VIRTUAL TREES IN THE CITY SYMPOSIUM

Conference Program

October 5th – 6th, 2026

Held Virtually

Talks are listed in schedule order, grouped by day, session, and concurrent track.

About This Symposium

Since 2012, Dr. Tenley Conway (University of Toronto Mississauga) and Dr. Shawn Landry (University of South Florida) have organized special sessions at the American Association of Geographers (AAG) Annual meeting, which is comprised of thousands of Geographers from around the world. Many researchers from other fields also regularly attend.

Research talks have been organized around themes such as: Urban Forest Governance, Policies, and Planning; Environmental Justice and Equitable Urban Forestry; Stewardship and Volunteer Labor; Trees as Green Infrastructure and Ecosystem Services; Amenity and Hazard Trees; Remote Sensing and Spatial Analyses; Volunteered Geographic Information in Urban and Community Forestry; Qualitative Methods in Urban Forestry; Urban Forests and Climate Resiliency; Urban Forestry Inventories and Monitoring and related topics.

The success of these special sessions has spawned the urbanforestsgrp@usf.edu listserv, a low-spam, high-fun place for researchers to share job postings, opportunities for collaboration, newly available datasets, and similar. See also https://treesinthecity.org.

Given the increasingly adopted online virtual conference format, why not convene more often to share and learn from each other?

In 2022, 2023, and 2024 we did just that. And we are doing it again this year on October 5-6, 2026.

Thank you for being part of this!

Organized by,

Dexter Locke, US Forest Service
Amber Grant, University of British Columbia
Shawn Landry, University of South Florida
Tenley Conway, University of Toronto Mississauga

Overview:

DAY 1 – Monday, October 5th, 2026

11:00 - 12:10: concurrent sessions

12:10 - 1:00: break with zoom room open for networking

1:00 - 2:00: concurrent sessions

DAY 2 – Tuesday October 6, 2026

10:00 - 11:10: sequential sessions

11:10 - 11:25: break with zoom room open for networking

11:25 - 12:25: sequential sessions

12:25 - 1:00: break with zoom room open for networking

1:00 - 2:00: concurrent sessions

DAY 1 – Monday, October 5th, 2026

Joint welcome: 11:00 AM - 11:10 AM EST

MORNING SESSIONS (CONCURRENT)

Option 1: Governance & Management of Urban Forests

JOIN HERE: https://utoronto.zoom.us/j/87280280088

11:10 AM - 11:25 AM

Shade Deficiency, Park Accessibility, and Frequent Visitation Among Older Florida Adultsn

Christy Suhendy

Co-authors: Christy Suhendy, Andrew K. Koeser, Ryan W. Klein, Laura Warner, Matilda van den Bosch, & Gail Hansen

Parks in warm climates depend heavily on tree canopy to remain comfortable, yet it is unclear whether perceived shade deficiency actually reduces how often older adults visit. This study asked whether shade deficiency independently predicts frequent park visitation among this population, alongside other park improvement needs and accessibility factors. We surveyed 1,237 Florida adults aged 45 and older using a cross-sectional online questionnaire. Frequent visitation was defined as at least once per week. Stepwise binary logistic regression identified independent predictors from a candidate set that included park improvement motivators, travel mode, travel time, age, and gender. Walking or biking to the park was the strongest predictor of frequent visitation (OR = 3.728, $p < 0.001$), followed by shorter travel time (OR = 0.627, $p < 0.001$), male gender (OR = 1.939, $p < 0.001$), and younger age (OR = 0.967, $p < 0.001$). Among park improvement motivators, shade deficiency (OR = 0.648, $p = 0.014$) and safety concerns (OR = 0.650, $p = 0.032$) independently reduced the likelihood of frequent visitation. Conversely, respondents who wanted better walking and biking paths (OR = 1.553, $p = 0.008$) or better lighting (OR = 1.918, $p = 0.004$) were more likely to be frequent visitors. Natural vegetation and trees ranked as the fourth most important park feature (39.0%). Shade deficiency reduces

frequent park visitation among older Florida adults independent of proximity and travel behavior. Canopy investment, combined with improvements to active transportation infrastructure and park safety, may meaningfully increase regular park use in this population.

11:25 AM - 11:40 AM

Impacts of restoration and management on threats and status of urban forest biodiversity

Shawn Fujioka — New York City Department of Parks and Recreation

Co-authors: Shawn Fujioka, Georgina Cullman, Matthew I Palmer, Karen Law, & Maria Uriarte

Urban green spaces, areas partially or completely covered by vegetation, are important yet threatened components of cities that require monitoring and maintenance. Forested natural areas, a subset characterized by structurally complex, naturally regenerating trees (Piana et al., 2021), face heightened human-caused disturbances such as pollution and land development. In New York City, green spaces account for 40.5% of land cover, including 11.6% classified as natural areas (Pregitzer et al., 2018). The New York City Department of Parks and Recreation (NYC Parks) manages 2,594 hectares of these forested natural areas. NYC Parks developed the Rapid Site Assessment (RSA), a protocol to document changes in site condition and evaluate site threat levels in these areas. They also track management efforts through the Natural Areas Management Application (NAMA). This study combines these two data sources to assess the impact of management hours and personnel type on change in threats to and status of biodiversity (measured in mean coefficient of conservatism and native species richness) in 45 sites within forested natural areas across New York City. The effectiveness of management in improving threats to these forests depends on personnel type and initial site condition, with work completed by NYC Parks staff leading to a 52% increase in the odds of threat improvement. Biodiversity significantly increased between sampling periods, often associated with concomitant decreases of threats. Given the dynamic nature of urban forests and their importance in sustaining both humans and wildlife, it is important to continue monitoring and studying additional characteristics to improve management efforts.

11:40 AM - 11:55 AM

Beyond Canopy Cover: Mapping the Temporal Reliability and Equity of Urban Shade

Hengyin Liao

Urban tree canopy is widely used as an indicator of urban greening and heat resilience, yet canopy extent alone may not fully represent when and where shade is available to people. This study examines the temporal reliability and spatial equity of urban shade across the University of British Columbia's Vancouver campus using high-resolution spatial data and GIS-based shade modelling. Shade conditions were simulated across multiple daytime hours and summarized to identify areas with consistently high, moderate, or limited shade availability. These patterns were then compared with indicators of heat exposure and social vulnerability to identify locations where limited shade may overlap with greater potential need. The analysis highlights important differences between the presence of vegetation and the timing and persistence of usable shade. Areas with substantial canopy or vegetation cover do not necessarily provide reliable shade throughout periods of daytime heat exposure, while other locations may provide more effective protection because of the spatial arrangement of trees, buildings, and pedestrian environments. These findings suggest that urban forestry and heat-adaptation planning may benefit from moving beyond canopy-cover targets alone toward measures that consider the timing, location, and reliability of shade. The study demonstrates how spatially explicit shade modelling can support more equitable and climate-responsive urban forest planning.

11:55 AM - 12:10 PM

Urban forestation research in geographic, temporal and socioecological context

Brad Oberle — The New York Botanical Garden

Co-authors: Brad Oberle, Timon McPherson, Elizabeth Cook, Meghan Midgley, Sarabeth Buckley, Clara Pregitzer, Rich Hallett, & Max Piana

Promoting urban sustainability through increased tree canopy requires establishing functional, biodiverse plant communities in small, underused spaces. A widely adopted approach, often attributed to Japanese scientist Akira Miyawaki, emphasizes community engagement and dense native plantings to accelerate growth in arbitrarily small patches. To better calibrate expectations for ecosystem services from these projects—commonly termed mini-, micro-, or pocket forests—we propose a new conceptual framework that integrates landscape ecology with socioecological systems theory. Ecosystem services such as heat mitigation, carbon storage, and habitat quality likely depend on patch size, connectivity, age, disturbance regimes, design choices, and policy context, which vary between isolated street trees, mature forests, vacant lots, and micro forests existing across the proposed axes. Collaborations between researchers and practitioners on experiments with long-term monitoring can improve theory, practice and policy.

Option 2:
Soil, Biochar Innovations, and Management Practices for Healthier Trees

JOIN HERE: https://umd.zoom.us/my/dexter.locke

11:10 AM - 11:25 AM

Rooted Practices: The Influence of Home Owners Associations on Tree Management Strategies and Urban Forest Vitality

Alyssa Vinson — University of Florida IFAS Extension

Co-authors: Alyssa Vinson, Andrew K. Koeser, Ryan Klein, Gail Hansen, Adam Dale, & Mysha Clarke

Urban forests provide critical ecosystem services, yet an increasing proportion of urban tree canopy is governed by homeowners associations (HOAs), whose policies and management decisions may substantially influence urban forest outcomes. This study examines how HOA governance affects tree health and adoption of recommended tree management practices in Florida communities. Research questions focus on whether canopy cover and tree health differ among HOA-governed neighborhoods, what management strategies are currently employed, what barriers limit implementation of best management practices, and how perceptions and values influence decision-making. Using a mixed-methods design, the study integrates spatial analysis of canopy data and neighborhood characteristics, field-based tree health assessments, surveys, and focus groups with HOA leaders and residents. Preliminary survey results indicate that respondents most commonly value trees for shade and aesthetics, while identifying premature tree failure, sidewalk conflicts, and pests or diseases as primary management concerns. Budget limitations, lack of knowledge, and social expectations emerged as key barriers to recommended tree care practices. Guided by the Social-Ecological Systems Framework, this research seeks to improve understanding of how governance structures shape urban forest vitality. Findings will support development of evidence-based recommendations for HOA policies and management practices, inform Extension education programming, and contribute to urban forestry policy discussions aimed at improving canopy resilience and community outcomes.

11:25 AM - 11:40 AM

Centering Soils in NYC’s Street Tree Canopy Growth

Sam Asher

New York City’s street trees provide shade, improve air quality, cool neighborhoods, and mitigate pollutants, making them essential for ecosystem health, community wellbeing, and climate resilience. To produce these benefits, trees need healthy soils, an aspect of nature-based solutions that is often neglected and undermaintained in urban greening projects. Street tree beds tend to be compacted and contaminated, making their soils poor in quality and reducing their capacities to sustain healthy root and canopy growth. At the grassroots level, New York has a rich history of street tree soil stewardship. However, limitations around staffing and funding pose challenges to expanding the scale of these operations. The New York City Urban Forest Plan, published in April 2026, establishes strategies to expand New York City’s tree canopy coverage from 22% to 30% by 2040. In order to succeed, this and future plans must acknowledge the critical role soil cultivation plays in developing full tree canopies. This research asks, how can New York City strategically expand its urban canopy while cultivating healthy soils that support ecosystem and community wellbeing? Through a review of academic, scientific, and policy-based literature; case study analyses of urban forest management plans and soil health initiatives; and interviews with key stakeholders in New York City’s street tree stewardship and soil health management; this project explores the existing approaches, challenges, and impacts of volunteer-driven grassroots soils and street tree stewardship on New York City’s urban forest. The value derived from community-scaled approaches to ecological management reveals opportunities for strengthening top-down planning and maintenance frameworks to deliver long-lasting benefits to social and environmental stakeholders. To promote biodiversity, mitigate extreme heat and flooding, and support healthy ecosystems and communities, New York City's approach to street tree stewardship must center soils across grassroots and governmental scales in order to achieve its canopy expansion goals. This work demonstrates how grassroots street tree stewards support sustainable systems of care by driving localized climate resiliency through soil health management, ultimately serving as models for advocacy and improvement.

11:40 AM - 11:55 AM

Biochar, greenhouse gases, and urban forestry: preliminary results of urban forestry wood waste & biochar trials

Prof. Sean Thomas – University of Toronto Institute of Forestry & Conservation

Co-authors: Sean Thomas, Imrul Kayes, Matt Ronan, & Melanie Sifton

Urban areas are now recognized as hotspots for greenhouse gas (GHG) emissions, accounting for more than half of total estimated GHG emissions globally. While energy use of the built environment and transportation sectors dominates emissions, direct GHG emissions from urban waste streams and soils are also large but poorly resolved contributors; moreover, urban land use can substantially modify energy demand – for example urban trees can mitigate the urban heat island effect and thus reduce energy use. A multi-year project partnering Canadian universities and city foresters was launched to better quantify GHG emissions from urban forestry waste at processing sites and when used as mulch in major urban areas in Canada. Our recent studies in log processing sites in operational forestry suggest that large methane emissions are associated with forestry waste material. Targeting reductions in methane emissions is important as methane accounts for ~30% of anthropogenic climate forcing and has a short atmospheric half-life. The study examines mitigation of GHG emission in this sector through conversion of urban forestry waste to pyrolyzed organic matter (biochar), with a focus on biochar use in urban soils and green infrastructure to enhance carbon sequestration, reduce substrate GHG emissions (particularly of methane), and increase urban vegetation growth and physiological performance.

11:55 AM - 12:10 PM

Shrinking paw prints in the urban forest: can biochar buffer excess dog urine in street tree pits?

Melanie Sifton — University of Toronto Institute of Forestry & Conservation

Co-authors: Melanie Sifton, Imrul Kayes, Matt Ronan, & Sean C. Thomas

Pets are on the rise globally and canine urine is estimated to be a major contributor to toxic levels of nitrogen, phosphorus and salt in city street tree soils, as well as a source of pathogenic microbes and odors. The environmental “paw print” of dog wastes introduced to urban environments has been identified as significant, yet impacts on vegetation and soils, and potential remediation options have been scarcely evaluated. Many trees in cities are affected by wanton deposition of dog wastes and city forestry professionals complain that trees in areas with high concentrations of pet dogs have poor health & low survival. Biochar has been shown to sorb a wide range of chemicals in the soil, with a particularly high affinity for ammonium, and can also balance soil moisture, nutrients and reduce bulk density -all helpful for urban forests. We hypothesize that wood biochar soil amendments applied to street tree pits will buffer impacts of excess dog waste on trees and soil. Preliminary results of a large-scale multi-year urban street tree biochar study in Toronto will be presented with a special focus on mitigation of dog waste effects in sidewalk street trees.

AFTERNOON SESSIONS (CONCURRENT)

Option 1: Public Discourse, Frameworks, and Community Voices

JOIN HERE: https://utoronto.zoom.us/j/87280280088

1:00 PM - 1:15 PM

Forest Thinning Pilot in Van Cortlandt Park, New York City

Karen Law — NYC Parks

Co-authors: Karen Law & Caitlin Lynch

The New York City Department of Parks and Recreation (NYC Parks) and other partner organizations planted 480,000 trees in natural areas across New York City between 2007 and 2015 as part of the MillionTreesNYC initiative. Trees were planted at an average spacing of 4 ft on center with a mixed palette of early and late successional species to ensure survival and because of limited scientific literature on best practices for urban reforestation at the time. Now, 10-20 years later, growth and survival rates of planted trees have exceeded expectations at some MillionTreesNYC natural area planting sites, and in some cases, dense stands of fast-growing early-successional trees are decreasing light availability for late-successional trees and understory species, which decreases structural diversity and limits habitat quality for birds and other wildlife.

As part of a pilot forest thinning study, in 2022, NYC Parks thinned the midstory trees (< 6 in. DBH) in a 3-acre MillionTreesNYC site in Van Cortlandt Park to observe the effects on understory oak growth rates, groundcover species composition, and woody seedling regeneration. Tuliptrees, sycamores, and other abundant, fast-growing trees were removed, with the goal of bringing more light to the understory and releasing oak species and other slow-growing tree species. NYC Parks monitored oak growth and understory cover annually for three years post-thinning within the thinned site and an adjacent unthinned control site. Results showed no significant differences in average understory percent cover, woody seedling count, oak growth, or oak survival yet did indicate some differences among groundcover species richness. The results of this study were additionally affected by deer herbivory, unstable and poor soil conditions, data collection timing and extent of thinning area. Our main takeaways are to space

out data collection timing, possibly increase number of stems/plots and to measure larger stems for more robust data comparisons.

1:15 PM - 1:30 PM

Urban tree preferences for climate action: Community perspectives in Lemon Grove, California

Andrés Peñalosa Reyna — University of California Irvine

Co-authors: Andrés P. Reyna, Ethan M. Nichols, & Amy Quandt

Urban forestry, the planting and management of urban trees, is often proposed in policy and practice as a nature-based solution aimed to promote climate resilience. For example, the City of Lemon Grove, California aims to utilize urban forestry in their Climate Action Plan to help meet their carbon mitigation goals as well as adapting to urban heat island effects. However, urban forestry efforts often do not take into account the perspectives of local citizens. The goal of this study was to better understand community perspectives on how to best implement an urban forestry project to meet community needs and climate action plan goals. An online survey of 64 Lemon Grove residents was conducted; with questions focused on understanding desired tree species, planting locations, and willingness of residents to participate in the funding, planting, and maintenance of an urban forestry project. Survey results indicated that residents prefer tree species with low water input requirements and a high tolerance for heat and direct light. Planting locations should benefit the maximum number of Lemon Grove residents at locations like roads, transit depots, and pedestrian areas such as schools, churches, and parks were highlighted by respondents. About 78% of respondents indicated that they would be willing to make a monthly donation between $1 and $20 USD toward the tree planting initiative. This study can be applied as a format to future urban forestry projects, utilizing community surveys to guide recommendations and meet climate action plan goals for just urban transitions.

1:30 PM - 1:45 PM

Accounting for Trees in the City: Urban Natural Capital and Ecosystem Services Across 863 U.S. Cities

Peter Ibsen — United States Geological Survey

Co-authors: Peter Ibsen, Levi Sweet-Breu, Lucila Corro, Mehdi Heris, Raimundo Atal, Greg Cermak, Zach Ancona, Elizabeth Kula, Leon Foks, Eric Lonsdorf, Dave Nowak, Jay Diffendorfer, & Kenneth J. Bagstad

We all know urban trees provide measurable benefits to cities, however these benefits often remain difficult to compare across regions, track through time, or incorporate into formal decision-making. Natural capital accounting offers one approach for organizing ecological and economic information into a consistent framework that can support urban planning and public investment decisions. Our recent USGS research has developed a national-scale urban natural capital accounting analysis of multiple urban forest-derived ecosystem services across 863 U.S. cities from 2011 to 2021.

Our work estimates the physical and monetary supply of four ecosystem services derived from urban forests and vegetation: heat mitigation through building energy savings, rainwater interception, carbon sequestration, and pollination supply. The analysis integrates a new enhanced urban tree canopy dataset with climate and urban form, not only to estimate service values at the city scale, but also to examine how those values vary across the United States and how certain ecosystem services may drive large shifts in valuation across time periods.

What we have found is that while urban forest-derived ecosystem services are relatively stable nationwide over the past decade, substantial variation exists among cities. That city-by-city variation can be driven by a unique combination of climate, land cover change, and shifts in population. The work demonstrates both the promise and limitations of applying natural capital accounting to urban forests at national scales. By translating urban tree and vegetation benefits into a repeatable accounting framework, we aim to provide a framework for tracking change through time and across cities and, importantly, identifying where improved data or locally grounded ecological measurements could strengthen future urban forest valuation.

1:45 PM - 2:00 PM

Who Speaks for Urban Trees and What do They Say?

Matthew Fry — School of Environment, Society & Sustainability, University of Utah

Co-authors: Matthew Fry, Zvonimir Simic, Ashley Coles, Yekang Ko, & Alexandra Ponette-González

News media tells audiences which issues to think about and how to think about them. It can also elevate some voices and ideas over others, which allows the media to influence participatory and recognitional aspects of debates and public discourse. Since trees cannot speak for themselves, others speak for them. In this research, we analyze what people say about urban trees and who says it. We examined news media coverage of urban trees across 28 cities in four U.S. states, analyzing 1,246 quotes from 407 articles. We coded quotes by speaker type – public official, expert, or resident – and identified 13 first order and 12 second order quote themes. We found that public officials are the most quoted (56%), followed by experts (27.5%) and residents (16.5%). Over half the quotes refer to tree management actions (31.6%) and tree promotion (23.8%) followed by tree benefits (16.1%), threats to trees (12.4%), and community engagement (10.1%). These findings bring up questions about equitable representation in the public discourse on urban trees and whose priorities matter.

Option 2: Climate, Shade, and Remote-Sensing Methods

JOIN HERE: https://umd.zoom.us/my/dexter.locke

1:00 PM - 1:15 PM

Climate and urban form explain shade patterns in U.S. cities

V. Kelly Turner — University of California Los Angeles

Co-authors: V. Kelly Turner, Isaac Buo, Ariane Middel, & Jean Claude Iradukunda

Cities lack systematically measured shade data to guide heat planning, even though shade is more effective at reducing radiant heat load than like greening and high-albedo surfaces, interventions for which data is widespread. Here, we treat shade as a measurable environmental service shaped by land-systems characteristics, analogous to how land systems science treats NDVI or albedo. Drawing from a national-scale, 1m resolution shade analysis across 330+ U.S. cities, analyzed at the census block group scale at 12:00 h, 15:00 h, and 18:00 h, we find that climate sets the floor for shade by constraining vegetative potential, and urban form sets the ceiling through building shade that dominates late-day shade production. Shade disparities are greatest at noon, but equalize later in the day as building shade increases. These predictable, generalizable patterns position shade for integration into land systems models and heat planning frameworks alongside temperature-based metrics.

1:15 PM - 1:30 PM

Surviving in a Desert City: A Longitudinal Street Tree Survivorship Analysis for Phoenix, Arizona Using Google Street View

Mahin Rahman — Arizona State University

Co-authors: Mahin Rahman, Aidan Caron, & Sara Meerow

Urban tree survival determines whether cities realize the environmental and social benefits expected from urban forestry investments, yet empirical information on street tree survivorship in hot, arid cities remains limited. This study examines the long-term survivability of street trees in Phoenix, Arizona, and

evaluates how tree characteristics, initial condition, taxonomy, and planting context are associated with survival. We integrate a 2011 tree inventory containing 27,919 records of street. A random sample of 261 street trees is evaluated using a longitudinal image-interpretation approach in which historical Google Street View and aerial imagery were used to establish the last date each tree could be observed alive and, in cases where trees died, the first date it is observed dead or removed. This approach provides an empirical framework for reconstructing individual-tree survival histories when repeated field inventories are unavailable or incomplete. Of the 261 sampled trees, the survival status of 251 trees is determined over a median follow-up period of 15.3 years. Cumulative survival from baseline to follow-up is 43.82%, corresponding to an estimated annual survival rate of 94.74% (95% CI: 93.83–95.53%). Estimated cumulative survival is evaluated by two methods, the constant hazard assumption and the Kaplan-Meier estimate, both of which yield similar results. Survival also varies across functional tree classes, genus, and site types, suggesting that both biological characteristics and planting context influence long-term tree persistence. Differences in survivorship among these groups highlight the importance of considering taxonomic and site-level characteristics when evaluating urban tree performance. This study demonstrates substantial long-term attrition of Phoenix street trees, potentially challenging the city's ambitious shade and greening goals, while showing that historical street-level imagery can reconstruct survival trajectories and inform species selection, planting decisions, and long-term urban forest management.

1:30 PM - 1:45 PM

Drones in the City: A case study of American elms in the urban landscape

Chris Copeland — University of Massachusetts Amherst

Co-authors: Chris Copeland & Rick Harper

American elm (Ulmus americana) is an important cultural and historic symbol of the North American landscape. However, with the initial introduction of Dutch elm disease (Ophiostoma ulmi) to the United States in the late 1920's, American elm populations have experienced a precipitous decline. The absence of this tree created a gap in riparian areas of native forests and resulted in a substantial

reduction in urban tree canopy throughout the United States and Canada. The American elms that remain in our urban forests are often in managed-decline or require monitoring for ongoing tolerance to Dutch elm disease. Urban forests may be monitored and supported with the implementation and maintenance of an accurate community tree inventory. However, urban tree inventories feature barriers to implementation including resources (i.e. labour, time, and finances), competing priorities, and gaps in knowledge. The objectives of this case study were to investigate the feasibility of structure-from-motion (SfM) approaches to measure tree height and trunk diameter (1) with oblique RGB imagery, (2) with and without GCP, and (3) during leaf-off and leaf-on conditions. This case study highlights the applicability and accuracy of Unoccupied Aerial Systems and Structure-from-Motion methods when collecting important urban tree inventory parameters, and presents an accessible, reliable, and replicable workflow for urban forestry practitioners.

1:45 PM - 2:00 PM

Mapping the desert urban forest at 0.3m spatial resolution

Insoo Kim — Arizona State University, School of Geographical Sciences and Urban Planning

Co-authors: Insoo Kim, Heather Baier, Daoqin Tong, & Kelli Larson

In arid desert cities, such as Phoenix, Arizona, urban forests and urban greening play a critical role in mitigating urban heat, improving environmental quality, and supporting residents' well-being. However, urban tree planting and management must be planned carefully under constrained water resources and limited resources. Fine-resolution maps of existing vegetation are therefore essential for data-driven spatial planning for urban forestry and climate adaptation. However, existing land cover maps are often outdated or too coarse to distinguish trees, shrubs, grass, and other urban land cover features at fine scales. Therefore, this study has developed a deep learning approach to produce a 0.3 m land cover map for the City of Phoenix by integrating 2023 National Agriculture Imagery Program (NAIP) imagery, NAIP-derived Normalized Difference Vegetation Index (NDVI), and a Canopy Height Model (CHM) derived from 2020-2021 Light Detection and Ranging (LiDAR). Based on the U-Net Swin-v2-Base architecture with SatlasPretrain aerial pre-trained weights, the model achieved 83.5%

classification accuracy, measured by a mean Intersection over Union, across seven land cover classes: tree (91.7%), grass (89.9%), shrub (37.2%), soil (90.6%), building (95.2%), asphalt (92.2%), and water (87.3%). The resulting high-resolution land cover map provides a detailed baseline for assessing Phoenix's urban forest and broader green infrastructure system, with high accuracy rates for trees and grass but lower accuracy for shrubs. Nevertheless, the produced maps can support further research to monitor urban vegetation change, evaluate heat-mitigation benefits, and develop spatial optimization models for efficient vegetation planning in desert regions. The proposed deep learning workflow can also be adapted to other regions to support urban forestry, green infrastructure assessment, and climate adaptation research.

DAY 2 – Tuesday, October 6th, 2026

Welcome: 10:00 AM - 10:10 AM EST

MORNING SESSIONS

Session 1: Tree Health, Survival, & Monitoring Methods

JOIN HERE: https://umd.zoom.us/my/dexter.locke

10:10 AM - 10:25 AM

A review and comparison of survival analysis techniques for urban forest monitoring data

Aidan Caron — Clark University

Survivorship is a fundamental indicator of whether urban trees are realizing their full potential to provide ecosystem services. Quantifying tree longevity depends not only on reliable inventory data, but on statistical methods capable of translating such data into guidance for urban forest managers. Yet, the array of existing survival analysis methods, combined with wide variation in how tree inventories are structured, makes it difficult for researchers and practitioners to know which techniques fit their data. This talk offers a comprehensive introduction to survival analysis for urban forestry, covering (1) three structural characteristics of inventory design, (2) the dominant descriptive and inferential approaches to quantifying tree survival, and (3) a decision framework for matching inventory data to appropriate survival analysis methods. We demonstrate this framework using inventory data from Massachusetts cities participating in the Greening the Gateway Cities planting program, showing how survival analysis can inform species selection and management practices.

10:25 AM - 10:40 AM

Environmental and built-environment drivers of resilience and survival in urban street trees in Athens, OH

Priyanwada Atapattu — Ohio University

Co-authors: Priyanwada Atapattu & Glenn Matlack

Urban street trees experience chronic stress from compacted soils, limited rooting space, and surrounding built infrastructure, yet the drivers of long-term resilience remain poorly understood. This study examined how soil microsite conditions and built-environment characteristics influence street tree survival over three decades in Athens, Ohio. Trees were inventoried in 1991, resurveyed in 2014, and comprehensively remeasured in 2024/25 across three neighbourhoods. Environmental variables measured in 2024/25 included soil moisture, soil compaction, soil pit area, distances to pavements and buildings, nearby building height, and tree orientation relative to structures. Tree survival in 2024/25 (alive/dead) was analysed using multiple logistic regression models, with DBH included as a covariate to control for tree size. Separate global models were developed for soil and built-environment predictors, followed by species-specific models for the four most abundant species. Across all trees, survival increased strongly with DBH, indicating greater resilience of larger individuals. In the soil model, higher soil moisture significantly increased survival probability, whereas soil compaction showed a weak effect. In the built-environment model, survival was higher for trees located farther from pavements and buildings and in areas with taller surrounding structures. Species-specific analyses revealed distinct adaptive responses, *Acer saccharinum* benefited from wetter soils, *Cornus florida* showed reduced survival with higher compaction and proximity to buildings, while Acer saccharum and Liquidambar styraciflua were primarily influenced by tree size. These findings highlight species-specific resilience shaped by interactions between tree size, soil conditions, and urban form, with implications for improving long-term urban tree management.

10:40 AM - 10:55 AM

Developing an ensemble of models to attribute effects of tree canopy on four health outcomes at the US census tract scale

Kanaan C. Hardaway — Purdue University

Co-authors: Kanaan C. Hardaway, Brady S. Hardiman, & Daniel G. Aliaga

The environment in which one lives influences one’s health. In cities, large portions of the environment are subject to human design, and these designs can

exacerbate harmful environmental conditions, such as temperature and air quality. A lot of work has been done showing how the biophysical characteristics shaped by these designs connect to temperature and air quality in cities. There is also a good amount of research connecting these harmful conditions to poor health outcomes. In this project, we identified an ensemble of models for measuring how these urban biophysical characteristics influence health outcomes directly and indirectly through effects on temperature and air quality across 330 United States (US) cities to construct health models for those cities. We specified a structural equation model using urban biophysical characteristics, air temperature, fine particulate matter, health outcomes, and some socioeconomic variables to control. We grouped the census tracts of the 330 cities by a mix of geographic and tract characteristics to identify what group a tract was best modelled in according to model fit and explanatory power. Using these methods, acceptable models were produced for over 97% of tracts. We present the results across six climate zones in the US—Southeast, East Central, Northeast, Western Mountains, Southwest, and West Coast. The control variables of income, age, race, and population density had the most influence in each climate zone. Tract temperature (AT) and fine particulate matter (PM2.5) were the next most important. AT was consistently associated with bad outcomes for coronary heart disease (CHD) and stroke across the West US and the Northeast Zone; it decreased asthma in the Southeast Zone. PM2.5 had particularly bad effects on asthma, CHD, and stroke in the Western Mountains Zone. Tree canopy showed beneficial impacts in the West US and uncertain or negative impacts in the East US. Impervious surface area generally was associated with better health outcomes, when it had a discernible effect. These broadscale results support understanding of the impact of human design in cities on human health. As integrated into the Urban Tree Resilience Environmental Effort (UTREE) platform, the analysis here forms the foundation of a tool enabling urban foresters and other practitioners to understand the impacts of trees on health across the US.

10:55 AM - 11:10 AM

Resident preferences for urban tree characteristics on public and private property in four US cities

Ashley Coles — Texas Christian University

Co-authors: Ashley Coles, Matthew Fry, Jun Hak Lee, Alexandra Ponette-González, & Yekang Ko

In order to facilitate program success and promote not only distributional justice, but also procedural and recognition justice, urban forestry programs should consider residents' preferences when deciding where and what types of trees to plant. This study surveyed residents of four US cities regarding their tree-related preferences and willingness to participate in urban forestry programs. Survey participants in Arlington, TX, Corvallis, OR, Eugene, OR, and Salt Lake City, UT rated the importance of tree benefits and characteristics for trees planted on public and private property. Factors associated with ecosystem services (e.g., air pollution filtration, shade) rated consistently high, while other characteristics more linked to personal preferences (e.g., flowering, tall or short height) showed greater variation. Some benefits and characteristics received higher ratings depending on whether the trees were planted on public or private property. While most respondents indicated they would be likely to participate in private tree planting initiatives, low awareness of their respective city's urban forestry program and other factors such as limited plantable area, maintenance concerns, and potential infrastructure damage remain significant barriers.

Session 2: Stewardship, Policy, and Public-Facing Tools

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11:25 AM - 11:40 AM

Stewardship Capacity, Tree Health Condition, and Localized Stories of Spatial Inequity

Natalia Piland — Center for Environment, Community, & Equity, American University

Co-authors: Natalia C. Piland and Tatjana Washington

Using existing datasets on D.C. street tree health condition and other tree data (McCoy et al. 2022), socioeconomic variables, and stewardship capacity and activities (Gearin et al. 2025), we explore potential relationships between variables and their spatial distribution. After characterizing these, we employ qualitative methods to reflect on the results with people who live in these neighborhoods. (By October, we will likely not have all results, but would like to present what we have and hear reactions from Trees in the City community members).

11:40 AM - 11:55 AM

Post-planting stewardship models can impact crown vigor in urban tree planting programs

Hannah Cooper — University of Maryland Department of Environmental Science and Technology

Co-authors: Hannah Cooper, Mitch Pavao-Zuckerman, & Nancy Sonti

Over the last several decades, urban tree management initiatives have sprouted in many major cities worldwide to increase tree canopy cover. These initiatives primarily focus on planting trees yet fail to incorporate long-term stewardship plans to ensure tree establishment and health. Stewardship (e.g., watering, mulching, identifying and treating disease) is critical to the health and survival of trees, particularly in urban environments that face additional stressors on establishment. Each initiative takes its own approach, or management model, to providing post-planting stewardship. This can range from simply providing

nursery trees to residents to providing comprehensive maintenance and resident education aligned with best practices of tree stewardship. Importantly, these management models vary both in how much is being done (i.e. what stewardship practices occur) and who is doing the work (i.e. the organization or residents). This study focused on two organizations in the Washington, D.C. metropolitan area and assessed the effectiveness of their management models on maintaining tree health through the establishment phase. One management model incorporates professional and homeowner stewardship (DDOT) and the other relies solely on homeowners to provide stewardship (TreeMontgomery). We evaluated a subsample of Celtis occidentalis (hackberry) and Amelanchier spp. (serviceberry) street trees planted between 2021-2024 from each group. We quantified both tree health and ecophysiology using visual observations and quantitative field and laboratory analyses. Crown vigor was scored as a combined metric of fine twig dieback, leaf discoloration, and leaf defoliation, following the Healthy Trees Healthy Cities protocol. Amelanchier spp. had higher overall crown vigor for TreeMontgomery (M = 4.30, SE = 0.19) than for DDOT(M = 3.52, SE = 0.19) (p = 0.0046), while C. occidentalis had similar crown vigor across management models (TreeMontgomery: M = 3.83, SE = 0.18; DDOT: M = 3.97, SE =0.17) (p = 0.079). The difference in crown vigor between species was not significant for either management model (TreeMontgomery: p = 0.08; DDOT: p = 0.079). These preliminary results suggest that the impact of management models on tree health during the establishment phase may be species-dependent, and that homeowner stewardship may be sufficient to support tree health.

11:55 AM - 12:10 PM

When a Tree Is Removed… What Happens Next?

Aline OTS Kuzma — University of Florida

Urban tree removal is an inevitable consequence of development, making tree mitigation policies one of the most widely used regulatory tools for protecting urban forests. Despite their widespread adoption, mitigation requirements vary considerably among jurisdictions. This presentation summarizes some mitigation-based tree protection policies adopted by local and county governments across the United States (n = 162). The analysis focuses on jurisdictions requiring mitigation beyond a simple one-for-one tree replacement

and compares how communities calculate replacement requirements using diameter at breast height (DBH), caliper inches, tree numbers, canopy area, or combinations of these approaches. The presentation also examines alternative mitigation mechanisms, including fee-in-lieu programs and tree banks, as well as policy provisions governing species selection, protections for significant trees, on-site versus off-site replacement, planting timelines, performance bonds, and post-planting monitoring. Beyond documenting policy variation, this presentation highlights emerging trends in urban tree mitigation and discusses their implications for urban forest governance. Participants will gain a broader understanding of the diverse approaches currently used across the United States, examples of innovative policy provisions, and practical considerations for evaluating or strengthening local mitigation ordinances. By comparing policy design across jurisdictions, this presentation aims to support municipal arborists, urban foresters, planners, policymakers, and researchers seeking more consistent, effective, and life-cycle-oriented approaches to urban tree protection and replacement.

12:10 PM - 12:25 PM

Urban Tree Inventory Interfaces: Marketing Tools for Engaging the Public

Emma Castiblanco — University of Utah (School of Environment, Society & Sustainability)

Co-authors: Emma Castiblanco and Matthew Fry

Despite being warned against “simply succumb[ing] to the glamour of having a computerized inventory” (Ziesemer, 1978), most cities now rely on digital tree inventories (Ma et al., 2021). After Esri released ArcGIS Online in 2012, digital tree inventories became widely available through online webpages as interactive interfaces. Many of these online inventories are created, designed and managed by private companies through contracts with municipalities. Digital urban forestry companies offer services to inventory trees and publish the interfaces, positioning their products as mechanisms for improving outreach and providing information to the public. As more cities adopt publicly-facing inventories, researchers should “consider the implications of cartographic representation (scale, colour, size, and shape) and user interface design to diversify public engagement more evenly

across the urban forest” (Atchinson et al. 2023, p 111) and determine if these sites are merely functioning as marketing tools. In this study, we use critical mapping (Kelly, 2023), discourse analysis, and feminist data studies to examine the content (spatial data), form (map design), and process (mapping workflows and mapmakers) of tree inventory interfaces associated with Esri, Davey Trees and PlanItGeo. Our findings demonstrate that the three companies broadly display similar content, like each tree’s spatial coordinates and species, with only minor differences in form. Moreover, we showcase how the decisions that underpin the creation of iconography, display information, and color choice for urban forestry inventory interfaces can impact their function as tools for public engagement.

AFTERNOON SESSIONS (CONCURRENT)

Option 1: Climate Change, Heat, and Urban Shade

JOIN HERE: https://umd.zoom.us/my/dexter.locke

1:00 PM - 1:15 PM

Climate change and Urban Trees: Findings from a Global Literature Review

Jacob Cecala — ORISE (US Forest Service-PSW)

Co-authors: Jacob Cecala, Lara Roman, & Natalie van Doorn

Urban forests are vital socio-ecological systems that provide numerous ecosystem services, serving as effective tools for adapting cities to climate change. However, globally urban forests are themselves increasingly threatened by shifting climate conditions. On top of urban-related stressors, urban forests are subjected to temperature fluctuations, altered precipitation regimes, and more frequent extreme weather events, resulting in economic strain and managerial challenges. Research on urban forest climate vulnerability remains fragmented due to diverse conceptual frameworks and methodological approaches, and limited geographic scope, in addition to the multidimensional, interdisciplinary nature of the topic. We conducted a systematic review analyzing 177 primary research articles published between 1993 and 2025, focusing on how climate vulnerability is conceptualized and methodologically estimated in urban forest research. We evaluate the application of the three components of climate vulnerability—exposure, sensitivity, and adaptive capacity—and identify six categories of methodological approaches used in studies: (1) climate niche-based approaches; (2) extreme weather event surveys; (3) practitioner perspectives and policy reviews; (4) dendrochronology; (5) phenological monitoring; and (6) in situ physiology. Our review reveals that climate exposure and sensitivity are frequently addressed. However, adaptive capacity is simultaneously the most neglected and least standardized component, often omitted due to quantification challenges or conflation with sensitivity. Methodologically, in situ physiology and dendrochronology were the most prevalent approaches, while multiple approaches were rarely combined within one study. We identify significant

research biases, with most research focusing on single cities and largely underrepresenting urban areas in the Global South. We conclude that future research would benefit from employing more interdisciplinary, multi-approach research that analyze both biophysical and institutional dimensions of urban forest climate vulnerability. Existing literature emphasizes the need for proactive, climate-adaptive management—including strategic diversification of species palettes, improved urban infrastructure, and multi-sector cooperation—to support long-term resilience of urban forests against climate change. Key priorities for the field include understanding intraspecific variation in climate vulnerability, expanding research to understudied geographic regions, and integrating social, economic, and management variables in studies.

1:15 PM - 1:30 PM

Quantifying Drought Impacts on Urban Forest Structure and Growth Using Multi-Temporal Airborne Lidar

Amy Dixon — University of California, Santa Barbara

Co-authors: Amy Dixon, Dar Roberts, Michael Alonzo, & Joe McFadden

Urban forests play a vital role in city life by providing ecosystem services such as heat mitigation, air pollutant removal, and stormwater retention. Climate change is expected to increase the frequency and intensity of extreme climate conditions such as the historic megadrought California experienced in 2011-2017. These events pose a serious risk to urban forest health, tree structure, and canopy coverage which can lead to significant reductions in the benefits provided. Airborne light detecting and ranging (lidar) data is a powerful tool that can map the 3-dimensional structure of individual tree canopies across cities. However, the use of lidar for monitoring and change detection is greatly limited by data availability as collection can be infrequent and costly. This study took advantage of lidar datasets collected over Santa Barbara, California, in 2010 and 2018, capturing pre- and post-drought urban forest conditions. Individual tree crowns were segmented and integrated with existing species classification data, tree inventories, and land-cover/land-use data. Tree crowns were paired between the time points (n = 73,905), and structural metrics such as tree height and crown area were calculated for both years. Allometric growth equations from the Urban Tree Database were used to estimate expected growth for each tree to

understand how the drought may have impacted species-specific growth. Tree loss was identified as a tree crown in 2010 that had no corresponding 2018 crown and a height less than 1m. Preliminary results show that despite the historic drought conditions, the urban forest grew with the average height increasing from 7.98m to 8.53m in 2010 and 2018, respectively. However, when compared to the allometric growth models, observed tree heights were on average 1.8m shorter than the expected heights which could indicate drought-related reductions in growth rates. Trees in taller height classes, relative to each species group, were more likely to have decreased in height between the two time points, while shorter trees had higher rates of absolute growth. Tree loss was greater among shorter and taller individuals, a pattern observed in other natural forest ecosystems.

1:30 PM - 1:45 PM

Potential Losses of Canopy and Ecosystem Services Associated with Insurance-Mandated Pruning in Florida, United States

Andrew Koeser — Davey Institute

In hurricane-prone regions, tree cover near buildings has become an increasing concern for homeowner insurance companies due to the potential for storm damage. Policies requiring the removal of trees located near or overhanging homes as a precondition for new coverage are not new to Florida, but they have become an increasingly common risk-mitigation strategy across the industry. Yet the cumulative, statewide consequences of these mandates for urban forests and the ecosystem services they provide remain poorly understood. This study uses visual canopy analysis to interpret 3,500 random points across Florida, assessing the potential impact of insurance-related tree-removal and pruning requirements on canopy coverage in developed areas statewide. Ecosystem service models are then applied to translate projected canopy loss into changes in air-pollutant removal, stormwater runoff mitigation, and carbon sequestration. By quantifying these tradeoffs, this research aims to inform public policy discussions and insurance industry practices, offering a data-driven perspective on the broader ecological and economic implications of large-scale, insurance-driven tree removal in developed landscapes.

1:45 PM - 2:00 PM

Perceived extreme heat risks and residential tree planting — understanding the adaptation gap in Phoenix Metro

Meer Ahsan Habib — School of Sustainability, ASU

Because of its location in the Sonoran Desert, Phoenix experiences a semi-arid climate characterized by very hot, dry summers, during which heat-related illnesses are common, with the greatest impact in neighborhoods with the highest temperatures and limited vegetation. Household-level adaptation to extreme heat in urban areas is shaped by knowledge of perceived heat risks, age, indoor temperature, subjective heat stress, and health impacts. A significant part of residential action for heat mitigation involves planned residential landscaping. The city of Phoenix has committed over $60 million over five years to expand tree canopies and build shade by 2030, including planting more than 27000 trees. Success heavily depends on residential tree planting, as 67% of the land is privately owned. We analyzed data from the 2021 Phoenix Area Social Survey (PASS) for 509 respondents across 12 neighborhoods in the Phoenix Metro to explore how perceptions of heat risk, income levels, and perceived benefits associated with trees are related to tree planting. We used descriptive statistics and nonparametric bivariate analyses to compare these factors between residents who planted trees and who did not. Results showed that residents who perceived greater benefits from trees (aesthetics, shade, and maintenance) were more likely to plant trees than those with higher incomes or higher perceptions of extreme heat risks. These results confirm findings from previous studies suggesting that residential tree planting in Phoenix is shaped by perceived personal benefits, rather than heat risk perceptions or income. Future work will examine the structural barriers and cognitive-behavioral factors that explain why perceived extreme-heat risk is not translated into tree planting as an adaptation strategy, despite recognition of that risk.

Option 2: Community Perspectives and Private Tree Stewardship

JOIN HERE https://utoronto.zoom.us/j/87280280088

1:00 PM - 1:15 PM

The Effects of Religious Beliefs on Canopy Cover

Alexander Martin — University of Oxford

Co-authors: Jacob Cecala, Lara Roman, & Natalie van Doorn

The Hutterites, like the Mennonites and Amish, are a communal Anabaptist population distributed across the Canadian Prairies and US Great Plains. Religion heavily influences the management of landscapes surrounding houses in Hutterite colonies, with some colonies surrounded by gravel or bare dirt while others have developed large gardens and planted ornamental trees and shrubs around houses. Distinctions between colonies is purported to exist based on the Hutterite kinships: the Schmiedeleut colonies have manicured lawns, flower gardens, and shade trees while the more conservative Dariusleut colonies have no flower beds or lawns at all, or some limited landscaping including shrubs and trees. The intermediary Lehrerleut colonies have functional shelterbelts and small areas of greenspace surrounding residential buildings. Building upon ethnographic work in these communities, this work quantifies canopy cover and examine the spatial distribution and composition of trees within Hutterite colonies. Canopy cover varies both by ecological regions and by kinships, both in the overall canopy cover and the aesthetic use of trees around built infrastructure. Higher levels of canopy cover occurring more frequently in Schmiedeleut colonies, consistent with earlier studies. This presentation contributes to broader discussions of how ethnocultural values shape landscape practices and environmental modification, providing one of few studies on religion's impacts on urban greening.

1:15 PM - 1:30 PM

Perceptions of trees, species diversity, and socio-demographics shape individuals' private tree maintenance activities

Luke Beattie — University of Alberta

Co-authors: Luke Beattie, Greg King, & Glen Hvenegaard

Trees on private residential property constitute a large portion of urban canopy cover, and residents' behaviours contribute to the structure and health of the urban forest. Little research addresses city residents' tree maintenance behaviours despite their importance for tree health, the delivery of ecosystem services, and the mitigation of ecosystem disservices. Using survey data from Camrose, Alberta, Canada, we identify factors associated with residents' tree maintenance activities. Results indicated that in 2024, 79% of residents pruned their trees, 68% watered, 33% fertilized, 18% mulched, and 8% applied pesticides. Residents spent an average of 14 hours and $164 CAD on tree maintenance annually. The vast majority (90%) of residents undertook maintenance themselves, with only 10% hiring a tree care company. Residents often practiced activities with one another; for example, watering was correlated with fertilizing, pruning, and mulching; while applying pesticides was only correlated with fertilizing. Descriptive modelling showed that positive perceptions of trees were associated with pruning, hiring a tree care company, and the total number of activities undertaken. Greater parcel-level tree diversity was associated with pruning, watering, fertilizing, and total activity. Older residents were more likely to water, fertilize, hire a tree care company, and undertake more maintenance activities. To promote private tree maintenance, information resources should be developed and distributed in areas with low parcel-level tree diversity to younger homeowners. These resources could be aimed at increasing overall maintenance activity, or be targeted to raise awareness of and improve the outcomes of specific activities.

1:30 PM - 1:45 PM

Urban Tree Planting Perspectives Among Landlords, Commercial Property Owners, and Owner-Occupied Homeowners: A Case Study in Worcester, Massachusetts

Robert Moore — Clark University

Co-authors: Robert Moore, Deborah Martin, Aidan Caron, & John Rogan

Tree planting initiatives are a common urban greening strategy that can be promoted or constrained by public engagement and perceptions. Because land available for tree planting is largely on private property, landowner awareness of

and willingness to participate in tree planting can severely limit the effectiveness of urban greening strategies. Thus, limited awareness of or opposition to tree planting programs may exacerbate issues associated with low tree abundance (e.g. urban heat island, poorer air quality, and greater stormwater runoff). We investigate urban landowner perspectives and knowledge surrounding local tree planting initiatives through an interview analysis case study of landowners in Worcester, Massachusetts. We conducted 31 semi-structured interviews between residential landlords, commercial property owners, and owner-occupied homeowners. Responses were coded and organized into themes exploring perceptions surrounding local greening initiatives. Results revealed a limited awareness of local tree planting programs. Secondly, although nearly all recognized the benefit of having trees, property owners found maintenance, property damage, and costs associated with trees as the primary concern and thus limiting motivation to plant new trees. Our findings suggest that characterizing the processes that shape people's motivations for tree planting may be key for city planners and policy makers in creating solutions to promote said motivation.

1:45 PM - 2:00 PM

Moving toward sustainable urban landscapes: Assessing and optimizing urban vegetation change in Central Arizona

Qinnan Zhu — Arizona State University

Co-authors: Qinnan Zhu, Daoqin Tong, Kelli Larson, Ariane Middel, & Amy Frazier

Land cover and management practices through urban greening have been widely promoted to enhance landscape sustainability by maximizing ecosystem services, reducing disservices, and supporting long-term human well-being. Urban greening, however, continues to encounter challenges. Many greening programs focus on a single environmental objective while ignoring critical ecosystem service trade-offs (e.g., water conservation vs. heat mitigation) and unintended consequences. Municipal greening efforts also frequently prioritize environmental goals over social constraints and outcomes, and few incorporate fine-scale strategies to determine where greening or landscape changes should occur. To address these gaps, this study develops innovative spatial optimization

models to design urban vegetation distributions that balance the trade-offs between vegetative cooling performances and irrigation demands while addressing greening equity. By embedding different socio-ecological priorities into objective functions and constraints, the models can generate solutions that maximize overall benefits. In particular, two separate spatial optimization models are constructed: one to evaluate current vegetation distribution, and the other to identify optimal locations for future greening and landscape changes.

Our results show that the existing vegetation distribution is less effective than the optimized configuration in balancing cooling benefits and water conservation. To enhance cooling benefits while limiting irrigation costs, new greening investments should prioritize neighborhoods with high population density, lower socioeconomic status, and access to reclaimed water. Scenario analyses further show that increasing citywide canopy targets yields additional cooling benefits, but these gains become relatively modest compared with the substantial increase in irrigation costs, indicating that more ambitious greening goals may not necessarily translate into more efficient outcomes. Overall, our spatial optimization framework provides a practical guide for long-term urban greening planning by supporting more balanced, efficient, and context-based decision-making.