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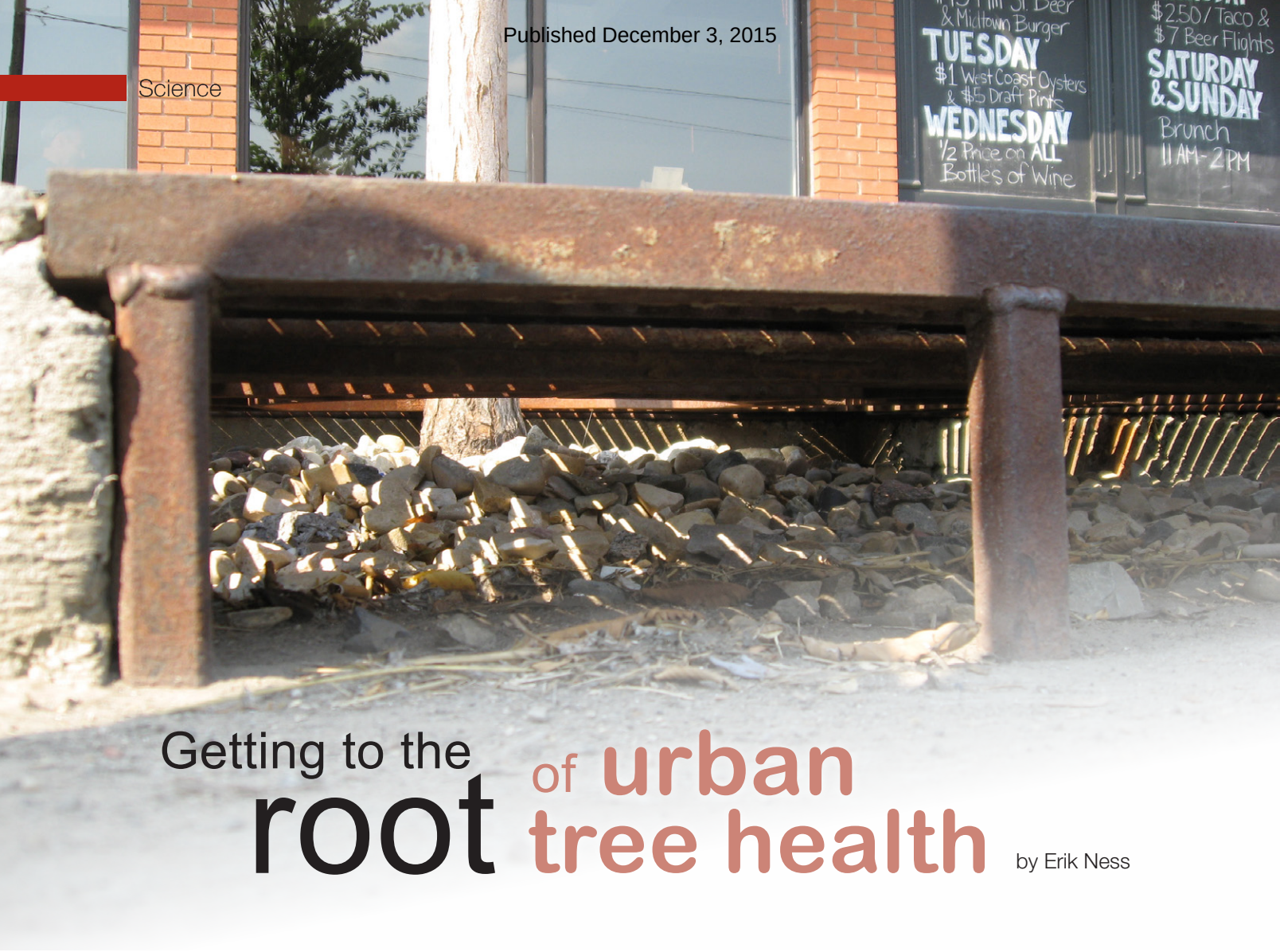

Getting to the root of urban tree health

by Erik Ness

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Politicians are always looking for babies to kiss. They love easy gestures like ribbon cuttings and hearty handshakes and, since at least 1872, tree planting.

In that year, the first Arbor Day in the United States was held in Nebraska City, NE. An estimated one million trees were planted that day across the state. There were grand parades.

Tree planting is also in vogue in American cities today. The U.S. Conference of Mayors has taken an activist stand on climate change, and tree planting is an easy and non-controversial way to further the green agenda. All 10 of the largest cities in the United States have some kind of effort to increase tree cover. Ambitious "million tree" initiatives have even launched in a few larger metro areas; Sacramento's goal is to plant five million.

Trees are popular and can provide extraordinary benefits to life in the city. They trap stormwater and provide cooling as they transpire. They generate oxygen, remove pollutants from the air, and provide habitat for birds and many other critters. They help save energy and even prolong the life of asphalt. A recent estimate puts the economic value of trees in the Chicago area alone at $51.2 billion.

But for real return on investment, trees must mature. Large healthy trees with a diameter at breast height greater than 30 inches filter approximately 70 times the air pollution of small healthy trees less than 3 inches in diameter. And not enough trees graduate to the canopy. A recent study of 20 American cities showed that 17 were losing tree cover.

"The mortality rate for urban trees is very high," says SSSA member Bryant Scharenbroch, a soil scientist at the University of Wisconsin–Stevens Point. He points to studies suggesting that 40 to 60% of urban trees die within the first 10 years. "Anybody can stick a hundred or a thousand or a million trees in the ground. But getting them to live past their first three or four years—that's really the key. You don't get any benefits until they get big. All the benefits that are associated with trees are strongly associated with leaf area, and that's tied with root area. That's the key thing: getting these trees to be really big and last a long time."

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Healthy Trees Start with Healthy Soils

Trees fail because of accidents, vandalism, or disease. They can be improperly planted, poorly chosen and placed, and not adequately nurtured during establishment. They can be staked too long, or not long enough. Heat and drought stress take their toll. All of these things can matter, but Scharenbroch is on a mission to upgrade the soil.

The problem of urban soil is fairly simple: it's often barely soil at all. The first thing city builders do is to remove it or modify it. They need something with minimal organic matter, a substance that can support a building or a road: gravel, rock, sand, and mineral soil. Even if it's not taken away, the soil is often diluted, contaminated, or compacted to the point where it cannot function. In essence, it is dead—a ghost of the living system that constitutes healthy soil.

Scharenbroch's fascination with the health and growth of urban trees began when he was still an undergraduate. He recognized that tree health and growth might be strongly tied to urban soil condition. "It's really important that we get in and fix the soil properties early to maximize the value of these trees," he says. Yet he found little practical support in the literature.

After graduate training, he landed at The Morton Arboretum in Chicago. The city has been an incubator for the urban forestry movement, and the Arboretum has prioritized work in soils. Eventually, he met ASA and SSSA member Dr. Lakhwinder Hundal, CPSS, chief soil scientist at the Metropolitan Water Reclamation District of Greater Chicago, which operates the world's largest wastewater facility. Hundal is charged with finding new and improved uses for its annual output of approximately 180,000 dry tons of biosolids every year—the nutrient-laden organic materials produced at the far end of your toilet.

Biosolids are invaluable raw materials, but in decades past, it was not uncommon for them to have been landfilled or incinerated. In the last few decades, many large cities have developed a robust market in biosolids, treating them and then selling them for spreading on agricultural fields. Biosolids have an understandable image problem, and sometimes raise safety concerns: they can be contaminated by heavy metals, microorganisms, and, increasingly, trace pharmaceuticals. Yet the business is now fairly mature, and farmers could probably use everything produced by America's sewage treatment infrastructure. But transporting biosolids is costly, and finding a use for them closer to home could save the city in both transportation and material costs.

> "We've established that biosolids do increase tree growth and do improve soil quality."

In 2010, with funding from the Tree Research and Education Endowment Fund, Scharenbroch set up 180 plots with five different tree species and a half dozen different soil treatments, ranging from standard commercial fertilizers to compost tea, wood chips, and biosolids. All treatments proved better than nothing, but biosolids were the clear winner: those trees grew bigger and faster. Their soil was richer in carbon, nitrogen, and phosphorus. "We've established that biosolids do increase tree growth and do improve soil quality," Scharenbroch says. "We can help to get these trees established by getting them to grow faster."

The city of Chicago has a surplus of wood waste due to the removal of tens of thousands of trees killed by the emerald ash borer (**right**). Lakwinder Hundal is hoping to blend that wood with biosolids from the Stickney Water Reclamation Plant of the Metropolitan Water Reclamation District of Greater Chicago (**above**) to create a compost (**far right**) that can be used to plant replacement trees. *Photos above and on the far right are courtesy of Dan Wendt, Public Affairs, MWRD, Chicago, IL. Photo to the immediate right is from Flickr/Arvell Dorsey Jr.*

Biosolids: The Secret Ingredient in Urban Forestry?

Though his primary portfolio is biosolids, Hundal is a soil scientist and oversees a lab that employs a half dozen more soil scientists. "Soil is actually a very complex medium," he says. "It's a living system. There is more life below ground than above ground."

And he sees biosolids as the secret ingredient in urban forestry. The key is the organic matter. "The minute you add biosolids, earthworms will show up," he explains. "They will dig deep, back and forth, making channels for water to go down." With the moisture, the bacteria and fungi revive, and they begin nutrient cycling with the roots. "Once you start nutrient cycling, the system is self sustainable," he says. "So now the whole ecosystem is coming back to life."

Quality soil amendments are like a booster rocket for young trees straining for the canopy. "When you do that at the time of planting a tree or any other vegetation, you give that system a jump start," Hundal says.

Ordinary compost has organic matter but not much in the way of nutrients. Biosolids have nutrients and organic matter. "Nature would take decades to achieve that same level," he says. "And they're available in cities, where the need is the highest," he says. "Rather than digging up farmers' fields to solve our urban needs for topsoil, we should be looking at resources that are locally produced and locally available."

Building on the work with the Morton, the city of Chicago is adding a new twist. It's removing tens of thousands of trees killed by the emerald ash borer, creating a problematic surplus of wood waste. So why not blend it with biosolids and make compost? "Marry them together and make a value-added product," Hundal says. His hope is the new mixture can be used to plant the replacement trees, fortifying the next generation of the urban forest. "We can't just cut these trees," he says. "We have to replace them. Make a cycle."

ASA and SSSA member Nicholas Basta, a soil scientist and restoration specialist at Ohio State University has also collaborated with Hundal on biosolids research, studying them in a

grassland restoration of the sprawling steelworks south and east of Chicago.

Biosolids were the overall winner in that research as well, yielding a more diverse assembly of plants. The ultimate vision is for a hickory forest, but a lot of healing and soil building needs to happen first. The project faced a potential shortage of soil-building material to cover the industrial slag. "The future of biosolids is bright," Basta concludes. "Our biggest limiting ingredients are organic materials. We're not going to be able to waste it. We're going to need every bit that we have."

Shifting the Paradigm from Tree Planting to Tree Performance

Greg McPherson is a research forester with the USDA Forest Service's Pacific Southwest Research Station located in Davis, CA. In the 1990s, he helped pioneer the urban forestry movement in Chicago.

In a 2012 interview with *American Forests*, he was asked to identify the biggest issue facing urban forestry. "Moving from the tree-planting paradigm to the tree-performance paradigm," he answered.

There are many pieces to this puzzle, but McPherson calls soil a "big up-front issue." Some things, like tree maintenance, you can figure out 5 or even 10 years later, and the learning curve shouldn't be too brutal. But to maximize success of these millions of new urban trees, you'd better make sure they get planted correctly.

"It's hard to go back and re-do the soil," he says. "There has to be awareness that would motivate the investment. Until we can really invest in the soil, creating that underground environment for healthy trees, we're not going to actualize the potential of trees to improve our environment."

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Scharenbroch doesn't want to disrespect the trees, but he argues that the real star here is the soil. Compare the services that a tree might provide to those of the soil, such as water retention. The tree gets its picture in the program, but it's not the workhorse. "It's your soils that are going to be capturing, storing, and cleaning that water," he argues.

He prefers to think of trees and soil as a system. The roots help feed the microbes, which in turn fix the nitrogen. The tree also adds organic matter to the soil, which in turn, boosts the soil's capacity to hold water. In this cycling—of nutrients, water, carbon—each process is more robust by virtue of the partnership.

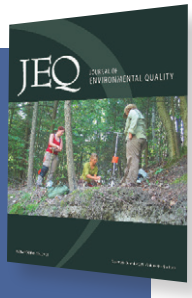
"If we can fix soils, or even provide just more soil for trees, we can have a huge impact on the urban environment," Scharenbroch says. "Not only through trees, but through the direct things that soil can do—which I think are neglected even more than the trees themselves."

People see a tree in the city, and they can stand underneath it on a hot day. They can watch it through the seasons. They can appreciate its form and its function, its beauty, and perhaps its business. But have they thought about its very foundation? "Those trees wouldn't be there without the soil," Scharenbroch says. "Getting people to recognize the soil, that's even harder."

E. Ness, contributing writer to CSA News *magazine*

Interested in This Topic?

The January–February 2016 issue of the *Journal of Environmental Quality* will feature two special sections related to this topic: "Soil in the City" and "The Urban Forest and Ecosystem Services." For the full presentation, visit https://dl.sciencesocieties.org/publications/jeq in mid-January. Or, you can check out the articles from these sections that have already been posted to the "Just Published" page at https://dl.sciencesocieties.org/publications/jeq/justpublished.



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