THE LAWN INSTITUTE
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THE UNIQUE ROLE OF GRASSES IN URBAN AND SUBURBAN ENVIRONMENTS

Urbanization is not a new reality but in recent years its pace has increased substantially. In 2008, for the first time in human history the world's population became evenly split between rural and urban environments. By 2030, the United Nations projects that this will likely shift even further where up to 60% of the world's population could be living in urban areas (Pop. Ref. Bureau, 2007). As this occurs, plants will continue to play an essential role in the success, comfort, health, and social wellbeing of millions of people. In order to take advantage of the many benefits that plants provide, it is important to understand their origin, growth, and specific roles in urban environments. This will allow all plants, including turfgrasses, to be utilized in a manner that allows urban planners to take advantage of their positive impacts, while responsibly managing important resources.

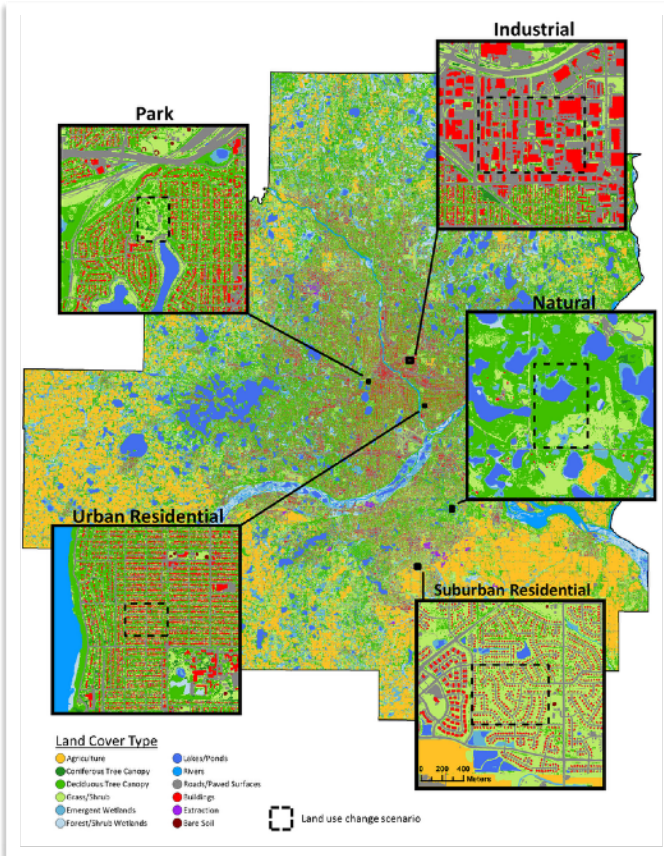
WHAT ARE GRASSES?

There are approximately 300,000 species of vascular plants that form the dominant vegetation covering the Earth's surface (Judd et al., 2008). Turfgrasses belong to the *Poaceae* family, which is the 5th largest family based on number of species and the third largest based on number of genera (Christenhusz and Byng, 2016). They are placed here along with important cereal and grain crops such as wheat, oats, and corn as well as rice, sorghum, and sugar cane. Four of the top five food crops in the world are grasses, and they provide over 90% of the world's caloric intake. This is a testament to the photosynthetic efficiency and hardiness of grasses. While there are over 12,000 species of grasses in the Poaceae family, approximately 25 of them are used as turfgrasses.

Turfgrasses have evolved through grazing such that their meristem, or growing point, remains at the soil surface allowing the leaves to be grazed or clipped without killing the plant. This is unlike any other flowering plant found in urban landscapes and is one of the most unique features of turfgrasses. It allows them to persist under mowing and foot traffic while forming a uniform ground cover that is functionally important to the success of many urban landscapes. Simply defined, turfgrasses are flowering plants capable of producing uniform perennial ground cover due to their unique growth habit and there are few, if any, other species of plants that can play a similar role.

Uniform ground cover and fibrous root system typical of perennial grass cover

ECOSYSTEM SERVICES AND THE VALUE OF LAWNS



Various Land Cover Types of a Typical Urban and Suburban Interface

The many benefits of perennial turfgrass plants in urban centers have been well-documented with regard to capturing rainfall, reducing stormflow, reducing erosion, protecting watersheds from soil and nutrient runoff, and filtering pollutants in urban runoff due to their fibrous root system, high organic matter content, and diverse populations of soil micro-organisms (Krenitsky et al., 1998; Beard and Green, 1994; Law et al., 2017; USEPA, 1993). They are also one of the most effective species of plants for remediating disturbed topsoil. Home and building construction practices often remove, destroy, or significantly impact the health of these systems and the high carbon sequestration rates and fibrous root systems of perennial grasses are one of the most effective ways of returning soil structure to a more natural state. In fact, the world's most productive soils developed under perennial grasslands (Gould and Shaw, 1983).

Approaches to reducing outdoor water use should include an emphasis on proper plant selection and planting techniques. Many species of warm-season turfgrasses are well-adapted to drought, and plant breeders have made great strides in producing hardy, drought-tolerant turfgrasses for use in southern and southwestern climates as well as improving their cold tolerance in order to extend their adaptation range further into central and northern climates. Due to a different photosynthetic pathway from cool-season turfgrasses, warm-season species have the capacity to sequester carbon dioxide while transpiring 50% less water (Taiz and Zeiger, 2010). Research shows that when properly planted, warm-season turfgrasses can survive 60 days or longer with no rainfall or supplemental irrigation (Chalmers, 2008). There is also substantial research to support the impacts of water-saving technologies such as smart irrigation systems, water sensors, and drip irrigation that have the potential to significantly reduce outdoor water use while preserving plant health.

The benefits of perennial grass cover on soil restoration, watershed protection, restoring biodiversity in urban soils, and sequestering carbon have been well-established. Yet, the largest potential benefit of urban turfgrasses with regard to energy is their ability to mitigate urban heat island effects, reduce energy costs, and reduce carbon emissions from power plants. While many species of flowers, shrubs, herbs, etc. are found in urban landscapes, trees and grasses are often regarded as having the largest impact on mitigating urban heat islands, reducing energy costs, and offsetting carbon emissions (Akbari et al., 2001; Wang et al., 2016; Zhang et al., 2014).

Rewarding the use of improved plant material, smart irrigation technologies, and proper planting techniques are worth consideration for alternative means of promoting water conservation in urban environments while also maximizing the positive benefits of perennial turfgrasses. Conversely, encouraging the removal of perennial plants in urban environments can also contribute to urban heat island effects including increased energy requirements, costs, and carbon emissions. Through proper selection, planting techniques, and management, perennial turf. These cooling effects are not only capable of reducing temperatures in urban environments, but also significantly reducing energy use, cooling costs, and carbon emissions from power plants. Wang et al. (2016) reported a 2.4^{o}C decrease in maximum daytime temperature in Arizona with a fractional lawn value of 60%, which reduced cooling costs by $1.20 - $1.80 per m^2 of turf. On a national scale, Akbari et al. (2001) reports that mitigating urban heat islands could reduce energy cost by up to 20% and $10B per year.

Grasses can make significant contributions to achieving six of seven of the U.S Green Building Council's Leadership in Energy and Environmental Design (LEED) goals as outlined in the Reference Guide for Homes Design and Construction with regard to their ability to reduce and sequester atmospheric carbon dioxide, protect water resources from soil and pollutant runoff, remediate disturbed topsoil, mitigate urban heat islands, and reduce energy costs. The unique growth habit, flowering, and fibrous root system of perennial turfgrasses make them one of the most appropriate plants for use in urban landscapes, and few, if any, other plant species can provide comparable benefits or functions.

KEY RESEARCH HIGHLIGHTS ON THE NATURAL CAPITAL OF PERENNIAL GRASS LAWNS

WATER, CARBON, AND OXYGEN DYNAMICS

- Warm-season grasses such as bermudagrass and zoyisagrass can use between 25 and 50% less water than cool-season grasses and have been shown to survive up to 60 days without rainfall or irrigation

- A 5,000 sq ft lawn in Southern California can produce enough fresh oxygen for 28 people each day.

- Residential lots in a typical urban/suburban setting account for 50.8% of carbon capture, 59.2% of water quality regulation, and 49.1% or runoff regulation.

- Carbon modeling research of a typical suburban home on a half-acre lot, landscape beds, shrubs, trees, and a grass lawn indicate that between 81 and 90% of the carbon captured in the landscape is captured by the lawn.

- Net carbon sequestration rates in urban lawns have been estimated at between 200 and 1,800 lbs of carbon per acre per year.

- Research modeling of carbon sequestration by lawns indicates that lawns in the United States alone can sequester between 12.5 million and 95 million tons of atmospheric carbon dioxide per year. That's equivalent to the annual emissions of between 2.4 million and 18 million typical passenger vehicles.

Carbon deposition from the fibrous root system of perennial grass cover into original topsoil

- The total root length in a typical lawn has been shown to range from 66 to over 3000 meters (or 0.2 to 1.8 miles) of root length per liter of soil.

SOIL ARTHROPODS AND SOIL MICROBIOME

- Managed lawns can host as many as 52 different arthropod families, with over half of them representing beneficial insects such as predators and parasitoids.
- Researchers in the United States found over 330,000 arthropods in 20 home lawns within just a 3-month sampling period.
- Ants are important providers of ecosystem services and are abundant and diverse in managed lawns.
- Up to 28 genera of nematodes can be found in home lawns including bacterivores, predators, omnivores, and plant parasites.
- The soil microbiome is made up of a complex network of micro-organisms including bacteria, fungi, and single-celled organisms called archaea and recent research has shown that grass lawns enhance soil microbial diversity when compared to bare soil and it helps regulate microbial community composition.
- Lawn establishment enhances soil microbial diversity compared to adjacent bare soils and also modulates the microbial community composition. These micro-organisms are vital to soil health and sustainability and are supported by the high carbon sequestration rates of the turf they flourish under.
- Microbial diversity remains relatively stable during lawn development and is comparable to the diversity in other plant systems.
- Almost all known bacterial and fungal phyla are detected in lawns, and patterns of phylum dominancy are similar to other systems.ors, omnivores, and plant parasites.
- Natural grass lawn ecosystems support abundant populations of edaphic organisms including earthworms, which combined with grass's highly dense root system increases soil macropore space and contributes to higher soil water infiltration rates and water-retention capacity compared to other landscape types.

RUNOFF REDUCTION AND STORMWATER FILTRATION

- A 5,000 sq. ft. natural grass lawn has the potential to capture around 2000 gallons of rainwater before runoff occurs on sandy-loam soil, and up to 27,000 gallons of rainwater before runoff occurs on sandy soil. The thatch alone on a 5,000 sq. ft. lawn can capture 500 gallons of rainfall before runoff occurs.

- Grass lawns provide ecosystem services such as water filtration, sediment reduction, runoff and flood control, and reductions in point and non-point source pollution.

- A recent study of a typical metropolitan area with a population of 407,000 people demonstrates that low-density, residential lots with 50 to 80% vegetation including lawns provided the greatest overall infiltration among various land-cover classes.

- The complex system of grass leaves, stems, and thatch creates hydraulic resistance to lateral water flow, which increases surface residence time and infiltration into soil, thereby reducing runoff velocity and amount.

- The extremely dense and fibrous root system of grass lawns act as a biological filter, trapping and removing non-point source pollutants before they enter groundwater.

- Natural grass is often used in catchment and filtration areas in urban areas due to its ability to trap pollutants including heavy metals, oils, grease and fuels, and household/industrial hazardous wastes before they enter surface waters.

- Of 11 pharmaceutical pollutants contained in recycled wastewater, none were detectable in drainage water leaving grass lawns highlighting the tremendous capacity of natural grass systems for filtering and purifying groundwater.

- The presence of natural grass has been shown to reduce runoff and soil losses from erosion from 6 to 18 times greater than bare soil, such as those found in xeriscapes.

All of the above statements are supported by research published in peer-reviewed academic journals and can be found at https://www.thelawninstitute.org/references/