Over time, these aesthetic ideals extended beyond private gardens into public parks, sports fields, and institutional landscapes, expressing shared cultural expectations of tidiness, beauty, and tranquillity, as well as aesthetic values appreciated by society at large [6,58,95].

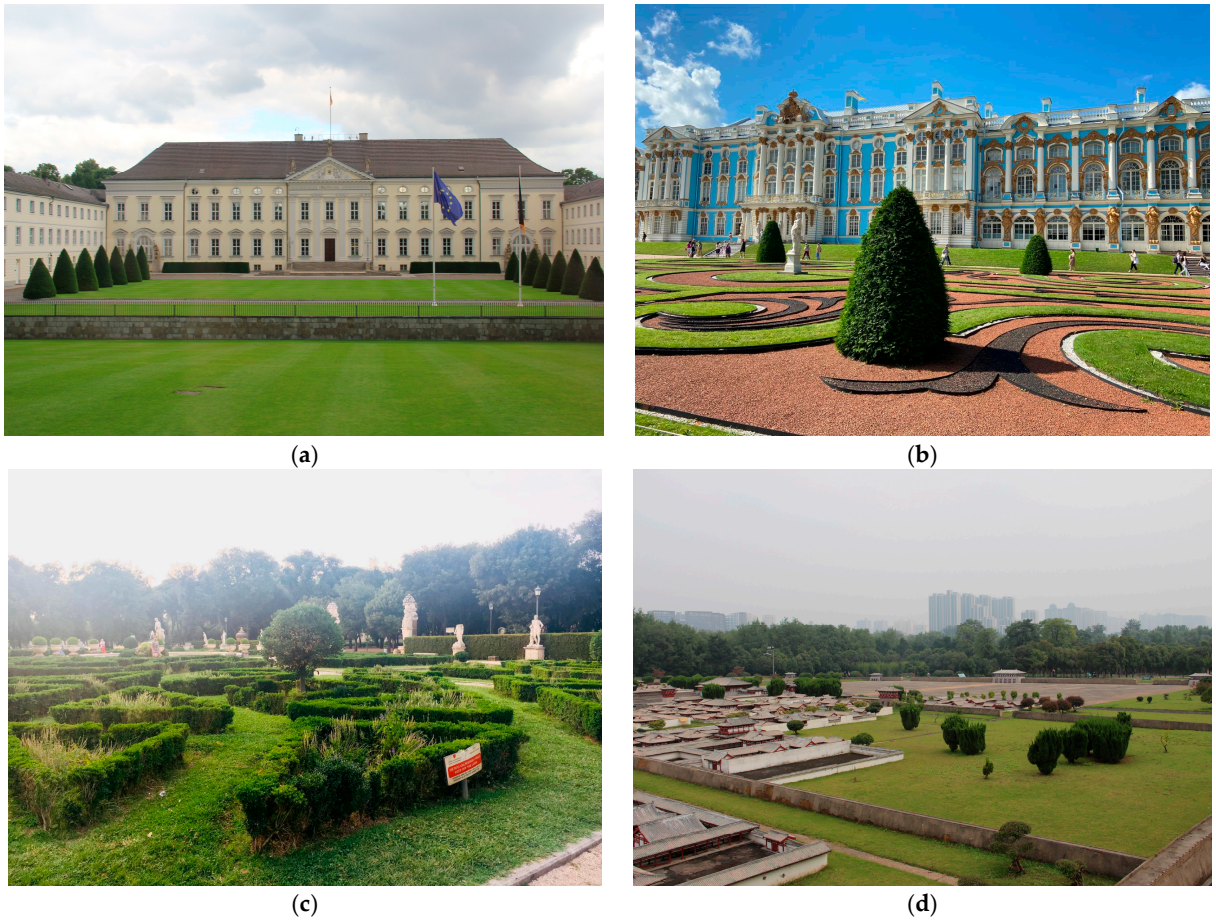


Figure 3. Extensive lawn areas within the formal French style parks of (**a**) Schloss Bellevue in Berlin, (**b**) Catherine Palace Park in St. Petersburg, (**c**) Park near the Borghese Art Gallery in Rome, and (**d**) lawn in Daming Palace National Heritage Park in Xi'an (Photos: authors).



(**a**) (**b**)

Figure 4. Manicured lawns in private gardens in (**a**) Leipzig, and (**b**) Uppsala.

Yet achieving this visual ideal requires continuous and resource-intensive maintenance, including frequent mowing, irrigation, weeding, fertilization, and application of herbicides and pesticides to maintain their uniform and "clean" appearance. Lawns also require specific soil preparation, seeding or growing turf, planning sites to form a dense sod (turf) composed of grass shoots, living stolons, and roots, interwoven with soil and soil fauna, creating uniformly green, walkable surfaces [48].

Although lawns provide certain ecosystem services (e.g., carbon sequestration, temperature regulation, and social well-being), their ecological footprint often outweighs these benefits, especially in arid [38,39,89] and densely urbanized regions [11,90,92,99]. In the time of climate change, the frequency of drought periods during summers has increased, and many municipalities are facing the need to revisit the maintenance schedules (e.g., introduction of occasional irrigations). Our research shows that conventional and heavily managed lawns generally support lower plant and wildlife diversity compared to more extensively managed grasslands or sustainable lawn alternatives. Moreover, irrigation demands and the reliance on fertilizers and herbicides exacerbate urban sustainability challenges, contributing to water scarcity, nutrient runoff, and soil and groundwater pollution [97,98]. Several studies also demonstrate that high energy and water inputs connected with conventional lawn maintenance contribute to greenhouse gas emissions, nutrient runoff, soil compaction, and degradation that leads to ecological trade-offs and reduced habitat quality [12,35,53,83,99,104]. Such lawns also act as pollinator voids, deterring pollinators from the site and nearby plantings, thereby reducing available or potentially usable pollinator habitat.

This tension between aesthetic expectations and ecological consequences positions the lawn as a deeply paradoxical feature of UBGI—simultaneously valued for its cultural symbolism and criticized for its environmental inefficiency [2,61,81,87]. In this light, the urban lawn embodies both a social construct of prosperity and a site of ecological cost, reflecting the broader contradictions of human–nature relationships in urban environments [13,48,51,95].

3.1.2. "Natural" Space Versus Artificial Habitat and Homogenization

Our research shows that lawns are often perceived as natural elements within the urban landscape, serving as proxies for "nature" in densely built urban environments [2,4,48,59–61,63]). This perception stems from their visual greenness, openness, and accessibility (importance of having an extra "outdoor space" close to home), which evoke associations with natural scenery and relaxation. Often, respondents mentioned the

lawn as an important element of their outdoor activities, particularly during the summer period, especially in temperate climates with distinct green summers and white winters. This aligns with the findings of other studies that emphasize lawns' value as a safe, orderly, and aesthetically pleasing space for recreation and social interaction, reinforcing their symbolic role as everyday nature for urban residents [1,15,86,90,95,106].

In reality, as our research indicates, urban lawns are highly anthropocentric and homogenized ecosystems, and in temperate climates, they are dominated by a small number of perennial turf-grass species and their cultivars that are growing in special turf/lawn farms: *Poa pratensis*, *Festuca rubra*, *Lolium perenne*, and *Agrostis* spp. The grass species originated in Western and Central European pastures and meadows 5000 years ago, became culturally embedded in urban landscapes designed during Medieval times, and were subsequently exported to other continents between the 18th and 20th centuries [63]. Thus, in Europe, these grasses can be considered part of an "urban nature" tradition, but when introduced to other biogeographic regions, they function as non-native species and often require extensive management to thrive, and can also become invasive. In dryer climates (e.g., Southern Europe), *Cynodon dactylon* is one of the most commonly used species for lawns. This species originates from tropical Africa. These chosen grass species are selected precisely for their uniform appearance, resilience to frequent mowing, and ability to withstand trampling. Our studies in various cities in Europe and outside [4,20,21,41,42,59,60,62] demonstrate that all lawns rely on intensive inputs such as modified soil compositions or soil replacement, regular applications of fertilizers, irrigation, herbicides, and frequent mowing to maintain the uniform turf-sod aesthetic. For instance, lawns are frequently seeded or vegetatively planted, and any other species are considered "weeds" and systematically eliminated. Moreover, our observation shows that with intensifying climate change, including more frequent heatwaves and droughts, the maintenance of high-quality lawns is rising steeply. In Germany, for example, as in Italy or Spain, rising summer temperatures and prolonged dry periods are creating conditions under which traditional turf-grass lawns struggle without increased irrigation and maintenance efforts. This led to the increasing use of artificial, plastic, or synthetic lawns because they require minimal maintenance, no watering or mowing, and retain a consistently neat appearance throughout the year [2,96] (Figure 5). This trend is often driven by water scarcity, urban lifestyle constraints, and aesthetic preferences, despite growing concerns about their negative environmental impact on both human health and ecosystems, and loss of ecological value. These include the release of microplastics and chemical substances, elevated surface temperatures contributing to the urban heat island effect, greenhouse emissions, and potential exposure to heavy metals and polycyclic aromatic hydrocarbons [6,92,97,103,110,133]. Moreover, the impervious surface of artificial turf prevents water infiltration, increasing stormwater runoff and pollutant transport [92,96,103].

Experts and land managers express concerns about these types of artificial lawns replacing living vegetation, leading to even further biodiversity decline and increased urban heat. In many arid regions, including those in Europe, Asia, Australia, and the United States, short-clipped, green plastic "turf" sheets that superficially resemble well-maintained grass are commonly used. These installations create pollinator and ecological voids within urban habitats, and are associated with high emission profiles, microplastic pollution, lack of permeability, and other health-related concerns [2,94,96]. Yet, they remain popular not only among private garden owners but also among municipalities and schools due to their durability, supposed water savings, and lower maintenance and costs [91,94]. Many large housing complexes, including senior living facilities, rely heavily on these artificial surfaces.

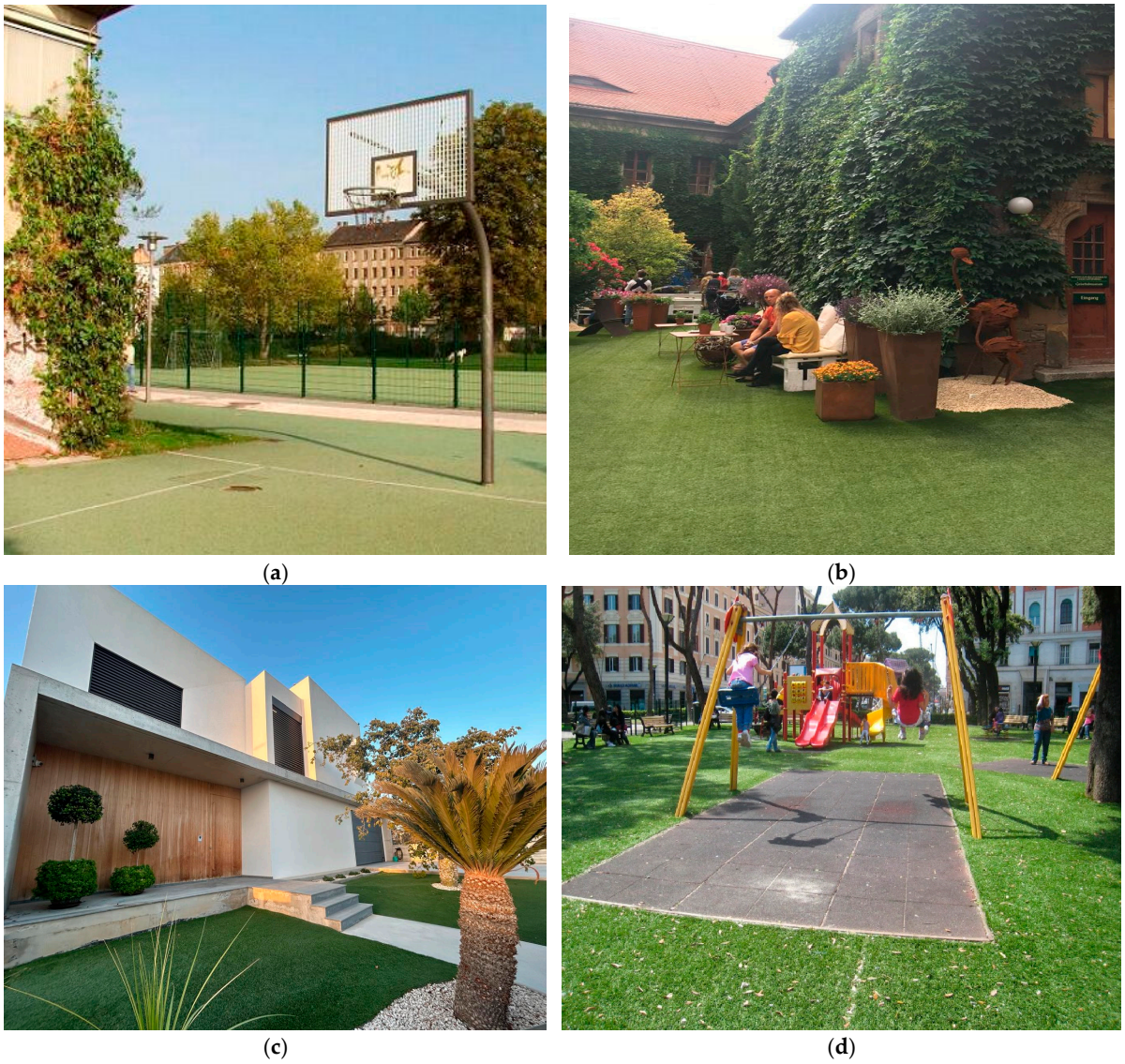


Figure 5. Artificial, synthetic/plastic lawns in (**a**) the sport facility of Leipzig, (**b**) the backyard of a house in Berlin, (**c**) in a front garden in Barcelona, and (**d**) in the playground of the Rome City Centre (Photos: authors).

Other studies (e.g., in Finland [87], France [53], Poland [13,36], Germany [84,95], Italy [39,43], China [89], the USA [58,104], Australia [5,20,41,42]) also emphasized the low level of regulatory services provided by urban lawns, their low biodiversity impact, and high maintenance costs that tend to increase during intensified climate change. This turns lawns into a tightly controlled environment disconnected from local ecological processes [11,104]. As a result, lawns exhibit low structural complexity and minimal species diversity compared to natural grasslands or meadow ecosystems [13,50,79,84], which leads to the ecological homogenization of urban areas. This homogenization results from lawn plant communities that are becoming increasingly similar in composition and structure across diverse biogeographical zones [2].

Our research has shown that lawns typically support only a fraction of the biodiversity found in semi-natural habitats. For instance, compared to biodiverse meadow-like lawns, conventional and intensively managed lawns often harbour significantly fewer pollinators, soil invertebrates, and flowering plants, while their simplified vegetation structure limits nesting and foraging opportunities for urban fauna (Figure 6). This was also confirmed by other studies [34,35,39,47,88]. Even when lawns occupy vast areas within cities, their

contribution to urban biodiversity and ecosystem functionality remains disproportionately low [39,81–83,88]. In this sense, lawns can be seen as "green deserts"—visually rich but ecologically limited, simplified, and species-poor [48,87].



Figure 6. Lawn as an important source for wildlife habitat provision: (**a**,**b**)—birds found in the conventional lawns, whereas (**c**,**d**)—insects detected in the nature-based/biodiversity-rich lawns in Leipzig public parks (Photos: authors).

Studies demonstrate the potential of lawns to sequester carbon in soils, especially in European cities located in temperate climates [99,101,104]. However, lifecycle analyses indicate that emissions from lawn management, including fuel for mowing, irrigation, and production of fertilizers and pesticides, can outweigh sequestration, effectively turning lawns into net carbon emitters. This illustrates a further ecological contradiction inherent in conventional lawn practices [83,87].

Beyond carbon balance, the intensive maintenance required to sustain lawns also amplifies other environmental pressures. Frequent mowing, irrigation, and chemical inputs not only increase greenhouse gas emissions but also contribute to nutrient runoff,

soil compaction, and decreased soil microbial diversity [53,81,98]. Even when lawns occupy large areas of urban space, their ecological contribution is often minimal compared to more diverse or structurally complex vegetation, such as meadows or near-natural plantings [39,58,79,83]. These findings highlight the tension between lawns' aesthetic and recreational benefits and their hidden environmental costs.

According to the results of our social research, the dependence of lawns on human intervention to maintain "natural" appearances highlights a fundamental paradox: lawns appear to people as natural elements precisely because they are so intensively managed [2,4,5,8,20,41]. Other studies also emphasized this phenomenon and therefore called for re-evaluating the cultural and ecological meaning of lawns within urban green infrastructure [34,37,58,89,95,97,98,102,113].

Thus, while lawns continue to serve as cultural symbols of wealth, prosperity, order, and naturalness, their ecological reality reveals them as designed landscapes, an emblem of human-controlled "nature" [13,48,87]. To address this, we advocate for a shift toward re-planning, re-designing, and searching for more nature-based lawn alternatives (Section 3.2).

3.1.3. Green Space Versus a "Brownscape"

The culturally constructed image of lawns as uniformly green, aesthetically ideal, and vibrant spaces contrasts with ecological and visual realities, particularly under environmental stress. During periods of drought, heatwaves, or water scarcity, resource-intensive lawns frequently deteriorate into so-called "brownscapes", losing their visual appeal and failing to provide intended ecosystem services (Figure 7). This phenomenon is typical for Western and Central European countries, where usually summer precipitation is enough to support turf grass species and where the irrigation of common lawns is not prescribed in the schedule. In dry summers, however, these lawns are vulnerable. This exposes the limitations of traditional maintenance regimes that prioritize appearance over resilience. The emergence of brownscapes that replace green lawnscapes already in June is not only a matter of visual degradation but also of functional loss. It was detected not only in Mediterranean climates (e.g., in Italy, Spain), but increasingly also in temperate Central and Northern Europe, including Germany, Russia, and Sweden, where summer droughts and heatwaves are now more frequent. The simplified lawn species composition, dominated by a few non-native, shallow-rooted grasses and annual forbs, limits both ecological resilience and the ability to buffer against climatic extremes, which is also highlighted in other studies [13,39,53,79,81,88].

The socio-cultural dimension of brownscapes is equally significant. Residents often perceive green, manicured lawns as symbols of care, order, and urban prosperity. When these lawns become brown or degraded, this perception is disrupted, creating dissatisfaction and reinforcing pressure for resource-intensive practices such as regular irrigation. This paradox, where lawns embody both ideals of well-being and vulnerability to climate stress, highlights the persistent tension between aesthetic expectations and ecological realities of plant life during seasons [9,15,48,81,86,87].

In this context, the transition from brownscapes back to vibrant, functional green spaces depends on adaptive design, reduced reliance on intensive inputs, and a broader acceptance of more heterogeneous and ecologically complex lawns [58,61,81,84]. This shift underscores the dual role of urban lawns as both cultural symbols and integral components of ecosystems, emphasizing the need to align aesthetic management with climate-adaptive and sustainable planning principles.



Figure 7. Lawn degradation detected already in June: brownscapes in (**a**) a neighbourhood park of Barcelona, (**b**) Lene-Voigt Park in Leipzig, (**c**) Zaryadye Park in Moscow, and (**d**) overused lawn in one of Xi'an's public parks. (Photos: authors).

3.1.4. Social and Emotional Value Versus Functional Utility

Lawns provide high social and emotional value, offering aesthetic pleasure, sensory satisfaction, and spaces perceived as relaxing, orderly, and safe [1,38,72,90]. Their visual uniformity and green colour are culturally associated with well-being and prosperity, contributing to residents' sense of identity and attachment to their neighborhood [4,48,86]. In urban contexts, lawns are often preferred for their perceived accessibility and openness, creating semi-public areas that encourage casual social interactions and passive recreation (Figure 8) [90,95,108].



(**a**) (**b**)

(**c**) (**d**)

Figure 8. Lawn as a space for recreation and social interactions: (**a**) Friedenspark in Leipzig, (**b**) Lene-Voigt Park in Leipzig, (**c**) Alexandrovsky Garden in St. Petersburg, and (**d**) public park in Xi'an (Photos: authors).

Despite these social and emotional benefits, the functional utility of conventional lawns is often limited. They support most of the passive recreation (e.g., resting and picnicking on grass) and moderate game activities [59,60,107]. Conventional lawns' uniformity and low structural diversity can make them less resilient to environmental stresses such as drought or soil compaction, further limiting their practical utility in urban landscapes [40,87,88].

The maintenance-intensive nature of conventional lawns also contributes to this functional limitation. Regular mowing, irrigation, and fertilization are required to maintain aesthetic standards, yet these practices restrict spontaneous, unsupervised use and often prevent ecological succession or rewilding [39,61]. Consequently, lawns occupy substantial urban space while providing minimal ecological benefits compared to alternative green infrastructures such as seasonal and perennial wildflower meadows, mixed native plantings, or multifunctional green corridors [58,81,113].

3.2. Integrating Contradictions: Toward Sustainable Alternatives (NBS) and Rewilding for Urban Lawns

The contradictions of conventional lawns highlight the need to rethink their design, management, and cultural values. NBS and rewilding approaches provide opportunities to address these issues by reducing maintenance intensity, increasing biodiversity, and

enhancing ecosystem services [2,59,76,115]. In the subsections below, we discuss the rationale for applying NBS, including rewilding, to urban lawns, present the typology of strategies and interventions, and propose a practical approach for their implementation.

3.2.1. Rationale and Benefits of NBS for Urban Lawns

Research increasingly advocates for more sustainable and resilient urban green strategies and proposes a variety of nature-based alternatives for lawns, which reduce the tension between "natural" aesthetics and human management [40,81,95]. A growing number of studies [34,39,58,59,83,113] have proposed lawn-related NBS that not only support biodiversity (e.g., richer assemblages of pollinators, soil invertebrates, and birds) and enhance habitat connectivity within the urban matrix, but also cope with environmental stress and sustain citizens' cultural expectations of UGS [13,40,95]. By doing so, they contribute to urban ecological resilience while accommodating people's desire for accessible native (not designed) nature.

Nature-based lawn alternatives can also provide restorative and psychological benefits in addition to their ecological, social, and aesthetic roles. Evidence from therapeutic landscape research and design demonstrates that even small or managed green spaces, including lawns, can support stress reduction, attention restoration, and emotional well-being [93]. As Vogt [134] argues in his influential book "A New Garden Ethic", traditional monoculture lawns suppress wildness and disconnect us from biodiversity. Thus, replacing them with native, species-rich plantings not only restores ecological function but also reconnects people with everyday wildness, fostering ethical engagement with nature and a sense of place. Choosing native species is not just aesthetic but deeply ethical, reflecting justice concerns for non-human species [134]. Similarly, findings on childhood experiences and interaction with semi-wild areas have shown that they foster meaningful place attachment and long-term pro-environmental values and behaviours [80]. Furthermore, healing garden design principles indicate that even modest vegetated areas can contribute to psychological rehabilitation and therapeutic engagement, underscoring the potential mental-health value of more diverse or ecologically enriched lawn alternatives [135].

Integrated lawnscapes combined with other plantings can further enhance these restorative functions by creating "gardens of healing and compassion". Such blended settings provide calming, restorative spaces for relaxation or meditation, while their stewardship offers enriching experiences for users, owners, and curators. Recognizing lawns (especially, their species-rich/nature-based alternatives) as part of these integrated plantings extends their role beyond aesthetics to encompass emotional, restorative, and therapeutic benefits to urban residents.

Cities in Europe are increasingly moving away from manicured lawns, instead embracing strips of native plants such as decorative grasses, herbs, and wildflowers, which attract a wider variety of insects, birds, and other wildlife [36,37,50,51]. By reducing intensive management, urban areas allow lawns and other green spaces to flourish naturally, fostering self-sustaining ecosystems. Rewilded areas have been shown to support higher biodiversity, including pollinators, birds, and beneficial insects, while simultaneously improving drought resilience and carbon capture [40,73,95]. Additionally, increased ecological complexity can help control pests and reduce reliance on harmful chemicals and pesticides through reconstructing sensitive networking between ecosystem components [73].

In the past decade, there has been a growing trend toward the beautification of lawns and the creation of opportunities for local pollinators through the addition of early-flowering bulbs (e.g., *Scilla* spp. and *Bellis perennis*) in conventional lawns (e.g., in urban public parks, street verges in many European countries). However, after flowering, these lawns are typically mown, and the largest areas revert to the appearance and management

of conventional lawns. Therefore, we did not explicitly include such lawns in our typology, as they still follow a high-maintenance management regime, even though they represent a more advanced form of the classical conventional lawn and can be considered a flower-rich (urban species-rich meadows) lawn type.

Rewilding marks a fundamental shift from centuries of landscape management aimed at controlling and navigating particular aesthetic perfection, such as smooth green carpet-lawn. Rewilding allows "land to become self-willed", letting nature take its course [13,20,75,87]. A key advantage of rewilding, as one of the nature-based lawn alternatives, is to return to natural processes that can "self-repair" lost vegetation without involving high-intensity maintenance operations (e.g., pruning, mowing, weeding). Moreover, the increased ecological complexity in rewilded lawns fosters a richer community of natural predators and pathogens, which can help control pests and decrease reliance on costly or harmful chemicals [73].

3.2.2. Typology of NBS for Urban Lawns

The literature review revealed several studies exploring NBS alternatives to conventional lawns. However, research on this topic remains sporadic and does not fully capture the complexity of the NBS concept. To address this gap, we developed a comprehensive NBS typology based on our experience of applying the NBS concept to urban lawns, combined with the findings from the literature review. Our NBS typology is organized around three primarily parameters: plant composition, plant structure and layers, and maintenance regime. Within both the NBS theoretical framework and practical application, we emphasize four key dimensions: *(a) addressing societal challenges*, where landscape planning and design regarding lawns contribute to sustainable outcomes; *(b) drawing inspiration from nature*, for example by referencing local native ecosystems or self-sustaining urban plant communities; (*c) delivering multiple benefits* for both people and nature; and (d) *building with nature and people*, highlighting the role of co-creation and integrating social dimensions in developing locally adapted, context-sensitive NBS lawn alternatives.

Each of the NBS types proposed below also integrates restorative, emotional, and ethical functions, emphasizing their potential to improve physical and mental health and foster meaningful human–nature interactions.

Our research identified **a wide range of NBS alternatives** to conventional lawns that are successfully implemented in various case studies around European and some Asian cities. One of the main parameters for classifying these alternative lawns is the use of low-growing, designed plant communities with a maintenance regime lower than that of conventional lawns. We grouped them into **seven main types**, which are characterized in Table 3 (Figures 9–15):

(1) **Urban semi-natural grasslands** retain a close-to-natural or semi-natural composition, often resulting from historical land use such as traditional farming practices (pastures and meadows) rather than intensive management, where grasses and forbs thrive together, providing valuable benefits for people and wildlife through essential ecosystem services. They often include remnants of older grasslands, which are mainly found in old parks like landscape gardens [136], where, before the introduction of the motorized lawn mower in the 1950th, such grasslands were used as pastures and meadows. Further examples can be found in urban parks, road verges, and other green spaces, including Tempelhofer Feld in Berlin (former airport area), Adlershof district in Berlin, and Lene-Voigt Park (former railway station) in Leipzig. Additional examples are provided by interventions within the peri-urban grassland/floodplain restoration projects in Leipzig, including Auwald (Riverside/Floodplain Forest), as

well as the metropolitan grassland biodiversity program and Appia Antica Regional Park in Rome (Figure 9).

(2) **Rewilded lawns** (spontaneous urban vegetation) are represented by areas where largely unmanaged or self-establishing (naturally or spontaneously growing) vegetation, which is not intentionally planted and cultivated by humans. They create more natural, species-rich covers. Our studies found that in Western, Northern (and recently in Eastern) Europe, the "go wild" approach is popular (e.g., Park Gleisdreieck in Berlin), whereas in China, Vietnam, and Russia, a balance is needed between the wild, variable, species-rich qualities of spontaneous vegetation (which can be seen as messy) and a better-kept lawn appearance (Figure 10). Hence, a managed mixed lawn using a "cues to care" approach of Nassauer [137] may be more successful than relying solely on entirely spontaneous growth.

(3) **Urban species-rich perennial meadows (meadow-like lawns and grass-free tapestry lawns)** use appropriate native perennial species to form dense, low-growing covers that need little mowing. They can be created by sowing seeds or planting pre-grown plugs—the faster but costlier option. Seeded lawns take longer to fill in, and some grasses may eventually return. Once established, they need minimal maintenance and can be walked on, though people often avoid stepping on the flowers. Examples include urban meadows within the projects on adaptive planting to enhance biodiversity and cope with climate change, and to design and manage meadow-like plant communities, where wildflower species play a significant role (but grasses can still be the foundation for such meadows) in city districts of Barcelona, Beijing, and Moscow. Also, they are promoted within the Parks programme and projects on restoration of species-rich flowering meadows (Blühwiesen) in Berlin (e.g., Park Gleisdreieck) and Leipzig (e.g., Johanna Park, Friedenspark), several kindergartens of Leipzig, as well as at the campuses of the UFZ and the Uppsala and Stockholm Universities. Grass-free/tapestry lawns, which are made from planted low-growing flowering perennial and annual species but without any grasses and cut once a season, are closely related to this category (e.g., SLU campus in Uppsala) (Figure 11).

(4) **Naturalistic mixed-herbaceous plantings**—an approach proposed by Dunnett and Hitchmough [138] that combines native herbaceous (perennials, including bulbs) and grass species with attractive non-native, flowering prairie plants and low-growing shrubs depending on climate (e.g., xerophyte species). The primary goal of this type was addressing biodiversity needs (attract pollinators) and the preference of urban citizens to bright, pretty flowers that could reinforce the aesthetic acceptance of alternative solutions. Among the examples are interventions within Barcelona's naturalisation Program and Superblocks Program, including greening the streets, reclaiming of inner blocks, and establishing green corridors with naturalistic mixed-herbaceous plantings with grasses and perennials, wildflower meadows in the Citadelle park. Many large naturalistic perennial plantings are found in Moscow at Krymskaya Embankment, Triumphalnaya Square, and Park Muzeon. Planting with native and non-native species in a more naturalistic style is detected in public parks of St. Petersburg, Leipzig, Berlin, and Xi'an, including the Botanical Garden areas. Greening with perennial plantings is typical for the campuses of the Uppsala and Stockholm Universities (Figure 12). This type is quite diverse and reflects the specifics of local perennial plants' availability in nurseries. This type is perhaps one of the most "horticultural" types that can include more maintenance operations compared to other, more "nature" driven types.

(5) **Mixed-vegetation groundcovers** are low-growing plant assemblages (grasses, forbs, and herbs) designed to replace conventional lawns in some particular parts of urban green spaces. They provide continuous ground cover, often similar in appearance

to uniform lawns, while enhancing biodiversity, providing pollinator habitat, and protecting soils. Case studies in Moscow and St. Petersburg show the shift of public preference for a mix of cultivated and spontaneous plants, highlighting that the success of groundcovers depends on balancing ecological aesthetics with public perception of "wildness" and maintenance. Plant composition varies depending on climatic conditions—northern cities such as Uppsala, Stockholm, and St. Petersburg, as well as Moscow, tend to use low-growing perennial groundcover species. In contrast, Barcelona and Rome favour mixed-vegetation groundcovers using drought-tolerant Mediterranean groundcovers. In Chinese cities, shade-tolerant native species are used, e.g., in demonstration gardens on the Xi'an University campus (Figure 13).

(6) **Edible lawn alternatives** are based on plants such as creeping herbs (e.g., thyme, oregano), strawberries, vegetables, low-growing fruit plants, and certain clovers that can be grown as a ground cover. Being part of the broader edible landscape concept, they provide a functional, sustainable, and often scented/aromatic alternative to traditional grass, attract pollinators, and produce food. Examples are found in community gardens, residential courtyards, and public green spaces in Leipzig and Berlin, but are not yet widely adopted in Swedish, Vietnamese, and Chinese cities (except for the Xi'an University campus and within the roof garden of the GreenCityLabHuế project). However, edible lawns are emerging in Moscow and St. Petersburg through urban gardening initiatives that combine edible and ornamental plants in residential/blocks' green areas, street verges, and flowerbeds, creating a mix of aesthetic appeal and functional food production (Figure 14).

(7) **Pictorial (annual) meadows** are created from native and exotic annual plants, providing colourful flowering sites that are also highly attractive to wildlife. They are found on university campuses and public parks in Stockholm and Uppsala. In Berlin and Leipzig, pictorial and wildflower meadow pilots have been implemented as part of municipal greening campaigns. In Germany, such meadows are often called Blühwiesen (the same as urban species-rich meadows—type 1) (Figure 15).



(**a**) (**b**)

Figure 9. Type 1: Semi-natural grasslands of Berlin Adlershof (**a**), and (**b**) Johanna Park of Leipzig (Photos: authors).



(**a**) (**b**)

Figure 10. Type 2: Rewilding lawns: Low-maintenance lawn-alternatives based on rewilding principles, letting a mix of plants thrive naturally: (**a**,**b**) go-wild biotope (spontaneous wilding) in Park Gleisdreieck in Berlin (photos: authors).



(**a**) (**b**)

(**c**) (**d**)

Figure 11. Type 3: Urban species-rich meadows and meadow-like lawns: (**a**) species-rich meadow in Helmholtz-Centre for Environmental research Campus in Leipzig, explaining the value of biodiverse lawns; (**b**) grass-free (tapestry) lawn in the SLU campus in Uppsala; and meadow-like lawns at the SLU campus in Uppsala (**c**) and in Zaryadye public park in Moscow (**d**) (Photos: authors).



(**a**) (**b**)

(**c**) (**d**)

Figure 12. Type 4: Naturalistic herbaceous perennial plantings: (**a**) native perennial shade-tolerant plantings in the Xian demonstration garden (Campus of Xi'an Architecture and Technology University), (**b**) native plantings in the housing area of Stockholm, (**c**) plantings with grass and herbaceous species in Zaryadye Park in Moscow, and (**d**) with drought-tolerant species for Mediterranean climate in Barcelona (Photos: authors).



(**a**) (**b**)

Figure 13. Type 5: Mixed-vegetation ground covers: (**a**) with oxalis in Xi'an and (**b**) drought-tolerant species in Barcelona (Photos: authors).



(**a**) (**b**) (**c**) (**d**)

Figure 14. Type 6: Edible lawns with herbs and vegetables in back- and front yards of houses in Leipzig (**a**) and Berlin (**b**); UFZ campus in Leipzig with an integrated community garden (**c**), and lawn with pumpkins in St. Petersburg (**d**) (photos: authors).



(**a**) (**b**) (**c**)

Figure 15. Type 7: Pictorial (annual) meadows in public parks of Stockholm (**a**) and Xi'an (**b**), and street verges of Berlin (**c**) (photos: authors).

The idea of using "near natural" planting design in urban areas (types 3, 4, 5) was introduced in Central Europe in the early 20th century by German landscape architects (e.g., Karl Förster).

Table 3. Key types of nature-based lawn alternatives identified in case study sites and the literature review, with their main characteristics.

Type of Alternative	Primary Goals	Other Co-Benefits	Design, Plant Composition, and Maintenance	Case Study	References
(1) Urban semi-natural grasslands (Figure 9)	Ecological (support original flora/fauna (pollinators))	Carbon sequestration, erosion control	Remnants of historically natural or semi-natural grasslands, or areas managed to mimic them. Rich variety of native wildflowers and grasses that developed over time. Mowing once or twice per year or grazing; no irrigation; adaptive to local soil and climate	Leipzig, Rome, Berlin	[34,38,39,81,83,95,131,136, 139,140]
(2) Rewilded lawns (spontaneous urban vegetation) (Figure 10)	Biodiversity restoration, ecosystem service enhancement	Carbon sequestration, microhabitats for insects and birds, and aesthetic variation	Mixture of spontaneously appearing native and exotic plants. Minimal human intervention; occasional control of aggressive weeds that could also become invasive; supports ecological succession	Leipzig, Berlin	[2,37,40,45,72–74,76,87,125,141,142]
(3) Urban species-rich meadows (meadows-like lawns) (Figure 11)	Biodiversity enhancement (incl. pollinator support), habitat provision	Aesthetic value, seasonal floral diversity	Intentionally planted or managed to have a high diversity of flowering plants, grasses, and other species. High content of flowering perennial plants. Composition and structure differ depending on the availability of soil nutrients, water, and mowing regime. Mowing once or twice per year; minimal irrigation; adaptive to local soil and climate	Barcelona, Beijing, Berlin, Leipzig, Moscow, Stockholm, Uppsala	[44,45,48,49,53,82,98,107, 114,131,139,143–145]
(4) Naturalistic herbaceous perennial plantings (Figure 12)	Biodiversity and aesthetic value	Could include Nitrogen-fixing species, pest control	Plant communities made from perennial grasses and forbs, native as well as some exotics. Low to medium maintenance; requires initial planting and occasional weeding	Berlin, Leipzig, Moscow, St.-Petersburg, Stockholm, Xi'an, Uppsala.	[2,6,43,48]
(5) Mixed-vegetation ground covers (Figure 13)	Soil protection, multifunctionality	Microclimate regulation, runoff reduction, visual diversity	Low maintenance, drought- or shade-tolerant ground-cover species; include diversity of species with decorative characteristics (diversity of colour, texture and forms). Minimal irrigation and occasional weeding	Leipzig, Berlin, Moscow, St.-Petersburg, Uppsala, Xi'an	[11,48,51]
(6) Edible lawn alternatives (Figure 14)	Food production and multifunctionality	Pollinator habitat, soil health, urban microclimate benefits	Often permaculture-inspired: low or no mowing, diverse edible species; some irrigation may be needed; maintenance depends on species selection	Berlin, Leipzig, Moscow, St. Petersburg	[11,51,57,133]
(7) Pictorial (annual) meadows (Figure 15)	Pollinator habitat, decorative purpose (colourful, designed meadow)	Visual diversity, runoff reduction	Made from native and exotic annual plants. Occasional weeding. Cut at the end of the season and reseed in the next year	Berlin, Leipzig, Stockholm, Xi'an, Uppsala	[1,48]

3.2.3. Implementation Methods and Practical Considerations

Sustainable management of urban lawns based on the NBS concept is a **multi-step process consisting of the following phases**:

- Selecting appropriate sites;
- Reducing management intensity;
- Planting native species;
- Engaging local communities in the planting and maintenance process;

- Applying adaptive management (e.g., research-based time of mowing aiming to achieve the best flowering effect and attract different groups of pollinators during the vegetative season).

Below, we provide **practical recommendations** for implementing nature-based alternatives, including rewilding, considering each of the proposed steps.

Step 1: Selecting appropriate sites. Implementing the NBS approach in urban lawns requires both ecological planning and adaptive management strategies that balance biodiversity goals with social acceptance and recreational use. It starts with site-specific planning, identifying areas that can be converted from intensively managed lawns to meadows, mixed herbaceous plantings, or low-maintenance grasslands. The scale of intervention can vary: from small sections in the park, for example, on the edge between different biotopes, such as forest and conventional lawns, roadside verges, rain and swale gardens margins, and community gardens, to large urban naturalistic parks and institutional grounds, depending on ecological potential, public use, and available resources. This is also mentioned in other studies in Australia [41,42,58], France [113], Russia [59,60,107], and Poland [36,37].

Step 2: Reducing management intensity. Practices such as less frequent mowing, minimal irrigation, and limiting chemical inputs allow native plants to establish and self-regulate, and foster natural processes that can be later regulated. For instance, alternating mowing cycles and creating mosaic habitats of different species of grasses, wildflowers, and shrubs can simultaneously support pollinators, birds, and other wildlife, while maintaining visually interesting design spaces for residents [36,40,50,51,73,95].

Step 3: Planting with native diverse species (different life forms, colour pallets, and textures combining in different planting design schemes). Prioritizing native and locally adapted species promotes ecological compatibility and enhances functional biodiversity, including natural pest control and pathogen regulation. Different studies worldwide pointed out that mixed-species plantings, polycultures, and drought-tolerant grasses can increase ecological resilience, reduce maintenance needs, and provide seasonal flowering patterns that support pollinators and other wildlife throughout the year [1,34,39,58,83,115].

Step 4: Engaging local communities. NBS approach is based on community engagement and citizen science initiatives, and also requires cooperation with local plant nurseries and scientists, which can guide plant selection, monitor biodiversity, and increase social acceptance of "messy", less-manicured landscapes by raising community awareness of the opportunities for greening for wildlife, and providing training programs and manuals to address the lack of knowledge. By combining ecological planning with public involvement, cities can implement multifunctional lawns that reconcile aesthetic expectations, recreational use, and ecological function [13,20,87].

Step 5: Adaptive monitoring and management. Nature-based lawn alternatives require continuous observation of species composition, growth patterns, and ecological interactions to inform management interventions when necessary. Our research demonstrates that iterative, practice-led approaches (e.g., adjusting mowing regimes, controlling undesirable weed species, and modifying plantings) lead to successful long-term outcomes for urban biodiversity [59,95,113].

Based on case studies and insights from the literature review, we summarize the specific barriers to implementing lawn alternatives and propose ways to overcome them (Table S1 in Supplementary Material). Our observations show that key barriers to implementing biodiverse and rewilded urban lawns include the lack of ecological education of the public, decision makers, and professionals responsible for planning, design, and maintenance of green spaces. Other limiting factors are restricted land and plant resources, insufficient funding, and a long history of social or aesthetic preferences for traditional lawns. Additionally, achieving successful flowering in herbaceous, species-rich meadows

requires proper soil preparation, specifically soils low in fertility, and removal of clippings (hay) to maintain these conditions.

To address these barriers, we proposed a variety of leveraging factors (see Table S1 in Supplementary Material) such as community engagement, citizen-science participation, ecological education at different levels (pre-school and universities; training of the professionals and UGS managers), access to native plants, demonstration sites in public spaces (especially in Botanic Gardens), and additional funding mechanisms/community fundraising schemes. These strategies can facilitate multifunctional, resilient urban green spaces that balance biodiversity goals with social acceptance.

4. Discussion

4.1. Urban Lawns Reconsidered

This study highlights the multifaceted role of urban lawns in Eurasian cities, revealing tensions between cultural, ecological, and functional dimensions. Lawns, traditionally valued for aesthetics, recreation, and social symbolism, impose ecological and economic costs due to intensive maintenance, homogenized plant composition, and vulnerability to climate stressors.

The exploration of NBS and urban rewilding offers a pathway to reconcile these contradictions. Case study sites and analysis of the recent literature show that rewilding and nature-based alternative lawn designs can improve biodiversity, ecological resilience, and multifunctionality while maintaining acceptable social and aesthetic values [6,8,34,43–45,72–74]. In addition to biodiversity and ecological benefits, nature-based and rewilded lawns can provide important restorative, emotional, and ethical values. Research shows that species-rich or semi-wild lawns support stress reduction, attention restoration, meaningful place attachment, and pro-environmental behaviour, while reconnecting people to everyday wildness and promoting ethical engagement with non-human life [80,93,134,135]. Strategies such as reduced mowing frequency and the timing of mowing (based on proper research of plant community successions), native and drought-tolerant plantings, and community participation can enhance ecological outcomes, even at small scales, for example, in private or small pocket public parks or street verges.

However, the successful implementation of these alternative solutions is context-dependent. As Table S1 (in Supplementary Material) demonstrates, the main barriers include limited ecological knowledge, restricted land and plant resources, funding constraints, specifics of laws and regulations, and entrenched cultural preferences for manicured lawns. Addressing these challenges requires integrative approaches combining ecological planning, ecological design and adaptive maintenance, community engagement, and education. Social acceptance of "wild" or less-maintained green spaces is particularly influenced by environmental identity, perception shifts, and the demonstration of multifunctional benefits [1,4,9,73,76,95,113,118,123,124,129,130]. Jørgensen [119] (2015) and Kowarik [70,75,142] further argued for a more inclusive perspective, suggesting that attempts to strictly separate nature from culture can be counterproductive or even detrimental. Urban rewilding is constrained by requirements for sufficient scale, remoteness, and naturalness, which explains why large-scale initiatives are mainly limited to small- and medium-sized cities and often face challenges such as limited site availability, fragmentation, and the absence of standardized legal frameworks.

4.2. Nexus Between NBS, Rewilding, and Other Sustainable Alternatives for Urban Lawns

The study presents a variety of sustainable strategies to conventional urban lawns, categorized into seven types of nature-based alternatives, including rewilding as one of them. However, although overlapping in some outcomes, nature-based alternatives to

urban lawns differ conceptually and functionally, and their adoption can vary in different countries. For example, in China, naturalistic planting, meadow-like and pictorial lawns have become popular in the last two decades, while the groundcover type with more even surfaces is one of the leading types. This reflects the traditional classic Chinese gardens, which often use uniform groundcovers from *Ophiopogon* spp., especially in shady places [4].

Nature-based lawn alternatives generally involve intentionally designed plantings that replace conventional lawns with species-rich meadows, mixed native grass polycultures, or pictorial lawns, providing ecosystem services such as pollinator support/habitat, carbon sequestration, and microclimate regulation [6,13,20,51,87,145]. These interventions are guided by ecological knowledge and landscape design principles to optimize specific benefits while remaining accessible and socially acceptable [4,10,11]. Moreover, beyond ecological gains, these lawns provide restorative, emotional, and ethical functions, supporting physical and mental health and fostering meaningful human–nature interactions [80,93,134,135].

Rewilding emphasizes reduced human management and the promotion of spontaneous ecological processes (succession), allowing urban ecosystems to self-organize and restore functional biodiversity over time [71,74,106,119,146]. It typically involves passive management of abandoned lawns, creation of secondary succession habitats, or reintroduction of keystone species, with a focus on ecological integrity rather than aesthetics [73,76,113]. From an ecological perspective, a rewilded lawn is closer to a semi-natural grassland type, where natural processes are also respected, but selective management, such as a carefully chosen time of cuttings, may still be applied to maintain desired functional outcomes.

Although pest management is an important aspect of conventional lawn care, it is often associated with the use of chemical pesticides, which can negatively affect pollinators, soil biodiversity, and other non-target organisms. Nature-based lawn alternatives, such as species-rich or rewilded lawns, can reduce pest pressures through increased ecological complexity, fostering natural predator-prey interactions and enhancing ecosystem resilience.

Nevertheless, not all sustainable lawn alternatives and rewilding approaches can be framed as NBS. While NBS are interventions intentionally designed to address the societal challenges and provide a variety of co-benefits through nature-based processes, some biodiversity-friendly lawn alternatives may lack sufficient scale, multifunctionality, or explicit social-ecological objectives to be considered NBS (see the eight criteria for framing intervention as NBS proposed by IUCN [23] and other approaches [2,25–27,147]). For instance, native grass or flowerbeds can enhance biodiversity and reduce maintenance but may fall short of broader urban resilience goals without strategic integration into planning frameworks [22,24].

4.3. Limitations and Future Research

Despite broad applicability, several limitations arise from the study design and methods. Our research combined comparative case analyses across nine Eurasian cities and a narrative review of 87 publications. While this mixed-methods approach allowed a holistic assessment of ecological and socio-cultural dimensions of urban lawns and their alternatives, it has certain limitations.

First, the literature review may be biased toward English-language and peer-reviewed sources available in scientific databases, potentially overlooking regionally relevant grey literature in local languages. Such local studies could provide more nuanced insights into lawn alternatives and context-specific practices.

Second, case study selection was limited to ten cities across temperate, Mediterranean, and tropical monsoon climates. Although diverse, the sample cannot fully capture global variability in cultural practices, geographic and socio-economic contexts, or urban planning frameworks. We acknowledge that our findings may not be directly transferable to cities

with extreme climates, different governance structures, or distinct historical traditions of lawn management.

Third, field observations, biodiversity assessments, and social surveys reflect short-term conditions and do not capture long-term ecological or social dynamics. Therefore, longitudinal ecological monitoring is needed to assess the persistence and resilience of rewilded lawns and alternative NBS approaches under climate change and urban pressures. Similarly, social surveys may not fully capture evolving public perceptions; thus, participatory approaches could be expanded to ensure broader stakeholder representation.

To address these limitations, future research should consider:

- Conducting longitudinal studies to assess ecological and social outcomes of alternative lawns over multiple seasons and years.
- Expanding comparative analyses to cities outside Eurasia, including arid, tropical, and subtropical regions, particularly in the Southern Hemisphere, using similar methodologies.
- Evaluating cost-effectiveness and scalability of nature-based and rewilding interventions.
- Integrating multi-disciplinary approaches, combining ecology, landscape architecture, urban planning, and social sciences to bridge theory and practical implementation.
- Adopting a transdisciplinary approach for investigating and achieving socio-cultural acceptance of diverse lawn alternatives and for extending strategies for community engagement, co-design, and environmental education.

These directions would strengthen the evidence base for integrating NBS and rewilding into sustainable urban lawn management, providing actionable insights for policymakers, designers, and communities.

5. Conclusions

This study demonstrates that NBS, including rewilding, offer practical pathways to reconcile ecological and social needs in establishing and managing urban lawns. A typology of such NBS alternatives to conventional lawns has been developed through case studies in Eurasian cities and a literature review, linking conceptual insights to real-world applications. Among them are urban species-rich meadows, semi-natural grasslands, naturalistic herbaceous perennial plantings, mixed-vegetation groundcovers, edible lawn alternatives, pictorial (annual) meadows, and rewilded lawns. Key interventions include reduced mowing regimes, multifunctional green spaces, community engagement, and adaptive management, all supporting resilient urban landscapes. The results show that these NBS approaches can enhance biodiversity, ecosystem service provision, and climate resilience while remaining socially acceptable and aesthetically appealing if the traditions of landscape design and cultural norms and preferences are considered. Key barriers and enabling factors have been identified, emphasizing the importance of ecological knowledge, social acceptance, access to suitable plant material, and flexible land-use planning.

Assessing urban lawns from ecological, cultural, and planning perspectives enables evidence-based recommendations for transitioning conventional lawns toward sustainable, biodiverse, and socially inclusive nature-based alternatives. By illustrating the potential of rewilding and NBS-oriented lawns, this study offers tangible strategies for cities to mitigate biodiversity loss, adapt to climate change, and foster stronger human–nature connections.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/d17120830/s1, Table S1: Rewilding of urban lawns: barriers and opportunities.

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