



Benefits of Trees and Urban Forests

This resource list compiled by Alliance for Community Trees (ACTrees) gathers the many scientifically proven benefits of urban forests into a single document for tree advocates to use. These facts come directly from primary research conducted by professional scientists, with all citations noted. Grouped by category, these benefits speak to the enormous monetary, social, and ecological value of urban forests to human society. They argue for the vital role of trees in our communities. ACTrees member organizations nationwide are working to bring these benefits to towns small and large, improving the health and livability of our communities by planting and caring for trees. To learn more, visit www.ACTrees.org

Green Infrastructure Benefits.....	2
Economic Benefits	2
Reducing Stormwater Run Off and Maintenance Costs.....	2
Improving Air Quality	3
Improving Water and Soil Quality.....	4
Public Health Benefits.....	4
Improving Attention.....	4
Decreasing Asthma & Obesity.....	4
Improving Physical and Mental Health.....	5
Reduced Hospital Days.....	5
Protection from UV rays.....	5
Noise Reduction.....	5
Roads and Traffic Benefits.....	5
Traffic Calming and Accident Reduction.....	5
Reducing Road Maintenance Costs.....	6
Business Benefits.....	6
Business Districts: Increased Sales, Desirability and Rents.....	6
Jobs.....	6
Property Value Benefits.....	6
Increasing Property Values.....	6
Climate Change and Carbon Benefits.....	7
Storing carbon and reduction of carbon emissions.....	7
Carbon Mitigation Programs.....	8
Reducing the Heat Island Effect.....	8
Energy Use Benefits.....	8
Community Benefits.....	9
Wildlife and Biodiversity.....	10
Canopy Cover Facts.....	10
Tree Canopy Loss.....	10



Green Infrastructure Benefits

Economic Benefits

- Urban forests in the United States contain about 3.8 billion trees, with an estimated structural asset value of \$2.4 trillion.¹⁰⁹
- Urban forests in the U.S. provide essential services to more than 220 million people (supporting 79 percent of the population).¹
- Trees in New York City provide \$5.60 in benefits for every dollar spent on tree planting and care.¹²⁰
- For every dollar spent on tree planting and maintenance, the city of Providence, RI reaps \$3.33 in benefits.⁸¹
- Street trees in Washington, DC, produce annual benefits of \$10.7 million.¹³
- Trees in Glendale, AZ, produce total annual benefits of \$665,856 or \$31 per tree.²
- Trees in Berkeley, CA, produce total annual benefits of \$3.25 million or \$89 per tree.²
- Trees in Minneapolis, MN, produce total annual net benefits of \$15.7 million or \$79 per tree.³⁶
- Trees in Mecklenburg County, NC, produce annual ecological benefits (stormwater management and air pollution mitigation) of over \$200 million per year.³
- The average annual net benefit of a mature large tree is \$85 in a yard and \$113 on public land.⁴
- New York's state parks and open space provide a \$2.7 billion annual economic benefit to local governments and taxpayers.⁵
- The value from urban forestry in Chicago totals \$2.3 billion¹³
- Portland invested \$8 million in green infrastructure to save \$250 million in hard infrastructure costs.
 - The value of green infrastructure on urban climate adaptation
- Net benefits for a yard and public tree summed over 40-year period⁷⁶:
 - Large Tree: \$4,320 (yard) and \$3,880 (public)
 - Medium Tree: \$1,040 (yard) and \$760 (public)
 - Small Tree: \$280 (yard) and \$40 (public)
 - Conifer: \$2,040 (yard) and \$1,640 (public)

Reducing Stormwater Run Off and Maintenance Costs

- Urban forest can reduce annual stormwater runoff by 2–7 percent, and a mature tree can store 50 to 100 gallons of water during large storms.¹⁰
- Green streets, rain barrels, and tree planting are estimated to be 3-6 times more effective in managing stormwater per \$1,000 invested than conventional methods.¹³
- Implementing green infrastructure practices in Detroit's sewage and water department will reduce combined sewer overflow volumes by 10-20% and reduce annual costs by \$159 million a year.⁶
- Portland, OR, is saving 43% (\$64 million) by integrating green infrastructure—including planting 4,000 trees—into a combined gray-green stormwater management solution rather than the standard gray infrastructure approach.⁷⁹
- Street trees in Minneapolis save \$9.1 million in stormwater treatments annually.⁶²
- Philadelphia's \$1.5 billion stormwater management plan focuses almost exclusively on eco-friendly solutions—bioswales, permeable pavement, street



Benefits of Trees and Urban Forests: A Research List

- trees--as a way of reducing the city's 15 billion gallons of annual water overflow.¹⁶
- Trees on UC San Diego's 1,200-acre campus trap and filter nearly 140 million gallons of stormwater runoff each year at a value of \$250,000.⁶⁵
 - The stormwater management value of Philadelphia's parkland and trees is \$5.9 million annually.¹¹
 - Urban greening in Washington, DC, prevents over 1.2 billion gallons of stormwater from entering the sewer system, 10% of the total volume. This represents a savings of \$4.74 billion in gray infrastructure costs per 30-year construction cycle.¹²
 - Trees in Houston, TX, provide \$1.3 billion in stormwater benefits (based on \$0.66 /cubic foot of storage).¹³
 - Each urban tree in Modesto, CA, reduces stormwater runoff by 845 gallons annually, with a benefit valued at \$7 per tree.⁸⁷
 - Street trees in New York City intercept 890 million gallons of stormwater annually: 1,525 gallons per tree on average, with a total value of over \$35 million each year.¹²⁰

Improving Air Quality

- Trees clean the air by absorbing carbon dioxide, sulphur dioxide, nitrous oxides and other pollutants, and also shade cars and parking lots, reducing ozone emissions from vehicles.⁷⁶
- The tree canopy of Houston, TX, removes 60,575 tons of air pollutants annually with a value of \$300 million.⁷⁶
- The tree canopy of New York City, removes 1,973 tons of air pollution annually at a value of \$9.24 million.⁸⁰
- The trees in the Atlanta metro area remove 19 million pounds (8,618 t) of air pollutants annually, for annual savings valued at \$47 million.⁷⁴
- The urban forest of Montgomery, AL, removes 1,603 tons of air pollutants annually valued at \$7.9 million.⁷⁸
- Trees and shrubs in Philadelphia removed 971 tons of air pollution annually at value to society of \$4.8 million.¹⁴
- Sacramento County's million trees remove approximately 1,607 tons of air pollutants annually. These trees removed 665 tons of ozone, 748 tons of PM10, 164 tons of NO2, and 30 tons of SO2. The total value of the annual reduction of ozone and particle pollution is \$28.7 million.¹⁸
- The urban trees of Los Angeles, CA, remove about 77,000 tons of carbon per year and about 1,976 tons of air pollution per year.¹⁰⁷
- Mature trees absorb 120-240 lbs of particulate pollution each year.¹⁵
- Urban trees in the US remove 711,000 metric tons of air pollution (O3, PM10, NO2, SO2, CO) annually, at a value of \$3.8 billion.¹⁷
- UFORE analysis of the urban tree benefits of Washington D.C.'s 1.9 million trees report the following⁷⁵:
 - 474,000 metric tons of Carbon stored (\$10.8 million value)
 - 14,600 metric tons/year of Carbon sequestered (\$334,000 value)
 - 490 metric tons/year total pollution removal (\$3.7 million value)
 - 23 metric tons/year of CO removed (\$32,000 value)
 - 65 metric tons/year NO2 removed (\$645,000 value)
 - 196 metric tons/year of O3 removed (\$1.9 million value)
 - 66 metric tons/year of SO2 removed (\$160,000 value)
 - 140 metric tons/year of PM10 removed (\$928,000 value).
- Net air pollutants removed, released, and avoided from Minneapolis's urban



Benefits of Trees and Urban Forests: A Research List

- trees average 2 lbs per tree and are valued at \$1.1 million annually. Avoided emissions of NO₂ and SO₂ total about 150 tons, valued at \$830,000.³⁶
- A big tree removes 60 to 70 times more pollution than a small tree.⁹⁸

Improving Water and Soil Quality

- Trees and other plants help remediate soils at landfills and other contaminated sites by absorbing, transforming, and containing a number of contaminants.¹⁹
- New York's implementation of a forest protection strategy instead of building a new water treatment plant will save the city \$6 billion.²⁰
- Switzerland saves roughly \$64 million a year by using water from forested watersheds that needs no water treatment plant.²⁰
- In studies at Pennsylvania State University, tracts of trees in municipal watersheds were used to purify partly treated sewage and protect surface waters.²¹
- Trees divert captured rainwater into the soil, where bacteria and other microorganisms filter out impurities. This reduces urban runoff and the amount of sediment, pollutants, and organic matter that reach streams.⁹

Public Health Benefits

Improving Attention

- Contrary to some beliefs, studies show that children with ADD function better after activities in green settings, and the "greener" a child's play area, the less severe his or her attention deficit symptoms.²²
- A study on children with attention deficit disorders discovered that the effect of a walk through a park is equal to peak effects of two typical ADHD medications.²³
- College students with more natural views from their dorm windows scored higher on attention tests.²⁴
- Trees help girls succeed. On average, the greener a girl's view from home, the better she concentrates and the better her self-discipline, enabling her to make more thoughtful choices and do better in school.¹¹⁶

Decreasing Asthma & Obesity

- Trees filter airborne pollutants and reduce the conditions that cause asthma and other respiratory problems.⁸⁹
- Researchers from Columbia University found childhood asthma rates were highest in parts of the city where tree density was lowest. The rate of asthma fell by 25% for every extra 340 trees per square kilometer, a pattern that held true even after taking account of differing sources of pollution, levels of affluence and population density.²⁶
- In a study, residents of areas with the highest levels of greenery were three times as likely to be physically active and 40% less likely to be overweight or obese than residents living in the least green settings.²⁵
- Neighborhood parks promote exercise, especially to people living within a mile of a park. In a study three-quarters of park users lived a mile or less from the park.²⁷
- Children in neighborhoods with more green space have lower odds of increased change in body mass index.²⁸
- Children and youth living in greener neighborhoods have lower body mass index.¹²²



Benefits of Trees and Urban Forests: A Research List

- The presence of parks is associated with higher levels of physical activity among adolescent girls, with the attendant health benefits of exercise.⁸⁸

Improving Physical and Mental Health

- Green environment impacts worker productivity: in one study workers without nature views from their desks claimed 23% more sick days than workers with views of nature.²⁹
- Park users report lower levels of anxiety and sadness after visiting parks.³⁰
- The longer park users stay in park settings, the less stress they report.³⁰
- Contact with nature not only decreases elementary school children's stress, but higher amounts of exposure to natural environments indicate lower levels of stress in a child.³¹
- Mental wellbeing improves from exercising outdoors compared to exercising indoors. Exercising in natural environments is associated with greater feelings of revitalization and positive engagement, decreases in tension, confusion, anger, depression, and increased energy.³²
- Visual exposure to settings with trees helps recovery from stress within five minutes, as indicated by changes in blood pressure and muscle tension.³³

Reduced Hospital Days

- Patients recovering from surgery in hospital rooms with window views of natural scene had shorter postoperative hospital stays, received fewer negative evaluations in nurses' notes, and took fewer potent analgesics than matched patients in similar rooms with windows facing a brick wall.³³

Protection from UV rays

- A person standing in direct sunlight takes 20 minutes to burn. However, under a tree providing 50% coverage it takes 50 minutes to burn, and under full shade it takes 100 minutes before one to get a sunburn.³⁴

Noise Reduction

- Trees reduce noise pollution by absorbing sounds. A belt of trees 98 feet wide and 49 feet tall can reduce highway noise by 6 to 10 decibels.⁹⁰
- Planting big enough trees and earth berms can cut traffic noise by up to half.²¹
- Trees absorb high frequency noise which are most distressing to people.³⁵
- Planting "noise buffers" composed of trees and shrubs can reduce 50% of noise to the human ear.³⁹

Roads and Traffic Benefits

Traffic Calming and Accident Reduction

- Street landscape improvements reduced accidents in Toronto by 5% to 20%, generating significant public costs savings, and boosted pedestrian use of urban arterials.³⁷
- Trees improve driving safety. One study found a 46% decrease in crash rates across urban arterial and highway sites after landscape improvements were installed.³⁸
- The presence of trees in a suburban landscape significantly reduced the cruising speed of drivers by an average of 3 miles per hour. Faster drivers and slower drivers both drove slower with the presence of trees.⁴⁰
- Exposure to a natural roadside setting decreased the magnitude of driver's



Benefits of Trees and Urban Forests: A Research List

stress response.⁴¹

- Highway drivers with views of natural roadsides displayed higher frustration tolerance, a known precursor of road rage.⁴¹
- Mid-block islands with trees can result in up to 7% reduction in motor vehicle speeds.⁹⁷
- Studies show that narrow lanes and street trees can reduce the severity of car crashes.¹¹⁰

Reducing Road Maintenance Costs

- Tree shade has been proven to reduce pavement fatigue, cracking rutting, shoving and other distress, saving on repair costs.⁴²
- Street trees prolong the life of pavement. Shaded roads can save up to 60% of repaving costs. That's a lot of savings considering the four million miles of roadways in the US.⁴²
- A study in Modesto, CA, projected that shade street trees will reduce costs for repaving by \$2,900 (58%) over a 30 year period, or \$7.13/m² compared to the unshaded street.⁴²
- Shade provided by trees reduces the need for maintenance and repaving. A study from US Davis found that, 20% shade on a street improves pavement condition by 11%, which is a 60% savings for resurfacing over 30 years.⁹⁶

Business Benefits

Business Districts: Increased Sales, Desirability and Rents

- Shoppers will travel further and longer to visit a district with high quality trees, and spend more time there once they arrive.⁴⁵
- People have more favorable perceptions of communities with green roads.⁴⁶
- Visitors to well-treed central business districts will spend 9 to 12 percent more for products.⁴⁶
- People will pay higher prices for goods in green communities. For instance, in one study, sports shoes were priced 7% higher in the green setting, and a sit-down dinner or a flower bouquet were 10% higher.⁴⁷
- A study found 7% higher rental rates for commercial offices having high quality landscapes.⁴⁴

Jobs

- In California in 2009, urban forestry supported 60,067 jobs, resulting in \$3.3 billion in individual income, \$826 million of Local, State, and Federal taxes, and added \$3.5 billion in values to CA's economy.⁷
- The environmental horticultural industry—including all businesses and government units involved in distributing, installing, and maintaining plants, landscapes, trees, and related equipment—in 2002 was estimated at \$147.8 billion in output, 1,964,339 jobs, \$95.1 billion in value added, and \$64.3 billion in labor income.⁹⁹

Property Value Benefits

Increasing Property Values

- Studies have found general increases of up to 37% in residential property values associated with the presence of trees and vegetation on a property.¹³



Benefits of Trees and Urban Forests: A Research List

- Philadelphia's water management plan includes improved and built green areas to capture stormwater, which will increase nearby property values by \$390 million.⁸
- Trees increased home sales prices in Athens, GA \$1475 to \$1750. This increase in property value results in an increase of \$100,000 in the city's property tax revenues.⁴⁹
- Street trees increase the value of homes in Portland by a total of \$1.1 billion, and, on average, add \$7,020 to the price of a house.⁵⁰
- New tree plantings increased surrounding housing values by approximately 10%, in the Philadelphia neighborhood of New Kensington, which translates to a \$4 million gain in property value through tree plantings.⁴⁸
- In Minnesota, a 10% increase in tree cover within 100 m increases average home sale price by \$1371 (0.48%) and within 250 m increases sale price by \$836 (0.29%).⁵⁶
- Minneapolis street trees add \$7.1 million to aesthetic and property values.⁶²
- Annual economic benefits of Washington DC street trees in 2011 were \$10.6 million, including \$5.1 million for property value.¹³

Climate Change and Carbon Benefits

Storing carbon and reduction of carbon emissions

- Urban trees in the U.S. store 700 million tons of carbon valued at \$14 billion with an annual carbon sequestration rate of 22.8 million tons per year valued at \$460 million annually.⁵²
- Planting 100 million urban trees can store and avoid up to 357 billion tons of carbon over the next 50 years.⁵¹
- Each year an acre of trees absorbs the amount of carbon produced by driving a car for 26,000 miles.⁹³
- Individual urban trees contain about four times more carbon than individual trees in forests.⁵²
- New York City's trees store about 1.35 million tons of carbon valued at \$24.9 million, and these trees remove over 42,000 tons of carbon each year.¹²¹
- The million trees in Sacramento County reduce atmospheric CO₂ at an annual value of \$3.3 million.¹⁸
- The urban trees of Los Angeles, CA, store 1.3 million tons of carbon valued at \$26.3 million.¹⁰⁷
- The urban forest in Casper, Wyoming, is estimated to store about 37,000 tons of carbon and to remove about 50 tons of air pollution per year.⁵⁴
- The 200,000 trees at UC San Diego reduce 10,000 tons of carbon dioxide emissions per year, 5% of its annual emissions, for annual savings of \$2.2 million. The total amount of carbon dioxide stored in UC San Diego's forest is 166,000 tons.⁶⁵
- Streets in Minneapolis, MN, reduce CO₂ emissions by 27,611 tons through energy savings and 29,526 tons through sequestration, at a total value of \$857,000.³⁶
- In 2006, the urban forest of Washington, D.C., was estimated to store about 526,000 tons of carbon.⁵³
- The urban forest in Chicago, IL, has a total carbon sequestration rate of 25,200-tons/year equivalent valued \$14.8 million/year.¹³



Benefits of Trees and Urban Forests: A Research List

- Urban trees sequester more carbon than individual trees in non-urban forests because the more open structure of the urban environment allows individual trees to intercept more light and grow faster. ⁵²
- The national average urban forest carbon storage density is 25.1 tC/ha. ⁵²

Carbon Mitigation Programs

- The Million Trees LA campaign to plant one million trees, started in 2007 with the aim to reduce atmospheric carbon dioxide by about 1 million tons over the next 35 years, equivalent to taking 7,000 cars off the road each year. ⁵⁷
- The NFL strives to make the Super Bowl a carbon-neutral event; carbon emissions from the game in Jacksonville, FL, were offset with the planting of more than 1,000 trees. For the Super Bowl in Detroit, the NFL planted 2,400 trees to combat greenhouse gas emissions from over 100 events associated with the game. ⁵⁸
- In 2008 Harbison-Mahony-Higgins Builders, Inc entered into a contract with the Sacramento Tree Foundation to offset the emissions of the company's new vehicle fleet: 580 trees planted to offset 2,665 tCO₂e. ⁵⁹
- In 2010, Cascade Land Conservancy's Carbon Mitigation Program collaborated with Pearl Jam, in which the Pearl Jam donated \$210,000 to offset the band's world tour carbon footprint of 7,000 tons of carbon dioxide through restoration of 33 acres of forest land. ⁴³

Reducing the Heat Island Effect

- Trees and vegetation lower surface and air temperatures by providing shade and through evapotranspiration. Shaded surfaces may be 20–45°F cooler than the peak temperatures of unshaded materials. Evapotranspiration, can help reduce peak summer temperatures by 2–9°F. ⁶⁰
- Tree planting is one of the most cost-effective means of mitigating urban heat islands. Air temperature differences of approximately 2 to 4°C have been observed across urban areas having variable tree cover, with approximately 1°C of temperature difference being associated with 10% canopy cover difference. ⁴¹
- The indirect cooling effect of evapotranspiration is greater than the direct effect of shading. As the number of trees in an area increase, relative contribution of evapotranspiration to overall cooling goes up, mitigating the urban heat effect. ⁶⁶
- Trees cool city heat islands by 10 degrees to 20 degrees, thus reducing ozone levels and helping cities meet the air quality standards required for disbursement of federal funds. ⁹⁴
- Mature tree canopy reduces air temperatures by about 5-10° F. ¹⁵

Energy Use Benefits

Energy Efficiency

- Just three strategically placed trees can decrease utility bills by 50%. ⁹¹
- The net cooling effect of a healthy tree is equivalent to 10 room-size air conditioners operating 20 hours a day. ¹⁵
- Evergreens serve as windbreaks and in the winter save 10-50% on heating costs. ⁸⁵
- A 20-percent tree canopy over a house results in annual cooling savings of 8 to 18% and annual heating savings of 2 to 8%. ¹³
- Properly placed trees can reduce cooling costs by 30 percent. Shading an air conditioning unit can increase its efficiency by 10 percent. ⁶⁸



Benefits of Trees and Urban Forests: A Research List

- A 25-foot tree reduces annual heating and cooling costs of a typical residence by 8 to 12 %.¹⁵
- Trees on the west and south sides of houses can reduce summertime electricity use by 185 kWh or 5.2%.⁸⁴
- Street trees in Minneapolis save \$6.8 million in energy costs annually.⁶²
- In cold climates, a 30% increase in urban tree cover can reduce winter heating bills by 10% in urban areas and by 20% in rural areas.⁶³
- Houston's regional urban forest save the city \$111.8 million in annual air conditioning costs and \$13.9 million in heating costs.⁷⁷
- In CA, if 50 million trees were planted, they would sequester about 4.5 million tons of CO₂ annually, and if planted strategically to provide shade they would reduce air conditioning energy use by 6,408 GWh, equivalent to 1.4 million tons of CO₂. The estimated total CO₂ reduction is the same as would be obtained from retrofitting all CA homes with energy-efficient electric appliances.⁶⁴
- UC San Diego's 200,000 trees help reduce energy use by 12,886 megawatt-hours by consuming solar energy through the process of "evapo-transpiration" and by blocking winter winds.⁶⁵
- The urban forest in Sacramento County, CA, has annual cooling savings of 157 GWh valued at \$18.3 million per year, and net effects on heating of 145 TJ is valued at \$1.3 million.⁶⁷
- Trees in Chicago are estimated to reduce annual residential energy costs by \$360,000 per year.¹⁰⁸
- 50 million shade trees planted in strategic, energy-saving locations could eliminate the need for seven 100-megawatt power plants.⁸⁶
- Electricity saved annually in Minneapolis from both shading and climate effects of street trees totals 32,921 MWh, for a retail savings of \$2.5 million (\$12.58 per tree).³⁶

Community Benefits

Less Violence and Crime

- Public housing residents with nearby trees and natural landscapes reported 25% fewer acts of domestic aggression and violence.⁶⁹
- There is less graffiti, vandalism, and littering in outdoor spaces with natural landscapes than in comparable plant-less spaces.⁷⁰
- Apartment buildings with high levels of greenery had 52% fewer crimes than those without any trees. Buildings with medium amounts of greenery had 42% fewer crimes.⁸²
- Results of a Portland crime study, found that street trees fronting a house reduced 44 crime occurrences. The net effect of all trees was a reduction in 33 crimes.⁸³

Improves Neighborhood, Connectivity

- Older adults who have more exposure to green common spaces report a stronger sense of unity among residents within their local neighborhood, and experience a stronger sense of belonging to the neighborhood.⁷¹
- Researches are finding signs of stronger communities where there are trees. In buildings with trees, people-report significantly better relations with their neighbors. People report a stronger feeling of unity and cohesion with their neighbors; they like where they are living more and they feel safer than residents who have few trees around them.⁷²



Benefits of Trees and Urban Forests: A Research List

- Surveys show that People feel trees improve communities by making people feel calmer, and improve ones quality of life. ⁶¹

Wildlife and Biodiversity

- Urban forests help create and enhance animal and plant habitats and can act as “reservoirs” for endangered species. Urban forest wildlife offers enjoyment to city dwellers and can serve as indicators of local environmental health.⁷³

Canopy Cover Facts

- How much tree cover a city needs depends on local climate. Eastern cities ideally need 40% cover and western cities need 25% canopy cover. ⁹⁸
- An estimated 634,400,000 trees are currently missing from metropolitan areas across the United States as the result of urban and suburban development. ¹⁰⁰
- Increased urban canopy cover, leads to reduced ozone concentrations in cities.¹⁰⁶
- Washington DC:
 - Washington D.C has lost 64% of its urban forest cover between 1973 and 1997 due to disease, development and natural attrition. ⁹⁵
 - A 1999, analysis of Washington, DC, showed that overall tree canopy declined from 37% to 21% between 1973 and 1997. The lost tree cover increased stormwater runoff by 34% and would have removed about 354,000 pounds of pollutants. ¹⁰⁰
 - Washington D.C has been working to improve its tree canopy. In 2009 the city’s urban tree canopy cover was 35% ¹⁰¹
- Los Angeles, CA, has 6 million trees with a tree cover of 24.9%..¹⁰⁷
- Chicago, IL, has about 3,585,000 trees with canopies that cover 17.2% of the city.¹⁰⁸
- New York City:
 - In 2006 New York City’s urban tree canopy (UTC) covered 44,509 acres or 24% of the city. For New York City to meet its goal of 30% UTC by 2030 will require 12,000 acres of additional tree canopy. ¹¹¹
 - New York City’s canopy cover was still 24% in 2010¹¹²
 - New York lost 9,000 acres (4.5%) of vegetative cover between 1984-2002. ¹¹²

Tree Canopy Loss

- Between 1985 and 2001 the City of San Antonio, TX, had lost 39% of its heavy tree canopy cover. ¹¹⁴
- According to Time Magazine in 2007, San Diego lost a quarter of its tree cover; the tree cover in Michigan, North Carolina and Florida has fallen to 27% of what it once was; Chicago and Philadelphia are just 16%. ⁹⁸
- Philadelphia lost 200,000 shade trees between 1976 and 2004, according to a 2004 study by forestry consultants ¹¹⁵
- Indianapolis urban canopy had a 25% net loss of trees between 1962 and 1993. ¹¹⁷
- In Atlanta, GA, the average tree cover declined from 45% to 29% between 1974 and 1996. This resulted in a 33% increase in stormwater runoff, translating to around 591 million cubic feet of water and a cost of \$1.18 billion for stormwater management infrastructure. ¹¹⁸



Benefits of Trees and Urban Forests: A Research List

- Charlotte, NC, lost 49% of tree canopy and 5% of its open space between 1985 and 2008. ¹¹⁹

U.S. City urban tree canopy cover percentages

- Rockville, MD 44% in 2009 ¹⁰¹
- New York, NY 24% in 2009 ¹⁰¹
- Annapolis, MD 41% in 2009 ¹⁰¹
- Burlington, VT 43% in 2009 ¹⁰¹
- Providence, RI 23% in 2009 ¹⁰¹
- Boston, MA 29% in 2008 ¹⁰²
- Portland, OR 42% in 1990 ¹⁰³
- Chicago, IL 14% in 2008 ¹⁰⁴
- Miami, FL 21% in 2008 ¹⁰⁴
- Seattle, WA 18% in 2008 ¹⁰⁴
- Ann Arbor, MI 33% in 2010 ¹⁰⁵

Tree canopy goal recommendations by geographic area ¹¹³

For metropolitan areas east of the Mississippi and in the Pacific Northwest

- Average tree cover counting all zones 40%
- Suburban residential zones 50%
- Urban residential zones 25%
- Central business districts 15%

For metropolitan areas in the Southwest and dry West

- Average tree cover counting all zones 25%
- Suburban residential zones 35%
- Urban residential zones 18%
- Central business districts 9%

Urban Forest Data from USDA Forest service Urban Forest Canopy data by state

- <http://www.nrs.fs.fed.us/data/urban/state/?state=>

Percent urban tree canopy cover of urban land for all available states from 2008

- <http://www.nrs.fs.fed.us/data/urban/state/viz.asp?var=STUCANPER&state=WV>

American Forests Urban Ecosystem Analyses of certain states and cities.

- <http://ftp.americanforests.org/resources/urbanforests/analysis.php>



Benefits of Trees and Urban Forests: A Research List

Works Cited

- ¹ Nowak, David, Susan Stein, Paula Randler, Eric Greenfield, Sara Comas, Mary Carr, and Ralph Alig. "Sustaining America's Urban Trees and Forests." *U.S. Department Agriculture, Forest Service, Northern Research Station* (2010). Web. <http://www.fs.fed.us/nrs/pubs/gtr/gtr_nrs62.pdf>.
- ² McPherson, Greg E., James R. Simpson, Paula J. Peper, Scott E. Maco, and Qingfu Xiao. "Municipal Forest Benefits and Costs in Five U.S. Cities." *Journal of Forestry* 103.8 (2005): 411-16. Web. <http://www.fs.fed.us/ccrc/topics/urban-forests/docs/jof_Dec_2005.pdf>
- ³ American Forests, and U.S. Forest Service. *Urban Ecosystems Analysis, Mecklenburg County, North Carolina*. Rep. 2003. Web. <http://www.americanforests.org/downloads/rea/AF_Charlotte.pdf>.
- ⁴ McPherson, Gregory E., James R. Simpson, Paula J. Peper, Shelley L. Gardner, Kelaine E. Vargas, and Qingfu Xiao. *Northeast Community Tree Guide: Benefits, Costs, and Strategic Planting*. Tech. USDA, Forest Service, Pacific Southwest Research Station, 2007. Web. <http://www.fs.fed.us/psw/publications/documents/psw_gtr202/psw_gtr202.pdf>.
- ⁵ *The Economic Benefits and Fiscal Impact of Parks and Open Space in Nassau and Suffolk Counties*. Rep. New York: Trust for Public Land, 2010. Web. <<http://www.landtrustalliance.org/about/regional-programs/ne/documents/LongIsland-lowres-final.pdf>>.
- ⁶ Berkooz, Corry Buckwalter. "Industry News - Green Infrastructure Storms Ahead." Water Environment Federation, 01 Mar. 2011. Web. <http://www.wef.org/about/StoryPage.aspx?story_id=159762164>.
- ⁷ Urban & Community Forestry at a Glance. *California Department of Forestry and Fire Protection*. <http://www.fire.ca.gov/communications/downloads/fact_sheets/UrbanForestry_factsheet_print2011.pdf>
- ⁸ Rodgers, Randy. "Philadelphia Plans for Green City, Clean Water." *Sustainable City Network*. 01 June 2011. Web. <http://www.sustainablecitynetwork.com/topic_channels/water/article_b296460c-8caa-11e0-93e0-001a4bcf6878.html>.
- ⁹ Environmental Services Division, Department of Environmental Resources, and Prince George's County, Maryland. *Bioretention Manual*. Publication. 2007. Web. <http://www.princegeorgescountymd.gov/Government/AgencyIndex/DER/ESG/Bioretention/pdf/Bioretention%20Manual_2009%20Version.pdf>.
- ¹⁰ Fazio, Dr. James R. "How Trees Can Retain Stormwater Runoff." *Tree City USA Bulletin* 55. Arbor Day Foundation. Web. <http://www.fs.fed.us/psw/programs/uesd/uep/products/11/800TreeCityUSABulletin_55.pdf>.
- ¹¹ Delaware Valley Regional Planning Commission. *Connections: the Regional Plan for a Sustainable Future. Long-range Plan for Greater Philadelphia*. Rep. 2009. Web. <<http://www.dvrpc.org/reports/09047.pdf>>.
- ¹² Deutsch, Barbara, Heather Whitlow, and Michael Sullivan. *The Green Build-out Model: Quantifying the Stormwater Management Benefits of Trees and Green Roofs in Washington, DC*. Rep. Casey Trees, Limno Tech, 2007. <http://www.capitolgreenroofs.com/pdfs/Green_Infrastructure_Report.pdf>.
- ¹³ Foster, Josh, Ashley Lowe, and Steve Winkelman. *The Value of Green Infrastructure for Urban Climate Adaptation*. Rep. Center for Clean Air Policy, 2011. Web. <http://www.ccap.org/docs/resources/989/Green_Infrastructure_FINAL.pdf>.
- ¹⁴ Nowak, David J., Robert E. Hoehn III, Daniel E. Crane, Jack C. Stevens, and Jeffery T. Walton. *Assessing Urban Forest Effects and Values: Philadelphia's Urban Forest*. Tech. USDA Forest Service, 2007. Web. <http://nrs.fs.fed.us/pubs/rb/rb_nrs007.pdf>.



Benefits of Trees and Urban Forests: A Research List

- ¹⁵ University of Washington, College of Forest Resources. *Urban Forest Values: Economic Benefits of Trees in Cities*. Rep. Center for Human Horticulture, 1998. Web. <<http://www.cfr.washington.edu/research/factSheets/29-UrbEconBen.pdf>>.
- ¹⁶ Baker, Linda. New Strategies for Controlling Stormwater Overflows. *Governing*. (2011). <<http://www.governing.com/topics/energy-env/New-Strategies-Controlling-Stormwater-Overflows.html>>
- ¹⁷ Nowak, David, Daniel Crane, and Jack Stevens. "Air Pollution Removal by Urban Trees and Shrubs in the United States." *Urban Forestry & Urban Greening* 4 (2006): 115-23. Web. <<http://www.fs.fed.us/ccrc/topics/urban-forests/docs/Air%20pollution%20removal%20by%20urban%20trees%20in%20the%20US.pdf>>
- ¹⁸ Center for Urban Forest Research, Pacific Southwest Research Station, USDA Forest Service. "Air Pollution Control- the Tree Factor." *Urban Forest Research* (Jan. 2005). Web. <http://www.treebenefits.terrasummit.com/Documents/Air_Quality/cufr562_Newsletter_Jan05_Special_Edition.pdf>.
- ¹⁹ Thaler, Jordan. "The Environment, Financial and Health Benefits of Urban Forestry." Web log post. *Center for City Parks Excellence*. The Trust for Public Land, 25 Mar. 2011. Web. <<http://cityparksblog.org/2011/03/25/the-environmental-financial-and-health-benefits-of-urban-forestry/>>.
- ²⁰ United Nations Economic Commission for Europe. Environment and Human Settlements Division. *Forests and Wetlands: Suppliers of Clean Water and First Line of Defense against Floods*. 14 Dec. 2004. Web. <http://www.unece.org/press/pr2004/04env_p22e.htm>.
- ²¹ World Forestry Center, and Robin Morgan. *A Technical Guide to Urban and Community Forestry*. Tech. USDA Forest Service, Northeast and Pacific Southwest Regions, 1993. Web. <<http://www.na.fs.fed.us/spfo/pubs/uf/techguide/toc.htm>>.
- ²² Taylor, Andrea, Frances Kuo, and Williams Sullivan. "Coping with ADD the Surprising Connection to Green Play Settings." *Environment and Behavior* (2001). Web. <<http://www.outdoorfoundation.org/pdf/CopingWithADD.pdf>>.
- ²³ Taylor, Andrea, and Frances Kuo. "Children with Attention Deficits Concentrate Better after Walk in the Park." *Journal of Attention Disorders* (2008). Web. <http://www.lansi-turku.net/sites/lansi-turku.net/files/Walk_in_the_Park-1.pdf>.
- ²⁴ Tennessen, Carolyn M., and Bernadine Cimprich. "Views to Nature: Effects on Attention." *Journal of Environmental Psychology* 15.1 (1995): 77-85. Web. <<http://www.eau.ee/~jkadri/kaust%202025/Tervendav/views%20to%20nature%20effects%20on%20attention.pdf>>.
- ²⁵ Ellaway, Anne, Sally Macintyre, and Xavier Bonnefoy. "Graffiti, Greenery, and Obesity in Adults: Secondary Analysis of European Cross Sectional Survey." *British Medical Journal* 331 (2005): 611-12. Web. <<http://www.bmj.com/content/331/7517/611.full>>.
- ²⁶ Lovasi, G. S., J. W. Quinn, K. M. Neckerman, M. S. Perzanowski, and A. Rundle. "A Rundle. Children Living in Areas with More Street Trees Have Lower Prevalence of Asthma." *Journal of Epidemiol Community Health* 62 (2008): 647-49. Web. <<http://www.ncbi.nlm.nih.gov/pubmed/18450765>>.
- ²⁷ Cohen, Deborah, Amber Sehgal, Stephanie Williamson, Roland Sturm, Thomas McKenzie, Rosa Lara, and Nicole Lurie. *Park Use and Physical Activity in a Sample of Public Parks in the City of Los Angeles*. Tech. no. TR-357-HLTH. RAND Corporation, 2006. Web. <http://www.rand.org/content/dam/rand/pubs/technical_reports/2006/RAND_TR357.pdf>.
- ²⁸ Bell, Janice F., Jeffery S. Wilson, and Gilbert C. Liu. "Neighborhood Greenness and 2-year Changes in Body Mass Index of Children and Youth." *American Journal of Preventive Medicine* 35.6 (2008): 547-53. Web. <<http://download.journals.elsevierhealth.com/pdfs/journals/0749-3797/PIIS0749379708007344.pdf>>.



Benefits of Trees and Urban Forests: A Research List

- ²⁹ Kaplan, Rachel, and Stephen Kaplan. *The Experience of Nature: a Psychological Perspective*. Cambridge: Cambridge UP, 1989. Web. <http://books.google.com/books?hl=en&lr=&id=7180AAAAIAAJ&oi=fnd&pg=PR7&dq=the+experience+of+nature+a+psychological+perspective&ots=TnH3MEI32e&sig=y_nWjXUm_xplrBNLudb5XZrdIB8#v=onepage&q&f=false>.
- ³⁰ Hull RB, Michael Se. Nature-based Recreation, Mood Change, and Stress Restoration. (1995). *Leisure Sciences*. 17(1):1-14. <<https://secure.sportquest.com/su.cfm?articulo=378585&title=378585>>
- ³¹ Wells, Nancy M., and Gary W. Evans. "Nearby Nature A Buffer of Life Stress among Rural Children." *Environment and Behavior* 35.3 (2003): 311-30. Web. <<http://www.outdoorfoundation.org/pdf/NearbyNature.pdf>>.
- ³² Ulrich, Roger S. "The Value of Trees to a Community" *Arbor Day Foundation*. Web. 27 June 2011. <<http://www.arborday.org/trees/benefits.cfm>>.
- ³³ Ulrich, R. S. "View through a Window May Influence Recovery from Surgery." *Science* 224.4647 (1984): 420-21. Web. <<http://www.sciencemag.org/content/224/4647/420.abstract>>.
- ³⁴ Purdue University. "Trees Could Affect Land Use, Reduce Skin Cancer." *San Diego Earth Times*. Mar. 2003. Web. <<http://www.sdearthtimes.com/et0203/et0203s12.html>>.
- ³⁵ McPherson, Gregory, James Simpson, Paula Peper, Qingfu Xiao, Dennis Pettinger, and Donald Hodel. *Tree Guidelines for Inland Empire Communities*. Rep. Western Center for Urban Forest Research and Education, USDA Forest Service, Pacific Southwest Research Station, 2001. Web. <http://www.fs.fed.us/psw/programs/uesd/uep/products/2/cufr_52.pdf>.
- ³⁶ McPherson, Gregory E., James R. Simpson, Paula J. Peper, Scott E. Maco, Shelley L. Gardner, Shuana L. Cozad, and Qingfu Xiao. *City of Minneapolis, Minnesota Municipal Tree Resource Analysis*. Tech. Center for Urban Forest Research, Pacific Southwest Research Station, USDA Forest Service. June 2005. Web. <http://www.fs.fed.us/psw/programs/uesd/uep/products/2/cufr645_MinneapolisMFRA.pdf>
- ³⁷ Wolf, Kathleen, and Nicholas Bratton. "Urban Tees and Traffic Safety: considering U.S. Roadside Policy and Crash Data." *Arboriculture & Urban Forestry* 32.4 (2006). Web. <http://www.naturewithin.info/Roadside/TransSafety_ArbUF.pdf>.
- ³⁸ Mok, Jeong-Hun, Harlow C. Landphair, and Jody R. Naderi. "Landscape Improvement Impacts on Roadside Safety in Texas." *Landscape and Urban Planning* 78.3 (2006): 263-74. Web. <http://www.naturewithin.info/Roadside/RdsdSftyTexas_L&UP.pdf>.
- ³⁹ USDA National Agroforestry Center. "Is Agroforestry a Solution to the Southeast's Poultry Waste Overload?" *Inside Agroforestry* 1998. Web. <<http://www.unl.edu/nac/ia/spring98/spring98.txt>>.
- ⁴⁰ Naderi, Jody R., Byoung S. Kweon, and Praveen Maghelal. "The Street Effect and Driver Safety." *ITE Journal on the Web* (2008). Web. <http://www.walkable.org/assets/downloads/StreetTreeEffectandDriverSafety_ITFeb08_.pdf>.
- ⁴¹ Dixon, Karin K., and Kathleen L. Wolf. "Benefits and Risks of Urban Roadside Landscape: Finding a Livable, Balanced Response." 3rd Urban Street Symposium, Seattle, Washington. 2007. Web. <http://www.urbanstreet.info/3rd_symp_proceedings/Benefits%20and%20Risks.pdf>.
- ⁴² McPherson, Gegory, and Jules Muchnick. "Effects of Street Tree Shade on Asphalt and Concrete Pavement Performance." *Journal of Arboriculture* 31.6 (2005): 303-10. Web. <http://www.fs.fed.us/psw/publications/mcpherson/psw_2005_mcpherson001_joa_1105.pdf>.
- ⁴³ Cascade Land Conservancy. *Pearl Jam Mitigates CO2 from 2009 World Tour in Partnership with Cascade Land Conservancy*. 29 Mar. 2010. Web. <<http://www.cascadeland.org/news/press-releases/pearl-jam-mitigates-co2-from-2009-world-tour-in-partnership-with-cascade-land-conservancy/>>.
- ⁴⁴ Laverne, Robert J., and Kimberly Winson-Geideman. "The Influence of Trees and Landscaping on Rental Rates at Office Buildings." *Journal of Arboriculture* 29.5 (2003): 281-90. Web. <http://www.skyhorsestation.com/pdf/article_trees_cmrcialbldgs.pdf>.



Benefits of Trees and Urban Forests: A Research List

- ⁴⁵ Wolf, Kathleen L. "Business District Streetscapes, Trees and Consumer Response." *Journal of Forestry* 103.8 (2005): 396-400. Web. <http://www.fs.fed.us/pnw/pubs/journals/pnw_2005_wolf001.pdf>.
- ⁴⁶ Wolf, Kathleen L. "Roadside Urban Trees, Balancing Safety and Community Values." *Arborist News* Dec. 2006: 56-57. Web. <http://www.naturewithin.info/Roadside/ArbNews_TreeSafety.pdf>.
- ⁴⁷ Wolf, Kathleen L., and Center for Urban Horticulture. "Community Image: Roadside Settings and Public Perceptions." *Human Dimensions of the Urban Forest* 10 (2000). Web. <<http://www.naturewithin.info/Roadside/Rsd-Community-FS10.pdf>>.
- ⁴⁸ Wachter, Susan. *The Determinants of Neighborhood Transformations in Philadelphia Identification and Analysis: The New Kensington Pilot Study*. Rep. Wharton School University of Pennsylvania, 2005. Web. <http://www.kabaffiliates.org/uploadedFiles/KAB_Affiliates.org/Wharton%20Study%20NK%20final.pdf>.
- ⁴⁹ Anderson, L.M., and H.K. Cordell. "Influence of Trees on Residential Property Values in Athens, Georgia (U.S.A.): A Survey Based on Actual Sales Prices." *Landscape and Urban Planning* 15.1-2 (1988): 153-64. Web. <http://www.srs.fs.usda.gov/pubs/ja/ja_anderson003.pdf>.
- ⁵⁰ Donovan, Geoffrey H., and David T. Butry. "Trees in the City: Valuing Street Trees in Portland, Oregon." *Landscape and Urban Planning* 94 (2010): 77-83. Web. <http://www.fs.fed.us/pnw/pubs/journals/pnw_2010_donovan001.pdf>
- ⁵¹ Nowak, David. "Atmospheric Carbon Reduction by Urban Trees." *Journal of Environmental Management* 37 (1993): 207-17. Web. <<http://gis.fs.fed.us/ccrc/topics/urban-forests/docs/Atmospheric%20carbon%20reduction%20by%20Urban%20Trees.pdf>>
- ⁵² Nowak, David, and Daniel Crane. "Carbon Storage and Sequestration by Urban Trees in the USA." *Environmental Pollution* 116 (2002): 381-89. Web. <http://nrs.fs.fed.us/pubs/jrnl/2002/ne_2002_nowak_002.pdf>.
- ⁵³ Nowak, David J., Robert E. Hoehn III, Daniel E. Crane, Jack C. Stevens, and Jeffery T. Walton. "Assessing Urban Forest Effects and Values: Washington, D.C.'s Urban Forest." *Resource Bulletin NRS-1* 2006. Northern Research Station, USDA Forest Service. Web. <http://nrs.fs.fed.us/pubs/rb/nrs_rb001.pdf>.
- ⁵⁴ Nowak, David J., Robert E. Hoehn III, Daniel E. Crane, Jack C. Stevens, Jeffery T. Walton. "Assessing urban forest effects and values: Casper's urban forest". *Resource bulletin NRS-4*. 2006 Northern Research Station, USDA Forest Service. Web. <http://nrs.fs.fed.us/pubs/rb/rb_nrs004.pdf>
- ⁵⁵ Idso, Sherwood B Dr., and Dr. Craig D. Idso. "Trees in the City: A New Role for the "Ultimate Urban Multitaskers"" *CO2 Science*. Center for the Study of Carbon Dioxide and Global Change. Web. <<http://www.co2science.org/articles/V6/N1/COM.php>>.
- ⁵⁶ Sander, Heather, Stephen Polasky, and Robert Haight. "The Value of Urban Tree Cover: A Hedonic Property Price Model in Ramsey and Dakota Counties, Minnesota, USA." *Ecological Economics* 69 (2010): 1646-656. Web. <http://www.nrs.fs.fed.us/pubs/jrnl/2010/nrs_2010_sander_001.pdf>.
- ⁵⁷ McPherson, Gregory. "Urban Tree Planting and Greenhouse Gas Reductions." *Arborist News* 2007. Web. <http://www.fs.fed.us/ccrc/topics/urban-forests/docs/UrbanTrees&GHG_AN.pdf>.
- ⁵⁸ Anderson, Scott. "Greening the Gridiron: Environmental Responsibility at the Super Bowl and Beyond." *Green Biz*. Climate Biz, 5 Feb. 2006. Web. <<http://www.greenbiz.com/news/2006/02/05/greening-gridiron-environmental-responsibility-super-bowl-and-beyond>>.
- ⁵⁹ Schadler, Elise, and Cecilia Danks. *Carbon Offsetting Through Urban Tree Planting: The Sacramento Tree Foundation and Harbison-Mahony-Higgins Builders, Inc.* Rep. Sacramento Tree Foundation, 2010. Web. <<http://www.uvm.edu/~7Ecfcm/UCF/SacTree.pdf>>.



Benefits of Trees and Urban Forests: A Research List

- ⁶⁰ "Trees and Vegetation | Heat Island Effect | US EPA." *US Environmental Protection Agency*. Web. <<http://www.epa.gov/heatisland/mitigation/trees.htm>>.
- ⁶¹ Lohr, Virginia, Caroline Pearson-Mims, John Tarnai, and Don Dillman. "How urban residents rate and rank the benefits and problems associated with trees in cities." *Journal of Arboriculture* 30.1(2004):28-35. Web. <http://www.sfrc.ufl.edu/urbanforestry/Resources/PDF%20downloads/Lohr_2004.pdf>
- ⁶² "City of Minneapolis, Minnesota Municipal Tree Resource Analysis." Center for Urban Forest Research, USDA Forest Service, Pacific Southwest Research Station, June 2005. Web. <http://www.fs.fed.us/psw/programs/cufr/products/2/cufr645_minneapolisMFRA.pdf>
- ⁶³ H. Akbari. "Shade trees reduce building energy use and CO2 emissions from power plants." *Environmental Pollution* 116 (2002) S119–S126. Web. <http://www.fs.fed.us/psw/programs/uesd/uep/products/12/psw_cufr703_Akbari_Reduce_Energy_Use.pdf>
- ⁶⁴ McPherson, E.G.; Simpson, J.R. Peper, P.J. Aguaron. "Urban Forestry and Climate Change." Albany, CA: USDA Forest Service, Pacific Southwest Research Station. (2008). Web. <<http://www.fs.fed.us/ccrc/topics/urban-forests/>>
- ⁶⁵ Vargas, Kelaine. "Ecosystem Services and Environmental Benefits of the UC San Diego Campus Forest." *Urban Ecos and USCD*. (2009). Web. <http://aps-web.ucsd.edu/sustainability/FM/PDFs/Campus_Forest_Environmental_Benefits_Report_1-09.pdf>
- ⁶⁶ Solecki, Williams, Cynthia Rosenweig, Lily Parshall, Greg Pope, Maria Clark, Jennifer Cox, and Mary Wienche. "Mitigation of the heat island effect in urban New Jersey". *Environmental Hazards*. 6 (2005): 39-49. Web. <http://geography.hunter.cuny.edu/courses/geog702/articles/heat_island_effect.pdf>
- ⁶⁷ Simpson, James. "Urban forest impacts on regional cooling and heating energy use: Sacramento County case study". *Journal of Arboriculture*. (1998). Web. <http://www.fs.fed.us/psw/programs/uesd/uep/products/cufr_25_JS98_45.PDF>
- ⁶⁸ Nebraska Forest Service. "Simply trees: tress for energy conservation". *Journal Star*. March 2011. Web. <http://journalstar.com/lifestyles/home-and-garden/article_97da4ef8-9dcf-5f1f-af9c-59ac2d2baee5.html>
- ⁶⁹ Kuo, F.E., and W.C. Sullivan. 2001. "Aggression and Violence in the Inner City: Effects of Environment Via Mental Fatigue". *Environment and Behavior* 33.4 (2001): 543-571. Web. <<http://www.outdoorfoundation.org/pdf/AggressionAndViolence.pdf>>
- ⁷⁰ Brunson, L. "Resident Appropriation of Defensible Space in Public Housing: Implications for Safety and Community." Doctoral Dissertation, University of Illinois, Champaign-Urbana, IL. (1999).
- ⁷¹ Kweon, BS, WC Sullivan, and R Angel. 1998. Green Common Spaces and the Social Integration of Inner-City Older Adults. *Environment and Behavior* 30, 6:832-858.
- ⁷² Sullivan, W.C. and K.E. Kuo. "Do trees strengthen urban communities, reduce domestic violence?" *Forestry Report R8-FR 56 USDA Forest Service/Southern Region*. (1996). Web. <http://www.paluc.org/pdfs/sprawl/health/sprawl_do_trees.pdf>
- ⁷³ Thaler, Jordan. "The environmental, financial and health benefits of urban forestry". Center for City Park Excellence. *The trust for Public Land*. (2011). Web. <<http://cityparksblog.org/2011/03/25/the-environmental-financial-and-health-benefits-of-urban-forestry/>>
- ⁷⁴ "Urban Ecosystem Analysis Atlanta Metro Area: Calculating the Value of Nature". *American Forests*. (2001). Web. <http://www.americanforests.org/downloads/rea/AF_Atlanta.pdf>
- ⁷⁵ "District of Columbia Assessment of Urban Forest Resources and Strategy". *District Department of Transportation*. (2010). Web. <<http://www.stateforesters.org/files/DC-Assess-Strategy-20100630.pdf>>



Benefits of Trees and Urban Forests: A Research List

- ⁷⁶ McPherson, Gregory, James Simpson, Paula Peper, Shelley Gardner, Kelaine Vargas, Scott Maco, and Qingfu Xiao. "Coastal Plain Community Tree Guide: Benefits, Costs, and Strategic Planting". *USDA, Forest Service, Pacific Southwest Research Station*. (2006). Web. <http://www.fs.fed.us/psw/programs/uesd/uep/products/2/cufr_679_gtr201_coastal_tree_guide.pdf>
- ⁷⁷ Smith, Peter, Michael Merritt, David Nowak, and David Hitchcock. "Houston's Regional Forest. Structure, Functions, Values." *USDA Forest Service, Texas Forest Service, HARC*. (2005). Web. <<http://www.houstonregionalforest.org/Report/>>
- ⁷⁸ American Forests. "Urban Ecological Analysis, Montgomery, AL." (2004). Web. <http://www.americanforests.org/downloads/rea/AF_Montgomery.pdf>
- ⁷⁹ Rosen, Mike. "Trees! Watershed Health and Urban Trees Protecting the Investment." *Environmental Services City of Portland, National Green Infrastructure Conference*. (2011).
- ⁸⁰ Nowak, David, Daniel Crane, and Jack Stevens. "Air pollution removal by urban trees and shrubs in the United States." *Urban Forestry and Urban Greening*. 4 (2006): 115–123. Web. <http://www.fs.fed.us/ue/newtown_square/publications/other_publishers/OCR/ue_2006_nowak01.pdf>
- ⁸¹ Cicilline, D.N., R. McMahon, and D. Still. 2008. "State of Providence's Urban Forest Report: the 2006 Street Tree Inventory, STRATUM Benefits Analysis, Urban Tree Canopy Study."
- ⁸² Kuo, Frances, and William Sullivan. "Environment and Crime in the Inner City: Does Vegetation Reduce Crime?" *Environment and Behavior* 33.3 (2001). Web. <<http://www.outdoorfoundation.org/pdf/EnvironmentAndCrime.pdf>>
- ⁸³ Donovan, Geoffrey, and Jeffrey Prestemon. "The effect of trees on crimes in Portland, Oregon". *Environment and Behavior*. (2010). Web. <<http://eab.sagepub.com/content/early/2010/09/16/0013916510383238>>
- ⁸⁴ Donovan, Geoffrey and Butry, David. "The value of shade: Estimating the effect of urban trees on summertime electricity use." *Energy and Buildings*. (2009) Vol. 41 (6) 662-668. Web.
- ⁸⁵ Trees Save Energy. *Maryland Department of Natural Resources*. Web. <<http://www.dnr.state.md.us/forests/publications/urban5.html>>
- ⁸⁶ McPherson, E.G. and Simpson, J.R., 2001. Effects of California's urban forests on energy use and potential savings from large-scale tree planting. Davis, CA: USDA Forest Service, Pacific Southwest Research Station, Center for Urban Forest Research. 35.
- ⁸⁷ McPherson, E.G., et. al. 1999. Benefit-cost analysis of Modesto's municipal urban forest. *J. Arbor.* 25(5):235-248.
- ⁸⁸ Cohen, Deborah, J. Scott Ashwood, Molly M. Scott, Adrian Overton, Kelly R. Evenson, Lisa K. Staten, Dwayne Porter, Thomas L. McKenzie, and Diane Catellier, "Public Parks and Physical Activity Among Adolescent Girls," *Pediatrics*, Vol. 118, No. 5, November 2006, pp. e1381–e1389.
- ⁸⁹ American Lung Association (ALA). 1997. *Childhood Asthma: A Matter of Control*. Pamphlet.
- ⁹⁰ NJ Forest Service. "Benefits of trees: trees enrich the health and quality of our environment". *NJ Department of Environmental Protection*. Web. <<http://www.state.nj.us/dep/seeds/docs/bot.pdf>>
- ⁹¹ Parker, John H. "Landscaping to Reduce the Energy Used in Cooling Buildings." *Journal of Forestry* 81.2 (1983): 82-105. *Society of American Foresters*. Web. <http://www.sfrc.ufl.edu/urbanforestry/Resources/PDF%20downloads/Parker_Miami%20landscape%20energy%20use_1983.pdf>.
- ⁹² Behe, B., J. Hardy, S. Barton, J. Brooker, T. Fernandez, C. Hall, J. Hicks, R. Hinson, P. Knight, R. McNiel, T. Page, B. Rowe, C. Safley, and R. Schutzki. "Landscape plant material, size, and design sophistication increase perceived home value". *Journal of Environmental Horticulture*. (2005). 23:127-133. Web. <http://www.hrresearch.org/docs/publications/JEH/JEH_2005/JEH_2005_23_3/JEH%2023-3-127-133.pdf>



Benefits of Trees and Urban Forests: A Research List

- ⁹³ Nowak, David J., "Benefits of Community Trees", (Brooklyn Trees, USDA Forest Service General Technical Report, in review).
- ⁹⁴ Hilltop Arboretum. "Nature the Changing Climate and You: Act Locally!" 5.4 (2007). Web. <[http://hilltop.lsu.edu/hilltop/hilltop.nsf/\\$Content/Newsletters/\\$file/07winter.pdf](http://hilltop.lsu.edu/hilltop/hilltop.nsf/$Content/Newsletters/$file/07winter.pdf)>
- ⁹⁵ "Urban Ecosystem Analysis the District of Columbia Calculating the Value of Nature." *American Forests*. (2000). Web. <http://ftp.americanforests.org/downloads/rea/AF_WashingtonDC.pdf>
- ⁹⁶ Geiger, J.R. and S.L. Gardner. "Why Shade Trees? The Unexpected Benefits." Center for Urban Forest Research, Pacific Southwest Research Station, USDA Forestry Service. 2006. Web. <http://www.fs.fed.us/psw/programs/uesd/uep/products/cufr_673_WhyShadeStreets_10-06.pdf>
- ⁹⁷ 107 Boston Complete Streets Guidelines: Boston Transportation Department Roadways Draft-December 2010 III. (2010). <http://www.bostoncompletestreets.org/pdf/3/chap3_3_reduce_operating_speed.pdf>
- ⁹⁸ Cray, Dan. "Why Cities are Uprooting Trees." *Time Magazine*. (2007). Web. <<http://www.time.com/time/magazine/article/0,9171,1635842,00.html>>
- ⁹⁹ Hall, Charles, Alan Hodges, and John Haydu. "Economic Impacts of the Green Industry in the United States." *USDA Urban and Community Forestry Advisory Committee*. (2005). <[http://www.ufe.org/files/pubs/EconomicImpactsOfTheUSGreen%20Industr\(NUCFACfinalreport\).pdf](http://www.ufe.org/files/pubs/EconomicImpactsOfTheUSGreen%20Industr(NUCFACfinalreport).pdf)>
- ¹⁰⁰ "American Forests Unveils the 'National Urban Tree Deficit.'" *American Forests*. (2011). Web. <<http://ftp.americanforests.org/news/display.php?id=18>>
- ¹⁰¹ O'Neil-Dunne, Jarlath. "A Report on the City of Rockville's Existing and Possible Urban Tree Canopy." *USDA Forest Service, MD Department of Natural Resources, and University of Vermont*. (2009). Web. <http://www.rockvillemd.gov/gis/UTC_Report_Rockville.pdf>
- ¹⁰² "State of the Urban Forest: A Summary of the Extent and Condition of Boston's Urban Forest." *Urban Ecology Institute*. (2008). Web. <<http://www.urbaneco.org/State%20of%20the%20Urban%20Forest%20Report.pdf>>
- ¹⁰³ Nowak, David, Rowan Rowntree, Gregory McPherson, Susan Sisinni, Esther Kerkmann, and Jack Stevens. "Measuring and analyzing urban tree cover." *Landscape and Urban Planning*. (1996). 36:49-57. Web. <http://www.nrs.fs.fed.us/pubs/jrnl/1996/ne_1996_nowak_001.pdf>
- ¹⁰⁴ "Protecting and Developing Urban Tree Canopy A 135-City Survey." *City Policy Associates and the United States Conference of Mayors*. (2008). Web. <<http://www.usmayors.org/trees/treefinalreport2008.pdf>>
- ¹⁰⁵ Hanou, Ian. "Ann Arbor, Michigan Urban Tree Canopy (UTC) Assessment." *AMEC Earth & Environmental Inc.* (2010). Web. <<http://www.a2gov.org/government/publicservices/fieldoperations/forestry/Documents/Ann%20Arbor%20UTC%20Report%20-%20AMEC%20-%20April-10.pdf>>
- ¹⁰⁶ Nowak, David, Robert Hoehn III, Daniel Crane, Jack Stevens and Jeffrey Walton. "Assessing Urban Forest Effects and Values Washington, D.C.'s Urban Forest." *USDA Forest Service*. (2006). Web. <http://www.nrs.fs.fed.us/pubs/rb/nrs_rb001.pdf>
- ¹⁰⁷ Nowak, David, Robert Hoehn III, Daniel Crane, Lorraine Weller, and Antonio Davila. "Assessing Urban Forest Effects and Values Los Angeles' Urban Forest." *USDA Forest Service*. (2011). Web. <http://www.nrs.fs.fed.us/pubs/rb/rb_nrs47.pdf>
- ¹⁰⁸ Nowak, David, Robert Hoehn III, Daniel Crane, Jack Stevens, and Cherie Fisher. "Assessing Urban Forest Effects and Values Chicago's Urban Forest." *USDA Forest Service*. (2010). Web. <http://www.nrs.fs.fed.us/pubs/rb/rb_nrs37.pdf>
- ¹⁰⁹ Nowak, D.J.; Crane, D.E.; Dwyer, J.F. 2002. "Compensatory value of urban trees in the United States." *Journal of Arboriculture*. 28(4): 194-199.
- ¹¹⁰ Greenway Guide: Slower, Safer Streets. *Dutchess County Planting & Development*. (2010)



Benefits of Trees and Urban Forests: A Research List

<http://www.sacog.org/complete-streets/toolkit/files/docs/StrengtheningCenters_SlowerSaferStreets.pdf>

¹¹¹ Grove, J. Morgan, Jarlath O'Neil-Dunne, Keith Pelletier, David Nowak, and Jeff Walton. "A report on New York City's present and possible urban tree canopy." *USDA Forest Service and University of Vermont*. (2006). Web.
<<http://www.itreetools.org/resources/reports/Pittsburg%20Municipal%20Forest%20Resource%20Analysis.pdf>>

¹¹² Pywell, Jonathan. "The Benefits of Valuing Urban Forests in New York City." *New York City Department of Parks and Recreation*. (2010). Web.
<<http://frec.vt.edu/urbanforestvalue/documents/Benefits%20of%20Valuing%20Urban%20Forests%20in%20NYC.pdf>>

¹¹³ "Setting Urban Tree Canopy Goals." *American Forests*. Web.
<<http://ftp.americanforests.org/resources/urbanforests/treedeficit.php>>

¹¹⁴ "Urban Ecosystem Analysis San Antonio, Texas Calculating the Value of Nature." *American Forests*. (2009). Web.
<http://ftp.americanforests.org/downloads/rea/SanAntonio_low%20res%20final.pdf>

¹¹⁵ "Next Great City Philadelphia." *Next Great City*. (2007). Web.
<http://www.may8consulting.com/publications/Next_Great_City.pdf>

¹¹⁶ Taylor, Andrea Faber; Kuo, Frances E.; Sullivan, William C. 2002. Views of Nature and Self-Discipline: Evidence from Inner City Children. *Journal of Environmental Psychology* 22(1-2).
<<http://faculty.une.edu/cas/szeeman/GK-12/articles/ViewsofNature.pdf>>

¹¹⁷ Purcell, Lindsey. "Urban Forestry Values and Resources." *Purdue University*. Web.
<<http://www.ag.purdue.edu/fnr/urbanforestry/Documents/UrbanForestryValues.pdf>>

¹¹⁸ "Urban Ecosystem Analysis Atlanta Metro Area Calculating the Value of Nature." *American Forests*. (2001). Web. <http://ftp.americanforests.org/downloads/rea/AF_Atlanta.pdf>

¹¹⁹ "Urban Ecosystem Analysis Mecklenburg County and the City of Charlotte, North Carolina Calculating the Value of Nature." *American Forests*. (2010). Web.
<http://ftp.americanforests.org/downloads/rea/AF_Charlotte_2010.pdf>

¹²⁰ Peper, Paula, E. Gregory McPherson, James Simpson, Shelley Gardner, Kelaine Vargas, Qingfu Xiao. "New York City, New York Municipal Forest Resource Analysis." *USDA Forest Service, Pacific Southwest Research Station and Center for Urban Forest Research*. (2007). Web.
<http://www.fs.fed.us/psw/programs/uesd/uep/products/2/psw_cufr687_NYC_MFRA.pdf>

¹²¹ Nowak, David and Jack Stevens. "Assessing Urban Forest Effects and Values New York City's Urban Forest." *USDA Forest Service*. (2007). <http://www.nrs.fs.fed.us/pubs/rb/rb_nrs009.pdf>

¹²² Bell, Janice, Jeffrey Wilson, and Gilbert Liu. "Neighborhood Greenness and 2-Year Changes in Body Mass Index of Children and Youth." *American Journal of Preventive Medicine*. (2008). Vol 35 (5): 547-553.
<<http://download.journals.elsevierhealth.com/pdfs/journals/0749-3797/PIIS0749379708007344.pdf>>

