USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

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The Cross-Pollinator

Connecting forested communities & delivering science for the trees outside your door

More Eyes on Trees: New Monitoring Resources for Urban Tree Management

Volunteers gather tree monitoring data in Pennsylvania. USDA Forest Service photos by Lara Roman.

SUMMARY

Around the world, factors such as invasive species, climate change, and increasingly variable weather have raised the importance of tree monitoring, stewardship, and planning, especially in urban areas. In the United States, USDA Forest Service scientists have collaborated with a variety of partners to develop a range of new resources to improve the health, monitoring, and stewardship of the urban forest. In the past few years, these new resources have included two field guides, five videos, more than 1,000 training sessions, and a mobile app.

With cities across the United States and around the world breaking heat records in the past year, interest in the cooling benefits of urban trees is also rising. It's been estimated that neighborhoods with concentrated areas of pavement and little tree canopy can be up to 10 or more degrees hotter than surrounding areas. As organizations such as the USDA Forest Service and The Nature Conservancy have often pointed out, trees' benefits include greenhouse gas absorption, mental and physical health improvement, air-pollution removal, wildlife habitat, water filtration, and—of course—shade. With these issues in mind, several resources have been developed by USDA Forest Service scientists and their research partners to help land managers to understand, optimize, and protect their urban tree resources. These add to and complement pre-existing resources and efforts such as i-Tree, Urban Forest Inventory and Analysis (uFIA), and urban tree canopy assessments. See the sidebar on page 2 for a description of these resources. Specifically, this newsletter will do a deep dive into the last two elements listed in the sidebar, but the first three are provided for greater context.

Urban Tree Monitoring: Tips, strategies, and best practices

To provide new guidance on urban tree monitoring and help improve urban forest stewardship, a team led by Forest Service scientists Lara Roman and Natalie van Doorn has created a five-video series "*Urban Tree Monitoring*" available on YouTube, and a pair of guides, "*Urban Tree Monitoring: A Field Guide*" and "*Urban Tree Monitoring: A Resource Guide*." Published in 2020, these guides and videos provide instructions on field monitoring of urban trees. Field monitoring is essential in understanding how urban forests change

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A QUICK LOOK AT A FEW KEY TOOLS IN THE URBAN FOREST TOOLBOX

A complete toolbox has many tools, but it's important to know the purpose and intended use of each one to maximize the toolbox's utility. While not comprehensive, here's a quick look at some of the most popular Forest Service urban forestry tools and how they may complement one another:

- i-Tree is a suite of tools designed to enhanced human and environmental health through analysis and reporting of the multiple benefits and values of trees and forests. Since its inception in 2006, i-Tree has established itself as the international standard set for tools that practitioners, educators, and local community advocates may use to quantify the benefits trees provide to people and communities.
- The Urban Forest Inventory & Analysis Program (Urban FIA) was developed based on Congressional direction in the 2014 Farm Bill. Urban FIA is a long-term monitoring program that produces a standard dataset across the country to track (and note trends in) the urban forest. The results of Urban FIA monitoring are being made available through city-based reports and MyCity'sTrees.
  - » i-Tree allows uFIA to report on ecosystem services (such as pollution, stormwater removal, etc.) to be able to generate city-based reports and data.
- Urban Tree Canopy Assessments use remotely-sensed high-resolution aerial imagery to precisely quantify and track tree canopy cover change over time.
- Field-Based Urban Tree Monitoring: This newsletter covers this topic in depth beginning on page 1 "Urban Tree Monitoring." In brief, urban forests are dynamic systems that change over time. Field-based urban tree monitoring generates long-term data on urban tree mortality, growth, and health. Consistent guidance on how to develop accurate, long-term tracking systems, and which variables are important to track and monitor, can provide field-based information on note only the quantity but also quality and health attributes of an urban forest.
- Healthy Trees Healthy Cities (HTHC): This newsletter covers this topic in depth beginning on page 3 "Healthy Trees Healthy Cities." In brief, HTHC is a collaborative initiative to promote the long-term health of urban trees by providing free tools and resources such as a smart-phone application ("app"), web-based project management dashboard, and training resources. These resources help communities track stewardship as well as tree health, providing locally as well as nationally-useful data in real-time.

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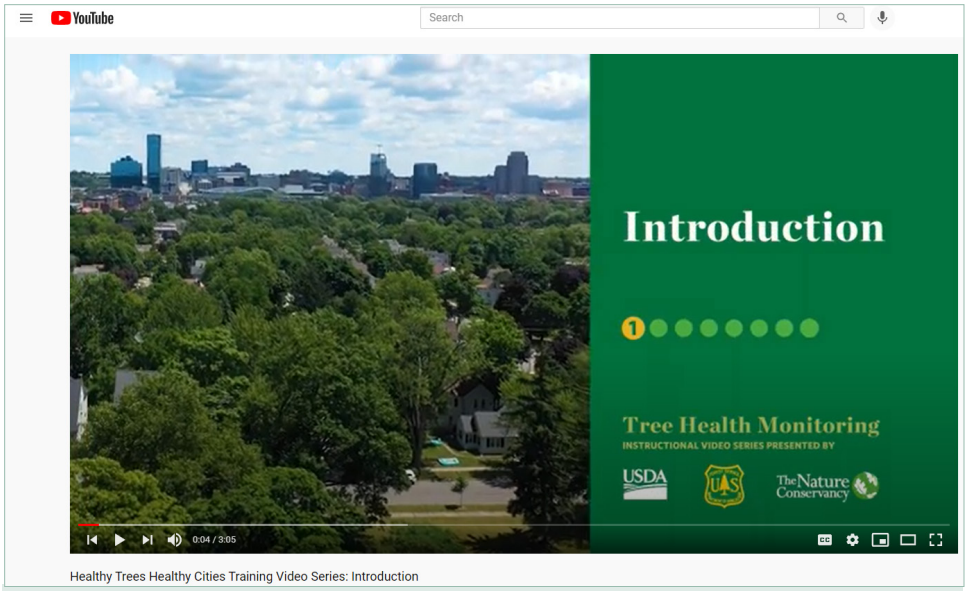
over time, providing insights on factors such as tree mortality and growth rates. The resources cover concepts, guidelines, and best practices for topics such as tree mortality status, trunk diameter, location methods, and fieldwork management. The monitoring protocols described in the guides and videos have been applied across the United States, including in Philadelphia, New York City, Massachusetts, California, Delaware, and Hawaii, with extensive transdisciplinary collaboration via the Urban Tree Growth & Longevity Working Group of the International Society of Arboriculture.



Healthy Trees Healthy Cities Training Video Series: Introduction

New guidance on urban tree monitoring is available in an eight-video series "Healthy Trees Healthy Cities," available on YouTube. See "Additional Resources" on page 5 for the YouTube link.

According to van Doorn, a research urban ecologist with the Pacific Southwest Research Station, "Many municipal arborists and other urban forestry professionals want to track the trees that they plant and manage so that they can understand mortality, growth, and health." The new videos and guides can help with this. According to van Doorn, "The first video is a great introduction because it presents the 'why' of monitoring projects. All of the videos are made so they can stand alone, though. The resource guide, which is fairly long, has callout boxes to get at the key points; that's also a great way to get started or if you know what you're looking for."

Lara Roman, a research ecologist with the Northern Research Station in Philadelphia, says urban tree monitoring is more complicated than it appears. "You have to consider capacity, tools, and guidelines, and all of the resources and approaches that apply to a city setting," she notes, adding that even terminology requires guidelines. For example, she says, "Say you inventoried the trees in a specific area and 10 years later you want to make a comparison. But how do you define a tree? What qualifies as a street tree? And what's the best way to measure a tree? It sounds kind of basic, but if the standards change or are unclear, then the data may be less useful."

A dead tree, a tree stump, and a removed street tree site in Philadelphia demonstrate the need for tree mortality monitoring descriptions that are more detailed than "alive" or "dead." USDA Forest Service photos by Lara Roman.

The need for standardization applies to spatial data as well, Roman notes, adding, "A yard tree planting record might say 100 Main Street, but coding systems are different and sometimes they're done poorly or other trees have been planted since then. A mapping program or website is likely to show that tree as being located in the middle of a house. It's a big issue, especially if you're using data from different groups, such as foresters, nonprofit partners, and citizen scientists." For monitoring, finding the same tree again in the future is paramount. To address this challenge, the Resource Guide discusses pros and cons of various tree location methods.

Tree Tending in Philadelphia

The Pennsylvania Horticultural Society was an early adopter of these guidelines. According to Dana Dentice, the Pennsylvania Horticultural Society's trees program manager, the organization has implemented many of the Forest Service's best practices for its Tree Tenders program. Founded in 1993, Tree Tenders is a volunteer urban tree planting and stewardship program and is a centerpiece of the Pennsylvania Horticultural Society's community engagement and greening work. Dentice says the program educates residents about the importance of increasing urban tree canopy, teaching them how to plant, prune, water, and otherwise maintain trees. More than 5,500 people in the Philadelphia area and beyond have graduated from the program in the past 28 years. Neighborhood-based Tree Tenders groups are now planting 1,600 to 2,000 public trees per year.

To collect data on the survival and health of the new plantings and present an opportunity for "tree checkup" reports with tree recipients, the Pennsylvania Horticultural Society launched its Tree Checkers summer monitoring program for Tree Tenders volunteers. "The Tree Checkers program has been around for a decade now," Dentice says, noting, "It wasn't until about 5 years ago that we started calling it 'civic science,' when that term wasn't widely used. The Forest Service monitoring guidelines helped us to refine our approach to collecting more meaningful and robust data." For example, she says, "In the first summer of the redesigned program, it was discovered that a good percentage of the trees had buried root flares, meaning that trees were planted too deeply, were buried in mulch, or had subsided in the soil post-planting. Tree monitoring helped to evaluate related health, planting, and mulching issues and led to new tree-planting guidelines and insights. Now we sometimes mark the trees to show people the proper depth and to emphasize the difference between a bulbous graft union and the root flare."

Overall, Dentice says, the guidelines will help the still-growing program adjust to changing times, with implications for improving and fine-tuning education, maintenance, stewardship, and species procurement. "It's getting wetter and hotter here," she notes, adding, "The program not only empowers volunteers to grow and manage trees in their neighborhood, but the monitoring will provide an important piece of information in determining what tree species are best suited to our current and expected climate."

Healthy Trees Healthy Cities: Combining Health Tracking and Stewardship for Early Intervention and Improved Outcomes

Other Forest Service resources for tracking tree health are provided via the Healthy Trees Healthy Cities (HTHC) initiative. Established in 2014, HTHC has directly reached approximately 1,000 people via

In a collaborative study with the USDA Forest Service and the University of Delaware, researchers in Philadelphia monitor planted experimental elm varieties using urban tree monitoring protocols. USDA Forest Service photo by Lara Roman.

training sessions in about 20 U.S. cities, bringing people together to learn about and care for urban trees. According to Richard Hallett, a Northern Research Station research ecologist, the sessions provide opportunities for scientists, civic ecologists, and environmental activists to collect scientifically rigorous data on stewardship activities and tree health in their neighborhoods. "We're getting great feedback on the sessions," Hallett says, adding, "An urban forest manager from Missouri told me that the content was perfect for use with the TreeKeepers volunteer stewardship program in Branson."

HTHC partly grew out of work Hallett had done as a rural forester in the northeast United States, Hallett explains, adding, "I'd been looking at tree health issues such as sugar maple decline and insects such as emerald ash borer and hemlock woolly adelgid. We were using remote sensing technology to map tree health." However, his later experience in urban areas found a different approach: "Despite tremendous progress in public awareness of the importance of tree health, particularly for the provision of human benefits, I found that tree health monitoring was still not a priority for many urban tree managers," Hallett explains.

In New York City, Hallett found that most urban tree studies were based on mortality; everything else was limited and subjective. "Stress could be detected but there was no methodology for evaluating it," he explains, adding, "If all you want to do is replace trees when they die, you're OK, but if you want to save ones that are stressed, which was a big concern after Hurricane Sandy in 2012, then you need something a little more fine-scale and sophisticated." As the northeast and other parts of the country experience tree health declines from a variety of stressors including pests and disease, extreme weather and other factors, it's important to track, anticipate and mitigate health challenges through management when possible, Hallett says.

The Healthy Trees Healthy Cities approach helped guide tree assessment in 18 high-density residential properties managed by the New York City Housing Authority. USDA Forest Service photo by Rich Hallett.

Urban data collection by Wisconsin Boy Scouts helped confirm the value of citizen-science tree-monitoring data. USDA Forest Service photo by Rich Hallett.

To address this need and to help facilitate research, the HTHC team helped to develop a mobile app of the same name. The app was made generally available in 2015 and can be found on healthytreeshealthycitiesapp.org and downloaded for free from Apple's App Store and Google Play. It offers a way to get more eyes on trees so new threats can be identified and addressed as quickly as possible. The app also provides civic ecologists and urban and rural forest managers with tools and a national database to help monitor and care for trees, whether they are threatened by invasive species, diseases or other stressors.

Hallett also hopes that the app will offset a shortage of workers in the arboriculture/urban forestry industry, which he believes will have a long-term impact on the human resources needed to manage America's growing urban forests. The app may also help in urban forestry training programs for underemployed individuals. "These programs, which are used by youth, veterans, the justice-involved, and others, are often underfunded relative to the impact they have on participants' lives," Hallett says, adding that a recent study involving urban data collection by Boy Scouts in Wisconsin confirmed the value of civic-science tree-monitoring data.

Applications in stewardship and social justice

The app is also user-friendly enough to be used by nonforesters, and it may have other applications, such as evaluating priorities in stewardship partnerships. According to Michelle Johnson, a research ecologist at the Northern Research Station's New York City Urban Field Station and the HTHC collaboration manager, "It's not only urban forest professionals who are using the tool; access to a free tool like this app is key for civic groups. It's also useful in evaluating tree health by neighborhood and seeing how that compares to stewardship group locations."

This approach has been used to evaluate tree health in the South Side area of Chicago and in 18 high density residential properties managed by the New York City Housing Authority (NYCHA). According to Rachel Holmes, the urban forestry strategist for Forest Service partner The Nature Conservancy and the HTHC national initiative coordinator, "Using a web-based dashboard and data gathered with the help of an intern using the app, we found that the NYCHA properties had about twice as many trees as expected and that the trees were not faring as well compared to trees in the broader area."

"Access to a free tool like this app is key for civic groups."

–Michelle Johnson, USDA Forest Service research ecologist

These studies helped guide further assessments and discussions of environmental justice. As Holmes explains, "If we're having conversations about social equity, we can't ignore trees and green spaces. As we work toward achieving equitable access to nature's benefits for all people, we need to consider the quality of these resources beyond just presence and absence. Our hope is that the HTHC app and data visualization dashboard, and the data gathered through these tools, will enable urban foresters and associates to make proactive management decisions that maximize ecosystem services, particularly in front-line communities."

KEY POINTS

- Stressors related to climate change, invasive species and other issues have raised the importance of understanding, managing, and improving urban tree resources.
- Research can support these efforts but there is room for improvement in terms of standardizing data collection and sharing best practices.
- Volunteer efforts can also be optimized by prioritizing projects and the use of nationwide databases.
- USDA Forest Service scientists and their partners have developed a range of urban tree inventory and monitoring resources, including field guides, videos, training sessions, and a mobile app.

MANAGEMENT IMPLICATIONS

- Despite progress in public awareness of the importance of tree health, particularly for the provision of human benefits, tree monitoring is still not a priority for urban tree managers.
- Past urban tree inventory and monitoring efforts have often been characterized by a lack of standardization, which can lower data's usefulness.
- Scientists with the USDA Forest Service and a variety of research partners have collaborated to develop a range of resources to help address these issues.
- Two general technical reports or "guides" and a series of five short videos have been developed to share best practices for urban tree monitoring.
- The Health Trees Healthy Cities Initiative provides training and a mobile app to help foresters and citizen-scientists to gather data on urban tree resources.

ADDITIONAL RESOURCES

Healthy Cities Healthy Trees website: https://healthytreeshealthycitiesapp.org.

Healthy Cities Healthy Trees training videos:
www.youtube.com/playlist?list=PLNsZX2SBTlVnvGmp_o-seEs6rYAzLhY2n.

Urban Tree Monitoring video series:
www.youtube.com/watch?v=kwwZDsyhhvA&list=PLNsZX2SBTlVne-C52PUv-eewpu4vWXCAN.

FURTHER READING

Hallett, R.; Hallett, T. 2018. Citizen science and tree health assessment: How useful are the data? Arboriculture & Urban Forestry. 44(6): 236–247. https://doi.org/10.48044/jauf.2018.021.

Hallett, R.; Johnson, M.L.; Sonti, N.F. 2018. Assessing the tree health impacts of saltwater flooding in coastal cities: A case study in New York City. Landscape and Urban Planning. 177: 171–177. https://doi.org/10.1016/j.landurbplan.2018.05.004.

Hilbert, D.R.; Roman, L.A.; Koeser, A.K. [et al.] 2019. Urban tree mortality: A literature review. Arboriculture & Urban Forestry. 45(5): 167–200. https://doi.org/10.48044/jauf.2019.015.

Magarik, Y.A.S.; Roman, L.A.; Henning, J.G. 2020. How should we measure the DBH of multi-stemmed urban trees? Urban Forestry & Urban Greening. 47: 126481. https://doi.org/10.1016/j.ufug.2019.126481.

Pontius, J.; Hallett, R. 2014. Comprehensive methods for earlier detection and monitoring of forest decline. Forest Science. 60(6): 1156–1163. https://doi.org/10.5849/forsci.13-121.

Roman, L.A.; Scharenbroch, B.C.; Ostberg, J.P.A. [et al.]. 2017. Data quality in citizen science urban tree inventories. Urban Forestry & Urban Greening. https://doi.org/10.1016/j.ufug.2017.02.001.

Roman, L.A.; Smith, B.C.; Dentice, D. [et al.]. 2018. Monitoring young tree performance with citizen scientists: The evolving Tree Checkers program in Philadelphia, PA. Arboriculture & Urban Forestry. 44: 255–265. https://doi.org/10.48044/jauf.2018.023.

Roman, L.A.; van Doorn, N.S.; McPherson, E.G. [et al.]. 2020. Urban tree monitoring: A field guide. Gen. Tech. Rep. NRS-194. Madison, WI: US Department of Agriculture, Forest Service, Northern Research Station. 48 p. https://doi.org/10.2737/NRS-GTR-194.

van Doorn, N.S.; Roman, L.A.; McPherson, E.G. [et al.]. 2020. Urban tree monitoring: A resource guide. Gen. Tech. Rep. PSW-GTR-266. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 132 p. https://doi.org/10.2737/PSW-GTR-266.

CONTRIBUTOR PROFILES

DANA DENTICE is an urban forestry program manager for the Pennsylvania Horticultural Society in Philadelphia. She manages various programs, including Tree Tenders and Tree Checkers. Her work includes data collection and management, tree identification, inventories, geographic information systems, tree planting and care, and event planning. Dentice received a bachelor's degrees in natural resources and landscape architecture and a master's degree in urban and regional planning, all from the University of Wisconsin-Madison. Additional information on the Pennsylvania Horticultural Society can be found at https://phsonline.org.

RICHARD HALLETT is a research ecologist with the Northern Research Station in New York City and Durham, NH. His research goal is to take lessons learned from traditional forest management research and practice and apply, adapt and or adopt strategies to effectively manage urban trees and forests. These new forest and tree management practices inform future rural forest management as those areas begin to experience increased temperatures and pressure from exotic invasive species. Hallett received a bachelor's degree in forest science from the University of Wisconsin and two degrees from the University of New Hampshire: a master's degree in forestry and a Ph.D. in natural resources. Additional information on Hallett can be found at www.nrs.fs.usda.gov/people/rhallett.

RACHEL HOLMES is the urban forestry strategist for The Nature Conservancy. She coordinates the Healthy Trees, Healthy Cities urban tree health monitoring national initiative and other urban forestry efforts including Treesilience. Holmes received bachelor's degrees in international environmental policy and religion from Rutgers University and master's degrees in forestry and divinity from Yale University. Additional information on Holmes can be found at www.conservationgateway.org/ConservationPractices/cities/hthc/About/Pages/Who-We-Are.aspx.

MICHELLE JOHNSON is a research ecologist at the Northern Research Station's New York City Urban Field Station. Her research has included studies related to environmental stewardship, urban parks and tree health, urban forest patches, and other human-environment relationships in urban areas. She received a bachelor's degree in biology from Eckerd College, a master's degree in natural resource planning from the University of Vermont, and a Ph.D. in ecology and environmental sciences from the University of Maine. Additional information on Johnson can be found at www.nrs.fs.usda.gov/people/michelleljohnson.

LARA ROMAN is a research ecologist with the Northern Research Station's Philadelphia Field Station. Her work addresses broad questions about how urban forests change over time, with a focus on tree demography, tree cover change, and the historical basis of present-day urban forest characteristics. Her studies take a transdisciplinary approach, with strong collaborations with urban forestry professionals. Roman received a bachelor's degree in biology and a master's degree in environmental studies from the University of Pennsylvania, and a Ph.D. in environmental science, policy, and management from the University of California, Berkeley. Additional information on Roman can be found at https://www.nrs.fs.fed.us/people/lroman.

NATALIE VAN DOORN is a research urban ecologist with the Pacific Southwest Research Station in Albany, CA. Her research strives to identify what drives changes in urban and wildland forests. To address this, she utilizes and contributes to long-term data sets on tree demography, forest biomass, and spatially explicit tree growth. van Doorn holds bachelor's, master's, and Ph.D. degrees focusing on forestry and environmental science, policy and management, all from the University of California, Berkeley. Additional information on Van Doorn can be found at www.fs.fed.us/psw/programs/uesd/staff/nvandoorn.

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BRIAN COOKE is a contract science writer for the Forest Service. He received a bachelor's degree in journalism-science writing from Lehigh University and is pursuing a master's degree in natural resource stewardship from Colorado State University. Cooke has written for the Forest Service Washington Office and for three Forest Service Research Stations, as well as for the National Park Service, the U.S. Fish & Wildlife Service, History Colorado, and various Forest Service partners and environmental services companies. His writing is colored by his National Park Service interpretive training and experience as a volunteer docent for Alcatraz Island National Historic Landmark, San Francisco Maritime National Historical Park, and Deadman Lookout Tower in the Roosevelt National Forest. Additional information on Cooke can be found at www.EnvironmentalStoryteller.com.

PURPOSE

The Cross-Pollinator is a science synthesis publication produced in cooperation between the Northern Research Station, the Urban Field Station Network, State and Private Forestry, and the Urban Forest Technology and Science Delivery Team. It spotlights transdisciplinary collaborations among researchers and practitioners that "cross" forest research with urban and community forests at a landscape scale.

ABOUT US

The mission of the Urban Field Station Network is to improve the quality of life in urban and urbanizing areas by conducting and supporting research and science exchange about social-ecological systems and urban-to-rural resource management. The mission of the Urban Forest Technology & Science Delivery Team is to work collaboratively to deliver quality urban natural resources science, technology, and information to improve the long-term sustainability of urban ecosystems and the broader watershed, for wildlife and people. Find out more at https://www.nrs.fs.usda.gov/ufs/; https://www.fs.usda.gov/research/urbanfieldstations; and https://www.vibrantcitieslab.com/

CONTACT INFORMATION

For more information or to sign up to be notified of future issues, visit https://www.fs.usda.gov/research/products/publications/crosspollinator.

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