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TREECONOMICS

Greg McPherson and the Center for Urban Forest Research tell us what a city's tree canopy is worth. It's more than you might think.

By Linda McIntyre

Greg McPherson, *opposite,* fell in love with research and the power of data while studying for his MLA and ultimately a PhD. He is a project leader with USDA Forest Service, Research & Development, Pacific Southwest Research Station.

PLANTING TREES in the city seems like a no-brainer. Trees are beautiful and, uh, they help clean our air and water. Don't they?

As city governments struggle to confront issues as urgent and diverse as crumbling infrastructure, disappearing water supplies, and failing schools, advocates of the urban forest need better arguments than this to justify the spending of limited funds on tree planting. Greg McPherson provides them.

McPherson, the director of the Center for Urban Forest Research (CUFR) at the University of California, Davis, has spent his career working to quantify the benefits of trees in cities and using that data to create tools to help landscape architects and others design tree planting projects that will give the biggest bang for the buck. Every dollar invested in planting and maintaining a tree, he says, over time gives back several times that amount in air and water quality improvements and energy savings. "This kind of work is exciting, because it elevates urban forestry from a 'kumbaya' idea," he says.

McPherson developed an early interest in ecology—he speaks fondly of the elms arching over the streets in the neighborhood where he grew up—and earned his undergraduate degree from the University of Michigan's School of Natural Resources. Afterward he took a job with a Detroit-area nursery owner who had a horticultural degree and a design/build sideline. McPherson enjoyed the work, took some classes in landscape and nursery management, and then went on to the MLA program at Utah State University. But, he says, early on in the program, "it was pretty evident that I was not a born designer!"

That realization didn't put him off his landscape architecture studies. He sought to prepare for a career in environmental planning instead and found one field service project especially edifying. The students worked on two sites, clustering housing units on one and building out the whole of the other with houses on larger lots. "We calculated the amount of infrastructure, estimated the cost difference, and saw how much more cost-effective it was to cluster development," McPherson says. "It was the first time I saw the power of putting numbers to things that were good for the environment." He wrote his thesis on the effects of tree shade on temperatures in-

CARMEN ALVAREZ, OPPOSITE

side and outside houses and, having been bitten by the research bug, went on to earn a doctorate at Syracuse under the tutelage of forest researcher Rowan Rowntree.

Later, while teaching courses in urban forestry and horticulture at the University of Arizona's School of Renewable Resources in Tucson, McPherson got involved with a nonprofit tree-planting group. Their efforts alarmed officials at the local water utility, who were trying to persuade citizens to conserve water and felt that planting water-loving trees would send a mixed message. Using data on trees' impact on energy conservation, reduction of dust (a big problem in desert cities), and other air quality improvements, McPherson convinced them that planting varieties needing little irrigation—about 1,000 gallons per year, what an individual would use in about 10 days at home—would generate benefits many times the initial investment. "They became supporters of Trees for Tucson," he says, mailing out tree-care information with water bills and helping to establish a tree bank. "(The experience) really propelled me to think in a more systematic way and to broaden the number and types of costs and benefits in my analyses." McPherson went on to apply this approach on a regional scale while leading the Chicago Urban Forest Climate Project for the U.S. Forest Service. When that project ended, he started up the CUFR in 1993 with forest meteorologist Jim Simpson and ecologist Paula Peper.

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THE WORK MCPHERSON and his colleagues at the CUFR do to quantify benefits makes for eye-catching figures. A 2005 study of street trees in Minneapolis, for example, showed annual savings of $6.8 million in energy costs and $9.1 million in stormwater treatment costs as well as a $7.1 million increase in property values. A 2006 study concluded that the six million trees in the southwestern U.S. project area stored about 304,000 tons of atmospheric carbon dioxide, 12,000 tons of ozone, and 9,000 tons of particulate matter.

Translating economic data into factoids like these, easily digestible by the layperson, can generate serious action. A 2006 CUFR study of urban trees in Modesto, California, showed a return of $1.89 in benefits for every dollar spent. It persuaded the city government to increase its tree budget and convinced the local electric company to invest $20,000 in the nonprofit Greater Modesto Tree Foundation.

The detailed and specific economic analysis the CUFR undertakes can also be invaluable for officials or groups seeking funding for tree planting. New York City Parks Commissioner Adrian Benepe used CUFR's STRATUM program (see "Cool Tools," page 3) to secure $400 million for tree planting from the city budget. "It was probably the single most important sales tool we used to convince policy makers to put money into trees," Benepe says.

"This isn't the glamorous side of forest research," says McPherson. "We're usually out in a parking lot, sucking up fumes and sweating." Gathering this data is also time, labor, and resource intensive; McPherson hopes to make it less so in the future. "That's one of the areas we're looking at now," he

Trees by the Numbers

RESEARCH DONE BY Greg McPherson, and research by others that he and his colleagues have analyzed in their own studies, has shown that trees can improve the urban environment in a variety of ways, including:

- **Reducing air temperature.** Trees and other plants on building sites can lower air temperatures; McPherson has measured differences of 10 degrees Fahrenheit between a Tucson park and a desert area.
- **Lowering heating costs.** Trees planted to function as windbreaks reduce wind speed and resulting air infiltration by up to 50 percent, reducing heat loss for potential annual heating savings of 10 to 12 percent.
- **Lowering cooling costs.** A 1993 CUFR study using data from Atlanta concluded that shade and lower air temperatures from three 25-foot-tall trees, two on the west side of a house and one on the east, could reduce cooling costs by 34 percent, and later research by the center showed that a strategically planted tree can save 100 kilowatt hours in annual electricity use.
- **Storing carbon dioxide.** A typical tree will reduce atmospheric carbon dioxide by about 200 pounds annually over a 40-year period. A recent study by McPherson and colleagues found that Los Angeles's Million Trees program would reduce atmospheric carbon dioxide by about one million tons over 35 years, equivalent to taking 7,000 cars off the road every year.
- **Reducing hydrocarbon emissions.** Parked cars emit hydrocarbons from gasoline evaporating out of leaky fuel tanks and worn hoses; these emissions are a significant component of urban smog, comprising as much as 20 percent of the total inventory of emissions. Shaded parking reduces these emissions by lowering air temperatures one to three degrees Fahrenheit, gasoline temperatures four to eight degrees, and temperatures inside the car by as much as 40 degrees. California funds tree planting in parking lots as an air quality improvement measure because of this impact.
- **Intercepting rainfall.** Studies simulating urban trees' effects on stormwater runoff have reported reductions of 2 to 7 percent. The crown of a mature tree can store 50 to 100 gallons of water during large storms. This interception and storage function reduces runoff volume and delays the onset of peak flows.
- **Increasing property values.** Consumer research suggests that buyers are willing to pay 3 to 7 percent more for houses with trees on the property; one comprehensive study found that each large tree in a front yard increased sales price by about 1 percent. Other studies have shown that shoppers prefer venues with trees, making more frequent and longer trips to such destinations, paying more for parking, and spending up to 12 percent more for goods and services.

To get a clear economic picture, these benefits have to be offset by costs for tree planting, maintenance, and infrastructure damage by roots and debris.

says. "How can we efficiently, accurately, and cost-effectively monitor tree survival and growth and carbon storage without having to go out in the field? That's where the costs come in."

Tracking trees' status over the long term will be crucial if governments go forward with policy tools such as carbon trading to address climate change. The data compiled by McPherson and the CUFR could be a key to implementing innovative programs. "There may be potential to create a revenue stream from our trees," he says. "(But) anyone who is going to invest in carbon credits through urban forestry needs to be assured that when a tree is planted, there will be a permanent carbon sink," says McPherson.

That investment would require more focused attention than most urban trees currently get. "It's a mixed bag," says McPherson. "A lot of communities have turned over the care of street trees to residents because of budget considerations. It's hard to get a good level of service."

That's ironic, since tree-planting programs are good politics these days. Just after taking office, for example, Los Angeles mayor Antonio Villaraigosa announced a program to plant a million trees in the city. Nobody was sure, however, whether there was sufficient planting space for the effort. His administration engaged McPherson and the CUFR to undertake an assessment of the existing tree canopy and opportunities for new planting. "Nobody knew whether there was space for a million trees," says McPherson. But he and his colleagues found just that—existing canopy of about 21 percent and plantable space for about 1.3 million trees.

Nice big round numbers and actual planting opportunities don't always match up so neatly, though. In McPherson's view, tree-planting efforts shouldn't focus on the numbers of trees. "That's kind of a false goal that could lead to putting trees in the wrong place or cluster bombing a city with trees," he says. "What's really important is to figure out how to create a canopy that is maximally functional. We should shoot for a performance standard, like how many megawatt hours of air-conditioning we can save, or how many pounds of nitrogen dioxide we can absorb, reducing ozone and smog."

Cool Tools

GREG MCPHERSON and his colleagues don't just amass data and crunch numbers on tree benefits—they use this data to develop computer programs and handbooks for practitioners trying to build better urban forests. Among these tools, all of the following are available free of charge:

STREET TREE RESOURCE ANALYSIS TOOL FOR URBAN FOREST MANAGERS (STRATUM). **STRATUM is a software application that helps landscape architects, arborists, tree organizations, and others analyze the costs and benefits of their city's street trees. Users plug in data from a full or sample tree inventory, and the program models the growth and impact of the tree set (for users who don't have an inventory, the i-Tree software suite that includes STRATUM has a utility that guides the collection of a sample inventory using a personal digital assistant). The resulting analysis is based on data on environmental conditions and geographic information in reference cities in 16 climate zones across North America, economic assessments from commercial arborists and municipal foresters, and studies on the impact of trees on property values.**

"You can use STRATUM to calculate how many pounds per year of ozone uptake, or nitrogen dioxide uptake, a tree will provide at five-year intervals," says McPherson. "It's a good way to get a ballpark estimate of the benefits of a tree-planting project. Early on the net is negative, but you start to see a net benefit after about four years."

See an overview of STRATUM, or get started on your own analysis, at *www.itreetools.org/street_trees/introduction_step1.shtm.*

ECOSMART. **Home owners and landscape architects working on residential projects can use this Internet-based computer program to estimate how strategic tree placement, stormwater management, and fire-prevention practices can save money on cooling, conserve water, and make a house safer for its inhabitants. Simulations can be run based on three different building vintages, 20 tree species, eight tree sizes, and 24 tree locations.**

Users begin the analysis by laying out lot parameters in plan view and adding buildings and pavement. Then they can play around with the landscape elements. The program can guide them through decisions on tree selection, placement, and pruning to reduce biomass that can be hazardous in conditions ripe for fire (users in wildfire areas are warned to consult an expert and not rely entirely on the program for fire safety). Users can test stormwater management best management practices such as infiltration basins, swales, cisterns, and drywells.

Looking ahead, McPherson and the CUFR staff hope to add additional functions to help users incorporate and evaluate more sustainable design elements such as removal of air pollutants and green waste recycling. Learn about and use this program at *www.ecoSmart.gov.*

COMMUNITY TREE GUIDES. **The CUFR is finishing up a series of tree guides for each of the STRATUM climate regions, providing an overview of the costs, benefits, and strategic considerations of tree planting. The guides give a helpful, if broad, snapshot of costs and benefits. The Piedmont guide, for example, estimates average annual net benefits (benefits less costs) of trees in the region as $7 to $18 for a small tree, $23 to $35 for a medium tree, $83 to $92 for a large tree, and $31 to $44 for a conifer. Some of the guides are available in printed form; others can be downloaded from the CUFR web site at *www.fs.fed. us/psw/programs/cufr/tree_guides.php.***

TREE-ANIMATION VIDEOS. **Attention, YouTube fans: The CUFR's newest tool is a tree animation program developed with scientists from Griefswald University in Germany. These videos, based on measured street tree data such as height and crown shape representing the tree's growth from four to 50 years, can help landscape architects, planners, and urban foresters visualize how a tree will look over time. The context for the animation includes buildings and a person to show scale, and the videos show both shadows cast on the ground plane and self-shadows within the tree. Animation videos have been completed for five species, and three or four more are in the works. Watch the ash tree video at *www.youtube.com/watch?v= KCxj3749otQ.* CUFR staff are working to convert the executable code into quicker and smaller GIF files easily viewable on their web site *(www.fs.fed.us/ psw/programs/cufr/)* and available for downloading.**

LOOKING AHEAD, McPherson hopes to capitalize on research the center has already done by putting it into more user-friendly formats. The CUFR has developed a matrix for the Sacramento region that can help with species selection by weighting attributes such as drought tolerance, smog reduction, and pollen production. "We've talked about a geographic information system decision support tool that could identify not only where possible planting sites are, but their relationship to buildings they might shade, utilities, and so on," he says. "It would be neat to have a pop-up tree selection menu where you could adjust the weighting, order choices based on species' ranking, and estimate the future stream of benefits from a tree of a particular species in a particular location."

But despite such promising ideas, and our increasingly apparent need for such tools, the CUFR's federal government funding is falling—down 10 percent a year for the past three years—rather than rising. The center's staff used to comprise 12 people; now it's down to four. Healthy urban trees are good economics and good politics, but as a society we're not putting our money where our rhetoric is.

McPherson draws an analogy to the concrete-intensive antiseptic zoos he visited during his Midwestern childhood. "Now I take my kids to the zoo and it's like a wild animal park," he says. "Somewhere in the past few decades, somebody got the idea we could create habitats that would nurture the spirits of these animals. It costs a lot of money to create habitat like that. And we pay to get in! But then we go back to (human) environments that are often stark and inhumane." Each tree that is properly planted and survives over the long term, says McPherson, creates a little speck of habitat for people in cities. LAM

Resources

■ Learn more about the CUFR's work, read its studies, and find links to free planning and analysis tools at *www.fs.fed.us/psw/programs/cufr/*.