



THE HUMAN HEALTH AND SOCIAL BENEFITS OF URBAN FORESTS

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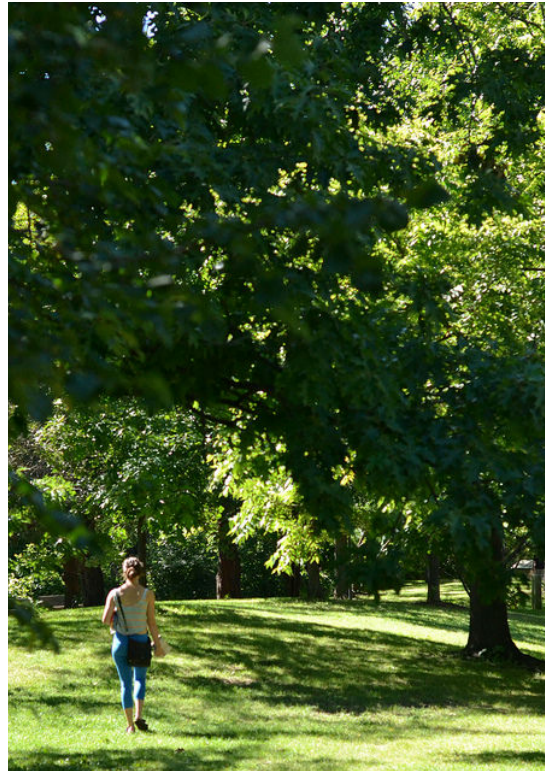
The Human Health and Social Benefits of Urban Forests

Executive Summary

Urban forests¹ can provide economic, environmental, and social benefits. Economic benefits such as lower heating and cooling costs and higher property values are fairly well recognized. From an environmental perspective, urban forests tend to enhance regional biodiversity, mitigate stormwater management demands, and improve air quality. Urban forests can also increase carbon sequestration and reduce the urban heat island effect.² However, the social and human health aspects of urban forests are not as well known, and a growing body of literature points toward substantial benefits in these areas as well.

Recent research suggests that urban forests can improve human mental and physical health, improve academic performance where school settings and classrooms integrate trees and forest views, increase social cohesion, and, in some cases, contribute to a reduction in crime. While urban forests provide an array of social benefits to people living and working in cities and visiting them, these benefits are often unevenly distributed. Uneven distribution of tree-related benefits frequently correlates with socioeconomic status, race, and ethnicity, and education level, as open space and urban tree cover are frequently less common in lower income neighborhoods

At a time when more and more people around the world live within cities, it is increasingly important to take advantage of the many benefits that urban forests offer. Robust and equitable urban forest management policies and incentives are needed in order to enable widespread access to the many benefits urban forests provide.



[Photo Credit: Meg Emory, 2016](#)

Introduction

Today there are about 4 billion urban trees¹ in the U.S., with another 70 billion trees growing in metropolitan areas.³ As urban land in the U.S. expands, so do urban forests. Urban land in the lower 48 states increased from 2.5% of total land area in 1990 to 3.1% in 2000, an increase in area about the size of Vermont and New Hampshire combined. Researchers from the U.S. Forest Service forecast that urban land in the coterminous U.S. will nearly triple in size to over 8% of the U.S. land base by 2050, an area larger than the state of Montana.⁴

¹ This report focuses on urban forests as defined by the Bureau of the Census, which includes: (1) urbanized areas with populations of 50,000 or more, (2) places that contain some urbanized areas within their boundaries, or (3) places with at least 2,500 people and located outside of urbanized areas.

² In 2011, the Alliance for Community Trees prepared a research resource list addressing the *Benefits of Trees and Urban Forests*, available at: http://actrees.org/files/Research/benefits_of_trees.pdf. For further discussion of the diverse benefits of urban forests, see previous Dovetail Reports, including: *Urban Wood Utilization and Industrial Clusters* (http://www.dovetailinc.org/report_pdfs/2010/werc63010finalreportsm.pdf); *Innovative Municipal Stormwater Management Approaches* (http://www.dovetailinc.org/report_pdfs/2012/dovetailstormwatermgmt0712.pdf); and *Carbon Sequestration in Wood Products, Urban Forests* (http://www.dovetailinc.org/report_pdfs/2011/dovetailurbansolidwoodcarbon0711-1.pdf).

³ Metropolitan areas are typically not defined by places (urban areas) but rather by counties. For example, the New York metro area covers 36 counties in NY, NJ, CT and PA.

⁴ See previous Dovetail Report: *Urban Wood Utilization and Industrial Clusters*, http://www.dovetailinc.org/report_pdfs/2010/werc63010finalreportsm.pdf

More than 80% of Americans live in urban areas. Some states have even higher rates of urban populations; for example, 95% of Californians live in urban areas.⁵ According to the World Health Organization (WHO) in 2014, 54% of the world's population lived in urban areas.⁶ The United Nations (UN) estimates that nearly 70% of the world's population will live in cities by 2050.⁷

Urban forests provide many benefits not the least of which are those related to human health and functioning of society. Examples of social benefits that urban trees provide include improved human mental and physical health, improved academic performance when school settings and classrooms integrate trees and forest views, better social cohesion, and crime reduction. Studies related to these benefits are discussed in detail in this report. Many of these studies provide insight into the potential for achieving broader benefit than is now being realized, but they also highlight a need for additional research in order to better understand the mechanisms at play.

Improved Mental and Physical Health

Exposure to large expanses of urban green space (e.g., parks and trails) has been found to improve human mental health and cognitive function. The practice of “forest bathing” has also been researched for its health benefits (Lee 2009; Lee 2011; Li 2010; also see sidebar). Numerous studies have found relationships between human exposure to urban forests and associated human mental and physical health benefits. Specifically, these findings indicate a connection between urban forests and:

- Higher birth weights (Dzhambov, Dimitrova, and Dimitrakova 2014),
- Fewer deaths from cardiovascular and lower-respiratory-tract illness (Donovan et al. 2013),
- Faster recovery from surgery (Ulrich 1984),
- Stress reduction (Thompson et al. 2012), and
- Lower prevalence of asthma rates (Lovasi et al. 2008).

Are “tree baths” more than just a walk in the forest?

By [Ruby Warrington](#) • 08/17/16 9:11am

A 2012 study cited health and money concerns as the key drivers behind New Yorkers reporting higher levels of stress than the national average. Time spent in nature, meanwhile, is widely recognized as an effective antidote—Frederick Law Olmsted, the landscape architect who designed Central Park, reminded us in 1865 that “the occasional contemplation of natural scenes of an impressive character...is favorable to the health and vigor of men and especially to the health and vigor of their intellect.”

Enter “forest bathing,” the Japanese art of [Shinrin-yoku](#), new to the spa menu at the [Mayflower Grace](#) in Washington, Connecticut, and a fast track to inner Zen for time-strapped New Yorkers. Essentially a guided, meditative walk among the trees, the term was coined by the Japanese Ministry of Agriculture, Forestry and Fisheries in 1982, after several studies showed marked health benefits from “making contact with and taking in the atmosphere of the forest.”

This is largely due to the presence of phytoncides—substances emitted by trees and other plants to protect themselves from harmful insects and germs. In humans, the effects of breathing these included decreased stress hormone activity and improved immunity for up to 30 days. Meanwhile, Japanese studies showed the wider benefits of Shinrin-yoku to be increased vigor, attentiveness, friendliness and self-confidence, along with decreased scores for hostility, boredom, depression, anger and fatigue.

Shinrin-yoku also reduced the concentration of cortisol⁸, reduced blood pressure and pulse rate and stabilized autonomic nervous activity, with tests showing decreased symptoms of headache, backache and muscle tension. Which all makes the simple act of taking a stroll in the forest read not unlike a prescription specifically designed to address so many of our modern city ills.

Excerpted from: <http://observer.com/2016/08/are-tree-baths-more-than-just-a-walk-in-the-forest/>

⁵ <http://www.reuters.com/article/usa-cities-population-idUSL2E8EQ5AJ20120326>

⁶ http://www.who.int/gho/urban_health/situation_trends/urban_population_growth_text/en/

⁷ <https://www.un.org/development/desa/en/news/population/world-urbanization-prospects.html>

In Scotland, researchers examined a possible connection between exposure to green spaces and reduced stress levels (Thompson et al. 2012). The researchers used salivary cortisol sampling⁸ to measure stress levels and compared salivary cortisol patterns of people living in greener neighborhoods with those of people living in less green neighborhoods. They also compared self-reported stress levels of the people in their sample. The researchers found a positive association between healthy salivary cortisol patterns which are indications of less stress, and the percentage of green space in a neighborhood.⁹ They also found an inverse association between the percent of green space in a neighborhood and self-reported stress levels. Both results held after adjusting for potential confounding variables, such as socio-economic status.

In a British study researchers analyzed the mental health effects of moving from less green urban residential areas to greener areas and vice versa (Alcock et al. 2014). The study found that people who moved to greener areas experienced overall improvements to their mental health while people who moved to less green areas experienced a temporary decline in mental health. These results suggest that greener urban residential areas have a positive effect on residents' mental health. However, researchers are not sure about the mechanisms that lead to improvements, and cannot explain the temporary mental health decline but long-term stability in people moving to less green areas.

A Tokyo study examined the connections between walkable urban green space and seniors' life expectancies (Takano, Nakamura, and Watanabe 2002). More specifically, they analyzed the five-year survival of 3,144 senior citizens of Tokyo in relation to baseline residential environment characteristics. The study found that the likelihood of five-year survival increased in relation to the amount of walkable space and green space nearby. The availability of green space also contributed to a positive attitude towards living in the neighborhood. In other words, urban green spaces, especially walkable green spaces, might help to increase the life expectancy of older adults.

Researchers have also found a possible connection between exposure to nature and an alleviation of attention-deficit/hyperactivity disorder (ADHD) symptoms. In a study on the effect of exposure to nature on ADHD symptoms, researchers examined how the settings of after-school and weekend activities affected children's ADHD symptoms (Kuo and Taylor 2004). The study found that there was a stronger reduction in symptoms after activities in green or natural settings compared to activities in other settings, even when the type of activity was the same.

In a 2001 study researchers found an association between green play settings and milder symptoms in children with Attention Deficit Disorder (ADD) compared to children who played indoors with no access to green spaces (Taylor, Kuo, and Sullivan 2001). Study results indicate that green spaces may help to improve attentional functioning in children with ADD. While this information is particularly important for people dealing with ADD, as the authors point out, all children and adults can benefit from improved attentional functioning. Combined with previously mentioned studies that point to a connection between exposure to green space and attentional functioning, this study makes a strong case for increasing urban forests and ensuring that they are readily and easily accessible to everyone, regardless of age, race or socioeconomic status.

⁸ Cortisol (hydrocortisone, Compound F) is the major glucocorticoid hormone produced in the adrenal cortex. Cortisol is actively involved in the regulation of calcium absorption, blood pressure maintenance, anti-inflammatory function, gluconeogenesis, gastric acid and pepsin secretion, and immune function. Quoted from: <https://www.salimetrics.com/biomarker/cortisol>

⁹ For additional background on the study of stress in humans and the use of salivary cortisol as a biomarker, see *How to Measure Stress in Humans?* from the Centre on Studies on Human Stress, available at: http://www.stresshuman.ca/documents/pdf/Mesures%20physiologiques/CESH_howMeasureStress-MB.pdf

Another aspect of health, is nutrition and alternative medicine.¹⁰ In a Seattle, Washington study (Poe 2012) researchers used ethnographic interviews to examine the importance of urban forests as a source of food, medicine, and materials for some urban residents. In particular, they addressed the conflicts between conventional urban forestry regimes in the U.S., which usually prohibit the gathering of forest products by individuals, with people for whom the gathering of urban forest products is an integral part of their lifestyle. While the percentage of the population that regularly engages in foraging practices may be fairly small, the people that do may depend on such practices for food, medicine, income, or to continue family or cultural traditions. The authors pointed out that urban forest food products may help to address some aspects of food security and a lack of access to healthy, culturally-appropriate foods in some urban communities.¹¹ They also addressed some of the problems associated with the gathering of urban forest products, such as an increased risk of toxicity based on their location. An additional group of researchers (McLain 2014) gathered information from Baltimore, New York City, Philadelphia, and Seattle, and found foraging to be an ongoing practice among diverse urban residents.

Improved Physical Activity

Researchers have found a positive correlation between access to green space and physical activity.¹² However, it is unclear how strong this correlation is, as study results vary and may depend on factors such as socioeconomic status and age.

A New York City study found a connection between street trees and the prevalence of asthma in children (Lovasi et al. 2008). Results showed “an increase in tree density of 1 standard deviation was associated with a 24-29% lower prevalence of asthma in young children” (Lovasi et al. 2008). However the increase in tree density was not associated with a lower rate of hospitalizations for asthma. The authors point out that the connection could be studied more by tracking the effect of a tree planting program in New York City, called PlaNYC, on asthma rates in the city.¹³

In a study in Denmark researchers examined the effect that different characteristics of urban green spaces in relation to urban residents might have on their physical activity (Schipperijn et al. 2013). They found that the size of the nearest urban green space, the distance to this space, and the number of features it possessed did not have a significant negative or positive correlation with outdoor physical activity (Schipperijn et al. 2013). They also did not find a correlation between outdoor physical activity and the quantity and size of urban green spaces within a one-kilometer range. However, the researchers pointed out that these results differ from results obtained in other countries such as the U.S. and that the relationship between urban green space and physical activity in the young, educated population of a city such as Odense, where the study was conducted, may not be representative of the effects of urban green spaces on physical activity in the larger Danish population, let alone the European or global population.

Improved Academic Performance

The ability of exposure to green spaces, including urban forests, to improve the attention function of children and adults has also been found to contribute to increased academic performance. For example, in the 1990s, researchers studied the effect of natural views from dormitory windows on students (Tennessen and Cimprich 1995). The researchers used a number of measures to evaluate

¹⁰ For a discussion of complementary and alternative medicine, including biologically-based practices, see: <http://www.mayoclinic.org/healthy-lifestyle/consumer-health/in-depth/alternative-medicine/art-20045267>

¹¹ For further discussion of the potential food supply benefits of urban forests, see the Dovetail Report *Utilizing Urban Forests for Fruit Production*, Available at: http://www.dovetailinc.org/report_pdfs/2011/dovetailurbanfruit0411.pdf

¹² Some research (Akers 2012) has attempted to “...establish the extent to which the color green, as a primitive visual feature of many natural environments, contributes to the green exercise effect.” See: <http://www.ncbi.nlm.nih.gov/pubmed/22857379>

¹³ Efforts within PlaNYC have included adding 950,000 trees and six million square feet of reflective rooftops. More information is available at: <http://www.nyc.gov/html/planyc/html/home/home.shtml>

students' ability to direct their attention and found that views of more natural surroundings correlated with better performance.

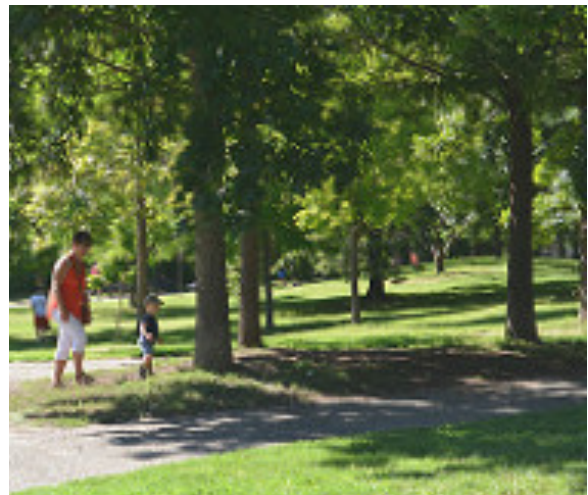
A Michigan study investigated the effect of exposure to green space in school on the academic success of students at 101 public high schools (Matsuoka 2010). A positive correlation was found between exposure to nature and students' success measured by standardized testing, rate of graduation, percentage of students planning to go to college, and rate of criminal behavior. These relationships held after controlling for factors such as socioeconomic status and race or ethnicity. In contrast, views of buildings and landscapes that lacked natural features were negatively associated with student performance. Interestingly, the relationship between student performance and views of "more natural landscapes during lunch time" was particularly strong, in spite of the relatively small amount of time that students spend in cafeterias as opposed to classrooms. The author suggests that this may be the case because natural views help to support the process of recovery and the attention restoration that takes place during lunch breaks (Matsuoka 2010).

Increased Social Cohesion

Possible connections between access to urban forests and other urban green spaces and increased social ties and interactions have also been examined. In 1997 a study explored how the amount of green space in the vicinity of two public housing projects in Chicago affected the extent to which residents frequented outdoor common areas (Coley, Sullivan, and Kuo 1997). Study results indicated that the amount of trees in the vicinity of the buildings affected the use of outdoor common spaces by their inhabitants. Additionally, study results showed that urban forests seemed to attract more people, and groups of people with a larger variety of ages, than spaces without trees. They also found that the higher the tree density and the closer the trees were located to housing, the more people gathered close to them. These results indicate that individuals and groups of people are attracted to urban trees located close to their homes.

In a further study in Chicago researchers hypothesized that greater levels of vegetation (trees and grass) in outdoor public areas would be associated with more robust social ties between people living adjacent to those areas (Kuo et al. 1998). Their results supported this hypothesis. More specifically, compared to residents living adjacent to relatively barren spaces, individuals living adjacent to greener common spaces had more social activities and more visitors, knew more of their neighbors, reported their neighbors were more concerned with helping and supporting one another, and had stronger feelings of belonging (Kuo et al. 1998). These findings show that vegetated outdoor common areas represent an attractive space in which neighbors can come together to improve their social ties in an informal setting.

A number of studies have focused on the benefits that urban forests may provide for increasing the social ties of various age groups. In a 1998 study researchers examined the effect of vegetation levels on children's outdoor activities and their access to adults outside inner-city housing (Taylor et al. 1998). Study results found that children played more and that their play was more creative in spaces with more trees. They also found that children tended to have more access to adults in spaces with more trees (Taylor et al. 1998). These results indicate that urban trees near housing may help improve children's play, supervision, and social ties, which in turn may have positive impacts on health and development.



[Photo Credit: Meg Emory, 2016](#)

In another study from 1998 researchers interviewed older adults from an inner-city community to examine what effect exposure to urban forests in their everyday lives had on their social ties (Kweon, Sullivan and Wiley 1998). Researchers were particularly interested in the social ties of older adults because of correlations between social interaction, health, and life expectancy found in previous studies. While the researchers found that the amount of exposure to urban forests was positively correlated with the strength of social ties, older adults with more exposure to urban forests did not report better levels of physical health. The authors argued that this may be the case because levels of green space in older urban adults' environments may not be high enough to affect their physical health or that the effect of green space on health may not be as strong for elderly people as for younger people. Regardless of whether these social ties have a positive effect on older adults' health, an improvement of older adults' social ties should be seen as a benefit of exposure to green space.

In a study conducted in the Netherlands researchers examined a possible connection between social contacts and the health effects of urban forestry. They found that a lack of green space (e.g., trees) in residential areas was associated with loneliness and a perceived lack of social support (Maas et al. 2009). This perceived loneliness and lack of social support was a mediating factor between green space and health. The results of this study not only indicate that there is a connection between green space in residential areas and better social ties, but also that improved social ties may be a possible pathway connecting green space and health.

Influence on Crime Rates

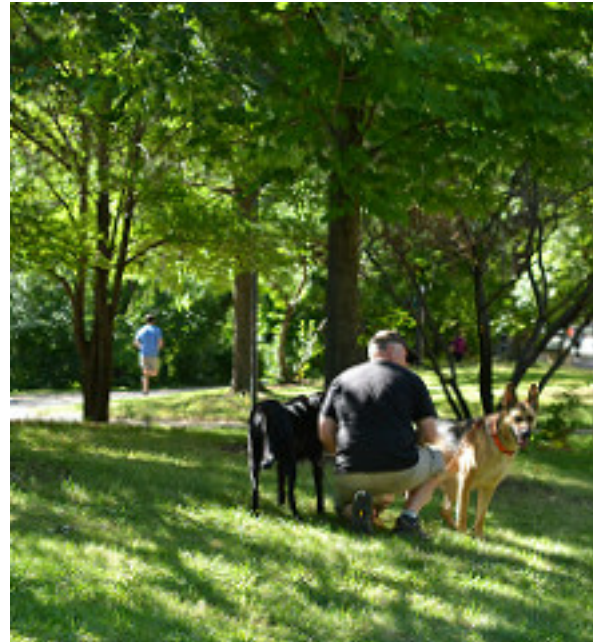
A number of studies have examined the relationship between urban forests and crime rates. Most have found a correlation between increased tree coverage and decreased crime rates, even after adjusting for a number of other variables, such as median household income, level of education, or rented versus owner-occupied housing in the neighborhoods that were studied (Gilstad-Hayden et al. 2015; Troy, Grove, and O'Neil-Dunne 2012).

Some studies have looked more closely at the effect that the configuration of urban trees on city blocks have on crime. These studies have found that while there is a general correlation between trees and lower crime rates, certain types of trees and planting configurations are actually associated with higher crime rates. This is particularly evident in the research done by Geoffrey H. Donovan and Jeffrey P. Prestemon in Portland, Oregon (2010) which found a correlation between larger trees and reduced crime, but they also found a correlation between groups of small trees and increased crime. These research results present an incentive to plant and maintain more large trees in residential areas, while also giving valuable information about the ideal placement of trees.

In a Baltimore study researchers found that an increase in tree canopy of about 10% was associated with a decrease in crime of about 12% (Troy, Grove, and O'Neil-Dunne 2012). This held true after they controlled for potentially confounding socioeconomic factors. The researchers point out that there may be other unknown variables contributing to this effect, but that the results suggest that "there is some genuine relationship between trees and crime". Similarly to Donovan and Prestemon, Troy and his colleagues found that trees on private property are more likely to be associated with crime than trees on public property. They suggest that trees on private property can serve as cover for criminals and that they ought to be chosen, spaced, and pruned more carefully to prevent this from happening.

A study on the effect of nearby parks on property values in Baltimore, MD discovered that property values are higher in correlation with park proximity only when the neighborhood's crime rate is below a certain level. When the crime rate is above that level, the proximity to a park seems to negatively affect property values. The crime threshold in question lies somewhere in the range of

406% to 484% of the national crime rate average (i.e., 4 to 5 times greater than the national average) (Troy and Grove 2008). The researchers argue that the results could motivate stakeholders to work together to reduce crime rates and improve park management, thereby transforming parks into an asset rather than a liability in neighborhoods with a history of high crime rates. However, they also point out that the relationship between parks, crime rates, and housing prices has not been clearly explained by their research and that this could be a goal of future studies. The results of this study show that parks are valued by nearby communities and the housing market when they and the neighborhoods they are in have a reputation of being safe. However, they also indicate that people may associate parks with danger and crime in neighborhoods with high crime rates. This would constitute an example of unequal access to the benefits of urban forests, as people in high crime neighborhoods may experience more of the negative effects associated with the presence of green space and trees than the benefits. Thus, physical accessibility to urban forests and green spaces is only part of the issue. Urban green spaces need to be safe and be perceived as safe so that urban residents can benefit from them.



[Photo Credit: Meg Emory, 2016](#)

Environmental Justice

While it can be seen that urban forests provide an array of benefits to people living and working in, and visiting cities, these benefits may be unevenly distributed throughout urban areas based on varying factors including land uses, socioeconomic status, race, ethnicity, and education level. A lack of easily accessible public green space for some urban demographics is an issue of environmental justice because of the diminished environmental and social benefits. Several scientific studies have sought to uncover the extent of differences in access to urban forests and the barriers to their associated environmental and social benefits.

A study conducted in six cities in Illinois investigated differences in access of ethnic or racial groups to parks and trees (Zhou and Kim 2013). Researchers found that racial minority groups had fewer trees and parks present in their neighborhoods, but that there were not large differences in ethnic groups' tree and park access. They also found that higher socioeconomic status correlated with a greater percentage of trees or tree canopy in a neighborhood.

Similarly, a study conducted in Hartford, Connecticut examined the relationship between street greenery and the socioeconomic status of urban residents (Li et al. 2015). Results showed a positive association between the residential green view index (a measure of the amount of street greenery) and income level, education level, and owner-occupied property (Li et al. 2015). A negative association between green view index and the proportion of Hispanics disappeared when controlled with income levels, indicating that access to street greenery is related more to socioeconomic status than to ethnicity or race. The researchers noted in their study that members of racial minorities often had lower socioeconomic status, which may explain the initial correlation between the proportion of Hispanics and a reduced green view index in the Hartford, Connecticut study.

In 2014, a Portland, Oregon study found that residents with low high school graduation rates and lower incomes were more likely to decline participation in a tree-planting program (Donovan and Mills 2014). This may be because the costs outweigh the benefits for many low-income residents who are asked to pay for and take care of a tree at the beginning of the program, while the benefits, such as increased home value and shade, do not manifest themselves for a number of years. Also, low-income residents are more likely to be renters and may move to another residence before they can benefit from such a program, while potentially dealing with the negative impacts that (particularly small) trees may have on crime in the meantime (Donovan and Mills 2014; Donovan and Prestemon 2016). Rental occupants may also not have permission to plant trees on the property, or the renter may be uncertain about their rights to modify the yard with plantings. Financial incentives that lower the cost for low-income residents may serve as one solution to improving urban forest access and participation in urban tree-planting programs. Making sure that renters have permission or understand their rights to plant trees may be important to increasing participation in these programs.

The Bottom Line

Urban forests play an incredibly important, multifaceted role in maintaining and improving not only the economic and environmental conditions of cities but also the health of their inhabitants. Urban forests provide vital social services such as improved mental and physical health, improved quality of life, increased social cohesion, improved academic performance, and can contribute to a reduction in crime. Additional research is needed to understand the mechanisms by which these benefits occur and any associated trade-offs. These social benefits are integral to sustaining thriving metropolitan areas, especially at a time when increasing rates of global populations live within cities. In order to enable access to urban forests and the benefits they provide to everyone, regardless of socioeconomic status, age, race or ethnicity, equitable urban forest management policies and tree planting incentives are needed to bridge the gap.

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