

**KEY WORDS:**

Lawns, Urban Landscapes, Biodiversity, Aesthetics

## The Landscape of Lawn

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Tekton Volume 7, Issue 2, September 2020, pp. 08-21

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**ABSTRACT**

This opinion paper discusses the proliferation of lawns in the urban landscape. It looks at the features ascribed to lawns that have found favour with designers and have contributed to lawn becoming the ubiquitous urban landscape, and the consequent ecological impact of lawns within the context of global urbanization. The goal of this article is to challenge designers to think outside their preconceived design ideals and aesthetic norms to reverse the current trend toward “lawn-ization” and instead, create landscapes that make a positive contribution to urban ecology and biodiversity.



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## Introduction

We live in urban times, as cities take over much of the inhabited environment. Urbanization is proceeding at an unprecedented scale, with 68% of the earth's population predicted to live in urban areas by the year 2050 (United Nations, 2018), i.e. in less than 30 years, 2 out of every 3 people will live in an urban area. As cities grow, they take over adjoining forest, wetland and farmland. The processes of urbanization require extensive landscape modification, far exceeding the actual footprint of the urbanized land, and existing landscapes are often wiped out in the creation of new urban biotypes.

The landscape vocabulary of choice that has accompanied this urbanization is the innocuous looking lawn. Ubiquitous in today's urban and suburban landscape, the word "park" conjures up the same image of a grassy area dotted with trees, no matter in what part of the world one may be (**Figures 1 and 2**). Lawns are the most common elements of green city spaces across the globe, covering up to 50%-70% of urban green areas (Ignatieva, Haase, Dushkova, & Haase, 2020). Over the course of less than two hundred years, lawn has become the most frequently encountered urban biotype, replacing forest, wetland and farmland, and continues to grow.

Why has a garden feature that came into being only three hundred years ago in one small part of the world become the dominant urban/ designed landscape, one that designers fall back on no matter where they live? How has lawn, which is often a purely decorative element, become the number one irrigated crop in the United States? How have we as designers facilitated this process and how can we do better?

Let us begin by looking at some of the qualities that we assign to lawns.



**Figure 1:** Nehru Park in Gurgaon, India (hot semi-arid climate per Koppen-Geiger classification)



**Figure 2:** Park in Quebec City, Canada (warm humid continental climate per Koppen-Geiger classification)

## Lawns as Civilized

Lawns have their beginnings in the meadow landscapes of Europe. Medieval Gardens were said to have small plots of lawn, although their lawns were heavily mixed with flowers, and bore little resemblance to today's green carpets. While certainly in use before, the vision

behind today's lawns can be traced to the gardens of Lancelot 'Capability' Brown (so called because he would describe the "capabilities" of their properties to his clients). Brown designed several of England's gardens in the mid to late 18th century, creating carefully constructed panoramas of parklands with wide undulating lawns, clumps of trees, serpentine lakes and streams with grassy banks.

This park landscape was embraced by the aristocracy not only for its beauty, but also because it provided unobstructed views to a grand mansion, a display of wealth and power visible from a distance. Brown's landscapes were simple, restrained and elegant, providing an idealized image of the English countryside, landscapes that looked so natural that it was difficult to even imagine that they had not always been there, let alone that they were designed (**Figures 3 and 4**). Blenheim Palace (located in Woodstock, UK: temperate oceanic climate according to the Koppen Geiger Climate classification: warm and temperate, significant rainfall, with precipitation even during the driest month) is one such example, a beautiful undulating parkland that provides both stunning views out to the landscape and a grand setting for the architecture. This pastoral ideal was fitting to England with its relatively mild temperatures, high rainfall and appropriate soils, and quickly became the quintessential English landscape, and the yardstick against which all other landscapes would be measured, no matter where in the world they may be.

The Englishman's love of the grass is well known and indeed all of the sports associated with the English: golf, cricket and football can be traced back to the grass. The English took this ideal landscape with them wherever they went. When Lord Curzon (Viceroy of India, 1898-1905) first set sight on (and fell in love with) the Taj Mahal in 1887-1888, the gardens in front of the monument contained "masses of foliage that would have almost obscured



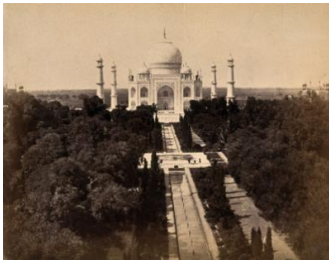
**Figure 3:** Blenheim Palace, Woodstock, UK.  
Source: Wikimedia Commons



**Figure 4:** Burghley House, Lincolnshire, U.K.  
Source: Wikimedia commons, Attributed to: PJ Marriott

the mausoleum when seen from ground level” (Herbert, 2011) (**Figures 5, 6 and 7**). Located in Agra, India (hot semi-arid climate according to Koppen Geiger Climate classification, with average temperatures over 32 C six months of the year, little rainfall throughout the year), the gardens had enchanted visitors with not only its pure geometric form, waterways and fountains, but also its orchards of fruit trees, fragrant flowers, and rows of cypress trees flanking the waterways, in short “all the beauties of Flora” (Herbert, 2011).

By the late 19th century, however, once Lord Curzon was done with the restoration of the monument and the improvement of the grounds, those fragrant gardens had been replaced with extensive lawns and wavy trees along their edges. That densely shaded landscape, so desirable in the dry heat of Agra, had been “refined” to suit English sensibilities. From being an essentially private and intimate garden meant to be enjoyed from within, with a mausoleum that revealed itself gradually as one moved through the space, it is now an open public landscape with endless vistas, a setting from which to behold a magnificent monument: in short, a landscape to be viewed, instead of one to be experienced (**Figures 8 and 9**).



**Figure 5:** Historic photograph of the Taj Mahal gardens, ca 1900.  
Source: Wikimedia Commons



**Figure 6:** Historic photograph of the Taj Mahal with the gardens in the foreground, photograph by Felice Beato, circa 1858.  
Source: Wikimedia Commons



**Figure 7:** Painting of the Taj Mahal by Edwin Lord Weeks, 1883.  
Source: Wikimedia Commons



**Figure 8:** Current gardens of the Taj Mahal.  
Source: Wikimedia Commons



**Figure 9:** Current gardens of the Taj Mahal. Compare with Figure 6. Source: Wikimedia Commons



*Figure 10: Suburban development in Massachusetts, USA*

Lawn turned out to be not only a symbol of the British Empire but also a symbol of Western civilization: land in regions as diverse as north-eastern America, Australia and New Zealand were labored upon and molded so that it conformed to the civilized ideal. When confronted with a climate of extreme heat and frequent droughts in Australia, settlers nevertheless sought to replicate the same landscape, valued not only because it reminded them of their idealized home, but also indicated progress. Ignatieva et al (Ignatieva, Haase, Dushkova, & Haase, 2020) mention that for these settlers, “lawns as part of a cultivated and irrigated garden, were a powerful symbol of the supposed superiority of the European civilization in contrast to the indigenous (Aboriginal) wilderness.”

While early lawns were a symbol of status and wealth in the United States, they have since come to be looked at as some kind of democratic ideal. The defining feature of American suburbs, no matter where they are located, whether in water-rich cities of the north-east or desert cities of the south-west, is houses sprinkled on expanses of lawns (**Figure 10**). These grassy expanses represent morality and domesticity, a badge of honour worn by law-abiding citizens working together for the common good. Currently, the lawn area in the United States is about 40 million acres and Americans spend about \$30 billion on lawn care every year. What is more concerning is that this area is growing at the rate of almost six hundred square miles a year, i.e. new lawn equal to two times the area of New York city every year in the United States alone.

Even in countries not exposed to Colonialism, there is the preconceived notion that Westernization = modernization/ progress. In China for example, lawns are a comparatively recent phenomenon, absent as they are in traditional Chinese gardens (**Figures 11 and 12**). Yet now, according to Yang et al (Yang, Ignatieva, Larsson, Zhang, & Ni, 2019), China is seeing a “dramatic increase in in yearly planted lawn area”, and “public lawns are one of the most visible elements of urban green spaces.” It should be noted that unlike other countries, most lawns in China are not meant to be used, they exist purely for aesthetic reasons. In their study of the historic city of Xian (cold, semi-arid climate according to Koppen Climate classification, no rain at all for 5.6 months of the year), Yang et al explored among other things, the motivations of park managers and landscape



**Figure 11:** Typical planting and inward nature of traditional garden, Shanghai, China



**Figure 12:** Recent development in China

architects behind the lawn landscape. Here are some of their responses: “Some politicians went abroad and found that the lawn covered a large portion of urban green spaces. They enjoyed the landscape very much and imported it to China.” “In recent years, we used more lawns than before because it is noble and graceful.”

All over the world, lawns are not only the most prolific urban landscape, they have also become the most urbane.

### Lawns as Green/ Ecological

On a very simplistic level, we are inclined to think that anything that looks green, must be green, i.e. it must provide unquestionable ecological benefits. Lawns do provide ecological benefits: they allow rainwater infiltration, trap atmospheric carbon dioxide, improve the soil structure and reduce the heat island effect in cities, when compared to any number of pavement systems.

However, urbanization today involves the conversion of forests, wetlands and farmland to urban areas. Within this context, lawn is not replacing existing pavement; it is, in most cases, replacing other existing landscape types. It would therefore be more relevant to compare lawn to other landscape types than to compare it with pavement.

Lawn is touted as providing a permeable surface that promotes infiltration, which it does in comparison with pavement. Selbig et al. (Selbig & Balster, 2013) evaluated rain gardens planted with either turf (i.e. lawn) grasses or native prairie grasses in Dane County, Wisconsin, USA. Median infiltration rates in rain gardens planted with turf were 0.28 inches per hour in clay soil and 2.5 inches in sandy soils, while rain gardens planted with prairie grasses infiltrated at a rate of 2.5 inches per hour and 4.2 inches per hour in clay and sandy soils respectively.

Additionally, it should be noted that lawn is usually fertilized, and any fertilizer that is not used by the grass may leach through the soil. Further, it is plant roots that bind accumulated sediments, such as any pollutants. Native prairie grasses in mid-western United States such as the Buffalo grass (*Buchloe dactyloides*) and Prairie Dropseed (*Sporobolus heterelopsis*) have roots that go over 6' deep into the soil. Turf grass species, on the other hand, have roots that are less than 6" long (often only 1" – 2" long), one of the reasons that lawn needs to be watered so often. Deeper roots increase the ability of the soil to absorb and retain water, bind pollutants and prevent runoff far better than the shallow roots of commercial turf grasses. They can tap into nutrients unavailable to shallow rooted plants and require less or no fertilization.

While lawns do trap atmospheric carbon dioxide and reduce the heat island effect in cities, gas-powered lawn mowers alone account for five percent of the air pollution in the United States according to the EPA. Some more statistics from the EPA include the following: At least 17 million gallons of gasoline are spilled annually just filling these lawn mowers. Using a gas-powered mower for one hour produces the same amount of emissions as 11 new cars also running for an hour.

Then there is the question of biodiversity, one of the major ecological challenges facing cities today. A study (Belcher, et al., 2019) done in Singapore (tropical rainforest climate according to Koppen Climate classification) compared the diversity of birds in three different urban environments: gardens, vacant lots and parking lots planted with trees and understory shrubs. Spaces designated as gardens needed to be at ground level (i.e. not roof gardens) with a minimum 25% of their land area being planted with foliage other than lawn and have some hardscape; parking lots had bays split up with rows of shrubs and large overstory trees, and vacant plots were lawn surrounded by trees on edge. In Singapore, vacant plots are heavily managed to appear neat and tidy, and their lawns are regularly mowed and maintained. In many parts of the world, the vacant plots would pass off as typical parkland. In results that can only be described as astonishing, it was found that the ground gardens and parking lots had a bird species richness of 18 - 19, while the vacant plots was half as much at 9. The researchers explained it as partly due to both gardens and parking lots having a similar vertical complexity in their vegetation (i.e. multiple layers of shrub and tree canopy). It appears that even a parking lot, provided it is well planted, can act as a better habitat for birds than maintained lawn. To this end, the researchers recommend replacing "heavily managed short grass turf with diverse vegetation types more similar to natural vegetation". Clearly, this discussion goes beyond the native/ non-native species debate to suggest that even if we do have only native trees sprinkled on a lawn, we may not be doing much to encourage wildlife species diversity. On the other hand, increasing the understory vegetation so that it covers at least 25% of the ground resulted in doubling wildlife species diversity.

By repeatedly comparing lawn to pavement, rather than to other landscape types that it is replacing, we reinforce the myth of lawn as a valid part of sustainable green infrastructure.



**Figure 13:** The “simple and natural” landscape of lawn and trees

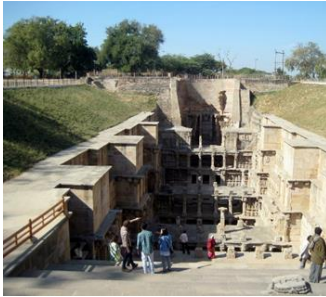
### Lawns as Natural

Often, landscape architects are either asked or put it on themselves to create a landscape that is “simple and natural”: one that is inevitably translated as a grassy parkland sprinkled with trees (**Figure 13**). This description is a paradox: for one, nature is not simple: it consists of incredibly complex organisms and processes that we are only starting to recognize, let alone understand. Two, lawn is not natural.

To keep the emerald green look that is so desirable, we rely on irrigation, fertilization, frequent mowing and herbicide applications. In desert city of Phoenix, Arizona (hot desert climate according to the Koppen Geiger Climate classification) in the United States, 74% of water used in residential areas is for outdoor purposes such as irrigation. Constant mowing succeeds in keeping the grass blades perpetually juvenile, and consequently perpetually green. Repeated applications of synthetic fertilizer are required in most temperate climates to trick the plants to putting out new growth and supersede the seasonal cycle of dormancy in grasses when they turn dry and brown. We have redefined as weed, all plants that common herbicides kill. We now have chemical lawns that are hazardous to the people who use them, leaching fertilizers into the soil. We often drink water laced with pesticides as the chemicals run off into drinking water bodies.

Lawn as a type of meadow plant community is alien to the native landscapes of most of the United States, Australia and Asia. Consequently, lawns in these regions are made of exotic imported plant species. Even in Western Europe, the meadows of which lawns have their origin, contemporary turf grass seed mix consists of hybrid species or monocultures that have no equivalents within the natural European environment and contribute little to urban diversity. Lawns have “limited ability to act as species reservoirs or corridors for native species” (Wheeler, et al., 2017). Ignatieva et al (Ignatieva, Haase, Dushkova, & Haase, 2020) mention that most of the lawns in the world consist of four European species in temperate climates, and five in warm climates, i.e. we are destroying our biodiversity and replacing it almost worldwide with nine species of plants. As Doug Tallamy mentions in his book, *Nature’s Best Hope*, “every square foot dedicated to lawn is a square foot that is degrading local ecosystems.”





**Figure 14:** The meticulously restored Rani-ki-Vav, Patan, India



**Figure 15:** The park-like setting for the Rani-ki-Vav, Patan, India



**Figure 16:** Temple in Bangkok, Thailand

### Lawns as Neutral

If lawns are green enough to appear natural, they are also bland enough to appear neutral. It is the very supposed neutrality of lawn that has led it to being indiscriminately used, with no regard to context. Patan, Gujarat (hot semi-arid climate according to Koppen Geiger Climate classification, average daily high temperature above 35 C in summer, no rain for seven months of the year) is the location of an ancient step well Rani ki Vav, or the Queen's stepwell. Built in the 11th century, the ornate stepwell served social and spiritual functions in addition to tapping into an underground aquifer. Silted over due to repeated flooding from the nearby river Saraswati starting from the 13th century, it was hidden from view for over seven hundred years. Rediscovered in the mid- 1900s, the step-well was meticulously restored by the Archaeological Society of India, over a period lasting more than three decades. Painstakingly rebuilt stone by stone, the monument was declared a UNESCO World Heritage Site, a unique architecture that belongs to a unique place. There is however nothing unique about the surroundings. In what has become typical of land around historic monuments the world over, the stepwell sits in a park-like setting (**Figures 14 and 15**). Lawn with a sprinkling of trees has replaced the arid desert or scrub vegetation that would have characterized this region a thousand years ago.

From temples in wet Bangkok (**Figure 16**) to stepwells in arid Patan, lawn has become the default landscape of historic architecture. Lawns have become such a part of our collective consciousness, so neutral, that we accept them blindly even in locations where their usage is clearly incongruous. That incongruity goes almost unnoticed, part of a reflex design vocabulary to which we do not pay a second look. As a result, architecture that arose because of water scarcity in the region is now surrounded by the most water guzzling landscape known: lawn.

### Lawns as Setting

One of the reasons that lawns are popular is because they are considered as ideal foils to more "interesting" architecture. A design idea endlessly self-propagated by modern day



**Figure 17:** Lawn as setting for modern architecture, Massachusetts, USA



**Figure 18:** Lawn as setting for architecture, Singapore

designers, lawns cater to the notion that the landscape needs to be subservient to the architecture, that it exists merely to provide a setting: a green carpet on which a building can be carefully displayed (**Figures 17 and 18**). Interestingly, Eugenia W. Herbert in her book *Flora's Empire* describes a Mughal ideal, a partnership between architecture and garden, where one is not more than the other. According to Herbert, in redesigning the grounds of the Taj Mahal, Lord Curzon imposed "a subordination of garden to architecture that might have baffled the Mughals."

The use of lawn as setting, a clean carpet that complements the clean lines of architecture relies on the artifice of lawn rather than any naturalness. It embraces stripping of character or eccentricities, presenting a simplified nature that is as man-made as the building which it displays. We let remain only those fragments of nature that will accentuate our creation: a sheet of water to enhance/ reflect a façade or select trees to frame a view. While defending his motives, his obituarist declared that "Lord Curzon had all the cultivated Briton's love of clearing away incongruous accretions which make a comprehensive view of a monument, and of setting the jewel again in an environment of greenery" (Herbert, 2011). It is a sentiment that is still shared by modern-day designers as they seek to clear the land of anything that may belong there to set their building in an environment of subdued greenery. In so many ways, we are still acting like cultivated Britons.

## Moving Forward

If worldwide we have accepted lawn as an ideal, natural landscape, how can the design community change its approach? Where can we start and what kind of changes do we need to make to tackle this problem of lawn-ization of the urban/suburban world?

### Start small

We need to come to a consensus that lawns do not need to occupy the majority area of all landscapes. While there cannot be a single alternative to lawn that is applicable worldwide, two changes that we can all embrace are (1) to reduce the area of lawn



**Figure 19:** Actively used lawn area in park in Stockholm, Sweden



**Figure 20:** Lawn in Chennai, India

and (2) to introduce appropriate regional understory vegetation. The first step that entomologist and author Douglas Tallamy advocates in order to allow native species to thrive is the reduction of lawn area (Tallamy, 2019). The reduction in lawn area needs to be based on an evaluation and better understanding of how people use exterior spaces. In regions where lawns are actively used, open lawns can be restricted to areas of active or semi-active recreation (**Figure 19**). In several cultures of Asia and Africa, people do not use lawns actively, and lawns are often off-limits (**Figure 20**). In these places, parks are better served with paths amid strolling gardens and hardscape zones to accommodate active uses within hardscape zones.

As the Singapore study showed, covering at least 25% of the site with under story vegetation of native vegetation can be a significant improvement. Public parks could have demonstration sites that display alternatives to lawns, or some parts of the park could be less actively managed, allowing successional processes of vegetation to take place. Together, these could help inform and influence public opinion.

### Educate Users

If 70% of the nature that a city-dweller observes is lawn, then lawns become the lens through which all nature is perceived and the yardstick through which all of nature is measured. Nature becomes desirable the more it resembles lawn, and less desirable the more it deviates from that norm. What may be thought of as “rewilding” on the part of some designers, may be interpreted as “neglect” or “untidy” by users.

Studies show that “Exposure to nature as an essential ingredient in developing an appreciation for biodiversity” and “A lack of knowledge was also linked to fear or discomfort with nature among some of the public” (Campbell-Arvai, 2019). Consequently, it becomes important to educate the users who have till now perhaps had a lack of exposure to anything other than manicured nature. In Malmo, Sweden, signs were put in

semi-natural park areas to “highlight local biodiversity in order to gain acceptance from the public for such management and habitats” (Aguilera, Ekross, Persson, Petterson, & Ockinger, 2019). Further, according to the authors of the same study “There is a risk of losing these green spaces, especially those that can be perceived as aesthetically unappealing for the general public.”

If signage is required to justify non-lawn habitats, then perhaps, we can go a step further and say that signage should also accompany all lawn areas. Few park users recognize the resources and energy that go into the maintenance of a park. The signage would explain exactly what lawn areas require in terms of irrigation, chemical input, mowing manhours, energy expenditure, etc., in language that is easy to understand. For example, in an arid region like Phoenix, Arizona, there could be signage on an acre of lawn that says, “This lawn consumes 27,138 gallons of water on one summer day, that’s enough water drinking water for you for the next 148 days.” Or “Mowing this lawn contributes 1,000 kg of carbon dioxide per year.”

### **Embrace a more integrated approach to land design, driven by ecological and cultural identities**

This seems a fashionably appropriate thing to say. However, hidden within this statement is the uncomfortable notion that designers may need to confront and question their own aesthetic norms as well as their values. It means confronting the practical implications of our aesthetic preferences and the value that we place on them vis a vis other factors. Some questions can be asked of individual projects and others require us to think of the community as a whole, and engage the participation of all stakeholders.

### **Here is a small sampling of questions that may arise**

What if local landscape character does not match our aesthetic preferences? If existing vegetation on site does not meet the aesthetics of our proposed design, then what do we choose to give up on or compromise on first? Often not a question of removing vegetation to satisfy building program requirements, this question deals more with a re-creation of the site solely to satisfy certain aesthetic preferences. What if we want a “simple” landscape, and the one we are presented with is wild and unruly? Nick Robinson, Australian landscape architect, talks about the “balance between artistic composition on the one hand and spontaneous local character on the other” (Robinson, 1993). What if understory vegetation blocks a choice view of a building? To many designers today, the visual experience appears to take precedence over everything else, and landscape architects willingly sacrifice existing vegetation to enhance or frame views from and to buildings, without calculating the environmental cost of doing so. Similarly, paths are often left unshaded in brutally hot climates, simply because designers are aiming for an “open” character for the landscape. We promote monocultures in our pursuit of simplicity.

Are we willing give up control and to accept changes in the landscape? There is aging, death and renewal in nature: these things are inescapable. Landscapes cannot be frozen in time, designed to capture a single moment for eternity. This does not mean that the site should not look “designed,” but rather that there needs to be a certain fluidity in the design, allowing landscapes to adapt to changes that occur with time.

Do human beings need to be able to access every square inch of earth? Lawns are not always occupied (in fact, seldom so, in suburban America and several regions of Asia), but allow people to feel like they are in control of the landscape, partly by giving them means to access every part of it if they so desire. Are we as a species, willing to give up some land whether in urban parks or in parking lots, so that other species can call it their home?

To combat shrinking biodiversity in our cities, designers need to think of land as more than just space left-over after constructing a building, and landscape architects need to think about plants as more than just a means to fill space. In the long-term, reversing the current lawn-ization of the urban landscape is not a mere refinement of design approaches, it calls for redefining our values: the importance (or lack thereof) that we place on different aspects of our environment will determine the quality of life that we will enjoy in our cities many years from now. ■

### Note:

All photographs courtesy the author unless otherwise mentioned.

### References

Aguilera, G., Ekross, J., Persson, A. S., Petterson, L. B., & Ockinger, E. (2019). Intensive management reduces butterfly diversity over time in urban green spaces. *Urban Ecosystems*, vol. 22, 335 - 344.

Belcher, R. N., Sadanandan, K. R., Goh, E. R., Chan, J. Y., Menz, S., & Schroepfer, T. (2019). Vegetation on and around large-scale buildings positively influences native tropical bird abundance and species richness. *Urban Ecosystems*, vol 22, 213-225.

Campbell-Arvai, V. (2019). Engaging urban nature: improving our understanding of public perceptions of the role of biodiversity in cities. *Urban Ecosystems*, 22, 409-423.

Herbert, E. W. (2011). *Flora's Empire: British Gardens in India*. New Delhi: Penguin Books.

Ignatieva, M., Haase, D., Dushkova, D., & Haase, A. (2020). Lawns in cities: from a globalized urban green space phenomenon to sustainable nature-based solutions. *Land*, 9, 73.

Robinson, N. (1993). Place and Plant Design - Plant Signatures. *The Landscape: Autumn*, 26 - 28.

Selbig, W. R., & Balster, N. (2013). Evaluation of Turf-Grass and Prairie-Vegetated Rain Gardens in a Clay and Sandy Soil. *2013 International Low Impact Development Symposium*. Saint Paul, Minnesota.

Tallamy, D. W. (2019). *Nature's Best Hope*. Portland, Oregon: Timber Press.

United Nations. (2018). *2018 Revision of World Urbanization Prospects*. New York: United Nations Department of Economic and Social Affairs.

Wheeler, M. M., Neill, C., Groffman, P. M., et al. (2017). Continental-scale homogenization of residential plant communities. *Landscape and Urban Planning*, 165, 54-63.

Yang, F., Ignatieva, M., Larsson, A., Zhang, S., & Ni, N. (2019). Public perceptions and preferences regarding lawns and their alternatives in China: A case study of Xi'an. *Urban Forestry & Urban Greening*, 46.