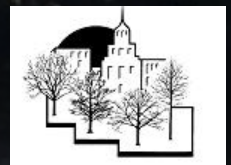
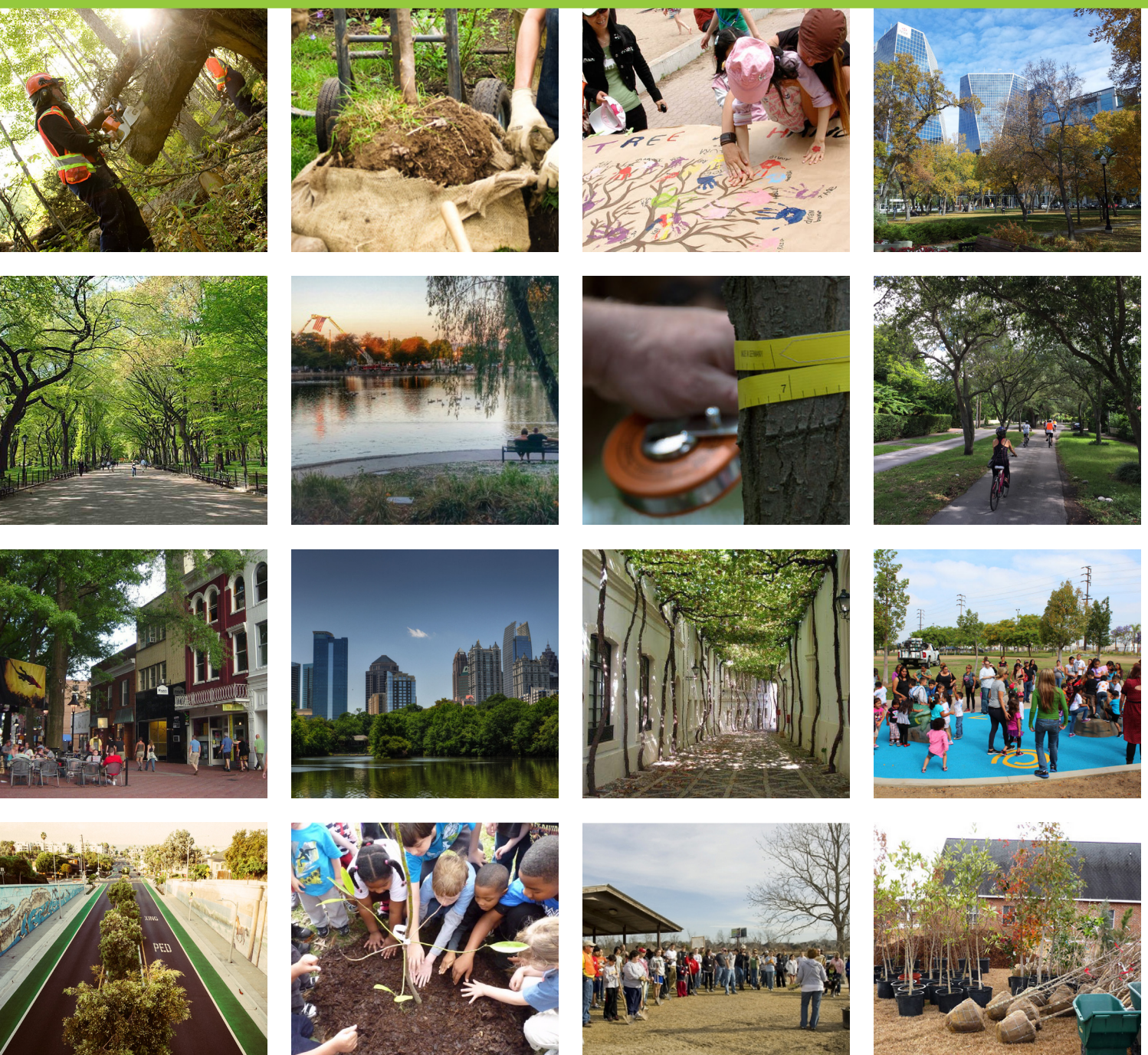


Ten-Year Urban Forestry Action Plan: 2016 -2026

Research Needs

Facilitated by the
National Urban and Community
Forestry Advisory Council





*Title page photo credit: Kathleen Wolf

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Table of Contents

A. Acknowledgments and Credits	4
B. Executive Summary	
1. Research Needs.....	5
2. Ten-Year Action Plan Highlights.....	6
C. Introduction: Research For Action	8
D. What is Science?	9
E. Guiding Principles	10
F. Expanding the Scale of Science	11
G. Research Needs and Strategies Framework	
1. Understand Ecosystem/Ecological Services.....	13
2. Promote Human and Community Health.....	14
3. Planting, Inventory & Analysis for Forest & Environmental Health.....	15
4. Anticipate Pests, Threats, Climate and Associated Changes and Risks.....	16
5. Enable Civic Stewardship & Improved Local Governance.....	17
6. Integrate Knowledge Networks and Data for Urban Socio-Ecological Systems.....	18
H. Research Framework Discovery Process	19
I. Science Delivery Needs	19
J. References	20

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Any views or opinions presented here are solely those of the authors and do not necessarily represent those of the contributors.

Action Plan Research Needs

Science, analytics and metrics are essential for effective and efficient operations of all urban built and natural systems. In recent decades urban forest planning, planting, and management have evolved from being informed by expert experience to adoption of widely shared, evidence-based best practices. Tree planting practices that promote longer lived, healthier trees have emerged from decades of arboriculture science. Full city assessments of tree canopy and tree inventories, used by many urban forest managers and their collaborators (such as community non-profits), have become a standard data set from which to set policy, create management plans, and sustain programs.

In addition, scientists representing many disciplines have discovered the functions and associated benefits that trees and urban forest ecosystems provide for urban residents. Original research has been used to construct analytic models (such as i-Tree) that

“Scientists representing many disciplines have discovered the functions and benefits that trees and urban forest ecosystems provide for urban residents.”

define and reveal ecosystem services (such as air quality, stormwater management, and human health) to help citizens and decision makers understand why investing in the urban forest is important.

This report presents a framework of research needs for urban forest ecosystems and metro nature for the next decade. The recommendations were derived from extensive document review, interviews with scientists, and listening sessions with national representatives of local communities and organizations. It should be noted that not all of the research needs align directly with the program goals and strategies of the core Action Plan. Nonetheless, the science recommendations, in total, continue the development of a knowledge base that demonstrates why and how urban forest ecosystems are essential in all cities.

Research Needs

What are the key science needs? What are the research questions that synchronize with the guiding principles? Distilled from a multi-modal national outreach, each Research Need is described in greater detail, with listed science strategies, in the pages that follow.

- A** Understand Ecosystem/Ecological Services
- B** Promote Human and Community Health
- C** Planting, Inventory, and Analysis for Forest and Environmental Health
- D** Prepare for Pests, Threats, Climate and Associated Changes and Risks
- E** Enable Civic Stewardship and Improved Local Governance
- F** Integrate Knowledge Networks and Data for Urban Socio-Ecological Systems

Guiding Principles

In order to deliver the greatest return for the nation's investment in urban socio-ecological studies, new research initiatives must carefully consider the full field of science opportunities. Several key ideas should guide decision making and implementation concerning future research and assessments:

- Means to the End - Build Local Capacity
- Build on Strength and Explore New Needs
- Replicate and Confirm
- Expand and Connect Science from Local Needs to National Programs
- Synthesize and Amplify Existing Knowledge

The Research Needs and Guiding Principles, explained in greater detail in this report, generally support the core Action Plan. Urban forestry program goals are supported by diverse, integrated research activity.

Ten-Year Action Plan Highlights

This research plan is a companion to the The National Ten-Year Urban and Community Forestry Action Plan, developed by the National Urban and Community Forestry Advisory Council (NUCFAC) for the USDA Forest Service, with extensive input from the U.S. urban forestry community. The Action Plan's purpose is to guide efforts to implement and expand urban and community forestry for the next ten years (2016 -2026). The plan will help expand awareness of the benefits that urban forests provide to communities throughout the nation, and support increased investments in urban forest resources for the benefit of current and future generations. These two pages are a summary of the Ten-Year Action Plan goals, actions, and recommendations for

improving the status of urban and community forestry for the United States and its Territories.

The Action Plan also identifies research needs, the focus of this report. Research provides the scientific evidence to support and promote more efficient and effective urban forestry programs at the national, state, and local levels. The USDA Forest Service has a much admired legacy of high quality, high impact science. In recent decades the science community has been more active concerning urban natural resources stewardship, and integrating that work with studies and analytic tools provided by other Federal agencies. This Research Needs report identifies and clarifies research highlights for the next decade.

Research provides the scientific evidence to support and promote more efficient and effective urban forestry programs at the national, state, and local levels.

Plan Vision
Urban And Community Forests Increase Sustainability, Wellness, and Resilience in All Communities.

Plan Mission
Help All Communities Create Urban and Community Forests that are Diverse, Healthy, and Accessible for All Citizens.



Photo Credit: Guy Kramer

Action Plan Goals



1. Integrate Urban and Community Forestry into All Scales of Planning
2. Promote the Role of Urban and Community Forestry in Human Health and Wellness
3. Cultivate Diversity, Equity and Leadership within the Urban Forestry Community
4. Strengthen Urban and Community Forest Health and Biodiversity for Long-Term Resilience
5. Improve Urban and Community Forest Management, Maintenance and Stewardship
6. Diversify, Leverage and Increase Funding for Urban and Community Forestry
7. Increase Public Awareness and Environmental Education to Promote Stewardship

Research for Action

Communities are coming to understand the importance of natural processes and ecosystems in cities as the source of solutions for urban challenges, and the urban forest is a key element. Urbanization pressures threaten both ecology and biodiversity, as well as human wellness and quality of life. Urban planning and design principles of the past are evolving

Ongoing research, assessment, and science delivery is absolutely necessary to inform emerging urban planning approaches, as well as sustainability and resiliency policy. Research must inform alternative approaches and translate findings to practical solutions.

to meet challenges and demands posed by both human and natural systems changes, often happening rapidly. The functions and benefits of natural systems within cities are increasingly recognized as being essential, not just nice to have. Traditional, predominantly gray infrastructure is being replaced by innovative, exploratory combinations of gray and green systems.

Tremendous challenges are encountered by community leaders and the 240 million residents of American cities. In most U.S. communities the scientific understanding of nature as a solution has either lagged or not been effectively integrated into local policy, programs or best practices. The solutions offered by urban forestry and ecosystems do not pertain only to specific natural spaces in cities, such as parks, gardens, and open spaces. In fact, recent research suggests that the presence of urban green contributes to solutions of some of the most important concerns of cities, such as air and water quality, transportation planning, human health, crime, high heat events and climate change, and community resilience.

Compared to traditions of wildland and rural landscape research, researchers must work together with local stakeholders and communities to address urban problems and solutions. When local stakeholders collaborate with experts and scientists, they become more aware of community systems and can initiate evidence-based solutions. Also, experts gain meaningful insight when they collaborate with community members to set up research projects.

While "urban forestry" is the focus of the Action Plan, the scientific community does research at two general levels. Some research provides ongoing, better knowledge about trees - their planting, growth, and management. Other research focuses on the urban forest as a component of more comprehensive city systems. Such studies explore green infrastructure, urban ecology, and/or socio-ecological systems.



Photo Credit: Rich Hallet

What is Science?

Basic and applied research is conducted by a science community that partially engages with the professional, civic and local government communities. Science questions are often formulated in collaboration with urban forestry and program-based professionals, and science projects are often conducted in the communities and contexts where urban forest planning and management occur.

Yet, the process and products of science are distinct from most program and professional activities. There are important interrelationships, yet research, being a process of discovery, is often conducted with an acceptance of uncertainty of outcomes and some level of risk. Some science may generate practical conclusions in a fairly

short time frame; the 'payback' from other studies may extend into a greater time in the future or may not play out at all.

Analytic methods are important for solving problems, adding new knowledge, and decision support. Yet, applying measures, metrics or statistics to a situation or objects is not always a science activity. New, rigorous science projects can be costly, but can produce widely usable knowledge. Some analytics are applied to more specific situations, and at lower cost. Research findings can also be translated to some situations without use of new measures, again at a cost savings. Communities should carefully consider the types of analytics and research that will best support their urban forest programs.

Basic research (also called fundamental research or discovery research) is a systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena, and may not apply to the real world in a direct way. Applied research is used to answer a specific question that has direct application, and may solve a problem. Urban ecosystems studies are often a blend of these two research functions.

Science Planning

What are the best analytic products to support urban forestry actions and programs? Stakeholders and agencies should consider these distinctions in future planning and budgeting:

Science/Research

The pursuit of new knowledge and understanding (for basic or applied purposes) by systematically developing research question(s) or hypotheses that reference theory and prior studies, propose appropriate methods, and apply analytic methods to discover original findings that are reported in peer-reviewed publications, particularly journals.

Assessment

The applied, repeated use of research that has been standardized as a best practice, often including guidelines for measures, field protocols, and technical reporting.

Science Delivery (aka Technology Transfer)

The process of translating either original research or assessments into products that enable practical application of findings, or display findings in ways that support local policy or programs.

An example of this distinction is the i-Tree suite of tools. Basic and applied research over the past two decades was published in scientific journals and informed the construction of models and tools, such as i-Tree Streets and Eco. Initial tools were field tested and validated across multiple regions of the U.S. They are now applied in cities and communities as assessments, and a standardized technical report is the product used by many communities to better understand their urban forest resource. Ongoing communications about the cumulative findings of the assessments, as well as the technical reports, is an example of science delivery. New basic and applied research

continues to support development of new assessment models and resulting tools.

Urban Tree Canopy (UTC) Assessments are the outcome of a similar evolution. Initiated by original research using remote sensing data, agency labs and consulting firms now provide technical support for assessments in communities. Ongoing research continues to inform new versions of UTC. Considering the social sciences, Stewardship Mapping (Stew-Map) is in transition from original research launched in New York City to use as a standardized assessment across multiple cities in the U.S.

Research Guiding Principles

Any planning for future research should recognize both past work and anticipate future needs. Budgets within the USDA Forest Service (and other agencies) have not kept pace with the demand for urban natural resources (UNR) research and city-based application. In order to deliver the greatest return for the nation's limited investment in UNR studies, new research initiatives must be carefully considered in light of all potential science opportunities. These key ideas should guide decision making and implementation concerning future research and assessments:

Means to the End - Building Local Capacity

Some outreach responses imply that science is a process of problem solving or data collection for a specific outcome. As research resources are limited, a potential litmus for developing and supporting science programs is a discussion about how potential products can build the capacity of decision-makers, managers, professionals, local agencies and NGOs to generate and sustain local urban forest ecosystems. Science delivery is also important to build community capacity.

Build on Strengths and Explore New Needs

Some research and assessment activities are momentum science that serves increasingly broader sets of populations and communities. Such a research program or series of studies has generated a critical knowledge base that supports assessment or management, and merits ongoing support. i-Tree and Stewardship Mapping are examples. Other topics represent emergent needs that will require resources to expand in effectiveness (such as urban wood utilization or environmental equity); to date there may be little evidence available to support programs or increase their effectiveness, but communities recognize increased need for knowledge.

Replicate and Confirm

The stakeholders and professional partners seek new research approaches and resources to support urban forest decision making and programs. In other instances, urban forestry community requests are for replicate studies to confirm that findings are specifically relevant in their own bioregions or urban megaregion. Such local research can have national significance if scaled up into networked knowledge that can be shared across regions or communities.

Expand and Connect Science from Local Needs to National Programs

Efforts should be made to standardize research programs and practices. So while a study may be conducted within a city or region, developing standard protocols (rather than one-off studies) will enable the resulting knowledge and data to become part of a larger effort (such as i-Tree and Stewardship Mapping) to build a better knowledge base.

Synthesize and Amplify Existing Knowledge

Effective science delivery will be just as important to the urban forestry community as are original studies. Focused, periodic review of current science - by theme, geographic or regional relevance, or in response to high priority issues - can then be distributed using effective, multi-mode process and products to assure that good science is put to good use. Educational institutions, including K-12 and higher education, can be engaged as both collaborating creators and users of science-based products.

Expanding the Scale of Science

The scale of research has become increasingly important in recent scientific publications, and was reinforced by expert contributions to this framework. The first suggestion concerning scale is to expand on trees as the focus of research. City trees and the urban forest are an important functional element across many urban places and urban systems. Yet a research focus on trees alone may restrict the value of research investments, and limit potential collaborations.

Broader opportunities are possible. For instance, a healthy, extensive urban forest contributes to green infrastructure (GI). The study and design of GI networks in metropolitan areas is an emerging interdisciplinary science that integrates local needs with diverse agency mandates (including air and water quality, and environmental justice). Interdisciplinary research teams, building knowledge that spans diverse needs, can help to create robust green infrastructure networks for our nation's cities, and then ensure systematic application of science in an equitable manner within and across cities.

The networking potential for multicity, regional, and national studies is another consideration of scale. Place-based urban

social-ecological research is immensely valuable in providing science to inform local programs and decision-making, including planning and land-use decisions, conservation policies, and urban forestry, parks, and public health programs. Place-based, or city-based, research efforts that are nationally networked are even more meaningful; this is when research and applications are replicated across an engaged network of cities and new knowledge is shared. Multicity data sets and shared methodologies allow for cross-comparative study, identification of broader scale patterns and trends, generalized knowledge and tools, peer learning, and diverse communities of practice.

Initial efforts at cross-city networked science are supporting advances in urban sustainability, resilience, and practical problem solving. The Forest Service's urban field stations, the National Science Foundation's network of Urban Long-Term Research Area Exploratory projects (ULTRA-Ex; now ceased), the Urban Waters Federal Partnership, and The Nature Conservancy's new North American urban network are milestone opportunities for nationally networked, place-based research.

City trees and the urban forest are an important functional element across many urban places and urban systems.

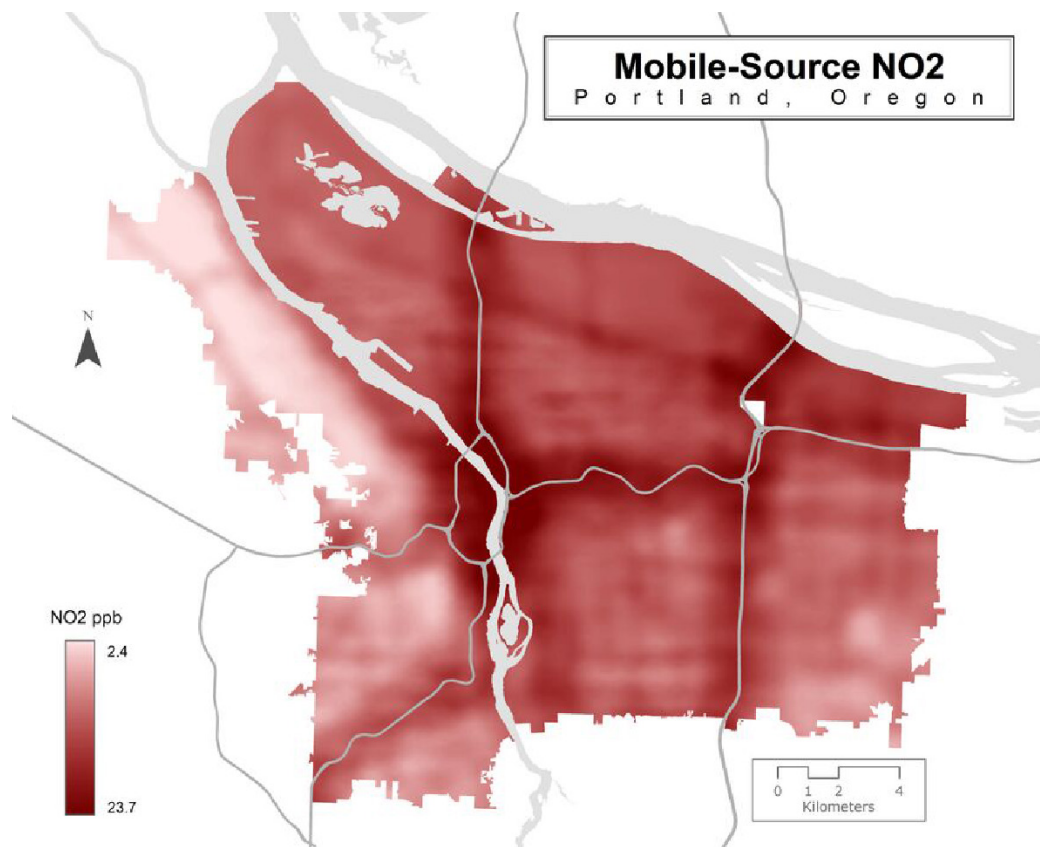


Photo Credit: Kathleen Wolf

Research Needs Framework

A framework of urban forest research needs is provided below. This framework is not intended to address every research or assessment need in every community. Its intent is to guide programs of science that respond to high priority needs in communities, and from a national perspective. Many entities support or conduct research on urban socio-

ecological systems; the framework can also be used by the USFS, other national agencies, and cooperating scientists (at universities and other institutions) in collaborative efforts to establish research and funding priorities over an extended time frame.

A Understand Ecosystem/
Ecological Services

B Promote Human and
Community Health

C Planting, Inventory, and
Analysis for Forest and
Environmental Health

D Prepare for Pests, Threats,
Climate and Associated
Changes and Risks

E Enable Civic Stewardship
and Improved Local
Governance

F Integrate Knowledge
Networks and Data for
Urban Socio-Ecological
Systems

Key to Objectives

Momentum Objective

- Research activity is well established and needs sustained support.

Emergent Objective

- Research activity either has begun recently and results hold high promise for urban forest planning, programs and management, or has been underway for some time but needs greater effort.

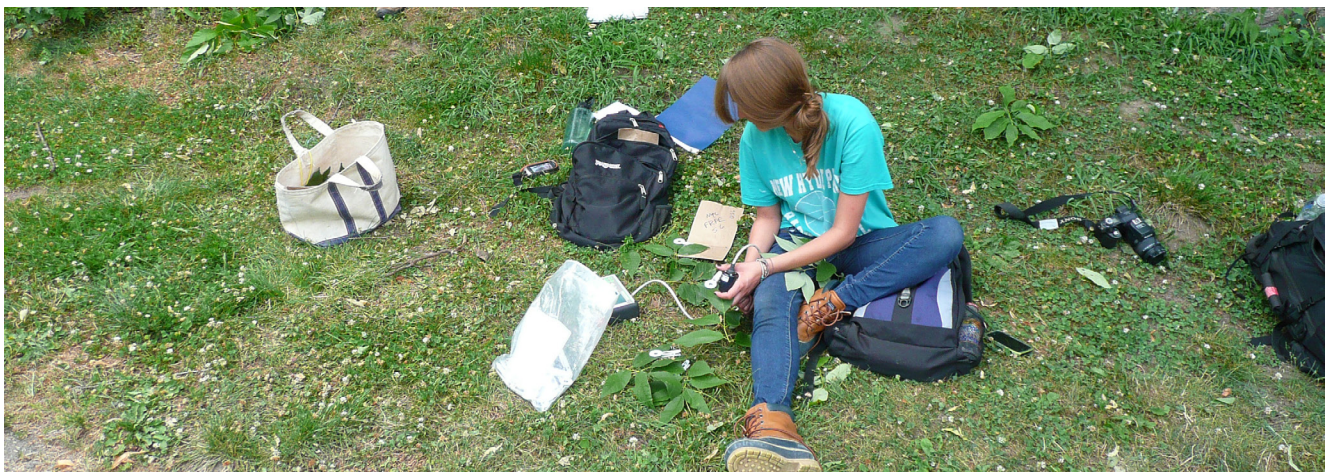


Photo credit: Rich Hallet

A Understand Ecosystem/ Ecological Services

Within several decades our understanding about the reasons to have trees in cities has moved from aesthetics to recognition of a wide array of human benefits and ecosystem services. Fact-based knowledge about urban forest ecosystem services and benefits often supports the first wave of messaging that builds local community support for urban forestry programs. Still, much of the U.S. population has relatively little knowledge about or understanding of how urban resources and nature provide critical benefits to communities and improve human well-being. Even fewer people may recognize how ecosystem threats (such as climate change and invasive species) may diminish quality of life by reducing or eliminating current services. Ongoing

Science focused on biogeographic regions can provide information that is suitably generalized across multiple communities.

research can boost the effectiveness of urban forest planning and management in achieving local policy initiatives (such as tree canopy goals), regulatory requirements (such as federal or state clean water laws), market-based conservation approaches, and environmental literacy. Additional study should address scale. For instance, science focused on biogeographic regions can provide information that is suitably generalized across multiple communities; science can also be applied to site-specific service benefit opportunities, such as use of plant materials to remove urban soils toxins.

Momentum Objectives

- Develop indicators for urban forest promotion and maintenance of urban environments and biogeochemical systems (air, water temp, carbon).
- Continue to translate evidence-based knowledge about urban forest ecosystem services to regionally relevant assessment models (e.g. i-Tree) that indicate urban forest structure, benefit, and value.
- Continue research on energy sourcing or savings related to trees, particularly in collaboration with organizations in the energy sector.

Emergent Objectives

- Study how urban forest structure and functions can best meet regulatory requirements.
- Assess and communicate regional ecosystem profiles across the U.S. (to include climate, weather, hydrology, and plant selections) to promote optimal urban forest ecosystem services outputs for diverse locations.
- Explore the use of plant materials in bioremediation to mitigate toxins and pollutants.
- Expand recognition of and develop metrics for the full range of urban ecosystem services (e.g. cultural services, urban wood utilization).



Photo credit: Kathleen Wolf

B Promote Human and Community Health

Cities are places of concentration of humans and their activities; they are the places where more than 80% of the U.S. population lives, works, learns, and seeks quality of life. A body of research representing many disciplines - including psychology, environmental health, epidemiology and anthropology - hints at the positive associations between urban forest ecosystems and human health and wellness. The [Green Cities: Good Health web site](#), a catalog of such research, shows that nature supports disease prevention and health promotion.

Additional research can address several needs. Communities need more knowledge about how benefits play out across social scales, from individuals to households, to

Urban forestry stewardship helps to build the social networks and capacities that enable people to be 'first responders' and cope with dramatic changes in their communities.

neighborhoods, and even entire cities. Also, additional information about vegetation character and exposure dosage (time and activity) can help communities better plan the places and nature-based programs that will promote health. In some instances urban vegetation can contribute to health concerns, such as pollen and asthma or harboring disease vectors like mosquitos, so science about disease prevention is also important. Finally, concerning resilience, studies should explore the initial findings suggesting that urban forestry stewardship helps to build the social networks and capacities that enable people to be 'first responders' and cope with dramatic changes in their communities.

Momentum Objectives

- Develop focused studies concerning public health benefits and concerns regarding tree canopy, urban ecosystems, and green infrastructure, to include health promotion and disease prevention, particularly in collaboration with public health and epidemiology organizations (such as the CDC and NIH).
- Expand knowledge of nature and community well-being and economy (such as crime prevention, transportation safety, and business and worker attraction).
- Continue studies about mitigation of negative health influences of vegetation, such as air quality in some settings, or habitat for disease vectors.

Emergent Objectives

- Provide evidence of improved human function and performance associated with presence of nearby nature (such as schools, offices, and workplace).
- Continue studies of individual and community resilience through civic ecology and nature-based recovery.
- Provide knowledge to promote environmental justice/equity and cultural relationships in urban forest and ecosystem programs.



Photo credit: Lance Davisson

C Planting, Inventory and Analysis for Forest and Environmental Health

As one scientist pointed out, if communities don't have healthy trees, they can't capture the health, energy, ecological, and other benefits that urban forests provide. Creating or conserving an urban forest in a community - in order to provide benefits and ecosystem services and enhance quality of life - requires several data supported activities. First, a community must be able to understand the character, extent, and health of the current urban forest. Standard canopy assessment or tree inventory practices are widely used; these were informed by early research and should be expanded as studies continue. Second, choices must be made about tree selection, care, and maintenance and research has helped to shape best practices, and scientific support should continue

If communities don't have healthy trees, they can't capture the health, energy, ecological, and other benefits that urban forests provide.

to inform on-the-ground urban forest management. Lastly, the urban forest is a dynamic, living resource that is being recognized as an important element across other urban systems. Additional research is needed to better understand how the urban forest, as a green infrastructure element, can be integrated with other urban systems, such as stormwater management installations, and with grey infrastructure like roofs and parking lots. Science-based assessment and

decision support tools are also needed to more rapidly recognize and respond to threats that may negatively impact the essential contributions of trees and forest patches across the entire urban to rural landscape gradient.

Momentum Objectives

- Continue to develop strategies & protocols to measure and monitor extent and condition of urban forests and canopy cover, locally as well as nationally (e.g. urban FIA, UTC), with attention to cost and data collection efficiencies for communities.
- Continue original research to support development of additional assessment models and tools (such as LIDAR and hyperspectral remote sensing for forest canopy and health condition assessments, and i-Tree).
- Expand knowledge of tree selection, placement, and growth factors (including soils), specifically to promote resilience (especially in response to climate change).
- Provide evidence to continue to develop, establish and promote standards & best practices for urban forest sustainability.

Emergent Objectives

- Expand diagnostics for urban forest health and threats and construct protocols for early detection, as well as routine and systematic assessment & reporting.
- Develop models and decision tools to support optimal urban forest, other green infrastructure, and gray infrastructure integration and configurations.
- Expand initial implementations of Urban FIA (USFS Forest Inventory and Analysis) for forest condition assessment and monitoring.

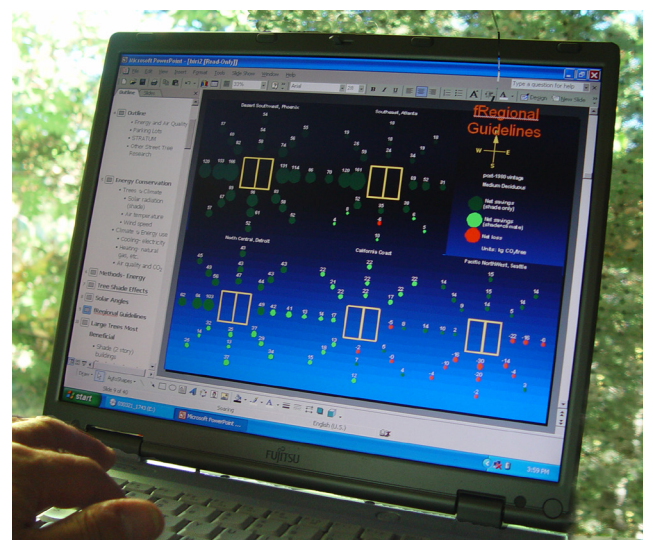


Photo credit: Guy Kramer

D Prepare for Pests, Threats, Climate and Associated Changes and Risks

Cities and regions are encouraged to conduct tree canopy assessments or tree inventories, set urban forest goals and policies, and adopt management plans to promote consistent, stable urban forest programs. Yet ever more communities are experiencing abrupt changes and threats. Some change transcends the urban forest system, such as a hurricane or tornado damage that impacts all city systems, including the urban forest. The 2014 National Climate Assessment summarized the impacts of climate change in the United States, now and in the future, and called out the wide-ranging changes and threats for all communities, including natural resources. Other changes are tree-focused, threatening the health or productivity of the forest, such as an insect pest or virulent disease. Some threats are abrupt, showing consequences in hours or days, and others simmer

Some threats are abrupt, showing consequences in hours or days, and others simmer for years with gradual implications (such as invasive plant species).

for years with gradual implications (such as invasive plant species). Research is needed to better understand and monitor current threats, to diminish tree loss, maintain urban forest health, and to sustain ecosystem services. Studies are also needed to help anticipate emergent threats or negative conditions to enable proactive management response. For example, the Urban Resilience to Extremes Sustainability Research Network (UREx SRN) is a NSF funded project involving an international network of diverse cities and scientists that will study integrated topics including flooding, extreme heat, and drought. Finally, social or policy studies can help to reveal the institutional best practices that can be put in place for threat response and community engagement for forest sustainability.

Emergent Objectives

- Given likely changes of the Anthropocene, effort is needed to better understand and work within change trending to anticipate and integrate Urban Forestry goals with likely futures, and study of vulnerable situations (such as found in tropical forestry) can provide insight for broader patterns and responses.
- Continue and expand studies of climate change and urban ecosystems implications to develop better, prioritized community response policy and programs.
- Clearly define and describe, then quantify urban forest threats and impacts from national to local scales, to include invasive plant species, insect pest invasions, land use development, urban wildfire, and climate scenarios.
- Create models and decision tools to support urban threat forecasting and management response, including trade-offs analysis for policy and budget scenarios.
- Use current and new evidence to construct best practices for tree/forest/ecosystem threat planning and management.



Photo credit: Rich Hallet

E Enable Civic Stewardship and Improved Local Governance

Unlike a more traditional forest reserve (such as a National Forest) an urban forest spans a complex mosaic of land uses, parcel sizes, and ownership types (including private, public, and institutions). In many instances tree canopy goals, a common expression of urban forest planning and management, can not be achieved solely by plantings on public properties so engagement of private property owners is necessary. At one level the funding and budget dynamics of this complex social and administrative situation are little understood. In addition, local governance of all urban systems, including the urban forest, is highly participatory as residents demand government transparency and a voice in the policies that shape their communities. Finally, few local governments have adequate resources to maintain and manage their urban forest resources so they are relying increasingly on the services of volunteer civic stewards and

Residents are being engaged as citizen scientists to help build local knowledge; youth participate and learn about natural resources careers and the importance of urban forest ecosystems in their communities.

the organizations that support them. Residents are being engaged as citizen scientists to help build local knowledge; youth participate and learn about natural resources careers and the importance of urban forest ecosystems in their communities. All of these social dynamics point to a need to continue and expand recent research initiatives in the realm of urban natural resources stewardship. The complex dynamics of social participation and engagement that are aligned with urban natural resources programs should be studied to both optimize the efforts of contributors, and to better understand human relationships to urban ecosystems. Finally, research is needed to address the needs and disparities of underserved groups or communities, and to actively engage them in urban forestry for community benefit and jobs development.

Momentum Objective

- Develop detailed cost-benefit analysis, including capital asset estimations, for local government budgets, to include tree maintenance and other direct tree costs, stewardship, civic engagement, and urban forest governance.



Photo credit: Amigos de los Rios

Emergent Objectives

- Study how to enlist and support citizens & property owners to plant trees and improve natural resource management on private properties.
- Conduct social marketing studies to more effectively present knowledge of physical, mental, and societal benefits of urban forestry and ecosystems, and urge positive behavior.
- Generate better knowledge about civic environmental stewardship motivations by volunteers and community organizations.
- Understand and develop collective impact stewardship networks & governance systems at the landscape scale, including stewardship mapping (Stew-Map), social networks and including knowledge-action networks.
- Promote concepts and evaluation approaches concerning how the urban forestry NGO community of practice can initiate and optimize partnerships, resources, and programs.

F Integrate Knowledge Networks and Data for Urban Socio-Ecological Systems

This goal was expressed by most scientists, but is a broader science 'ecosystem' idea, rather than a collection of research questions or topics. Most of the scientists are anticipating the necessity for 'big data' to address the complexity of both biophysical and social challenges in cities. Many spoke of cities as socio-ecological systems, also described (by the National Science Foundation) as coupled human and natural systems.

Regional Data Platform

Scientists envision the possibility of a common data platform that would be constructed across a region (including city/county jurisdictions) or geoclimate zone to consolidate research and science management. In this way efficiencies of data collection and analysis are gained as standardized measures and metrics enable more consistent and efficient problem solving. Computational power and access is rapidly making this vision possible. This approach is being explored and incrementally underway within the Urban Long Term Ecological Research projects funded by the National Science Foundation (in Baltimore and Phoenix). The [EnviroAtlas](#) project (sponsored by the Environmental Protection Agency) is generating place-based data platforms for cities, and incorporates USDA Forest Service data.

Scientists envision the possibility of a common data platform that would be constructed across a region (including city/county jurisdictions) or geoclimate zone to consolidate research and science management.

Example of Regional Science

To illustrate this vision, consider this scenario for 'Big City'. One team collects routine urban FIA (Forest Inventory and Assessment) data and enters it into a shared data platform, hosted and managed by a local university. Another does a thorough parks and open space assessment, including social data on users. Another team collects Stewardship Mapping data about stewardship groups and their project sites. Another uses LIDAR data to analyze tree stress and incidence of Emerald Bad Bug. The city and county contribute their data layers, such as parks locations, parcel ownership, crime statistics, etc. All data sets are accessed from a shared data portal (having protocols for inputs and use).

After some time there is a 'critical mass' of data sets that enables more complex research questions and analysis. Scientists with a focus on modeling advance i-Tree analysis, generating new models with both biophysical and social metrics. Other modelers explore the socio-ecological relationships of stewardship activity, urban forestry management practices, and climate outcomes. A steering committee reviews new data layer proposals, and also reaches out to scientists across multiple agencies (such as USFS, EPA, NASA, or HUD) that can leverage the existing data to enhance their analytic contributions.

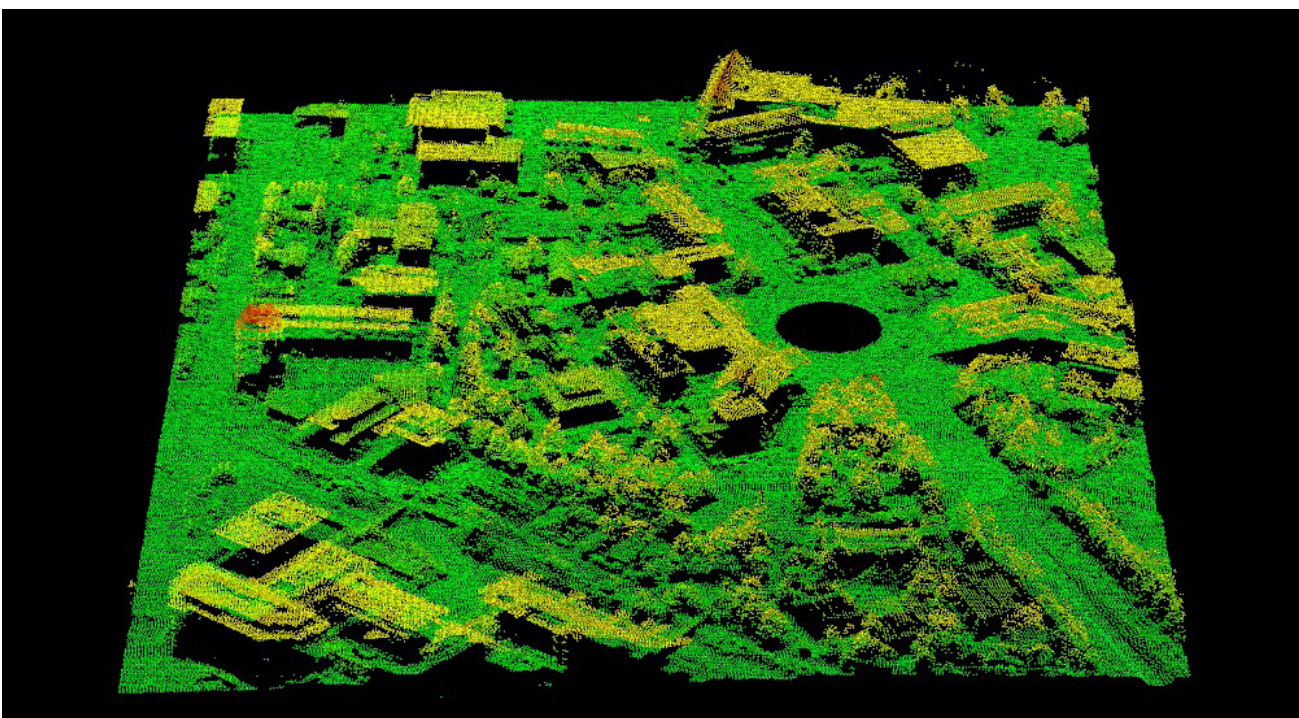


Photo credit: Kathleen Wolf

Research Framework Discovery Process

How were these research needs identified? Who helped craft the urban and community forestry research framework?

A multi-step process was used to formulate then finalize this framework of current and future science needs concerning urban ecosystems. The ongoing focus of the outreach and synthesis was to discover and communicate the practical science and evidence that can help communities to better plan, manage and sustain their urban forests, and make their communities more resilient.

In an exploratory phase key documents were identified. There are several scientific reviews that make research recommendations, including a report from a National Academy of Sciences workshop. Second, science needs have been identified by several working groups (such as the [Sustainable Urban Forests Coalition](#) (SUFC) and the Vibrant Cities Task Force. The USDA Forest Service also has a research needs briefing.

The Action Plan is intended to reflect the needs of professional, management, NGO, and urban forestry communities. The second discovery phase involved professional and manager inputs. Numerous research suggestions were sorted from the national outreach for the core plan. In addition, a research needs brainstorming workshop was conducted at the national Alliance for Community Trees members meeting in November 2014 (> 100 participants).

Based on document inputs and urban forestry community engagements a research framework was drafted. The framework was vetted in several ways. It was discussed by a group of scientists that participate in monthly USDA Forest Service Urban Field Station calls, and the National Program Lead for Urban Research with the USDA Forest Service. Confirmatory interviews were scheduled with 12 scientists representing the USDA Forest Service, universities, private sector, and arboreta. The framework was also reviewed by the Research Committee of the Sustainable Urban Forests Coalition and the National Urban and Community Forestry Action Plan Advisory Team.

Science Delivery Needs

The national outreach and synthesis process revealed a very complex and dynamic scientific and technical 'ecosystem' concerning urban forest ecosystems and urban ecology. Given the pace of urbanization of the U.S. (and the world) the past decade seems to have brought forth much greater interest and activity in urban based science.

There were paradoxes in both the written and verbal inputs:

- **Needs Disparities** - Some informants would call out the need for additional science about a topic, and other informants would say, 'no, we know enough to do good'. In some instances a person claiming a need seemed to not be aware of existing science.

- **Regional Replication** - Some informants may be able to call out the need to replicate a study in their community, to address the specific biophysical and/or social aspects of their place. Others would respond that work had already been done in the bioregional location, though in a different city. And there was some discussion of the understanding of the generalizability of science, in that research design is often intended to address a question that is salient to many situations though the field work may be conducted in one place.

- **Science Sourcing** - In some instances informants called for new science for a place, and others observed that the question may have been answered locally by an agency, municipal technical department, or NGO. Ever-more local entities have science and technical capacity and their products may be the on-the-ground information that is needed by the urban forest managers. Often this information is not found in peer-reviewed publications; the technical reports are often of high quality, yet not widely known.

Each of these situations supports the need for a national, comprehensive program of science delivery. The collection and translation of scientific and technical evidence should be made available for easy distribution and access. While USDA Forest Service products should be highlighted, local community partnerships are also important. For instance, local agencies and non-profits may be able to distill findings that are particularly relevant in their community, translate key points into multiple languages, and more effectively distribute materials within their communities.

Each of these situations is an indication of the need for a national, comprehensive program of science delivery



Photo Credit: Paul Byerly

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