



USDA FOREST SERVICE
RESEARCH & DEVELOPMENT

Science

URBANRESEARCH

PROVIDING KNOWLEDGE AND TOOLS FOR
RESILIENT COMMUNITIES

The USDA Forest Service provides information on urban forests and their fundamental role in improving resilience, adding key decision tools to a community's resilience toolkit.

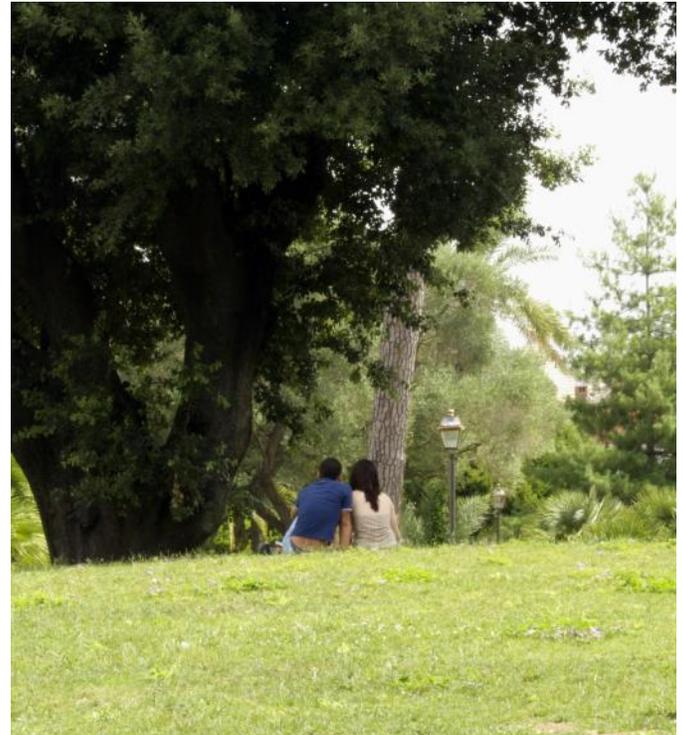
RESILIENT CITIES are cities that can recover quickly and continue to function, and even thrive after a sudden disturbance or in times of long-term stress. A growing body of research indicates that trees and urban green space are critical to building and maintaining resilience.

WHAT WE DO

- The Forest Service helps local governments and planners understand and use the latest science on how green space improves the quality of the urban environment and how stewardship can support communities.
- The Forest Service uses hyperspectral imagery and vegetation surveys to assess the health of the urban forest. Scientists analyze urban forest data and provide tools to help communities identify the best locations for trees and areas in most need of environmental stewardship.
- Forest Service social scientists study why and how urban residents engage with green space, and illuminate the benefits that people gain from their interactions with nature.



Many cities recognize that trees build resilience and seek to expand their tree canopy. Washington, DC aims to reach 40% tree cover by 2032.



Urban green spaces can be restorative places to connect with others and recuperate from life's stressors.

WHY

Resilient cities draw strength from their green spaces. Urban areas face more frequent and intense disturbances associated with climate change, such as heat waves, coastal flooding, extreme storms, and poor air quality. Urban green space helps to cool cities during the summer, control storm water, and capture air pollutants. Green space can reduce stress and neighborhood crime, and provides places for neighbors to forge strong connections. Healthy and empowered communities are better equipped to deal with change in a positive way.

for more information

BETH LARRY
NATIONAL PROGRAM LEADER
URBAN RESEARCH
urbanresearch@fs.fed.us

www.fs.fed.us/research/urban

RESEARCH HIGHLIGHTS: RESILIENT FORESTS

Green space can buffer cities from disturbances like extreme storms and heat waves, but trees and other plants must be healthy and in the right place to provide these services. Forest Service scientists conduct research that helps urban planners and other natural resource managers create and maintain resilient green spaces.



There are many ways that people can incorporate green spaces right where they live.

How would you grade your city's forest? Forest Service scientists scored the forest resilience of 29 California cities using two methods: The *Pest Vulnerability Matrix* and *iTree*. The *Pest Vulnerability Matrix* quantifies tree species vulnerability to invasive insects or diseases. *iTree Streets* calculates the value of ecosystem services provided by trees.



Top grades went to cities with both young and old trees, and a diverse mix of species. Cities that avoided vulnerable species and received most of their ecosystem services from less vulnerable species also scored highly. The scientists followed up with customized recommendations to help the cities

improve the resiliency of their forests.

McPherson EG & Kotow L. 2013. A municipal forest report card: Results for California, USA. *Urban Forestry and Urban Greening* 12: 134-143.

Spotting early signs of tree decline. Urban trees face many stressors, including drought, high temperatures, and storm surge during extreme weather events—but we know that early stress detection can save trees. Forest Service scientists developed a suite of methods to measure subtle changes in tree health and can now closely track forest health before, during, and after a disturbance. The Forest Service is bringing these methods and new tools to urban land managers and citizen scientists.

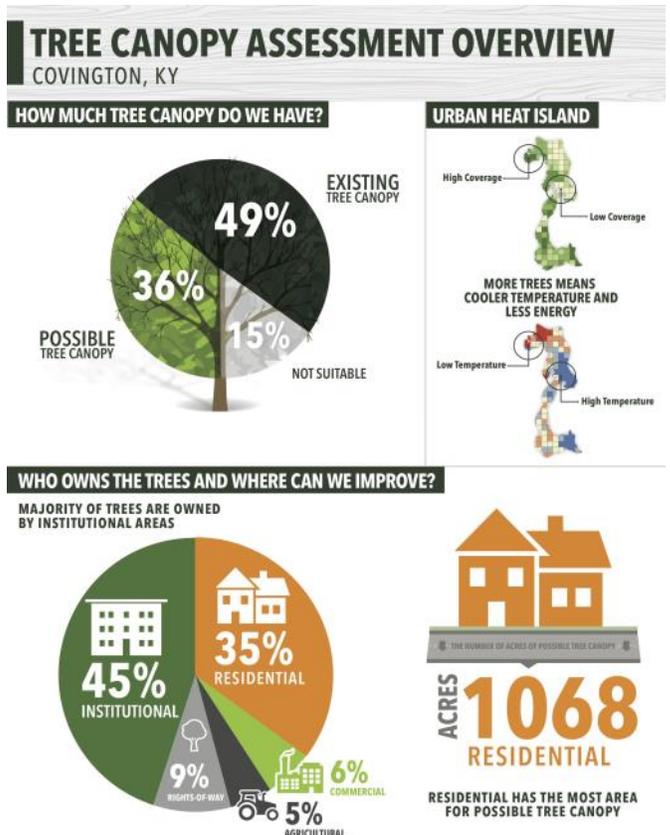
Pontius J & Hallett R. 2014. Comprehensive methods for earlier detection and monitoring of forest decline. *Forest Science* 60: 1156-1163.

Picking the best tree planting locations. Cities increasingly recognize the importance of urban trees and want to plant more, but not all locations are best for trees. Forest Service scientists use GIS mapping and local stakeholder input to help communities prioritize their planting efforts. They first determine where trees can grow, and then narrow those choices to locations where trees are socially desirable and financially efficient to plant. This work is now profiled in the White House's U.S. Climate Resilience Toolkit.

<http://toolkit.climate.gov/tool/urban-tree-canopy-assessment>

Locke DH et al. 2013. Applications of urban tree canopy assessment and prioritization tools: supporting collaborative decision making to achieve urban sustainability goals. *Cities and the Environment* 6: Article 7.

Battaglia M et al. 2014. It's not easy going green: Obstacles to tree-planting programs in East Baltimore. *Cities and the Environment* 7: Article 6.



The first step in an urban tree canopy assessment is to figure out where trees currently are and where they might possibly grow.

RESEARCH HIGHLIGHTS: RESILIENT COMMUNITIES

Forest Service scientists study how green space improves the quality of life for urban communities by cleaning pollutants from the air, reducing summer temperatures, and controlling storm water. They also examine how green space reduces street crime and how stewardship of green space can forge stronger social bonds.

Using green infrastructure to build resilience. While many cities install green infrastructure primarily to reduce runoff from extreme storms, green infrastructure also contributes to urban resilience by reducing local temperatures, sequestering carbon dioxide, and reducing energy needs. A 2014 Forest Service report brings the best available science together to help city officials and community groups decide where to establish green space and how to best manage it.

Low SC. 2014. Cumulative effects: managing natural resources for resilience in the urban context. *USDA Forest Service RMRS-P-71*: 393-401.

Identifying trends in rebuilding after fire. With climate change, wildfires are increasingly common. At the same time, more and more people are choosing to live in forests with greater fire risk—sometimes, their homes are destroyed. Forest Service scientists are studying where and why people choose to rebuild. This research helps to anticipate places that may need more fire control in the future and informs policies about how people might rebuild safely.

Alexandre PM et al. 2015. Rebuilding and new housing development after wildfire. *International Journal of Wildland Fire* 24: 138-149.

Building community capacity for disaster recovery. Stewarding green spaces can help communities regain a sense of control, purposefully participate in recovery efforts, and find meaning for themselves and their neighbors. Living memorials are an important part of the grieving and healing process. Forest Service scientists are examining the role of environmental stewardship in post-Hurricane Sandy NYC and post-tornado Joplin MO to learn how interacting with and creating green spaces helps people recover from disasters.

Svensden ES & Campbell LK. 2014. Community-based memorials to September 11, 2001: environmental stewardship as memory work. *Green in the Red Zone: Disaster, Resilience and Community Greening*. Tidball KY & Krasny ME, eds. Springer. p.339-355.

http://www.nrs.fs.fed.us/nyc/focus/resilience_health_well_being/living_memorials

Connecting communities with environmental stewardship. When people engage in environmental stewardship they not only protect green spaces, they also forge stronger social bonds with their neighbors. Forest Service scientists are mapping spatial and collaborative connections among stewardship

groups with a tool called STEW-MAP. These organizational networks show community-level governance structures that can be tapped for leadership before, during, and after disasters.

Connolly JJ et al. 2013. Organizing urban ecosystem services through environmental stewardship governance in New York City. *Landscape Urban Planning* 109: 76-84.

http://www.nrs.fs.fed.us/nyc/focus/stewardship_mapping/

Reducing crime with street trees. Crime strains communities and weakens social bonds, but green space can help to prevent crime in the first place. Forest Service scientists have linked green space with reduced crime rates in several U.S. cities. In Portland OR, single family homes with large trees experienced lower crime. In Philadelphia PA, narcotics possession and burglaries were reduced for up to a half-mile away from green storm water infrastructure. In Baltimore MD, increasing tree cover, especially on public lands, was associated with a decrease in crime.

Kondo MC et al. 2015. The impact of green stormwater infrastructure installation on surrounding health and safety. *American Journal of Public Health* 105: e114-e121.

Troy A et al. 2012. The relationship between tree canopy and crime rates across an urban-rural gradient in the greater Baltimore region. *Landscape and Urban Planning* 106: 262-270.

Donovan GH & Prestemon JP 2012. The effect of trees on crime in Portland, Oregon. *Environment and Behavior* 44: 3-30.



Sharing green space provides opportunities for people to meet neighbors, to whom they might turn in times of trouble.

RESEARCH HIGHLIGHTS: RESILIENT PEOPLE

Urban green space enhances well-being and provides space to exercise and find solace. Physically, psychologically and emotionally healthy people are more resilient to the stresses of manmade and natural disasters.



"Green exercise," or exercise in the presence of nature, is linked to improved mood and greater physical activity.

Ensuring good health and green spaces for all. People in impoverished neighborhoods are often disproportionately burdened with health issues. They also often lack access to green spaces and the many health benefits they offer. Forest Service scientists assessed the current state of knowledge on how green space can improve health outcomes for those who need it the most, and identified key research gaps.

Jennings V & Johnson Gaither C. 2015. Approaching environmental health disparities and green spaces: an ecosystem services perspective. *International Journal of Environmental Research and Public Health* 12:1952-1968.

Unhealthy trees may lead to unhealthy people. Forest Service scientists used the loss of 100 million trees to Emerald Ash Borer as a unique natural experiment to examine the relationship between trees and human health. After controlling for a wide range of public health drivers, they found a link between tree death and human mortality, adding to growing evidence that nature provides health benefits.

Donovan GH et al. 2013. The relationship between trees and human health: Evidence from the spread of the Emerald Ash Borer. *American Journal of Preventive Medicine* 44:139-145.

Improving health with a breath of fresh air. Air pollution, like particulate matter and ozone, can harm people, especially the young, the elderly, or those with breathing issues. Forest Service scientists modeled tree cover and local air pollution, and estimated that U.S. trees remove 17.4 million tonnes of air pollution per year with health effects valued at \$6.8 billion.

Nowak D et al. 2014. Trees and forest effects on air quality and human health in the United States. *Environmental Pollution* 193:119-129.

Creating restorative spaces for health and well-being. Green spaces foster human health in a multitude of ways, including through civic stewardship and innovative design. Forest Service scientists convened experts from ecology, medicine, psychology, social epidemiology, urban design, and landscape architecture to characterize the features of restorative, resilient, and sustainable green space.



Campbell L & Wiesen A, eds. 2009. Restorative Commons: Creating Health and Well-being through Urban Landscapes. GTR NRS-P-39.

helping communities transition to a sustainable future

Urban Research at the USDA Forest Service provides leading science and decision tools to inform urban natural resources stewardship and improve environmental health and community well-being in urban areas. Our research helps to create more livable, desirable, and sustainable communities.