FACILITIES MANAGEMENT RESOURCES SUSTAINABILITY

Natural Landscaping and Artificial Turf: Achieving Water Use and Pesticide Reduction

BuildingGreen

By Alex Wilson and Jessica Boehland

What's Wrong with the Conventional Lawn?

Throughout North America today, the dominant landscaping aesthetic is a broad, open lawn punctuated by trees and shrubs. While this landscaping system has been engrained into us through our culture and media, it creates an ecologically depleted landscape that requires significant amounts of resources and chemicals to maintain, especially in dry climates.

Conventional lawns require inputs of water and energy while causing air, water, and noise pollution. Annually in the U.S. we spend tens of billions of dollars caring for them. In some areas we use over half of our municipal freshwater to irrigate lawns, and we fortify them with millions of tons of fertilizer and thousands of tons of pesticides. What's wrong with this picture?

From an environmental, health, and even economic standpoint, a lot is wrong with conventional turf. Maintenance of turf necessitates regular mowing during the growing season, which is responsible for approximately 5% of the nation's air pollution, according to the U.S. Environmental Protection Agency (EPA)—and a good deal more in many metropolitan areas. A typical 3.5 horsepower gas mower emits about the same quantity of volatile organic compounds (VOCs) in one hour as a late-model car driven 340 miles (550 km), according to the California Air Resources Board. On top of that, EPA estimates that users of such equipment spill 17 million gallons of fuel each year—which is more than the Exxon Valdez oil spill!

Watering lawns consumes 30% of municipal freshwater in the eastern U.S. and 60% in the West. A *U.S. News & World Report* article reported that a 1,000 square-foot (93 m2) lawn requires, on average, 10,000 gallons (37,850 liters) per summer. With droughts continuing in the West and expected to increase in severity as a result of global climate change, this is a growing concern.

To maintain lush lawns, we use a lot of fertilizer—some 70 million tons (64 million tonnes) per year in the U.S. We use more fertilizer on our lawns in the U.S. than India uses on its food crops. Nitrogen fertilizers are produced by converting molecular nitrogen (N2) in the air into ammonia through the Haber-Bosch process, which is extremely energy-intensive, requiring approximately 18,000 Btus per pound (41 GJ/tonne) of primary energy input, which comes primarily from natural gas. Worldwide, ammonia production accounts for approximately 1% of global primary energy use.

Insecticides, herbicides, fungicides, and other pesticides are a growing concern with lawns. U.S. homeowners use 67 million pounds (30 million kg) of pesticides on lawns each year, according to EPA. Our suburban lawns and gardens receive heavier pesticide applications than our agricultural land: between 3.2 and 9.8 pounds per acre (3.6–11 kg/ha) vs. an average of 2.7 pounds per acre (3.0 kg/ha) for agricultural lands.

Along with the resource and environmental burdens of producing fertilizers and pesticides, a significant portion of these chemicals applied to lawns ends up in stormwater runoff and in groundwater. According to EPA, 40–60% of the nitrogen applied to lawns ends up in surface

water or groundwater. Stormwater runoff from turf is one of North America's biggest sources of water pollution.

Noise pollution is another concern. Lawnmowers, weed whackers, hedge trimmers, and leaf blowers cause significant noise pollution, a very real but often overlooked health hazard.

Due to the need for all this maintenance, lawns are a huge expense. Homeowners spend roughly $27 billion per year on lawn care, according to the National Wildlife Federation (NWF)—ten times more than we spend on school textbooks. At the business level, the lawn care industry did approximately $61 billion in business in 1997 and has been experiencing roughly 20% annual growth in recent years. On a per-acre basis, maintenance costs for mowing, irrigation, and application of fertilizer and pesticides average $1,120 per year, according to the organization Wild Ones Natural Landscapers.

Benefits of Natural Landscaping

Natural prairie landscaping is projected to save the Metropolitan Water Reclamation District of Chicago thousands of dollars per year compared with the turf that is being replaced.

Just as there are significant environmental burdens and costs associated with conventional turf landscaping, there are benefits associated with natural landscaping. The primary benefits are described below.

Reduced air pollution. Native landscaping generally does not require regular mowing, which eliminates or greatly reduces the air pollution resulting from turf landscapes. There can be pollution emissions from natural landscaping, however—see discussion below on pollution from fire management.

Reduced nutrient runoff. Native landscaping does not require fertilizer, so the runoff and infiltration of nutrients is eliminated. Buffers of natural landscaping can be used to capture runoff from hard surfaces or less permeable turf to keep the pollutants in that stormwater from entering surface waters. Keeping nutrients out of the groundwater also protects surface waters, because groundwater surfaces in springs and flows into streams and rivers.

Reduced pesticide use. Because natural landscaping involves the establishment of balanced ecosystems, the use of herbicides, insecticides, and other pesticides is generally not required (though herbicides are often used to remove invasive plants during the establishment of natural landscapes). Reduced operation of lawnmowers and other lawn-care-related power equipment reduces air pollution both locally and regionally, thus improving health. And keeping pollutants out of water supplies also protects our health.

Increased biodiversity. Natural landscapes inherently support greater biodiversity than conventional turf landscapes. Native plants provide diverse food and habitat for birds, small mammals, insects, reptiles, and amphibians. In heavily developed urban areas, even small patches of natural landscape can be critical in maintaining populations of native fauna and flora.

Cost avoidance. Significant savings in landscape management costs can be realized by converting lawns to natural landscapes. While the initial costs of creating natural landscapes can be relatively high, annual operating costs of established natural landscapes are generally far lower than annual operating costs of lawn area. Operating cost savings were a primary motivation for the Metropolitan Water Reclamation District of Chicago to convert turf area to tall-grass prairie—to date, approximately 20 acres (8 ha) of turf has been restored to natural landscape, with guidance from Conservation Design Forum of Elmhurst, Illinois.

Downsides of Natural Landscaping

While the arguments for natural landscaping are compelling, there are some challenges:

- The aesthetic palette is more limited. Strict adherence to an all-native landscaping program restricts plant choices, which many property owners (as well as landscape architects and landscapers) object to.
- Establishing and maintaining natural landscapes requires new knowledge and skills. There are both direct and indirect costs associated with building these skills, and there is often inherent resistance to change in any profession.
- Fire management, a key component of many—if not most—natural landscapes, poses obvious risk and liability. These risks gained national attention when, on May 4, 2000, a prescribed burn at Bandelier National Monument in Los Alamos, New Mexico, got out of hand and burned nearly 48,000 acres (19,400 ha), destroying 400 homes and causing more than a billion dollars in damage.
- Fire management also generates air pollution. Depending on the type of landscape and the weather conditions during a prescribed burn, however, these emissions are usually fairly low.

Establishing Natural Landscapes

The key to establishing natural landscapes is careful planning to ensure that adequate management and stewardship is carried out until the landscape is established, at which point maintenance requirements become fairly minimal. Natural habitat landscaping is not about individual plant species but about ecosystems. With natural landscaping, the goal is to create balanced, self-sustaining ecosystems, not just assemblages of individual native plants. Because almost any ecosystem existing today has been degraded to some extent, creating a healthy, largely self-sustaining landscape often requires significant restoration work.

Dealing with invasive plants

Invasive exotic plants are the bane of natural landscaping. Hundreds of plant species are wreaking havoc in ecosystems throughout North America. Each region of the country has particular invasive plant species that are problematic: from kudzu in the Southeast to honeysuckle and Japanese knotweed in the Northeast to cheatgrass and garlic mustard in the Midwest and West.

Strategies for removal of invasive plants all have advantages and disadvantages: hand-pulling is labor-intensive but safe for the environment; herbicides (such as Roundup®) are fast and easy but may have unintended consequences for other organisms in the ecosystem; turning over the soil (to kill turf grass, for example) avoids chemicals but may damage the soil structure and soil microorganisms; prescribed burns are often the best method to control invasives and allow the ecosystem to return to a pre-European settlement balance, but they cause safety concerns and air pollution.

The success of invasive plants is often related to changes in overall habitat conditions. When conditions that favor native species are restored through such restoration management tools as selective clearing to provide appropriate light levels and annual burn management, the invasive species are often gradually eliminated.

Converting turf to natural landscapes

A number of approaches can be taken to convert turf or other invasive vegetation to natural (restored) ecosystems. Short-lived herbicides are effective, and have the advantage of keeping root systems in place to help prevent erosion while new species are being established. Mechanical strategies, including repeated discing and harrowing, are also effective, and do not present any toxicity concerns Sometimes simply easing off on mowing allows native species to gradually return—if native species are growing nearby—but this approach yields less certain results than complete replacement of the existing vegetation, and often nearby intact habitats do not exist.

In designing landscapes that will be managed with controlled burns, firebreaks often make

sense. Roads can serve as firebreaks. Bands of turf grass along road corridors and around building can make sense to keep fire under control.

Increasing people's comfort with natural ecosystems

Given the American infatuation with lawns, social and psychological factors often emerge as barriers to natural landscape designs. Joan Nassauer, Ph.D., FASLA, of the University of Michigan, has researched human responses to various landscape designs.

Her research suggests that most Americans (indeed, people in most Western cultures) are uncomfortable with landscapes that they perceive to be wild or unmaintained, but are attracted to natural plantings within an obviously managed context. Signs of human care and attention to a space, whether it is a recently mown lawn or a freshly painted picket fence, represent what Nassauer calls "cues to care." Thus, boundaries of well-maintained turf around naturally landscaped areas not only provide firebreaks but also increase most people's comfort level with the native plantings.

Which Grass is Greener? Comparing Natural and Artificial Turf

Another alternative to the resource-intensive conventional lawn is artificial turf. Early adopters of plastic grass were professional sports teams, who had the cash to spend on the newest technologies. Artificial turf continues to replace natural playing fields not just for the pros but for college-level athletes and Little Leaguers alike.

And it doesn't stop there. Artificial turf is replacing grass in a variety of applications, ranging from community parks to parking-lot medians, and even outside American homes. Plastic grass sidesteps many of natural turf's downsides, but could it possibly be greener than grass itself?

Early Artificial Turf

The first artificial turf, which would become known as AstroTurf, was made by the Chemstrand Company, a subsidiary of the Monsanto Company, and installed in 1964 at the Moses Brown School in Providence, Rhode Island. In 1965, Monsanto's artificial turf was laid in Houston's AstroDome, the largest indoor sports facility in the world at the time.

Popular for its convenience, early artificial turf was largely loathed by the athletic community. First-generation artificial turf was typically stiff, low-pile polypropylene or nylon fiber adhered to a concrete or asphalt base. The fibers caused "turf burn," the hard base was less forgiving than soil, and athletes are united in their claims that first-generation turf caused more injuries than grass. Although this primitive turf is still available, it has been largely superseded by softer, safer, more naturalistic surfaces.

In the early 1990s, artificial turf began expanding from playing fields to other uses. Increasing incidences of drought, concern over the dangers posed by pesticides, and the grasslike look and feel of modern artificial turf have led to increasingly use of plastic grass in parks, day care centers, dog runs, and the yards of homes and businesses.

Second-Generation Artificial Turf

FieldTurf ushered in the second generation of artificial turf. Unlike the original AstroTurf, this "infilled" turf includes a layer of sand and rubber pellets to surround polyethylene fibers. Infilled products are safer than earlier systems and feel remarkably similar to real turf grass.

Second-generation artificial turf is significantly evolved from earlier products. The part of artificial turf that is the equivalent of the blades of natural grass is generally made of a green-colored, UV-stabilized polyethylene or polypropylene fiber in piles of two inches or higher. These blades are tufted into a porous backing, generally made of polyethylene, polypropylene, or polyurethane. Surrounding the blades of grass is a crumb layer of silica sand and/or rubber bits ranging in diameter from 0.5 to 1.5 millimeters. After the crumb layer is added, the blades typically stand about 3/ 4" tall (19 mm), though different heights can be specified for different applications. Many products include a shock pad. Finally, most manufacturers incorporate a drainage layer of crushed stone below the backing layer, and a few incorporate perforated-pipe drainage systems. Artificial turf systems are generally warranted for about eight years, but the actual life expectancy is unknown.

Benefits of Artificial Turf

Recycled Content and Reusability.
The rubber bits in the crumb layer of artificial turf are often made from recycled tires. Memorial Stadium field at the University of Nebraska–Lincoln used 14,000 recycled Nebraska tires. Some artificial turf also incorporates recycled tennis shoes. If it is replaced before it is worn out, artificial turf can be reused. When Aloha Stadium, in Honolulu, Hawaii, upgraded its fields in 1999, and again in 2003, state officials donated the used AstroTurf to local high schools. RS Global, Inc., based in Carrollton, Texas, has removed artificial turf from more than one hundred used fields over the past three years. RS Global breaks the turf into pieces for use in smaller applications, such as batting cages.

Reduced water use.
From an environmental perspective, the potential for water savings is probably the most significant benefit of artificial turf. Plastic grass, of course, needs no irrigation to stay green. The only water used on artificial turf is to cool it down in extremely hot conditions or clean it, if necessary. The City of San Marcos, Texas awarded Southwest Texas State University with a Water Efficiency Achievement Award in 2003 for converting the natural field at Bobcat Stadium to SRI's AstroPlay ®, a move which the school estimates is saving more than 2 million gallons (7.5 million liters) of water each year.

Reduced pesticide and fertilizer use.
Since artificial turf needs no regular chemical treatment, it eliminates a major source of non-point-source groundwater pollution and human exposure to chemicals. For residential applications, artificial turf also offers the benefit of reducing the amount of chemicals (and dirt) tracked into homes. Artificial turf's chemical-free care may make it especially appropriate for daycare centers and dog yards, because children and pets spend more time than adults in close contact with grass, and they are affected more severely by contact with pesticides.

Reduced maintenance.
Artificial turf needs no mowing, watering, fertilizing, aerating, or reseeding, and it will not outgrow its painted field lines; synthetic grass, though, demands its own maintenance regimen. Caring for residential artificial turf generally involves just the occasional use of a leaf blower or a carpet rake. When necessary, artificial turf can be washed with a garden hose. Biological material, including leaves and feces, will not decompose as quickly on plastic as on natural grass, so when such materials find their way onto artificial turf, more maintenance is required to keep it tidy. Depending on its use, residential turf can often go six weeks or longer without any maintenance.

Turf, Air Quality, and the Atmosphere

Through the process of photosynthesis, grass converts carbon dioxide to oxygen and other gases. Turfgrass Producers International (TPI) claims that a 2,500 ft ² (230 m ²) lawn releases "enough oxygen for a family of four to breathe." Simultaneously, the absorption of carbon dioxide mitigates to some extent the process of global climate change. Another argument for natural grass is its ability to cool the surrounding area through evapotranspiration. According to TPI, lawns are 14°F (8°C) cooler than bare soil on hot days, or 30° (17°C) cooler than asphalt. Natural grass also helps to clean the air: grass areas trap 12 million tons (10.8 million tonnes) of dust and dirt from the air each year, TPI reports, and some studies have shown that grass absorbs carbon monoxide.

Artificial turf, in contrast, frequently offgasses volatile organic compounds (VOCs). This could be a concern for children, who are often more sensitive to emissions, and especially for the rapidly growing number of Americans with asthma. Artificial turf also contributes to the urban heat-island effect. Although they look green from an angle, artificial fields are often closer to black when viewed from above, owing to the rubber layer surrounding the blades. Darren Gill, marketing manager for artificial turf company FieldTurf, says that in direct sun, artificial turf averages between 6 and 10°F (3–6°C) warmer than grass, though he's seen differences as high as 15°F (8°C). He also mentioned that in especially warm climates, maintenance staff sometimes spray sports fields with water once or twice a day to keep them cool. This

tendency to heat up in hot weather makes artificial fields less appropriate in southern climates. Gill stresses that artificial turf cools quickly when it's not in direct sun.

Ecology

Of the 50 species cultivated for use as turf, only a handful dominate the market. In colder climates, four or five species are typically mixed for each application, according to Joyce, while in warmer climates turf is generally close to a true monoculture. The species of grass we commonly use on our lawns did not evolve here and are not adapted to America's climates and ecologies. Left to their own devices, most of these grasses would happily go dormant and turn brown during dry spells. Even where these species are native, they do not naturally grow in a monoculture, bereft of other plant species, as we expect them to do on our lawns and golf courses. Intruding plants and animals are called weeds and pests, and we obliterate them with chemicals. DDT, once a popular turf grass pesticide, was actually marketed as "the atomic bomb of the insect world."

A new movement in turf management shows some promise of improvement for biodiversity. In order to avoid the need for pesticides, fertilizers, and irrigation, some homeowners are planting grass species that are drought-tolerant or native to their climates. Buffalo grass, for example, native to America's central and southern Great Plains, is gaining popularity in hot climates. The Prairie Nursery Corporation, based in Wisconsin, has been marketing a mix of native fescue grasses for lawns since 1993. Their No Mow mix, including cool-season fescue grasses native to Oregon and Canada, was designed for the colder, less sunny climate of the northern U.S.

Kim Sorvig, research associate professor at the University of New Mexico, and co-author of *Sustainable Landscape Construction: A Guide to Green Building Outdoors*, is concerned about the soil conditions under artificial turf. "It blocks both water and sunlight either completely or in very large degree," he said, "and without that, you can't have a living system in the soil." Sorvig thinks it is ironic that artificial turf is heralded as a solution to water shortages, since it diminishes the health of the underlying soil, thereby decreasing its ability to hold water. "When you remove the vegetation from an area so completely," he said, "you're actually, in the long term, contributing to drought."

The only application for which Sorvig believes artificial turf is appropriate is indoor stadiums, since they are "already separated from the soil system." Ecology may be one area where neither artificial nor conventionally maintained natural turf can claim victory.

Biophilia

The biggest strength of artificial turf is also its biggest weakness. Artificial turf remains a "monofilament ribbon file product"; by definition, it can never be alive. So why bother to make it look or feel like the real thing? Nostalgia begins to explain our intangible trouble with artificial turf—gone are the stubborn grass stains and the smell of freshly mown grass. The best explanation, though, is that we feel an innate connection to good-old-fashioned grass.

Harvard biologist Edward O. Wilson sought to explain this phenomenon in his 1984 book *Biophilia: The Human Bond with Other Species.* Human beings, he argued, subconsciously seek a connection with other species and with life. Plastic grass will always feel foreign to us because it is not living and robs us of our cues to natural processes. It refuses to die—or even fade—as the seasons change.

So-called natural turf, it has been argued, is itself far from natural. Most turf grass yards and fields would be biological impossibilities without significant inputs of water, chemicals, and energy. Yet, grassy lawns feel natural. Perhaps our biophilic impulse is fooled by this seemingly natural landscape. Or perhaps it doesn't care—a living landscape is a living landscape, no matter how it came to be.

Final Thoughts

Conventionally managed natural turf carries a plethora of environmental burdens, but it does support soil organisms to some degree. The grass and these organisms play a crucial ecological role by purifying water as it leaches into the earth. It is questionable, though, whether this function is positive enough to offset the repercussions of watering, pest treatments, fertilization, and mowing.

Playing fields subject to heavy use, especially where pristine appearance is a priority, may represent a setting in which artificial turf can be justified. But the fact that it doesn't support soil organisms, and therefore is a biologically dead zone, suggests that its use should be limited.

In many situations, the optimal choice, at least from an environmental perspective, is a natural landscape of native or adapted plants. Approaching the condition of a natural ecosystem, such a landscape minimizes maintenance while offering biological diversity.

In places where a uniform, cropped surface is needed, natural turf managed in an ecologically sound manner is a good choice. Natural lawns and fields can be maintained responsibly by beginning with native and adapted species that require little or no water, allowing them to go dormant (and turn brown) at times, and feeding them appropriate, organic fertilizers. Even mowing, when necessary, can be done using low-emitting and quiet machinery. The result may not live up to the standards of the Garden Club of America, but other species will approve. **Visit BuildingGreen's Web site**.